ANTI-SIGLEC-9 ANTIBODIES AND METHODS OF USE THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 62/248,231, filed October 29, 2015, which is hereby incorporated by reference in its entirety.

SUBMISSION OF SEQUENCE LISTING ON ASCII TEXT FILE

[0002] The content of the following submission on ASCII text file is incorporated herein by reference in its entirety: a computer readable form (CRF) of the Sequence Listing (file name: 735022001040SEQLISTING.TXT, date recorded: October 28, 2016, size: 197 KB).

FIELD OF THE INVENTION

[0003] This present disclosure relates to anti-Siglec-9 antibodies and therapeutic uses of such antibodies.

BACKGROUND OF THE INVENTION

[0004] Sialic acid-binding Ig-like lectin-9 (Siglec-9), is a type 1, immunoglobulin-like, transmembrane protein expressed on immune and hematopoietic cells, including immature and mature myeloid cells, such as monocytes, macrophages, dendritic cells, neutrophils, and microglial cells, as well as lymphoid cells, such as natural killer cells, and subsets of T cells (Crocker et al. (2007) Nat Rev Immunol. 7:255–266; O'Reilly and Paulson (2009) Trends in Pharm. Sci. 30:5:240-248; and Macauley et al. (2014) Nat. Rev. Imm. 14: 653-666). Siglec-9 is a member of the Siglec family of lectins that bind sialic acid residues of glycoproteins and glycolipids. One potential binding target for Siglec proteins is gangliosides; that is, glycolipids that consist of a ceramide linked to a sialylated glycan. Most gangliosides share a common lacto-ceramide core and one or more sialic acid residues. Diversity in the Siglec ligands is generated by the addition of other neutral sugars and sialic acid in different linkages, either branched or terminal, and modification of sialic acid itself.

[0005] Fourteen Siglec proteins have been identified in humans and nine in mice that are comprised of 2-17 extracellular Ig domains including an amino-terminal V-set domain that contains the sialic acid-binding site. The sialic acid-binding region is located on the V-set Ig-like domain, which contains a two aromatic residues and one arginine motif highly conserved in all Siglecs (Crocker et al. (2007) Nat Rev Immunol. 7:255–266; McMillan and Crocker (2008) Carbohydr Res. 343:2050–2056; Von Gunten and Bochner (2008) Ann NY Acad Sci. 1143:61–82; May et al. (1998) Mol Cell. 1:719–728; Crocker et al. (1999) Biochem J. 341:355–361; and Crocker and Varki (2001) Trends Immunol. 2:337–342). The binding sites to sialylated ligands have been mapped by crystal structures with and without ligand bound (Attrill et al., (2006) J. Biol. Chem.281 32774-32783;

Alphey et al. (2003) J. Biol. Chem. 278:5 3372-3377; Varki et al., Glycobiology, 16 pp. 1R–27R; and May et al. (1998) Mol. Cell 1:5:719-728). Since cell membranes are rich in sialic acids, ligand binding by Siglecs can occur in cis and in trans, both affecting their functional properties. Each Siglec has a distinct preference for binding the diverse types of sialylated glycans that are found on the surface of mammalian cells (Crocker et al. (2007) Nat Rev Immunol. 7:255–266; and Crocker et al. (2007) Nat Rev Immunol. 7:255–266). Most Siglec proteins, including Siglec-9, contain one or more immunoreceptor tyrosine-based inhibitory motif (ITIM) sequences in their cytoplasmic tails, which enable them as inhibitory receptors and negative regulators of immune functions through recruitment of the tyrosine phosphatases SHP1 and SHP2 (Crocker et al. (2007) Nat Rev Immunol. 7:255–266; McMillan and Crocker (2008) Carbohydr Res. 343:2050–2056; and Von Gunten and Bochner (2008) Ann NY Acad Sci. 1143:61–82). Certain Siglecs contain immunoreceptor tyrosine-based activating motif (ITAM) sequences in their cytoplasmic tails, which enable them to act as activating receptors and positive regulators of immune function through predicted recruitment of spleen tyrosine kinase (Syk) (Macauley SM. et al., (2014) *Nature Reviews Immunology* 14, 653–666). The Siglec protein family is associated with multiple human diseases including, autoimmunity, susceptibility to infection, multiple types of cancer including lymphoma, leukemia and acute myeloid leukemia, systemic lupus erythematosus, rheumatoid arthritis, neurodegenerative disorders, asthma, allergy, sepsis, chronic obstructive pulmonary disease, graft-versus-host disease, eosinophilia, and osteoporosis (Macauley SM. et al., (2014) *Nature Reviews Immunology* 14, 653–666).

[0006] Siglec-9 was cloned in 2000 from peripheral blood mononuclear cells (Angata and Varki (2000) J. Biol. Chem. 275:29: 22127-22135) and selective expression was detected on granulocytes and monocytes. An independent group isolated Siglec-9 from HL-60 (human promyelocytic leukemia) cells and demonstrated expression on monocytes, neutrophils, NK cells and a small subset of T cells (Zhang et al. (2000) J. Biol. Chem. 275:29 22121-22126).

[0007] Siglec-9 contains an extracellular N-terminal Ig-like (immunoglobulin-like) V-type domain, two Ig-like C2-set domains as well as two consensus ITIM motifs in its cytoplasmic domain. Expression of Siglec-9 in COS cells demonstrated sialic acid-dependent binding of red blood cells, which is mediated by terminal α2-3 or α2-6 sialic acid linkages (Angata and Varki (2000) J. Biol. Chem. 275: 22127-22135, Zhang et al. (2000) J. Biol. Chem. 275:29 22121-22126). It was further confirmed that Siglec-9 is masked by endogenous cellular sialic acids and binds to exogenous terminal α2-3 or α2-6 sialic acid probes only upon sialidase treatment of the cells (Yamaji (2002) J. Biol. Chem. 277:8 6324-6332). Ligand specificity within the N-terminal V-set Ig-like domain of Siglec-9 was mapped to a small region, Asn^{70}-Lys^{75}, by swapping Siglec-7 with Siglec-9 regions and vice versa. Acquisition of the respective Siglec ligand specificity within these amino acid residues supports the notion that ligand specificity is dictated by interactions in the variable C-C' loop (Yamaji

(2002) J. Biol. Chem. 277:8 6324-6332). Pathogens have apparently subverted the sialic acid as "self" system as it has been reported that group B *Streptococcus* can bind Siglec-9 on human neutrophils thereby reducing the immune response to the bacteria, which can either be pathogenic or commensal (Carlin et al (2009) Blood 113: 3333-3336). Other sources of *in vivo* Siglec-9 sialic acid ligands are tumor-secreted mucins, such as MUC1, MUC2, MUC16; Siglec-9 was shown to bind mucins from the sera of cancer patients (Ohta et al. (2010) Biochem. and Biophys. Res. Comm. 402: 663-669; Belisle et al. (2010) Mol. Cancer 9:118).

[0008] Siglec-9 undergoes phosphorylation of Tyr-433, and Tyr-456 by tyrosine kinases, likely c-Src or Lck, and functions as an inhibitory receptor (Avril et al., (2004) J. Imm. 173: 6841-6849). Following phosphorylation on the proximal Tyr-433 in the ITIM domain, Siglec-9 binds SHP-2/PTPN11 and SHP-1/PTPN6. The membrane distal ITIM motif does not appear to contribute significantly as mutation did not preclude tyrosine phosphorylation or inhibitory function of Siglec-9. Siglec-9 was shown to inhibit FcεRI-mediated activities in rat basophilic leukemia cells, which have been previously used to characterize an inhibitory receptor class expressed on NK cells called KIRs (Killer Ig-like receptors) (Avril et al., (2004) J. Imm. 173: 6841-6849). Phosphatase activity is additionally associated with decreased intracellular calcium mobilization, and decreased tyrosine phosphorylation on multiple proteins (Ulyanova, T., et al., (1999) *Eur J Immunol* 29, 3440-3449; Paul, S.P., et al., (2000). *Blood* 96, 483-490) as well as with blockade of signal transduction and immune response, in part, through dephosphorylation of signaling molecules on adjacent activating receptors, including those that contain ITAM motifs, pattern recognition receptors, Toll-like receptors and damage-associated molecular pattern (DAMP) receptors. It has been proposed that the association between ITIM-containing Siglec receptors and activating receptors may be mediated by extracellular ligands that bind and bridge these receptors (Macauley SM. et al., (2014) *Nature Reviews Immunology* 14, 653–666).

[0009] Some, but not all, Siglec ligands induce receptor downregulation (Macauley SM. et al., (2014) *Nature Reviews Immunology* 14, 653–666). Ligand-induced receptor degradation has been reported for tyrosine kinase receptors (Monsonego-Oran et al., (2002) Febs letters 528, 83-89; and Fasen et al., (2008) Cell & Molecular Biology 9. 251-266), as well as for steroid receptors (Callige et al., (2005) Mol. Cell. Biol. 25. 4349-4358; and Pollenz et al., (2006) Chemico-Biological Interactions. 164. 49-59). Siglec-9 is thought to be to constitutively recycled in acute myeloid leukemia (AML) cells and has been shown to mediate rapid endocytosis of an anti-Siglec-9 monoclonal antibody on these cells (Biedermann et al. (2007) Leuk. Res. 31:2:211-220). However, no decrease in cellular levels of Siglec-9 has been reported in either AML or normal primary immune cells. Likewise, no receptor recycling or antibody-dependent receptor down regulation has been reported in any type of primary cells. Expression of Siglec-9 on the cell surface is dependent in part

on the membrane proximal ITIM motif, but not the distal motif, according to mutational analysis performed in an overexpression system (Biedermann et al. (2007) Leuk. Res. 31:2:211-220).

[0010] Siglec-9 has been described as having immunomodulatory effects on cytokine production. Overexpression of Siglec-9 in a macrophage cell line and concomitant TLR stimulation has been shown to be associated with a decrease in production of proinflammatory cytokines TNF-alpha and IL-6, as well as upregulation of IL-10 (Ando et al. (2008) Biochem. And Biophys. Res. Comm. 369:878-883). It has also been shown that tumor-produced mucins bind to Siglec-9, as well as immature DCs (Ohta et al. (2010) Biochem. and Biophys. Res. Comm. 402: 663-669). In the presence of LPS and mucins, immature DCs produced less IL-12, but IL-10 production was maintained. This suggests that Siglec-9 skews cytokine production from pro-inflammatory to anti-inflammatory, thereby maintaining an immunological state of tolerance as opposed to clearance of offending pathogens, cancer, or other pathologies.

[0011] The inhibitory role of Siglec-9 has been further characterized in the function of natural killer cells and regulation of lymphoid cells, such as T cells and neutrophils (Crocker et al., (2012) Ann. N Y Acad. Sci. 1253, 102–111; Pillai et al., (2012) Annu. Rev. Immunol. 30, 357–392; von Gunten and Bochner (2008) Ann. N Y Acad. Sci. 1143, 61–82; Jandus et al. (2014) J. Clin. Invest. 124(4) 1810-1820; Ikehara et al. (2004) J. Biol. Chem. 279:41 43117-43125; and von Gunten et al. (2005) Blood 106(4) 1423-1431). Functional studies in natural killer cells have demonstrated that tumor cells expressing Siglec-9 binding sialic acid ligands inhibit NK cell activation and tumor cell killing. Many human tumors robustly upregulate sialic acid ligands that bind Siglec-9, which enables immune evasion and cancer progression (Jandus et al. (2014) J. Clinic. Invest. 124:4: 1810-1820). It is thought that sialic acid upregulation on tumors facilitates a state of "super self" that strongly inhibits natural killer cell immunosurveillance (Macauley and Paulson (2014) Nat. Chem. Biol. 10:1: 7-8). In lymphoid lineage cells, Siglec-9 has been shown to negatively regulate T cell receptor signaling via ITIM tyrosine phosphorylation and SHP-1 binding. Downstream TCR signaling molecules ZAP-70 showed reduced phosphorylation on Tyr^{319} and decreased NFAT transcriptional activity. The inhibitory effects of Siglec-9 on TCR signaling were reduced upon mutation of a conserved Arg residue in the sialic acid ligand-binding domain (Ikehara et al. (2004) J. Biol. Chem. 279:41 43117-43125). In neutrophils, Siglec-9 engagement mediates cell death via apoptotic and non-apoptotic mechanisms. Neutrophils derived from non-diseased or rheumatoid arthritis and acute septic shock patients underwent Siglec-9 dependent death, demonstrated by antibody crosslinking. Septic or RA-patient-derived neutrophils demonstrated significantly more cell death upon Siglec-9 ligation; this increase could be mimicked by short term pre-incubation with pro-inflammatory cytokines, suggesting that inflammation leads to priming of the Siglec-9 death pathway (Belisle et al. (2010) Mol. Cancer 9:118).

[0012] The murine homolog of Siglec-9 is Siglec-E, which is 53% similar. Siglec-E was shown to bind human red blood cells in a sialic acid dependent manner, and functionally like Siglec-9, recruits SHP-1 and SHP-2 via ITIMs to mediate inhibitory signaling in immune cells (Yu et al Biochem. J. (2001) 353, 483–492). In mice, genetic inactivation of Siglec-E does not lead to obvious developmental, histological, or behavioral abnormalities; and Siglec-E-deficient mice breed normally, indicating that Siglec-E is not an essential gene and that its function may be limited to innate immunity (McMillan et al. (2013) Blood 121:11: 2084-2094). Upon challenge of Siglec-E deficient mice with aerosol LPS, increased neutrophil recruitment in the lung was demonstrated, which could be reversed by blockade of the β2-integrin CD11b. The Siglec-E deficient neutrophils were shown to have increased phosphorylation of Syk and p38 MAPK in a CD11b-dependent manner. This suggests that Siglec-E functions to suppress neutrophil recruitment in a model of acute lung inflammation (McMillan et al. (2013) Blood 121:11: 2084-2094). In a syngeneic cancer model, neutrophils from Siglec-E deficient mice enhanced tumor cell killing *ex vivo* and demonstrated increased ROS production and apoptosis inducing ligands such as TRAIL and FasL (Laubli et al (2014) PNAS 111 (39) 14211–14216).

[0013] In oncology, Siglec-9 has been suggested as a therapeutic target for acute myeloid leukemia as it is expressed on primary AML cells, yet absent from progenitors on numerous patient bone marrow samples (Biedermann et al. (2007) Leuk. Res. 31:2:211-220). In solid cancers, epithelial tumor cells produce heavily glycosylated mucins that bind Siglec-9, suggesting that blocking the increased ligand interactions would be therapeutically beneficial (Ohta et al. (2010) Biochem. and Biophys. Res. Comm. 402: 663-669; Belisle et al. (2010) Mol. Cancer 9:118). Furthermore, robust expression of Siglec-9 ligands and tumor infiltrating Siglec-9^+ immune cells were found in histological sections of colorectal, breast, ovarian, non-small lung cell, and prostate cancer (Laubli et al (2014) PNAS 111 (39) 14211–14216). A naturally occurring Siglec-9 K131Q (A391C) polymorphism (rs16988910) that reduces sialyl ligand binding was found to significantly improve early survival (<2 years) in non-small-cell lung cancer patients, though the effect was lost after 2 years (Laubli et al (2014) PNAS 111 (39) 14211–14216).

[0014] It has recently been proposed that sialylglycoproteins expressed on cancer cells transduce 'activation' signals into tumor cells via Siglec-9 binding, resulting in degradation of Focal adhesion kinase (FAK) and increased cell motility and invasion (Sabit et al. (2013) J. Biol. Chem. 288(49): 35417-35427). These results suggest that Siglec-9-sialyl ligand interactions not only contribute to inhibitory effects on numerous cell types of the immune system, but could also enhance tumor metastasis via direct effects on cancer cells.

[0015] Antibodies to Siglec-9 have been described in, for example, WO2007049044, US8394382, EP1954318, and US20130302317. However, no antibodies that decrease the cellular

levels of Siglec-9 or that disrupt the interactions between Siglec-9 and one or more of its ligands have been reported.

[0016] Accordingly, there is a need for therapeutic antibodies that specifically bind Siglec-9 and reduce Siglec-9 expression on the cell surface, reduce interactions between Siglec-9 and one or more Siglec-9 ligands, and/or reduce one or more Siglec-9 activities in order to treat one or more diseases, disorders, and conditions associated with undesired Siglec-9 activity.

[0017] All references cited herein, including patents, patent applications and publications, are hereby incorporated by reference in their entirety.

SUMMARY

[0017a] In one aspect, the present disclosure refers to an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody decreases cell surface levels of Siglec-9, as determined by a fluorescence-activated cell sorting (FACS) assay using a threshold value of 21% or higher reduction of Siglec-9 cell surface levels to indicate a decrease, and does not inhibit interaction between Siglec-9 and sialic acid-containing glycoproteins, as determined by a FACS assay using a threshold value of 80% or higher Siglec-9-Fc binding to U937 cells to indicate non-inhibition.

[0017b] Disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues selected from the group consisting of:

i. amino acid residues185-194 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 185-194 of SEQ ID NO: 1;
ii. amino acid residues 86-96 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 of SEQ ID NO: 1;
iii. amino acid residues 86-96 and 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 and 105-116 of SEQ ID NO: 1;
iv. amino acid residues 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 105-116 of SEQ ID NO: 1; and
v. amino acid residues 107-115 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 107-115 of SEQ ID NO: 1.

[0017c] Disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody competes with one or more antibodies selected from the group consisting of 2D4, 5B1, 6B2, 6D8, 7H12, and any combination thereof for binding to Siglec-9.

[0017d] Disclosed is an isolated anti-Siglec-9 antibody which binds essentially the same Siglec-9 epitope as a monoclonal antibody selected from the group consisting of: 2D4, 5B1, 6B2, 6D8, and 7H12.

[0017e] In yet another aspect, the present disclosure refers to an isolated nucleic acid comprising a nucleic acid sequence encoding the anti-Siglec-9 antibody disclosed herein.

[0017f] In yet another aspect, the present disclosure refers to a vector comprising the nucleic acid disclosed herein.

[0017g] In yet another aspect, the present disclosure refers to an isolated host cell comprising the vector disclosed herein.

[0017h] In yet another aspect, the present disclosure refers to a method of producing an anti-Siglec-9 antibody, comprising culturing the host cell disclosed herein so that the anti-Siglec-9 antibody is produced.

[0017i] In yet another aspect, the present disclosure refers to a pharmaceutical composition comprising the anti-Siglec-9 antibody disclosed herein, and a pharmaceutically acceptable carrier.

[0017j] Disclosed is use of a therapeutically effective amount of the anti-Siglec-9 antibody disclosed herein in the manufacture of a medicament for reducing risk of or treating a disease, disorder, or injury selected from the group consisting of dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, taupathy disease, infections, and cancer.

[0018] The present disclosure is generally directed to Siglec-9 agents, such as anti-Siglec-9 antibodies, and methods of using such Siglec-9 agents. The methods provided herein find use in preventing, reducing risk, or treating an individual having dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, solid and blood cancer, bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential

thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9 and/or Siglec-9 ligands, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza. The methods provided herein also find use in inducing or promoting the survival, maturation, functionality, migration, or proliferation of one or more immune cells in an individual in need thereof. The

methods provided herein find further use in decreasing the activity, functionality, or survival of regulatory T cells, tumor-imbedded immunosuppressor dendritic cells, tumor-imbedded immunosuppressor macrophages, neutrophils, natural killer (NK) cells, myeloid-derived suppressor cells, tumor-associated macrophages, neutrophils, NK cells, acute myeloid leukemia (AML) cells, chronic lymphocytic leukemia (CLL) cell, or chronic myeloid leukemia (CML) cell in an individual in need thereof. The methods provided herein also find use in decreasing cellular levels of Siglec-9.

[0019] Certain parts of the present disclosure are based, at least in part, on the identification of anti-Siglec-9 antibodies that are capable of decreasing cell surface levels of Siglec-9 on human primary immune cells and Siglec-9-expressing cell lines and/or that are capable of inhibiting the binding of Siglec-9 ligands to Siglec-9 (*see, e.g.*, **Examples 3-5**).

[0020] Accordingly, disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody decreases cellular levels of Siglec-9. In some examples, the anti-Siglec-9 antibody decreases cellular levels of Siglec-9 without inhibiting interaction between Siglec-9 and one or more Siglec-9 ligands. In some examples, the antibody further inhibits interaction between Siglec-9 and one or more Siglec-9 ligands. Also disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody decreases cellular levels of Siglec-9 and inhibits interaction between Siglec-9 and one or more Siglec-9 ligands.

[0021] In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody decreases cell surface levels of Siglec-9, decreases intracellular levels of Siglec-9, decreases total levels of Siglec-9, or any combination thereof. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody induces Siglec-9 degradation, Siglec-9 cleavage, Siglec-9 internalization, Siglec-9 shedding, downregulation of Siglec-9 expression, or any combination thereof. In some examplesthat may be combined with any of the preceding examples, the antibody decreases cellular levels of Siglec-9 *in vivo*. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody inhibits cell surface clustering of Siglec-9. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody inhibits one or more Siglec-9 activities. In some examplesthat may be combined with any of the preceding examples, the one or more Siglec-9 activities selected from the group consisting of: (a) Siglec-9 binding to one or more Siglec-9 ligands, optionally wherein the one or more Siglec-9 ligands are selected from the group consisting of sialic acid-containing glycoproteins, sialic acid-containing glycolipids, and any combination thereof; (b) Siglec-9 binding to SHP1 or SHP2; (c) phosphorylation of Tyr-433, Tyr-456, or both, induced by one or more SRC family tyrosine kinases, optionally, wherein the one or more SRC family tyrosine kinases are selected from the group consisting of Syk, LCK, FYM, and

ZAP-70; (d) modulated expression of one or more pro-inflammatory cytokines, optionally wherein the one or more pro-inflammatory cytokines are selected from a group consisting FN-α4, IFN-beta, IL-1β, IL-1alpha, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-33, MCP-1, and MIP-1-beta; (e) modulated expression of one or more pro-inflammatory cytokines in one or more cells selected from the group consisting of macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; (f) modulated expression of one or more anti-inflammatory cytokines, optionally wherein the one or more anti-inflammatory cytokines are selected from the group consisting of IL-4, IL-10, IL-13, IL-35, IL-16, TGF-beta, IL-1Ra, G-CSF, and soluble receptors for TNF, IFN-beta1a, IFN-beta1b, or IL-6; (g) modulated expression of one or more anti-inflammatory cytokines in one or more cells selected from the group consisting of macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; (h) modulate expression of one or more proteins selected from the group consisting of C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and PYCARD; (i) inhibition of extracellular signal-regulated kinase (ERK) phosphorylation; (j) decreasing tyrosine phosphorylation on one or more cellular proteins, optionally, wherein the one or more cellular proteins comprise ZAP-70 and the tyrosine phosphorylation occurs on Tyr-319 of ZAP-70; (k) modulated expression of C-C chemokine receptor 7 (CCR7); (l) inhibition of microglial cell chemotaxis toward CCL19-expressing and CCL21-expressing cells; (m) decreasing T cell proliferation induced by one or more cells selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, M1 microglia, activated M1 microglia, M2 microglia, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, and M2 NK cells; (n) inhibition of osteoclast production, decreased rate of osteoclastogenesis, or both; (o) decreasing survival of one or more cells selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; (p) decreasing proliferation of one or more cells selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils,

M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; (q) inhibiting migration of one or more cells selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; (r) inhibiting one or more functions of one or more cells selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; (s) inhibiting maturation of one or more cells selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; (t) inhibition of one or more types of clearance selected from the group consisting of apoptotic neuron clearance, nerve tissue debris clearance, dysfunctional synapse clearance, non-nerve tissue debris clearance, bacteria clearance, other foreign body clearance, disease-causing protein clearance, disease-causing peptide clearance, and tumor cell clearance; optionally wherein the disease-causing protein is selected from the group consisting of amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides and the tumor cell is from a cancer selected from the group consisting of bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer,

fibrosarcoma, and thyroid cancer; (u) inhibition of phagocytosis of one or more of apoptotic neurons, nerve tissue debris, dysfunctional synapses, non-nerve tissue debris, bacteria, other foreign bodies, disease-causing proteins, disease-causing peptides, disease-causing nucleic acids, or tumor cells; optionally wherein the disease-causing nucleic acids are antisense GGCCCC (G2C4) repeat-expansion RNA, the disease-causing proteins are selected from the group consisting of amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides, and the tumor cells are from a cancer selected from the group consisting of bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, or thyroid cancer; (v) binding to Siglec-9 ligand on tumor cells; (w) binding to Siglec-9 ligand on cells selected from the group consisting of neutrophils, dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, macrophages, and NK cells; (x) inhibition of tumor cell killing by one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; (y) inhibiting anti-tumor cell proliferation activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; (z) inhibition of anti-tumor cell metastasis activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; (aa) inhibition of one or more ITAM motif containing receptors, optionally wherein the one or more ITAM motif containing receptors are selected from the group consisting of TREM1, TREM2, Sirp beta, FcgR, DAP10, and DAP12; (bb) inhibition of signaling by one or more pattern recognition receptors (PRRs), optionally wherein the one or more PRRs are selected from the group consisting of receptors that identify pathogen-associated molecular patterns (PAMPs), receptors that identify damage-associated molecular patterns (DAMPs), and any combination thereof; (cc) inhibition of one or more receptors comprising the motif $D/Ex_{0-2}YxxL/IX_{6-8}YxxL/I$ (SEQ ID NO: 252); (dd) inhibition of signaling by one or more Toll-like receptors; (ee) inhibition of the JAK-STAT signaling pathway;

(ff) inhibition of nuclear factor kappa-light-chain-enhancer of activated B cells (NFκB); (gg) de-phosphorylation of an ITAM motif containing receptor; (hh) modulated expression of one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells, optionally wherein the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells comprise CD86, C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and/or PYCARD, and the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells are expressed on one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; (ii) increasing expression of one or more Siglec-9-dependent genes; (jj) normalization of disrupted Siglec-9-dependent gene expression; (kk) decreasing expression of one or more ITAM-dependent genes, optionally wherein the one more ITAM-dependent genes are activated by nuclear factor of activated T cells (NFAT) transcription factors; (ll) promoting differentiation of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells; (mm) promoting or rescuing functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells; (nn) increasing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells into tumors; (oo) increasing the number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; (pp) enhancing tumor-promoting activity of myeloid-derived suppressor cells; (qq) increasing expression of tumor-promoting cytokines in a tumor or in peripheral blood, optionally wherein the tumor-promoting cytokines are TGF-beta or IL-10; (rr) increasing tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; (ss) enhancing tumor-promoting activity of myeloid-derived suppressor cells (MDSC); (tt) decreasing activation of tumor-specific T lymphocytes with tumor killing potential; (uu) decreasing infiltration of tumor-specific NK cells with tumor killing potential; (vv) decreasing the tumor killing potential of NK cells; (ww) decreasing infiltration of tumor-specific B lymphocytes with potential to enhance immune response; (xx) decreasing infiltration of tumor-specific T lymphocytes with tumor killing potential; (yy) increasing tumor volume; (zz) increasing tumor

growth rate; (aaa) increasing metastasis; (bbb) increasing rate of tumor recurrence; (ccc) decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more target proteins selected from the group consisting of PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, BTLA, KIR, GAL9, TIM3, A2AR, LAG, DR-5, TREM1, TREM2, CSF-1 receptor, and any combination thereof, or of one or more cancer vaccines; (ddd) inhibition of PLCγ/PKC/calcium mobilization; and (eee) inhibition of PI3K/Akt, Ras/MAPK signaling. In some examplesthat may be combined with any of the preceding examples, the one or more Siglec-9 activities are selected from the group consisting of: (a) enhancing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, myeloid derived suppressor cells, tumor-associated macrophages, immunosuppressor neutrophils, non-tumorigenic $CD45^+CD14^+$ myeloid cells, and regulatory T cells into tumors; (b) increasing number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; (r) enhancing tumor-promoting activity of non-tumorigenic myeloid-derived suppressor cells and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells; (c) enhancing survival of non-tumorigenic myeloid-derived suppressor cells (MDSC) and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells; (d) decreasing activation of tumor-specific T lymphocytes with tumor killing potential; (e) decreasing activation of $CD45^+CD3^+$ T lymphocytes with tumor killing potential; (f) decreasing infiltration of tumor-specific NK cells with tumor killing potential; (g) decreasing infiltration of tumor-specific B lymphocytes with potential to enhance immune response; (h) decreasing infiltration of tumor-specific T lymphocytes with tumor killing potential; and (i) decreasing infiltration of $CD45^+CD3^+$ T lymphocytes. In some examplesthat may be combined with any of the preceding examples, the one or more Siglec-9 activities selected from the group consisting of: (a) Siglec-9 binding to one or more Siglec-9 ligands, optionally wherein the one or more Siglec-9 ligands are selected from the group consisting of sialic acid-containing glycoproteins, sialic acid-containing glycolipids, and any combination thereof; (b) decreasing proliferation of one or more cells selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; (c) inhibiting migration of one or more cells selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T

cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; (d) inhibiting one or more functions of one or more cells selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; (e) inhibition of one or more types of clearance selected from the group consisting of apoptotic neuron clearance, nerve tissue debris clearance, dysfunctional synapse clearance, non-nerve tissue debris clearance, bacteria clearance, other foreign body clearance, disease-causing protein clearance, disease-causing peptide clearance, and tumor cell clearance; optionally wherein the disease-causing protein is selected from the group consisting of amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides and the tumor cell is from a cancer selected from the group consisting of bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer; (f) inhibition of tumor cell killing by one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; (g) inhibiting anti-tumor cell proliferation activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; (h) modulating expression of one or more inflammatory receptors, optionally wherein the one or more inflammatory receptors comprise CD86 and the one or more inflammatory receptors are expressed on one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; (i) promoting or rescuing functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated

macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells; (j) increasing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, non-tumorigenic $CD45^+CD14^+$ myeloid cells, and regulatory T cells into tumors; (k) increasing the number of tumor-promoting myeloid/granulocytic immune-suppressive cells and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells in a tumor, in peripheral blood, or other lymphoid organ; (l) enhancing tumor-promoting activity of myeloid-derived suppressor cells and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells; (m) enhancing survival of non-tumorigenic myeloid-derived suppressor cells and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells; (n) decreasing activation of tumor-specific T lymphocytes with tumor killing potential; (o) decreasing infiltration of tumor-specific NK cells with tumor killing potential; (p) increasing tumor volume; (q) increasing tumor growth rate; and (r) decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more target proteins selected from the group consisting of PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, TREM1, TREM2, CD39, CD73, CSF-1 receptor, and any combination thereof, or of one or more cancer vaccines. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody exhibits one or more activities selected from the group consisting of consisting of: (a) increasing the number of tumor infiltrating $CD3^+$ T cells; (b) decreasing cellular levels of CD33 in non-tumorigenic $CD14^+$myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (c) reducing the number of non-tumorigenic $CD14^+$ myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (d) reducing PD-L1 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (e) reducing PD-L2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (f) reducing B7-H2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (g) reducing B7-H3 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (h) reducing CD200R levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (i) reducing CD163 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (j)

reducing CD206 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (k) decreasing tumor growth rate of solid tumors; (l) reducing tumor volume; (m) increasing efficacy of one or more PD-1 inhibitors; (n) increasing efficacy of one or more checkpoint inhibitor therapies and/or immune-modulating therapies, optionally wherein the one or more checkpoint inhibitor therapies and/or immune-modulating therapies target one or more of CTLA4, the adenosine pathway, PD-L1, PD-L2, OX40, TIM3, LAG3, or any combination thereof; (o) increasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof; (p) increasing proliferation of T cells in the presence of non-tumorigenic myeloid-derived suppressor cells (MDSC); (q) inhibiting differentiation, survival, and/or one or more functions of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (r) killing CD33-expressing immunosuppressor non-tumorigenic myeloid cells and/or non-tumorigenic CD14-expressing cells in solid tumors and associated blood vessels when conjugated to a chemical or radioactive toxin. In some examplesthat may be combined with any of the preceding examples, the one or more Siglec-9 ligands are selected from the group consisting of Siglec-9 ligands expressed on red blood cells, Siglec-9 ligands expressed on bacterial cells, Siglec-9 ligands expressed on apoptotic cells, Siglec-9 ligands expressed on nerve cells, Siglec-9 ligands expressed on glia cells, Siglec-9 ligands expressed on microglia, Siglec-9 ligands expressed on astrocytes, Siglec-9 ligands expressed on tumor cells, Siglec-9 ligands expressed on viruses, Siglec-9 ligands expressed on dendritic cells, Siglec-9 ligands bound to beta amyloid plaques, Siglec-9 ligands bound to Tau tangles, Siglec-9 ligands on disease-causing proteins, Siglec-9 ligands on disease-causing peptides, Siglec-9 ligands expressed on macrophages, Siglec-9 ligands expressed on neutrophils, Siglec-9 ligands expressed on natural killer cells, Siglec-9 ligands expressed on monocytes, Siglec-9 ligands expressed on T cells, Siglec-9 ligands expressed on T helper cells, Siglec-9 ligands expressed on cytotoxic T cells, Siglec-9 ligands expressed on B cells, Siglec-9 ligands expressed on tumor-imbedded immunosuppressor dendritic cells, Siglec-9 ligands expressed on tumor-imbedded immunosuppressor macrophages, Siglec-9 ligands expressed on myeloid-derived suppressor cells, Siglec-9 ligands expressed on regulatory T cells, secreted mucins, sialic acid, sialic acid-containing glycolipids, sialic acid-containing glycoproteins, alpha-2,8-disialyl containing glycolipids, branched alpha-2,6-linked sialic acid-containing glycoproteins, terminal alpha-2,6-linked sialic acid-containing glycolipids, terminal alpha-2,3-linked sialic acid-containing glycoproteins, and disialogangliosides. In some examplesthat may be combined with any of the preceding examples, the cellular levels of Siglec-9 are measured on primary cells selected from the group consisting of dendritic cells,

bone marrow-derived dendritic cells, monocytes, microglia, macrophages, neutrophils, and NK cells, or on cell lines, and wherein the cellular levels of Siglec-9 are measured utilizing an *in vitro* cell assay. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody does not reduce TREM2 expression. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody exhibits one or more activities selected from the group consisting of consisting of: (a) increasing the number of tumor infiltrating $CD3^+$ T cells; (b) decreasing cellular levels of Siglec-9 in non-tumorigenic CD14+ myeloid cells, optionally wherein the non-tumorigenic CD14+ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic CD14+ myeloid cells are present in blood; (c) reducing the number of non-tumorigenic CD14+ myeloid cells, optionally wherein the non-tumorigenic CD14+ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic CD14+ myeloid cells are present in blood; (d) reducing PD-L1 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (e) reducing PD-L2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (f) reducing B7-H2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (g) reducing B7-H3 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (h) reducing CD200R levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (i) reducing CD163 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (j) reducing CD206 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (k) decreasing tumor growth rate of solid tumors; (l) reducing tumor volume; (m) increasing efficacy of one or more PD-1 inhibitors; (n) increasing efficacy of one or more checkpoint inhibitor therapies and/or immune-modulating therapies, optionally wherein the one or more checkpoint inhibitor therapies and/or immune-modulating therapies target one or more of CTLA4, the adenosine pathway, PD-L1, PD-L2, PD-L1, PD-L2, OX40, TIM3, LAG3, or any combination thereof; (o) increasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof; (p) increasing proliferation of T cells in the presence of non-tumorigenic myeloid-derived suppressor cells (MDSC); (q) inhibiting differentiation, survival, and/or one or more functions of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (r) killing Siglec-9-expressing

immunosuppressor non-tumorigenic myeloid cells and/or non-tumorigenic CD14-expressing cells in solid tumors and associated blood vessels when conjugated to a chemical or radioactive toxin.

[0022] In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds a discontinuous Siglec-9 epitope. In some examplesthat may be combined with any of the preceding examples, the discontinuous Siglec-9 epitope comprises two or more peptides, three or more peptides, four or more peptides, five or more peptides, six or more peptides, seven or more peptides, eight or more peptides, nine or more peptides, or 10 or more peptides. In some examplesthat may be combined with any of the preceding examples, each of the peptides comprise five or more, six or more, seven or more, eight or more, nine or more, 10 or more, 11 or more, 12 or more, 13 or more 14 or more, 15 or more, 16 or more, 17 or more, 18 or more, 19 or more, or 20 or more amino acid residues of the amino acid sequence of SEQ ID NO: 1; or five or more, six or more, seven or more, eight or more, nine or more, 10 or more, 11 or more, 12 or more, 13 or more 14 or more, 15 or more, 16 or more, 17 or more, 18 or more, 19 or more, or 20 or more amino acid residues on a mammalian Siglec-9 protein corresponding to the amino acid sequence of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to a conformational epitope of Siglec-9. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 20-347, 20-140, 141-347, 146-347, 146-229, 236-336, or 146-347 of SEQ ID NO: 1; or within amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 20-347, 20-140, 141-347, 146-347, 146-229, 236-336, or 146-347 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues selected from the group consisting of: i. amino acid residues 62-76 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 of SEQ ID NO: 1; ii. amino acid residues 62-76 and 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 and 86-92 of SEQ ID NO: 1; iii. amino acid residues 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-92 of SEQ ID NO: 1; iv. amino acid residues 86-96 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 of SEQ ID NO: 1; v. amino acid residues 86-96 and 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 and 105-116 of SEQ ID NO: 1; vi. amino acid residues 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 105-116 of SEQ ID NO: 1; vii. amino acid residues 107-115 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 107-115 of SEQ ID NO: 1; and viii. amino

acid residues185-194 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 185-194 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 62-76 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 62-76 and 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 and 86-92 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-92 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-96 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-96 and 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 and 105-116 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 105-116 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 107-115 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 107-115 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 185-194 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 185-194 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds to one or more amino acid residues selected from the group consisting of L22, H48, W50, I51, Y52, K123, I126, D189, P190, R194 of SEQ ID NO: 1, or one or more amino acid residues on a mammalian Siglec-7 protein corresponding to an amino acid residue selected from the group consisting of L22, H48, W50, I51, Y52, K123, I126, D189, P190, R194 of SEQ ID NO: 1. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody competes with one or more antibodies selected from the

group consisting of 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof for binding to Siglec-9.

[0023] In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain, the heavy chain variable domain, or both comprise at least one, two, three, four, five, or six HVRs selected from HVR-L1, HVR-L2, HVR-L3, HVR-H1, HVR-H2, and HVR-H3 of a monoclonal antibody selected from the group consisting of: 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2. In some examplesthat may be combined with any of the preceding examples: (a) the HVR-L1 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 6-9, 172, and 173; or (b) the HVR-L2 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 10-13, 174, and 175; or (c) the HVR-L3 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 14-18, 176, and 177; or (d) the HVR-H1 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 19-21, 178, and 179; or (e) the HVR-H2 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 22-25, 180, and 181; or (f) the HVR-H3 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 26-29, 182, and 183. In some examplesthat may be combined with any of the preceding examples: (a) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 6, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 10, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 14, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 19, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 22, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 26; or (b) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 7, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 11, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 15, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 20, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 23, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 27; or (c) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 8, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 12, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 16, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 21, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 24, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 28; or (d) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 9, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 13, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 17, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 21, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 25, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 29; or (e) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 8, the HVR-L2

comprises the amino acid sequence of SEQ ID NO: 12, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 18, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 21, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 24, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 28; or (f) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 172, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 174, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 176, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 178, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 180, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 182; or (g) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 173, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 175, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 177, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 179, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 181, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 183. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 6, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 10, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 14, and wherein the heavy chain variable region comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 19, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 22, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 26. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 7, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 11, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 15, and wherein the heavy chain variable region comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 20, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 23, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 27. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 8, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 12, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 16, and wherein the heavy chain variable region comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28. In some examplesthat may be combined with any of the preceding

examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 9, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 13, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 17, and wherein the heavy chain variable region comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 25, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 29. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 8, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 12, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 18, and wherein the heavy chain variable region comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 172, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 174, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 176, and wherein the heavy chain variable region comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 178, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 180, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 182. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 173, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 175, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 177, and wherein the heavy chain variable region comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 179, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 181, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 183. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: (a) an HVR-L1 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 6-9, 172, and 173, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 6-9, 172, and 173; (b) an HVR-L2 comprising an amino acid sequence selected from the group consisting of

SEQ ID NOs: 10-13, 174, and 175, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 10-13, 174, and 175; and (c) an HVR-L3 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 14-18, 176, and 177, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 14-18, 176, and 177; and wherein the heavy chain variable domain comprises: (a) an HVR-H1 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 19-21, 178, and 179, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 19-21, 178, and 179; (b) an HVR-H2 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 22-25, 180, and 181, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 22-25, 180, and 181; and (c) an HVR-H3 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 26-29, 182, and 183, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 26-29, 182, and 183. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 61-115 and 197-204; and/or a heavy chain variable domain comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 116-170 and 205-212. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein: (a) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 61; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 116; or (b) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 72; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 127; or (c) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 83; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 138; or (d) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 94; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 149; or (e) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 105; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 160; or (f) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 197; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 205; or (g) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 201; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 210. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises a

light chain variable domain of a monoclonal antibody selected from the group consisting of: 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2; and/or a heavy chain variable domain of a monoclonal antibody selected from the group consisting of: 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2.

[0024] Also disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 20-347, 20-140, 141-347, 146-347, 146-229, 236-336, or 146-347 of SEQ ID NO: 1; or within amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 20-347, 20-140, 141-347, 146-347, 146-229, 236-336, or 146-347 of SEQ ID NO: 1. In some examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues selected from the group consisting of: i. amino acid residues 62-76 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 of SEQ ID NO: 1; ii. amino acid residues 62-76 and 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 and 86-92 of SEQ ID NO: 1; iii. amino acid residues 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-92 of SEQ ID NO: 1; iv. amino acid residues 86-96 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 of SEQ ID NO: 1; v. amino acid residues 86-96 and 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 and 105-116 of SEQ ID NO: 1; vi. amino acid residues 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 105-116 of SEQ ID NO: 1; vii. amino acid residues 107-115 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 107-115 of SEQ ID NO: 1; and viii. amino acid residues185-194 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 185-194 of SEQ ID NO: 1. In some examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 62-76 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 of SEQ ID NO: 1. In some examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 62-76 and 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 and 86-92 of SEQ ID NO: 1. In some examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-92 of SEQ ID NO: 1. In some examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-96 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-

96 of SEQ ID NO: 1. In some examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-96 and 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 and 105-116 of SEQ ID NO: 1. In some examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 105-116 of SEQ ID NO: 1. In some examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 107-115 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 107-115 of SEQ ID NO: 1. In some examples, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 185-194 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 185-194 of SEQ ID NO: 1. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acid residues selected from the group consisting of L22, H48, W50, I51, Y52, K123, I126, D189, P190, R194 of SEQ ID NO: 1, or one or more amino acid residues on a mammalian Siglec-7 protein corresponding to an amino acid residue selected from the group consisting of L22, H48, W50, I51, Y52, K123, I126, D189, P190, R194 of SEQ ID NO: 1.

[0025] Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 62-76 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 of SEQ ID NO: 1. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 62-76 and 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 62-76 and 86-92 of SEQ ID NO: 1. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-92 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-92 of SEQ ID NO: 1. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-96 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 of SEQ ID NO: 1. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-96 and 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 and 105-116 of SEQ ID NO: 1. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 105-

116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 105-116 of SEQ ID NO: 1. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 107-115 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 107-115 of SEQ ID NO: 1. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 185-194 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 185-194 of SEQ ID NO: 1.

[0026] Also disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain, the heavy chain variable domain, or both comprise at least one, two, three, four, five, or six HVRs selected from HVR-L1, HVR-L2, HVR-L3, HVR-H1, HVR-H2, and HVR-H3 of a monoclonal antibody selected from the group consisting of: 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2. In some examples: (a) the HVR-L1 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 6-9, 172, and 173; or (b) the HVR-L2 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 10-13, 174, and 175; or (c) the HVR-L3 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 14-18, 176, and 177; or (d) the HVR-H1 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 19-21, 178, and 179; or (e) the HVR-H2 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 22-25, 180, and 181; or (f) the HVR-H3 comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 26-29, 182, and 183. In some examples: (a) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 6, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 10, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 14, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 19, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 22, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 26; or (b) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 7, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 11, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 15, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 20, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 23, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 27; or (c) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 8, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 12, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 16, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 21, the HVR-H2 comprises the amino

acid sequence of SEQ ID NO: 24, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 28; or (d) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 9, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 13, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 17, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 21, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 25, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 29; or (e) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 8, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 12, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 18, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 21, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 24, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 28; or (f) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 172, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 174, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 176, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 178, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 180, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 182; or (g) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 173, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 175, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 177, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 179, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 181, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 183. In some examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 6, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 10, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 14, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 19, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 22, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 26. In some examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 7, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 11, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 15, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 20, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 23, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 27. In some examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 8, an HVR-L2 comprising the amino acid

sequence of SEQ ID NO: 12, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 16, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28. In some examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 9, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 13, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 17, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 25, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 29. In some examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 8, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 12, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 18, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28. In some examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 172, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 174, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 176, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 178, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 180, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 182. In some examples, the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 173, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 175, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 177, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 179, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 181, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 183. In some examples, the light chain variable domain comprises: (a) an HVR-L1 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 6-9, 172, and 173, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 6-9, 172, and 173; (b) an HVR-L2 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 10-

13, 174, and 175, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 10-13, 174, and 175; and (c) an HVR-L3 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 14-18, 176, and 177, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 14-18, 176, and 177; and wherein the heavy chain variable domain comprises: (a) an HVR-H1 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 19-21, 178, and 179, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 19-21, 178, and 179; (b) an HVR-H2 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 22-25, 180, and 181, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 22-25, 180, and 181; and (c) an HVR-H3 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 26-29, 182, and 183, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 26-29, 182, and 183.

[0027] Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 6, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 10, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 14, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 19, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 22, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 26. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 7, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 11, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 15, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 20, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 23, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 27. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 8, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 12, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 16, and wherein the heavy chain variable

domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 9, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 13, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 17, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 25, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 29. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 8, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 12, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 18, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 172, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 174, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 176, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 178, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 180, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 182. Also disclosed is an isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 173, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 175, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 177, and wherein the heavy chain variable domain comprises: an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 179, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 181, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 183. Also disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 61-115 and 197-204 and/or a heavy chain

variable domain comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 116-170 and 205-212. Also disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, and wherein: (a) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 61; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 116; or (b) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 72; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 127; or (c) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 83; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 138; or (d) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 94; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 149; or (e) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 105; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 160; or (f) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 197; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 205; or (g) the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 201; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 210. Also disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain of a monoclonal antibody selected from the group consisting of: 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2; and/or a heavy chain variable domain of a monoclonal antibody selected from the group consisting of: 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2. Also disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody competes with one or more antibodies selected from the group consisting of 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof for binding to Siglec-9. Also disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody which binds essentially the same Siglec-9 epitope as a monoclonal antibody selected from the group consisting of: 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2. Also disclosed is an isolated (e.g., monoclonal) anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises: (a) an HVR-L1 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 6-9, 172, and 173, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 6-9, 172, and 173; (b) an HVR-L2 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 10-

13, 174, and 175, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 10-13, 174, and 175; and (c) an HVR-L3 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 14-18, 176, and 177, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 14-18, 176, and 177; and wherein the heavy chain variable domain comprises: (a) an HVR-H1 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 19-21, 178, and 179, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 19-21, 178, and 179; (b) an HVR-H2 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 22-25, 180, and 181, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 22-25, 180, and 181; and (c) an HVR-H3 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 26-29, 182, and 183, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from the group consisting of SEQ ID NOs: 26-29, 182, and 183.

[0028] In some examplesthat may be combined with any of the preceding examples, the antibody is of the IgG class the IgM class, or the IgA class. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody has an IgG1, IgG2, IgG3, or IgG4 isotype. In some examplesthat may be combined with any of the preceding examples, the antibody binds an inhibitory Fc receptor. In some examplesthat may be combined with any of the preceding examples, the inhibitory Fc receptor is inhibitory Fc-gamma receptor IIB (FcγIIB). In some examplesthat may be combined with any of the preceding examples: (a) the anti-Siglec-9 antibody has a human or mouse IgG1 isotype and comprises one or more amino acid substitutions in the Fc region at a residue position selected from the group consisting of: N297A, D265A, D270A, L234A, L235A, G237A, P238D, L328E, E233D, G237D, H268D, P271G, A330R, C226S, C229S, E233P, L234V, L234F, L235E, P331S, S267E, L328F, A330L, M252Y, S254T, T256E, N297Q, P238S, P238A, A327Q, A327G, P329A, K322A, T394D, and any combination thereof, wherein the numbering of the residues is according to EU or Kabat numbering, or comprises an amino acid deletion in the Fc region at a position corresponding to glycine 236; (b) the anti-Siglec-9 antibody has an IgG1 isotype and comprises an IgG2 isotype heavy chain constant domain 1(CH1) and hinge region, optionally wherein the IgG2 isotype CH1 and hinge region comprises the amino acid sequence of ASTKGPSVFP LAPCSRSTSE STAALGCLVK DYFPEPVTVS WNSGALTSGVHTFPAVLQSS GLYSLSSVVT VPSSNFGTQT YTCNVDHKPS NTKVDKTVERKCCVECPPCP (SEQ ID NO: 171), and optionally wherein the antibody Fc region comprises a S267E amino acid substitution, a L328F amino acid substitution, or both, and/or a

N297A or N297Q amino acid substitution, wherein the numbering of the residues is according to EU numbering; (c) the anti-Siglec-9 antibody has an IgG2 isotype and comprises one or more amino acid substitutions in the Fc region at a residue position selected from the group consisting of: P238S, V234A, G237A, H268A, H268Q, V309L, A330S, P331S, C214S, C232S, C233S, S267E, L328F, M252Y, S254T, T256E, H268E, N297A, N297Q, A330L, and any combination thereof, wherein the numbering of the residues is according to EU or Kabat numbering; (d) the anti-Siglec-9 antibody has a human or mouse IgG4 isotype and comprises one or more amino acid substitutions in the Fc region at a residue position selected from the group consisting of: L235A, G237A, S228P, L236E, S267E, E318A, L328F, M252Y, S254T, T256E, E233P, F234V, L234A/F234A, S228P, S241P, L248E, T394D, N297A, N297Q, L235E, and any combination thereof, wherein the numbering of the residues is according to EU or Kabat numbering; or (e) the anti-Siglec-9 antibody has a hybrid IgG2/4 isotype, and optionally wherein the antibody comprises an amino acid sequence comprising amino acids 118 to 260 of human IgG2 and amino acids 261 to 447 of human IgG4, wherein the numbering of the residues is according to EU or, Kabat numbering. In some examplesthat may be combined with any of the preceding examples: (a) the anti-Siglec-9 antibody has a human or mouse IgG1 isotype and comprises one or more amino acid substitutions in the Fc region at a residue position selected from the group consisting of: N297A, N297Q, D270A, D265A, L234A, L235A, C226S, C229S, P238S, E233P, L234V, P238A, A327Q, A327G, P329A, K322A, L234F, L235E, P331S, T394D, A330L, M252Y, S254T, T256E, and any combination thereof, wherein the numbering of the residues is according to EU or Kabat numbering; (b) the anti-Siglec-9 antibody has an IgG2 isotype and comprises one or more amino acid substitutions in the Fc region at a residue position selected from the group consisting of: P238S , V234A, G237A, H268A, H268Q, H268E, V309L, N297A, N297Q, A330S, P331S, C232S, C233S, M252Y, S254T, T256E, and any combination thereof, wherein the numbering of the residues is according to EU or Kabat numbering; or (c) the anti-Siglec-9 antibody has an IgG4 isotype and comprises one or more amino acid substitutions in the Fc region at a residue position selected from the group consisting of: E233P, F234V, L234A/F234A, L235A, G237A, E318A, S228P, L236E, S241P, L248E, T394D, M252Y, S254T, T256E, N297A, N297Q, and any combination thereof, wherein the numbering of the residues is according to EU or Kabat numbering. In some examplesthat may be combined with any of the preceding examples: (a) the Fc region further comprises one or more additional amino acid substitutions at a position selected from the group consisting of A330L, L234F; L235E, P331S, and any combination thereof, wherein the numbering of the residues is according to EU or Kabat numbering; (b) the Fc region further comprises one or more additional amino acid substitutions at a position selected from the group consisting of M252Y, S254T,T256E, and any combination thereof, wherein the numbering of the residues is according to EU or Kabat numbering; or (c) the Fc region further comprises a S228P

amino acid substitution according to EU or Kabat numbering. In some examplesthat may be combined with any of the preceding examples, the antibody has an IgG4 isotype. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody comprises an S228P amino acid substitution at residue position 228, an F234A amino acid substitution at residue position 234, and an L235A amino acid substitution at residue position 235, wherein the numbering of the residue position is according to EU or Kabat numbering. In some examplesthat may be combined with any of the preceding examples, the Siglec-9 protein is a mammalian protein or a human protein. In some examplesthat may be combined with any of the preceding examples, the Siglec-9 protein is a wild-type protein. In some examplesthat may be combined with any of the preceding examples, the Siglec-9 protein is a naturally occurring variant. In some examplesthat may be combined with any of the preceding examples, the Siglec-9 protein is expressed on one or more cells selected from the group consisting of human dendritic cells, human macrophages, human neutrophils, human NK cells, human monocytes, human osteoclasts, human T cells, human T helper cell, human cytotoxic T cells, human granulocytes, and human microglia. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds specifically to a mammalian Siglec-9 protein, human Siglec-9 protein, or both. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds Siglec-9 in a pH dependent manner. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody binds Siglec-9 at a pH that ranges from 5.5 to 8.0. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody dissociates from Siglec-9 at a pH of less than 5.0. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is an antibody fragment that binds to an epitope comprising amino acid residues on human Siglec-9 or a mammalian Siglec-9 protein. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is an antibody fragment that binds to one or more human proteins selected from the group consisting of human Siglec-9, a naturally occurring variant of human Siglec-9, and a disease variant of human Siglec-9. In some examplesthat may be combined with any of the preceding examples, the antibody fragment is cross-linked to a second antibody fragment that binds to one or more human proteins selected from the group consisting of human Siglec-9, a naturally occurring variant of human Siglec-9, and a disease variant of human Siglec-9. In some examplesthat may be combined with any of the preceding examples, the fragment is an Fab, Fab', Fab'-SH, F(ab')2, Fv, or scFv fragment. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is a murine antibody. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is a humanized antibody, a bispecific antibody, a

monoclonal antibody, a multivalent antibody, a conjugated antibody, or a chimeric antibody. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is a bispecific antibody recognizing a first antigen and a second antigen. In some examplesthat may be combined with any of the preceding examples, the first antigen is Siglec-9 and the second antigen is: (a) an antigen facilitating transport across the blood-brain-barrier; (b) an antigen facilitating transport across the blood-brain-barrier selected from the group consisting of transferrin receptor (TR), insulin receptor (HIR), insulin-like growth factor receptor (IGFR), low-density lipoprotein receptor related proteins 1 and 2 (LPR-1 and 2), diphtheria toxin receptor, CRM197, a llama single domain antibody, TMEM 30(A), a protein transduction domain, TAT, Syn-B, penetratin, a poly-arginine peptide, an angiopep peptide, and ANG1005; (c) a disease-causing agent selected from the group consisting of disease-causing peptides or proteins or, disease-causing nucleic acids, wherein the disease-causing nucleic acids are antisense GGCCCC (G2C4) repeat-expansion RNA, the disease-causing proteins are selected from the group consisting of amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides; (d) ligands and/or proteins expressed on immune cells, wherein the ligands and/or proteins selected from the group consisting of PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, CD39, CD73, and phosphatidylserine; and (e) a protein, lipid, polysaccharide, or glycolipid expressed on one or more tumor cells. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is a conjugated antibody. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is conjugated to a detectable marker, a toxin, or a therapeutic agent. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is conjugated to a toxin selected from the group consisting of ricin, ricin A-chain, doxorubicin, daunorubicin, a maytansinoid, taxol, ethidium bromide, mitomycin, etoposide, tenoposide, vincristine, vinblastine, colchicine, dihydroxy anthracin dione, actinomycin, diphtheria toxin, *Pseudomonas* exotoxin (PE) A, PE40, abrin, abrin A chain,

modeccin A chain, alpha-sarcin, gelonin, mitogellin, retstrictocin, phenomycin, enomycin, curicin, crotin, calicheamicin, *Saponaria officinalis* inhibitor, glucocorticoid, auristatin, auromycin, yttrium, bismuth, combrestatin, duocarmycins, dolastatin, cc1065, and a cisplatin. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is used in combination with one or more antibodies that specifically bind a disease-causing protein selected from the group consisting of amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides, and any combination thereof; or with one or more antibodies that bind an immunomodulatory protein selected from the group consisting of: PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, CD39, CD73, TREM1, TREM2, CD33, Siglec-5, Siglec-7, Siglec-11, phosphatidylserine, disease-causing nucleic acids, antisense GGCCCC (G2C4) repeat-expansion RNA, and any combination thereof. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody has dissociation constant (K_D) for human Siglec-9 and mammalian Siglec-9 that ranges from about 10 nM to about10 pM, or less than 10 pM, wherein the K_D is determined at a temperature of approximately 25°C. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody has dissociation constant (K_D) for human Siglec-9 that ranges from about 9 nM to about 300 pM, or less than 300 pM, wherein the K_D is determined at a temperature of approximately 25°C. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody has dissociation constant (K_D) for human Siglec-9 that ranges from about 9 nM to about 230 pM, or less than 230 pM, wherein the K_D is determined at a temperature of approximately 25°C.

[0029] Also disclosed is an isolated nucleic acid comprising a nucleic acid sequence encoding the anti-Siglec-9 antibody of any of the preceding examples. Also disclosed is a vector comprising the nucleic acid of any of the preceding examples. Other aspects of the present disclosure relate to an isolated host cell comprising the vector of any of the preceding examples. Also disclosed is

a method of producing an anti-Siglec-9 antibody, comprising culturing the host cell of any of the preceding examplesso that the anti-Siglec-9 antibody is produced. In some examples, the method further comprises recovering the anti-Siglec-9 antibody produced by the host cell. Also disclosed is an isolated anti-Siglec-9 antibody produced by the method of any of the preceding examples. Also disclosed is a pharmaceutical composition comprising the anti-Siglec-9 antibody of any of the preceding examples, and a pharmaceutically acceptable carrier.

[0030] Also disclosed is a method of preventing, reducing risk, or treating a disease, disorder, or injury selected from the group consisting of dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer, bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, tumors that express one or more Siglec-9 ligands, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza, comprising administering to an individual in need thereof a therapeutically effective amount of an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both. Also disclosed is an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both for use in preventing, reducing risk, or treating a disease, disorder, or injury

selected from the group consisting of dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer, bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, tumors that express one or more Siglec-9 ligands, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza. Also disclosed is use of an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both in the manufacture of a medicament for preventing, reducing risk, or treating a disease, disorder, or injury selected from the group consisting of dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis,

low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer, bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, tumors that express one or more Siglec-9 ligands, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza. Also disclosed is a method of preventing, reducing risk, or treating a disease, disorder, or injury selected from the group consisting of dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, taupathy disease, infections, and cancer, comprising administering to an individual in need thereof a therapeutically effective amount of an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both. Also disclosed is an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both for use in preventing, reducing risk, or treating a disease, disorder, or injury selected from the group consisting of dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, taupathy disease, infections, and cancer. Also disclosed is use of an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both in the manufacture of a medicament for preventing, reducing risk, or treating a disease, disorder, or injury selected from the group consisting of dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, taupathy disease, infections, and cancer. In some examplesthe disease, disorder, or injury is cancer, and wherein the agent inhibits one or more Siglec-9 activities selected from the group consisting of: (a) promoting proliferation, maturation, migration, differentiation, and/or functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid derived suppressor cells, tumor-associated macrophages, tumor-associated suppressor neutrophils, tumor-associated suppressor NK cells, and regulatory T cells; (b) enhancing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid derived suppressor cells, tumor-associated macrophages, tumor-associated suppressor neutrophils, tumor-associated suppressor NK cells, and regulatory T cells into tumors; (c)

increasing number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; (d) enhancing tumor-promoting activity of myeloid-derived suppressor cells (MDSC); (e) increasing expression of tumor-promoting cytokines in a tumor or in peripheral blood, optionally wherein the tumor-promoting cytokines are TGF-beta or IL-10; (f) increasing tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; (g) decreasing activation of tumor-specific T lymphocytes with tumor killing potential; (h) decreasing infiltration of tumor-specific T lymphocytes with tumor killing potential; (i) increasing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, non-tumorigenic $CD45^+CD14^+$ myeloid cells, and regulatory T cells into tumors; (j) increasing the number of tumor-promoting myeloid/granulocytic immune-suppressive cells and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells in a tumor, in peripheral blood, or other lymphoid organ; (k) enhancing tumor-promoting activity of myeloid-derived suppressor cells and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells; (l) enhancing survival of non-tumorigenic myeloid-derived suppressor cells and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells; (m) decreasing activation of tumor-specific T lymphocytes with tumor killing potential; (n) decreasing infiltration of tumor-specific NK cells with tumor killing potential; (o) increasing tumor volume; (p) increasing tumor growth rate; (q) increasing metastasis; (r) increasing rate of tumor recurrence; (s) decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more target proteins selected from the group consisting of PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, CD39, CD73, and any combination thereof, or one or more cancer vaccines; (t) inhibition of PLCγ/PKC/calcium mobilization; and (u) inhibition of PI3K/Akt, Ras/MAPK signaling. In some examples, the cancer expresses Siglec-9 or one or more Siglec-9 ligands. In some examplesthat may be combined with any of the preceding examples, the disease, disorder, or injury is cancer, and the agent inhibits one or more Siglec-9 activities selected from the group consisting of: (a) promoting proliferation, maturation, migration, differentiation, and/or functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, non-tumorigenic myeloid derived suppressor cells, tumor-associated macrophages, , non-tumorigenic $CD14^+$ myeloid cells, and regulatory T cells; (b) enhancing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, non-tumorigenic myeloid derived suppressor cells, tumor-associated macrophages, and regulatory T cells into tumors; (c) increasing

number of tumor-promoting myeloid/granulocytic immune-suppressive cells and/or non-tumorigenic $CD14^+$ myeloid cells in a tumor, in peripheral blood, or other lymphoid organ; (d) enhancing tumor-promoting activity of non-tumorigenic myeloid-derived suppressor cells and/or non-tumorigenic $CD14^+$ myeloid cells; (e) increasing expression of tumor-promoting cytokines in a tumor or in peripheral blood, optionally wherein the tumor-promoting cytokines are TGF-beta or IL-10; (f) increasing tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; (g) decreasing activation of tumor-specific T lymphocytes with tumor killing potential; (h) decreasing infiltration of tumor-specific T lymphocytes with tumor killing potential; (i) decreasing infiltration of tumor-specific NK cells with tumor killing potential; (j) decreasing tumor killing potential of NK cells; (k) decreasing infiltration of tumor-specific B lymphocytes with potential to enhance immune response; (l) increasing tumor volume; (m) increasing tumor growth rate; (n) increasing metastasis; (o) increasing rate of tumor recurrence; (p) increasing expression of one or more PD-1 ligands; (q) decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more proteins selected from the group consisting of CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, BTLA, KIR, GAL9, TIM3, A2AR, LAG, DR-5, TREM1, TREM2, CSF-1 receptor, and any combination thereof, or of one or more cancer vaccines; (r) inhibition of PLCγ/PKC/calcium mobilization; (s) inhibition of PI3K/Akt, Ras/MAPK signaling; and (t) decreasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof. In some examplesthat may be combined with any of the preceding examples, the disease, disorder, or injury is cancer, and the agent exhibits one or more activities selected from the group consisting of consisting of: (a) increasing the number of tumor infiltrating $CD3^+$ T cells; (b) decreasing cellular levels of Siglec-9 in non-tumorigenic $CD14^+$myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (c) reducing the number of non-tumorigenic $CD14^+$ myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (d) reducing PD-L1 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (e) reducing PD-L2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (f) reducing B7-H2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (g) reducing B7-H3

levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (h) reducing CD200R levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (i) reducing CD163 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (j) reducing CD206 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (k) decreasing tumor growth rate of solid tumors; (l) reducing tumor volume; (m) increasing efficacy of one or more PD-1 inhibitors; (n) increasing efficacy of one or more checkpoint inhibitor therapies and/or immune-modulating therapies, optionally wherein the one or more checkpoint inhibitor therapies and/or immune-modulating therapies target one or more of CTLA4, the adenosine pathway, PD-L1, PD-L2, OX40, TIM3, LAG3, or any combination thereof; (o) increasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof; (p) increasing proliferation of T cells in the presence of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (q) inhibiting differentiation, survival, and/or one or more functions of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (r) killing Siglec-9-expressing immunosuppressor myeloid cells and/or CD14-expressing cells in solid tumors and associated blood vessels when conjugated to a chemical or radioactive toxin. In some examplesthat may be combined with any of the preceding examples, the agent exhibits one or more activities selected from the group consisting of consisting of: (a) increasing the number of tumor infiltrating $CD3^+$ T cells; (b) decreasing cellular levels of CD33 in non-tumorigenic $CD14^+$myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (c) reducing the number of non-tumorigenic $CD14^+$ myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (d) reducing PD-L1 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (e) reducing PD-L2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (f) reducing B7-H2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (g) reducing B7-H3 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (h) reducing CD200R levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (i) reducing CD163 levels in one or more cells, optionally

wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (j) reducing CD206 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (k) decreasing tumor growth rate of solid tumors; (l) reducing tumor volume; (m) increasing efficacy of one or more PD-1 inhibitors; (n) increasing efficacy of one or more checkpoint inhibitor therapies and/or immune-modulating therapies, optionally wherein the one or more checkpoint inhibitor therapies and/or immune-modulating therapies target one or more of CTLA4, the adenosine pathway, PD-L1, PD-L2, OX40, TIM3, LAG3, or any combination thereof; (o) increasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof; (p) increasing proliferation of T cells in the presence of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (q) inhibiting differentiation, survival, and/or one or more functions of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (r) killing CD33-expressing immunosuppressor myeloid cells and/or CD14-expressing cells in solid tumors and associated blood vessels when conjugated to a chemical or radioactive toxin. In some examples, the cancer is selected from the group consisting of bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), and multiple myeloma. In some examples, the agent is selected from the group consisting of an antibody, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a Siglec-9 immunoadhesin, an antisense molecule, an siRNA, a small molecule inhibitor, a protein, and a peptide. In some examples, the agent is an isolated anti-Siglec-9 antibody. In some examples, the anti-Siglec-9 antibody is the anti-Siglec-9 antibody of any of the preceding examples. In some examples, the one or more immune cells are selected from the group consisting of dendritic cells, macrophages, neutrophils, NK cells, microglia, T cells, T helper cells, cytotoxic T cells, and any combination thereof.

[0031] Also disclosed is a method of inducing or promoting the survival, maturation, functionality, migration, or proliferation of one or more immune cells in an individual in need thereof, comprising administering to the individual a therapeutically effective amount of an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both. Also disclosed is an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more

Siglec-9 ligands, or both for use in inducing or promoting the survival, maturation, functionality, migration, or proliferation of one or more immune cells in an individual in need thereof. Also disclosed is use of an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both in the manufacture of a medicament for inducing or promoting the survival, maturation, functionality, migration, or proliferation of one or more immune cells in an individual in need thereof. In some examplesthe one or more immune cells are selected from the group consisting of dendritic cells, macrophages, neutrophils, NK cells, microglia, T cells, T helper cells, cytotoxic T cells, and any combination thereof. In some examples, the agent is selected from the group consisting of an antibody, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a Siglec-9 immunoadhesin, an antisense molecule, an siRNA, a small molecule inhibitor, a protein, and a peptide. In some examples, the agent is an isolated anti-Siglec-9 antibody. In some examples, the anti-Siglec-9 antibody is the anti-Siglec-9 antibody of any of the preceding examples. In some examples, the one or more immune cells are selected from the group consisting of dendritic cells, macrophages, neutrophils, NK cells, microglia, T cells, T helper cells, cytotoxic T cells, and any combination thereof.

[0032] Also disclosed is a method of decreasing the activity, functionality, or survival of regulatory T cells, tumor-imbedded immunosuppressor dendritic cells, tumor-imbedded immunosuppressor macrophages, myeloid-derived suppressor cells, tumor-associated macrophages, acute myeloid leukemia (AML) cells, chronic lymphocytic leukemia (CLL) cell, or chronic myeloid leukemia (CML) cells in an individual in need thereof, comprising administering to the individual a therapeutically effective amount of an agent that binds or interacts with Siglec-9. Also disclosed is use of an agent that binds or interacts with Siglec-9 for use in decreasing the activity, functionality, or survival of regulatory T cells, tumor-imbedded immunosuppressor dendritic cells, tumor-imbedded immunosuppressor macrophages, myeloid-derived suppressor cells, tumor-associated macrophages, acute myeloid leukemia (AML) cells, chronic lymphocytic leukemia (CLL) cell, or chronic myeloid leukemia (CML) cells in an individual in need thereof. Also disclosed is use of an agent that binds or interacts with Siglec-9 in the manufacture of a medicament for decreasing the activity, functionality, or survival of regulatory T cells, tumor-imbedded immunosuppressor dendritic cells, tumor-imbedded immunosuppressor macrophages, myeloid-derived suppressor cells, tumor-associated macrophages, acute myeloid leukemia (AML) cells, chronic lymphocytic leukemia (CLL) cell, or chronic myeloid leukemia (CML) cells in an individual in need thereof. In some examples, the agent is an isolated anti-Siglec-9 antibody or anti-Siglec-9 antibody conjugate. In some examples, the anti-Siglec-9 antibody is the anti-Siglec-9 antibody of any of the preceding examples.

[0033] Also disclosed is relate a method of decreasing cellular levels of Siglec-9 on one or more cells in an individual in need thereof, comprising administering to the individual a therapeutically effective amount of an isolated anti-Siglec-9 antibody. Also disclosed is use of an isolated anti-Siglec-9 antibody for use in decreasing cellular levels of Siglec-9 on one or more cells in an individual in need thereof. Also disclosed is use of an isolated anti-Siglec-9 antibody in the manufacture of a medicament for decreasing cellular levels of Siglec-9 on one or more cells in an individual in need thereof. In some examples, the anti-Siglec-9 antibody decreases cellular levels of Siglec-9 *in vivo*. In some examples, the anti-Siglec-9 antibody is the anti-Siglec-9 antibody of any of the preceding examples.

[0034] In some examplesthat may be combined with any of the preceding examples, the method further comprising administering to the individual at least one antibody that specifically binds to an inhibitory checkpoint molecule, and/or one or more standard or investigational anti-cancer therapies. In some examplesthat may be combined with any of the preceding examples, the at least one antibody that specifically binds to an inhibitory checkpoint molecule is administered in combination with the anti-Siglec-9 antibody. In some examplesthat may be combined with any of the preceding examples, the at least one antibody that specifically binds to an inhibitory checkpoint molecule is selected from the group consisting of an anti-PD-L1 antibody, an anti-CTLA4 antibody, an anti-PD-L2 antibody, an anti-PD-1 antibody, an anti-B7-H3 antibody, an anti-B7-H4 antibody, and anti-HVEM antibody, an anti- B- and T-lymphocyte attenuator (BTLA) antibody, an anti-Killer inhibitory receptor (KIR) antibody, an anti-GAL9 antibody, an anti-TIM-1 antibody, an anti-TIM3 antibody, an anti-TIM-4 antibody, an anti-A2AR antibody, an anti-CD39 antibody, an anti-CD73 antibody, an anti-LAG-3 antibody, an anti-phosphatidylserine antibody, an anti-CD27 antibody, an anti-CD30 antibody, an anti-TNFa antibody, an anti-CD33 antibody, an anti-Siglec-5 antibody, an anti-Siglec-7 antibody, an anti-Siglec-11 antibody, an antagonistic anti-TREM1 antibody, an antagonistic anti-TREM2 antibody, an anti-TIGIT antibody, an anti-VISTA antibody, an anti-CD2 antibody, an anti-CD5 antibody, and any combination thereof. In some examplesthat may be combined with any of the preceding examples, the one or more standard or investigational anti-cancer therapies are selected from the group consisting of radiotherapy, cytotoxic chemotherapy, targeted therapy, imatinib therapy, trastuzumab therapy, etanercept therapy, adoptive cell transfer (ACT) therapy, chimeric antigen receptor T cell transfer (CAR-T) therapy, vaccine therapy, and cytokine therapy. In some examplesthat may be combined with any of the preceding examples, the method further comprising administering to the individual at least one antibody that specifically binds to an inhibitory cytokine. In some examplesthat may be combined with any of the preceding examples, the at least one antibody that specifically binds to an inhibitory

cytokine is administered in combination with the anti-Siglec-9 antibody. In some exampless that may be combined with any of the preceding examples, the at least one antibody that specifically binds to an inhibitory cytokine is selected from the group consisting of an anti-CCL2 antibody, an anti-CSF-1 antibody, an anti-IL-2 antibody, and any combination thereof. In some examplesthat may be combined with any of the preceding examples, the method further comprising administering to the individual at least one agonistic antibody that specifically binds to a stimulatory checkpoint protein. In some examplesthat may be combined with any of the preceding examples, the at least one agonistic antibody that specifically binds to a stimulatory checkpoint protein is administered in combination with the anti-Siglec-9 antibody. In some examplesthat may be combined with any of the preceding examples, the at least one agonistic antibody that specifically binds to a stimulatory checkpoint protein is selected from the group consisting of an agonist anti-CD40 antibody, an agonist anti-OX40 antibody, an agonist anti-ICOS antibody, an agonist anti-CD28 antibody, an agonistic anti-TREM1 antibody, an agonistic anti-TREM2 antibody, an agonist anti-CD137/4-1BB antibody, an agonist anti-CD27 antibody, an agonist anti-glucocorticoid-induced TNFR-related protein GITR antibody, an agonist anti-CD30 antibody, an agonist anti-BTLA antibody, an agonist anti-HVEM antibody, an agonist anti-CD2 antibody, an agonist anti-CD5 antibody, and any combination thereof. In some examplesthat may be combined with any of the preceding examples, the method further comprising administering to the individual at least one stimulatory cytokine. In some examplesthat may be combined with any of the preceding examples, the at least one stimulatory cytokine is administered in combination with the anti-Siglec-9 antibody. In some examplesthat may be combined with any of the preceding examples, the at least one stimulatory cytokine is selected from the group consisting of IFN-α4, IFN-β, IL-1β, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-23, CXCL10, IL-33, MCP-1, MIP-1-beta, and any combination thereof.

[0035] Also disclosed is a method of assessing responsiveness of a subject in need thereof to an agent that binds or interacts with Siglec-9, the method comprising: a. measuring the expression levels of $CD45^+$ and $CD14^+$ on non-tumorigenic myeloid cells in a blood sample obtained from the subject prior to administering to the subject an anti-Siglec-9 antibody; b. administering to the subject a therapeutically effective amount of the agent; and c. measuring the expression levels of $CD45^+$ and $CD14^+$ on non-tumorigenic myeloid cells in a blood sample obtained from the subject after administration of the anti-Siglec-9 antibody, wherein a reduction in the levels of $CD45^+$ $CD14^+$ on non-tumorigenic myeloid cells after administration of the anti-Siglec-9 antibody indicates the subject is responsive to the agent. In some examples, the method of assessing responsiveness further comprises administering one or more additional therapeutically effective

amounts of the agent. In some examplesthat may be combined with any of the preceding examples, the agent is selected from the group consisting of an antibody, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a Siglec-9 immunoadhesin, a soluble Siglec receptor, a Siglec-Fc fusion protein, a Siglec immunoadhesin, an antisense molecule, an siRNA, a small molecule inhibitor, a protein, and a peptide. In some examplesthat may be combined with any of the preceding examples, the agent is an isolated anti-Siglec-9 antibody or anti-Siglec-9 antibody conjugate. In some examplesthat may be combined with any of the preceding examples, the anti-Siglec-9 antibody is the anti-Siglec-9 antibody of any of the preceding examples.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] **FIG. 1A** depicts an amino acid sequence alignment between human Siglec-9 (SEQ ID NO: 1), chimpanzee Siglec-9 (SEQ ID NO: 2), green monkey Siglec-9 (SEQ ID NO: 3), rhesus macaque Siglec-9 (SEQ ID NO: 4), and mouse Siglec-9 (SEQ ID NO: 5). An asterisk ("*") indicates positions which have a single, fully conserved residue; A colon (":") indicates conservation between groups of strongly similar properties - scoring > 0.5 in the Gonnet PAM 250 matrix; and a period (".") indicates conservation between groups of weakly similar properties - scoring =< 0.5 in the Gonnet PAM 250 matrix. **FIG. 1B** depicts binding reactivity in percentage to wild-type Siglec-9 (% WT) of antibodies of the present disclosure to the indicated Siglec-9 mutants. **FIG. 1C** depicts a Phyre2-derived model of Siglec-9 (based on the crystal structure of Siglec-5; PDB ID 2ZG2) indicating amino acid residues involved in binding of anti-Siglec-9 antibody 2D4. Critical residues for binding are indicated with red spheres. **FIG. 1D** depicts a Phyre2-derived model of Siglec-9 (based on the crystal structure of Siglec-5; PDB ID 2ZG2) indicating amino acid residues involved in binding of anti-Siglec-9 antibody 5C6. Critical residues for binding are indicated with red spheres. **FIG. 1E** depicts a Phyre2-derived model of Siglec-9 (based on the crystal structure of Siglec-5; PDB ID 2ZG2) indicating amino acid residues involved in binding of anti-Siglec-9 antibody 12B12. Critical residues for binding are indicated with red spheres.

[0037] **FIG. 2** shows glycan-binding specificities of human Siglec proteins, such as Siglec-9. This figure shows a summary of the most commonly reported specificities for the most commonly studied sialylated glycans. Relative binding within studies of each Siglec is indicated as ++, strong binding; +, detectable binding; and –, very weak or undetectable binding. Not shown is the recently reported strong-binding preference of hSiglec-8 and mSiglec-F for 6′-sulfated-sialyl-Lewis x (sLex) and of hSiglec-9 for 6-sulfated-sLex. With a few exceptions (CD22 and MAG), results of binding specificity studies of human Siglecs by different investigators using different assays have varied significantly. In addition to assay formats and glycan linker issues, the density and arrangement of the ligands studied could be responsible for this variation (Varki et al., (2006) Glycobiol. 16:1R-27R).

[0038] **FIG. 3** shows the structure and metabolism of disialogangliosides in mammalian brain. The nomenclature of disialogangliosides in the figure follows the system of Svennerholm (1964) J. Lipid Res. 5:145–155 (Ariga T et al. (2008) J. Lipid Res. 49:1157-1175).

[0039] **FIG. 4** depicts results of FACS analysis demonstrating Siglec-9 expression in human primary immune cells.

[0040] **FIG. 5** depicts FACS analysis of Siglec-9 antibodies binding to human primary dendritic cells compared to isotype controls.

[0041] **FIG. 6A** depicts Biacore sensorgrams showing binding affinity of Siglec-9 antibodies of the present disclosure to purified Siglec-9-his tagged protein. **FIG. 6B** depicts ForteBio sensorgrams showing binding affinity of Siglec-9 antibodies of the present disclosure to purified Siglec-9-his tagged protein. **FIG. 6C** depicts shows a schematic for combining antibody light chain variable region (VL) sequences of humanized versions of anti-Siglec-9 antibody 5C6 (AbM S9-5C6.3). Additional variations are listed below each sequence. The figure includes sequences for versions of humanized antibody 5C6. In the figure, IGKV230*01 (SEQ ID NO: 213); Joining region (SEQ ID NO: 214); 5C6.3 (SEQ ID NO: 215); 2-30*01 (SEQ ID NO: 216); h5C6.3-L1 (SEQ ID NO: 217); h5C6.3-L2 (SEQ ID NO: 218); h5C6.3-L3 (SEQ ID NO: 219). **FIG. 6D** shows a schematic for combining antibody heavy chain variable region (VH) sequences of humanized versions of anti-Siglec-9 antibody 5C6 (AbM S9-5C6.3). Additional variations are listed below each sequence. The figure includes sequences for versions of humanized antibody 5C6. In the figure, IGHV1-18*01 (SEQ ID NO: 220); Joining region (SEQ ID NO: 221); 5C6.3 (SEQ ID NO: 222); 1-18*01 (SEQ ID NO: 223); h5C6.3-H1 (SEQ ID NO: 224); h5C6.3-H2 (SEQ ID NO: 225); h5C6.3-H3 (SEQ ID NO: 226) ; h5C6.3-H4 (SEQ ID NO: 227). **FIG. 6E** shows a schematic for combining antibody light chain variable region (VL) sequences of humanized versions of anti-Siglec-9 antibody 12B12 (AbM S9-12B12.2). Additional variations are listed below each sequence. The figure includes sequences for versions of humanized antibody 12B12. In the figure, IGKV1-39*01 (SEQ ID NO: 228); Joining region (SEQ ID NO: 229); 12B12.2 (SEQ ID NO: 230); 1-39*01 (SEQ ID NO: 231); h12B12.2-L1 (SEQ ID NO: 232); h12B12.2-L2 (SEQ ID NO: 233); h12B12.2-L3 (SEQ ID NO: 234). **FIG. 6F** shows a schematic for combining antibody heavy chain variable region (VH) sequences of humanized versions of anti-Siglec-9 antibody 12B12 (AbM S9-12B12.2). Additional variations are listed below each sequence. The figure includes sequences for versions of humanized antibody 12B12. In the figure, IGHV3-23*04 (SEQ ID NO: 235); Joining region (SEQ ID NO: 236); 12B12.2 (SEQ ID NO: 237); 3-23*04 (SEQ ID NO: 238); h12B12.2-H1 (SEQ ID NO: 239); h12B12.2-H2 (SEQ ID NO: 240). For **FIG. 6C-6F**, CDR sequences are depicted in bold; residue numbering shown as sequential (seq) or according to Chothia; "b" refers to buried sidechain; "p" refers to partially buried; "i" refers to sidechain at interface between VH and VL domains; sequence differences between human and

murine germlines are noted by an asterisk (*); potential additional mutations in frameworks are noted below the sequence; potential changes in CDR sequences are noted below each CDR sequence (such changes may prevent asparagine (N) deamidation, tryptophan (W) oxidation, or isoaspartate (DG) formation).

[0042] **FIG. 7A-7H** depict Siglec-9 antibody-dependent downregulation of cell surface Siglec-9 receptor on various human cell types. **FIG. 7A** depicts THP-1 acute monocytic lymphoma cells. **FIG. 7B** depicts human primary monocytes. **FIG. 7C** depicts human primary microglia. **FIG. 7D** depicts human primary macrophages. **FIG. 7E** depicts human primary dendritic cells. **FIG. 7F** depicts antibody titration with human primary dendritic cells. **FIG. 7G** shows *in vivo* reduction in cell surface levels of Siglec-9 following antibody treatment *in vivo*. **FIG. 7H** shows expression of unrelated receptor CD33. CD33 was used as a control. Cell surface levels of CD33 were not significantly reduced following antibody treatment *in vivo*. **FIG. 7I** depicts an antibody concentration titration curve for reducing cell surface expression of Siglec-9 on human primary macrophages with Siglec-9 antibodies 5C6 (S9-5C6), 12B12 (S9-12B12), 17C2 (S9-17C2), and isotype control (mIgG2a). **FIG. 7J** depicts an antibody concentration titration curve for reducing cell surface expression of control receptor CD11b on human primary macrophages with Siglec-9 antibodies 5C6 (S9-5C6), 12B12 (S9-12B12), 17C2 (S9-17C2), and isotype control (mIgG2a). **FIG. 7K** depicts Siglec-9 and CD33 expression in peripheral myeloid cells from humanized NSG mice 21 days after treatment with anti-Siglec-9 antibody 2D4 or isotype control antibody (MOPC-21). **FIG. 7L** shows *in vivo* reduction in cell surface levels of Siglec-9 following antibody treatment *in vivo*. **FIG. 7M** shows expression of unrelated receptor CD33. CD33 was used as a control. Cell surface levels of CD33 were not significantly reduced following antibody treatment *in vivo*. **FIG. 7N** shows FACS gating strategy for blood samples from humanized NSG mice 21 days after treatment with anti-Siglec-9 antibody 2D4 or isotype control antibody (MOPC21). **FIG. 7O** depicts levels of Siglec-9 surface expression and TREM2 surface expression on human dendritic cells after treatment with an anti-Siglec-9 antibody 2D4 or an isotype control antibody, as compared to a no antibody control. **FIG. 7P** depicts levels of CD11c surface expression, Siglec-9 surface expression, and TREM2 surface expression on human dendritic cells after treatment with an anti-Siglec-9 antibody 2D4. **FIG. 7Q** depicts ability of Siglec-9 antibodies of the present disclosure to block binding of Siglec-9 (Siglec-9-FC) to sialic acid ligands endogenously expressed on U937 cancer cells.

[0043] **FIG. 8** depicts FACS analysis showing that sialic acid ligands on dendritic cells restrict T cell proliferation during mixed lymphocyte reaction with human primary cells.

[0044] **FIG. 9** depicts results showing that sialic acid Siglec-9 ligands on dendritic cells restrict T cell proliferation during mixed lymphocyte reaction.

[0045] **FIG. 10A-10H** depict results showing Siglec-9 receptor and increased Siglec-9 ligand expression on human myeloid cells induced by various stimuli. **FIG. 10A and 10B** depict results showing Siglec-9 receptor and increased Siglec-9 ligand expression on human primary dendritic cells after treatment with tumor supernatant. **FIG. 10C and 10D** depict results showing increased Siglec-9 ligand expression on human primary dendritic cells after treatment with tumor supernatant. **FIG. 10E and 10F** depict results showing Siglec-9 receptor expression on human dendritic cells during LPS-induced inflammation. **FIG. 10G and 10H** depict results showing an increase in sialic acid expression on human myeloid cells during LPS-induced inflammation. These finding indicate that tumors can evade immune surveillance by upregulating the level of inhibitory ligands to Siglec-9 on the tumor cells and on immune cells.

[0046] **FIG. 11** depicts results showing that sialidase treatment to remove Siglec-9 ligands from *E. coli* increases phagocytosis by human primary dendritic cells.

[0047] **FIG. 12** depicts Siglec-9 ligand expression in brain sections from an Alzheimer's disease brain (AD) and a healthy brain (non-AD). **FIG. 12** shows immunohistochemistry staining of Siglec-9-Fc in AD and non-AD brain samples from two donors (Donor 1 and Donor 2).

[0048] **FIG. 13** depicts results showing that expression of inhibitory Siglec-9 ligands is increased in lung tumor cells, melanoma cells, and colon cancer cells. The results indicate that inhibitory Siglec-9 ligands contribute to cancer pathology in these tumor types.

[0049] **FIG. 14** depicts expression of Siglec-9 in cells of NOG mice injected with human peripheral blood cells. 12 weeks after engraftment with human fetal liver $CD34^+$ cells, humanized mice were transplanted with patient-derived melanoma. Peripheral blood, spleen, and tumor tissues were dissociated and analyzed for immune cell markers and Siglec-9 expression. For FACS analysis, human hematopoietic cells were identified by CD45 expression, then gated CD14+, CD3+ populations. The results indicate that inhibitory Siglec-9 ligands contribute to cancer pathology in this tumor type.

[0050] **FIG. 15A** depicts a PD-1/Siglec-9 combination antibody treatment protocol for a mouse model of patient-derived cancer in immunologically humanized mice. **FIG. 15B** depicts *in vivo* reduction in cell surface levels of Siglec-9 on CD14+ myeloid cells from blood samples of mice treated with Keytruda® (pembrolizumab) anti-PD-1 antibody alone or in combination with anti-Siglec-9 antibody 2D4. **FIG. 15C** depicts *in vivo* cell surface levels of control receptor CD33 on CD14+ myeloid cells from blood samples of mice treated with Keytruda® (pembrolizumab) anti-PD-1 antibody alone or in combination with anti-Siglec-9 antibody 2D4. **FIG. 15D** depicts *in vivo* reduction in peripheral blood $CD14^+$ myeloid cells from mice treated with Keytruda® (pembrolizumab) anti-PD-1 antibody alone or in combination with anti-Siglec-9 antibody 2D4. **FIG. 15E** depicts *in vivo* increase in peripheral blood $CD3^+$ T cells in blood samples from mice treated

with Keytruda® (pembrolizumab) anti-PD-1 antibody alone or in combination with anti-Siglec-9 antibody 2D4. **FIG. 15F** depicts *in vivo* reduction in tumor infiltrating $CD14^+$ myeloid cells from mice treated with Keytruda® (pembrolizumab) anti-PD-1 antibody alone or in combination with anti-Siglec-9 antibody 2D4. **FIG. 15G** depicts *in vivo* increase in tumor infiltrating $CD3^+$ T cells from mice treated with Keytruda® (pembrolizumab) anti-PD-1 antibody alone or in combination with anti-Siglec-9 antibody 2D4. **FIG. 15H** depicts mean tumor volume after treatment with Keytruda® (pembrolizumab) anti-PD-1 antibody alone or in combination with anti-Siglec-9 antibody 2D4 in mice that were engrafted with human immune stem cells from human donor 984480112. **FIG. 15I** depicts mean tumor volume after treatment with Keytruda® (pembrolizumab) anti-PD-1 antibody alone or in combination with anti-Siglec-9 antibody 2D4 in mice that were engrafted with human immune stem cells from human donor 17509112. **FIG. 15J** depicts mean tumor volume after treatment with Keytruda® (pembrolizumab) anti-PD-1 antibody alone or in combination with anti-Siglec-9 antibody2D4 in mice that were engrafted with human immune stem cells from human donor 165547112.

DETAILED DESCRIPTION OF THE INVENTION

General techniques

[0051] The techniques and procedures described or referenced herein are generally well understood and commonly employed using conventional methodology by those skilled in the art, such as, for example, the widely utilized methodologies described in Sambrook et al., *Molecular Cloning: A Laboratory Manual* 3d edition (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y.; *Current Protocols in Molecular Biology* (F.M. Ausubel, et al. eds., (2003)); the series *Methods in Enzymology* (Academic Press, Inc.): *PCR 2: A Practical Approach* (M.J. MacPherson, B.D. Hames and G.R. Taylor eds. (1995)), Harlow and Lane, eds. (1988) *Antibodies, A Laboratory Manual*, and *Animal Cell Culture* (R.I. Freshney, ed. (1987)); *Oligonucleotide Synthesis* (M.J. Gait, ed., 1984); *Methods in Molecular Biology*, Humana Press; *Cell Biology: A Laboratory Notebook* (J.E. Cellis, ed., 1998) Academic Press; *Animal Cell Culture* (R.I. Freshney), ed., 1987); *Introduction to Cell and Tissue Culture* (J.P. Mather and P.E. Roberts, 1998) Plenum Press; *Cell and Tissue Culture: Laboratory Procedures* (A. Doyle, J.B. Griffiths, and D.G. Newell, eds., 1993-8) J. Wiley and Sons; *Handbook of Experimental Immunology* (D.M. Weir and C.C. Blackwell, eds.); *Gene Transfer Vectors for Mammalian Cells* (J.M. Miller and M.P. Calos, eds., 1987); *PCR: The Polymerase Chain Reaction*, (Mullis et al., eds., 1994); *Current Protocols in Immunology* (J.E. Coligan et al., eds., 1991); *Short Protocols in Molecular Biology* (Wiley and Sons, 1999); *Immunobiology* (C.A. Janeway and P. Travers, 1997); *Antibodies* (P. Finch, 1997); *Antibodies: A Practical Approach* (D. Catty., ed., IRL Press, 1988-1989); *Monoclonal Antibodies: A Practical Approach* (P. Shepherd and C. Dean,

eds., Oxford University Press, 2000); *Using Antibodies: A Laboratory Manual* (E. Harlow and D. Lane (Cold Spring Harbor Laboratory Press, 1999); *The Antibodies* (M. Zanetti and J. D. Capra, eds., Harwood Academic Publishers, 1995); and *Cancer: Principles and Practice of Oncology* (V.T. DeVita et al., eds., J.B. Lippincott Company, 1993).

Definitions

[0052] As used herein, the term "*preventing*" includes providing prophylaxis with respect to occurrence or recurrence of a particular disease, disorder, or condition in an individual. An individual may be predisposed to, susceptible to a particular disease, disorder, or condition, or at risk of developing such a disease, disorder, or condition, but has not yet been diagnosed with the disease, disorder, or condition.

[0053] As used herein, an individual "*at risk*" of developing a particular disease, disorder, or condition may or may not have detectable disease or symptoms of disease, and may or may not have displayed detectable disease or symptoms of disease prior to the treatment methods described herein. "At risk" denotes that an individual has one or more risk factors, which are measurable parameters that correlate with development of a particular disease, disorder, or condition, as known in the art. An individual having one or more of these risk factors has a higher probability of developing a particular disease, disorder, or condition than an individual without one or more of these risk factors.

[0054] As used herein, the term "*treatment*" refers to clinical intervention designed to alter the natural course of the individual being treated during the course of clinical pathology. Desirable effects of treatment include decreasing the rate of progression, ameliorating or palliating the pathological state, and remission or improved prognosis of a particular disease, disorder, or condition. An individual is successfully "treated", for example, if one or more symptoms associated with a particular disease, disorder, or condition are mitigated or eliminated.

[0055] An "*effective amount*" refers to at least an amount effective, at dosages and for periods of time necessary, to achieve the desired therapeutic or prophylactic result. An effective amount can be provided in one or more administrations. An effective amount herein may vary according to factors such as the disease state, age, sex, and weight of the individual, and the ability of the treatment to elicit a desired response in the individual. An effective amount is also one in which any toxic or detrimental effects of the treatment are outweighed by the therapeutically beneficial effects. For prophylactic use, beneficial or desired results include results such as eliminating or reducing the risk, lessening the severity, or delaying the onset of the disease, including biochemical, histological and/or behavioral symptoms of the disease, its complications and intermediate pathological phenotypes presenting during development of the disease. For therapeutic use, beneficial or desired results include clinical results such as decreasing one or more symptoms resulting from the disease, increasing the quality of life of those suffering from the disease, decreasing the dose of other

medications required to treat the disease, enhancing effect of another medication such as via targeting, delaying the progression of the disease, and/or prolonging survival. An effective amount of drug, compound, or pharmaceutical composition is an amount sufficient to accomplish prophylactic or therapeutic treatment either directly or indirectly. As is understood in the clinical context, an effective amount of a drug, compound, or pharmaceutical composition may or may not be achieved in conjunction with another drug, compound, or pharmaceutical composition. Thus, an "effective amount" may be considered in the context of administering one or more therapeutic agents, and a single agent may be considered to be given in an effective amount if, in conjunction with one or more other agents, a desirable result may be or is achieved..

[0056] A "*therapeutically effective amount*" is at least the minimum concentration required to effect a measurable improvement of a particular disease, disorder, or condition. A therapeutically effective amount herein may vary according to factors such as the disease state, age, sex, and weight of the patient, and the ability of the Siglec-9 protein antagonist to elicit a desired response in the individual. A therapeutically effective amount is also one in which any toxic or detrimental effects of the Siglec-9 protein antagonist are outweighed by the therapeutically beneficial effects.

[0057] As used herein, administration "*in conjunction*" with another compound or composition includes simultaneous administration and/or administration at different times. Administration in conjunction also encompasses administration as a co-formulation or administration as separate compositions, including at different dosing frequencies or intervals, and using the same route of administration or different routes of administration.

[0058] An "*individual*" for purposes of treatment, prevention, or reduction of risk refers to any animal classified as a mammal, including humans, domestic and farm animals, and zoo, sport, or pet animals, such as dogs, horses, rabbits, cattle, pigs, hamsters, gerbils, mice, ferrets, rats, cats, and the like. Preferably, the individual is human.

[0059] The term "*immunoglobulin*" (Ig) is used interchangeably with "*antibody*" herein. The term "antibody" herein is used in the broadest sense and specifically covers monoclonal antibodies, polyclonal antibodies, multispecific antibodies (*e.g.* bispecific antibodies) formed from at least two intact antibodies, and antibody fragments so long as they exhibit the desired biological activity.

[0060] The basic 4-chain antibody unit is a heterotetrameric glycoprotein composed of two identical light (L) chains and two identical heavy (H) chains. The pairing of a V_H and V_L together forms a single antigen-binding site. For the structure and properties of the different classes of antibodies, *see, e.g.*, *Basic and Clinical Immunology*, 8th Ed., Daniel P. Stites, Abba I. Terr and Tristram G. Parslow (eds.), Appleton & Lange, Norwalk, CT, 1994, page 71 and Chapter 6.

[0061] The L chain from any vertebrate species can be assigned to one of two clearly distinct types, called kappa ("κ") and lambda ("λ"), based on the amino acid sequences of their constant

domains. Depending on the amino acid sequence of the constant domain of their heavy chains (CH), immunoglobulins can be assigned to different classes or isotypes. There are five classes of immunoglobulins: IgA, IgD, IgE, IgG, and IgM, having heavy chains designated alpha ("α"), delta ("δ"), epsilon ("ε"), gamma ("γ") and mu ("μ"), respectively. The γ and α classes are further divided into subclasses (isotypes) on the basis of relatively minor differences in the CH sequence and function, *e.g.*, humans express the following subclasses: IgG1, IgG2, IgG3, IgG4, IgA1, and IgA2. The subunit structures and three dimensional configurations of different classes of immunoglobulins are well known and described generally in, for example, Abbas *et al.*, Cellular and Molecular Immunology, 4th ed. (W.B. Saunders Co., 2000).

[0062] "*Native antibodies*" are usually heterotetrameric glycoproteins of about 150,000 daltons, composed of two identical light (L) chains and two identical heavy (H) chains. Each light chain is linked to a heavy chain by one covalent disulfide bond, while the number of disulfide linkages varies among the heavy chains of different immunoglobulin isotypes. Each heavy and light chain also has regularly spaced intrachain disulfide bridges. Each heavy chain has at one end a variable domain (V_H) followed by a number of constant domains. Each light chain has a variable domain at one end (V_L) and a constant domain at its other end; the constant domain of the light chain is aligned with the first constant domain of the heavy chain, and the light chain variable domain is aligned with the variable domain of the heavy chain. Particular amino acid residues are believed to form an interface between the light chain and heavy chain variable domains.

[0063] An "*isolated*" antibody, such as an anti-Siglec-9 antibody of the present disclosure, is one that has been identified, separated and/or recovered from a component of its production environment (*e.g.*, naturally or recombinantly). Preferably, the isolated polypeptide is free of association with all other contaminant components from its production environment. Contaminant components from its production environment, such as those resulting from recombinant transfected cells, are materials that would typically interfere with research, diagnostic or therapeutic uses for the antibody, and may include enzymes, hormones, and other proteinaceous or non-proteinaceous solutes. In preferred embodiments, the polypeptide will be purified: (1) to greater than 95% by weight of antibody as determined by, for example, the Lowry method, and in some embodiments, to greater than 99% by weight; (2) to a degree sufficient to obtain at least 15 residues of N-terminal or internal amino acid sequence by use of a spinning cup sequenator, or (3) to homogeneity by SDS-PAGE under non-reducing or reducing conditions using Coomassie blue or, preferably, silver stain. Isolated antibody includes the antibody *in situ* within recombinant T cells since at least one component of the antibody's natural environment will not be present. Ordinarily, however, an isolated polypeptide or antibody will be prepared by at least one purification step.

[0064] The "*variable region*" or "*variable domain*" of an antibody, such as an anti-Siglec-9 antibody of the present disclosure, refers to the amino-terminal domains of the heavy or light chain of the antibody. The variable domains of the heavy chain and light chain may be referred to as "V_H" and "V_L", respectively. These domains are generally the most variable parts of the antibody (relative to other antibodies of the same class) and contain the antigen binding sites.

[0065] The term "*variable*" refers to the fact that certain segments of the variable domains differ extensively in sequence among antibodies, such as anti-Siglec-9 antibodies of the present disclosure,. The V domain mediates antigen binding and defines the specificity of a particular antibody for its particular antigen. However, the variability is not evenly distributed across the entire span of the variable domains. Instead, it is concentrated in three segments called hypervariable regions (HVRs) both in the light-chain and the heavy chain variable domains. The more highly conserved portions of variable domains are called the framework regions (FR). The variable domains of native heavy and light chains each comprise four FR regions, largely adopting a beta-sheet configuration, connected by three HVRs, which form loops connecting, and in some cases forming part of, the beta-sheet structure. The HVRs in each chain are held together in close proximity by the FR regions and, with the HVRs from the other chain, contribute to the formation of the antigen binding site of antibodies (*see* Kabat et al., *Sequences of Immunological Interest*, Fifth Edition, National Institute of Health, Bethesda, MD (1991)). The constant domains are not involved directly in the binding of antibody to an antigen, but exhibit various effector functions, such as participation of the antibody in antibody-dependent-cellular toxicity.

[0066] The term "*monoclonal antibody*" as used herein refers to an antibody, such as an anti-Siglec-9 antibody of the present disclosure, obtained from a population of substantially homogeneous antibodies, *i.e.*, the individual antibodies comprising the population are identical except for possible naturally occurring mutations and/or post-translation modifications (*e.g.*, isomerizations, amidations) that may be present in minor amounts. Monoclonal antibodies are highly specific, being directed against one or more antigenic sites. In some embodiments, a monoclonal antibody of the present disclosure can be a bispecific antibody. In contrast to polyclonal antibody preparations which typically include different antibodies directed against different determinants (epitopes), each monoclonal antibody is directed against a single determinant on the one or more antigenic sites. The modifier "monoclonal" indicates the character of the antibody as being obtained from a substantially homogeneous population of antibodies, and is not to be construed as requiring production of the antibody by any particular method. For example, the monoclonal antibodies to be used in accordance with the present disclosure may be made by a variety of techniques, including, for example, phage-display technologies (*see, e.g.*, Clackson *et al.*, *Nature*, 352:624-628 (1991); Marks *et al.*, *J. Mol. Biol.* 222:581-597 (1992); Sidhu *et al.*, *J. Mol. Biol.* 338(2): 299-310 (2004); Lee et al., *J. Mol. Biol.*

340(5):1073-1093 (2004); Fellouse, *Proc. Nat'l Acad. Sci. USA* 101(34):12467-472 (2004); and Lee *et al.*, *J. Immunol. Methods* 284(1-2):119-132 (2004), the hybridoma method (*e.g.*, Kohler and Milstein., *Nature*, 256:495-97 (1975); Hongo et al., *Hybridoma,* 14 (3):253-260 (1995), Harlow et al., *Antibodies: A Laboratory Manual*, (Cold Spring Harbor Laboratory Press, 2d ed. 1988); Hammerling et al., in: *Monoclonal Antibodies and T-Cell Hybridomas* 563-681 (Elsevier, N.Y., 1981)), recombinant DNA methods (see, *e.g.*, U.S. Patent No. 4,816,567), and technologies for producing human or human-like antibodies in animals that have parts or all of the human immunoglobulin loci or genes encoding human immunoglobulin sequences (see, *e.g.*, WO 1998/24893; WO 1996/34096; WO 1996/33735; WO 1991/10741; Jakobovits et al., *Proc. Nat'l Acad. Sci. USA* 90:2551 (1993); Jakobovits *et al.*, *Nature* 362:255-258 (1993); Bruggemann *et al.*, *Year in Immunol.* 7:33 (1993); U.S. Patent Nos. 5,545,807; 5,545,806; 5,569,825; 5,625,126; 5,633,425; and 5,661,016; Marks *et al.*, *Bio/Technology* 10:779-783 (1992); Lonberg *et al.*, *Nature* 368:856-859 (1994); Morrison, *Nature* 368:812-813 (1994); Fishwild et al., *Nature Biotechnol.* 14:845-851 (1996); Neuberger, *Nature Biotechnol.* 14:826 (1996); and Lonberg and Huszar, *Intern. Rev. Immunol.* 13:65-93 (1995).

[0067] The terms "*full-length antibody*," "*intact antibody*" or "*whole antibody*" are used interchangeably to refer to an antibody, such as an anti-Siglec-9 antibody of the present disclosure, in its substantially intact form, as opposed to an antibody fragment. Specifically whole antibodies include those with heavy and light chains including an Fc region. The constant domains may be native sequence constant domains (*e.g.*, human native sequence constant domains) or amino acid sequence variants thereof. In some cases, the intact antibody may have one or more effector functions.

[0068] An "*antibody fragment*" comprises a portion of an intact antibody, preferably the antigen binding and/or the variable region of the intact antibody. Examples of antibody fragments include Fab, Fab', $F(ab')_2$ and Fv fragments; diabodies; linear antibodies (*see* U.S. Patent 5,641,870, Example 2; Zapata et al., *Protein Eng.* 8(10):1057-1062 (1995)); single-chain antibody molecules and multispecific antibodies formed from antibody fragments.

[0069] Papain digestion of antibodies, such as anti-Siglec-9 antibodies of the present disclosure, produces two identical antigen-binding fragments, called "*Fab*" fragments, and a residual "*Fc*" fragment, a designation reflecting the ability to crystallize readily. The Fab fragment consists of an entire L chain along with the variable region domain of the H chain (V_H), and the first constant domain of one heavy chain (C_H1). Each Fab fragment is monovalent with respect to antigen binding, *i.e.*, it has a single antigen-binding site. Pepsin treatment of an antibody yields a single large $F(ab')_2$ fragment which roughly corresponds to two disulfide linked Fab fragments having different antigen-binding activity and is still capable of cross-linking antigen. Fab' fragments differ from Fab fragments by having a few additional residues at the carboxy terminus of the C_H1 domain including

one or more cysteines from the antibody hinge region. Fab'-SH is the designation herein for Fab' in which the cysteine residue(s) of the constant domains bear a free thiol group. $F(ab')_2$ antibody fragments originally were produced as pairs of Fab' fragments which have hinge cysteines between them. Other chemical couplings of antibody fragments are also known.

[0070] The Fc fragment comprises the carboxy-terminal portions of both H chains held together by disulfides. The effector functions of antibodies are determined by sequences in the Fc region, the region which is also recognized by Fc receptors (FcR) found on certain types of cells.

[0071] "*Fv*" is the minimum antibody fragment which contains a complete antigen-recognition and -binding site. This fragment consists of a dimer of one heavy- and one light-chain variable region domain in tight, non-covalent association. From the folding of these two domains emanate six hypervariable loops (3 loops each from the H and L chain) that contribute the amino acid residues for antigen binding and confer antigen binding specificity to the antibody. However, even a single variable domain (or half of an Fv comprising only three HVRs specific for an antigen) has the ability to recognize and bind antigen, although at a lower affinity than the entire binding site.

[0072] *"Single-chain Fv"* also abbreviated as *"sFv"* or *"scFv"* are antibody fragments that comprise the VH and VL antibody domains connected into a single polypeptide chain. Preferably, the sFv polypeptide further comprises a polypeptide linker between the V_H and V_L domains which enables the sFv to form the desired structure for antigen binding. For a review of the sFv, *see* Pluckthun in *The Pharmacology of Monoclonal Antibodies*, vol. 113, Rosenburg and Moore eds., Springer-Verlag, New York, pp. 269-315 (1994).

[0073] "*Functional fragments*" of antibodies, such as anti-Siglec-9 antibodies of the present disclosure, comprise a portion of an intact antibody, generally including the antigen binding or variable region of the intact antibody or the F region of an antibody which retains or has modified FcR binding capability. Examples of antibody fragments include linear antibody, single-chain antibody molecules and multispecific antibodies formed from antibody fragments.

[0074] The term "*diabodies*" refers to small antibody fragments prepared by constructing sFv fragments (see preceding paragraph) with short linkers (about 5-10) residues) between the V_H and V_L domains such that inter-chain but not intra-chain pairing of the V domains is achieved, thereby resulting in a bivalent fragment, *i.e.*, a fragment having two antigen-binding sites. Bispecific diabodies are heterodimers of two "crossover" sFv fragments in which the V_H and V_L domains of the two antibodies are present on different polypeptide chains. Diabodies are described in greater detail in, for example, EP 404,097; WO 93/11161; Hollinger et al., *Proc. Nat'l Acad. Sci. USA* 90:6444-48 (1993).

[0075] As used herein, a "chimeric antibody" refers to an antibody (immunoglobulin), such as an anti-Siglec-9 antibody of the present disclosure, in which a portion of the heavy and/or light chain

is identical with or homologous to corresponding sequences in antibodies derived from a particular species or belonging to a particular antibody class or subclass, while the remainder of the chain(s) is(are) identical with or homologous to corresponding sequences in antibodies derived from another species or belonging to another antibody class or subclass, as well as fragments of such antibodies, so long as they exhibit the desired biological activity (U.S. Patent No. 4,816,567; Morrison et al., *Proc. Nat'l Acad. Sci. USA*, 81:6851-55 (1984)). Chimeric antibodies of interest herein include PRIMATIZED® antibodies wherein the antigen-binding region of the antibody is derived from an antibody produced by, *e.g.*, immunizing macaque monkeys with an antigen of interest. As used herein, "humanized antibody" is used a subset of "chimeric antibodies."

[0076] "*Humanized*" forms of non-human (*e.g.*, murine) antibodies, such as anti-Siglec-9 antibodies of the present disclosure, are chimeric antibodies that contain minimal sequence derived from non-human immunoglobulin. In one embodiment, a humanized antibody is a human immunoglobulin (recipient antibody) in which residues from an HVR of the recipient are replaced by residues from an HVR of a non-human species (donor antibody) such as mouse, rat, rabbit or non-human primate having the desired specificity, affinity, and/or capacity. In some instances, FR residues of the human immunoglobulin are replaced by corresponding non-human residues. Furthermore, humanized antibodies may comprise residues that are not found in the recipient antibody or in the donor antibody. These modifications may be made to further refine antibody performance, such as binding affinity. In general, a humanized antibody will comprise substantially all of at least one, and typically two, variable domains, in which all or substantially all of the hypervariable loops correspond to those of a non-human immunoglobulin sequence, and all or substantially all of the FR regions are those of a human immunoglobulin sequence, although the FR regions may include one or more individual FR residue substitutions that improve antibody performance, such as binding affinity, isomerization, immunogenicity, and the like. The number of these amino acid substitutions in the FR is typically no more than 6 in the H chain, and in the L chain, no more than 3. The humanized antibody optionally will also comprise at least a portion of an immunoglobulin constant region (Fc), typically that of a human immunoglobulin. For further details, *see, e.g.*, Jones et al., *Nature* 321:522-525 (1986); Riechmann et al., *Nature* 332:323-329 (1988); and Presta, *Curr. Op. Struct. Biol.* 2:593-596 (1992). *See also*, for example, Vaswani and Hamilton, *Ann. Allergy, Asthma & Immunol.* 1:105-115 (1998); Harris, *Biochem. Soc. Transactions* 23:1035-1038 (1995); Hurle and Gross, *Curr. Op. Biotech.* 5:428-433 (1994); and U.S. Patent Nos. 6,982,321 and 7,087,409.

[0077] A "*human antibody*" is one that possesses an amino-acid sequence corresponding to that of an antibody, such as an anti-Siglec-9 antibody of the present disclosure, produced by a human and/or has been made using any of the techniques for making human antibodies as disclosed herein.

This definition of a human antibody specifically excludes a humanized antibody comprising non-human antigen-binding residues. Human antibodies can be produced using various techniques known in the art, including phage-display libraries. Hoogenboom and Winter, *J. Mol. Biol.*, 227:381 (1991); Marks et al., *J. Mol. Biol.*, 222:581 (1991). Also available for the preparation of human monoclonal antibodies are methods described in Cole et al., *Monoclonal Antibodies and Cancer Therapy*, Alan R. Liss, p. 77 (1985); Boerner et al., *J. Immunol.*, 147(1):86-95 (1991). *See also* van Dijk and van de Winkel, *Curr. Opin. Pharmacol.* 5:368-74 (2001). Human antibodies can be prepared by administering the antigen to a transgenic animal that has been modified to produce such antibodies in response to antigenic challenge, but whose endogenous loci have been disabled, *e.g.*, immunized xenomice (*see, e.g.*, U.S. Patent Nos. 6,075,181 and 6,150,584 regarding XENOMOUSE™ technology). *See also*, for example, Li et al., *Proc. Nat'l Acad. Sci. USA*, 103:3557-3562 (2006) regarding human antibodies generated via a human B-cell hybridoma technology.

[0078] The term "*hypervariable region*," "*HVR*," or "*HV*," when used herein refers to the regions of an antibody-variable domain, such as that of an anti-Siglec-9 antibody of the present disclosure, that are hypervariable in sequence and/or form structurally defined loops. Generally, antibodies comprise six HVRs; three in the VH (H1, H2, H3), and three in the VL (L1, L2, L3). In native antibodies, H3 and L3 display the most diversity of the six HVRs, and H3 in particular is believed to play a unique role in conferring fine specificity to antibodies. *See, e.g.*, Xu et al., *Immunity* 13:37-45 (2000); Johnson and Wu in *Methods in Molecular Biology* 248:1-25 (Lo, ed., Human Press, Totowa, NJ, 2003)). Indeed, naturally occurring camelid antibodies consisting of a heavy chain only are functional and stable in the absence of light chain. See, *e.g.*, Hamers-Casterman et al., *Nature* 363:446-448 (1993) and Sheriff et al., *Nature Struct. Biol.* 3:733-736 (1996).

[0079] A number of HVR delineations are in use and are encompassed herein. The HVRs that are EU or Kabat complementarity-determining regions (CDRs) are based on sequence variability and are the most commonly used (Kabat et al., *supra*). Chothia refers instead to the location of the structural loops (Chothia and Lesk *J. Mol. Biol.* 196:901-917 (1987)). The AbM HVRs represent a compromise between the EU or Kabat CDRs and Chothia structural loops, and are used by Oxford Molecular's AbM antibody-modeling software. The "contact" HVRs are based on an analysis of the available complex crystal structures. The residues from each of these HVRs are noted below.

Loop	Kabat	AbM	Chothia	Contact
L1	L24-L34	L24-L34	L26-L32	L30-L36
L2	L50-L56	L50-L56	L50-L52	L46-L55
L3	L89-L97	L89-L97	L91-L96	L89-L96
H1	H31-H35B	H26-H35B	H26-H32	H30-H35B (Kabat numbering)
H1	H31-H35	H26-H35	H26-H32	H30-H35 (Chothia numbering)
H2	H50-H65	H50-H58	H53-H55	H47-H58
H3	H95-H102	H95-H102	H96-H101	H93-H101

[0080] HVRs may comprise "extended HVRs" as follows: 24-36 or 24-34 (L1), 46-56 or 50-56 (L2), and 89-97 or 89-96 (L3) in the VL, and 26-35 (H1), 50-65 or 49-65 (a preferred embodiment) (H2), and 93-102, 94-102, or 95-102 (H3) in the VH. The variable-domain residues are numbered according to EU or Kabat et al., *supra*, for each of these extended-HVR definitions.

[0081] "*Framework*" or "*FR*" residues are those variable-domain residues other than the HVR residues as herein defined.

[0082] The phrase "*variable-domain residue-numbering as in EU or Kabat*" or "*amino-acid-position numbering as in EU or Kabat*," and variations thereof, refers to the numbering system used for heavy-chain variable domains or light-chain variable domains of the compilation of antibodies in EU or Kabat et al., *supra*. Using this numbering system, the actual linear amino acid sequence may contain fewer or additional amino acids corresponding to a shortening of, or insertion into, a FR or HVR of the variable domain. For example, a heavy-chain variable domain may include a single amino acid insert (residue 52a according to Kabat) after residue 52 of H2 and inserted residues (*e.g.*, residues 82a, 82b, and 82c, *etc.* according to Kabat) after heavy-chain FR residue 82. The EU or Kabat numbering of residues may be determined for a given antibody by alignment at regions of homology of the sequence of the antibody with a "standard" Kabat numbered sequence.

[0083] The EU or Kabat numbering system is generally used when referring to a residue in the variable domain (approximately residues 1-107 of the light chain and residues 1-113 of the heavy chain) (*e.g.*, Kabat et al., Sequences of Immunological Interest. 5th Ed. Public Health Service, National Institutes of Health, Bethesda, Md. (1991)). The "EU or Kabat numbering system" or "EU index" is generally used when referring to a residue in an immunoglobulin heavy chain constant region (*e.g.*, the EU index reported in Kabat *et al., supra*). The "EU index as in Kabat" refers to the residue numbering of the human IgG1 EU antibody. Unless stated otherwise herein, references to residue numbers in the variable domain of antibodies means residue numbering by the Kabat numbering system. Unless stated otherwise herein, references to residue numbers in the constant domain of antibodies means residue numbering by the EU or Kabat numbering system (*e.g., see* United States Patent Publication No. 2010-280227).

[0084] An "*acceptor human framework*" as used herein is a framework comprising the amino acid sequence of a VL or VH framework derived from a human immunoglobulin framework or a human consensus framework. An acceptor human framework "derived from" a human immunoglobulin framework or a human consensus framework may comprise the same amino acid sequence thereof, or it may contain pre-existing amino acid sequence changes. In some embodiments, the number of pre-existing amino acid changes are 10 or less, 9 or less, 8 or less, 7 or less, 6 or less, 5 or less, 4 or less, 3 or less, or 2 or less. Where pre-existing amino acid changes are present in a VH, preferable those changes occur at only three, two, or one of positions 71H, 73H and

78H; for instance, the amino acid residues at those positions may by 71A, 73T and/or 78A. In one embodiment, the VL acceptor human framework is identical in sequence to the VL human immunoglobulin framework sequence or human consensus framework sequence.

[0085] A "*human consensus framework*" is a framework that represents the most commonly occurring amino acid residues in a selection of human immunoglobulin VL or VH framework sequences. Generally, the selection of human immunoglobulin VL or VH sequences is from a subgroup of variable domain sequences. Generally, the subgroup of sequences is a subgroup as in Kabat et al., *Sequences of Proteins of Immunological Interest*, 5th Ed. Public Health Service, National Institutes of Health, Bethesda, MD (1991). Examples include for the VL, the subgroup may be subgroup kappa I, kappa II, kappa III or kappa IV as in Kabat *et al., supra.* Additionally, for the VH, the subgroup may be subgroup I, subgroup II, or subgroup III as in Kabat *et al., supra.*

[0086] An "*amino-acid modification*" at a specified position, *e.g.*, of an anti-Siglec-9 antibody of the present disclosure, refers to the substitution or deletion of the specified residue, or the insertion of at least one amino acid residue adjacent the specified residue. Insertion "adjacent" to a specified residue means insertion within one to two residues thereof. The insertion may be N-terminal or C-terminal to the specified residue. The preferred amino acid modification herein is a substitution.

[0087] An "*affinity-matured*" antibody, such as an anti-Siglec-9 antibody of the present disclosure, is one with one or more alterations in one or more HVRs thereof that result in an improvement in the affinity of the antibody for antigen, compared to a parent antibody that does not possess those alteration(s). In one embodiment, an affinity-matured antibody has nanomolar or even picomolar affinities for the target antigen. Affinity-matured antibodies are produced by procedures known in the art. For example, Marks et al., *Bio/Technology* 10:779-783 (1992) describes affinity maturation by VH- and VL-domain shuffling. Random mutagenesis of HVR and/or framework residues is described by, for example: Barbas et al. *Proc Nat. Acad. Sci. USA* 91:3809-3813 (1994); Schier et al. *Gene* 169:147-155 (1995); Yelton et al. *J. Immunol.* 155:1994-2004 (1995); Jackson et al., *J. Immunol.* 154(7):3310-9 (1995); and Hawkins *et al, J. Mol. Biol.* 226:889-896 (1992).

[0088] As use herein, the term "*specifically recognizes*" or "*specifically binds*" refers to measurable and reproducible interactions such as attraction or binding between a target and an antibody, such as an anti-Siglec-9 antibody of the present disclosure, that is determinative of the presence of the target in the presence of a heterogeneous population of molecules including biological molecules. For example, an antibody, such as an anti-Siglec-9 antibody of the present disclosure, that specifically or preferentially binds to a target or an epitope is an antibody that binds this target or epitope with greater affinity, avidity, more readily, and/or with greater duration than it binds to other targets or other epitopes of the target. It is also understood by reading this definition that, for example, an antibody (or a moiety) that specifically or preferentially binds to a first target

may or may not specifically or preferentially bind to a second target. As such, "*specific binding*" or "*preferential binding*" does not necessarily require (although it can include) exclusive binding. An antibody that specifically binds to a target may have an association constant of at least about $10^{3}\ M^{-1}$ or $10^{4}\ M^{-1}$, sometimes about $10^{5}\ M^{-1}$ or $10^{6}\ M^{-1}$, in other instances about $10^{6}\ M^{-1}$ or $10^{7}\ M^{-1}$, about $10^{8}\ M^{-1}$ to $10^{9}\ M^{-1}$, or about $10^{10}\ M^{-1}$ to $10^{11}\ M^{-1}$ or higher. A variety of immunoassay formats can be used to select antibodies specifically immunoreactive with a particular protein. For example, solid-phase ELISA immunoassays are routinely used to select monoclonal antibodies specifically immunoreactive with a protein. *See, e.g.*, Harlow and Lane (1988) Antibodies, A Laboratory Manual, Cold Spring Harbor Publications, New York, for a description of immunoassay formats and conditions that can be used to determine specific immunoreactivity.

[0089] As used herein, an "*interaction*" between a Siglec-9 protein and a second protein encompasses, without limitation, protein-protein interaction, a physical interaction, a chemical interaction, binding, covalent binding, and ionic binding. As used herein, an antibody "inhibits interaction" between two proteins when the antibody disrupts, reduces, or completely eliminates an interaction between the two proteins. An antibody of the present disclosure, or fragment thereof, "inhibits interaction" between two proteins when the antibody or fragment thereof binds to one of the two proteins.

[0090] An "*agonist*" antibody or an "*activating*" antibody is an antibody, such as an agonist anti-Siglec-9 antibody of the present disclosure, that induces (*e.g.*, increases) one or more activities or functions of the antigen after the antibody binds the antigen.

[0091] A "*blocking*" antibody, an "*antagonist*" antibody, or an "*inhibitory*" antibody is an antibody, such as an anti-Siglec-9 antibody of the present disclosure, that inhibits or reduces (*e.g.*, decreases) antigen binding to one or more ligand after the antibody binds the antigen, and/or that inhibits or reduces (*e.g.*, decreases) one or more activities or functions of the antigen after the antibody binds the antigen. In some embodiments, blocking antibodies, antagonist antibodies, or inhibitory antibodies substantially or completely inhibit antigen binding to one or more ligand and/or one or more activities or functions of the antigen.

[0092] Antibody "*effector functions*" refer to those biological activities attributable to the Fc region (a native sequence Fc region or amino acid sequence variant Fc region) of an antibody, and vary with the antibody isotype.

[0093] The term "*Fc region*" herein is used to define a C-terminal region of an immunoglobulin heavy chain, including native-sequence Fc regions and variant Fc regions. Although the boundaries of the Fc region of an immunoglobulin heavy chain might vary, the human IgG heavy-chain Fc region is usually defined to stretch from an amino acid residue at position Cys226, or from Pro230, to the carboxyl-terminus thereof. The C-terminal lysine (residue 447 according to the EU or Kabat

numbering system) of the Fc region may be removed, for example, during production or purification of the antibody, or by recombinantly engineering the nucleic acid encoding a heavy chain of the antibody. Accordingly, a composition of intact antibodies may comprise antibody populations with all K447 residues removed, antibody populations with no K447 residues removed, and antibody populations having a mixture of antibodies with and without the K447 residue. Suitable native-sequence Fc regions for use in the antibodies of the present disclosure include human IgG1, IgG2, IgG3 and IgG4.

[0094] A "*native sequence Fc region*" comprises an amino acid sequence identical to the amino acid sequence of an Fc region found in nature. Native sequence human Fc regions include a native sequence human IgG1 Fc region (non-A and A allotypes); native sequence human IgG2 Fc region; native sequence human IgG3 Fc region; and native sequence human IgG4 Fc region as well as naturally occurring variants thereof.

[0095] A "*variant Fc region*" comprises an amino acid sequence which differs from that of a native sequence Fc region by virtue of at least one amino acid modification, preferably one or more amino acid substitution(s). Preferably, the variant Fc region has at least one amino acid substitution compared to a native sequence Fc region or to the Fc region of a parent polypeptide, *e.g.* from about one to about ten amino acid substitutions, and preferably from about one to about five amino acid substitutions in a native sequence Fc region or in the Fc region of the parent polypeptide. The variant Fc region herein will preferably possess at least about 80% homology with a native sequence Fc region and/or with an Fc region of a parent polypeptide, and most preferably at least about 90% homology therewith, more preferably at least about 95% homology therewith.

[0096] "*Fc receptor*" or "*FcR*" describes a receptor that binds to the Fc region of an antibody. The preferred FcR is a native sequence human FcR. Moreover, a preferred FcR is one which binds an IgG antibody (a gamma receptor) and includes receptors of the FcγRI, FcγRII, and FcγRIII subclasses, including allelic variants and alternatively spliced forms of these receptors, FcγRII receptors include FcγRIIA (an "activating receptor") and FcγRIIB (an "inhibiting receptor"), which have similar amino acid sequences that differ primarily in the cytoplasmic domains thereof. Activating receptor FcγRIIA contains an immunoreceptor tyrosine-based activation motif ("ITAM") in its cytoplasmic domain. Inhibiting receptor FcγRIIB contains an immunoreceptor tyrosine-based inhibition motif ("ITIM") in its cytoplasmic domain. (*see, e.g.*, M. Daëron, *Annu. Rev. Immunol.* 15:203-234 (1997)). FcRs are reviewed in Ravetch and Kinet, *Annu. Rev. Immunol.* 9:457-92 (1991); Capel et al., *Immunomethods* 4:25-34 (1994); and de Haas et al., *J. Lab. Clin. Med.* 126: 330-41 (1995). Other FcRs, including those to be identified in the future, are encompassed by the term "FcR" herein. FcRs can also increase the serum half-life of antibodies.

[0097] Binding to FcRn *in vivo* and serum half-life of human FcRn high-affinity binding polypeptides can be assayed, *e.g.*, in transgenic mice or transfected human cell lines expressing human FcRn, or in primates to which the polypeptides having a variant Fc region are administered. WO 2004/42072 (Presta) describes antibody variants with improved or diminished binding to FcRs. *See also, e.g.*, Shields et al., *J. Biol. Chem.* 9(2):6591-6604 (2001).

[0098] As used herein, "*percent (%) amino acid sequence identity*" and "*homology*" with respect to a peptide, polypeptide or antibody sequence refers to the percentage of amino acid residues in a candidate sequence that are identical with the amino acid residues in the specific peptide or polypeptide sequence, after aligning the sequences and introducing gaps, if necessary, to achieve the maximum percent sequence identity, and not considering any conservative substitutions as part of the sequence identity. Alignment for purposes of determining percent amino acid sequence identity can be achieved in various ways that are within the skill in the art, for instance, using publicly available computer software such as BLAST, BLAST-2, ALIGN or MEGALIGN™ (DNASTAR) software. Those skilled in the art can determine appropriate parameters for measuring alignment, including any algorithms known in the art needed to achieve maximal alignment over the full length of the sequences being compared.

[0099] An "*isolated*" cell is a molecule or a cell that is identified and separated from at least one contaminant cell with which it is ordinarily associated in the environment in which it was produced. In some embodiments, the isolated cell is free of association with all components associated with the production environment. The isolated cell is in a form other than in the form or setting in which it is found in nature. Isolated cells are distinguished from cells existing naturally in tissues, organs, or individuals. In some embodiments, the isolated cell is a host cell of the present disclosure.

[0100] An "*isolated*" nucleic acid molecule encoding an antibody, such as an anti-Siglec-9 antibody of the present disclosure, is a nucleic acid molecule that is identified and separated from at least one contaminant nucleic acid molecule with which it is ordinarily associated in the environment in which it was produced. Preferably, the isolated nucleic acid is free of association with all components associated with the production environment. The isolated nucleic acid molecules encoding the polypeptides and antibodies herein is in a form other than in the form or setting in which it is found in nature. Isolated nucleic acid molecules therefore are distinguished from nucleic acid encoding the polypeptides and antibodies herein existing naturally in cells.

[0101] The term "*vector*," as used herein, is intended to refer to a nucleic acid molecule capable of transporting another nucleic acid to which it has been linked. One type of vector is a "plasmid," which refers to a circular double stranded DNA into which additional DNA segments may be ligated. Another type of vector is a phage vector. Another type of vector is a viral vector, wherein additional DNA segments may be ligated into the viral genome. Certain vectors are capable of autonomous

replication in a host cell into which they are introduced (*e.g.*, bacterial vectors having a bacterial origin of replication and episomal mammalian vectors). Other vectors (*e.g.*, non-episomal mammalian vectors) can be integrated into the genome of a host cell upon introduction into the host cell, and thereby are replicated along with the host genome. Moreover, certain vectors are capable of directing the expression of genes to which they are operatively linked. Such vectors are referred to herein as "recombinant expression vectors," or simply, "expression vectors." In general, expression vectors of utility in recombinant DNA techniques are often in the form of plasmids. In the present specification, "plasmid" and "vector" may be used interchangeably as the plasmid is the most commonly used form of vector.

[0102] "*Polynucleotide*," or "*nucleic acid*," as used interchangeably herein, refer to polymers of nucleotides of any length, and include DNA and RNA. The nucleotides can be deoxyribonucleotides, ribonucleotides, modified nucleotides or bases, and/or their analogs, or any substrate that can be incorporated into a polymer by DNA or RNA polymerase or by a synthetic reaction. A polynucleotide may comprise modified nucleotides, such as methylated nucleotides and their analogs. If present, modification to the nucleotide structure may be imparted before or after assembly of the polymer. The sequence of nucleotides may be interrupted by non-nucleotide components. A polynucleotide may comprise modification(s) made after synthesis, such as conjugation to a label. Other types of modifications include, for example, "caps," substitution of one or more of the naturally occurring nucleotides with an analog, internucleotide modifications such as, for example, those with uncharged linkages (*e.g.*, methyl phosphonates, phosphotriesters, phosphoamidates, carbamates, *etc.*) and with charged linkages (*e.g.*, phosphorothioates, phosphorodithioates, *etc.*), those containing pendant moieties, such as, for example, proteins (*e.g.*, nucleases, toxins, antibodies, signal peptides, ply-L-lysine, *etc.*), those with intercalators (*e.g.*, acridine, psoralen, *etc.*), those containing chelators (*e.g.*, metals, radioactive metals, boron, oxidative metals, *etc.*), those containing alkylators, those with modified linkages (*e.g.*, alpha anomeric nucleic acids, *etc.*), as well as unmodified forms of the polynucleotides(s). Further, any of the hydroxyl groups ordinarily present in the sugars may be replaced, for example, by phosphonate groups, phosphate groups, protected by standard protecting groups, or activated to prepare additional linkages to additional nucleotides, or may be conjugated to solid or semi-solid supports. The 5' and 3' terminal OH can be phosphorylated or substituted with amines or organic capping group moieties of from 1 to 20 carbon atoms. Other hydroxyls may also be derivatized to standard protecting groups. Polynucleotides can also contain analogous forms of ribose or deoxyribose sugars that are generally known in the art, including, for example, 2'-O-methyl-, 2'-O-allyl-, 2'-fluoro- or 2'-azido-ribose, carbocyclic sugar analogs, α-anomeric sugars, epimeric sugars such as arabinose, xyloses or lyxoses, pyranose sugars, furanose sugars, sedoheptuloses, acyclic analogs, and basic nucleoside analogs such as methyl riboside. One

or more phosphodiester linkages may be replaced by alternative linking groups. These alternative linking groups include, but are not limited to, embodiments wherein phosphate is replaced by P(O)S ("thioate"), P(S)S ("dithioate"), (O)NR2 ("amidate"), P(O)R, P(O)OR', CO, or CH2 ("formacetal"), in which each R or R' is independently H or substituted or unsubstituted alkyl (1-20 C) optionally containing an ether (-O-) linkage, aryl, alkenyl, cycloalkyl, cycloalkenyl or araldyl. Not all linkages in a polynucleotide need be identical. The preceding description applies to all polynucleotides referred to herein, including RNA and DNA.

[0103] A "*host cell*" includes an individual cell or cell culture that can be or has been a recipient for vector(s) for incorporation of polynucleotide inserts. Host cells include progeny of a single host cell, and the progeny may not necessarily be completely identical (in morphology or in genomic DNA complement) to the original parent cell due to natural, accidental, or deliberate mutation. A host cell includes cells transfected *in vivo* with a polynucleotide(s) of the present disclosure.

[0104] "*Carriers*" as used herein include pharmaceutically acceptable carriers, excipients, or stabilizers that are nontoxic to the cell or mammal being exposed thereto at the dosages and concentrations employed. Often the physiologically acceptable carrier is an aqueous pH buffered solution. Examples of physiologically acceptable carriers include buffers such as phosphate, citrate, and other organic acids; antioxidants including ascorbic acid; low molecular weight (less than about 10 residues) polypeptide; proteins, such as serum albumin, gelatin, or immunoglobulins; hydrophilic polymers such as polyvinylpyrrolidone; amino acids such as glycine, glutamine, asparagine, arginine or lysine; monosaccharides, disaccharides, and other carbohydrates including glucose, mannose, or dextrins; chelating agents such as EDTA; sugar alcohols such as mannitol or sorbitol; salt-forming counterions such as sodium; and/or nonionic surfactants such as TWEEN™, polyethylene glycol (PEG), and PLURONICS™.

[0105] As used herein, the term "*apoptosis*" refers to gene-directed process of intracellular cell destruction. Apoptosis is distinct from necrosis; it includes cytoskeletal disruption, cytoplasmic shrinkage and condensation, expression of phosphatidylserine on the outer surface of the cell membrane and blebbing, resulting in the formation of cell membrane bound vesicles or apoptotic bodies. The process is also referred to as "programmed cell death." During apoptosis, characteristic phenomena such as curved cell surfaces, condensation of nuclear chromatin, fragmentation of chromosomal DNA, and loss of mitochondrial function are observed. Various known technologies may be used to detect apoptosis, such as staining cells with Annexin V, propidium iodide, DNA fragmentation assay and YO-PRO-1 (Invitrogen). In some embodiments, staining with Annexin V and propidium iodide may be used, and the combined percentages of the Annexin V+/PI+, Annexin V+/PI- and Annexin V-/PI+ populations are considered as dead cells.

[0106] As used herein, the term "*agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both*" refers to a molecule that reduces (including significantly), decreases, blocks, inhibits, or interferes with a Siglec-9 (mammalian, such as a human Siglec-9) biological activity *in vitro*, *in situ*, and/or *in vivo*. The term "agent" implies no specific mechanism of biological action whatsoever, and expressly includes and encompasses all possible pharmacological, physiological, and biochemical interactions with a Siglec-9 whether direct or indirect, and whether interacting with a Siglec-9, one or more of its ligands, or through another mechanism, and its consequences which can be achieved by a variety of different, and chemically divergent, compositions. Exemplary agents include, without limitation, an anti-Siglec-9 antibody that specifically binds to a Siglec-9, a soluble Siglec-9 receptor protein, a soluble Siglec-9-Fc fusion protein (e.g., Siglec-9 immunoadhesin), a soluble Siglec receptor that binds to a Siglec-9 ligand, a Siglec-Fc fusion protein (e.g., Siglec immunoadheisn) that binds to a Siglec-9 ligand, an anti-sense molecule directed to a nucleic acid encoding a Siglec-9, a short interfering RNA ("siRNA") molecule directed to a nucleic acid encoding a Siglec-9, a Siglec-9 inhibitory compound, an RNA or DNA aptamer that binds to a Siglec-9, and a Siglec-9 structural analog. In some embodiments, a Siglec-9 inhibitor (*e.g.,* an antibody) binds (physically interacts with) an agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both, binds to a Siglec-9 ligand, and/or inhibits (reduces) Siglec-9 synthesis or production. In other embodiments, an agent of the present disclosure inhibitor binds a Siglec-9 and prevents its binding to one or more of its ligands. In still other embodiments, an agent of the present disclosure reduces or eliminates expression (*i.e.,* transcription or translation) of a Siglec-9. Examples of types of agent that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both are provided herein.

[0107] As used herein, the term "*agent that binds or interacts with Siglec-9*" refers to a molecule that either directly or indirectly interacts with a Siglec-9 protein. The term "agent" implies no specific mechanism of biological action whatsoever, and expressly includes and encompasses all possible pharmacological, physiological, and biochemical interactions with a Siglec-9 whether direct or indirect, and whether interacting with a Siglec-9or through another mechanism, and its consequences which can be achieved by a variety of different, and chemically divergent, compositions. Exemplary agents include, without limitation, an anti-Siglec-9 antibody that specifically binds to a Siglec-9.

[0108] As used herein, the term "RNA interference" or "RNAi" refers generally to a process in which a double-stranded RNA molecule or a short hairpin RNA molecule reducing or inhibiting the expression of a nucleic acid sequence with which the double-stranded or short hairpin RNA molecule shares substantial or total homology. The term "short interfering RNA" or "siRNA" or "RNAi agent" refers to an RNA sequence that elicits RNA interference. *See* Kreutzer et al., WO 00/44895;

Zernicka-Goetz et al., WO 01/36646; Fire, WO 99/32619; Mello and Fire, WO 01/29058. As used herein, siRNA molecules include RNA molecules encompassing chemically modified nucleotides and non-nucleotides. The term "ddRNAi agent" refers to a DNA-directed RNAi agent that is transcribed from an exogenous vector. The terms "short hairpin RNA" or "shRNA" refer to an RNA structure having a duplex region and a loop region. In certain embodiments, ddRNAi agents are expressed initially as shRNAs.

[0109] As used herein, the term "aptamer" refers to a heterologous oligonucleotide capable of binding tightly and specifically to a desired molecular target, such as, for example, common metabolic cofactors (*e.g.,* Coenzyme A, S-adenosyl methionine, and the like), proteins (*e.g.,* complement protein C5, antibodies, and the like), or conserved structural elements in nucleic acid molecules (*e.g.,* structures important for binding of transcription factors and the like). Aptamers typically comprise DNA or RNA nucleotide sequences ranging from about 10 to about 100 nucleotides in length, from about 10 to about 75 nucleotides in length, from about 10 to about 50 nucleotides in length, from about 10 to about 35 nucleotides in length, and from about 10 to about 25 nucleotides in length. Synthetic DNA or RNA oligonucleotides can be made using standard solid phase phosphoramidite methods and equipment, such as by using a 3900 High Throughput DNA Synthesizer™, available from Applied Biosystems (Foster City, CA). Aptamers frequently incorporate derivatives or analogs of the commonly occurring nucleotides found in DNA and RNA (*e.g.,* A, G, C, and T/U), including backbone or linkage modifications (*e.g.,* peptide nucleic acid (PNA) or phosphothioate linkages) to increase resistance to nucleases, binding avidity, or to otherwise alter their pharmacokinetic properties. Exemplary modifications are set forth in U.S. Patent Nos. 6,455,308; 4,469,863; 5,536,821; 5,541,306; 5,637,683; 5,637,684; 5,700,922; 5,717,083; 5,719,262; 5,739,308; 5,773,601; 5,886,165; 5,929,226; 5,977,296; 6,140,482; and in WIPO publications WO 00/56746 and WO 01/14398. Methods for synthesizing oligonucleotides comprising such analogs or derivatives are disclosed, for example, in the patent publications cited above, and in U.S. Patent Nos. 6,455,308; 5,614,622; 5,739,314; 5,955,599; 5,962,674; 6,117,992; and in WO 00/75372.

[0110] The term "*about*" as used herein refers to the usual error range for the respective value readily known to the skilled person in this technical field. Reference to "*about*" a value or parameter herein includes (and describes) embodiments that are directed to that value or parameter *per se*.

[0111] As used herein and in the appended claims, the singular forms "a," "an," and "the" include plural reference unless the context clearly indicates otherwise. For example, reference to an "antibody" is a reference to from one to many antibodies, such as molar amounts, and includes equivalents thereof known to those skilled in the art, and so forth.

[0112] It is understood that aspect and embodiments of the present disclosure described herein include "comprising," "consisting," and "consisting essentially of" aspects and embodiments.

Overview

[0113] The present disclosure relates to agents (e.g., anti-Siglec-9 antibodies) that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligands, or that bind Siglec-9 without decreasing cellular levels of Siglec-9 and/or without inhibiting interaction between Siglec-9 and one or more Siglec-9 ligands; methods of making and using such agents (e.g., anti-Siglec-9 antibodies); pharmaceutical compositions containing such agents (e.g., anti-Siglec-9 antibodies); nucleic acids encoding such agents (e.g., anti-Siglec-9 antibodies); and host cells containing nucleic acids encoding such agents (e.g., anti-Siglec-9 antibodies).

[0114] In some embodiments, anti-Siglec-9 antibodies of the present disclosure have one or more antagonistic activities that are due, at least in part, to the ability of the antibodies inhibit the interaction between Siglec-9 and one or more natural glycan ligands. In some embodiments, the anti-Siglec-9 antibodies of the present disclosure may have one or more antagonistic activities that are due, at least in part, to the ability of the antibodies to reduce cellular expression (*e.g.*, cell surface expression) of Siglec-9 by inducing degradation, down regulation, cleavage, receptor desensitization, and/or lysosomal targeting of Siglec-9.

[0115] In some embodiments, antibody-induced Siglec-9 activity can be determined or tested *in vitro* by any of the techniques disclosed herein (*see, e.g.,* **Examples 1-5**), including, without limitation, testing plate-binding of full-length anti-Siglec-9 antibodies to increase the density of antibodies exposed to Siglec-9, cross-linking anti-Siglec-9 antibodies with a secondary antibody, cross-linking anti-Siglec-9 antibodies with cells that express one or more Fcg receptors (e.g., FcgRIIB), using Siglec-9 antibodies in solution, and using Fab fragments of Siglec-9 antibodies.

[0116] Certain aspects of the present disclosure are based, at least in part, on the identification of agents, such as anti-Siglec-9 antibodies, that exhibit the ability to compete with one or more Siglec-9 ligands for binding to Siglec-9 and/or the ability to decrease cell surface levels of Siglec-9 on cells, resulting in the reduction, neutralization, prevention, or curbing of one or more Siglec-9 activities. Exemplary Siglec-9 activities include, without limitation, phosphorylation of Tyr-433 and Tyr-456 by a Src family tyrosine kinase, such as Syk, LCK, FYM, and/or ZAP70; recruitment of and binding to the tyrosine-specific protein phosphatases SHP1 and SHP2; recruitment of and binding to PLC-gamma1, which acts as a guanine nucleotide exchange factor for Dynamini-1; recruitment of and binding to SH2-domain containing protein (*e.g.*, Crkl); recruitment of and binding to the spleen tyrosine kinase Syk; recruitment of and binding to SH3-SH2-SH3 growth factor receptor-bound protein 2 (Grb2); recruitment of and binding to multiple SH2-containing proteins; modulated expression of one or more pro-inflammatory cytokines, such as FN-α4, IFN-beta, IL-1β, IL-1alpha,

TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, CRP, MCP-1, and MIP-1-beta; modulated expression of one or more pro-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; increased expression of one or more anti-inflammatory cytokines, such as IL-4, IL-10, IL-13, IL-35, IL-16, TGF-beta, IL-1Ra, G-CSF, and soluble receptors for TNF, IFN-beta1a, IFN-beta1b, or IL-6; modulated expression of one or more anti-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; modulate expression of one or more proteins selected from C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and PYCARD; inhibition of extracellular signal-regulated kinase (ERK) phosphorylation; decreasing tyrosine phosphorylation on one or more cellular proteins, optionally, wherein the one or more cellular proteins comprise ZAP-70 and the tyrosine phosphorylation occurs on Tyr-319 of ZAP-70; modulated expression of C-C chemokine receptor 7 (CCR7); inhibition of microglial cell chemotaxis toward CCL19-expressing and CCL21-expressing cells; decreasing T cell proliferation induced by one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, M1 microglia, activated M1 microglia, M2 microglia, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, and M2 NK cells; inhibition of osteoclast production, decreased rate of osteoclastogenesis, or both; decreasing survival of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; decreasing proliferation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibiting migration of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic

T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibiting one or more functions of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibiting maturation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibition of one or more types of clearance selected from apoptotic neuron clearance, nerve tissue debris clearance, dysfunctional synapse clearance, non-nerve tissue debris clearance, bacteria clearance, other foreign body clearance, disease-causing protein clearance, disease-causing peptide clearance, and tumor cell clearance; optionally wherein the disease-causing protein is selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides and the tumor cell is from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer; inhibition of phagocytosis of one or more of apoptotic neurons, nerve tissue debris, dysfunctional synapses, non-nerve tissue debris, bacteria, other foreign bodies, disease-causing proteins, disease-causing peptides, disease-causing nucleic acids, or tumor cells; optionally wherein the disease-causing nucleic acids are antisense GGCCCC (G2C4) repeat-expansion RNA, the disease-causing proteins are selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin,

superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides, and the tumor cells are from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, or thyroid cancer; binding to Siglec-9 ligand on tumor cells; binding to Siglec-9 ligand on cells selected from neutrophils, dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, macrophages, and NK cells; inhibition of tumor cell killing by one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; inhibiting anti-tumor cell proliferation activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; inhibition of anti-tumor cell metastasis activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; inhibition of one or more ITAM motif containing receptors, optionally wherein the one or more ITAM motif containing receptors are selected from TREM1, TREM2, Sirp beta, FcgR, DAP10, and DAP12; inhibition of signaling by one or more pattern recognition receptors (PRRs), optionally wherein the one or more PRRs are selected from receptors that identify pathogen-associated molecular patterns (PAMPs), receptors that identify damage-associated molecular patterns (DAMPs), and any combination thereof; inhibition of one or more receptors comprising the motif $D/Ex_{0-2}YxxL/IX_{6-8}YxxL/I$ (SEQ ID NO: 252); inhibition of signaling by one or more Toll-like receptors; inhibition of the JAK-STAT signaling pathway; inhibition of nuclear factor kappa-light-chain-enhancer of activated B cells (NFκB); de-phosphorylation of an ITAM motif containing receptor; modulated expression of one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells, optionally wherein the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells comprise CD86, C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and/or PYCARD, and the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells are expressed on one or more of microglia, macrophages, neutrophils, NK

cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; increasing expression of one or more Siglec-9-dependent genes; normalization of disrupted Siglec-9-dependent gene expression; decreasing expression of one or more ITAM-dependent genes, optionally wherein the one more ITAM-dependent genes are activated by nuclear factor of activated T cells (NFAT) transcription factors; promoting or rescuing functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells; increasing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells into tumors; increasing the number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; enhancing tumor-promoting activity of myeloid-derived suppressor cells; increasing expression of tumor-promoting cytokines in a tumor or in peripheral blood, optionally wherein the tumor-promoting cytokines are TGF-beta or IL-10; increasing tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; enhancing tumor-promoting activity of myeloid-derived suppressor cells (MDSC); decreasing activation of tumor-specific T lymphocytes with tumor killing potential; decreasing infiltration of tumor-specific NK cells with tumor killing potential; decreasing the tumor killing potential of NK cells; decreasing infiltration of tumor-specific B lymphocytes with potential to enhance immune response; decreasing infiltration of tumor-specific T lymphocytes with tumor killing potential; increasing tumor volume; increasing tumor growth rate; increasing metastasis; increasing rate of tumor recurrence; decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more target proteins selected from PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, TREM1, TREM2, CD39, CD73, CSF-1 receptor, and any combination thereof, or of one or more cancer vaccines; inhibition of PLCγ/PKC/calcium mobilization; and inhibition of PI3K/Akt, Ras/MAPK signaling.

[0117] In some embodiments, treatment of cancer with agents, such as Siglec-9 blocking antibodies: (i) directly or indirectly decrease the survival, proliferation, maturation, differentiation, and/or functionality of tumor-promoting myeloid/granulocytic immune-suppressive cells that accumulate in the tumor, in peripheral blood, and in lymphoid organs of cancer patients; (ii) decrease the number of tumor-promoting myeloid/granulocytic immune-suppressive cells in the tumor, in the

peripheral blood, and in other lymphoid organs of a cancer patient; (iii) block tumor-promoting activity of myeloid-derived suppressor cells (MDSC); (iv) decrease expression of tumor-promoting cytokines, such as TGF-beta and IL-10, in the tumor and in the peripheral blood of a cancer patient; (v) decrease tumor-promoting FoxP3+ regulatory T lymphocyte infiltration in the tumor; (vi) increase infiltration and activation of T lymphocytes with tumor killing potential; (vii) increase infiltration of tumor-specific NK cells with tumor killing potential; (viii) increase the tumor killing potential of NK cells; (ix) increase infiltration of tumor-specific B lymphocytes with potential to enhance immune response; (x) decrease tumor volume; (xi) reduce tumor growth rate; (xii) reduce and/or inhibit metastasis; (xiii) reduce rate of tumor recurrence; (xiv) increase efficacy of immune-therapy that modulates anti-tumor T cell responses, such as PD1/PDL1, CTLA4, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, KIR, GAL9, CD2, CD5, CD39, CD73, CD30, TIGIT, VISTA, TIM1, TIM3, TIM4, and cancer vaccines, (xv) induce, activate, or otherwise increase PLCγ/PKC/calcium mobilization; and (xvi) induce, activate, or otherwise increase PI3K/Akt, Ras/MAPK signaling.

[0118] Immunosuppressor cells are sometimes also referred to as myeloid-derived suppressor cells (MDSC). In humans, MDSCs can be defined by one of the following combination of markers: (1) $CD14^+$ $HLA\text{-}DR^{low/-}$, (2) $CD14^+$ $IL4R\alpha^+$, (3) $CD14^+$ $HLA\text{-}DR^-$ $IL4R\alpha^+$, (4) $CD34^+$ $CD14^+$ $CD11b^+$ $Siglec\text{-}9^+$, (5) $CD11b^+$ $CD14^+$ $Siglec\text{-}9^+$, (6) $Siglec\text{-}9^+$ $HLA\text{-}DR^-$, (7) Lin^- $HLA\text{-}DR^-$, (8) Lin^- $HLA\text{-}DR^-$ $Siglec\text{-}9^+$, (9) Lin^- $HLA\text{-}DR^-$ $Siglec\text{-}9^+$ $CD11b^+$, (10) Lin^- $Siglec\text{-}9^+$ $CD11b^+$ $CD15^+$, (11) Lin^- $HLA\text{-}DR^-$ $Siglec\text{-}9^+$ $CD11b^+$ $CD14^-$ $CD15^+$, (12) $CD11b^+$ $CD14^-$ $Siglec\text{-}9^+$, (13) $CD11b^+$ $CD14^-$ $HLA\text{-}DR^-$ $Siglec\text{-}9^+$ $CD15^+$, (14) $Siglec\text{-}9^+$ $HLA\text{-}DR^-$ $CD15^+$, (15) $CD15^+$ $IL4R\alpha^+$, (16) $CD11b^+$ $CD15^+$ $CD66b^+$, (17) $CD15^+$ FSC^{low} SSC^{high}, (18) $CD15^{high}$ $Siglec\text{-}9^+$, (19) $CD11b^+$ $CD14^-$ $CD15^+$, (20) $CD66b^+$ SSC^{high}, and (21) $CD11b^+$ $CD15^+$ (see also Solito S et al. Annals of the NY Academy of Sciences, 2014). In mice, MDSCs can be defined by the expression of the surface markers $CD45^+$, $CD11b^+$, $Gr1^+$, and/or $Il4Ra^+$. Additional exemplary immunosuppressive monocytic lineages are $CD45^+$, $CD11b^+$, $Gr1^{low}$; and $CD45^+$, $CD11c^+$.

[0119] The present disclosure further relates to agents that bind or interact with Siglec-9, such as anti-Siglec-9 antibodies. In certain embodiments, the anti-Siglec-9 antibodies do not significantly decrease cell surface levels of Siglec-9, and/or do not inhibit interaction between Siglec-9 and one or more Siglec-9 ligands.

Siglec-9 proteins

[0120] In one aspect, the present disclosure provides agents, such as isolated (*e.g.*, monoclonal) antibodies, that interact with or otherwise bind to regions, such as epitopes, within a Siglec-9 protein of the present disclosure. In some embodiments, agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, bind to a Siglec-9 protein and modulate one or more Siglec-9

activities after binding to the Siglec-9 protein, for example, an activity associated with Siglec-9 expression in a cell. Siglec-9 proteins of the present disclosure include, without limitation, a mammalian Siglec-9 protein, human Siglec-9 protein, mouse Siglec-9 protein, and rat Siglec-9 protein.

[0121] Siglec-9 is variously referred to as a Siglec-9 molecule, Sialic acid-binding Ig-like lectin 9, CD329 antigen, CD329; CDw329, FOAP-9, and OBBP-LIKE.

[0122] Siglec-9 is an immunoglobulin-like receptor primarily expressed on myeloid lineage cells, including without limitation, macrophages, neutrophils, NK cells, dendritic cells, osteoclasts, monocytes, and microglia. In some embodiments, Siglec-9 forms a receptor-signaling complex with CD64. In some embodiments, Siglec-9 signaling results in the downstream inhibition of PI3K or other intracellular signals. On myeloid cells, Toll-like receptor (TLR) signals are important for the inhibition of Siglec-9 activities, *e.g.*, in the context of an infection response. TLRs also play a key role in the pathological inflammatory response, *e.g.*, TLRs expressed in macrophages, neutrophils, NK cells and dendritic cells.

[0123] Various Siglec-9 homologs are known, including without limitation, human Siglec-9, chimpanzee Siglec-9, green monkey Siglec-9, rhesus macaque Siglec-9, and mouse Siglec-9. The amino acid sequence of human Siglec-9 is set forth below as SEQ ID NO: 1:

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         10          20          30          40          50
MLLLLLPLLW GRERAEGQTS KLLTMQSSVT VQEGLCVHVP CSFSYPSHGW
         60          70          80          90         100
IYPGPVVHGY WFREGANTDQ DAPVATNNPA RAVWEETRDR FHLLGDPHTK
        110         120         130         140         150
NCTLSIRDAR RSDAGRYFFR MEKGSIKWNY KHHRLSVNVT ALTHRPNILI
        160         170         180         190         200
PGTLESGCPQ NLTCSVPWAC EQGTPPMISW IGTSVSPLDP STTRSSVLTL
        210         220         230         240         250
IPQPQDHGTS LTCQVTFPGA SVTTNKTVHL NVSYPPQNLT MTVFQGDGTV
        260         270         280         290         300
STVLGNGSSL SLPEGQSLRL VCAVDAVDSN PPARLSLSWR GLTLCPSQPS
        310         320         330         340         350
NPGVLELPWV HLRDAAEFTC RAQNPLGSQQ VYLNVSLQSK ATSGVTQGVV
        360         370         380         390         400
GGAGATALVF LSFCVIFVVV RSCRKKSARP AAGVGDTGIE DANAVRGSAS
        410         420         430         440         450
QGPLTEPWAE DSPPDQPPPA SARSSVGEGE LQYASLSFQM VKPWDSRGQE
        460
ATDTEYSEIK IHR
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[0124] In some embodiments, the Siglec-9 is a preprotein that includes a signal sequence. In some embodiments, the Siglec-9 is a mature protein. In some embodiments, the mature Siglec-9 protein does not include a signal sequence. In some embodiments, the mature Siglec-9 protein is

expressed on a cell. In some embodiments, the mature Siglec-9 protein is expressed on a cell, such as the surface of a cell, including, without limitation, human dendritic cells, human macrophages, human monocytes, human osteoclasts, human neutrophils, human T cells, human helper T cell, human cytotoxic T cells, human granulocytes, and human microglia. Agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may bind any of the Siglec-9 proteins of the present disclosure expressed on any cell disclosed herein.

[0125] Siglec-9 proteins of the present disclosure, such as human Siglec-9, contain several domains, including without limitation, a signal sequence located at amino acid residues 1-17 SEQ ID NO: 1, an extracellular immunoglobulin-like variable-type (IgV) domain located at amino acid residues 20-140 of SEQ ID NO: 1, two Ig-like C2-type domains located at amino acid residues 146-229 and 236-336 of SEQ ID NO: 1, a transmembrane domain located at amino acid residues 348-370 of SEQ ID NO: 1, an ITIM motif located at amino acid residues 431-436 of SEQ ID NO: 1, and SLAM-like motif located at amino acid residues 454-459 of SEQ ID NO: 1. As one of skill in the art will appreciate, the beginning and ending residues of the domains of the present disclosure may vary depending upon the computer modeling program used or the method used for determining the domain.

[0126] Certain aspects of the present disclosure provide anti-Siglec-9 antibodies that bind to a human Siglec-9, or a homolog thereof, including without limitation a mammalian Siglec-9 protein and Siglec-9 orthologs from other species. Exemplary Siglec-9 homologs and orthologs are listed in **Table A**.

Table A: Siglec-9 homologs and orthologs

Organism	Siglec-9 Accession Number
Chimpanzee *(Pan troglodytes)*	NCBI Accession No. XP_003316614
Green monkey (*Chlorocebus sabaeus)*	NCBI Accession No. XP_007995940.1
Rhesus macaque (*Macaca mulatta*)	NCBI Accession No. XP_001114560.2
Mouse (*Mus musculus)*	NCBI Accession No. NP_112458.2

[0127] Accordingly, as used herein a "Siglec-9" protein of the present disclosure includes, without limitation, a mammalian Siglec-9 protein, human Siglec-9 protein, and primate Siglec-9 protein. Additionally, anti-Siglec-9 antibodies of the present disclosure may bind an epitope within one or more of a mammalian Siglec-9 protein, human Siglec-9 protein, and primate Siglec-9. In some embodiments, anti-Siglec-9 antibodies of the present disclosure may bind specifically to a mammalian Siglec-9 protein, human Siglec-9 protein, or both. In certain embodiments, anti-Siglec-9 antibodies of the present disclosure may bind specifically to human Siglec-9, primate Siglec-9, or both.

[0128] In some embodiments, agents of the present disclosure that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligands, or that bind or interact with Siglec-9, such as anti-Siglec-9 antibodies of the present disclosure, may bind Siglec-9 in a pH dependent manner. In some embodiments, agents of the present disclosure, such as anti-Siglec-9 antibodies, can bind to Siglec-9 at a neutral pH and be internalized without dissociating from the Siglec-9 protein. Alternatively, at an acidic pH agents of the present disclosure, such as anti-Siglec-9 antibodies, may dissociate from Siglec-9 once they are internalized and are then degraded by endosome/lysosome pathway. In certain embodiments, an anti-Siglec-9 antibody binds Siglec-9 at a pH that ranges from 5.5 to 8.0, from 5.5 to 7.5, from 5.5 to 7.0, from 5.5 to 6.5, from 5.5 to 6.0, from 6.0 to 8.0, from 6.5 to 8.0, from 7.0 to 8.0, from 7.5 to 8.0, from 6.0 to 7.5, from 6.0 to 7.0, from 6.5 to 7.5. In certain embodiments, an anti-Siglec-9 antibody dissociates from Siglec-9 at a pH of less than 6.0, less than 5.5, less than 5.0, less than 4.5, less than 4.0, less than 3.5, less than 3.0, less than 2.5, or less than 2.0.

[0129] In some embodiments, agents of the present disclosure that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligands, or that bind or interact with Siglec-9, such as anti-Siglec-9 antibodies of the present disclosure, bind to a wild-type Siglec-9 protein of the present disclosure, naturally occurring variants thereof, and/or disease variants thereof.

[0130] In some embodiments, agents of the present disclosure that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligands, or that bind or interact with Siglec-9, such as anti-Siglec-9 antibodies of the present disclosure, bind a variant of human Siglec-9.

[0131] In some embodiments, agents of the present disclosure that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligands, or that bind or interact with Siglec-9, such as anti-Siglec-9 antibodies of the present disclosure, bind to a Siglec-9 protein expressed on the surface of a cell including, without limitation, human dendritic cells, human macrophages, human NK cells, human monocytes, human osteoclasts, human neutrophils, human T cells, human T helper cell, human cytotoxic T cells, human granulocytes, and human microglia. In some embodiments, agents of the present disclosure that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligands, or that bind or interact with Siglec-9, such as anti-Siglec-9 antibodies of the present disclosure, bind to a Siglec-9 protein expressed on the surface of a cell and modulate (*e.g.*, induce or inhibit) at least one Siglec-9 activity of the present disclosure after binding to the surface expressed Siglec-9 protein. In some embodiments of the present disclosure, the anti-Siglec-9 antibody binds specifically to a Siglec-9 protein. In some embodiments of the present disclosure, the anti-Siglec-9 antibody further binds to at

least one additional Siglec protein. In some embodiments, the anti-Siglec-9 antibody modulates one or more activities of the at least one additional Siglec protein or of a cell expressing the at least one additional Siglec protein.

Siglec-9 ligands

[0132] Siglec-9 proteins of the present disclosure can interact with (*e.g.*, bind to) one or more Siglec-9 ligands.

[0133] Exemplary Siglec-9 ligands include, without limitation, sialic acid, sialic acid-containing glycolipids, sialic acid-containing glycoproteins, alpha-2,8-disialyl containing glycolipids, branched alpha-2,6-linked sialic acid-containing glycoproteins, terminal alpha-2,6-linked sialic acid-containing glycolipids, terminal alpha-2,3-linked sialic acid-containing glycoproteins, disialogangliosides (*e.g.*, gangliosides or glycolipids containing a ceramide linked to a sialylated glycan), secreted mucins, Siglec-9 ligands expressed on red blood cells, Siglec-9 ligands expressed on bacterial cells, Siglec-9 ligands expressed on apoptotic cells, Siglec-9 ligands expressed on nerve cells, Siglec-9 ligands expressed on glia cells, Siglec-9 ligands expressed on microglia, Siglec-9 ligands expressed on astrocytes, Siglec-9 ligands expressed on tumor cells, Siglec-9 ligands expressed on viruses, Siglec-9 ligands expressed on dendritic cells, Siglec-9 ligands bound to beta amyloid plaques, Siglec-9 ligands bound to Tau tangles, Siglec-9 ligands on disease-causing proteins, Siglec-9 ligands on disease-causing peptides, Siglec-9 ligands expressed on macrophages, Siglec-9 ligands expressed on neutrophils, Siglec-9 ligands expressed on natural killer cells, Siglec-9 ligands expressed on monocytes, Siglec-9 ligands expressed on T cells, Siglec-9 ligands expressed on T helper cells, Siglec-9 ligands expressed on cytotoxic T cells, Siglec-9 ligands expressed on B cells, Siglec-9 ligands expressed on tumor-imbedded immunosuppressor dendritic cells, Siglec-9 ligands expressed on tumor-imbedded immunosuppressor macrophages, Siglec-9 ligands expressed on myeloid-derived suppressor cells, Siglec-9 ligands expressed on regulatory T cells. In some embodiments, Siglec-9 ligands of the present disclosure are ganglioside (e.g., disialogangliosides). Disialogangliosides generally share a common lacto-ceramide core and one or more sialic acid residues.

[0134] Further examples of suitable Siglec-9 ligands are depicted in **FIG. 2**.

[0135] Further examples of suitable ganglioside (e.g., disialogangliosides) ligands are depicted in **FIG. 3** and listed in **Table B**. Generally, a ganglioside (e.g., disialogangliosides) is a molecule composed of a glycosphingolipid with one or more sialic acids (*e.g.*, n-acetyl-neuraminic acid, NANA) linked on the sugar chain.

Table B: Structures of exemplary ganglioside Siglec-9 ligands

GM2-1 = aNeu5Ac(2-3)bDGalp(1-?)bDGalNAc(1-?)bDGalNAc(1-?)bDGlcp(1-1)Cer
GM3 = aNeu5Ac(2-3)bDGalp(1-4)bDGlcp(1-1)Cer
GM2,GM2a(?) = bDGalpNAc(1-4)[aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer

GM2b(?) = aNeu5Ac(2-8)aNeu5Ac(2-3)bDGalp(1-4)bDGlcp(1-1)Cer
GM1,GM1a = bDGalp(1-3)bDGalNAc[aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer
asialo-GM1,GA1 = bDGalp(1-3)bDGalpNAc(1-4)bDGalp(1-4)bDGlcp(1-1)Cer
asialo-GM2,GA2 = bDGalpNAc(1-4)bDGalp(1-4)bDGlcp(1-1)Cer
GM1b = aNeu5Ac(2-3)bDGalp(1-3)bDGalNAc(1-4)bDGalp(1-4)bDGlcp(1-1)Cer
GD3 = aNeu5Ac(2-8)aNeu5Ac(2-3)bDGalp(1-4)bDGlcp(1-1)Cer
GD2 = bDGalpNAc(1-4)[aNeu5Ac(2-8)aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer
GD1a = aNeu5Ac(2-3)bDGalp(1-3)bDGalNAc(1-4)[aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer
GD1alpha = aNeu5Ac(2-3)bDGalp(1-3)bDGalNAc(1-4)[aNeu5Ac(2-6)]bDGalp(1-4)bDGlcp(1-1)Cer
GD1b = bDGalp(1-3)bDGalNAc(1-4)[aNeu5Ac(2-8)aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer
GT1a = aNeu5Ac(2-8)aNeu5Ac(2-3)bDGalp(1-3)bDGalNAc(1-4)[aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer
GT1,GT1b = aNeu5Ac(2-3)bDGalp(1-3)bDGalNAc(1-4)[aNeu5Ac(2-8)aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer
OAc-GT1b = aNeu5Ac(2-3)bDGalp(1-3)bDGalNAc(1-4)aXNeu5Ac9Ac(2-8)aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer
GT1c = bDGalp(1-3)bDGalNAc(1-4)[aNeu5Ac(2-8)aNeu5Ac(2-8)aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer
GT3 = aNeu5Ac(2-8)aNeu5Ac(2-8)aNeu5Ac(2-3)bDGal(1-4)bDGlc(1-1)CerGQ1b = aNeu5Ac(2-8)aNeu5Ac(2-3)bDGalp(1-3)bDGalNAc(1-4)[aNeu5Ac(2-8)aNeu5Ac(2-3)]bDGalp(1-4)bDGlcp(1-1)Cer
GGal = aNeu5Ac(2-3)bDGalp(1-1)Cer
where:
aNeu5Ac = 5-acetyl-alpha-neuraminic acid
aNeu5Ac9Ac = 5,9-diacetyl-alpha-neuraminic acid
bDGalp = beta-D-galactopyranose
bDGalpNAc = N-acetyl-beta-D-galactopyranose
bDGlcp = beta-D-glucopyranose
Cer = ceramide (general N-acylated sphingoid)

Siglec-9 agents

[0136] Certain aspects of the present disclosure relate to agents (e.g., Siglec-9 agents) that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligands. Other aspects of the present disclosure relate to agents (e.g., Siglec-9 agents) that bind Siglec-9 without decreasing cellular levels of Siglec-9 and/or without inhibiting interaction between Siglec-9 and one or more Siglec-9 ligands. Further aspects of the present disclosure relate to agents (e.g., Siglec-9 agents) that bind or interact with Siglec-9. In some embodiments, agents of the present disclosure block, inhibit, reduce, or interfere with one or more activities of a Siglec-9 protein *in vitro*, *in situ*, and/or *in vivo*. In some embodiments, agents of the present disclosure do not block, inhibit, reduce, or interfere with one or more activities of a Siglec-9 protein *in vitro*, *in situ*, and/or *in vivo*. In some embodiments, agents of the present disclosure, increase, activate or induce one or more activities of a Siglec-9 protein *in vitro*, *in situ*, and/or *in vivo*.

[0137] In certain embodiments, agents of the present disclosure are agents (e.g., Siglec-9 agents) that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligand. An agent of the present disclosure that decreases cellular levels of Siglec-9 and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands is a molecule having one or more of the following characteristics: (1) inhibits or reduces one or more Siglec-9 activities; (2) the

ability to inhibit or reduce binding of a Siglec-9 to one or more of its ligands; (3) the ability to reduce Siglec-9 expression (such as at the mRNA level and/or at protein level) in Siglec-9-expressing cells; (4) the ability to interact, bind, or recognize a Siglec-9 protein; (5) the ability to specifically interact with or bind to a Siglec-9 protein; and (6) the ability to treat, ameliorate, or prevent any aspect of a disease or disorder described or contemplated herein.

[0138] Exemplary agents that inhibit the production of Siglec-9 include, without limitation, compounds that specifically inhibit Siglec-9 synthesis and/or release, antisense molecules directed to a Siglec-9, or a short interfering RNA (siRNA) molecule directed to a nucleic acid encoding a Siglec-9. Additional exemplary agents that inhibit one or more Siglec-9 activities include, without limitation, anti-Siglec-9 antibodies that specifically bind to a Siglec-9 protein, compounds that specifically inhibit one or more Siglec-9 activities such as small molecule inhibitors and/or peptide inhibitors, compounds that specifically inhibit Siglec-9 binding to one or more ligands, a Siglec-9 structural analog, or an RNA or DNA aptamer that binds a Siglec-9. In some embodiments, an agent that decreases cellular levels of Siglec-9 and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands is an allosteric inhibitor. In some embodiments, an agent that decreases cellular levels of Siglec-9 and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands is an orthosteric inhibitor.

[0139] In certain embodiments, an agent that decreases cellular levels of Siglec-9 and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands is a small molecule inhibitor, including, without limitation, small peptides or peptide-like molecules, soluble peptides, and synthetic non-peptidyl organic or inorganic compounds. A small molecule inhibitor may have a molecular weight of any of about 100 to about 20,000 daltons (Da), about 500 to about 15,000 Da, about 1000 to about 10,000 Da. Methods for making and testing the inhibitory effect a small molecule has on one or more Siglec-9 activities are well known in the art and such methods can be used to assess the effect of the small molecule inhibitor on Siglec-9 activity. For example, any of the methods and assays disclosed herein may be used to screen for small molecule inhibitors that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligand.

[0140] In certain embodiments, an agent that decreases cellular levels of Siglec-9 and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands is an anti-Siglec-9 antibody that binds or physically interacts with a Siglec-9. The antibody may have nanomolar or even picomolar affinities for the target antigen (*e.g.,* Siglec-9). In certain embodiments, the Kd of the antibody is about 0.05 to about 100 nM. For example, Kd of the antibody is any of about 100 nM, about 50 nM, about 10 nM, about 1 nM, about 900 pM, about 800 pM, about 790 pM, about 780 pM, about 770 pM, about 760 pM, about 750 pM, about 740 pM, about 730 pM, about 720 pM, about 710 pM, about

700 pM, about 650 pM, about 600 pM, about 590 pM, about 580 pM, about 570 pM, about 560 pM, about 550 pM, about 540 pM, about 530 pM, about 520 pM, about 510 pM, about 500 pM, about 450 pM, about 400 pM, about 350 pM about 300 pM, about 290 pM, about 280 pM, about 270 pM, about 260 pM, about 250 pM, about 240 pM, about 230 pM, about 220 pM, about 210 pM, about 200 pM, about 150 pM, about 100 pM, or about 50 pM to any of about 2 pM, about 5 pM, about 10 pM, about 15 pM, about 20 pM, or about 40 pM. Methods for the preparation and selection of antibodies that interact and/or bind with specificity to a Siglec-9 are described herein.

[0141] In certain embodiments, an agent that decreases cellular levels of Siglec-9and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands comprises at least one antisense molecule capable of blocking or decreasing the expression of a functional Siglec-9 by targeting nucleic acids encoding a Siglec-9. Nucleic acid sequences of Siglec-9 are known in the art. For example, a human Siglec-9 can have a nucleic acid sequence as shown in NCBI Accession number NM_001198558.1 and a chimpanzee Siglec-9 can have a nucleic acid sequence as shown in NCBI Accession No. XM_003316566.3 and a mouse SIGLEC-E can have a nucleic acid sequence as shown in NCBI Accession No. NM_031181.2. Methods are known for the preparation of antisense oligonucleotide molecules and such methods can be used to prepare antisense oligonucleotides that will specifically bind one or more of a Siglec-9 mRNA without cross-reacting with other polynucleotides. Exemplary sites of targeting include, but are not limited to, the initiation codon, the 5' regulatory regions, the coding sequence, including any conserved consensus regions, and the 3' untranslated region. In certain embodiments, the antisense oligonucleotides are about 10 to about 100 nucleotides in length, about 15 to about 50 nucleotides in length, about 18 to about 25 nucleotides in length, or more. In certain embodiments, the oligonucleotides further comprise chemical modifications to increase nuclease resistance and the like, such as, for example, phosphorothioate linkages and 2'-O-sugar modifications known to those of ordinary skill in the art.

[0142] In certain embodiments, an agent that decreases cellular levels of Siglec-9 and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands comprises at least one siRNA molecule capable of blocking or decreasing the expression of a functional Siglec-9 by targeting nucleic acids encoding a Siglec-9. Methods for preparation of siRNA molecules are well known in the art and such methods can be used to prepare siRNA molecules that will specifically target a Siglec-9 mRNA without cross-reacting with other polynucleotides. siRNA molecules may be generated by methods such as by typical solid phase oligonucleotide synthesis, and often will incorporate chemical modifications to increase half-life and/or efficacy of the siRNA agent, and/or to allow for a more robust delivery formulation. Alternatively, siRNA molecules are delivered using a vector encoding an expression cassette for intracellular transcription of siRNA.

[0143] In certain embodiments, an agent that decreases cellular levels of Siglec-9 and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands is an RNA or DNA aptamer that binds or physically interacts with a Siglec-9, and blocks interactions between a Siglec-9 and one or more of its ligands. In certain embodiments, the aptamer comprises at least one RNA or DNA aptamer that binds to a mature form of Siglec-9.

[0144] In certain embodiments, an agent that decreases cellular levels of Siglec-9 and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands comprises at least one Siglec-9 structural analog. The term Siglec-9 structural analog refers to compounds that have a similar three dimensional structure as part of that of a Siglec-9 and which bind to one or more CD3 ligands under physiological conditions *in vitro* or *in vivo*, wherein the binding at least partially inhibits a Siglec-9 biological activity. Suitable Siglec-9 structural analogs can be designed and synthesized through molecular modeling of Siglec-9 binding to a ligand, such as a Siglec-9 ligand of the present disclosure. The Siglec-9 structural analogs can be monomers, dimers, or higher order multimers in any desired combination of the same or different structures to obtain improved affinities and biological effects. In some embodiments, the agent binds to or interacts with an amino acid sequence of a Siglec-9.

[0145] In certain embodiments, an agent that decreases cellular levels of Siglec-9 and/or inhibits interaction between Siglec-9 and one or more Siglec-9 ligands comprises a soluble Siglec-9 receptor protein, a soluble Siglec-9-Fc fusion protein (e.g., Siglec-9 immunoadhesin), a soluble Siglec receptor that binds to a Siglec-9 ligand, a Siglec-Fc fusion protein (e.g., Siglec immunoadhesin) that binds to a Siglec-9 ligand. In certain embodiments, such agents bind one or more Siglec-9 ligands and thereby prevent the interaction between a given Siglec-9 ligand and a functional Siglec-9 receptor.

[0146] In certain embodiments, agents of the present disclosure are agents (e.g., Siglec-9 agents) that bind or interact with Siglec-9. Exemplary agents that bind or interact with Siglec-9 include, without limitation, inert anti-Siglec-9 antibodies, agonist anti-Siglec-9 antibodies, Siglec-9 ligands, Siglec-9 ligand agonist fragments, Siglec-9 immunoadhesins, Siglec-9 soluble receptors, Siglec-Fc fusion proteins (e.g., Siglec immunoadhesins), soluble Siglec receptors, Siglec-9 ligand mimetics, and small molecule compounds. A small molecule compound may have a molecular weight of any of about 100 to about 20,000 daltons (Da), about 500 to about 15,000 Da, about 1000 to about 10,000 Da. Methods for making and testing the effect an agent has on one or more Siglec-9 activities are well known in the art and such methods can be used to assess the effect of the small molecule inhibitor on Siglec-9 activity. For example, any of the methods and assays disclosed herein may be used to screen for small molecule inhibitors that bind or interact with Siglec-9.

Assays

[0147] Agents that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligands may be identified and/or characterized using methods well known in the art, such as, for example, radiolabeled inhibitor assays, optical assays, protein binding assays, biochemical screening assays, immunoassays, mass shift measurement assays, fluorescence assays, and/or fluorogenic peptide cleavage assays.

Binding assays and other assays

[0148] In certain embodiments, agents that decrease cellular levels of Siglec-9 and/or inhibit interaction between Siglec-9 and one or more Siglec-9 ligands can be identified by techniques well known in the art for detecting the presence of a Siglec-9 agent candidate's interaction and/or binding affinity to a Siglec-9.

[0149] In certain embodiments, agents that interact with a Siglec-9 can be identified using a radiolabeled inhibitor assay. For example, a known amount of a radiolabeled agent candidate may be incubated with a known amount of immobilized Siglec-9 and a buffer. Subsequently, the immobilized Siglec-9 may be washed with a buffer and the immobilized Siglec-9 may be measured for the remaining presence of the radiolabeled Siglec-9 agent candidate using techniques known in the art, such as, for example, a gamma counter. A measurement indicating the presence of a radiolabeled substance may indicate the radiolabeled agent candidate is capable of interacting with and/or binding to Siglec-9.

[0150] In certain embodiments, an agent that interacts with a Siglec-9 may be identified using an optical technique. An exemplary optical technique to detect a Siglec-9 agent may include, *e.g.*, attaching Siglec-9 to a colorimetric resonant grafting surface, thereby shifting the wavelength of reflected light due to changes in the optical path the light must take, and subsequently measuring additional changes in the wavelength of reflected light when a candidate agent is allowed to interact with Siglec-9. For example, no change in the measured wavelength of reflected light when an agent is incubated with Siglec-9 may indicate that the agent candidate is unable to interact with Siglec-9. Changes in the measured wavelength of reflected light when an agent candidate is incubated with Siglec-9 may indicate that the agent candidate is capable of binding and/or interacting with Siglec-9.

[0151] In certain embodiments, an agent that interacts with a Siglec-9 may be identified using a protein-binding assay. An exemplary protein-binding assay to detect a Siglec-9 agent may include, *e.g.*, co-immunoprecipitation of a Siglec-9 in the presence of the agent candidate. For example, a Siglec-9 may be incubated with the agent candidate in buffer, and subsequently an immobilized molecule specific to capture a Siglec-9, such as, for example, an anti-Siglec-9 antibody, may be used to capture Siglec-9 in the presence of the agent candidate and bind the Siglec-9, potentially with an interacting agent candidate, during wash procedures known in the art. Subsequently, Siglec-9,

potentially with an interacting agent candidate, can be released and the presence of an agent candidate may be detected, based on the agent candidate characteristics, by techniques, such as, for example, mass spectrometry and/or Western blot.

[0152] In certain embodiments, an agent that interacts with a Siglec-9 may be identified using a biochemical and/or an immunoassay assay well known in the art. An exemplary technique may include, *e.g.*, an assay to quantitatively measure changes in Siglec-9 concentration and/or protein half-life using techniques, such as, for example, Western blot, immunostaining, and co-immunoprecipitation. For example, an agent candidate may be incubated with a sample containing a Siglec-9, such as a cell expressing Siglec-9, and subsequently Siglec-9 protein quantity and/or cellular levels may be measured at points during a time course study. Changes in protein quantity, cellular levels, and/or protein half-life in comparison to a control treatment may indicate that the Siglec-9 agent candidate may be capable of altering Siglec-9 half-life and/or activity.

[0153] In certain embodiments, a mass shift measurement assay may be used to identify an agent that interacts with a Siglec-9. An exemplary mass shift measurement assay may include, *e.g.*, detecting the presence of a strongly and/or covalently bound Siglec-9 agent by measuring a change in Siglec-9 mass when the agent candidate is interacting with Siglec-9 by using instruments, such as, but not limited to, a mass spectrometer. For example, a mass shift assay may be performed on a whole protein and/or a peptide-based analysis, depending on the nature of the agent candidate interaction. Detection of a mass shift correlating with the addition of said agent candidate to Siglec-9 may indicate that the agent candidate may be capable of interacting with or otherwise inhibiting a Siglec-9. Additionally, an exemplary mass shift measurement assay may include, *e.g.*, detecting the addition of mass to Siglec-9 correlating with the respective agent candidate mass when the agent candidate is interacting with Siglec-9 using techniques, such as, for example, surface plasmon resonance. For example, the change in the refractive index of light may be measured and correlated with a change in mass of Siglec-9 attached to a sensor surface.

[0154] In certain embodiments, a chemical cross-linking assay may be used to identify a Siglec-9 agent that interacts with a Siglec-9. For example, an agent candidate may be incubated with a Siglec-9, *in vivo* or *in vitro*, with a molecule cross-linker capable of covalently linking an agent candidate interacting with Siglec-9 to said Siglec-9 molecule. Subsequently, techniques, such as, but not limited to, mass spectrometry and/or Western blot, may be used to identify an agent candidate that may be capable of interacting with or otherwise inhibiting Siglec-9. For example, detection of Siglec-9covalently cross-linked with the agent candidate may indicate that the agent candidate may be capable of interacting with or otherwise inhibiting Siglec-9.

[0155] In certain embodiments, agents that interact with a Siglec-9 may be identified using a fluorescence assay. For example, a known amount of a fluorescent agent candidate may be incubated

with a known amount of immobilized Siglec-9 and a buffer. Subsequently, the immobilized Siglec-9 may be washed with a buffer and the immobilized Siglec-9 may be measured for the remaining presence of a fluorescent Siglec-9 agent candidate using techniques known in the art, such as, but not limited to, fluorescence detection. A measurement indicating the presence of a fluorescent substance may indicate the fluorescent agent candidate is capable of interacting with and/or binding to Siglec-9.

Activity assays

[0156] Assays known in the art and described herein (*e.g.,* **Examples 1-10**) can be used for identifying and testing biological activities of Siglec-9 agents of the present disclosure. In some embodiments, assays for testing the ability of Siglec-9 agents for modulating one or more Siglec-9 activities are provided.

Anti-Siglec-9 antibodies

[0157] Certain aspects of the present disclosure relate to anti-Siglec-9 antibodies that decrease cellular levels of Siglec-9 and/or inhibit interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands. In some embodiments, the anti-Siglec-9 antibody decreases cellular levels of Siglec-9 without inhibiting the interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands. In some embodiments, the anti-Siglec-9 antibody inhibits the interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands. In some embodiments, the anti-Siglec-9 antibody decreases cellular levels of Siglec-9 and inhibits the interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands. Other aspects of the present disclosure relate to anti-Siglec-9 antibodies that bind Siglec-9 without decreasing cellular levels of Siglec-9 and/or without inhibiting interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands.

[0158] As disclosed herein, Siglec-9 may be constitutively recycled on cells, and as such may recycle into the cell (e.g., endocytose) any agents (e.g., antibodies) that bind Siglec-9 on the cell surface. However, such endocytosis may not lead to a decrease in cellular levels (e.g., cell surface levels) of Siglec-9. While it has been shown that acute myeloid leukemia (AML) cells may mediate endocytosis of anti-Siglec-9 antibodies bound to surface-expressed Siglec-9, no decrease in cellular levels of Siglec-9 was demonstrated. Accordingly, certain aspects of the present disclosure relate to anti-Siglec-9 antibodies that not only bind to cell surface-expressed Siglec-9, but also decrease cellular levels of Siglec-9. In some embodiments, anti-Siglec-9 antibodies of the present disclosure bind cell surface-expressed Siglec-9 and are further endocytosed into the cell. In some embodiments, anti-Siglec-9 antibodies of the present disclosure bind cell surface-expressed Siglec-9 without being endocytosed into the cell.

[0159] Cellular levels of Siglec-9 may refer to, without limitation, cell surface levels of Siglec-9, intracellular levels of Siglec-9, and total levels of Siglec-9. In some embodiments, a decrease in cellular levels of Siglec-9 comprises decrease in cell surface levels of Siglec-9. As used herein, an

anti-Siglec-9 antibody decreases cell surface levels of Siglec-9 if it induces a decrease of 21% or more in cell surface levels of Siglec-9 as measured by any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art, for example utilizing flow cytometry, such as fluorescence-activated cell sorting (FACS), to measure cell surface levels of Siglec-9. In some embodiments, a decrease in cellular levels of Siglec-9 comprises a decrease in intracellular levels of Siglec-9. As used herein, an anti-Siglec-9 antibody decreases intracellular levels of Siglec-9 if it induces a decrease of 21% or more in intracellular levels of Siglec-9 as measured by any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art, for example immunostaining, Western blot analysis, co-immunoprecipitation, and cell cytometry. In some embodiments, a decrease in cellular levels of Siglec-9 comprises a decrease in total levels of Siglec-9. As used herein, an anti-Siglec-9 antibody decreases total levels of Siglec-9 if it induces a decrease of 21% or more in total levels of Siglec-9 as measured by any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art, for example immunostaining, Western blot analysis, co-immunoprecipitation, and cell cytometry. In some embodiments, the anti-Siglec-9 antibodies induce Siglec-9 degradation, Siglec-9 cleavage, Siglec-9 internalization, Siglec-9 shedding, and/or downregulation of Siglec-9 expression. In some embodiments, cellular levels of Siglec-9 are measured on primary cells (*e.g.*, dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, and macrophages) or on cell lines utilizing an *in vitro* cell assay.

[0160] In some embodiments, anti-Siglec-9 antibodies of the present disclosure decrease cellular levels of Siglec-9 by at least 21%, at least 22%, at least 23%, at least 24%, at least 25%, at least 26%, at least 27%, at least 28%, at least 29%, at least 30%, at least 31%, at least 32%, at least 33%, at least 34%, at least 35%, at least 36%, at least 37%, at least 38%, at least 39%, at least 40%, at least 41%, at least 42%, at least 43%, at least 44%, at least 45%, at least 46%, at least 47%, at least 48%, at least 49%, at least 50%, at least 51%, at least 52%, at least 53%, at least 54%, at least 55%, at least 56%, at least 57%, at least 58%, at least 59%, at least 60%, at least 61%, at least 62%, at least 63%, at least 64%, at least 65%, at least 66%, at least 67%, at least 68%, at least 69%, at least 70%, at least 71%, at least 72%, at least 73%, at least 74%, at least 75%, at least 76%, at least 77%, at least 78%, at least 79%, at least 80%, at least 81%, at least 82%, at least 83%, at least 84%, at least 85%, at least 86%, at least 87%, at least 88%, at least 89%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or more as compared to cellular levels of Siglec-9 in the absence of the anti-Siglec-9 antibody.

[0161] Any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art may be used to measure inhibition of interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands. In some embodiments, anti-Siglec-9 antibodies of the present disclosure inhibit interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands by at least 21%, at least

22%, at least 23%, at least 24%, at least 25%, at least 26%, at least 27%, at least 28%, at least 29%, at least 30%, at least 31%, at least 32%, at least 33%, at least 34%, at least 35%, at least 36%, at least 37%, at least 38%, at least 39%, at least 40%, at least 41%, at least 42%, at least 43%, at least 44%, at least 45%, at least 46%, at least 47%, at least 48%, at least 49%, at least 50%, at least 51%, at least 52%, at least 53%, at least 54%, at least 55%, at least 56%, at least 57%, at least 58%, at least 59%, at least 60%, at least 61%, at least 62%, at least 63%, at least 64%, at least 65%, at least 66%, at least 67%, at least 68%, at least 69%, at least 70%, at least 71%, at least 72%, at least 73%, at least 74%, at least 75%, at least 76%, at least 77%, at least 78%, at least 79%, at least 80%, at least 81%, at least 82%, at least 83%, at least 84%, at least 85%, at least 86%, at least 87%, at least 88%, at least 89%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or more at saturating antibody concentrations (*e.g.*, 67 nM) utilizing any *in vitro* assay or cell-based culture assay described herein or known in the art.

[0162] In some embodiments, anti-Siglec-9 antibodies of the present disclosure inhibit cell surface clustering of Siglec-9. In some embodiments, anti-Siglec-9 antibodies of the present disclosure inhibit one or more activities of a Siglec-9 protein, including, without limitation, phosphorylation of Tyr-433 and Tyr-456 by a Src family tyrosine kinase, such as Syk, LCK, FYM, and/orZAP70; recruitment of and binding to the tyrosine-specific protein phosphatases SHP1 and SHP2; recruitment of and binding to PLC-gamma1, which acts as a guanine nucleotide exchange factor for Dynamini-1; recruitment of and binding to SH2-domain containing protein (*e.g.*, Crkl); recruitment of and binding to the spleen tyrosine kinase Syk; recruitment of and binding to SH3-SH2-SH3 growth factor receptor-bound protein 2 (Grb2); recruitment of and binding to multiple SH2-containing proteins; modulated expression of one or more pro-inflammatory cytokines, optionally wherein the one or more anti-inflammatory cytokines are selected from a group consisting FN-α4, IFN-beta, IL-1β, IL-1alpha, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-33, MCP-1, and MIP-1-beta; modulated expression of one or more pro-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; modulated expression of one or more anti-inflammatory cytokines, optionally wherein the one or more anti-inflammatory cytokines are selected from IL-4, IL-10, IL-13, IL-35, IL-16, TGF-beta, IL-1Ra, G-CSF, and soluble receptors for TNF, IFN-beta1a, IFN-beta1b, or IL-6; modulated expression of one or more anti-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; modulate expression of one or more proteins selected from C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1,

CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and PYCARD; inhibition of extracellular signal-regulated kinase (ERK) phosphorylation; decreasing tyrosine phosphorylation on one or more cellular proteins, optionally, wherein the one or more cellular proteins comprise ZAP-70 and the tyrosine phosphorylation occurs on Tyr-319 of ZAP-70; modulated expression of C-C chemokine receptor 7 (CCR7); inhibition of microglial cell chemotaxis toward CCL19-expressing and CCL21-expressing cells; decreasing T cell proliferation induced by one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, M1 microglia, activated M1 microglia, M2 microglia, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, and M2 NK cells; inhibition of osteoclast production, decreased rate of osteoclastogenesis, or both; decreasing survival of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; decreasing proliferation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibiting migration of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibiting one or more functions of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibiting maturation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1

microglia, activated M1 microglia, and M2 microglia; inhibition of one or more types of clearance selected from apoptotic neuron clearance, nerve tissue debris clearance, dysfunctional synapse clearance, non-nerve tissue debris clearance, bacteria clearance, other foreign body clearance, disease-causing protein clearance, disease-causing peptide clearance, and tumor cell clearance; optionally wherein the disease-causing protein is selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides and the tumor cell is from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer; inhibition of phagocytosis of one or more of apoptotic neurons, nerve tissue debris, dysfunctional synapses, non-nerve tissue debris, bacteria, other foreign bodies, disease-causing proteins, disease-causing peptides, disease-causing nucleic acids, or tumor cells; optionally wherein the disease-causing nucleic acids are antisense GGCCCC (G2C4) repeat-expansion RNA, the disease-causing proteins are selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides, and the tumor cells are from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, or thyroid cancer; binding to Siglec-9 ligand on tumor cells; binding to Siglec-9 ligand

on cells selected from neutrophils, dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, macrophages, and NK cells; inhibition of tumor cell killing by one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; inhibiting anti-tumor cell proliferation activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; inhibition of anti-tumor cell metastasis activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; modulated expression of one or more inflammatory receptors, optionally wherein the one or more inflammatory receptors comprise CD86 and the one or more inflammatory receptors are expressed on one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; inhibition of one or more ITAM motif containing receptors, optionally wherein the one or more ITAM motif containing receptors are selected from TREM1, TREM2, Sirp beta, FcgR, DAP10, and DAP12; inhibition of signaling by one or more pattern recognition receptors (PRRs), optionally wherein the one or more PRRs are selected from receptors that identify pathogen-associated molecular patterns (PAMPs), receptors that identify damage-associated molecular patterns (DAMPs), and any combination thereof; inhibition of one or more receptors comprising the motif $D/Ex_{0-2}YxxL/IX_{6-8}YxxL/I$ (SEQ ID NO: 252); inhibition of signaling by one or more Toll-like receptors; inhibition of the JAK-STAT signaling pathway; inhibition of nuclear factor kappa-light-chain-enhancer of activated B cells (NFκB); de-phosphorylation of an ITAM motif containing receptor; modulated expression of one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells, optionally wherein the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells comprise CD86, C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and/or PYCARD, and the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells are expressed on one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; increasing expression of one or more Siglec-9-dependent genes; normalization of disrupted Siglec-9-dependent gene expression; decreasing expression of one or more ITAM-dependent genes, optionally wherein the one more ITAM-dependent genes are activated by nuclear factor of activated T cells (NFAT) transcription factors; promoting or rescuing functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated

macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells; increasing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells into tumors; increasing the number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; enhancing tumor-promoting activity of myeloid-derived suppressor cells; increasing expression of tumor-promoting cytokines in a tumor or in peripheral blood, optionally wherein the tumor-promoting cytokines are TGF-beta or IL-10; increasing tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; enhancing tumor-promoting activity of myeloid-derived suppressor cells (MDSC); decreasing activation of tumor-specific T lymphocytes with tumor killing potential; decreasing infiltration of tumor-specific NK cells with tumor killing potential; decreasing the tumor killing potential of NK cells; decreasing infiltration of tumor-specific B lymphocytes with potential to enhance immune response; decreasing infiltration of tumor-specific T lymphocytes with tumor killing potential; increasing tumor volume; increasing tumor growth rate; increasing metastasis; increasing rate of tumor recurrence; decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more target proteins selected from PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, TREM1, TREM2, CD39, CD73, CSF-1 receptor, and any combination thereof, or of one or more cancer vaccines; inhibition of PLCγ/PKC/calcium mobilization; inhibition of PI3K/Akt, Ras/MAPK signaling; enhancement of infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, myeloid derived suppressor cells, tumor-associated macrophages, immunosuppressor neutrophils, non-tumorigenic $CD45^+CD14^+$ myeloid cells, and regulatory T cells into tumors; increase in the number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; (r) enhancing tumor-promoting activity of non-tumorigenic myeloid-derived suppressor cells and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells; enhancement of survival of non-tumorigenic myeloid-derived suppressor cells (MDSC) and/or non-tumorigenic $CD45^+CD14^+$ myeloid cells; decrease in activation of tumor-specific T lymphocytes with tumor killing potential; (e) decreasing activation of $CD45^+CD3^+$ T lymphocytes with tumor killing potential; decrease in infiltration of tumor-specific NK cells with tumor killing potential; decrease in infiltration of tumor-specific B lymphocytes with potential to enhance immune response; decrease in infiltration of tumor-specific T lymphocytes with tumor killing potential; and decrease in infiltration of $CD45^+CD3^+$ T lymphocytes.

[0163] In some embodiments, the anti-Siglec-9 antibodies inhibit interaction (*e.g.*, binding) between a Siglec-9 protein of the present disclosure and one or more Siglec-9 ligands including, without limitation, Siglec-9 ligands expressed on red blood cells, Siglec-9 ligands expressed on bacterial cells, Siglec-9 ligands expressed on apoptotic cells, Siglec-9 ligands expressed on nerve cells, Siglec-9 ligands expressed on glia cells, Siglec-9 ligands expressed on microglia, Siglec-9 ligands expressed on astrocytes, Siglec-9 ligands expressed on tumor cells, Siglec-9 ligands expressed on viruses, Siglec-9 ligands expressed on dendritic cells, Siglec-9 ligands bound to beta amyloid plaques, Siglec-9 ligands bound to Tau tangles, Siglec-9 ligands on disease-causing proteins, Siglec-9 ligands on disease-causing peptides, Siglec-9 ligands expressed on macrophages, Siglec-9 ligands expressed on neutrophils, Siglec-9 ligands expressed on natural killer cells, Siglec-9 ligands expressed on monocytes, Siglec-9 ligands expressed on T cells, Siglec-9 ligands expressed on T helper cells, Siglec-9 ligands expressed on cytotoxic T cells, Siglec-9 ligands expressed on B cells, Siglec-9 ligands expressed on tumor-imbedded immunosuppressor dendritic cells, Siglec-9 ligands expressed on tumor-imbedded immunosuppressor macrophages, Siglec-9 ligands expressed on myeloid-derived suppressor cells, Siglec-9 ligands expressed on regulatory T cells, secreted mucins, sialic acid, sialic acid-containing glycolipids, sialic acid-containing glycoproteins, alpha-2,8-disialyl containing glycolipids, branched alpha-2,6-linked sialic acid-containing glycoproteins, terminal alpha-2,6-linked sialic acid-containing glycolipids, terminal alpha-2,3-linked sialic acid-containing glycoproteins, and gangliosides (e.g., disialogangliosides).

[0164] In some embodiments, anti-Siglec-9 antibodies of the present disclosure bind to a Siglec-9 protein of the present disclosure expressed on the surface of cell and the naked antibodies inhibit interaction (*e.g.*, binding) between the Siglec-9 protein and one or more Siglec-9 ligands. In some embodiments, anti-Siglec-9 antibodies of the present disclosure that bind to a Siglec-9 protein of the present disclosure inhibit interaction (*e.g.*, binding) between the Siglec-9 protein and one or more Siglec-9 ligands by reducing the effective levels of Siglec-9 that is available to interact with these proteins either on the cell surface or inside the cell. In some embodiments, anti-Siglec-9 antibodies of the present disclosure that bind to a Siglec-9 protein of the present disclosure inhibit interaction (*e.g.*, binding) between the Siglec-9 protein and one or more Siglec-9 ligands by inducing degradation of Siglec-9.

[0165] In some embodiments that may be combined with any of the preceding embodiments, the anti-Siglec-9 antibody exhibits one or more activities selected from the group consisting of consisting of: (a) increasing the number of tumor infiltrating $CD3^+$ T cells; (b) decreasing cellular levels of Siglec-9 in non-tumorigenic CD14+ myeloid cells, optionally wherein the non-tumorigenic CD14+ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic CD14+ myeloid cells are present in blood; (c) reducing the number of non-tumorigenic CD14+ myeloid cells,

optionally wherein the non-tumorigenic CD14+ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic CD14+ myeloid cells are present in blood; (d) reducing PD-L1 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (e) reducing PD-L2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (f) reducing B7-H2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (g) reducing B7-H3 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (h) reducing CD200R levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (i) reducing CD163 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (j) reducing CD206 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (k) decreasing tumor growth rate of solid tumors; (l) reducing tumor volume; (m) increasing efficacy of one or more PD-1 inhibitors; (n) increasing efficacy of one or more checkpoint inhibitor therapies and/or immune-modulating therapies, optionally wherein the one or more checkpoint inhibitor therapies and/or immune-modulating therapies target one or more of CTLA4, the adenosine pathway, PD-L1, PD-L2, PD-L1, PD-L2, OX40, TIM3, LAG3, or any combination thereof; (o) increasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof; (p) increasing proliferation of T cells in the presence of non-tumorigenic myeloid-derived suppressor cells (MDSC); (q) inhibiting differentiation, survival, and/or one or more functions of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (r) killing Siglec-9-expressing immunosuppressor non-tumorigenic myeloid cells and/or non-tumorigenic CD14-expressing cells in solid tumors and associated blood vessels when conjugated to a chemical or radioactive toxin. In some embodiments that may be combined with any of the preceding embodiments, the anti-Siglec-9 antibody is not conjugated to an agent, optionally wherein the agent is drug, toxin, chemotherapeutic, or radioisotope.

[0166] Other aspects of the present disclosure relate to anti-Siglec-9 antibodies that do not significantly decrease cell surface levels of Siglec-9 and/or do not inhibit interaction between Siglec-9 and one or more Siglec-9 ligands.

[0167] As used herein, an anti-Siglec-9 antibody does not significantly decrease cell surface levels of Siglec-9 if it decreases ligand binding to Siglec-9 by less than 20% as compared to cellular levels of Siglec-9 in the absence of the anti-Siglec-9 antibody utilizing any *in vitro* cell-based assays

or suitable *in vivo* model described herein or known in the art. In some embodiments, anti-Siglec-9 antibodies of the present disclosure decrease cell surface levels of Siglec-9 by less than 20%, less than 19%, less than 18%, less than 17%, less than 16%, less than 15%, less than 14%, less than 13%, less than 12%, less than 11%, less than 10%, less than 9%, less than 8%, less than 7%, less than 6%, less than 5%, less than 4%, less than 3%, less than 2%, or less than 1% as compared to cellular levels of Siglec-9 in the absence of the anti-Siglec-9 antibody.

[0168] As used herein, an anti-Siglec-9 antibody does not inhibit the interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands if it decreases ligand binding to Siglec-9 by less than 20% at saturating antibody concentrations (*e.g.*, 67 nM) utilizing any *in vitro* assay or cell-based culture assay described herein or known in the art. In some embodiments, anti-Siglec-9 antibodies of the present disclosure inhibit interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands by less than 20%, less than 19%, less than 18%, less than 17%, less than 16%, less than 15%, less than 14%, less than 13%, less than 12%, less than 11%, less than 10%, less than 9%, less than 8%, less than 7%, less than 6%, less than 5%, less than 4%, less than 3%, less than 2%, or less than 1% at saturating antibody concentrations (*e.g.*, 67 nM) utilizing any *in vitro* assay or cell-based culture assay described herein or known in the art.

[0169] As used herein, levels of Siglec-9 may refer to expression levels of the gene encoding Siglec-9; to expression levels of one or more transcripts encoding Siglec-9; to expression levels of Siglec-9 protein; and/or to the amount of Siglec-9 protein present within cells and/or on the cell surface. Any methods known in the art for measuring levels of gene expression, transcription, translation, and/or protein abundance or localization may be used to determine the levels of Siglec-9.

[0170] Additionally, anti-Siglec-9 antibodies of the present disclosure can be used to prevent, reduce risk of, or treat dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal

pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and/or Haemophilus influenza. In some embodiments, anti-Siglec-9 antibodies of the present disclosure can be used for inducing or promoting the survival, maturation, functionality, migration, or proliferation of one or more immune cells in an individual in need thereof; or for decreasing the activity, functionality, or survival of regulatory T cells, tumor-imbedded immunosuppressor dendritic cells, tumor-imbedded immunosuppressor macrophages, myeloid-derived suppressor cells, tumor-associated macrophages, acute myeloid leukemia (AML) cells, chronic lymphocytic leukemia (CLL) cell, and/or chronic myeloid leukemia (CML) cell in an individual in need thereof. In some embodiments, anti-Siglec-9 antibodies of the present disclosure are monoclonal antibodies.

[0171] In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure decreases cellular levels of Siglec-9 (*e.g.*, cell surface levels, intracellular levels, and/or total levels). In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure induces downregulation of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure induces cleavage of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure induces internalization of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure induces shedding of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure induces degradation of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure induces desensitization of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure acts as a ligand mimetic to transiently activate Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure acts as a ligand mimetic and transiently activates Siglec-9 before inducing a decrease in cellular levels of Siglec-9 and/or inhibition of interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure acts as a ligand mimetic and transiently activates Siglec-9 before inducing degradation of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure acts as a ligand mimetic and transiently activates Siglec-9 before inducing cleavage of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure acts as a ligand mimetic and transiently activates Siglec-9 before inducing internalization

of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure acts as a ligand mimetic and transiently activates Siglec-9 before inducing shedding of Siglec-9. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure acts as a ligand mimetic and transiently activates Siglec-9 before inducing downregulation of Siglec-9 expression. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure acts as a ligand mimetic and transiently activates Siglec-9 before inducing desensitization of Siglec-9.

[0172] In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure is a murine antibody. In some embodiments, an isolated anti-Siglec-9 antibody of the present disclosure is a human antibody, a humanized antibody, a bispecific antibody, a monoclonal antibody, a multivalent antibody, or a chimeric antibody. Exemplary descriptions of such antibodies are found throughout the present disclosure.

[0173] In some embodiments, anti-Siglec-9 antibodies of the present disclosure bind to a human Siglec-9, or a homolog thereof, including without limitation, a mammalian Siglec-9 protein, chimpanzee Siglec-9 protein (NCBI Accession No. XP_003316614), green money Siglec-9 protein (NCBI Accession No. XP_007995940.1), rhesus macaque Siglec-9 protein (NCBI Accession No. XP_001114560.2), and mouse SIGLEC-E protein (NCBI Accession No. NP_112458.2). In some embodiments, anti-Siglec-9 antibodies of the present disclosure specifically bind to human Siglec-9. In some embodiments, anti-Siglec-9 antibodies of the present disclosure specifically bind to primate Siglec-9. In some embodiments, anti-Siglec-9 antibodies of the present disclosure specifically bind to both human Siglec-9 and primate Siglec-9.

[0174] In some embodiments, anti-Siglec-9 antibodies of the present disclosure are agonist antibodies or antagonist antibodies that bind to a Siglec-9 protein of the present disclosure expressed on the surface of a cell and modulate (e.g., induce or inhibit) one or more Siglec-9 activities of the present disclosure after binding to the surface-expressed Siglec-9 protein. In some embodiments, anti-Siglec-9 antibodies of the present disclosure are inert antibodies.

[0175] In some embodiments, anti-Siglec-9 antibodies of the present disclosure do not significantly reduce TREM2 expression, including, without limitation, cell surface levels of TREM2, intracellular levels of TREM2, and/or total levels of TREM2. In some embodiments, an anti-Siglec-9 antibody does not reduce cellular levels of TREM2 *in vivo*. In some embodiments, the cellular levels of TREM2 are measured on primary cells selected from dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, macrophages, neutrophils, and NK cells, or on cell lines, and wherein the cellular levels of TREM2 are measured utilizing an *in vitro* cell assay. As used herein, an anti-Siglec-9 antibody does not significantly reduce cTREM2 expression if it reduced TREM2 by less than 20% as compared toTREM2 expression in the absence of the anti-Siglec-9 antibody utilizing any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art.

In some embodiments, anti-Siglec-9 antibodies of the present disclosure decrease TREM2 expression by less than 20%, less than 19%, less than 18%, less than 17%, less than 16%, less than 15%, less than 14%, less than 13%, less than 12%, less than 11%, less than 10%, less than 9%, less than 8%, less than 7%, less than 6%, less than 5%, less than 4%, less than 3%, less than 2%, or less than 1% as compared to TREM2 expression in the absence of the anti-Siglec-9 antibody.

Anti-Siglec-9 antibody-binding regions

[0176] Certain aspects of the preset disclosure provide anti-Siglec-9 antibodies that bind to one or more amino acids within amino acid residues 20-347, 20-140, 141-347, 146-347, 146-229, 236-336, or 146-347 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 20-347, 20-140, 141-347, 146-347, 146-229, 236-336, or 146-347 of SEQ ID NO: 1. In some embodiments, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 62-76 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 62-76 of SEQ ID NO: 1. In some embodiments, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 62-76 and 86-92 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 62-76 and 86-92 of SEQ ID NO: 1. In some embodiments, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-92 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 86-92 of SEQ ID NO: 1. In some embodiments, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-96 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 86-96 of SEQ ID NO: 1. In some embodiments, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 86-96 and 105-116 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 86-96 and 105-116 of SEQ ID NO: 1. In some embodiments, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 105-116 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 105-116 of SEQ ID NO: 1. In some embodiments, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 107-115 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 107-115 of SEQ ID NO: 1. In some embodiments, the anti-Siglec-9 antibody binds to one or more amino acids within amino acid residues 185-194 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 185-194 of SEQ ID NO: 1.

[0177] In some embodiments, an anti-Siglec-9 antibody of the present disclosure binds to one or more amino acid residues selected from L22, H48, W50, I51, Y52, K123, I126, D189, P190, R194 of SEQ ID NO: 1, or one or more amino acid residues on a mammalian Siglec-9 protein corresponding to an amino acid residue selected from L22, H48, W50, I51, Y52, K123, I126, D189, P190, R194 of SEQ ID NO: 1. In some embodiments, an anti-Siglec-9 antibody of the present disclosure binds to one or more, two or more, or all three amino acid residues selected from D189, P190, and R194 of SEQ ID NO: 1, or one or more, two or more, or all three amino acid residues on a mammalian Siglec-9 protein corresponding to an amino acid residue selected from D189, P190, and R194 of SEQ ID NO: 1. In some embodiments, an anti-Siglec-9 antibody of the present disclosure binds to one or more, two or more, three or more, four or more, or all five amino acid residues selected from H48, W50, I51, Y52, and I126 of SEQ ID NO: 1, or one or more, two or more, three or more, four or more, or all five amino acid residues on a mammalian Siglec-9 protein corresponding to an amino acid residue selected from H48, W50, I51, Y52, and I126 of SEQ ID NO: 1. In some embodiments, an anti-Siglec-9 antibody of the present disclosure binds to one or more, two or more, three or more, four or more, five or more, or all six amino acid residues selected from L22, H48, W50, I51, Y52, and K123 of SEQ ID NO: 1, or one or more, two or more, three or more, four or more, five or more, or all six amino acid residues on a mammalian Siglec-9 protein corresponding to an amino acid residue selected from L22, H48, W50, I51, Y52, and K123 of SEQ ID NO: 1.

[0178] As indicated in **Table 8B**, the critical Siglec-9 residues involved in binding by antibody 2D4 corresponded to amino acid residues D189, P190, and R194 of SEQ ID NO: 1. The critical Siglec-9 residues involved in binding by antibody 12B12 corresponded to amino acid residues H48, W50, I51, Y52, and I126 of SEQ ID NO: 1. The critical Siglec-9 residues involved in binding by antibody 5C6 corresponded to amino acid residues L22, H48, W50, I51, Y52, and K123 of SEQ ID NO: 1.

[0179] Other aspects of the preset disclosure provide anti-Siglec-9 antibodies that decrease cellular levels of Siglec-9 and/or inhibit interaction (*e.g.*, binding) between Siglec-9, and that bind one or more Siglec-9 ligands bind to one or more amino acids within amino acid residues 62-76, 62-76 and 86-92, 86-92, 86-96, 86-96 and 105-116, 105-116, or 107-115 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 62-76, 62-76 and 86-92, 86-92, 86-96, 86-96 and 105-116, 105-116, or 107-115 of SEQ ID NO: 1.

[0180] Other aspects of the preset disclosure provide anti-Siglec-9 antibodies that do not significantly decrease cell surface levels of Siglec-9 and/or do not inhibit interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands, and that bind to one or more amino acids within amino acid residues 185-194 of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a

Siglec-9 homolog or ortholog corresponding to amino acid residues 185-194 of SEQ ID NO: 1. Other aspects of the preset disclosure provide anti-Siglec-9 antibodies that do not significantly decrease cell surface levels of Siglec-9 and/or do not inhibit interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands, and that bind to one or more amino acids within amino acid residues 62-76of human Siglec-9 (SEQ ID NO: 1), or within amino acid residues on a Siglec-9 homolog or ortholog corresponding to amino acid residues 6of SEQ ID NO: 1.

[0181] In some embodiments, anti-Siglec-9 antibodies of the present disclosure may bind a conformational epitope. In some embodiments, anti-Siglec-9 antibodies of the present disclosure may bind a discontinuous Siglec-9 epitope. In some embodiments, the discontinuous Siglec-9 epitope may have two or more peptides, three or more peptides, four or more peptides, five or more peptides, six or more peptides, seven or more peptide, eight or more peptides, nine or more peptides, or 10 or more peptides. As disclosed herein, Siglec-9 epitopes may comprise one or more peptides comprising five or more, six or more, seven or more, eight or more, nine or more, 10 or more, 11 or more, 12 or more, 13 or more 14 or more, 15 or more, 16 or more, 17 or more, 18 or more, 19 or more, or 20 or more amino acid residues of the amino acid sequence of SEQ ID NO: 1, or five or more, six or more, seven or more, eight or more, nine or more, 10 or more, 11 or more, 12 or more, 13 or more 14 or more, 15 or more, 16 or more, 17 or more, 18 or more, 19 or more, or 20 or more amino acid residues on a mammalian Siglec-9 protein corresponding to the amino acid sequence of SEQ ID NO: 1.

[0182] In some embodiments, anti-Siglec-9 antibodies of the present disclosure competitively inhibit binding of at least one antibody selected from any of the antibodies listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**. In some embodiments, anti-Siglec-9 antibodies of the present disclosure competitively inhibit binding of at least one antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2.

[0183] In some embodiments, anti-Siglec-9 antibodies of the present disclosure bind to an epitope of human Siglec-9 that is the same as or overlaps with the Siglec-9 epitope bound by at least one antibody selected from any of the antibodies listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**. In some embodiments, anti-Siglec-9 antibodies of the present disclosure bind to an epitope of human Siglec-9 that is the same as or overlaps with the Siglec-9 epitope bound by at least one antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2.

[0184] In some embodiments, anti-Siglec-9 antibodies of the present disclosure bind essentially the same Siglec-9 epitope bound by at least one antibody selected from any of the antibodies listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**. In some embodiments, anti-Siglec-9 antibodies of the present disclosure bind essentially the same Siglec-9 epitope bound by at least one antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2. Detailed exemplary methods for mapping

an epitope to which an antibody binds are provided in Morris (1996) "Epitope Mapping Protocols," in *Methods in Molecular Biology* vol. 66 (Humana Press, Totowa, NJ).

[0185] In some embodiments, anti-Siglec-9 antibodies of the present disclosure compete with one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof for binding to Siglec-9 when the anti-Siglec-9 antibody reduces the binding of one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof to Siglec-9 by an amount the ranges from about 50% to 100%, as compared to binding to Siglec-9 in the absence of the anti-Siglec-9 antibody. In some embodiments, an anti-Siglec-9 antibody of the present disclosure competes with one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof for binding to Siglec-9 when the anti-Siglec-9 antibody reduces the binding of one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof to Siglec-9 by at least 50%, at least 55%, by at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or 100%, as compared to binding to Siglec-9 in the absence of the anti-Siglec-9 antibody. In some embodiments, an anti-Siglec-9 antibody of the present disclosure that reduces the binding of one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof to Siglec-9 by 100% indicates that the anti-Siglec-9 antibody essential completely blocks the binding of one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof to Siglec-9. In some embodiments, the anti-Siglec-9 antibody and the one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof are present in an amount that corresponds to a 10:1 ratio, 9:1 ratio, 8:1 ratio, 7:1 ratio, 6:1 ratio, 5:1 ratio, 4:1 ratio, 3:1 ratio, 2:1 ratio, 1:1 ratio, 0.75:1 ratio, 0.5:1 ratio, 0.25:1 ratio, 0.1:1 ratio, 0.075:1 ratio, 0.050:1 ratio, 0.025:1 ratio, 0.01:1 ratio, 0.0075: ratio, 0.0050:1 ratio, 0.0025:1 ratio, 0.001: ratio, 0.00075:1 ratio, 0.00050:1 ratio, 0.00025:1 ratio, 0.0001: ratio, 1:10 ratio, 1:9 ratio, 1:8 ratio, 1:7 ratio, 1:6 ratio, 1:5 ratio, 1:4 ratio, 1:3 ratio, 1:2 ratio, 1:0.75 ratio, 1:0.5 ratio, 1:0.25 ratio, 1:0.1 ratio, 1:0.075 ratio, 1:0.050 ratio, 1:0.025 ratio, 1:0.01 ratio, 1:0.0075 ratio, 1:0.0050 ratio, 1:0.0025 ratio, 1:0.001 ratio, 1:0.00075 ratio, 1:0.00050 ratio, 1:0.00025 ratio, or 1:0.0001ratio of anti-Siglec-9 antibody to one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof. In some embodiments, the anti-Siglec-9 antibody is present in excess by an amount that ranges from about 1.5-fold to 100-fold, or greater than 100-fold compared to the amount of the one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof. In some embodiments, the anti-Siglec-9 antibody is present in an amount that is about a 2-fold, 3-fold, 4-fold, 5-fold, 6-fold, 7-fold, 8-fold, 9-fold, 10-fold, 15-fold, 20-fold, 25-fold, 30-fold, 35-fold, 40-fold, 45-fold, 50-fold, 55-fold, 60-fold, 65-fold, 70-fold, 75-fold, 80-

fold, 85-fold, 90-fold, 95-fold, or 100-fold excess compared to the amount of the one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof.

[0186] Any suitable competition assay or Siglec-9 binding assay known in the art, such as BIAcore analysis, ELISA assays, or flow cytometry, may be utilized to determine whether an anti-Siglec-9 antibody competes with one or more antibodies selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof for binding to Siglec-9. In an exemplary competition assay, immobilized Siglec-9 or cells expressing Siglec-9 on the cell surface are incubated in a solution comprising a first labeled antibody that binds to Siglec-9 (e.g., human or non-human primate) and a second unlabeled antibody that is being tested for its ability to compete with the first antibody for binding to Siglec-9. The second antibody may be present in a hybridoma supernatant. As a control, immobilized Siglec-9 or cells expressing Siglec-9 is incubated in a solution comprising the first labeled antibody but not the second unlabeled antibody. After incubation under conditions permissive for binding of the first antibody to Siglec-9, excess unbound antibody is removed, and the amount of label associated with immobilized Siglec-9 or cells expressing Siglec-9 is measured. If the amount of label associated with immobilized Siglec-9 or cells expressing Siglec-9 is substantially reduced in the test sample relative to the control sample, then that indicates that the second antibody is competing with the first antibody for binding to Siglec-9. *See*, Harlow and Lane (1988) *Antibodies: A Laboratory Manual* ch.14 (Cold Spring Harbor Laboratory, Cold Spring Harbor, NY).

Anti-Siglec-9 antibody light chain and heavy chain variable regions

[0187] In some embodiments, anti-Siglec-9 antibodies of the present disclosure comprise (a) a light chain variable region comprising at least one, two, or three HVRs selected from HVR-L1, HVR-L2, and HVR-L3 of any one of the antibodies listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof; and/or (b) a heavy chain variable region comprising at least one, two, or three HVRs selected from HVR-H1, HVR-H2, and HVR-H3 of any one of the antibodies listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof. In some embodiments, the HVR-L1, HVR-L2, HVR-L3, HVR-H1, HVR-H2, and HVR-H3 comprise EU or Kabat CDR, Chothia CDR, or Contact CDR sequences as shown in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or from an antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, 17C2, and any combination thereof.

[0188] In some embodiments, anti-Siglec-9 antibodies of the present disclosure comprise at least one, two, three, four, five, or six HVRs selected from (i) HVR-L1 comprising the amino acid sequence of any of the HVR-L1 sequences listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or from an antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2; (ii) HVR-L2

comprising the amino acid sequence of any of the HVR-L2 sequences listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or from an antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2; (iii) HVR-L3 comprising the amino acid sequence of any of the HVR-L3 sequences listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or from an antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2; (iv) HVR-H1 comprising the amino acid sequence of any of the HVR-H1 sequences listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or from an antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2; (v) HVR-H2 comprising the amino acid sequence of any of the HVR-H2 sequences listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or from an antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2; and (vi) HVR-H3 comprising the amino acid sequence of any of the HVR-H3 sequences listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or from an antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2.

[0189] In some embodiments, anti-Siglec-9 antibodies of the present disclosure comprise a light chain variable domain and a heavy chain variable domain, wherein the light chain variable domain comprises one or more of: (a) an HVR-L1 comprising an amino acid sequence selected from SEQ ID NOs: 6-9, 172, and 173, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from SEQ ID NOs: 6-9, 172, and 173; (b) an HVR-L2 comprising an amino acid sequence selected from SEQ ID NOs: 10-13, 174, and 175, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from SEQ ID NOs: 10-13, 174, and 175; and (c) an HVR-L3 comprising an amino acid sequence selected from SEQ ID NOs: 14-18, 176, and 177, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from SEQ ID NOs: 14-18, 176, and 177; and/or wherein the heavy chain variable domain comprises one or more of: (a) an HVR-H1 comprising an amino acid sequence selected from SEQ ID NOs: 19-21, 178, and 179, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from SEQ ID NOs: 19-21, 178, and 179; (b) an HVR-H2 comprising an amino acid sequence selected from SEQ ID NOs: 22-25, 180, and 181, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from SEQ ID NOs: 22-25, 180, and 181; and (c) an HVR-H3 comprising an amino acid sequence selected from SEQ ID NOs: 26-29, 182, and 183, or an amino acid sequence with at least about 90% homology to an amino acid sequence selected from SEQ ID NOs: 26-29, 182, and 183.

[0190] In some embodiments, anti-Siglec-9 antibodies of the present disclosure comprise a light chain variable domain and a heavy chain variable domain, wherein (a) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 6, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 10, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 14, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 19, the HVR-H2 comprises the amino acid sequence of SEQ

ID NO: 22, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 26; (b) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 7, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 11, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 15, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 20, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 23, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 27; (c) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 8, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 12, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 16, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 21, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 24, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 28; (d) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 9, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 13, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 17, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 21, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 25, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 29; (e) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 8, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 12, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 18, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 21, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 24, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 28; (f) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 172, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 174, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 176, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 178, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 180, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 182; or (g) the HVR-L1 comprises the amino acid sequence of SEQ ID NO: 173, the HVR-L2 comprises the amino acid sequence of SEQ ID NO: 175, the HVR-L3 comprises the amino acid sequence of SEQ ID NO: 177, the HVR-H1 comprises the amino acid sequence of SEQ ID NO: 179, the HVR-H2 comprises the amino acid sequence of SEQ ID NO: 181, and the HVR-H3 comprises the amino acid sequence of SEQ ID NO: 183.

[0191] In some embodiments, anti-Siglec-9 antibodies of the present disclosure comprise a light chain variable region of any one of the antibodies listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2; and/or a heavy chain variable region of any one of the antibodies listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2. In some embodiments, anti-Siglec-9 antibodies of the present disclosure comprise a light chain variable region comprising an amino acid sequence selected from any of SEQ ID NOs: 61-115 and 197-204; and/or a heavy chain variable domain comprising an amino acid sequence selected from any of SEQ ID NOs: 116-170 and 205-212. In

some embodiments, the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 61; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 116. In some embodiments, the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 72; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 127. In some embodiments, the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 83; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 138. In some embodiments, the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 94; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 149. In some embodiments, the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 105; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 160. In some embodiments, the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 197; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 205. In some embodiments, the light chain variable domain comprises the amino acid sequence of SEQ ID NO: 201; and the heavy chain variable domain comprises the amino acid sequence of SEQ ID NO: 210.

[0192] In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 5C6-H1 and the light chain variable domain of antibody 5C6-L1. In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 5C6-H2 and the light chain variable domain of antibody 5C6-L2. In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 5C6-H2 and the light chain variable domain of antibody 5C6-L3. In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 5C6-H3 and the light chain variable domain of antibody 5C6-L2. In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 5C6-H3 and the light chain variable domain of antibody 5C6-L3. In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 5C6-H4 and the light chain variable domain of antibody 5C6-L2. In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 5C6-H4 and the light chain variable domain of antibody 5C6-L3.

[0193] In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 12B12-H1 and the light chain variable domain of antibody 12B12-L1. In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 12B12-H2 and the light chain variable domain of antibody 12B12-L1. In some embodiments, the anti-Siglec-9 antibody comprises the heavy chain variable domain of antibody 12B12-H2 and the light chain variable domain of antibody 12B12-L2. In some embodiments, the anti-Siglec-9 antibody

comprises the heavy chain variable domain of antibody 12B12-H2 and the light chain variable domain of antibody 12B12-L3.

[0194] In some embodiments, the anti-Siglec-9 antibody is anti-Siglec-9 monoclonal antibody 2D4. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody which binds essentially the same TREM2 epitope as 2D4. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain of monoclonal antibody 2D4. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 2D4. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain and the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 2D4.

[0195] In some embodiments, the anti-Siglec-9 antibody is anti-Siglec-9 monoclonal antibody 2D5. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody which binds essentially the same TREM2 epitope as 2D5. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain of monoclonal antibody 2D5. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 2D5. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain and the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 2D5.

[0196] In some embodiments, the anti-Siglec-9 antibody is anti-Siglec-9 monoclonal antibody 5B1. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody which binds essentially the same TREM2 epitope as 5B1. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain of monoclonal antibody 5B1. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 5B1. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain and the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 5B1.

[0197] In some embodiments, the anti-Siglec-9 antibody is anti-Siglec-9 monoclonal antibody 6B2. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody which binds essentially the same TREM2 epitope as 6B2. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain of monoclonal antibody 6B2. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of

monoclonal antibody 6B2. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain and the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 6B2.

[0198] In some embodiments, the anti-Siglec-9 antibody is anti-Siglec-9 monoclonal antibody 6D8. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody which binds essentially the same TREM2 epitope as 6D8. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain of monoclonal antibody 6D8. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 6D8. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain and the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 6D8.

[0199] In some embodiments, the anti-Siglec-9 antibody is anti-Siglec-9 monoclonal antibody 7H12. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody which binds essentially the same TREM2 epitope as 7H12. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain of monoclonal antibody 7H12. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 7H12. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain and the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 7H12.

[0200] In some embodiments, the anti-Siglec-9 antibody is anti-Siglec-9 monoclonal antibody 5C6. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody which binds essentially the same TREM2 epitope as 5C6. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain of monoclonal antibody 5C6. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 5C6. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain and the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 5C6.

[0201] In some embodiments, the anti-Siglec-9 antibody is anti-Siglec-9 monoclonal antibody 12B12. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody which binds essentially the same TREM2 epitope as 12B12. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable

domain of monoclonal antibody 12B12. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 12B12. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain and the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 12B12.

[0202] In some embodiments, the anti-Siglec-9 antibody is anti-Siglec-9 monoclonal antibody 17C2. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody which binds essentially the same TREM2 epitope as 17C2. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain of monoclonal antibody 17C2. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 17C2. In some embodiments, the anti-Siglec-9 antibody is an isolated antibody comprising the HVR-H1, HVR-H2, and HVR-H3 of the heavy chain variable domain and the HVR-L1, HVR-L2, and HVR-L3 of the light chain variable domain of monoclonal antibody 17C2.

[0203] Any of the antibodies of the present disclosure may be produced by a cell line. In some embodiments, the cell line may be a mammalian cell line. In certain embodiments, the cell line may be a hybridoma cell line. In other embodiments, the cell line may be a yeast cell line. Any cell line known in the art suitable for antibody production may be used to produce an antibody of the present disclosure. Exemplary cell lines for antibody production are described throughout the present disclosure.

[0204] In some embodiments, the anti-Siglec-9 antibody is an anti-Siglec-9 monoclonal antibody selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2. In certain embodiments, the anti-Siglec-9 antibody is an antagonist antibody. In certain embodiments, the anti-Siglec-9 antibody is an agonist antibody or an inert antibody.

Anti-Siglec-9 antibody binding affinity

[0205] The dissociation constants (K_D) of anti-Siglec-9 antibodies for human Siglec-9, mammalian Siglec-9, or both, may be less than 100nM, less than 90 nM, less than 80 nM, less than 70 nM, less than 60 nM, less than 50 nM, less than 40 nM, less than 30 nM, less than 20 nM, less than 10 nM, less than 9.5 nM, less than 9 nM, less than 8.5 nM, less than 8 nM, less than 7.5 nM, less than 7 nM, less than 6.9 nM, less than 6.8 nM, less than 6.7 nM, less than 6.6 nM, less than 6.5 nM, less than 6.4 nM, less than 6.3 nM, less than 6.2 nM, less than 6.1 nM, less than 6 nM, less than 5.9 nM, less than 5.8 nM, less than 5.7 nM, less than 5.6 nM,less than 5.5 nM, less than 5.4 nM, less than 5.3 nM, less than 5.2 nM, less than 5.1 nM, less than 5 nM, less than 4.5 nM, less than 4 nM, less

than 3.5 nM, less than 3 nM, less than 2.9 nM, less than 2.8 nM, less than 2.7 nM, less than 2.6 nM,less than 2.5 nM, less than 2.4 nM, less than 2.3 nM, less than 2.2 nM, less than 2.1 nM, less than 2 nM, less than 1.5 nM, less than 1 nM, less than 0.9 nM, less than 0.8 nM, less than 0.79 nM, less than 0.78 nM, less than 0.77 nM, less than 0.76 nM, less than 0.75 nM, less than 0.74 nM, less than 0.73 nM, less than 0.72 nM, less than 0.71 nM,less than 0.70 nM, less than 0.6 nM, less than 0.59 nM, less than 0.58 nM, less than 0.57 nM, less than 0.56 nM, less than 0.55 nM, less than 0.54 nM, less than 0.53 nM, less than 0.52 nM, less than 0.51 nM,less than 0.50 nM, less than 0.4 nM, less than 0.3 nM, less than 0.29 nM, less than 0.28 nM, less than 0.27 nM, less than 0.26 nM, less than 0.25 nM, less than 0.24 nM, less than 0.23 nM, less than 0.22 nM, less than 0.21 nM, less than 0.2 nM, less than 0.1 nM, or less than 0.05 nM (i.e., 50 pM). In some embodiments, the antibody has a dissociation constant (K_D) for human Siglec-9, mammalian Siglec-9, or both, that ranges from less than 10 nM to less than 10 pM (i.e., 0.01 nM). In some embodiments, the antibody has a dissociation constant (K_D) for human Siglec-9 that ranges from about 9 nM to about 300 pM, or less than 300 pM. In some embodiments, the antibody has a dissociation constant (K_D) for human Siglec-9 that ranges from about 9 nM to about 230 pM, or less than 2300 pM. Dissociation constants may be determined through any analytical technique, including any biochemical or biophysical technique such as ELISA, surface plasmon resonance (SPR), bio-layer interferometry (*see*, *e.g.*, Octet System by ForteBio), isothermal titration calorimetry (ITC), differential scanning calorimetry (DSC), circular dichroism (CD), stopped-flow analysis, and colorimetric or fluorescent protein melting analyses. In some embodiments, the K_D is determined using a full-length antibody in a monovalent form. In some embodiments, the K_D is determined utilizing, for example, a surface plasmon resonance assay or Fortebio assay as described herein (see, *e.g.,* **Example 1**).

[0206] Additional anti-Siglec-9 antibodies, *e.g.*, antibodies that specifically bind to a Siglec-9 protein of the present disclosure, may be identified, screened, and/or characterized for their physical/chemical properties and/or biological activities by various assays known in the art.

Anti-Siglec-9 antibodies capable of binding Fc gamma receptors

[0207] In some embodiments, anti-Siglec-9 antibodies of the present disclosure retain the ability to bind Fc gamma receptors. In some embodiments, such antibodies when they have the correct epitope specificity that is compatible with receptor activation may have features that enable them to cluster and transiently stimulate, for example, the Siglec-9 receptor. In some embodiments, such antibodies may subsequently act as longer-term inhibitors of Siglec-9 expression and/or one or more activities of a Siglec-9 protein by inducing Siglec-9 degradation, Siglec-9 desensitization, Siglec-9 cleavage, Siglec-9 internalization, Siglec-9 shedding, downregulation of Siglec-9 expression, and/or lysosomal degradation of Siglec-9.

[0208] *In vivo*, anti-Siglec-9 antibodies of the present disclosure may cluster receptors and transiently activate Siglec-9 by any one or more of multiple potential mechanisms. Some isotypes of human antibodies such as IgG2 have, due to their unique structure, an intrinsic ability to cluster receptors, or retain receptors in a clustered configuration, thereby transiently activating receptors such as Siglec-9 without binding to an Fc receptor (*e.g.*, White et al., (2015) Cancer Cell 27, 138–148).

[0209] In some embodiments, other antibodies may cluster receptors (*e.g.,* Siglec-9) by binding to Fcg receptors on adjacent cells. In some embodiments, binding of the constant IgG Fc region of the antibody to Fcg receptors may lead to aggregation of the antibodies, and the antibodies in turn may aggregate the receptors to which they bind through their variable region (Chu et al (2008) Mol Immunol, 45:3926-3933; and Wilson et al., (2011) Cancer Cell 19, 101–113). In some embodiments, binding to the inhibitory Fcg receptor FcgR (FcgRIIB) that does not elicit cytokine secretion, oxidative burst, increased phagocytosis, and enhanced antibody-dependent, cell-mediated cytotoxicity (ADCC) is a preferred way to cluster antibodies *in vivo*, since binding to FcgRIIB is not associated with adverse immune response effects.

[0210] There are other mechanisms by which anti-Siglec-9 antibodies of the present disclosure can cluster receptors. For example, antibody fragments (*e.g.,* Fab fragments) that are cross-linked together may be used to cluster receptors (*e.g.,* Siglec-9) in a manner similar to antibodies with Fc regions that bind Fcg receptors, as described above. In some embodiments, cross-linked antibody fragments (*e.g.,* Fab fragments) may transiently function as agonist antibodies if they induce receptor clustering on the cell surface and bind an appropriate epitope on the target (*e.g.,* Siglec-9).

[0211] Therefore, in some embodiments, antibodies of the present disclosure that bind a Siglec-9 protein may include agonist antibodies that due to their epitope specificity bind Siglec-9 and transiently activate one or more Siglec-9 activities before they, for example, decrease cellular levels of Siglec-9, inhibit one or more Siglec-9 activities (e.g., due to decreased cellular levels of Siglec-9), and/or inhibit interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands. In some embodiments, such antibodies may bind to the ligand-binding site on Siglec-9 and transiently mimic the action of a natural ligand. Alternatively, such antibodies may stimulate the target antigen to transduce signal by binding to one or more domains that are not the ligand-binding sites. In some embodiments, such antibodies would not interfere with ligand binding. In some embodiments, regardless of whether antibodies bind or do not bind to the ligand-binding site on Siglec-9, the antibodies may subsequently act as longer term inhibitors of Siglec-9 expression and/or one or more activities of a Siglec-9 protein by inducing Siglec-9 degradation, Siglec-9 desensitization, Siglec-9 cleavage, Siglec-9 internalization, Siglec-9 shedding, downregulation of Siglec-9 expression, and/or lysosomal degradation of Siglec-9.

[0212] In some embodiments, an anti-Siglec-9 antibody of the present disclosure is a transient agonist antibody that transiently induces one or more activities of a Siglec-9 protein. In some embodiments, the antibody transiently induces the one or more activities after binding to a Siglec-9 protein that is expressed in a cell. In some embodiments, the Siglec-9 protein is expressed on a cell surface. In some embodiments, the one or more activities of a Siglec-9 protein that are transiently induced by transient agonist anti-Siglec-9 antibodies of the present disclosure may include, without limitation, phosphorylation of Tyr-433 and Tyr-456 by a Src family tyrosine kinase, such as Syk, LCK, FYM, and/or ZAP70; recruitment of and binding to the tyrosine-specific protein phosphatases SHP1 and SHP2; recruitment of and binding to PLC-gamma1, which acts as a guanine nucleotide exchange factor for Dynamini-1; recruitment of and binding to SH2-domain containing protein (*e.g.*, Crkl); recruitment of and binding to the spleen tyrosine kinase Syk; recruitment of and binding to SH3-SH2-SH3 growth factor receptor-bound protein 2 (Grb2); recruitment of and binding to multiple SH2-containing proteins; modulated expression of one or more pro-inflammatory cytokines, such as FN-α4, IFN-beta, IL-1β, IL-1alpha, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, CRP, MCP-1, and MIP-1-beta; modulated expression of one or more pro-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; increased expression of one or more anti-inflammatory cytokines, such as IL-4, IL-10, IL-13, IL-35, IL-16, TGF-beta, IL-1Ra, G-CSF, and soluble receptors for TNF, IFN-beta1a, IFN-beta1b, or IL-6; modulated expression of one or more anti-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; modulate expression of one or more proteins selected from C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and PYCARD; inhibition of extracellular signal-regulated kinase (ERK) phosphorylation; decreasing tyrosine phosphorylation on one or more cellular proteins, optionally, wherein the one or more cellular proteins comprise ZAP-70 and the tyrosine phosphorylation occurs on Tyr-319 of ZAP-70; modulated expression of C-C chemokine receptor 7 (CCR7); inhibition of microglial cell chemotaxis toward CCL19-expressing and CCL21-expressing cells; decreasing T cell proliferation induced by one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, M1 microglia, activated M1 microglia, M2 microglia, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, and M2 NK cells; inhibition of osteoclast production, decreased rate of osteoclastogenesis, or both;

decreasing survival of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; decreasing proliferation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibiting migration of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibiting one or more functions of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibiting maturation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; inhibition of one or more types of clearance selected from apoptotic neuron clearance, nerve tissue debris clearance, dysfunctional synapse clearance, non-nerve tissue debris clearance, bacteria clearance, other foreign body clearance, disease-causing protein clearance, disease-causing peptide clearance, and tumor cell clearance; optionally wherein the disease-causing protein is selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin,

immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides and the tumor cell is from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer; inhibition of phagocytosis of one or more of apoptotic neurons, nerve tissue debris, dysfunctional synapses, non-nerve tissue debris, bacteria, other foreign bodies, disease-causing proteins, disease-causing peptides, disease-causing nucleic acids, or tumor cells; optionally wherein the disease-causing nucleic acids are antisense GGCCCC (G2C4) repeat-expansion RNA, the disease-causing proteins are selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides, and the tumor cells are from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, or thyroid cancer; binding to Siglec-9 ligand on tumor cells; binding to Siglec-9 ligand on cells selected from neutrophils, dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, macrophages, and NK cells; inhibition of tumor cell killing by one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; inhibiting anti-tumor cell proliferation activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; inhibition of anti-tumor cell metastasis activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; inhibition of one or more ITAM motif containing receptors, optionally wherein the one or more ITAM motif containing receptors are selected from TREM1, TREM2, Sirp beta, FcgR, DAP10, and DAP12; inhibition of

signaling by one or more pattern recognition receptors (PRRs), optionally wherein the one or more PRRs are selected from receptors that identify pathogen-associated molecular patterns (PAMPs), receptors that identify damage-associated molecular patterns (DAMPs), and any combination thereof; inhibition of one or more receptors comprising the motif D/Ex_{0-2}YxxL/IX_{6-8}YxxL/I (SEQ ID NO: 252); inhibition of signaling by one or more Toll-like receptors; inhibition of the JAK-STAT signaling pathway; inhibition of nuclear factor kappa-light-chain-enhancer of activated B cells (NFκB); de-phosphorylation of an ITAM motif containing receptor; modulated expression of one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells, optionally wherein the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells comprise CD86, C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and/or PYCARD, and the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells are expressed on one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; increasing expression of one or more Siglec-9-dependent genes; normalization of disrupted Siglec-9-dependent gene expression; decreasing expression of one or more ITAM-dependent genes, optionally wherein the one more ITAM-dependent genes are activated by nuclear factor of activated T cells (NFAT) transcription factors; promoting or rescuing functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells; increasing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells into tumors; increasing the number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; enhancing tumor-promoting activity of myeloid-derived suppressor cells; increasing expression of tumor-promoting cytokines in a tumor or in peripheral blood, optionally wherein the tumor-promoting cytokines are TGF-beta or IL-10; increasing tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; enhancing tumor-promoting activity of myeloid-derived suppressor cells (MDSC); decreasing activation of tumor-specific T lymphocytes with tumor killing potential; decreasing infiltration of tumor-specific NK cells with tumor killing potential; decreasing the tumor killing potential of NK cells; decreasing infiltration of tumor-specific B lymphocytes with potential to enhance immune response; decreasing infiltration of tumor-specific T lymphocytes with

tumor killing potential; increasing tumor volume; increasing tumor growth rate; increasing metastasis; increasing rate of tumor recurrence; decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more target proteins selected from PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, TREM1, TREM2, CD39, CD73, CSF-1 receptor, and any combination thereof, or of one or more cancer vaccines; inhibition of PLCγ/PKC/calcium mobilization; and inhibition of PI3K/Akt, Ras/MAPK signaling. Anti-Siglec-9 antibodies of the present disclosure may be tested for their ability to transiently induce one or more activities of a Siglec-9 protein utilizing any suitable technique or assay known in the art and disclosed herein. Regardless of the activities that such antibodies transiently induce, such antibodies may subsequently act as longer-term inhibitors of Siglec-9 expression and/or one or more activities of a Siglec-9 protein by inducing Siglec-9 degradation, Siglec-9 desensitization, Siglec-9 cleavage, Siglec-9 internalization, Siglec-9 shedding, downregulation of Siglec-9 expression, and/or lysosomal degradation of Siglec-9. In some embodiments, the Siglec-9 antibody transiently induces one or more activities of a Siglec-9 protein independently of binding to an Fc receptor.

[0213] Exemplary antibody Fc isotypes and modifications are provided in Table C below. In some embodiments, an anti-Siglec-9 antibody of the present disclosure that is capable of binding an Fc gamma receptor has an Fc isotype listed in Table C below.

Table C: Exemplary anti-Siglec-9 antibody Fc isotypes that are capable of binding Fc gamma receptor

Fc Isotype	Mutation (EU or Kabat numbering scheme)
IgG1	N297A
IgG1	D265A and N297A
IgG1	D270A
IgG1	L234A and L235A L234A and G237A L234A and L235A and G237A
IgG1	D270A, and/or P238D, and/or L328E, and/or E233D, and/or G237D, and/or H268D, and/or P271G, and/or A330R
IgG1	P238D and L328E and E233D and G237D and H268D and P271G and A330R
IgG1	P238D and L328E and G237D and H268D and P271G and A330R
IgG1	P238D and S267E and L328F and E233D and G237D and H268D and P271G and A330R
IgG1	P238D and S267E and L328F and G237D and H268D and P271G and A330R
IgG2	V234A and G237A
IgG4	L235A and G237A and E318A

Fc Isotype	Mutation (EU or Kabat numbering scheme)
IgG4	S228P and L236E
IgG2/4 hybrid	IgG2 aa 118 to 260 and IgG4 aa 261 to 447
	H268Q and V309L; and A330S and P331S
IgG1	C226S and C229S and E233P and L234V and L235A
IgG1	L234F and L235E and P331S
IgG2	C232S or C233S
IgG2	A330S and P331S
IgG1	S267E, and L328F S267E alone
IgG2	S267E and L328F
IgG4	S267E and L328F
IgG2	WT HC with Kappa (light chain) LC HC C127S with Kappa LC Kappa LC C214S Kappa LC C214S and HC C233S Kappa LC C214S and HC C232S Any of the above listed mutations together with P330S and P331S mutations F(ab')2 fragment of WT IgG1 and any of the above listed mutations
IgG1	Substitute the Constant Heavy 1 (CH1) and hinge region of IgG1 With CH1 and hinge region of IGg2 ASTKGPSVFP LAPCSRSTSE STAALGCLVK DYFPEPVTVS WNSGALTSGV HTFPAVLQSS GLYSLSSVVT VPSSNFGTQT YTCNVDHKPS NTKVDKTVER KCCVECPPCP (SEQ ID NO: 171) With a Kappa LC
IgG1	Any of the above listed mutations together with A330L and/ or L234F and/or L235E and/or P331S
IgG1, IgG2, or IgG4	Any of the above listed mutations together with M252Y and/or S254T and/or T256E
Mouse IgG1	For mouse disease models
IgG4	WT

[0214] In addition to the isotypes described in Table C, and without wishing to be bound to theory, it is thought that antibodies with human IgG1 or IgG3 isotypes and mutants thereof (e.g. Strohl (2009) Current Opinion in Biotechnology 2009, 20:685–691) that bind the Fcg Receptors I, IIA, IIC, IIIA, IIIB in human and/or Fcg Receptors I, III and IV in mouse, may also act as transient agonist antibodies.

[0215] In some embodiments, the Fc gamma receptor-binding antibody is of the IgG class, the IgM class, or the IgA class. In some embodiments, the Fc gamma receptor-binding antibody has an IgG1, IgG2, IgG3, or IgG4 isotype.

[0216] In certain embodiments, the Fc gamma receptor-binding antibody has an IgG2 isotype. In some embodiments, the Fc gamma receptor-binding antibody contains a human IgG2 constant region.

In some embodiments, the human IgG2 constant region includes an Fc region. In some embodiments, the Fc gamma receptor-binding antibody binds an inhibitory Fc receptor. In certain embodiments, the inhibitory Fc receptor is inhibitory Fc-gamma receptor IIB (FcγIIB). In some embodiments, the Fc region contains one or more modifications. For example, in some embodiments, the Fc region contains one or more amino acid substitutions (*e.g.,* relative to a wild-type Fc region of the same isotype). In some embodiments, the one or more amino acid substitutions are selected from V234A (Alegre et al., (1994) *Transplantation* 57:1537-1543. 31; Xu et al., (2000) *Cell Immunol*, 200:16-26), G237A (Cole et al. (1999) *Transplantation*, 68:563-571), H268Q, V309L, A330S, P331S (US 2007/0148167; Armour et al. (1999) *Eur J Immunol* 29: 2613-2624; Armour et al. (2000) *The Haematology Journal* 1(Suppl.1):27; Armour et al. (2000) *The Haematology Journal* 1(Suppl.1):27), C232S, and/or C233S (White et al.(2015) *Cancer Cell* 27, 138–148), S267E, L328F (Chu et al., (2008) *Mol Immunol*, 45:3926-3933), M252Y, S254T, and/or T256E, where the amino acid position is according to the EU or Kabat numbering convention.

[0217] In some embodiments, the Fc gamma receptor-binding antibody has an IgG2 isotype with a heavy chain constant domain that contains a C127S amino acid substitution, where the amino acid position is according to the EU or Kabat numbering convention (White et al.,(2015) *Cancer Cell* 27, 138-148; Lightle et al., (2010) *PROTEIN SCIENCE* 19:753-762; and WO2008079246).

[0218] In some embodiments, the Fc gamma receptor-binding antibody has an IgG2 isotype with a Kappa light chain constant domain that contains a C214S amino acid substitution, where the amino acid position is according to the EU or Kabat numbering convention (White et al.,(2015) *Cancer Cell* 27, 138-148; Lightle et al., (2010) *PROTEIN SCIENCE* 19:753-762; and WO2008079246).

[0219] In certain embodiments, the Fc gamma receptor-binding antibody has an IgG1 isotype. In some embodiments, the Fc gamma receptor-binding antibody contains a mouse IgG1 constant region. In some embodiments, the Fc gamma receptor-binding antibody contains a human IgG1 constant region. In some embodiments, the human IgG1 constant region includes an Fc region. In some embodiments, the Fc gamma receptor-binding antibody binds an inhibitory Fc receptor. In certain embodiments, the inhibitory Fc receptor is inhibitory Fc-gamma receptor IIB (FcγIIB). In some embodiments, the Fc region contains one or more modifications. For example, in some embodiments, the Fc region contains one or more amino acid substitutions (*e.g.,* relative to a wild-type Fc region of the same isotype). In some embodiments, the one or more amino acid substitutions are selected from N297A (Bolt S et al. (1993) *Eur J Immunol* 23:403-411), D265A (Shields et al. (2001) *R. J. Biol. Chem.* 276, 6591–6604), D270A, L234A, L235A (Hutchins et al. (1995) *Proc Natl Acad Sci* USA, 92:11980-11984; Alegre et al., (1994) *Transplantation* 57:1537-1543. 31; Xu et al., (2000) *Cell Immunol*, 200:16-26), G237A (Alegre et al. (1994) *Transplantation* 57:1537-1543. 31; Xu et al. (2000) *Cell Immunol*, 200:16-26), P238D, L328E, E233D, G237D, H268D, P271G, A330R, C226S,

C229S, E233P, L234V, L234F, L235E (McEarchern et al., (2007) *Blood*, 109:1185-1192), P331S (Sazinsky et al., (2008) *Proc Natl Acad Sci USA* 2008, 105:20167-20172), S267E, L328F, A330L, M252Y, S254T, T256E, N297Q, P238S, P238A, A327Q, A327G, P329A, K322A, and/or T394D, where the amino acid position is according to the EU or Kabat numbering convention.

[0220] In some embodiments, the antibody includes an IgG2 isotype heavy chain constant domain 1(CH1) and hinge region (White et al., (2015) Cancer Cell 27, 138–148). In certain embodiments, the IgG2 isotype CH1 and hinge region contain the amino acid sequence of ASTKGPSVFPLAPCSRSTSESTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLY SLSSVVTVPSSNFGTQTYTCNVDHKPSNTKVDKTVERKCCVECPPCP (SEQ ID NO: 171). In some embodiments, the antibody Fc region contains a S267E amino acid substitution, a L328F amino acid substitution, or both, and/or a N297A or N297Q amino acid substitution, where the amino acid position is according to the EU or Kabat numbering convention.

[0221] In certain embodiments, the Fc gamma receptor-binding antibody has an IgG4 isotype. In some embodiments, the Fc gamma receptor-binding antibody contains a human IgG4 constant region. In some embodiments, the human IgG4 constant region includes an Fc region. In some embodiments, the Fc gamma receptor-binding antibody binds an inhibitory Fc receptor. In certain embodiments, the inhibitory Fc receptor is inhibitory Fc-gamma receptor IIB (FcγIIB). In some embodiments, the Fc region contains one or more modifications. For example, in some embodiments, the Fc region contains one or more amino acid substitutions (*e.g.,* relative to a wild-type Fc region of the same isotype). In some embodiments, the one or more amino acid substitutions are selected from L235A, G237A, S228P, L236E (Reddy et al., (2000) *J Immunol*,164:1925-1933), S267E, E318A, L328F, M252Y, S254T, and/or T256E, where the amino acid position is according to the EU or Kabat numbering convention.

[0222] In certain embodiments, the Fc gamma receptor-binding antibody has a hybrid IgG2/4 isotype. In some embodiments, the Fc gamma receptor-binding antibody includes an amino acid sequence containing amino acids 118 to 260 according to EU or, Kabat numbering of human IgG2 and amino acids 261-447 according to EU or, Kabat numbering of human IgG4 (WO 1997/11971; WO 2007/106585).

[0223] In certain embodiments, the antibody contains a mouse IgG4 constant region (Bartholomaeus, et al. (2014). J. Immunol. 192, 2091–2098).

[0224] In some embodiments, the Fc region further contains one or more additional amino acid substitutions selected from A330L, L234F; L235E, or P331S according to EU or, Kabat numbering; and any combination thereof.

Inert antibodies

[0225] Another class of anti-Siglec-9 antibodies of the present disclosure includes inert antibodies. As used herein, "inert" antibodies refer to antibodies that specifically bind their target antigen (*e.g.*, Siglec-9) but do not modulate (*e.g.*, decrease/inhibit or activate/induce) antigen function. For example, in the case of Siglec-9, inert antibodies do not modulate cellular levels of Siglec-9, do not modulate interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands, or do not modulate one or more activities of a Siglec-9 protein. In some embodiments, antibodies that do not have the ability to cluster Siglec-9 on the cell surface may be inert antibodies even if they have an epitope specificity that is compatible with receptor activation.

[0226] In some embodiments, antibodies that bind a Siglec-9 protein may include antibodies that bind Siglec-9 but, due to their epitope specificity, or characteristics, do not decrease cellular levels of Siglec-9 and/or inhibit interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands. In some embodiments, such antibodies can be used as cargo to, for example, transport toxins (*e.g.*, chemotherapeutics) into tumor cells. Such antibodies may be superior to current commercially available anti-Siglec-9 antibodies that reduce cellular levels of Siglec-9, such as gemtuzumab zogamicin, which is conjugated to a cytotoxic agent from the class of calicheamicins and is used to target and kill acute myelogenous leukemia tumors (Naito et al., (2000), Leukemia, 14, 1436-1443; Ricart (2011) Clin Cancer Res 17; 6417-6436; Hamann et al., (2002) Journal: Bioconjugate Chemistry, 13, 47-58; Beitz et al., (2001) Clin Cancer Res 7 ; 1490–6; and Malik M. et al. (2015) Human Molecular Genetics,1–14.). In some embodiments, inert anti-Siglec-9 antibodies of the present disclosure may be superior to commercial antibodies, such as gemtuzumab zogamicin, because antibodies that do not decrease cellular levels of Siglec-9 will leave Siglec-9 intact on the surface of tumor cells for targeting by additional toxin-conjugated antibodies. In contrast, antibodies that decrease cellular levels of Siglec-9 will remove Siglec-9 from the cell surface and will lead to protection of the tumor cells from further targeting by toxin-conjugated antibodies. Therefore, in some embodiments, antibodies of the present disclosure are inert antibodies that bind Siglec-9 but are incapable of decreasing cellular levels of Siglec-9, inhibiting interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands, or inducing one or more activities of a Siglec-9 protein.

[0227] Antibodies that either decrease or do not decrease cellular levels of Siglec-9 on cells can be combined with an inert Fc region that displays reduced binding to one or more Fcg Receptor. Examples of such Fc regions and modifications are provided in Table D below. In some embodiments, the antibody with an inert Fc region has an Fc isotype listed in Table D below.

Antagonist anti-Siglec-9 antibodies

[0228] A third class of anti-Siglec-9 antibodies of the present disclosure includes antagonist antibodies. In some embodiments, antibodies that bind a Siglec-9 protein may include antagonist antibodies that reduce cellular levels of Siglec-9, inhibit interaction (*e.g.*, binding) between Siglec-9 and/or one or more Siglec-9 ligands, and inhibit one or more activities of a Siglec-9 protein. Such antibodies inhibit one or more activities of a Siglec-9 protein either by preventing interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands or by preventing signal transduction from the extracellular domain of Siglec-9 into the cell cytoplasm in the presence of one or more Siglec-9 ligands. Antagonist antibodies also can inhibit one or more activities of a Siglec-9 protein by decreasing cell surface levels of Siglec-9 by inducing Siglec-9 degradation, Siglec-9 desensitization, Siglec-9 cleavage, Siglec-9 internalization, Siglec-9 shedding, downregulation of Siglec-9 expression, and/or lysosomal degradation of Siglec-9. In some embodiments, such antagonist anti-Siglec-9 antibodies may not transiently activate Siglec-9.

[0229] In some embodiments, antagonist anti-Siglec-9 antibodies of the present disclosure may have the epitope specificity of a transient agonist anti-Siglec-9 antibody of the present disclosure, but have an Fc domain that is not capable of binding Fcg receptors and thus is unable to, for example, transiently clustering and activating Siglec-9.

[0230] In some embodiments, antagonist anti-Siglec-9 antibodies of the present disclosure have, without limitation, one or more of the following activities: the ability to decrease binding of a Siglec-9 protein to one or more Siglec-9 ligands, such as sialic acid-containing glycolipids or sialic acid-containing glycoproteins, the ability to decrease the binding of a suppressor of cytokine signaling (SOCS) protein (*e.g.,* SOCS3 protein) to a Siglec-9 protein, the ability to increase the proteasomal degradation of a Siglec-9 protein, the ability to reduce functional expression of Siglec-9 on the surface of circulating dendritic cells, macrophages, monocytes, T cells, and/or microglia, the ability to decrease or inhibit phosphorylation of Tyr-433 and Tyr-456 by a Src family tyrosine kinase, such as Syk, LCK, FYM, and/orZAP70; the ability to inhibit recruitment of and binding to the tyrosine-specific protein phosphatases SHP1 and SHP2; the ability to inhibit recruitment of and binding to PLC-gamma1, which acts as a guanine nucleotide exchange factor for Dynamini-1; the ability to inhibit recruitment of and binding to SH2-domain containing protein (*e.g.*, Crkl); the ability to inhibit recruitment of and binding to the spleen tyrosine kinase Syk; the ability to inhibit recruitment of and binding to SH3-SH2-SH3 growth factor receptor-bound protein 2 (Grb2); the ability to inhibit recruitment of and binding to multiple SH2-containing proteins; the ability to modulate expression of one or more pro-inflammatory cytokines, optionally wherein the one or more anti-inflammatory cytokines are selected from FN-α4, IFN-beta, IL-1β, IL-1alpha, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-33, MCP-1, and MIP-1-

beta; the ability to modulate expression of one or more pro-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; the ability to modulate expression of one or more anti-inflammatory cytokines, optionally wherein the one or more anti-inflammatory cytokines are selected from IL-4, IL-10, IL-13, IL-35, IL-16, TGF-beta, IL-1Ra, G-CSF, and soluble receptors for TNF, IFN-beta1a, IFN-beta1b, or IL-6; the ability to modulate expression of one or more anti-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; the ability to modulate expression of one or more proteins selected from C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and PYCARD; the ability to counteract inhibition of extracellular signal-regulated kinase (ERK) phosphorylation; the ability to prevent decreased tyrosine phosphorylation on one or more cellular proteins, optionally, wherein the one or more cellular proteins comprise ZAP-70 and the tyrosine phosphorylation occurs on Tyr-319 of ZAP-70; the ability to modulate expression of C-C chemokine receptor 7 (CCR7); the ability to prevent inhibition of microglial cell chemotaxis toward CCL19-expressing and CCL21-expressing cells; the ability to prevent decreasing T cell proliferation induced by one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, M1 microglia, activated M1 microglia, M2 microglia, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, and M2 NK cells; the ability to prevent inhibition of osteoclast production, the ability to prevent decreased rate of osteoclastogenesis, or both; the ability to prevent decreased survival of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; the ability to prevent decreased proliferation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; the ability to enhance migration of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1

neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; the ability to prevent a decrease in one or more functions of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; the ability to enhance maturation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; the ability to enhance one or more types of clearance selected from apoptotic neuron clearance, nerve tissue debris clearance, dysfunctional synapse clearance, non-nerve tissue debris clearance, bacteria clearance, other foreign body clearance, disease-causing protein clearance, disease-causing peptide clearance, and tumor cell clearance; optionally wherein the disease-causing protein is selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides and the tumor cell is from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer; inhibition of phagocytosis of one or more of apoptotic neurons, nerve tissue debris, dysfunctional synapses, non-nerve tissue debris, bacteria, other foreign bodies, disease-causing proteins, disease-causing peptides, disease-causing nucleic acids, or tumor cells; optionally wherein the disease-causing nucleic acids are antisense GGCCCC (G2C4) repeat-expansion RNA, the disease-causing proteins are selected from amyloid beta, oligomeric amyloid

beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides, and the tumor cells are from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, or thyroid cancer; binding to Siglec-9 ligand on tumor cells; binding to Siglec-9 ligand on cells selected from neutrophils, dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, macrophages, and NK cells; inhibition of tumor cell killing by one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; activating anti-tumor cell proliferation activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; the ability to enhance anti-tumor cell metastasis activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; the ability to enhance the activity of one or more ITAM motif containing receptors, optionally wherein the one or more ITAM motif containing receptors are selected from TREM1, TREM2, SIRP beta, Fc gamma receptors (FcgR), DAP10, and DAP12; the ability to enhance signaling by one or more pattern recognition receptors (PRRs), optionally wherein the one or more PRRs are selected from receptors that identify pathogen-associated molecular patterns (PAMPs), receptors that identify damage-associated molecular patterns (DAMPs), and any combination thereof; the ability to enhance activity of one or more receptors comprising the motif $D/Ex_{0-2}YxxL/IX_{6-8}YxxL/I$ (SEQ ID NO: 252); the ability to enhance signaling by one or more Toll-like receptors; the ability to enhance the JAK-STAT signaling pathway; the ability to enhance the activity of nuclear factor kappa-light-chain-enhancer of activated B cells (NFκB); the ability to increase phosphorylation of an ITAM motif containing receptor; the ability to increase expression of one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells, optionally wherein the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells comprise CD86, C1qa, C1qB, C1qC, C1s, C1R,

C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and/or PYCARD, and the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells are expressed on one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; the ability to decrease expression of one or more Siglec-9-dependent genes; the ability to enhance expression of one or more ITAM-dependent genes, optionally wherein the one more ITAM-dependent genes are activated by nuclear factor of activated T cells (NFAT) transcription factors; the ability to decrease or otherwise inhibit differentiation of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells; the ability to decrease or otherwise inhibit functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells; the ability to decrease or otherwise inhibit infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells into tumors; the ability to decrease or otherwise inhibit the number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; the ability to decrease or otherwise inhibit tumor-promoting activity of myeloid-derived suppressor cells; the ability to decrease or otherwise inhibit expression of tumor-promoting cytokines, such as TGF-beta or IL-10, in a tumor or in peripheral blood; the ability to decrease or otherwise inhibit tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; the ability to decrease or otherwise inhibit tumor-promoting activity of myeloid-derived suppressor cells (MDSC); the ability to increase or otherwise enhance tumor-specific T lymphocytes with tumor killing potential; the ability to increase or otherwise enhance infiltration of tumor-specific NK cells with tumor killing potential; the ability to increase or otherwise enhance the tumor killing potential of NK cells; the ability to increase or otherwise enhance infiltration of tumor-specific B lymphocytes with potential to enhance immune response; the ability to increase or otherwise enhance infiltration of tumor-specific T lymphocytes with tumor killing potential; the ability to decrease tumor volume; the ability to decrease tumor growth rate; the ability to decrease or otherwise inhibit metastasis; the ability to decrease rate of tumor recurrence; the ability to increase or otherwise enhance efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-

therapies are immune-therapies that target one or more target proteins selected from PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, TREM1, TREM2, CD39, CD73, CSF-1 receptor, and any combination thereof, or of one or more cancer vaccines; the ability to increase or otherwise enhance PLCγ/PKC/calcium mobilization; and the ability to increase or otherwise enhance PI3K/Akt, Ras/MAPK signaling.

[0231] In some embodiments, antagonist anti-Siglec-9 antibodies of the present disclosure have an Fc region that displays reduced binding to one or more Fcg Receptor. Examples of such Fc regions and modifications are provided in Table D below. In some embodiments, the antibody has an Fc isotype listed in **Table D** below.

Antibody Fc isotypes with reduced binding to Fc gamma receptors

[0232] In some embodiments, anti-Siglec-9 antibodies with reduced binding to Fc gamma receptors have an Fc isotype listed in **Table D** below.

Table D: Exemplary anti-Siglec-9 antibody Fc isotypes with reduced binding to Fc gamma receptor

Fc Isotype	**Mutation (EU or Kabat numbering scheme)**
IgG1	N297Aor N297Q
IgG1	D265A, D270A, and N297A
IgG1	L234A and L235A
IgG2	V234A and G237A
IgG4	F235A and G237A and E318A E233P and/or F234V N297Aor N297Q
IgG4	S228P and L236E S241P S241P and L248E S228P and F234A and L235A
IgG2	H268Q and V309L and A330S and P331S
IgG1	C220S and C226S and C229S and P238S
IgG1	C226S and C229S and E233P and L234V, and L235A
IgG1	E233P and L234V and L235A and G236-deleted P238A D265A N297A A327Q or A327G P329A
IgG1	K322A and L234A and L235A
IgG1	L234Fand L235E and P331S
IgG1 or IgG4	T394D
IgG2	C232S or C233S N297Aor N297Q
IgG2	V234A and G237A and P238S and H268A and V309L and A330S and P331S

Fc Isotype	Mutation (EU or Kabat numbering scheme)
IgG1, IgG2, or IgG4	delta a,b , c, ab, ac, g modifications
IgG1	Any of the above listed mutations together with A330L or L234F and/or L235E and/or P331S
IgG1, IgG2, or IgG4	Any of the above listed mutations together with M252Y and/or S254T and/or T256E

[0233] In certain embodiments, the anti-Siglec-9 antibody has an IgG1 isotype. In some embodiments, the antibody contains a mouse IgG1 constant region. In some embodiments, the antibody contains a human IgG1 constant region. In some embodiments, the human IgG1 constant region includes an Fc region. In some embodiments, the Fc region contains one or more modifications. For example, in some embodiments, the Fc region contains one or more amino acid substitutions (*e.g.,* relative to a wild-type Fc region of the same isotype).

[0234] In some embodiments, the one or more amino acid substitutions are selected from N297A, N297Q (Bolt S et al. (1993) *Eur J Immunol* 23:403-411), D270A, D265A, L234A, L235A (McEarchern et al., (2007) *Blood*, 109:1185-1192), C226S, C229S (McEarchern et al., (2007) *Blood*, 109:1185-1192), P238S (Davis et al., (2007) *J Rheumatol*, 34:2204-2210), E233P, L234V (McEarchern et al., (2007) *Blood*, 109:1185-1192), P238A, A327Q, A327G, P329A (Shields RL. et al., (2001) *J Biol Chem.* 276(9):6591-604), K322A, L234F, L235E (Hezareh,et al., (2001) J Virol *75*, 12161–12168; Oganesyan et al., (2008). *Acta Crystallographica 64*, 700–704), P331S (Oganesyan et al., (2008) *Acta Crystallographica 64*, 700–704), T394D (Wilkinson et al. (2013) *MAbs* 5(3): 406–417), A330L, M252Y, S254T, and/or T256E, where the amino acid position is according to the EU or Kabat numbering convention. In certain embodiments, the Fc region further includes an amino acid deletion at a position corresponding to glycine 236 according to the EU or Kabat numbering convention.

[0235] In some embodiments, the anti-Siglec-9 antibody has an IgG1 isotype with a heavy chain constant region that contains a C220S amino acid substitution according to the EU or Kabat numbering convention. In some embodiments, the Fc region further contains one or more additional amino acid substitutions selected from t A330L, L234F; L235E, and/or P331S according to EU or Kabat numbering convention. In certain embodiments, the anti-Siglec-9 antibody has an IgG2 isotype. In some embodiments, the anti-Siglec-9 antibody contains a human IgG2 constant region. In some embodiments, the human IgG2 constant region includes an Fc region. In some embodiments, the Fc region contains one or more modifications. For example, in some embodiments, the Fc region contains one or more amino acid substitutions (*e.g.,* relative to a wild-type Fc region of the same isotype). In some embodiments, the one or more amino acid substitutions are selected from P238S, V234A, G237A, H268A, H268Q, H268E, V309L, N297A, N297Q, V309L, A330S, P331S, C232S,

C233S, M252Y, S254T, and/or T256E, where the amino acid position is according to the EU or Kabat numbering convention (Vafa O. et al., (2014) Methods 65:114–126).

[0236] In certain embodiments, the anti-Siglec-9 antibody has an IgG4 isotype. In some embodiments, the anti-Siglec-9 antibody contains a human IgG4 constant region. In some embodiments, the human IgG4 constant region includes an Fc region. In some embodiments, the Fc region contains one or more modifications. For example, in some embodiments, the Fc region contains one or more amino acid substitutions (*e.g.,* relative to a wild-type Fc region of the same isotype). In some embodiments, the one or more amino acid substitutions are selected from E233P, F234V, L235A, G237A, E318A (Hutchins et al. (1995) *Proc Natl Acad Sci* USA, 92:11980-11984), S228P, L234A/F234A,, L236E, S241P, L248E (Reddy et al., (2000) *J Immunol*,164:1925-1933; Angal et al., (1993) *Mol Immunol*. 30(1):105-8; US 8614299 B2; Vafa O. et al., (2014) Methods 65:114–126), T394D, M252Y, S254T, T256E, N297A, and/or N297Q, where the amino acid position is according to the EU or Kabat numbering convention.

[0237] In some embodiments, the Fc region further contains one or more additional amino acid substitutions selected from a M252Y, S254T, and/or T256E, where the amino acid position is according to the EU or Kabat numbering convention.

Further IgG mutations

[0238] In some embodiments, one or more of the IgG1 variants described herein may be combined with an A330L mutation (Lazar et al., (2006) Proc Natl Acad Sci USA, 103:4005-4010), or one or more of L234F, L235E, and/or P331S mutations (Sazinsky et al., (2008) Proc Natl Acad Sci USA, 105:20167-20172), where the amino acid position is according to the EU or Kabat numbering convention, to eliminate complement activation. In some embodiments, the IgG variants described herein may be combined with one or more mutations to enhance the anti-Siglec-9 antibody half-life in human serum (e.g. M252Y, S254T,T256E mutations according to the EU or Kabat numbering convention) (Dall'Acqua et al., (2006) J Biol Chem, 281:23514-23524; and Strohl e al., (2009) Current Opinion in Biotechnology, 20:685–691).

[0239] In some embodiments, an IgG4 variant of the present disclosure may be combined with an S228P mutation according to the EU or Kabat numbering convention (Angal et al., (1993) Mol Immunol, 30:105-108) and/or with one or more mutations described in Peters et al., (2012) J Biol Chem. 13;287(29):24525-33) to enhance antibody stabilization.

Bispecific antibodies

[0240] Certain aspects of the present disclosure relate to bispecific antibodies that bind to one or more domains on a Siglec-9 protein of the present disclosure and a second antigen. Methods of generating bispecific antibodies are well known in the art and described herein. In some

embodiments, bispecific antibodies of the present disclosure bind to one or more amino acid residues of a Siglec-9 protein of the present disclosure, such as one or more amino acid residues of human Siglec-9 (SEQ ID NO: 1), or amino acid residues on a Siglec-9 protein corresponding to amino acid residues of SEQ ID NO: 1. In some embodiments, bispecific antibodies of the present disclosure recognize a first antigen and a second antigen. In some embodiments, the first antigen is a Siglec-9 protein or a naturally occurring variant thereof. In some embodiments, the second antigen is also a Siglec-9 protein, or a naturally occurring variant thereof. In some embodiments, the second antigen is an antigen facilitating transport across the blood-brain-barrier (*see*, *e.g.*, Gabathuler R., *Neurobiol. Dis*. 37 (2010) 48-57). Such second antigens include, without limitation, transferrin receptor (TR), insulin receptor (HIR), insulin-like growth factor receptor (IGFR), low-density lipoprotein receptor related proteins 1 and 2 (LPR-1 and 2), diphtheria toxin receptor, CRM197, a llama single domain antibody, TMEM 30(A), a protein transduction domain, TAT, Syn-B, penetratin, a poly-arginine peptide, Angiopep peptides such as ANG1005 (*see*, *e.g.*, Gabathuler, 2010), and other cell surface proteins that are enriched on blood-brain barrier endothelial cells (*see*, *e.g.*, Daneman et al., PLoS One. 2010 Oct 29;5(10):e13741). In some embodiments, the second antigen is a disease-causing protein including, without limitation, amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides. In some embodiments, the second antigen is one or more ligands and/or proteins expressed on immune cells, including without limitation, PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, CD39, CD73, and phosphatidylserine. In some embodiments, the second antigen is a protein, lipid, polysaccharide, or glycolipid expressed on one or more tumor cells.

Antibody fragments

[0241] Certain aspects of the present disclosure relate to antibody fragments that bind to one or more of a Siglec-9 protein of the present disclosure, a naturally occurring variant of a Siglec-9

protein, and a disease variant of a Siglec-9 protein. In some embodiments, the antibody fragment is an Fab, Fab', Fab'-SH, F(ab')2, Fv or scFv fragment.

[0242] In some embodiments, the antibody fragment is used in combination with a second Siglec-9 antibody and/or with one or more antibodies that specifically bind a disease-causing protein selected from: amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides, and any combination thereof; or with one or more antibodies that bind an immunomodulatory protein selected from: PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, CD39, CD73, phosphatidylserine, and any combination thereof.

[0243] In some embodiments, antibody fragments of the present disclosure may be functional fragments that bind the same epitope as any of the anti-Siglec-9 antibodies of the present disclosure. In some embodiments, the antibody fragments are miniaturized versions of the anti-Siglec-9 antibodies or antibody fragments of the present disclosure that have the same epitope of the corresponding full-length antibody, but have much smaller molecule weight. Such miniaturized anti-Siglec-9 antibody fragments may have better brain penetration ability and a shorter half-life, which is advantageous for imaging and diagnostic utilities (*see e.g.*, Lütje S et al., *Bioconjug Chem.* 2014 Feb 19;25(2):335-41; Tavaré R et al., *Proc Natl Acad Sci U S A*. 2014 Jan 21;111(3):1108-13; and Wiehr S et al., *Prostate*. 2014 May;74(7):743-55). Accordingly, in some embodiments, anti-Siglec-9 antibody fragments of the present disclosure have better brain penetration as compared to their corresponding full-length antibodies and/or have a shorter half-life as compared to their corresponding full-length antibodies.

Antibody frameworks

[0244] Any of the antibodies described herein further include a framework. In some embodiments, the framework is a human immunoglobulin framework. For example, in some embodiments, an antibody (*e.g.,* an anti-Siglec-9 antibody) comprises HVRs as in any of the above embodiments and further comprises an acceptor human framework, *e.g.*, a human immunoglobulin

framework or a human consensus framework. Human immunoglobulin frameworks may be part of the human antibody, or a non-human antibody may be humanized by replacing one or more endogenous frameworks with human framework region(s). Human framework regions that may be used for humanization include but are not limited to: framework regions selected using the "best-fit" method (see, e.g., Sims et al. *J. Immunol.* 151:2296 (1993)); framework regions derived from the consensus sequence of human antibodies of a particular subgroup of light or heavy chain variable regions (see, e.g., Carter et al. *Proc. Natl. Acad. Sci. USA*, 89:4285 (1992); and Presta et al. *J. Immunol.*, 151:2623 (1993)); human mature (somatically mutated) framework regions or human germline framework regions (see, e.g., Almagro and Fransson, *Front. Biosci.* 13:1619-1633 (2008)); and framework regions derived from screening FR libraries (see, e.g., Baca et al., *J. Biol. Chem.* 272:10678-10684 (1997) and Rosok et al., *J. Biol. Chem.* 271:22611-22618 (1996)).

[0245] In some embodiments, an antibody comprises a light chain variable region comprising an HVR-L1, an HVR-L2, and an HVR-L3 of the present disclosure and one, two, three or four of the light chain framework regions as shown in **Table 4A**. In some embodiments, an antibody comprises a heavy chain variable region comprising an HVR-H1, an HVR-H2, and an HVR-H3 of the present disclosure and one, two, three or four of the heavy chain framework regions as shown in **Table 3B**. In some embodiments, an antibody comprises a light chain variable region comprising an HVR-L1, an HVR-L2, and an HVR-L3 of the present disclosure and one, two, three or four of the light chain framework regions as shown in **Table 4A** and further comprises a heavy chain variable region comprising an HVR-H1, an HVR-H2, and an HVR-H3 of the present disclosure and one, two, three or four of the heavy chain framework regions as shown in **Table 4B**.

Antibody preparation

[0246] Anti-Siglec-9 antibodies of the present disclosure can encompass polyclonal antibodies, monoclonal antibodies, humanized and chimeric antibodies, human antibodies, antibody fragments (*e.g.*, Fab, Fab'-SH, Fv, scFv, and $F(ab')_2$), bispecific and polyspecific antibodies, multivalent antibodies, heteroconjugate antibodies, conjugated antibodies, library derived antibodies, antibodies having modified effector functions, fusion proteins containing an antibody portion, and any other modified configuration of the immunoglobulin molecule that includes an antigen recognition site, such as an epitope having amino acid residues of a Siglec-9 protein of the present disclosure, including glycosylation variants of antibodies, amino acid sequence variants of antibodies, and covalently modified antibodies. The anti-Siglec-9 antibodies may be human, murine, rat, or of any other origin (including chimeric or humanized antibodies).

(1) Polyclonal antibodies

[0247] Polyclonal antibodies, such as polyclonal anti-Siglec-9 antibodies, are generally raised in animals by multiple subcutaneous (sc) or intraperitoneal (ip) injections of the relevant antigen and an adjuvant. It may be useful to conjugate the relevant antigen (*e.g.*, a purified or recombinant Siglec-9 protein of the present disclosure) to a protein that is immunogenic in the species to be immunized, *e.g.*, keyhole limpet hemocyanin (KLH), serum albumin, bovine thyroglobulin, or soybean trypsin inhibitor, using a bifunctional or derivatizing agent, *e.g.*, maleimidobenzoyl sulfosuccinimide ester (conjugation through cysteine residues), N-hydroxysuccinimide (through lysine residues), glutaraldehyde, succinic anhydride, $SOCl_2$, or $R^1N=C=NR$, where R and R^1 are independently lower alkyl groups. Examples of adjuvants which may be employed include Freund's complete adjuvant and MPL-TDM adjuvant (monophosphoryl Lipid A, synthetic trehalose dicorynomycolate). The immunization protocol may be selected by one skilled in the art without undue experimentation.

[0248] The animals are immunized against the desired antigen, immunogenic conjugates, or derivatives by combining, *e.g.*, 100 μg (for rabbits) or 5 μg (for mice) of the protein or conjugate with 3 volumes of Freund's complete adjuvant and injecting the solution intradermally at multiple sites. One month later, the animals are boosted with 1/5 to 1/10 the original amount of peptide or conjugate in Freund's complete adjuvant by subcutaneous injection at multiple sites. Seven to fourteen days later, the animals are bled and the serum is assayed for antibody titer. Animals are boosted until the titer plateaus. Conjugates also can be made in recombinant cell culture as protein fusions. Also, aggregating agents such as alum are suitable to enhance the immune response.

(2) Monoclonal antibodies

[0249] Monoclonal antibodies, such as monoclonal anti-Siglec-9 antibodies, are obtained from a population of substantially homogeneous antibodies, *i.e.*, the individual antibodies comprising the population are identical except for possible naturally occurring mutations and/or post-translational modifications (*e.g.*, isomerizations, amidations) that may be present in minor amounts. Thus, the modifier "monoclonal" indicates the character of the antibody as not being a mixture of discrete antibodies.

[0250] For example, the monoclonal anti-Siglec-9 antibodies may be made using the hybridoma method first described by Kohler et al., *Nature,* 256:495 (1975), or may be made by recombinant DNA methods (U.S. Patent No. 4,816,567).

[0251] In the hybridoma method, a mouse or other appropriate host animal, such as a hamster, is immunized as hereinabove described to elicit lymphocytes that produce or are capable of producing antibodies that will specifically bind to the protein used for immunization (*e.g.*, a purified or recombinant Siglec-9 protein of the present disclosure). Alternatively, lymphocytes may be

immunized *in vitro*. Lymphocytes then are fused with myeloma cells using a suitable fusing agent, such as polyethylene glycol, to form a hybridoma cell (Goding, *Monoclonal Antibodies: Principles and Practice*, pp.59-103 (Academic Press, 1986)).

[0252] The immunizing agent will typically include the antigenic protein (*e.g.*, a purified or recombinant Siglec-9 protein of the present disclosure) or a fusion variant thereof. Generally peripheral blood lymphocytes ("PBLs") are used if cells of human origin are desired, while spleen or lymph node cells are used if non-human mammalian sources are desired. The lymphoctyes are then fused with an immortalized cell line using a suitable fusing agent, such as polyethylene glycol, to form a hybridoma cell. Goding, *Monoclonal Antibodies: Principles and Practice*, Academic Press (1986), pp. 59-103.

[0253] Immortalized cell lines are usually transformed mammalian cells, particularly myeloma cells of rodent, bovine or human origin. Usually, rat or mouse myeloma cell lines are employed. The hybridoma cells thus prepared are seeded and grown in a suitable culture medium that preferably contains one or more substances that inhibit the growth or survival of the unfused, parental myeloma cells. For example, if the parental myeloma cells lack the enzyme hypoxanthine guanine phosphoribosyl transferase (HGPRT or HPRT), the culture medium for the hybridomas typically will include hypoxanthine, aminopterin, and thymidine (HAT medium), which are substances that prevent the growth of HGPRT-deficient cells.

[0254] Preferred immortalized myeloma cells are those that fuse efficiently, support stable high-level production of antibody by the selected antibody-producing cells, and are sensitive to a medium such as HAT medium. Among these, preferred are murine myeloma lines, such as those derived from MOPC-21 and MPC-11 mouse tumors (available from the Salk Institute Cell Distribution Center, San Diego, California USA), as well as SP-2 cells and derivatives thereof (*e.g.*, X63-Ag8-653) (available from the American Type Culture Collection, Manassas, Virginia USA). Human myeloma and mouse-human heteromyeloma cell lines have also been described for the production of human monoclonal antibodies (Kozbor, *J. Immunol.*, 133:3001 (1984); Brodeur et al., *Monoclonal Antibody Production Techniques and Applications*, pp. 51-63 (Marcel Dekker, Inc., New York, 1987)).

[0255] Culture medium in which hybridoma cells are growing is assayed for production of monoclonal antibodies directed against the antigen (*e.g.*, a Siglec-9 protein of the present disclosure). Preferably, the binding specificity of monoclonal antibodies produced by hybridoma cells is determined by immunoprecipitation or by an *in vitro* binding assay, such as radioimmunoassay (RIA) or enzyme-linked immunosorbent assay (ELISA).

[0256] The culture medium in which the hybridoma cells are cultured can be assayed for the presence of monoclonal antibodies directed against the desired antigen (*e.g.*, a Siglec-9 protein of the present disclosure). Preferably, the binding affinity and specificity of the monoclonal antibody can

be determined by immunoprecipitation or by an *in vitro* binding assay, such as radioimmunoassay (RIA) or enzyme-linked assay (ELISA). Such techniques and assays are known in the in art. For example, binding affinity may be determined by the Scatchard analysis of Munson et al., *Anal. Biochem.*, 107:220 (1980).

[0257] After hybridoma cells are identified that produce antibodies of the desired specificity, affinity, and/or activity, the clones may be subcloned by limiting dilution procedures and grown by standard methods (Goding, *supra*). Suitable culture media for this purpose include, for example, D-MEM or RPMI-1640 medium. In addition, the hybridoma cells may be grown *in vivo* as tumors in a mammal.

[0258] The monoclonal antibodies secreted by the subclones are suitably separated from the culture medium, ascites fluid, or serum by conventional immunoglobulin purification procedures such as, for example, protein A-Sepharose chromatography, hydroxylapatite chromatography, gel electrophoresis, dialysis, affinity chromatography, and other methods as described above.

[0259] Anti-Siglec-9 monoclonal antibodies may also be made by recombinant DNA methods, such as those disclosed in U.S. Patent No. 4,816,567, and as described above. DNA encoding the monoclonal antibodies is readily isolated and sequenced using conventional procedures (*e.g.*, by using oligonucleotide probes that specifically bind to genes encoding the heavy and light chains of murine antibodies). The hybridoma cells serve as a preferred source of such DNA. Once isolated, the DNA may be placed into expression vectors, which are then transfected into host cells such as *E. coli* cells, simian COS cells, Chinese hamster ovary (CHO) cells, or myeloma cells that do not otherwise produce immunoglobulin protein, in order to synthesize monoclonal antibodies in such recombinant host cells. Review articles on recombinant expression in bacteria of DNA encoding the antibody include Skerra et al., *Curr. Opin. Immunol.*, 5:256-262 (1993) and Plückthun, *Immunol. Rev.* 130:151-188 (1992).

[0260] In certain embodiments, anti-Siglec-9 antibodies can be isolated from antibody phage libraries generated using the techniques described in McCafferty et al., *Nature*, 348:552-554 (1990). Clackson et al., *Nature*, 352:624-628 (1991) and Marks et al., *J. Mol. Biol.*, 222:581-597 (1991) described the isolation of murine and human antibodies, respectively, from phage libraries. Subsequent publications describe the production of high affinity (nanomolar ("nM") range) human antibodies by chain shuffling (Marks et al., *Bio/Technology*, 10:779-783 (1992)), as well as combinatorial infection and *in vivo* recombination as a strategy for constructing very large phage libraries (Waterhouse et al., *Nucl. Acids Res.*, 21:2265-2266 (1993)). Thus, these techniques are viable alternatives to traditional monoclonal antibody hybridoma techniques for isolation of monoclonal antibodies of desired specificity (*e.g.*, those that bind a Siglec-9 protein of the present disclosure).

[0261] The DNA encoding antibodies or fragments thereof may also be modified, for example, by substituting the coding sequence for human heavy- and light-chain constant domains in place of the homologous murine sequences (U.S. Patent No. 4,816,567; Morrison, et al., *Proc. Natl Acad. Sci. USA*, 81:6851 (1984)), or by covalently joining to the immunoglobulin coding sequence all or part of the coding sequence for a non-immunoglobulin polypeptide. Typically such non-immunoglobulin polypeptides are substituted for the constant domains of an antibody, or they are substituted for the variable domains of one antigen-combining site of an antibody to create a chimeric bivalent antibody comprising one antigen-combining site having specificity for an antigen and another antigen-combining site having specificity for a different antigen.

[0262] The monoclonal antibodies described herein (*e.g.*, anti-Siglec-9 antibodies of the present disclosure or fragments thereof) may by monovalent, the preparation of which is well known in the art. For example, one method involves recombinant expression of immunoglobulin light chain and a modified heavy chain. The heavy chain is truncated generally at any point in the Fc region so as to prevent heavy chain crosslinking. Alternatively, the relevant cysteine residues may be substituted with another amino acid residue or are deleted so as to prevent crosslinking. *In vitro* methods are also suitable for preparing monovalent antibodies. Digestion of antibodies to produce fragments thereof, particularly Fab fragments, can be accomplished using routine techniques known in the art.

[0263] Chimeric or hybrid anti-Siglec-9 antibodies also may be prepared *in vitro* using known methods in synthetic protein chemistry, including those involving crosslinking agents. For example, immunotoxins may be constructed using a disulfide-exchange reaction or by forming a thioether bond. Examples of suitable reagents for this purpose include iminothiolate and methyl-4-mercaptobutyrimidate.

(3) Humanized antibodies

[0264] Anti-Siglec-9 antibodies of the present disclosure or antibody fragments thereof may further include humanized or human antibodies. Humanized forms of non-human (*e.g.*, murine) antibodies are chimeric immunoglobulins, immunoglobulin chains or fragments thereof (such as Fab, Fab'-SH, Fv, scFv, $F(ab')_2$ or other antigen-binding subsequences of antibodies) which contain minimal sequence derived from non-human immunoglobulin. Humanized antibodies include human immunoglobulins (recipient antibody) in which residues from a complementarity determining region (CDR) of the recipient are replaced by residues from a CDR of a non-human species (donor antibody) such as mouse, rat or rabbit having the desired specificity, affinity and capacity. In some instances, Fv framework residues of the human immunoglobulin are replaced by corresponding non-human residues. Humanized antibodies may also comprise residues which are found neither in the recipient antibody nor in the imported CDR or framework sequences. In general, the humanized antibody will comprise substantially all of at least one, and typically two, variable domains, in which all or

substantially all of the CDR regions correspond to those of a non-human immunoglobulin and all or substantially all of the FR regions are those of a human immunoglobulin consensus sequence. The humanized antibody optimally will also comprise at least a portion of an immunoglobulin constant region (Fc), typically that of a human immunoglobulin. Jones et al., *Nature* 321: 522-525 (1986); Riechmann et al., *Nature* 332: 323-329 (1988) and Presta, *Curr. Opin. Struct. Biol.* 2: 593-596 (1992).

[0265] Methods for humanizing non-human anti-Siglec-9 antibodies are well known in the art. Generally, a humanized antibody has one or more amino acid residues introduced into it from a source which is non-human. These non-human amino acid residues are often referred to as "import" residues, which are typically taken from an "import" variable domain. Humanization can be essentially performed following the method of Winter and co-workers, Jones et al., *Nature* 321:522-525 (1986); Riechmann et al., *Nature* 332:323-327 (1988); Verhoeyen et al., *Science* 239:1534-1536 (1988), or through substituting rodent CDRs or CDR sequences for the corresponding sequences of a human antibody. Accordingly, such "humanized" antibodies are chimeric antibodies (U.S. Patent No. 4,816,567), wherein substantially less than an intact human variable domain has been substituted by the corresponding sequence from a non-human species. In practice, humanized antibodies are typically human antibodies in which some CDR residues and possibly some FR residues are substituted by residues from analogous sites in rodent antibodies.

[0266] The choice of human variable domains, both light and heavy, to be used in making the humanized antibodies is very important to reduce antigenicity. According to the so-called "best-fit" method, the sequence of the variable domain of a rodent antibody is screened against the entire library of known human variable-domain sequences. The human sequence which is closest to that of the rodent is then accepted as the human framework (FR) for the humanized antibody. Sims et al., *J. Immunol.*, 151:2296 (1993); Chothia et al., *J. Mol. Biol.*, 196:901 (1987). Another method uses a particular framework derived from the consensus sequence of all human antibodies of a particular subgroup of light or heavy chains. The same framework may be used for several different humanized antibodies. Carter et al., *Proc. Nat'l Acad. Sci. USA* 89:4285 (1992); Presta et al., *J. Immunol.* 151:2623 (1993).

[0267] Furthermore, it is important that antibodies be humanized with retention of high affinity for the antigen and other favorable biological properties. To achieve this goal, according to a preferred method, humanized antibodies are prepared by a process of analyzing the parental sequences and various conceptual humanized products using three-dimensional models of the parental and humanized sequences. Three-dimensional immunoglobulin models are commonly available and are familiar to those skilled in the art. Computer programs are available which illustrate and display probable three-dimensional conformational structures of selected candidate

immunoglobulin sequences. Inspection of these displays permits analysis of the likely role of the residues in the functioning of the candidate immunoglobulin sequence, *i.e.*, the analysis of residues that influence the ability of the candidate immunoglobulin to bind its antigen. In this way, FR residues can be selected and combined from the recipient and import sequences so that the desired antibody characteristic, such as increased affinity for the target antigen or antigens (*e.g.*, Siglec-9 proteins of the present disclosure), is achieved. In general, the CDR residues are directly and most substantially involved in influencing antigen binding.

[0268] Various forms of the humanized anti-Siglec-9 antibody are contemplated. For example, the humanized anti-Siglec-9 antibody may be an antibody fragment, such as an Fab, which is optionally conjugated with one or more cytotoxic agent(s) in order to generate an immunoconjugate. Alternatively, the humanized anti-Siglec-9 antibody may be an intact antibody, such as an intact IgG1 antibody.

(4) Human antibodies

[0269] Alternatively, human anti-Siglec-9 antibodies can be generated. For example, it is now possible to produce transgenic animals (*e.g.*, mice) that are capable, upon immunization, of producing a full repertoire of human antibodies in the absence of endogenous immunoglobulin production. The homozygous deletion of the antibody heavy-chain joining region (J_H) gene in chimeric and germ-line mutant mice results in complete inhibition of endogenous antibody production. Transfer of the human germ-line immunoglobulin gene array in such germ-line mutant mice will result in the production of human antibodies upon antigen challenge. *See, e.g.*, Jakobovits et al., *Proc. Nat'l Acad. Sci. USA*, 90:2551 (1993); Jakobovits et al., *Nature*, 362:255-258 (1993); Bruggermann et al., *Year in Immunol.*, 7:33 (1993); U.S. Patent Nos. 5,591,669 and WO 97/17852.

[0270] Alternatively, phage display technology can be used to produce human anti-Siglec-9 antibodies and antibody fragments *in vitro*, from immunoglobulin variable (V) domain gene repertoires from unimmunized donors. McCafferty et al., *Nature* 348:552-553 (1990); Hoogenboom and Winter, *J. Mol. Biol.* 227: 381 (1991). According to this technique, antibody V domain genes are cloned in-frame into either a major or minor coat protein gene of a filamentous bacteriophage, such as M13 or fd, and displayed as functional antibody fragments on the surface of the phage particle. Because the filamentous particle contains a single-stranded DNA copy of the phage genome, selections based on the functional properties of the antibody also result in selection of the gene encoding the antibody exhibiting those properties. Thus, the phage mimics some of the properties of the B-cell. Phage display can be performed in a variety of formats, reviewed in, *e.g.*, Johnson, Kevin S. and Chiswell, David J., *Curr. Opin Struct. Biol.* 3:564-571 (1993). Several sources of V-gene segments can be used for phage display. Clackson et al., Nature 352:624-628 (1991) isolated a diverse array of anti-oxazolone antibodies from a small random combinatorial library of V genes

derived from the spleens of immunized mice. A repertoire of V genes from unimmunized human donors can be constructed and antibodies to a diverse array of antigens (including self-antigens) can be isolated essentially following the techniques described by Marks et al., J. Mol. Biol. 222:581-597 (1991), or Griffith et al., EMBO J. 12:725-734 (1993). *See also* U.S. Patent. Nos. 5,565,332 and 5,573,905. Additionally, yeast display technology can be used to produce human anti-Siglec-9 antibodies and antibody fragments *in vitro (e.g.*, WO 2009/036379; WO 2010/105256; WO 2012/009568; US 2009/0181855; US 2010/0056386; and Feldhaus and Siegel (2004) J. Immunological Methods 290:69-80). In other embodiments, ribosome display technology can be used to produce human anti-Siglec-9 antibodies and antibody fragments *in vitro* (*e.g.*, Roberts and Szostak (1997) Proc Natl Acad Sci 94:12297-12302; Schaffitzel et al. (1999) J. Immunolical Methods 231:119-135; Lipovsek and Plückthun (2004) J. Immunological Methods 290:51-67).

[0271] The techniques of Cole et al., and Boerner et al., are also available for the preparation of human anti-Siglec-9 monoclonal antibodies (Cole et al., Monoclonal Antibodies and Cancer Therapy, Alan R. Liss, p. 77 (1985) and Boerner et al., *J. Immunol.* 147(1): 86-95 (1991). Similarly, human anti-Siglec-9 antibodies can be made by introducing human immunoglobulin loci into transgenic animals, *e.g.*, mice in which the endogenous immunoglobulin genes have been partially or completely inactivated. Upon challenge, human antibody production is observed, which closely resembles that seen in humans in all respects, including gene rearrangement, assembly and antibody repertoire. This approach is described, for example, in U.S. Patent Nos. 5,545,807; 5,545,806, 5,569,825, 5,625,126, 5,633,425, 5,661,016 and in the following scientific publications: Marks et al., *Bio/Technology* 10: 779-783 (1992); Lonberg et al., *Nature* 368: 856-859 (1994); Morrison, *Nature* 368: 812-13 (1994), Fishwild et al., *Nature Biotechnology* 14: 845-51 (1996), Neuberger, *Nature Biotechnology* 14: 826 (1996) and Lonberg and Huszar, *Intern. Rev. Immunol.* 13: 65-93 (1995).

[0272] Finally, human anti-Siglec-9 antibodies may also be generated in vitro by activated B-cells (see U.S. Patent Nos 5,567,610 and 5,229,275).

(5) Antibody fragments

[0273] In certain embodiments there are advantages to using anti-Siglec-9 antibody fragments, rather than whole anti-Siglec-9 antibodies. Smaller fragment sizes allow for rapid clearance and better brain penetration.

[0274] Various techniques have been developed for the production of antibody fragments. Traditionally, these fragments were derived via proteolytic digestion of intact antibodies (*see, e.g.*, Morimoto et al., *J. Biochem. Biophys. Method.* 24:107-117 (1992); and Brennan et al., *Science* 229:81 (1985)). However, these fragments can now be produced directly by recombinant host cells, for example, using nucleic acids encoding anti-Siglec-9 antibodies of the present disclosure. Fab, Fv and scFv antibody fragments can all be expressed in and secreted from *E. coli*, thus allowing the

straightforward production of large amounts of these fragments. A anti-Siglec-9 antibody fragments can also be isolated from the antibody phage libraries as discussed above. Alternatively, Fab'-SH fragments can be directly recovered from *E. coli* and chemically coupled to form $F(ab')_2$ fragments (Carter et al., *Bio/Technology* 10:163-167 (1992)). According to another approach, $F(ab')_2$ fragments can be isolated directly from recombinant host cell culture. Production of Fab and $F(ab')_2$ antibody fragments with increased *in vivo* half-lives are described in U.S. Patent No. 5,869,046. In other embodiments, the antibody of choice is a single chain Fv fragment (scFv). See WO 93/16185; U.S. Patent No. 5,571,894 and U.S. Patent No. 5,587,458. The anti-Siglec-9 antibody fragment may also be a "linear antibody," *e.g.*, as described in U.S. Patent 5,641,870. Such linear antibody fragments may be monospecific or bispecific.

(6) Bispecific and polyspecific antibodies

[0275] Bispecific antibodies (BsAbs) are antibodies that have binding specificities for at least two different epitopes, including those on the same or another protein (*e.g.*, one or more Siglec-9 proteins of the present disclosure). Alternatively, one part of a BsAb can be armed to bind to the target Siglec-9 antigen, and another can be combined with an arm that binds to a second protein. Such antibodies can be derived from full length antibodies or antibody fragments (*e.g.*, $F(ab')_2$ bispecific antibodies).

[0276] Methods for making bispecific antibodies are known in the art. Traditional production of full length bispecific antibodies is based on the coexpression of two immunoglobulin heavy-chain/light chain pairs, where the two chains have different specificities. Millstein et al., *Nature*, 305:537-539 (1983). Because of the random assortment of immunoglobulin heavy and light chains, these hybridomas (quadromas) produce a potential mixture of 10 different antibody molecules, of which only one has the correct bispecific structure. Purification of the correct molecule, which is usually done by affinity chromatography steps, is rather cumbersome, and the product yields are low. Similar procedures are disclosed in WO 93/08829 and in Traunecker et al., *EMBO J.*, 10:3655-3659 (1991).

[0277] According to a different approach, antibody variable domains with the desired binding specificities (antibody-antigen combining sites) are fused to immunoglobulin constant domain sequences. The fusion preferably is with an immunoglobulin heavy chain constant domain, comprising at least part of the hinge, C_H2, and C_H3 regions. It is preferred to have the first heavy-chain constant region (C_H1) containing the site necessary for light chain binding, present in at least one of the fusions. DNAs encoding the immunoglobulin heavy chain fusions and, if desired, the immunoglobulin light chain, are inserted into separate expression vectors, and are co-transfected into a suitable host organism. This provides for great flexibility in adjusting the mutual proportions of the three polypeptide fragments in embodiments when unequal ratios of the three polypeptide chains

used in the construction provide the optimum yields. It is, however, possible to insert the coding sequences for two or all three polypeptide chains in one expression vector when the expression of at least two polypeptide chains in equal ratios results in high yields or when the ratios are of no particular significance.

[0278] In a preferred embodiment of this approach, the bispecific antibodies are composed of a hybrid immunoglobulin heavy chain with a first binding specificity in one arm, and a hybrid immunoglobulin heavy chain-light chain pair (providing a second binding specificity) in the other arm. It was found that this asymmetric structure facilitates the separation of the desired bispecific compound from unwanted immunoglobulin chain combinations, as the presence of an immunoglobulin light chain in only half of the bispecific molecules provides for an easy way of separation. This approach is disclosed in WO 94/04690. For further details of generating bispecific antibodies, see, for example, Suresh et al., *Methods in Enzymology* 121: 210 (1986).

[0279] According to another approach described in WO 96/27011 or U.S. Patent No. 5,731,168, the interface between a pair of antibody molecules can be engineered to maximize the percentage of heterodimers which are recovered from recombinant cell culture. The preferred interface comprises at least a part of the C_H3 region of an antibody constant domain. In this method, one or more small amino acid side chains from the interface of the first antibody molecule are replaced with larger side chains (*e.g.*, tyrosine or tryptophan). Compensatory "cavities" of identical or similar size to the large side chains(s) are created on the interface of the second antibody molecule by replacing large amino acid side chains with smaller ones (*e.g.*, alanine or threonine). This provides a mechanism for increasing the yield of the heterodimer over other unwanted end-products such as homodimers.

[0280] Techniques for generating bispecific antibodies from antibody fragments have been described in the literature. For example, bispecific antibodies can be prepared using chemical linkage. Brennan et al., *Science* 229:81 (1985) describe a procedure wherein intact antibodies are proteolytically cleaved to generate $F(ab')_2$ fragments. These fragments are reduced in the presence of the dithiol complexing agent sodium arsenite to stabilize vicinal dithiols and prevent intermolecular disulfide formation. The Fab' fragments generated are then converted to thionitrobenzoate (TNB) derivatives. One of the Fab'-TNB derivatives is then reconverted to the Fab'-TNB derivative to form the bispecific antibody. The bispecific antibodies produced can be used as agents for the selective immobilization of enzymes.

[0281] Fab' fragments may be directly recovered from *E. coli* and chemically coupled to form bispecific antibodies. Shalaby et al., *J. Exp. Med.* 175: 217-225 (1992) describes the production of fully humanized bispecific antibody $F(ab')_2$ molecules. Each Fab' fragment was separately secreted from *E. coli* and subjected to directed chemical coupling *in vitro* to form the bispecific antibody. The bispecific antibody thus formed was able to bind to cells overexpressing the ErbB2 receptor and

normal human T cells, as well as trigger the lytic activity of human cytotoxic lymphocytes against human breast tumor targets.

[0282] Various techniques for making and isolating bivalent antibody fragments directly from recombinant cell culture have also been described. For example, bivalent heterodimers have been produced using leucine zippers. Kostelny et al., *J. Immunol.*, 148(5):1547-1553 (1992). The leucine zipper peptides from the Fos and Jun proteins were linked to the Fab' portions of two different antibodies by gene fusion. The antibody homodimers were reduced at the hinge region to form monomers and then re-oxidized to form the antibody heterodimers. The "diabody" technology described by Hollinger et al., *Proc. Nat'l Acad. Sci. USA*, 90: 6444-6448 (1993) has provided an alternative mechanism for making bispecific/bivalent antibody fragments. The fragments comprise a heavy-chain variable domain (V_H) connected to a light-chain variable domain (V_L) by a linker which is too short to allow pairing between the two domains on the same chain. Accordingly, the V_H and V_L domains of one fragment are forced to pair with the complementary V_L and V_H domains of another fragment, thereby forming two antigen-binding sites. Another strategy for making bispecific/bivalent antibody fragments by the use of single-chain Fv (sFv) dimers has also been reported. *See* Gruber et al., *J. Immunol.*, 152:5368 (1994).

[0283] Antibodies with more than two valencies are also contemplated. For example, trispecific antibodies can be prepared. Tutt et al., *J. Immunol.* 147:60 (1991).

[0284] Exemplary bispecific antibodies may bind to two different epitopes on a given molecule (*e.g.*, a Siglec-9 protein of the present disclosure). Alternatively, an arm targeting a Siglec-9 signaling component may be combined with an arm which binds to a triggering molecule on a leukocyte such as a T cell receptor molecule (*e.g.*, CD2, CD3, CD28 or B7), or Fc receptors for IgG (FcγR), such as FcγRI (CD64), FcγRII (CD32) and FcγRIII (CD16) so as to focus cellular defense mechanisms to the cell expressing the particular protein. Bispecific antibodies may also be used to localize cytotoxic agents to cells which express a particular protein. Such antibodies possess a protein-binding arm and an arm which binds a cytotoxic agent or a radionuclide chelator, such as EOTUBE, DPTA, DOTA or TETA. Another bispecific antibody of interest binds the protein of interest and further binds tissue factor (TF).

(7) Multivalent antibodies

[0285] A multivalent antibody may be internalized (and/or catabolized) faster than a bivalent antibody by a cell expressing an antigen to which the antibodies bind. The anti-Siglec-9 antibodies of the present disclosure or antibody fragments thereof can be multivalent antibodies (which are other than of the IgM class) with three or more antigen binding sites (*e.g.*, tetravalent antibodies), which can be readily produced by recombinant expression of nucleic acid encoding the polypeptide chains of the antibody. The multivalent antibody can comprise a dimerization domain and three or more

antigen binding sites. The preferred dimerization domain comprises an Fc region or a hinge region. In this scenario, the antibody will comprise an Fc region and three or more antigen binding sites amino-terminal to the Fc region. The preferred multivalent antibody herein contains three to about eight, but preferably four, antigen binding sites. The multivalent antibody contains at least one polypeptide chain (and preferably two polypeptide chains), wherein the polypeptide chain or chains comprise two or more variable domains. For instance, the polypeptide chain or chains may comprise VD1-(X1)n-VD2-(X2)n-Fc, wherein VD1 is a first variable domain, VD2 is a second variable domain, Fc is one polypeptide chain of an Fc region, X1 and X2 represent an amino acid or polypeptide, and n is 0 or 1. Similarly, the polypeptide chain or chains may comprise V_H-C_H1-flexible linker-V_H-C_H1-Fc region chain; or V_H-C_H1-V_H-C_H1-Fc region chain. The multivalent antibody herein preferably further comprises at least two (and preferably four) light chain variable domain polypeptides. The multivalent antibody herein may, for instance, comprise from about two to about eight light chain variable domain polypeptides. The light chain variable domain polypeptides contemplated here comprise a light chain variable domain and, optionally, further comprise a CL domain. The multivalent antibodies may recognize the Siglec-9 antigen as well as, without limitation, additional antigens A beta peptide, antigen or an alpha synuclain protein antigen or, Tau protein antigen or, TDP-43 protein antigen or, prion protein antigen or, huntingtin protein antigen, or RAN, translation Products antigen, including the DiPeptide Repeats,(DPRs peptides) composed of glycine-alanine (GA), glycine-proline (GP), glycine-arginine (GR), proline-alanine (PA), or proline-arginine (PR), insulin receptor, insulin like growth factor receptor, transferrin receptor, or any other antigen that facilitates antibody transfer across the blood brain barrier.

(8) Heteroconjugate antibodies

[0286] Heteroconjugate antibodies are also within the scope of the present disclosure. Heteroconjugate antibodies are composed of two covalently joined antibodies (*e.g.*, anti-Siglec-9 antibodies of the present disclosure or antibody fragments thereof). For example, one of the antibodies in the heteroconjugate can be coupled to avidin, the other to biotin. Such antibodies have, for example, been proposed to target immune system cells to unwanted cells, U.S. Patent No. 4,676,980, and have been used to treat HIV infection. International Publication Nos. WO 91/00360, WO 92/200373 and EP 0308936. It is contemplated that the antibodies may be prepared *in vitro* using known methods in synthetic protein chemistry, including those involving crosslinking agents. For example, immunotoxins may be constructed using a disulfide exchange reaction or by forming a thioether bond. Examples of suitable reagents for this purpose include iminothiolate and methyl-4-mercaptobutyrimidate and those disclosed, for example, in U.S. Patent No. 4,676,980. Heteroconjugate antibodies may be made using any convenient cross-linking methods. Suitable

cross-linking agents are well known in the art, and are disclosed in U.S. Patent No. 4,676,980, along with a number of cross-linking techniques.

(9) Effector function engineering

[0287] It may also be desirable to modify an anti-Siglec-9 antibody of the present disclosure to modify effector function and/or to increase serum half-life of the antibody. For example, the Fc receptor binding site on the constant region may be modified or mutated to remove or reduce binding affinity to certain Fc receptors, such as FcγRI, FcγRII, and/or FcγRIII. In some embodiments, the effector function is impaired by removing N-glycosylation of the Fc region (*e.g.*, in the CH 2 domain of IgG) of the antibody. In some embodiments, the effector function is impaired by modifying regions such as 233-236, 297, and/or 327-331 of human IgG as described in PCT WO 99/58572 and Armour et al., *Molecular Immunology* 40: 585-593 (2003); Reddy et al., *J. Immunology* 164:1925-1933 (2000).

[0288] To increase the serum half-life of the antibody, one may incorporate a salvage receptor binding epitope into the antibody (especially an antibody fragment) as described in U.S. Patent 5,739,277, for example. As used herein, the term "*salvage receptor binding epitope*" refers to an epitope of the Fc region of an IgG molecule (*e.g.*, IgG_1, IgG_2, IgG_3, or IgG_4) that is responsible for increasing the *in vivo* serum half-life of the IgG molecule.

(10) Other amino acid sequence modifications

[0289] Amino acid sequence modifications of anti-Siglec-9 antibodies of the present disclosure, or antibody fragments thereof, are also contemplated. For example, it may be desirable to improve the binding affinity and/or other biological properties of the antibodies or antibody fragments. Amino acid sequence variants of the antibodies or antibody fragments are prepared by introducing appropriate nucleotide changes into the nucleic acid encoding the antibodies or antibody fragments, or by peptide synthesis. Such modifications include, for example, deletions from, and/or insertions into and/or substitutions of, residues within the amino acid sequences of the antibody. Any combination of deletion, insertion, and substitution is made to arrive at the final construct, provided that the final construct possesses the desired characteristics (*i.e.*, the ability to bind or physically interact with a Siglec-9 protein of the present disclosure). The amino acid changes also may alter post-translational processes of the antibody, such as changing the number or position of glycosylation sites.

[0290] A useful method for identification of certain residues or regions of the anti-Siglec-9 antibody that are preferred locations for mutagenesis is called "alanine scanning mutagenesis" as described by Cunningham and Wells in *Science*, 244:1081-1085 (1989). Here, a residue or group of target residues are identified (*e.g.*, charged residues such as arg, asp, his, lys, and glu) and replaced

by a neutral or negatively charged amino acid (most preferably alanine or polyalanine) to affect the interaction of the amino acids with the target antigen. Those amino acid locations demonstrating functional sensitivity to the substitutions then are refined by introducing further or other variants at, or for, the sites of substitution. Thus, while the site for introducing an amino acid sequence variation is predetermined, the nature of the mutation *per se* need not be predetermined. For example, to analyze the performance of a mutation at a given site, alanine scanning or random mutagenesis is conducted at the target codon or region and the expressed antibody variants are screened for the desired activity.

[0291] Amino acid sequence insertions include amino- ("N") and/or carboxy- ("C") terminal fusions ranging in length from one residue to polypeptides containing a hundred or more residues, as well as intrasequence insertions of single or multiple amino acid residues. Examples of terminal insertions include an antibody with an N-terminal methionyl residue or the antibody fused to a cytotoxic polypeptide. Other insertional variants of the antibody molecule include the fusion to the N- or C-terminus of the antibody to an enzyme or a polypeptide which increases the serum half-life of the antibody.

[0292] Another type of variant is an amino acid substitution variant. These variants have at least one amino acid residue in the antibody molecule replaced by a different residue. The sites of greatest interest for substitutional mutagenesis include the hypervariable regions, but FR alterations are also contemplated. Conservative substitutions are shown in the **Table E** below under the heading of "preferred substitutions". If such substitutions result in a change in biological activity, then more substantial changes, denominated "exemplary substitutions" in **Table E**, or as further described below in reference to amino acid classes, may be introduced and the products screened.

Table E: Amino acid substitutions

Original Residue	Exemplary Substitutions	Preferred Substitutions
Ala (A)	val; leu; ile	val
Arg (R)	lys; gln; asn	lys
Asn (N)	gln; his; asp, lys; arg	gln
Asp (D)	glu; asn	glu
Cys (C)	ser; ala	ser
Gln (Q)	asn; glu	asn
Glu (E)	asp; gln	asp
Gly (G)	ala	ala
His (H)	asn; gln; lys; arg	arg
Ile (I)	leu; val; met; ala; phe; norleucine	leu
Leu (L)	norleucine; ile; val; met; ala; phe	ile
Lys (K)	arg; gln; asn	arg
Met (M)	leu; phe; ile	leu
Phe (F)	leu; val; ile; ala; tyr	tyr
Pro (P)	ala	ala

Original Residue	Exemplary Substitutions	Preferred Substitutions
Ser (S)	thr	thr
Thr (T)	Ser	ser
Trp (W)	tyr; phe	tyr
Tyr (Y)	trp; phe; thr; ser	phe
Val (V)	ile; leu; met; phe; ala; norleucine	leu

[0293] Substantial modifications in the biological properties of the antibody are accomplished by selecting substitutions that differ significantly in their effect on maintaining (a) the structure of the polypeptide backbone in the area of the substitution, for example, as a sheet or helical conformation, (b) the charge or hydrophobicity of the molecule at the target site, or (c) the bulk of the side chain. Naturally occurring residues are divided into groups based on common side-chain properties:

(1) hydrophobic: norleucine, met, ala, val, leu, ile;

(2) neutral hydrophilic: cys, ser, thr;

(3) acidic: asp, glu;

(4) basic: asn, gln, his, lys, arg;

(5) residues that influence chain orientation: gly, pro; and

(6) aromatic: trp, tyr, phe.

[0294] Non-conservative substitutions entail exchanging a member of one of these classes for another class.

[0295] Any cysteine residue not involved in maintaining the proper conformation of the antibody also may be substituted, generally with serine, to improve the oxidative stability of the molecule and prevent aberrant crosslinking. Conversely, cysteine bond(s) may be added to the antibody to improve its stability (particularly where the antibody is an antibody fragment, such as an Fv fragment).

[0296] A particularly preferred type of substitutional variant involves substituting one or more hypervariable region residues of a parent antibody (*e.g.* a humanized or human anti-Siglec-9 antibody). Generally, the resulting variant(s) selected for further development will have improved biological properties relative to the parent antibody from which they are generated. A convenient way for generating such substitutional variants involves affinity maturation using phage display. Briefly, several hypervariable region sites (*e.g.*, 6-7 sites) are mutated to generate all possible amino substitutions at each site. The antibody variants thus generated are displayed in a monovalent fashion from filamentous phage particles as fusions to the gene III product of M13 packaged within each particle. The phage-displayed variants are then screened for their biological activity (*e.g.*, binding affinity) as herein disclosed. In order to identify candidate hypervariable region sites for modification, alanine scanning mutagenesis can be performed to identify hypervariable region residues contributing significantly to antigen binding. Alternatively, or additionally, it may be

beneficial to analyze a crystal structure of the antigen-antibody complex to identify contact points between the antibody and the antigen (*e.g.,* a Siglec-9 protein of the present disclosure). Such contact residues and neighboring residues are candidates for substitution according to the techniques elaborated herein. Once such variants are generated, the panel of variants is subjected to screening as described herein and antibodies with superior properties in one or more relevant assays may be selected for further development.

[0297] Another type of amino acid variant of the antibody alters the original glycosylation pattern of the antibody. By altering is meant deleting one or more carbohydrate moieties found in the antibody, and/or adding one or more glycosylation sites that are not present in the antibody.

[0298] Glycosylation of antibodies is typically either N-linked or O-linked. N-linked refers to the attachment of the carbohydrate moiety to the side chain of an asparagine residue. The tripeptide sequences asparagine-X-serine and asparagine-X-threonine, where X is any amino acid except proline, are the recognition sequences for enzymatic attachment of the carbohydrate moiety to the asparagine side chain. Thus, the presence of either of these tripeptide sequences in a polypeptide creates a potential glycosylation site. O-linked glycosylation refers to the attachment of one of the sugars N-aceylgalactosamine, galactose, or xylose to a hydroxyamino acid, most commonly serine or threonine, although 5-hydroxyproline or 5-hydroxylysine may also be used.

[0299] Addition of glycosylation sites to the antibody is conveniently accomplished by altering the amino acid sequence such that it contains one or more of the above-described tripeptide sequences (for N-linked glycosylation sites). The alteration may also be made by the addition of, or substitution by, one or more serine or threonine residues to the sequence of the original antibody (for O-linked glycosylation sites).

[0300] Nucleic acid molecules encoding amino acid sequence variants of the anti-IgE antibody are prepared by a variety of methods known in the art. These methods include, but are not limited to, isolation from a natural source (in the case of naturally occurring amino acid sequence variants) or preparation by oligonucleotide-mediated (or site-directed) mutagenesis, PCR mutagenesis, and cassette mutagenesis of an earlier prepared variant or a non-variant version of the antibodies (*e.g.,* anti-Siglec-9 antibodies of the present disclosure) or antibody fragments.

(11) Antibody conjugates

[0301] Anti-Siglec-9 antibodies of the present disclosure, or antibody fragments thereof, can be conjugated to a detectable marker, a toxin, or a therapeutic agent. Any suitable method known in the art for conjugating molecules, such as a detectable marker, a toxin, or a therapeutic agent to antibodies may be used.

[0302] For example, drug conjugation involves coupling of a biological active cytotoxic (anticancer) payload or drug to an antibody that specifically targets a certain tumor marker (e.g. a

protein that, ideally, is only to be found in or on tumor cells). Antibodies track these proteins down in the body and attach themselves to the surface of cancer cells. The biochemical reaction between the antibody and the target protein (antigen) triggers a signal in the tumor cell, which then absorbs or internalizes the antibody together with the cytotoxin. After the ADC is internalized, the cytotoxic drug is released and kills the cancer. Due to this targeting, ideally the drug has lower side effects and gives a wider therapeutic window than other chemotherapeutic agents. Technics to conjugate antibodies are disclosed are known in the art (*see, e.g.*, Jane de Lartigue, OncLive July 5, 2012; ADC Review on antibody-drug conjugates; and Ducry et al., (2010). *Bioconjugate Chemistry* 21 (1): 5–13).

[0303] In some embodiments, an anti-Siglec-9 antibody of the present disclosure may be conjugated to a toxin selected from ricin, ricin A-chain, doxorubicin, daunorubicin, a maytansinoid, taxol, ethidium bromide, mitomycin, etoposide, tenoposide, vincristine, vinblastine, colchicine, dihydroxy anthracin dione, actinomycin, diphtheria toxin, *Pseudomonas* exotoxin (PE) A, PE40, abrin, abrin A chain, modeccin A chain, alpha-sarcin, gelonin, mitogellin, retstrictocin, phenomycin, enomycin, curicin, crotin, calicheamicin, *Saponaria officinalis* inhibitor, glucocorticoid, auristatin, auromycin, yttrium, bismuth, combrestatin, duocarmycins, dolastatin, cc1065, and a cisplatin.

(12) Other antibody modifications

[0304] Anti-Siglec-9 antibodies of the present disclosure, or antibody fragments thereof, can be further modified to contain additional non-proteinaceous moieties that are known in the art and readily available. Preferably, the moieties suitable for derivatization of the antibody are water-soluble polymers. Non-limiting examples of water-soluble polymers include, but are not limited to, polyethylene glycol (PEG), copolymers of ethylene glycol/propylene glycol, carboxymethylcellulose, dextran, polyvinyl alcohol, polyvinyl pyrrolidone, poly-1, 3-dioxolane, poly-1,3,6-trioxane, ethylene/maleic anhydride copolymer, polyaminoacids (either homopolymers or random copolymers), and dextran or poly(n-vinyl pyrrolidone)polyethylene glycol, polypropylene glycol homopolymers, polypropylene oxide/ethylene oxide co-polymers, polyoxyethylated polyols (*e.g.*, glycerol), polyvinyl alcohol, and mixtures thereof. Polyethylene glycol propionaldehyde may have advantages in manufacturing due to its stability in water. The polymer may be of any molecular weight, and may be branched or unbranched. The number of polymers attached to the antibody may vary, and if more than one polymer is attached, they can be the same or different molecules. In general, the number and/or type of polymers used for derivatization can be determined based on considerations including, but not limited to, the particular properties or functions of the antibody to be improved, whether the antibody derivative will be used in a therapy under defined conditions, *etc.* Such techniques and other suitable formulations are disclosed in *Remington: The Science and Practice of Pharmacy*, 20th Ed., Alfonso Gennaro, Ed., Philadelphia College of Pharmacy and Science (2000).

Binding assays and other assays

[0305] Anti-Siglec-9 antibodies of the present disclosure may be tested for antigen binding activity, *e.g.*, by known methods such as ELISA, surface plasmon resonance (SPR), Western blot, *etc.*

[0306] In some embodiments, competition assays may be used to identify an antibody that competes with any of the antibodies listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2. In certain embodiments, such a competing antibody binds to the same epitope (e.g., a linear or a conformational epitope) that is bound by any of the antibodies listed in **Tables 2, 3, 4A, 4B, 7A, and 7B**, or selected from 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2. Detailed exemplary methods for mapping an epitope to which an antibody binds are provided in Morris (1996) "Epitope Mapping Protocols," in *Methods in Molecular Biology* vol. 66 (Humana Press, Totowa, NJ).

[0307] In an exemplary competition assay, immobilized Siglec-9 or cells expressing Siglec-9 on a cell surface are incubated in a solution comprising a first labeled antibody that binds to Siglec-9 (*e.g.*, human or non-human primate) and a second unlabeled antibody that is being tested for its ability to compete with the first antibody for binding to Siglec-9. The second antibody may be present in a hybridoma supernatant. As a control, immobilized Siglec-9 or cells expressing Siglec-9 is incubated in a solution comprising the first labeled antibody but not the second unlabeled antibody. After incubation under conditions permissive for binding of the first antibody to Siglec-9, excess unbound antibody is removed, and the amount of label associated with immobilized Siglec-9 or cells expressing Siglec-9 is measured. If the amount of label associated with immobilized Siglec-9 or cells expressing Siglec-9 is substantially reduced in the test sample relative to the control sample, then that indicates that the second antibody is competing with the first antibody for binding to Siglec-9. *See*, Harlow and Lane (1988) *Antibodies: A Laboratory Manual* ch.14 (Cold Spring Harbor Laboratory, Cold Spring Harbor, NY).

Nucleic acids, vectors, and host cells

[0308] Anti-Siglec-9 antibodies of the present disclosure may be produced using recombinant methods and compositions, *e.g.*, as described in U.S. Patent No. 4,816,567. In some embodiments, isolated nucleic acids having a nucleotide sequence encoding any of the anti-Siglec-9 antibodies of the present disclosure are provided. Such nucleic acids may encode an amino acid sequence containing the VL and/or an amino acid sequence containing the VH of the anti-Siglec-9 antibody (*e.g.*, the light and/or heavy chains of the antibody). In some embodiments, one or more vectors (*e.g.*, expression vectors) containing such nucleic acids are provided. In some embodiments, a host cell containing such nucleic acid is also provided. In some embodiments, the host cell contains (*e.g.*, has been transduced with): (1) a vector containing a nucleic acid that encodes an amino acid sequence

containing the VL of the antibody and an amino acid sequence containing the VH of the antibody, or (2) a first vector containing a nucleic acid that encodes an amino acid sequence containing the VL of the antibody and a second vector containing a nucleic acid that encodes an amino acid sequence containing the VH of the antibody. In some embodiments, the host cell is eukaryotic, *e.g.*, a Chinese Hamster Ovary (CHO) cell or lymphoid cell (*e.g.*, Y0, NS0, Sp20 cell).

[0309] Methods of making an anti-Siglec-9 antibody of the present disclosure are provided. In some embodiments, the method includes culturing a host cell of the present disclosure containing a nucleic acid encoding the anti-Siglec-9 antibody, under conditions suitable for expression of the antibody. In some embodiments, the antibody is subsequently recovered from the host cell (or host cell culture medium).

[0310] For recombinant production of an anti-Siglec-9 antibody of the present disclosure, a nucleic acid encoding the anti-Siglec-9 antibody is isolated and inserted into one or more vectors for further cloning and/or expression in a host cell. Such nucleic acid may be readily isolated and sequenced using conventional procedures (*e.g.*, by using oligonucleotide probes that are capable of binding specifically to genes encoding the heavy and light chains of the antibody).

[0311] Suitable vectors containing a nucleic acid sequence encoding any of the anti-Siglec-9 antibodies of the present disclosure, or fragments thereof polypeptides (including antibodies) described herein include, without limitation, cloning vectors and expression vectors. Suitable cloning vectors can be constructed according to standard techniques, or may be selected from a large number of cloning vectors available in the art. While the cloning vector selected may vary according to the host cell intended to be used, useful cloning vectors generally have the ability to self-replicate, may possess a single target for a particular restriction endonuclease, and/or may carry genes for a marker that can be used in selecting clones containing the vector. Suitable examples include plasmids and bacterial viruses, *e.g.*, pUC18, pUC19, Bluescript (*e.g.*, pBS SK+) and its derivatives, mpl8, mpl9, pBR322, pMB9, ColE1, pCR1, RP4, phage DNAs, and shuttle vectors such as pSA3 and pAT28. These and many other cloning vectors are available from commercial vendors such as BioRad, Strategene, and Invitrogen.

[0312] Expression vectors generally are replicable polynucleotide constructs that contain a nucleic acid of the present disclosure. The expression vector may replicable in the host cells either as episomes or as an integral part of the chromosomal DNA. Suitable expression vectors include but are not limited to plasmids, viral vectors, including adenoviruses, adeno-associated viruses, retroviruses, cosmids, and expression vector(s) disclosed in PCT Publication No. WO 87/04462. Vector components may generally include, but are not limited to, one or more of the following: a signal sequence; an origin of replication; one or more marker genes; suitable transcriptional controlling elements (such as promoters, enhancers and terminator). For expression (*i.e.*, translation), one or

more translational controlling elements are also usually required, such as ribosome binding sites, translation initiation sites, and stop codons.

[0313] The vectors containing the nucleic acids of interest can be introduced into the host cell by any of a number of appropriate means, including electroporation, transfection employing calcium chloride, rubidium chloride, calcium phosphate, DEAE-dextran, or other substances; microprojectile bombardment; lipofection; and infection (*e.g.*, where the vector is an infectious agent such as vaccinia virus). The choice of introducing vectors or polynucleotides will often depend on features of the host cell. In some embodiments, the vector contains a nucleic acid containing one or more amino acid sequences encoding an anti-Siglec-9 antibody of the present disclosure.

[0314] Suitable host cells for cloning or expression of antibody-encoding vectors include prokaryotic or eukaryotic cells. For example, anti-Siglec-9 antibodies of the present disclosure may be produced in bacteria, in particular when glycosylation and Fc effector function are not needed. For expression of antibody fragments and polypeptides in bacteria (*e.g.*, U.S. Patent Nos. 5,648,237, 5,789,199, and 5,840,523; and Charlton, *Methods in Molecular Biology, Vol. 248* (B.K.C. Lo, ed., Humana Press, Totowa, NJ, 2003), pp. 245-254, describing expression of antibody fragments in *E. coli*.). After expression, the antibody may be isolated from the bacterial cell paste in a soluble fraction and can be further purified.

[0315] In addition to prokaryotes, eukaryotic microorganisms, such as filamentous fungi or yeast, are also suitable cloning or expression hosts for antibody-encoding vectors, including fungi and yeast strains whose glycosylation pathways have been "humanized," resulting in the production of an antibody with a partially or fully human glycosylation pattern (*e.g.*, Gerngross, *Nat. Biotech.* 22:1409-1414 (2004); and Li et al., *Nat. Biotech.* 24:210-215 (2006)).

[0316] Suitable host cells for the expression of glycosylated antibody can also be derived from multicellular organisms (invertebrates and vertebrates). Examples of invertebrate cells include plant and insect cells. Numerous baculoviral strains have been identified which may be used in conjunction with insect cells, particularly for transfection of *Spodoptera frugiperda* cells. Plant cell cultures can also be utilized as hosts (*e.g.*, U.S. Patent Nos. 5,959,177, 6,040,498, 6,420,548, 7,125,978, and 6,417,429, describing PLANTIBODIES™ technology for producing antibodies in transgenic plants.).

[0317] Vertebrate cells may also be used as hosts. For example, mammalian cell lines that are adapted to grow in suspension may be useful. Other examples of useful mammalian host cell lines are monkey kidney CV1 line transformed by SV40 (COS-7); human embryonic kidney line (293 or 293 cells as described, *e.g.*, in Graham et al., *J. Gen Virol.* 36:59 (1977)); baby hamster kidney cells (BHK); mouse sertoli cells (TM4 cells as described, *e.g.*, in Mather, *Biol. Reprod.* 23:243-251 (1980)); monkey kidney cells (CV1); African green monkey kidney cells (VERO-76); human cervical

carcinoma cells (HELA); canine kidney cells (MDCK; buffalo rat liver cells (BRL 3A); human lung cells (W138); human liver cells (Hep G2); mouse mammary tumor (MMT 060562); TRI cells, as described, *e.g.*, in Mather et al., *Annals N.Y. Acad. Sci.* 383:44-68 (1982); MRC 5 cells; and FS4 cells. Other useful mammalian host cell lines include Chinese hamster ovary (CHO) cells, including DHFR- CHO cells (Urlaub et al., *Proc. Natl. Acad. Sci. USA* 77:4216 (1980)); and myeloma cell lines such as Y0, NS0 and Sp2/0. For a review of certain mammalian host cell lines suitable for antibody production, see, *e.g.*, Yazaki and Wu, *Methods in Molecular Biology, Vol. 248* (B.K.C. Lo, ed., Humana Press, Totowa, NJ), pp. 255-268 (2003).

Siglec-9 Activities

PI3K activation

[0318] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may induce PI3K activation after binding to a Siglec-9 protein expressed in a cell.

[0319] PI3Ks are a family of related intracellular signal transducer kinases capable of phosphorylating the 3-position hydroxyl group of the inositol ring of phosphatidylinositol (PtdIns). The PI3K family is divided into three different classes (Class I, Class II, and Class III) based on primary structure, regulation, and *in vitro* lipid substrate specificity.

[0320] Activated PI3K produces various 3-phosphorylated phosphoinositides, including without limitation, PtdIns3P, PtdIns(3,4)P2, PtdIns(3,5)P2, and PtdIns(3,4,5)P3. These 3-phosphorylated phosphoinositides function in a mechanism by which signaling proteins are recruited to various cellular membranes. These signaling proteins contain phosphoinositide-binding domains, including without limitation, PX domains, pleckstrin homology domains (PH domains), and FYVE domains. Any method known in the art for determining PI3K activation may be used.

[0321] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased levels of PI3K activity, including, without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures,

spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Modulated expression of cytokines

[0322] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may modulate (e.g., increase or decrease) pro-inflammatory mediators in the brain after binding to a Siglec-9 protein expressed on a cell surface. In certain embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, modulate the expression of cytokines (e.g., proinflammatory mediators) and/or reduce the expression of anti-inflammatory mediators after binding to a Siglec-9 protein expressed in a cell.

[0323] Inflammation is part of a complex biological response of vascular tissues to harmful stimuli, such as pathogens, damaged cells, and irritants. The classical signs of acute inflammation are pain, heat, redness, and swelling. Inflammation is an immune response that protects an organism by limiting the site of injury or clearing an infection by recruiting and activating cells of the immune system. The inflammatory response is tightly regulated and restricted in its duration and severity to avoid causing damage to the organism. Inflammation can be classified as either acute or chronic. Acute inflammation is driven by the innate immune response, which initially recognizes harmful stimuli and recruits leukocytes from the blood into the injured tissues. A cascade of biochemical events, including cytokine and chemokine release, propagates the inflammatory response, involving the local vascular system, the immune system, and various cells within the injured tissue. Chronic inflammation is prolonged and persistent which leads to a progressive shift in the type of immune cells participating in the inflammatory response. Chronic inflammation is characterized by progressive destruction and fibrosis of the tissue as a result of the inflammatory process.

[0324] As used herein, anti-inflammatory mediators are proteins involved either directly or indirectly (*e.g.*, by way of an anti-inflammatory signaling pathway) in a mechanism that reduces, inhibits, or inactivates an inflammatory response. Any method known in the art for identifying and characterizing anti-inflammatory mediators may be used. Examples of anti-inflammatory mediators include, without limitation, cytokines, such as IL-4, IL-10, IL-13, IL-35, IL-16, IFN-alpha, TGF-beta, IL-1Ra, G-CSF, and soluble receptors for TNF-alpha or IL-6. Examples of pro-inflammatory mediators include, without limitation, cytokines, such as FN-α4, IFN-β, IL-1β, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-23, CXCL10, IL-33, CRP, IL-33, MCP-1, and MIP-1-beta.

[0325] In some embodiments, the Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may modulate (e.g., increase or decrease) expression of cytokines, such as IL-1b, IL-8, and TNF-a. In certain embodiments, modulated expression of the cytokines occurs in macrophages, neutrophils, natural killer (NK) cells, dendritic cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and/or microglial cells. Modulated expression may include, without limitation, an increase in gene expression, an increase in transcriptional expression, or an increase in protein expression. Any method known in the art for determining gene, transcript (*e.g.*, mRNA), and/or protein expression may be used. For example, Northern blot analysis may be used to determine cytokine gene expression levels, RT-PCR may be used to determine the level of cytokine transcription, and Western blot analysis may be used to determine cytokine protein levels.

[0326] As used herein, a cytokine may have modulated expression if its expression in one or more cells of a subject treated with an Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, is modulated as compared to the expression of the same cytokine expressed in one or more cells of a corresponding subject that is not treated with the Siglec-9 agent. In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may modulate cytokine expression in one or more cells of a subject by at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 100%, at least 110%, at least 115%, at least 120%, at least 125%, at least 130%, at least 135%, at least 140%, at least 145%, at least 150%, at least 160%, at least 170%, at least 180%, at least 190%, or at least 200% for example, as compared to cytokine expression in one or more cells of a corresponding subject that is not treated with the Siglec-9 agent. In other embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, modulate cytokine expression in one or more cells of a subject by at least 1.5 fold, at least 1.6 fold, at least 1.7 fold, at least 1.8 fold, at least 1.9 fold, at least 2.0 fold, at least 2.1

fold, at least 2.15 fold, at least 2.2 fold, at least 2.25 fold, at least 2.3 fold, at least 2.35 fold, at least 2.4 fold, at least 2.45 fold, at least 2.5 fold, at least 2.55 fold, at least 3.0 fold, at least 3.5 fold, at least 4.0 fold, at least 4.5 fold, at least 5.0 fold, at least 5.5 fold, at least 6.0 fold, at least 6.5 fold, at least 7.0 fold, at least 7.5 fold, at least 8.0 fold, at least 8.5 fold, at least 9.0 fold, at least 9.5 fold, or at least 10 fold, for example, as compared to cytokine expression in one or more cells of a corresponding subject that is not treated with the Siglec-9 agent.

[0327] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are useful for preventing, lowering the risk of, or treating conditions and/or diseases associated with abnormal levels of one or more pro-inflammatory mediators, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Modulated expression of pro-inflammatory mediators

[0328] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may modulate (e.g., increase or decrease) the expression of pro-inflammatory mediators after binding to a Siglec-9 protein expressed in a cell.

[0329] As used herein, pro-inflammatory mediators are proteins involved either directly or indirectly (*e.g.*, by way of pro-inflammatory signaling pathways) in a mechanism that induces, activates, promotes, or otherwise increases an inflammatory response. Any method known in the art for identifying and characterizing pro-inflammatory mediators may be used.

[0330] Examples of pro-inflammatory mediators include, without limitation, cytokines, such as type I and II interferons, IL-1β, TNF-α, IL-6, IL-8, IL-20 family members, IL-33, LIF, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, and CRP.

[0331] In some embodiments, the anti-Siglec-9 antibodies of the present disclosure may modulate functional expression and/or secretion of pro-inflammatory mediators, such as type I and II interferons, FN-α4, IFN-β, IL-1β, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-23, CXCL10, IL-33, CRP, IL-33, MCP-1, and MIP-1-beta. In certain embodiments, modulated expression of the pro-inflammatory mediators occurs in macrophages, neutrophils, NK cells, dendritic cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and/or microglial cells. Modulated expression may include, without limitation, a modulated gene expression, modulated transcriptional expression, or modulated protein expression. Any method known in the art for determining gene, transcript (*e.g.*, mRNA), and/or protein expression may be used. For example, Northern blot analysis may be used to determine pro-inflammatory mediator gene expression levels, RT-PCR may be used to determine the level of pro-inflammatory mediator transcription, and Western blot analysis may be used to determine pro-inflammatory mediator protein levels.

[0332] In certain embodiments, pro-inflammatory mediators include inflammatory cytokines. Accordingly, in certain embodiments, the Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may modulate secretion of one or more inflammatory cytokines. Examples of inflammatory cytokines whose secretion may be modulated by the anti-Siglec-9 antibodies of the present disclosure include, without limitation, such as type I and II interferons, FN-α4, IFN-β, IL-1β, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-23, CXCL10, IL-33, CRP, IL-33, MCP-1, and MIP-1-beta.

[0333] In certain embodiments, pro-inflammatory mediators include inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells. Accordingly, in certain embodiments, the Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may modulate expression of one or more inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells. Examples of inflammatory receptors, proteins of the complement cascade, and/or receptors that are expressed on immune cells whose expression may be modulated by the Siglec-9 agents of the present

disclosure, such as anti-Siglec-9 antibodies of the present disclosure, include, without limitation, CD86, CD80, CD83, C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and PYCARD.

[0334] As used herein, a pro-inflammatory mediator may have modulated expression if its expression in one or more cells of a subject treated with a Siglec-9 agent, such as an agonist anti-Siglec-9 antibody of the present disclosure is modulated (e.g., increased or decreased) as compared to the expression of the same pro-inflammatory mediator expressed in one or more cells of a corresponding subject that is not treated with the agonist anti-Siglec-9 antibody. In some embodiments, the anti-Siglec-9 antibody of the present disclosure may modulate pro-inflammatory mediator expression in one or more cells of a subject by at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 100%, at least 110%, at least 115%, at least 120%, at least 125%, at least 130%, at least 135%, at least 140%, at least 145%, at least 150%, at least 160%, at least 170%, at least 180%, at least 190%, or at least 200% for example, as compared to pro-inflammatory mediator expression in one or more cells of a corresponding subject that is not treated with the anti-Siglec-9 antibody. In other embodiments, the anti-Siglec-9 antibody may modulate pro-inflammatory mediator expression in one or more cells of a subject by at least at least 1.5 fold, at least 1.6 fold, at least 1.7 fold, at least 1.8 fold, at least 1.9 fold, at least 2.0 fold, at least 2.1 fold, at least 2.15 fold, at least 2.2 fold, at least 2.25 fold, at least 2.3 fold, at least 2.35 fold, at least 2.4 fold, at least 2.45 fold, at least 2.5 fold, at least 2.55 fold, at least 3.0 fold, at least 3.5 fold, at least 4.0 fold, at least 4.5 fold, at least 5.0 fold, at least 5.5 fold, at least 6.0 fold, at least 6.5 fold, at least 7.0 fold, at least 7.5 fold, at least 8.0 fold, at least 8.5 fold, at least 9.0 fold, at least 9.5 fold, or at least 10 fold, for example, as compared to pro-inflammatory mediator expression in one or more cells of a corresponding subject that is not treated with the anti-Siglec-9 antibody.

[0335] In some embodiments, some Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may be useful for preventing, lowering the risk of, or treating conditions and/or diseases associated with abnormal levels of one or more pro-inflammatory mediators, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies,

multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

ERK phosphorylation

[0336] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may induce extracellular signal-regulated kinase (ERK) phosphorylation after binding to a Siglec-9 protein expressed in a cell.

[0337] Extracellular-signal-regulated kinases (ERKs) are widely expressed protein kinase intracellular signaling kinases that are involved in, for example, the regulation of meiosis, mitosis, and postmitotic functions in differentiated cells. Various stimuli, such as growth factors, cytokines, virus infection, ligands for heterotrimeric G protein-coupled receptors, transforming agents, and carcinogens, activate ERK pathways. Phosphorylation of ERKs leads to the activation of their kinase activity.

[0338] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased levels of ERK phosphorylation, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system

atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Syk phosphorylation

[0339] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may induce spleen tyrosine kinase (Syk) phosphorylation after binding to a Siglec-9 protein expressed in a cell.

[0340] Spleen tyrosine kinase (Syk) is an intracellular signaling molecule that functions downstream of Siglec-9 by phosphorylating several substrates, thereby facilitating the formation of a signaling complex leading to cellular activation and inflammatory processes.

[0341] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased levels of Syk phosphorylation, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration,

glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Siglec-9 phosphorylation

[0342] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may transiently induce Siglec-9 phosphorylation of Tyr-433 and Tyr-456 by a by Src family tyrosine kinase such as Src, Syk, Fyn, Fgr, Lck, Hck, Blk, Lyn, and Frk after binding to a Siglec-9 protein expressed in a cell.

[0343] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased levels of Siglec-9 phosphorylation, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer,

prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Phosphorylation of ITAM motif containing receptors

[0344] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may induce phosphorylate ITAM motif-containing receptors, such as TREM1, TREM2, Sirp beta, FcgR, DAP10, and DAP12, after binding to a Siglec-9 protein expressed in a cell.

[0345] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased levels of phosphorylation of ITAM motif-containing receptors, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic

infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Modulated expression of C-C chemokine receptor 7

[0346] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may modulate expression of C-C chemokine receptor 7 (CCR7) after binding to a Siglec-9 protein expressed in a cell. Modulated (e.g., increased or decreased) expression may include, without limitation, modulation in gene expression, modulation in transcriptional expression, or modulation in protein expression. Any method known in the art for determining gene, transcript (*e.g.*, mRNA), and/or protein expression may be used. For example, Northern blot analysis may be used to determine anti-inflammatory mediator gene expression levels, RT-PCR may be used to determine the level of anti-inflammatory mediator transcription, and Western blot analysis may be used to determine anti-inflammatory mediator protein levels.

[0347] C-C chemokine receptor 7 (CCR7) is a member of the G protein-coupled receptor family. CCR7 is expressed in various lymphoid tissues and can activate B cells and T cells. In some embodiments, CCR7 may modulate the migration of memory T cells to secondary lymphoid organs, such as lymph nodes. In other embodiments, CCR7 may stimulate dendritic cell maturation. CCR7 is a receptor protein that can bind the chemokine (C-C motif) ligands CCL19/ELC and CCL21.

[0348] As used herein, CCR7 may have modulated expression if its expression in one or more cells of a subject treated with an Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, is modulated (e.g., increased or decreased) as compared to the expression of CCR7 expressed in one or more cells of a corresponding subject that is not treated with the Siglec-9 agent. In some embodiments, an Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, may modulate CCR7 expression in one or more cells of a subject by at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 100%, at least 110%, at least 115%, at least 120%, at least 125%, at least 130%, at least 135%, at least 140%, at least 145%, at least 150%, at least 160%, at least 170%, at least 180%, at least 190%, or at least 200% for example, as compared to CCR7 expression in one or more cells of a corresponding subject that is not treated with the Siglec-9 agent. In other embodiments, an Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, modulates CCR7 expression in one or more cells of a subject by at least 1.5 fold, at least 1.6 fold, at least 1.7 fold, at least 1.8 fold, at least 1.9 fold, at least 2.0 fold, at least 2.1 fold, at least 2.15 fold, at least 2.2 fold, at least 2.25 fold, at least 2.3 fold, at least 2.35 fold, at least 2.4 fold, at least 2.45 fold, at least 2.5 fold, at least 2.55 fold, at least 3.0 fold,

at least 3.5 fold, at least 4.0 fold, at least 4.5 fold, at least 5.0 fold, at least 5.5 fold, at least 6.0 fold, at least 6.5 fold, at least 7.0 fold, at least 7.5 fold, at least 8.0 fold, at least 8.5 fold, at least 9.0 fold, at least 9.5 fold, or at least 10 fold, for example, as compared to CCR7 expression in one or more cells of a corresponding subject that is not treated with the Siglec-9 agent.

[0349] In some embodiments, increased expression of CCR7 occurs in macrophages, neutrophils, NK cells, dendritic cells, and/or microglial cells. Increased expression of CCR7 may induce microglial cell chemotaxis toward cells expressing the chemokines CCL19 and CCL21. Accordingly, in certain embodiments, anti-Siglec-9 antibodies of the present disclosure may induce microglial cell chemotaxis toward CCL19 and CCL21 expressing cells.

[0350] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are useful for preventing, lowering the risk of, or treating conditions and/or diseases associated with abnormal levels of CCR7, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Enhancement or normalization of the ability of bone marrow-derived dendritic cells to induce antigen-specific T cell proliferation

[0351] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may enhance and/or normalize the ability of bone marrow-derived dendritic cells to induce antigen-specific T cell proliferation after binding to a Siglec-9 protein expressed in a cell.

[0352] In some embodiments, Siglec-9 agents of the present disclosure, such as antagonist anti-Siglec-9 antibodies of the present disclosure, may enhance and/or normalize the ability of bone marrow-derived dendritic cells to induce antigen-specific T cell proliferation in one or more bone marrow-derived dendritic cells of a subject by at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 100%, at least 110%, at least 115%, at least 120%, at least 125%, at least 130%, at least 135%, at least 140%, at least 145%, at least 150%, at least 160%, at least 170%, at least 180%, at least 190%, or at least 200% for example, as compared to the ability of bone marrow-derived dendritic cells to induce antigen-specific T cell proliferation in one or more bone marrow-derived dendritic cells of a corresponding subject that is not treated with the agent. In other embodiments, the Siglec-9 agent, such as an antagonist anti-Siglec-9 antibody, may enhance and/or normalize the ability of bone marrow-derived dendritic cells to induce antigen-specific T cell proliferation in one or more bone marrow-derived dendritic cells of a subject by at least at least 1.5 fold, at least 1.6 fold, at least 1.7 fold, at least 1.8 fold, at least 1.9 fold, at least 2.0 fold, at least 2.1 fold, at least 2.15 fold, at least 2.2 fold, at least 2.25 fold, at least 2.3 fold, at least 2.35 fold, at least 2.4 fold, at least 2.45 fold, at least 2.5 fold, at least 2.55 fold, at least 3.0 fold, at least 3.5 fold, at least 4.0 fold, at least 4.5 fold, at least 5.0 fold, at least 5.5 fold, at least 6.0 fold, at least 6.5 fold, at least 7.0 fold, at least 7.5 fold, at least 8.0 fold, at least 8.5 fold, at least 9.0 fold, at least 9.5 fold, or at least 10 fold, for example, as compared to the ability of bone marrow-derived dendritic cells to induce antigen-specific T cell proliferation in one or more bone marrow-derived dendritic cells of a corresponding subject that is not treated with the Siglec-9 agent.

[0353] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased or dysregulated ability of bone marrow-derived dendritic cells to induce antigen-specific T cell proliferation, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis,

rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Osteoclast production

[0354] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may induce osteoclast production and/or increase the rate of osteoclastogenesis after binding to a Siglec-9 protein expressed in a cell.

[0355] As used herein, an osteoclast is a type of bone cell that can remove bone tissue by removing its mineralized matrix and breaking up the organic bone (*e.g.*, bone resorption). Osteoclasts can be formed by the fusion of cells of the myeloid lineage. In some embodiments, osteoclasts may be characterized by high expression of tartrate resistant acid phosphatase (TRAP) and cathepsin K.

[0356] As used herein, the rate of osteoclastogenesis may be increased if the rate of osteoclastogenesis in a subject treated with a Siglec-9 agent of the present disclosure, such as antagonist anti-Siglec-9 antibody, is greater than the rate of osteoclastogenesis in a corresponding subject that is not treated with the Siglec-9 agent. In some embodiments, a Siglec-9 agent, such as an antagonist anti-Siglec-9 antibody of the present disclosure, may increase the rate of osteoclastogenesis in a subject by at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 100%, at least 110%, at least 115%, at least 120%, at least 125%, at least 130%, at least 135%, at least 140%, at

least 145%, at least 150%, at least 160%, at least 170%, at least 180%, at least 190%, or at least 200% for example, as compared to rate of osteoclastogenesis in a corresponding subject that is not treated with the Siglec-9 agent. In other embodiments, a Siglec-9 agent, such as an antagonist anti-Siglec-9 antibody of the present disclosure, may increase the rate of osteoclastogenesis in a subject by at least 1.5 fold, at least 1.6 fold, at least 1.7 fold, at least 1.8 fold, at least 1.9 fold, at least 2.0 fold, at least 2.1 fold, at least 2.15 fold, at least 2.2 fold, at least 2.25 fold, at least 2.3 fold, at least 2.35 fold, at least 2.4 fold, at least 2.45 fold, at least 2.5 fold, at least 2.55 fold, at least 3.0 fold, at least 3.5 fold, at least 4.0 fold, at least 4.5 fold, at least 5.0 fold, at least 5.5 fold, at least 6.0 fold, at least 6.5 fold, at least 7.0 fold, at least 7.5 fold, at least 8.0 fold, at least 8.5 fold, at least 9.0 fold, at least 9.5 fold, or at least 10 fold, for example, as compared to rate of osteoclastogenesis in a corresponding subject that is not treated with the Siglec-9 agent.

[0357] As used herein, the rate of osteoclastogenesis may be decreased if the rate of osteoclastogenesis in a subject treated with a Siglec-9 agent, such as an agonist anti-Siglec-9 antibody of the present disclosure, is smaller than the rate of osteoclastogenesis in a corresponding subject that is not treated with the Siglec-9 agent. In some embodiments, a Siglec-9 agent, such as an agonist anti-Siglec-9 antibody of the present disclosure, may decrease the rate of osteoclastogenesis in a subject by at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 100%, at least 110%, at least 115%, at least 120%, at least 125%, at least 130%, at least 135%, at least 140%, at least 145%, at least 150%, at least 160%, at least 170%, at least 180%, at least 190%, or at least 200% for example, as compared to rate of osteoclastogenesis in a corresponding subject that is not treated with the Siglec-9 agent. In other embodiments, a Siglec-9 agent, such as an agonist anti-Siglec-9 antibody of the present disclosure, may decrease the rate of osteoclastogenesis in a subject by at least 1.5 fold, at least 1.6 fold, at least 1.7 fold, at least 1.8 fold, at least 1.9 fold, at least 2.0 fold, at least 2.1 fold, at least 2.15 fold, at least 2.2 fold, at least 2.25 fold, at least 2.3 fold, at least 2.35 fold, at least 2.4 fold, at least 2.45 fold, at least 2.5 fold, at least 2.55 fold, at least 3.0 fold, at least 3.5 fold, at least 4.0 fold, at least 4.5 fold, at least 5.0 fold, at least 5.5 fold, at least 6.0 fold, at least 6.5 fold, at least 7.0 fold, at least 7.5 fold, at least 8.0 fold, at least 8.5 fold, at least 9.0 fold, at least 9.5 fold, or at least 10 fold, for example, as compared to rate of osteoclastogenesis in a corresponding subject that is not treated with the Siglec-9 agent.

[0358] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with abnormal bone formation and maintenance including

osteoporosis, which is associated with pathological decrease in bone density and osteoporotic diseases which are associated with pathological increase in bone density.

Proliferation and survival of Siglec-9-expressing cells

[0359] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may increase the proliferation, survival, and/or function of dendritic cells, macrophages, neutrophils, NK cells, monocytes, neutrophils, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and microglial cells after binding to Siglec-9 protein expressed on a cell.

[0360] As used herein, macrophages of the present disclosure include, without limitation, M1 macrophages, activated M1 macrophages, and M2 macrophages. As used herein, neutrophils of the present disclosure include, without limitation, M1 neutrophils, activated M1 neutrophils, and M2 neutrophils. As used herein, natural killer (NK) cells of the present disclosure include, without limitation, M1 NK cells, activated M1 NK cells, and M2 NK cells. As used herein, microglial cells of the present disclosure include, without limitation, M1 microglial cells, activated M1 microglial cells, and M2 microglial cells.

[0361] Microglial cells are a type of glial cell that are the resident macrophages of the brain and spinal cord, and thus act as the first and main form of active immune defense in the central nervous system (CNS). Microglial cells constitute 20% of the total glial cell population within the brain. Microglial cells are constantly scavenging the CNS for plaques, damaged neurons and infectious agents. The brain and spinal cord are considered "immune privileged" organs in that they are separated from the rest of the body by a series of endothelial cells known as the blood–brain barrier, which prevents most pathogens from reaching the vulnerable nervous tissue. In the case where infectious agents are directly introduced to the brain or cross the blood–brain barrier, microglial cells must react quickly to limit inflammation and destroy the infectious agents before they damage the sensitive neural tissue. Due to the unavailability of antibodies from the rest of the body (few antibodies are small enough to cross the blood brain barrier), microglia must be able to recognize foreign bodies, swallow them, and act as antigen-presenting cells activating T cells. Since this process must be done quickly to prevent potentially fatal damage, microglial cells are extremely sensitive to even small pathological changes in the CNS. They achieve this sensitivity in part by having unique potassium channels that respond to even small changes in extracellular potassium.

[0362] In some embodiments, anti-Siglec-9 antibodies of the present disclosure may increase the expression of CD80, CD83 and/or CD86 on dendritic cells, monocytes, macrophages, neutrophils, NK cells, and/or microglia.

[0363] As used herein, the rate of proliferation, survival, and/or function of macrophages, neutrophils, NK cells, dendritic cells, monocytes, T cells, and/or microglia may include increased

expression if the rate of proliferation, survival, and/or function of dendritic cells, macrophages, neutrophils, NK cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, and/or microglia in a subject treated with a Siglec-9 agent, such as an anti-Siglec-9 antibody of the present disclosure, is greater than the rate of proliferation, survival, and/or function of dendritic cells, macrophages, neutrophils, NK cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and/or microglia in a corresponding subject that is not treated with the Siglec-9 agent. In some embodiments, a Siglec-9 agent, such as an anti-Siglec-9 antibody of the present disclosure, may increase the rate of proliferation, survival, and/or function of dendritic cells, macrophages, neutrophils, NK cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and/or microglia in a subject by at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 100%, at least 110%, at least 115%, at least 120%, at least 125%, at least 130%, at least 135%, at least 140%, at least 145%, at least 150%, at least 160%, at least 170%, at least 180%, at least 190%, or at least 200% for example, as compared to the rate of proliferation, survival, and/or function of dendritic cells, macrophages, neutrophils, NK cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and/or microglia in a corresponding subject that is not treated with the Siglec-9 agent. In other embodiments, a Siglec-9 agent, such as an anti-Siglec-9 antibody of the present disclosure, may increase the rate of proliferation, survival, and/or function of dendritic cells, macrophages, neutrophils, NK cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and/or microglia in a subject by at least 1.5 fold, at least 1.6 fold, at least 1.7 fold, at least 1.8 fold, at least 1.9 fold, at least 2.0 fold, at least 2.1 fold, at least 2.15 fold, at least 2.2 fold, at least 2.25 fold, at least 2.3 fold, at least 2.35 fold, at least 2.4 fold, at least 2.45 fold, at least 2.5 fold, at least 2.55 fold, at least 3.0 fold, at least 3.5 fold, at least 4.0 fold, at least 4.5 fold, at least 5.0 fold, at least 5.5 fold, at least 6.0 fold, at least 6.5 fold, at least 7.0 fold, at least 7.5 fold, at least 8.0 fold, at least 8.5 fold, at least 9.0 fold, at least 9.5 fold, or at least 10 fold, for example, as compared to the rate of proliferation, survival, and/or function of dendritic cells, macrophages, neutrophils, NK cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and/or microglia in a corresponding subject that is not treated with the Siglec-9 agent.

[0364] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with a reduction in proliferation, survival, increased apoptosis and/or function of dendritic cells, neutrophils, macrophages, neutrophils, NK cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and/or microglia including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed

dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Clearance and phagocytosis

[0365] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may induce clearance and/or phagocytosis after binding to a Siglec-9 protein expressed in a cell of one or more of apoptotic neurons, nerve tissue debris of the nervous system, non-nerve tissue debris of the nervous system, dysfunctional synapses, bacteria, other foreign bodies, disease-causing proteins, disease-causing peptides, disease-causing nucleic acid, or tumor cells. In certain embodiments, disease-causing proteins include, without limitation, amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides,

glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides. In certain embodiments, disease-causing nucleic acids include, without limitation, antisense GGCCCC (G2C4) repeat-expansion RNA.

[0366] In some embodiments, the Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may induce of one or more types of clearance, including without limitation, apoptotic neuron clearance, nerve tissue debris clearance, dysfunctional synapse clearance, non- nerve tissue debris clearance, bacteria or other foreign body clearance, disease-causing protein clearance, disease-causing peptide clearance, disease-causing nucleic acid clearance, and tumor cell clearance.

[0367] In some embodiments, the Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may induce phagocytosis of one or more of apoptotic neurons, nerve tissue debris, dysfunctional synapses, non-nerve tissue debris, bacteria, other foreign bodies, disease-causing proteins, disease-causing peptides, disease-causing nucleic acid, and/or tumor cells.

[0368] In some embodiments, the Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may increase phagocytosis by neutrophils, macrophages, neutrophils, NK cells, dendritic cells, monocytes, and/or microglia under conditions of reduced levels of macrophage colony-stimulating factor (M-CSF).

[0369] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with apoptotic neurons, nerve tissue debris of the nervous system, non-nerve tissue debris of the nervous system, bacteria, other foreign bodies, disease-causing proteins, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell

cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Siglec-9-dependent gene expression

[0370] In some embodiments, Siglec-9 agents of the present disclosure, such as antagonist anti-Siglec-9 antibodies of the present disclosure, may decrease the activity and/or expression of Siglec-9-dependent genes, and by that increase gene expression associated with signaling cascade that activate the immune system such as gene expression associated with ITAM containing receptors, pattern recognition receptors, of Toll-like receptors, of damage-associated molecular pattern (DAMP) receptors such as one or more transcription factors of the nuclear factor of activated T cells (NFAT) family of transcription factors.

[0371] In some embodiments, Siglec-9 agents of the present disclosure, such as antagonist anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with high levels of Siglec-9-dependent genes, including without limitation, dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid

leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza.

Siglec-9-dependent activation of T cells

[0372] In some embodiments, Siglec-9 agents of the present disclosure, such as antagonist anti-Siglec-9 antibodies of the present disclosure, may increase the activity of cytotoxic T cells helper T cells or both. In some embodiments, Siglec-9 agents of the present disclosure, such as antagonist anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased activity of cytotoxic T cells helper T cells or both, including without limitation, tumors, including solid tumors such as bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer.

Siglec-9-dependent inhibition of neutrophils

[0373] In some embodiments, Siglec-9 agents of the present disclosure, such as agonist anti-Siglec-9 antibodies of the present disclosure, may decrease the activity of neutrophils. In some embodiments, Siglec-9 agents of the present disclosure, such as agonist anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased activity of the activity of natural killer cells, neutrophils or both, including without limitation, tumors, including solid tumors such as bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer.

Siglec-9-dependent enhanced cell killing by natural killer (NK) cells

[0374] In some embodiments, Siglec-9 agents of the present disclosure, such as antagonist anti-Siglec-9 antibodies of the present disclosure, may increase the killing activity of NK cells. In some embodiments, Siglec-9 agents of the present disclosure, such as antagonistic anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased activity of natural killer cells, neutrophils or both,

including without limitation, tumors, including solid tumors such as bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer.

Siglec-9-dependent inhibition of tumor-associated immune cells

[0375] In some embodiments, Siglec-9 agents of the present disclosure, such as agonist anti-Siglec-9 antibodies of the present disclosure, may decrease the activity, decrease the proliferation, decrease the survival, decrease the functionality, decrease infiltration to tumors or lymphoid organs (e.g., the spleen and lymph nodes), and/or promote apoptosis of T-regulatory cells or inhibitory tumor-imbedded immunosuppressor dendritic cells or, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, or, myeloid-derived suppressor cells. In some embodiments, Siglec-9 agents of the present disclosure, such as agonist anti-Siglec-9 antibodies of the present disclosure, are beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with the activity of one or more type of immune suppressor cells, including without limitation, tumors, including solid tumors that do not express Siglec-9 such as bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, thyroid cancer, and blood tumors that express Siglec-9, such as leukemia cells.

Pharmaceutical compositions

[0376] Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, can be incorporated into a variety of formulations for therapeutic administration by combining the agents, such as anti-Siglec-9 antibodies, with appropriate pharmaceutically acceptable carriers or diluents, and may be formulated into preparations in solid, semi-solid, liquid or gaseous forms. Examples of such formulations include, without limitation, tablets, capsules, powders, granules, ointments, solutions, suppositories, injections, inhalants, gels, microspheres, and aerosols. Pharmaceutical compositions can include, depending on the formulation desired, pharmaceutically-acceptable, non-toxic carriers of diluents, which are vehicles commonly used to formulate pharmaceutical compositions for animal or human administration. The diluent is selected so as not to affect the biological activity of the combination. Examples of such diluents include, without limitation, distilled water, buffered water, physiological saline, PBS, Ringer's solution, dextrose solution, and Hank's solution. A pharmaceutical composition or formulation of the present disclosure can further include other carriers, adjuvants, or non-toxic, nontherapeutic, nonimmunogenic stabilizers, excipients and the like. The compositions can also include additional

substances to approximate physiological conditions, such as pH adjusting and buffering agents, toxicity adjusting agents, wetting agents and detergents.

[0377] A pharmaceutical composition of the present disclosure can also include any of a variety of stabilizing agents, such as an antioxidant for example. When the pharmaceutical composition includes a polypeptide, the polypeptide can be complexed with various well-known compounds that enhance the *in vivo* stability of the polypeptide, or otherwise enhance its pharmacological properties (*e.g.*, increase the half-life of the polypeptide, reduce its toxicity, and enhance solubility or uptake). Examples of such modifications or complexing agents include, without limitation, sulfate, gluconate, citrate and phosphate. The polypeptides of a composition can also be complexed with molecules that enhance their *in vivo* attributes. Such molecules include, without limitation, carbohydrates, polyamines, amino acids, other peptides, ions (*e.g.*, sodium, potassium, calcium, magnesium, manganese), and lipids.

[0378] Further examples of formulations that are suitable for various types of administration can be found in Remington's *Pharmaceutical Sciences*, Mace Publishing Company, Philadelphia, PA, 17th ed. (1985). For a brief review of methods for drug delivery, see, Langer, *Science* 249:1527-1533 (1990).

[0379] For oral administration, the active ingredient can be administered in solid dosage forms, such as capsules, tablets, and powders, or in liquid dosage forms, such as elixirs, syrups, and suspensions. The active component(s) can be encapsulated in gelatin capsules together with inactive ingredients and powdered carriers, such as glucose, lactose, sucrose, mannitol, starch, cellulose or cellulose derivatives, magnesium stearate, stearic acid, sodium saccharin, talcum, magnesium carbonate. Examples of additional inactive ingredients that may be added to provide desirable color, taste, stability, buffering capacity, dispersion or other known desirable features are red iron oxide, silica gel, sodium lauryl sulfate, titanium dioxide, and edible white ink. Similar diluents can be used to make compressed tablets. Both tablets and capsules can be manufactured as sustained release products to provide for continuous release of medication over a period of hours. Compressed tablets can be sugar coated or film coated to mask any unpleasant taste and protect the tablet from the atmosphere, or enteric-coated for selective disintegration in the gastrointestinal tract. Liquid dosage forms for oral administration can contain coloring and flavoring to increase patient acceptance.

[0380] Formulations suitable for parenteral administration include aqueous and non-aqueous, isotonic sterile injection solutions, which can contain antioxidants, buffers, bacteriostats, and solutes that render the formulation isotonic with the blood of the intended recipient, and aqueous and non-aqueous sterile suspensions that can include suspending agents, solubilizers, thickening agents, stabilizers, and preservatives.

[0381] The components used to formulate the pharmaceutical compositions are preferably of high purity and are substantially free of potentially harmful contaminants (*e.g.*, at least National Food (NF) grade, generally at least analytical grade, and more typically at least pharmaceutical grade). Moreover, compositions intended for *in vivo* use are usually sterile. To the extent that a given compound must be synthesized prior to use, the resulting product is typically substantially free of any potentially toxic agents, particularly any endotoxins, which may be present during the synthesis or purification process. Compositions for parental administration are also sterile, substantially isotonic and made under GMP conditions.

[0382] Formulations may be optimized for retention and stabilization in the brain or central nervous system. When the agent is administered into the cranial compartment, it is desirable for the agent to be retained in the compartment, and not to diffuse or otherwise cross the blood brain barrier. Stabilization techniques include cross-linking, multimerizing, or linking to groups such as polyethylene glycol, polyacrylamide, neutral protein carriers, *etc.* in order to achieve an increase in molecular weight.

[0383] Other strategies for increasing retention include the entrapment of an agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, in a biodegradable or bioerodible implant. The rate of release of the therapeutically active agent is controlled by the rate of transport through the polymeric matrix, and the biodegradation of the implant. The transport of drug through the polymer barrier will also be affected by compound solubility, polymer hydrophilicity, extent of polymer cross-linking, expansion of the polymer upon water absorption so as to make the polymer barrier more permeable to the drug, geometry of the implant, and the like. The implants are of dimensions commensurate with the size and shape of the region selected as the site of implantation. Implants may be particles, sheets, patches, plaques, fibers, microcapsules and the like and may be of any size or shape compatible with the selected site of insertion.

[0384] The implants may be monolithic, *i.e.* having the active agent homogenously distributed through the polymeric matrix, or encapsulated, where a reservoir of active agent is encapsulated by the polymeric matrix. The selection of the polymeric composition to be employed will vary with the site of administration, the desired period of treatment, patient tolerance, the nature of the disease to be treated and the like. Characteristics of the polymers will include biodegradability at the site of implantation, compatibility with the agent of interest, ease of encapsulation, a half-life in the physiological environment.

[0385] Biodegradable polymeric compositions which may be employed may be organic esters or ethers, which when degraded result in physiologically acceptable degradation products, including the monomers. Anhydrides, amides, orthoesters or the like, by themselves or in combination with other monomers, may find use. The polymers will be condensation polymers. The polymers may be cross-

linked or non-cross-linked. Of particular interest are polymers of hydroxyaliphatic carboxylic acids, either homo- or copolymers, and polysaccharides. Included among the polyesters of interest are polymers of D-lactic acid, L-lactic acid, racemic lactic acid, glycolic acid, polycaprolactone, and combinations thereof. By employing the L-lactate or D-lactate, a slowly biodegrading polymer is achieved, while degradation is substantially enhanced with the racemate. Copolymers of glycolic and lactic acid are of particular interest, where the rate of biodegradation is controlled by the ratio of glycolic to lactic acid. The most rapidly degraded copolymer has roughly equal amounts of glycolic and lactic acid, where either homopolymer is more resistant to degradation. The ratio of glycolic acid to lactic acid will also affect the brittleness of in the implant, where a more flexible implant is desirable for larger geometries. Among the polysaccharides of interest are calcium alginate, and functionalized celluloses, particularly carboxymethylcellulose esters characterized by being water insoluble, a molecular weight of about 5 kD to 500 kD, *etc.* Biodegradable hydrogels may also be employed in the implants of the present disclosure. Hydrogels are typically a copolymer material, characterized by the ability to imbibe a liquid. Exemplary biodegradable hydrogels which may be employed are described in Heller in: Hydrogels in Medicine and Pharmacy, N. A. Peppes ed., Vol. III, CRC Press, Boca Raton, Fla., 1987, pp 137-149.

Pharmaceutical dosages

[0386] Pharmaceutical compositions of the present disclosure containing a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, may be administered to an individual in need of treatment with the Siglec-9 agent, preferably a human, in accord with known methods, such as intravenous administration as a bolus or by continuous infusion over a period of time, by intramuscular, intraperitoneal, intracerobrospinal, intracranial, intraspinal, subcutaneous, intra-articular, intrasynovial, intrathecal, oral, topical, or inhalation routes.

[0387] Dosages and desired drug concentration of pharmaceutical compositions of the present disclosure may vary depending on the particular use envisioned. The determination of the appropriate dosage or route of administration is well within the skill of an ordinary artisan. Animal experiments provide reliable guidance for the determination of effective doses for human therapy. Interspecies scaling of effective doses can be performed following the principles described in Mordenti, J. and Chappell, W. "The Use of Interspecies Scaling in Toxicokinetics," In *Toxicokinetics and New Drug Development*, Yacobi et al., Eds, Pergamon Press, New York 1989, pp.42-46.

[0388] For *in vivo* administration of any of the Siglec-9 agents of the present disclosure, such as any of the anti-Siglec-9 antibodies of the present disclosure, normal dosage amounts may vary from about 10 ng/kg up to about 100 mg/kg of an individual's body weight or more per day, preferably about 1 mg/kg/day to 10 mg/kg/day, depending upon the route of administration. For repeated administrations over several days or longer, depending on the severity of the disease, disorder, or

condition to be treated, the treatment is sustained until a desired suppression of symptoms is achieved.

[0389] An exemplary dosing regimen may include administering an initial dose of a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody, of about 2 mg/kg, followed by a weekly maintenance dose of about 1 mg/kg every other week. Other dosage regimens may be useful, depending on the pattern of pharmacokinetic decay that the physician wishes to achieve. For example, dosing an individual from one to twenty-one times a week is contemplated herein. In certain embodiments, dosing ranging from about 3 μg/kg to about 2 mg/kg (such as about 3 μg/kg, about 10 μg/kg, about 30 μg/kg, about 100 μg/kg, about 300 μg/kg, about 1 mg/kg, and about 2/mg/kg) may be used. In certain embodiments, dosing frequency is three times per day, twice per day, once per day, once every other day, once weekly, once every two weeks, once every four weeks, once every five weeks, once every six weeks, once every seven weeks, once every eight weeks, once every nine weeks, once every ten weeks, or once monthly, once every two months, once every three months, or longer. Progress of the therapy is easily monitored by conventional techniques and assays. The dosing regimen, including the Siglec-9 agent, such as the anti-Siglec-9 antibody administered, can vary over time independently of the dose used.

[0390] Dosages for a particular Siglec-9 agent, such as a particular anti-Siglec-9 antibody, may be determined empirically in individuals who have been given one or more administrations of the Siglec-9agent, such as the anti-Siglec-9 antibody. Individuals are given incremental doses of a Siglec-9 agent, such as an anti-Siglec-9 antibody. To assess efficacy of a Siglec-9 agent, such as an anti-Siglec-9 antibody, a clinical symptom of any of the diseases, disorders, or conditions of the present disclosure (*e.g.*, frontotemporal dementia, Alzheimer's disease, vascular dementia, seizures, retinal dystrophy, a traumatic brain injury, a spinal cord injury, long-term depression, atherosclerotic vascular diseases, and undesirable symptoms of normal aging) can be monitored.

[0391] Administration of a Siglec-9 agent, such as an anti-Siglec-9 antibody of the present disclosure, can be continuous or intermittent, depending, for example, on the recipient's physiological condition, whether the purpose of the administration is therapeutic or prophylactic, and other factors known to skilled practitioners. The administration of a Siglec-9 agent, such as an anti-Siglec-9 antibody, may be essentially continuous over a preselected period of time or may be in a series of spaced doses.

[0392] Guidance regarding particular dosages and methods of delivery is provided in the literature; see, for example, U.S. Patent Nos. 4,657,760; 5,206,344; or 5,225,212. It is within the scope of the present disclosure that different formulations will be effective for different treatments and different disorders, and that administration intended to treat a specific organ or tissue may necessitate delivery in a manner different from that to another organ or tissue. Moreover, dosages

may be administered by one or more separate administrations, or by continuous infusion. For repeated administrations over several days or longer, depending on the condition, the treatment is sustained until a desired suppression of disease symptoms occurs. However, other dosage regimens may be useful. The progress of this therapy is easily monitored by conventional techniques and assays.

Therapeutic uses

[0393] Further aspects of the present disclosure provide methods of modulating (*e.g.*, activating or inhibiting) one or more Siglec-9 activities, including with limitation, modulating (*e.g.*, activating or inhibiting) a Siglec-9 protein of the present disclosure, counteracting one or more phosphorylation of Tyr-433 and Tyr-456 by a Src family tyrosine kinase, such as Syk, LCK, FYM, and/or ZAP70; recruitment of and binding to the tyrosine-specific protein phosphatases SHP1 and SHP2; recruitment of and binding to PLC-gamma1, which acts as a guanine nucleotide exchange factor for Dynamini-1; recruitment of and binding to SH2-domain containing protein (*e.g.*, Crkl); recruitment of and binding to the spleen tyrosine kinase Syk; recruitment of and binding to SH3-SH2-SH3 growth factor receptor-bound protein 2 (Grb2); recruitment of and binding to multiple SH2-containing proteins; modulating (e.g., activating or inhibiting) expression of one or more pro-inflammatory cytokines, optionally wherein the one or more anti-inflammatory cytokines are selected from FN-α4, IFN-beta, IL-1β, IL-1alpha, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-33, MCP-1, and MIP-1-beta; modulating (*e.g.*, activating or inhibiting) expression of one or more pro-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; modulating (*e.g.*, activating or inhibiting) expression of one or more anti-inflammatory cytokines, optionally wherein the one or more anti-inflammatory cytokines are selected from IL-4, IL-10, IL-13, IL-35, IL-16, TGF-beta, IL-1Ra, G-CSF, and soluble receptors for TNF, IFN-beta1a, IFN-beta1b, or IL-6; modulating (*e.g.*, activating or inhibiting) expression of one or more anti-inflammatory cytokines in one or more cells selected from macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, and microglial cells; modulating (*e.g.*, activating or inhibiting) expression of one or more proteins selected from C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and PYCARD; activation of extracellular signal-regulated kinase (ERK) phosphorylation; modulating (e.g., activating or inhibiting) tyrosine phosphorylation on one or more cellular proteins, optionally, wherein the one or more cellular proteins comprise ZAP-70 and the tyrosine phosphorylation occurs on Tyr-319 of ZAP-70; modulating (e.g., activating or inhibiting) expression of C-C chemokine

receptor 7 (CCR7); activation of microglial cell chemotaxis toward CCL19-expressing and CCL21-expressing cells; modulating (e.g., activating or inhibiting) T cell proliferation induced by one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, M1 microglia, activated M1 microglia, M2 microglia, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, and M2 NK cells; modulating (*e.g.*, activating or inhibiting) osteoclast production, modulating (*e.g.*, activating or inhibiting) rate of osteoclastogenesis, or both; modulating (*e.g.*, activating or inhibiting) survival of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; modulating (e.g., activating or inhibiting) proliferation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; modulating (e.g., activating or inhibiting) migration of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; modulating (e.g., activating or inhibiting) one or more functions of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; modulating (e.g., activating or inhibiting) maturation of one or more cells selected from dendritic cells, bone marrow-derived dendritic cells, macrophages, neutrophils, NK cells, M1 macrophages, M1 neutrophils, M1 NK cells, activated M1 macrophages, activated M1 neutrophils, activated M1 NK cells, M2 macrophages, M2 neutrophils, M2 NK cells, monocytes, osteoclasts, T cells, T helper cells, cytotoxic T cells, granulocytes, neutrophils, microglia, M1 microglia, activated M1 microglia, and M2 microglia; activation of one or more types of clearance selected from apoptotic neuron clearance, nerve tissue debris clearance,

dysfunctional synapse clearance, non-nerve tissue debris clearance, bacteria clearance, other foreign body clearance, disease-causing protein clearance, disease-causing peptide clearance, and tumor cell clearance; optionally wherein the disease-causing protein is selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides and the tumor cell is from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer; activation of phagocytosis of one or more of apoptotic neurons, nerve tissue debris, dysfunctional synapses non-nerve tissue debris, bacteria, other foreign bodies, disease-causing proteins, disease-causing peptides, disease-causing nucleic acids, or tumor cells; optionally wherein the disease-causing nucleic acids are antisense GGCCCC (G2C4) repeat-expansion RNA, the disease-causing proteins are selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides, and the tumor cells are from a cancer selected from bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, or thyroid cancer; inhibiting binding to Siglec-9 ligand on tumor cells; modulating (e.g., activating or inhibiting) binding to Siglec-9 ligand on cells selected from neutrophils, dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, macrophages,

and NK cells; activation of tumor cell killing by one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; activating anti-tumor cell proliferation activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; activation of anti-tumor cell metastasis activity of one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; modulating (e.g., activating or inhibiting) of one or more ITAM motif containing receptors, optionally wherein the one or more ITAM motif containing receptors are selected from TREM1, TREM2, Sirp beta, FcgR, DAP10, and DAP12; modulating (e.g., activating or inhibiting) of signaling by one or more pattern recognition receptors (PRRs), optionally wherein the one or more PRRs are selected from receptors that identify pathogen-associated molecular patterns (PAMPs), receptors that identify damage-associated molecular patterns (DAMPs), and any combination thereof; modulating (e.g., activating or inhibiting) of one or more receptors comprising the motif D/Ex_{0-2}YxxL/IX_{6-8}YxxL/I (SEQ ID NO: 252); modulating (e.g., activating or inhibiting) of signaling by one or more Toll-like receptors; modulating (e.g., activating or inhibiting) of the JAK-STAT signaling pathway; modulating (e.g., activating or inhibiting) of nuclear factor kappa-light-chain-enhancer of activated B cells (NFκB); phosphorylation of an ITAM motif containing receptor; modulating (e.g., activating or inhibiting) expression of one or more inflammatory receptors, proteins of the complement cascade, and/or receptors, optionally wherein the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors comprise CD86, C1qa, C1qB, C1qC, C1s, C1R, C4, C2, C3, ITGB2, HMOX1, LAT2, CASP1, CSTA, VSIG4, MS4A4A, C3AR1, GPX1, TyroBP, ALOX5AP, ITGAM, SLC7A7, CD4, ITGAX, and/or PYCARD, and the one or more inflammatory receptors, proteins of the complement cascade, and/or receptors are expressed on one or more of microglia, macrophages, neutrophils, NK cells, dendritic cells, bone marrow-derived dendritic cells, neutrophils, T cells, T helper cells, or cytotoxic T cells; modulating (e.g., activating or inhibiting) expression of one or more Siglec-9-dependent genes; normalization of disrupted Siglec-9-dependent gene expression; modulating (e.g., activating or inhibiting) expression of one or more ITAM-dependent genes, optionally wherein the one more ITAM-dependent genes are activated by nuclear factor of activated T cells (NFAT) transcription factors; rescuing functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells; reducing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages,

tumor-associated neutrophils, tumor-associated NK cells, and regulatory T cells into tumors; increasing the number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; enhancing tumor-promoting activity of myeloid-derived suppressor cells; increasing expression of tumor-promoting cytokines in a tumor or in peripheral blood, optionally wherein the tumor-promoting cytokines are TGF-beta or IL-10; increasing tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; enhancing tumor-promoting activity of myeloid-derived suppressor cells (MDSC); decreasing activation of tumor-specific T lymphocytes with tumor killing potential; decreasing infiltration of tumor-specific NK cells with tumor killing potential; decreasing the tumor killing potential of NK cells; decreasing infiltration of tumor-specific B lymphocytes with potential to enhance immune response; decreasing infiltration of tumor-specific T lymphocytes with tumor killing potential; increasing tumor volume; increasing tumor growth rate; increasing metastasis; increasing rate of tumor recurrence; decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more target proteins selected from PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, TREM1, TREM2, CD39, CD73, CSF-1 receptor, and any combination thereof, or of one or more cancer vaccines; inhibition of PLCγ/PKC/calcium mobilization; and/or inhibition of PI3K/Akt, Ras/MAPK signaling in an individual in need thereof, by administering to the individual a therapeutically effective amount of a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, to modulate (e.g., activate or inhibit) one or more of the Siglec-9 activities in the individual.

[0394] As disclosed herein, Siglec-9 agents of the present disclosure that bind Siglec-9, decrease cellular levels of Siglec-9, inhibit interaction between Siglec-9 and one or more Siglec-9 ligands, or any combination thereof, such as anti-Siglec-9 antibodies of the present disclosure, may be used for preventing, reducing risk, or treating dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis,

eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and/or Haemophilus influenza. In some embodiments, the agents are selected from antibodies, soluble Siglec-9 receptors, Siglec-9-Fc fusion proteins, Siglec-9 immunoadhesins, soluble Siglec receptors that binds one or more Siglec-9 ligands, Siglec-Fc fusion proteins, Siglec immunoadhesins, antisense molecules, siRNAs, small molecule inhibitors, proteins, and peptides. In some embodiments, the Siglec-9 agents are agonist antibodies. In some embodiments, the Siglec-9 agents are inert antibodies. In some embodiments, the Siglec-9 agents are antagonist antibodies.

[0395] In some embodiments, the present disclosure provides methods of preventing, reducing risk, or treating dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer, bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic

myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer, infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and/or Haemophilus influenza, by administering to an individual in need thereof a therapeutically effective amount of an agent of the present disclosure that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both. In some embodiments, the agent is selected from an antibody, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a Siglec-9 immunoadhesin, a soluble Siglec receptor that binds one or more Siglec-9 ligands, a Siglec-Fc fusion protein, a Siglec immunoadhesin, an antisense molecule, an siRNA, a small molecule inhibitor, a protein, and a peptide. In some embodiments, the agent is an anti-Siglec-9 antibody of the present disclosure.

[0396] In some embodiments, the present disclosure provides methods of preventing, reducing risk, or treating cancer, by administering to an individual in need thereof, a therapeutically effective amount of an agent of the present disclosure that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both. In some embodiments, the agent is selected from an antibody, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a Siglec-9 immunoadhesin, a soluble Siglec receptor that binds one or more Siglec-9 ligands, a Siglec-Fc fusion protein, a Siglec immunoadhesin, an antisense molecule, an siRNA, a small molecule inhibitor, a protein, and a peptide. In certain embodiments, the agent is an anti-Siglec-9 antibody of the present disclosure. In some embodiments, the anti-Siglec-9 antibody inhibits one or more Siglec-9 activities selected from: (a) promoting proliferation, maturation, migration, differentiation, and/or functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid derived suppressor cells, tumor-associated macrophages, tumor-associated suppressor neutrophils, tumor-associated suppressor NK cells, and regulatory T cells; (b) enhancing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, immunosuppressor NK cells, myeloid derived suppressor cells, tumor-associated macrophages, tumor-associated suppressor neutrophils, tumor-associated suppressor NK cells, and regulatory T cells into tumors; (c) increasing number of tumor-promoting myeloid/granulocytic immune-suppressive cells in a tumor, in peripheral blood, or other lymphoid organ; (d) enhancing tumor-promoting activity of myeloid-derived suppressor cells (MDSC); (e) increasing expression of tumor-promoting cytokines in a tumor or in peripheral blood, optionally wherein the tumor-promoting cytokines are TGF-beta or IL-10; (f) increasing tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; (g) decreasing activation of tumor-specific T lymphocytes with tumor killing potential; (h) decreasing infiltration of tumor-specific T lymphocytes with tumor killing potential; (i) decreasing infiltration of tumor-

specific NK cells with tumor killing potential; (j) decreasing the tumor killing potential of NK cells; (k) decreasing infiltration of tumor-specific B lymphocytes with potential to enhance immune response; (l) increasing tumor volume; (m) increasing tumor growth rate; (n) increasing metastasis; (o) increasing rate of tumor recurrence; (p) decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more target proteins selected from PD1/PDL1, CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, CD30, TIGIT, VISTA, KIR, GAL9, TIM1, TIM3, TIM4, A2AR, LAG3, DR-5, CD2, CD5, TREM1, TREM2, CD39, CD73, CSF-1 receptor, and any combination thereof, or cancer vaccines; (q) inhibition of PLCγ/PKC/calcium mobilization; and (r) inhibition of PI3K/Akt, Ras/MAPK signaling. In some embodiments, the anti-Siglec-9 antibody inhibits one or more Siglec-9 activities selected from the group consisting of: (a) promoting proliferation, maturation, migration, differentiation, and/or functionality of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, non-tumorigenic myeloid derived suppressor cells, tumor-associated macrophages, , non-tumorigenic $CD14^+$ myeloid cells, and regulatory T cells; (b) enhancing infiltration of one or more of immunosuppressor dendritic cells, immunosuppressor macrophages, immunosuppressor neutrophils, non-tumorigenic myeloid derived suppressor cells, tumor-associated macrophages, and regulatory T cells into tumors; (c) increasing number of tumor-promoting myeloid/granulocytic immune-suppressive cells and/or non-tumorigenic $CD14^+$ myeloid cells in a tumor, in peripheral blood, or other lymphoid organ; (d) enhancing tumor-promoting activity of non-tumorigenic myeloid-derived suppressor cells and/or non-tumorigenic $CD14^+$ myeloid cells; (e) increasing expression of tumor-promoting cytokines in a tumor or in peripheral blood, optionally wherein the tumor-promoting cytokines are TGF-beta or IL-10; (f) increasing tumor infiltration of tumor-promoting FoxP3+ regulatory T lymphocytes; (g) decreasing activation of tumor-specific T lymphocytes with tumor killing potential; (h) decreasing infiltration of tumor-specific T lymphocytes with tumor killing potential; (i) decreasing infiltration of tumor-specific NK cells with tumor killing potential; (j) decreasing tumor killing potential of NK cells; (k) decreasing infiltration of tumor-specific B lymphocytes with potential to enhance immune response; (l) increasing tumor volume; (m) increasing tumor growth rate; (n) increasing metastasis; (o) increasing rate of tumor recurrence; (p) increasing expression of one or more PD-1 ligands; (q) decreasing efficacy of one or more immune-therapies that modulate anti-tumor T cell responses, optionally wherein the one or more immune-therapies are immune-therapies that target one or more proteins selected from the group consisting of CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, LIGHT, BTLA, KIR, GAL9, CD2, CD5, CD39, CD73, CD30, TIGIT, VISTA, TIM1, TIM3, TIM4, A2AR, LAG, DR-5, TREM1,

TREM2, CSF-1 receptor, and any combination thereof, or of one or more cancer vaccines; (r) inhibition of PLCγ/PKC/calcium mobilization; (s) inhibition of PI3K/Akt, Ras/MAPK signaling; and (t) decreasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof. In some embodiments, the anti-Siglec-9 antibody exhibits one or more activities selected from the group consisting of consisting of: (a) increasing the number of tumor infiltrating $CD3^+$ T cells; (b) decreasing cellular levels of Siglec-9 in non-tumorigenic $CD14^+$myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (c) reducing the number of non-tumorigenic $CD14^+$ myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (d) reducing PD-L1 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (e) reducing PD-L2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (f) reducing B7-H2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (g) reducing B7-H3 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (h) reducing CD200R levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (i) reducing CD163 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (j) reducing CD206 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (k) decreasing tumor growth rate of solid tumors; (l) reducing tumor volume; (m) increasing efficacy of one or more PD-1 inhibitors; (n) increasing efficacy of one or more checkpoint inhibitor therapies and/or immune-modulating therapies, optionally wherein the one or more checkpoint inhibitor therapies and/or immune-modulating therapies target one or more of CTLA4, the adenosine pathway, PD-L1, PD-L2, OX40, TIM3, LAG3, or any combination thereof; (o) increasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof; (p) increasing proliferation of T cells in the presence of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (q) inhibiting differentiation, survival, and/or one or more functions of non-tumorigenic myeloid-derived

suppressor cells (MDSC); and (r) killing Siglec-9-expressing immunosuppressor myeloid cells and/or CD14-expressing cells in solid tumors and associated blood vessels when conjugated to a chemical or radioactive toxin. In some embodiments that may be combined with any of the preceding embodiments, the disease, disorder, or injury is cancer, and the agent exhibits one or more activities selected from the group consisting of consisting of: (a) increasing the number of tumor infiltrating $CD3^+$ T cells; (b) decreasing cellular levels of Siglec-9 in non-tumorigenic $CD14^+$myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (c) reducing the number of non-tumorigenic $CD14^+$ myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (d) reducing PD-L1 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (e) reducing PD-L2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (f) reducing B7-H2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (g) reducing B7-H3 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (h) reducing CD200R levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (i) reducing CD163 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (j) reducing CD206 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (k) decreasing tumor growth rate of solid tumors; (l) reducing tumor volume; (m) increasing efficacy of one or more PD-1 inhibitors; (n) increasing efficacy of one or more checkpoint inhibitor therapies and/or immune-modulating therapies, optionally wherein the one or more checkpoint inhibitor therapies and/or immune-modulating therapies target one or more of CTLA4, the adenosine pathway, PD-L1, PD-L2, OX40, TIM3, LAG3, or any combination thereof; (o) increasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof; (p) increasing proliferation of T cells in the presence of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (q) inhibiting differentiation, survival, and/or one or more functions of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (r) killing Siglec-9-expressing immunosuppressor myeloid cells and/or CD14-expressing cells in solid tumors and associated blood vessels when conjugated to a chemical or radioactive toxin. In some embodiments that may be combined with any of the preceding

embodiments, the agent exhibits one or more activities selected from the group consisting of consisting of: (a) increasing the number of tumor infiltrating $CD3^+$ T cells; (b) decreasing cellular levels of Siglec-9 in non-tumorigenic $CD14^+$myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (c) reducing the number of non-tumorigenic $CD14^+$ myeloid cells, optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are tumor infiltrating cells or optionally wherein the non-tumorigenic $CD14^+$ myeloid cells are present in blood; (d) reducing PD-L1 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (e) reducing PD-L2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (f) reducing B7-H2 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (g) reducing B7-H3 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (h) reducing CD200R levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (i) reducing CD163 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (j) reducing CD206 levels in one or more cells, optionally wherein the one or more cells are non-tumorigenic myeloid-derived suppressor cells (MDSC); (k) decreasing tumor growth rate of solid tumors; (l) reducing tumor volume; (m) increasing efficacy of one or more PD-1 inhibitors; (n) increasing efficacy of one or more checkpoint inhibitor therapies and/or immune-modulating therapies, optionally wherein the one or more checkpoint inhibitor therapies and/or immune-modulating therapies target one or more of CTLA4, the adenosine pathway, PD-L1, PD-L2, OX40, TIM3, LAG3, or any combination thereof; (o) increasing efficacy of one or more chemotherapy agents, optionally wherein the one or more of the chemotherapy agents are gemcitabine, capecitabine, anthracyclines, doxorubicin (Adriamycin®), epirubicin (Ellence®), taxanes, paclitaxel (Taxol®), docetaxel (Taxotere®), 5-fluorouracil (5-FU), cyclophosphamide (Cytoxan®), carboplatin (Paraplatin®), and any combination thereof; (p) increasing proliferation of T cells in the presence of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (q) inhibiting differentiation, survival, and/or one or more functions of non-tumorigenic myeloid-derived suppressor cells (MDSC); and (r) killing Siglec-9-expressing immunosuppressor myeloid cells and/or CD14-expressing cells in solid tumors and associated blood vessels when conjugated to a chemical or radioactive toxin.

[0397] As disclosed herein, agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may also be used for inducing and/or promoting the survival maturation, functionality, migration, or proliferation of one or more immune cells (*e.g.*, innate immune cells or adaptive immune cells). In some embodiments, the present disclosure provides methods of inducing

or promoting the survival, maturation, functionality, migration, or proliferation of one or more immune cells in an individual in need thereof, by administering to the individual a therapeutically effective amount of an agent of the present disclosure that decreases cellular levels of Siglec-9, inhibits interaction between Siglec-9 and one or more Siglec-9 ligands, or both. In some embodiments, the agent is selected from an antibody, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a Siglec-9 immunoadhesin, a soluble Siglec receptor that binds one or more Siglec-9 ligands, a Siglec-Fc fusion protein, a Siglec immunoadhesin, an antisense molecule, an siRNA, a small molecule inhibitor, a protein, and a peptide. In some embodiments, the agent is an isolated anti-Siglec-9 antibody of the present disclosure. In some embodiments, the one or more immune cells are selected from dendritic cells, macrophages, neutrophils, NK cells, microglia, T cells, T helper cells, cytotoxic T cells, and any combination thereof.

[0398] Other aspects of the present disclosure relate to a method of assessing responsiveness of a subject in need thereof to an agent that binds or interacts with Siglec-9, the method comprising: a. measuring the expression levels of $CD45^+$ and $CD14^+$ on non-tumorigenic myeloid cells in a blood sample obtained from the subject prior to administering to the subject an anti-Siglec-9 antibody; b. administering to the subject a therapeutically effective amount of the agent; and c. measuring the expression levels of $CD45^+$ and $CD14^+$ on non-tumorigenic myeloid cells in a blood sample obtained from the subject after administration of the anti-Siglec-9 antibody, wherein a reduction in the levels of $CD45^+$ $CD14^+$ on non-tumorigenic myeloid cells after administration of the anti-Siglec-9 antibody indicates the subject is responsive to the agent. In some embodiments, the method of assessing responsiveness further comprises administering one or more additional therapeutically effective amounts of the agent. In some embodiments that may be combined with any of the preceding embodiments, the agent is selected from the group consisting of an antibody, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a Siglec-9 immunoadhesin, a soluble Siglec receptor, a Siglec-Fc fusion protein, a Siglec immunoadhesin, an antisense molecule, an siRNA, a small molecule inhibitor, a protein, and a peptide. Any suitable methods for obtaining a sample, such as a blood sample, may be used. In some embodiments, the method of assessing responsiveness further comprises administering one or more additional therapeutically effective amounts of the agent. In some embodiments, the agent is selected from the group consisting of an antibody, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a Siglec-9 immunoadhesin, a soluble Siglec receptor, a Siglec-Fc fusion protein, a Siglec immunoadhesin, an antisense molecule, an siRNA, a small molecule inhibitor, a protein, and a peptide. In some embodiments, the agent is an isolated anti-Siglec-9 antibody or anti-Siglec-9 antibody conjugate. In some embodiments, the anti-Siglec-9 antibody is the anti-Siglec-9 antibody of the present disclosure. In some embodiments, the subject is human.

[0399] In some embodiments, the agent is an agonist anti-Siglec-9 antibody. In some embodiments, the agent is a transient agonist anti-Siglec-9 antibody of the present disclosure that initially acts as an agonist and then acts as a long-term antagonist antibody. In some embodiments, the agent is an inert anti-Siglec-9 antibody. In some embodiments, the agent is an antagonist anti-Siglec-9 antibody. In some embodiments, the anti-Siglec-9 antibody reduces cellular (*e.g.*, cell surface, intracellular, or total) levels of Siglec-9. In some embodiments, the anti-Siglec-9 antibody induces degradation of Siglec-9. In some embodiments, the anti-Siglec-9 antibody induces cleavage of Siglec-9. In some embodiments, the anti-Siglec-9 antibody induces internalization of Siglec-9. In some embodiments, the anti-Siglec-9 antibody induces shedding of Siglec-9. In some embodiments, the anti-Siglec-9 antibody induces downregulation of Siglec-9 expression. In some embodiments, the anti-Siglec-9 antibody inhibits interaction (*e.g.*, binding) between Siglec-9 and one or more Siglec-9 ligands. In some embodiments, the anti-Siglec-9 antibody transiently activates and then induces degradation of Siglec-9. In some embodiments, the anti-Siglec-9 antibody transiently activates and then induces cleavage of Siglec-9. In some embodiments, the anti-Siglec-9 antibody transiently activates and then induces internalization of Siglec-9. In some embodiments, the anti-Siglec-9 antibody transiently activates and then induces shedding of Siglec-9. In some embodiments, the anti-Siglec-9 antibody transiently activates and then induces downregulation of Siglec-9 expression. In some embodiments, the anti-Siglec-9 antibody transiently activates and then induces decreased expression of Siglec-9. In certain embodiments, the individual has a Siglec-9 variant allele.

[0400] As disclosed herein, agents of the present disclosure that bind or interact with Siglec-9, such as anti-Siglec-9 antibodies of the present disclosure, may further be used for decreasing the activity, functionality, or survival of regulatory T cells, tumor-imbedded immunosuppressor dendritic cells, tumor-imbedded immunosuppressor macrophages, tumor-imbedded immunosuppressor neutrophils, tumor-imbedded immunosuppressor NK cells, myeloid derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, acute myeloid leukemia (AML) cells, chronic lymphocytic leukemia (CLL) cell, and/or chronic myeloid leukemia (CML) cells. In some embodiments, the present disclosure provides methods of decreasing the activity, functionality, or survival of regulatory T cells, tumor-imbedded immunosuppressor dendritic cells, tumor-imbedded immunosuppressor macrophages, tumor-imbedded immunosuppressor neutrophils, tumor-imbedded immunosuppressor NK cells, myeloid-derived suppressor cells, tumor-associated macrophages, tumor-associated neutrophils, tumor-associated NK cells, acute myeloid leukemia (AML) cells, chronic lymphocytic leukemia (CLL) cell, or chronic myeloid leukemia (CML) cells in an individual in need thereof, by administering to the individual a therapeutically effective amount of an agent that binds or interacts with Siglec-9. In some embodiments, the agent is selected from an antibody, an antagonist antibody, an inert antibody, an agonist antibody, a Siglec-9

ligand, a Siglec-9 ligand agonist fragment, a Siglec-9 immunoadhesin, a Siglec-9 ligand mimetic, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a soluble Siglec receptor that binds one or more Siglec-9 ligands, a Siglec-Fc fusion protein that binds one or more Siglec-9 ligands, and a small molecule compound. In some embodiments, the agent is an isolated anti-Siglec-9 antibody or anti-Siglec-9 antibody conjugate of the present disclosure. In some embodiments, the anti-Siglec-9 antibody conjugate comprises an anti-Siglec-9 antibody conjugated to a detectable marker, a toxin, or a therapeutic agent.

[0401] As disclosed herein, agents of the present disclosure that bind or interact with Siglec-9, such as anti-Siglec-9 antibodies of the present disclosure, may be used for decreasing cellular levels of Siglec-9 on one or more cells *in vitro* or *in vivo*, including without limitation, red blood cells, bacterial cells, apoptotic cells, nerve cells, glia cells, microglia, astrocytes, tumor cells, viruses, dendritic cells, Siglec-9 ligands bound to beta amyloid plaques, Siglec-9 ligands bound to Tau tangles, Siglec-9 ligands on disease-causing proteins, Siglec-9 ligands on disease-causing peptides, macrophages, neutrophils, natural killer cells, monocytes, T cells, T helper cells, cytotoxic T cells, B cells, tumor-imbedded immunosuppressor dendritic cells, tumor-imbedded immunosuppressor macrophages, myeloid-derived suppressor cells, and/or regulatory T cells. In some embodiments, the present disclosure provides methods of decreasing cellular levels of Siglec-9 on one or more cells in an individual in need thereof, by administering to the individual a therapeutically effective amount of an agent that binds or interacts with Siglec-9. In some embodiments, the agent is selected from an antibody, an antagonist antibody, an inert antibody, an agonist antibody, a Siglec-9 ligand, a Siglec-9 ligand agonist fragment, a Siglec-9 immunoadhesin, a Siglec-9 ligand mimetic, a soluble Siglec-9 receptor, a Siglec-9-Fc fusion protein, a soluble Siglec receptor that binds one or more Siglec-9 ligands, a Siglec-Fc fusion protein that binds one or more Siglec-9 ligands, and a small molecule compound. In some embodiments, the agent is an isolated anti-Siglec-9 antibody or anti-Siglec-9 antibody conjugate of the present disclosure. In some embodiments, the anti-Siglec-9 antibody conjugate comprises an anti-Siglec-9 antibody conjugated to a detectable marker, a toxin, or a therapeutic agent. In some embodiments, the one or more cells are selected from red blood cells, bacterial cells, apoptotic cells, nerve cells, glia cells, microglia, astrocytes, tumor cells, viruses, dendritic cells, Siglec-9 ligands bound to beta amyloid plaques, Siglec-9 ligands bound to Tau tangles, Siglec-9 ligands on disease-causing proteins, Siglec-9 ligands on disease-causing peptides, macrophages, neutrophils, natural killer cells, monocytes, T cells, T helper cells, cytotoxic T cells, B cells, tumor-imbedded immunosuppressor dendritic cells, tumor-imbedded immunosuppressor macrophages, myeloid-derived suppressor cells, regulatory T cells, and any combination thereof.

[0402] Cellular levels of Siglec-9 may refer to, without limitation, cell surface levels of Siglec-9, intracellular levels of Siglec-9, and total levels of Siglec-9. In some embodiments, a decrease in

cellular levels of Siglec-9 comprises decrease in cell surface levels of Siglec-9. As used herein, an anti-Siglec-9 antibody decreases cell surface levels of Siglec-9 if it induces a decrease of 21% or more in cell surface levels of Siglec-9 as measured by any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art. In some embodiments, a decrease in cellular levels of Siglec-9 comprises a decrease in intracellular levels of Siglec-9. As used herein, an anti-Siglec-9 antibody decreases intracellular levels of Siglec-9 if it induces a decrease of 21% or more in intracellular levels of Siglec-9 as measured by any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art. In some embodiments, a decrease in cellular levels of Siglec-9 comprises a decrease in total levels of Siglec-9. As used herein, an anti-Siglec-9 antibody decreases total levels of Siglec-9 if it induces a decrease of 21% or more in total levels of Siglec-9 as measured by any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art. In some embodiments, the anti-Siglec-9 antibodies induce Siglec-9 degradation, Siglec-9 cleavage, Siglec-9 internalization, Siglec-9 shedding, and/or downregulation of Siglec-9 expression. In some embodiments, cellular levels of Siglec-9 are measured on primary cells (*e.g.*, dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, and macrophages) or on cell lines utilizing an *in vitro* cell assay.

[0403] In some embodiments the individual has a heterozygous variant of Siglec-9.

[0404] In some embodiments, the methods of the present disclosure may further involve the coadministration of Siglec-9 agents, such as anti-Siglec-9 antibodies or bispecific anti-Siglec-9 antibodies, with antibodies that bind to pattern recognition receptors, antibodies that bind to Toll-like receptors, antibodies that bind to damage-associated molecular pattern (DAMP) receptors, and/or antibodies that bind to cytokine or antibodies to interleukins).

[0405] In some embodiments, the methods of the present disclosure may further include administering to the individual at least one antibody that specifically binds to an inhibitory checkpoint molecule, and/or one or more standard or investigational anti-cancer therapies. In some embodiments, the at least one antibody that specifically binds to an inhibitory checkpoint molecule is administered in combination with the anti-Siglec-9 antibody. In some embodiments, the at least one antibody that specifically binds to an inhibitory checkpoint molecule is selected from an anti-PD-L1 antibody, an anti-CTLA4 antibody, an anti-PD-L2 antibody, an anti-PD-1 antibody, an anti-B7-H3 antibody, an anti-B7-H4 antibody, and anti-HVEM antibody, an anti- B- and T-lymphocyte attenuator (BTLA) antibody, an anti-Killer inhibitory receptor (KIR) antibody, an anti-GAL9 antibody, an anti-TIM-1 antibody, an anti-TIM3 antibody, an anti-TIM-4 antibody, an anti-A2AR antibody, an anti-CD39 antibody, an anti-CD73 antibody, an anti-LAG-3 antibody, an anti-phosphatidylserine antibody, an anti-CD27 antibody, an anti-CD30 antibody, an anti-TNFa antibody, an anti-CD33 antibody, an anti-Siglec-5 antibody, an anti-Siglec-7 antibody, an anti-Siglec-11 antibody, an

antagonistic anti-TREM1 antibody, an antagonistic anti-TREM2 antibody, an anti-TIGIT antibody, an anti-VISTA antibody, an anti-CD2 antibody, an anti-CD5 antibody, and any combination thereof. In some embodiments, the one or more standard or investigational anti-cancer therapies are selected from radiotherapy, cytotoxic chemotherapy, targeted therapy, imatinib therapy, trastuzumab therapy, etanercept therapy, adoptive cell transfer (ACT) therapy, chimeric antigen receptor T cell transfer (CAR-T) therapy, vaccine therapy, and cytokine therapy.

[0406] In some embodiments, the methods of the present disclosure may further include administering to the individual at least one antibody that specifically binds to an inhibitory cytokine. In some embodiments, the at least one antibody that specifically binds to an inhibitory cytokine is administered in combination with the Siglec-9 agent, such as an anti-Siglec-9 antibody. In some embodiments, the at least one antibody that specifically binds to an inhibitory cytokine is selected from an anti-CCL2 antibody, an anti-CSF-1 antibody, an anti-IL-2 antibody, and any combination thereof.

[0407] In some embodiments, the methods of the present disclosure may further include administering to the individual at least one agonistic antibody that specifically binds to a stimulatory checkpoint protein. In some embodiments, the at least one agonistic antibody that specifically binds to a stimulatory checkpoint protein is administered in combination with the Siglec-9 agent, such as an anti-Siglec-9 antibody. In some embodiments, the at least one agonistic antibody that specifically binds to a stimulatory checkpoint protein is selected from an agonist anti-CD40 antibody, an agonist anti-OX40 antibody, an agonist anti-ICOS antibody, an agonist anti-CD28 antibody, an agonistic anti-TREM1 antibody, an agonistic anti-TREM2 antibody, an agonist anti-CD137/4-1BB antibody, an agonist anti-CD27 antibody, an agonist anti-glucocorticoid-induced TNFR-related protein GITR antibody, an agonist anti-CD30 antibody, an agonist anti-BTLA antibody, an agonist anti-HVEM antibody, an agonist anti-CD2 antibody, an agonist anti-CD5 antibody, and any combination thereof.

[0408] In some embodiments, the methods of the present disclosure may further include administering to the individual at least one stimulatory cytokine. In some embodiments, the at least one stimulatory cytokine is administered in combination with the Siglec-9 agent, such as an anti-Siglec-9 antibody. In some embodiments, the at least one stimulatory cytokine is selected from FN-α4, IFN-β, IL-1β, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-23, CXCL10, IL-33, MCP-1, MIP-1-beta, and any combination thereof.

Dementia

[0409] Dementia is a non-specific syndrome (*i.e.*, a set of signs and symptoms) that presents as a serious loss of global cognitive ability in a previously unimpaired person, beyond what might be expected from normal ageing. Dementia may be static as the result of a unique global brain injury.

Alternatively, dementia may be progressive, resulting in long-term decline due to damage or disease in the body. While dementia is much more common in the geriatric population, it can also occur before the age of 65. Cognitive areas affected by dementia include, without limitation, memory, attention span, language, and problem solving. Generally, symptoms must be present for at least six months to before an individual is diagnosed with dementia.

[0410] Exemplary forms of dementia include, without limitation, frontotemporal dementia, Alzheimer's disease, vascular dementia, semantic dementia, and dementia with Lewy bodies.

[0411] In some embodiments, administering a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, can prevent, reduce the risk, and/or treat dementia. In some embodiments, administering a Siglec-9 agent, such as an anti-Siglec-9 antibody, may modulate one or more Siglec-9 activities in an individual having dementia.

Frontotemporal dementia

[0412] Frontotemporal dementia (FTD) is a condition resulting from the progressive deterioration of the frontal lobe of the brain. Over time, the degeneration may advance to the temporal lobe. Second only to Alzheimer's disease (AD) in prevalence, FTD accounts for 20% of pre-senile dementia cases. The clinical features of FTD include memory deficits, behavioral abnormalities, personality changes, and language impairments (Cruts, M. & Van Broeckhoven, C., Trends Genet. 24:186-194 (2008); Neary, D., et al., Neurology 51:1546-1554 (1998); Ratnavalli, E., Brayne, C., Dawson, K. & Hodges, J. R., Neurology 58:1615-1621 (2002)).

[0413] A substantial portion of FTD cases are inherited in an autosomal dominant fashion, but even in one family, symptoms can span a spectrum from FTD with behavioral disturbances, to Primary Progressive Aphasia, to Cortico-Basal Ganglionic Degeneration. FTD, like most neurodegenerative diseases, can be characterized by the pathological presence of specific protein aggregates in the diseased brain. Historically, the first descriptions of FTD recognized the presence of intraneuronal accumulations of hyperphosphorylated Tau protein in neurofibrillary tangles or Pick bodies. A causal role for the microtubule associated protein Tau was supported by the identification of mutations in the gene encoding the Tau protein in several families (Hutton, M., et al., Nature 393:702-705 (1998). However, the majority of FTD brains show no accumulation of hyperphosphorylated Tau but do exhibit immunoreactivity to ubiquitin (Ub) and TAR DNA binding protein (TDP43) (Neumann, M., et al., Arch. Neurol. 64:1388-1394 (2007)). A majority of those FTD cases with Ub inclusions (FTD-U) were shown to carry mutations in the Progranulin gene.

[0414] In some embodiments, administering a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, can prevent, reduce the risk, and/or treat FTD. In some embodiments, administering a Siglec-9 agent, such as an anti-Siglec-9 antibody, may modulate one or more Siglec-9 activities in an individual having FTD.

Alzheimer's disease

[0415] Alzheimer's disease (AD), is the most common form of dementia. There is no cure for the disease, which worsens as it progresses, and eventually leads to death. Most often, AD is diagnosed in people over 65 years of age. However, the less-prevalent early-onset Alzheimer's can occur much earlier.

[0416] Common symptoms of Alzheimer's disease include, behavioral symptoms, such as difficulty in remembering recent events; cognitive symptoms, confusion, irritability and aggression, mood swings, trouble with language, and long-term memory loss. As the disease progresses bodily functions are lost, ultimately leading to death. Alzheimer's disease develops for an unknown and variable amount of time before becoming fully apparent, and it can progress undiagnosed for years.

[0417] In some embodiments, administering a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, can prevent, reduce the risk, and/or treat Alzheimer's disease. In some embodiments, administering a Siglec-9 agent, such as an anti-Siglec-9 antibody, may modulate one or more Siglec-9 activities in an individual having Alzheimer's disease.

Parkinson's disease

[0418] Parkinson's disease, which may be referred to as idiopathic or primary parkinsonism, hypokinetic rigid syndrome (HRS), or paralysis agitans, is a neurodegenerative brain disorder that affects motor system control. The progressive death of dopamine-producing cells in the brain leads to the major symptoms of Parkinson's. Most often, Parkinson's disease is diagnosed in people over 50 years of age. Parkinson's disease is idiopathic (having no known cause) in most people. However, genetic factors also play a role in the disease.

[0419] Symptoms of Parkinson's disease include, without limitation, tremors of the hands, arms, legs, jaw, and face, muscle rigidity in the limbs and trunk, slowness of movement (bradykinesia), postural instability, difficulty walking, neuropsychiatric problems, changes in speech or behavior, depression, anxiety, pain, psychosis, dementia, hallucinations, and sleep problems.

[0420] In some embodiments, administering a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, can prevent, reduce the risk, and/or treat Parkinson's disease. In some embodiments, administering a Siglec-9 agent, such as an anti-Siglec-9 antibody, may modulate one or more Siglec-9 activities in an individual having Parkinson's disease.

Amyotrophic lateral sclerosis (ALS)

[0421] As used herein, amyotrophic lateral sclerosis (ALS) or, motor neuron disease or, Lou Gehrig's disease are used interchangeably and refer to a debilitating disease with varied etiology characterized by rapidly progressive weakness, muscle atrophy and fasciculations, muscle spasticity,

difficulty speaking (dysarthria), difficulty swallowing (dysphagia), and difficulty breathing (dyspnea).

[0422] It has been shown that Progranulin plays a role in ALS (Schymick, JC et al., (2007) J Neurol Neurosurg Psychiatry.;78:754-6) and protects again the damage caused by ALS causing proteins such as TDP-43 (Laird, AS et al., (2010). PLoS ONE 5: e13368). It was also demonstrated that pro-NGF induces p75 mediated death of oligodendrocytes and corticospinal neurons following spinal cord injury (Beatty et al., Neuron (2002),36, pp. 375-386; Giehl et al, Proc. Natl. Acad. Sci USA (2004), 101, pp 6226-30).

[0423] In some embodiments, administering a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, can prevent, reduce the risk, and/or treat ALS. In some embodiments, administering a Siglec-9 agent, such as an anti-Siglec-9 antibody, may modulate one or more Siglec-9 activities in an individual having amyotrophic lateral sclerosis.

Huntington's disease

[0424] Huntington's disease (HD) is an inherited neurodegenerative disease caused by an autosomal dominant mutation in the Huntingtin gene (HTT). Expansion of a cytokine-adenine-guanine (CAG) triplet repeat within the Huntingtin gene results in production of a mutant form of the Huntingtin protein (Htt) encoded by the gene. This mutant Huntingtin protein (mHtt) is toxic and contributes to neuronal death. Symptoms of Huntington's disease most commonly appear between the ages of 35 and 44, although they can appear at any age.

[0425] Symptoms of Huntington's disease, include, without limitation, motor control problems, jerky, random movements (chorea), abnormal eye movements, impaired balance, seizures, difficulty chewing, difficulty swallowing, cognitive problems, altered speech, memory deficits, thinking difficulties, insomnia, fatigue, dementia, changes in personality, depression, anxiety, and compulsive behavior.

[0426] In some embodiments, administering a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, can prevent, reduce the risk, and/or treat Huntington's disease (HD). In some embodiments, administering a Siglec-9 agent, such as an anti-Siglec-9 antibody, may modulate one or more Siglec-9 activities in an individual having Huntington's disease.

Taupathy disease

[0427] Taupathy diseases, or Tauopathies, are a class of neurodegenerative disease caused by aggregation of the microtubule-associated protein tau within the brain. Alzheimer's disease (AD) is the most well-known taupathy disease, and involves an accumulation of tau protein within neurons in the form of insoluble neurofibrillary tangles (NFTs). Other taupathy diseases and disorders include

progressive supranuclear palsy, dementia pugilistica (chromic traumatic encephalopathy), frontotemporal dementia and parkinsonism linked to chromosome 17, Lytico-Bodig disease (Parkinson-dementia complex of Guam), Tangle-predominant dementia, Ganglioglioma and gangliocytoma, Meningioangiomatosis, Subacute sclerosing panencephalitis, lead encephalopathy, tuberous sclerosis, Hallervorden-Spatz disease, lipofuscinosis, Pick's disease, corticobasal degeneration, Argyrophilic grain disease (AGD), Huntington's disease, and frontotemporal lobar degeneration.

[0428] In some embodiments, administering a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, can prevent, reduce the risk, and/or treat taupathy disease. In some embodiments, administering a Siglec-9 agent, such as an anti-Siglec-9 antibody, may modulate one or more Siglec-9 activities in an individual having a taupathy disease.

Multiple sclerosis

[0429] Multiple sclerosis (MS) can also be referred to as disseminated sclerosis or encephalomyelitis disseminata. MS is an inflammatory disease in which the fatty myelin sheaths around the axons of the brain and spinal cord are damaged, leading to demyelination and scarring as well as a broad spectrum of signs and symptoms. MS affects the ability of nerve cells in the brain and spinal cord to communicate with each other effectively. Nerve cells communicate by sending electrical signals called action potentials down long fibers called axons, which are contained within an insulating substance called myelin. In MS, the body's own immune system attacks and damages the myelin. When myelin is lost, the axons can no longer effectively conduct signals. MS onset usually occurs in young adults, and is more common in women.

[0430] Symptoms of MS include, without limitation, changes in sensation, such as loss of sensitivity or tingling; pricking or numbness, such as hypoesthesia and paresthesia; muscle weakness; clonus; muscle spasms; difficulty in moving; difficulties with coordination and balance, such as ataxia; problems in speech, such as dysarthria, or in swallowing, such as dysphagia; visual problems, such as nystagmus, optic neuritis including phosphenes, and diplopia; fatigue; acute or chronic pain; and bladder and bowel difficulties; cognitive impairment of varying degrees; emotional symptoms of depression or unstable mood; Uhthoff's phenomenon, which is an exacerbation of extant symptoms due to an exposure to higher than usual ambient temperatures; and Lhermitte's sign, which is an electrical sensation that runs down the back when bending the neck.

[0431] In some embodiments, administering a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure, can prevent, reduce the risk, and/or treat multiple sclerosis. In some embodiments, administering a Siglec-9 agent, such as an anti-Siglec-9 antibody, may modulate one or more Siglec-9 activities in an individual having multiple sclerosis.

Cancer

[0432] Further aspects of the present disclosure provide methods for preventing, reducing risk, or treating cancer, by administering to an individual in need thereof a therapeutically effective amount of a Siglec-9 agent of the present disclosure, such as an isolated anti-Siglec-9 antibody of the present disclosure. Any of the isolated antibodies of the present disclosure may be used in these methods. In some embodiments, the isolated antibody is an agonist antibody of the present disclosure. In other embodiments, the isolated antibody is an antagonist antibody of the present disclosure. In other embodiments, the isolated antibody is an inert antibody of the present disclosure. In other embodiments, the isolated antibody is an antibody conjugate of the present disclosure.

[0433] As disclosed herein, the tumor microenvironment is known to contain a heterogeneous immune infiltrate, which includes T lymphocytes, macrophages, neutrophils, NK cells, and cells of myeloid/granulocytic lineage. The presence and activity of T-regulatory cells, tumor-imbedded immunosuppressor myeloid cells, and/or M2-macrophages, M2-neutrophils, and/or M2-NK cells in tumors is associated with poor prognosis. In contrast, the presence and activity of cytotoxic T cells is beneficial for cancer therapy. Therapies that directly or indirectly enhance the activity of cytotoxic T cells and reduce the number and activity of the various immunosuppressor cells, are expected to provide significant therapeutic benefit. A seminal preclinical study has shown synergies between drugs that target immunosuppressor cells (*e.g.,* CSF1/CSF1R blocking antibodies) and immune checkpoint blocking antibodies that activate cytotoxic T cells, indicating that manipulating both cell types shows efficacy in tumor models where individual therapies are poorly effective (Zhu Y; Cancer Res. 2014 Sep 15; 74(18):5057-69). Therefore, in some embodiments, blocking Siglec-9, which is expressed on myeloid cells, subset of T cells, and tumor-associated immune cells, may stimulate beneficial anti-tumor immune response, resulting in a therapeutic anti-tumor immune response.

[0434] In some embodiments, the methods for preventing, reducing risk, or treating an individual having cancer further include administering to the individual at least one antibody that specifically binds to an inhibitory checkpoint molecule. Examples of antibodies that specifically bind to an inhibitory checkpoint molecule include, without limitation, an anti-PD-L1 antibody, an anti-CTLA4 antibody, an anti-PD-L2 antibody, an anti-PD-1 antibody, an anti-B7-H3 antibody, an anti-B7-H4 antibody, and anti-HVEM antibody, an anti- B- and T-lymphocyte attenuator (BTLA) antibody, an anti-Killer inhibitory receptor (KIR) antibody, an anti-GAL9 antibody, an anti-TIM-1 antibody, an anti-TIM3 antibody, an anti-TIM-4 antibody, an anti-A2AR antibody, an anti-CD39 antibody, an anti-CD73 antibody, an anti-LAG-3 antibody, an anti-phosphatidylserine antibody, an anti-CD27 antibody, an anti-CD30 antibody, an anti-TNFa antibody, an anti-CD33 antibody, an anti-Siglec-5 antibody, an anti-Siglec-7 antibody, an anti-Siglec-11 antibody, an antagonistic anti-TREM1 antibody, an antagonistic anti-TREM2 antibody, an anti-TIGIT antibody, an anti-VISTA antibody, an

anti-CD2 antibody, an anti-CD5 antibody, and any combination thereof. In some embodiments, the at least one antibody that specifically binds to an inhibitory checkpoint molecule is administered in combination with a Siglec-9 agent of the present disclosure, such as an antagonist anti-Siglec-9 antibody of the present disclosure.

[0435] In some embodiments, a cancer to be prevented or treated by the methods of the present disclosure includes, without limitation, squamous cell cancer (e.g., epithelial squamous cell cancer), lung cancer including small-cell lung cancer, non-small cell lung cancer, adenocarcinoma of the lung and squamous carcinoma of the lung, cancer of the peritoneum, hepatocellular cancer, gastric or stomach cancer including gastrointestinal cancer and gastrointestinal stromal cancer, pancreatic cancer, glioblastoma, cervical cancer, ovarian cancer, liver cancer, bladder cancer, cancer of the urinary tract, hepatoma, breast cancer, colon cancer, rectal cancer, colorectal cancer, endometrial or uterine carcinoma, salivary gland carcinoma, kidney or renal cancer, prostate cancer, vulval cancer, thyroid cancer, hepatic carcinoma, anal carcinoma, penile carcinoma, melanoma, superficial spreading melanoma, lentigo maligna melanoma, acral lentiginous melanomas, nodular melanomas, multiple myeloma and B cell lymphoma; chronic lymphocytic leukemia (CLL); acute lymphoblastic leukemia (ALL); hairy cell leukemia; chronic myeloblastic leukemia; and post-transplant lymphoproliferative disorder (PTLD), as well as abnormal vascular proliferation associated with phakomatoses, edema (such as that associated with brain tumors), Meigs' syndrome, brain, as well as head and neck cancer, and associated metastases. In some embodiments, the cancer is colorectal cancer. In some embodiments, the cancer is selected from non-small cell lung cancer, glioblastoma, neuroblastoma, renal cell carcinoma, bladder cancer, ovarian cancer, melanoma, breast carcinoma, gastric cancer, and hepatocellular carcinoma. In some embodiments, the cancer is triple-negative breast carcinoma. In some embodiments, the cancer may be an early stage cancer or a late stage cancer. In some embodiments, the cancer may be a primary tumor. In some embodiments, the cancer may be a metastatic tumor at a second site derived from any of the above types of cancer.

[0436] In some embodiments, Siglec-9 agents of the present disclosure, such as anti-Siglec-9 antibodies of the present disclosure, may be used for preventing, reducing risk, or treating cancer, including, without limitation, bladder cancer breast cancer, colon and rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, and thyroid cancer.

[0437] In some embodiments, the present disclosure provides methods of preventing, reducing risk, or treating an individual having cancer, by administering to the individual a therapeutically effective amount of a Siglec-9 agent of the present disclosure, such as an anti-Siglec-9 antibody of the present disclosure.

[0438] In some embodiments, the method further includes administering to the individual at least one antibody that specifically binds to an inhibitory immune checkpoint molecule, and/or another standard or investigational anti-cancer therapy. In some embodiments, the at least one antibody that specifically binds to an inhibitory checkpoint molecule is administered in combination with the Siglec-9 agent, such as an anti-Siglec-9 antibody of the present disclosure. In some embodiments, the at least one antibody that specifically binds to an inhibitory checkpoint molecule is selected from an anti-PD-L1 antibody, an anti-CTLA4 antibody, an anti-PD-L2 antibody, an anti-PD-1 antibody, an anti-B7-H3 antibody, an anti-B7-H4 antibody, and anti-HVEM antibody, an anti- B- and T-lymphocyte attenuator (BTLA) antibody, an anti-Killer inhibitory receptor (KIR) antibody, an anti-GAL9 antibody, an anti-TIM-1 antibody, an anti-TIM3 antibody, an anti-TIM-4 antibody, an anti-A2AR antibody, an anti-CD39 antibody, an anti-CD73 antibody, an anti-LAG-3 antibody, an anti-phosphatidylserine antibody, an anti-CD27 antibody, an anti-CD30 antibody, an anti-TNFa antibody, an anti-CD33 antibody, an anti-Siglec-5 antibody, an anti-Siglec-7 antibody, an anti-Siglec-11 antibody, an antagonistic anti-TREM1 antibody, an antagonistic anti-TREM2 antibody, an anti-TIGIT antibody, an anti-VISTA antibody, an anti-CD2 antibody, an anti-CD5 antibody, and any combination thereof. In some embodiments, the standard or investigational anti-cancer therapy is one or more therapies selected from radiotherapy, cytotoxic chemotherapy, targeted therapy, imatinib (Gleevec®), trastuzumab (Herceptin®), adoptive cell transfer (ACT), chimeric antigen receptor T cell transfer (CAR-T), vaccine therapy, and cytokine therapy.

[0439] In some embodiments, the method further includes administering to the individual at least one antibody that specifically binds to an inhibitory cytokine. In some embodiments, the at least one antibody that specifically binds to an inhibitory cytokine is administered in combination with the Siglec-9 agent, such as an anti-Siglec-9 antibody of the present disclosure. In some embodiments, the at least one antibody that specifically binds to an inhibitory cytokine is selected from an anti-CCL2 antibody, an anti-CSF-1 antibody, an anti-IL-2 antibody, and any combination thereof.

[0440] In some embodiments, the method further includes administering to the individual at least one agonistic antibody that specifically binds to a stimulatory immune checkpoint protein. In some embodiments, the at least one agonistic antibody that specifically binds to a stimulatory checkpoint protein is administered in combination with the Siglec-9 agent, such as an anti-Siglec-9 antibody of the present disclosure. In some embodiments, the at least one agonistic antibody that specifically binds to a stimulatory checkpoint protein is selected from an agonist anti-CD40 antibody, an agonist anti-OX40 antibody, an agonist anti-ICOS antibody, an agonist anti-CD28 antibody, an agonistic anti-TREM1 antibody, an agonistic anti-TREM2 antibody, an agonist anti-CD137/4-1BB antibody, an agonist anti-CD27 antibody, an agonist anti-glucocorticoid-induced TNFR-related protein GITR

antibody, an agonist anti-CD30 antibody, an agonist anti-BTLA antibody, an agonist anti-HVEM antibody, an agonist anti-CD2 antibody, an agonist anti-CD5 antibody, and any combination thereof.

[0441] In some embodiments, the method further includes administering to the individual at least one stimulatory cytokine. In some embodiments, the at least one stimulatory cytokine is administered in combination with the Siglec-9 agent, such as an anti-Siglec-9 antibody of the present disclosure. In some embodiments, the at least one stimulatory cytokine is selected from FN-α4, IFN-β, IL-1β, TNF-α, IL-6, IL-8, CRP, IL-20 family members, LIF, IFN-γ, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, IL-23, CXCL10, IL-33, MCP-1, MIP-1-beta, and any combination thereof.

Kits/Articles of Manufacture

[0442] The present disclosure also provides kits and/or articles of manufacture containing a Siglec-9 agent of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein), or a functional fragment thereof. Kits and/or articles of manufacture of the present disclosure may include one or more containers comprising a purified antibody of the present disclosure. In some embodiments, the kits and/or articles of manufacture further include instructions for use in accordance with the methods of this disclosure. In some embodiments, these instructions comprise a description of administration of the Siglec-9 agent of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein) to prevent, reduce risk, or treat an individual having a disease, disorder, or injury selected from dementia, frontotemporal dementia, Alzheimer's disease, vascular dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, rheumatoid arthritis, wound healing, Crohn's disease, inflammatory bowel disease, ulcerative colitis, obesity, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomartous disorders, sarcoidosis, diseases of aging, seizures, spinal cord injury, traumatic brain injury, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, multiple sclerosis, low bone density, osteoporosis, osteogenesis, osteopetrotic disease, Paget's disease of bone, and cancer including bladder cancer, brain cancer, breast cancer, colon cancer, rectal cancer, endometrial cancer, kidney cancer, renal cell cancer, renal pelvis cancer, leukemia, lung cancer, melanoma, non-Hodgkin's lymphoma, pancreatic cancer, prostate cancer, ovarian cancer, fibrosarcoma, acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), multiple myeloma, polycythemia vera, essential thrombocytosis, primary or idiopathic myelofibrosis, primary or idiopathic myelosclerosis, myeloid-derived tumors, tumors that express Siglec-9, thyroid cancer,

infections, CNS herpes, parasitic infections, Trypanosome infection, Cruzi infection, *Pseudomonas aeruginosa* infection, *Leishmania donovani* infection, group B *Streptococcus* infection, *Campylobacter jejuni* infection, *Neisseria meningiditis* infection, type I HIV, and Haemophilus influenza, according to any methods of this disclosure.

[0443] In some embodiments, the instructions comprise a description of how to detect a Siglec-9 protein, for example in an individual, in a tissue sample, or in a cell. The kit and/or article of manufacture may further comprise a description of selecting an individual suitable for treatment based on identifying whether that individual has the disease and the stage of the disease.

[0444] In some embodiments, the kits and/or articles of manufacture may further include another antibody of the present disclosure (*e.g.,* at least one antibody that specifically binds to an inhibitory checkpoint molecule, at least one antibody that specifically binds to an inhibitory cytokine, and/or at least one agonistic antibody that specifically binds to a stimulatory checkpoint protein) and/or at least one stimulatory cytokine. In some embodiments, the kits and/or articles of manufacture may further include instructions for using the antibody and/or stimulatory cytokine in combination with a Siglec-9 agent of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein), instructions for using a Siglec-9 agent of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein) in combination with an antibody and/or stimulatory cytokine, or instructions for using a Siglec-9 agent of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein) and an antibody and/or stimulatory cytokine, according to any methods of this disclosure.

[0445] The instructions generally include information as to dosage, dosing schedule, and route of administration for the intended treatment. The containers may be unit doses, bulk packages (*e.g.*, multi-dose packages) or sub-unit doses. Instructions supplied in the kits and/or articles of manufacture of the present disclosure are typically written instructions on a label or package insert (*e.g.*, a paper sheet included in the kit), but machine-readable instructions (*e.g.*, instructions carried on a magnetic or optical storage disk) are also acceptable.

[0446] The label or package insert indicates that the composition is used for treating, *e.g.*, a disease of the present disclosure. Instructions may be provided for practicing any of the methods described herein.

[0447] The kits and/or articles of manufacture of this disclosure are in suitable packaging. Suitable packaging includes, but is not limited to, vials, bottles, jars, flexible packaging (*e.g.*, sealed Mylar or plastic bags), and the like. Also contemplated are packages for use in combination with a specific device, such as an inhaler, nasal administration device (*e.g.*, an atomizer) or an infusion device such as a minipump. A kit and/or article of manufacture may have a sterile access port (for example the container may be an intravenous solution bag or a vial having a stopper pierceable by a hypodermic injection needle). The container may also have a sterile access port (*e.g.*, the container

may be an intravenous solution bag or a vial having a stopper pierceable by a hypodermic injection needle). At least one active agent in the composition is a Siglec-9 agent of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein). The container may further comprise a second pharmaceutically active agent.

[0448] Kits and/or articles of manufacture may optionally provide additional components such as buffers and interpretive information. Normally, the kit comprises a container and a label or package insert(s) on or associated with the container.

Diagnostic uses

[0449] The Siglec-9 agents of the present disclosure, such as the isolated antibodies of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein) also have diagnostic utility. This disclosure therefore provides for methods of using the antibodies of this disclosure, or functional fragments thereof, for diagnostic purposes, such as the detection of a Siglec-9 protein in an individual or in tissue samples derived from an individual.

[0450] In some embodiments, the individual is a human. In some embodiments, the individual is a human patient suffering from, or at risk for developing a disease, disorder, or injury of the present disclosure. In some embodiments, the diagnostic methods involve detecting a Siglec-9 protein in a biological sample, such as a biopsy specimen, a tissue, or a cell. A Siglec-9 agent of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein) is contacted with the biological sample and antigen-bound antibody is detected. For example, a biopsy specimen may be stained with an anti-Siglec-9 antibody described herein in order to detect and/or quantify disease-associated cells. The detection method may involve quantification of the antigen-bound antibody. Antibody detection in biological samples may occur with any method known in the art, including immunofluorescence microscopy, immunocytochemistry, immunohistochemistry, ELISA, FACS analysis, immunoprecipitation, or micro-positron emission tomography. In certain embodiments, the antibody is radiolabeled, for example with ^{18}F and subsequently detected utilizing micro-positron emission tomography analysis. Antibody-binding may also be quantified in a patient by non-invasive techniques such as positron emission tomography (PET), X-ray computed tomography, single-photon emission computed tomography (SPECT), computed tomography (CT), and computed axial tomography (CAT).

[0451] In other embodiments, an isolated antibody of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein) may be used to detect and/or quantify, for example, microglia in a brain specimen taken from a preclinical disease model (*e.g.,* a non-human disease model). As such, an isolated antibody of the present disclosure (*e.g.,* an anti-Siglec-9 antibody described herein) may be useful in evaluating therapeutic response after treatment in a model for a nervous system disease or injury such as frontotemporal dementia, Alzheimer's disease, vascular dementia, seizures, retinal

dystrophy, atherosclerotic vascular diseases, Nasu-Hakola disease, or multiple sclerosis, as compared to a control.

[0452] The present disclosure will be more fully understood by reference to the following Examples. They should not, however, be construed as limiting the scope of the present disclosure. All citations throughout the disclosure are hereby expressly incorporated by reference.

EXAMPLES

Example 1: Production, identification, and characterization of anti-Siglec-9 antibodies

Introduction

[0453] The amino acid sequence of human Siglec-9 is set forth below in SEQ ID NO: 1. Human Siglec-9 contains a signal sequence located at amino acid residues 1-17 SEQ ID NO: 1, an extracellular immunoglobulin-like variable-type (IgV) domain located at amino acid residues 20-140 of SEQ ID NO: 1, two Ig-like C2-type domains located at amino acid residues 146-229 and 236-336 of SEQ ID NO: 1, a transmembrane domain located at amino acid residues 348-370 of SEQ ID NO: 1, an ITIM motif 1 located at amino acid residues 431-436 of SEQ ID NO: 1, and a SLAM-like motif located at amino acid residues 454-459 of SEQ ID NO: 1. An alignment of human Siglec-9 with Siglec-9 homologs is shown in **FIG. 1A**.

[0454] Siglec-9 amino acid sequence (SEQ ID NO: 1):

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         10          20          30          40          50
MLLLLLPLLW GRERAEGQTS KLLTMQSSVT VQEGLCVHVP CSFSYPSHGW
         60          70          80          90         100
IYPGPVVHGY WFREGANTDQ DAPVATNNPA RAVWEETRDR FHLLGDPHTK
        110         120         130         140         150
NCTLSIRDAR RSDAGRYFFR MEKGSIKWNY KHHRLSVNVT ALTHRPNILI
        160         170         180         190         200
PGTLESGCPQ NLTCSVPWAC EQGTPPMISW IGTSVSPLDP STTRSSVLTL
        210         220         230         240         250
IPQPQDHGTS LTCQVTFPGA SVTTNKTVHL NVSYPPQNLT MTVFQGDGTV
        260         270         280         290         300
STVLGNGSSL SLPEGQSLRL VCAVDAVDSN PPARLSLSWR GLTLCPSQPS
        310         320         330         340         350
NPGVLELPWV HLRDAAEFTC RAQNPLGSQQ VYLNVSLQSK ATSGVTQGVV
        360         370         380         390         400
GGAGATALVF LSFCVIFVVV RSCRKKSARP AAGVGDTGIE DANAVRGSAS
        410         420         430         440         450
QGPLTEPWAE DSPPDQPPPA SARSSVGEGE LQYASLSFQM VKPWDSRGQE
        460
ATDTEYSEIK IHR
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[0455] The purpose of the following Example was to produce Siglec-9-binding antibodies (*e.g.*, antagonistic antibodies, Siglec-9 specific antibodies) that enhance the beneficial effects of dendritic

cells, monocytes, macrophages, neutrophils, NK cells, T cells, and/or microglia. Antibodies that bind the extracellular domain of Siglec-9, particularly the IgV domain (amino acid residues 20-140 of SEQ ID NO: 1) are generated using mouse hybridoma technology, phage display technology, and yeast display technology. Antibodies are identified and then screened for their ability to compete with Siglec-9 ligands on binding to Siglec-9, to induce Siglec-9 downregulation, to induce Siglec-9 desensitization, to induce Siglec-9 degradation, to induce Siglec-9 targeting to the lysosome, to induce Siglec-9 cleavage, to modulate Siglec-9 signaling and/or one or more functions in cells and in animals *in vivo*, as described in the following Examples. Exemplary ligands bound by Siglec-9 are depicted in **FIG. 2** and **FIG. 3**.

[0456] For example, anti-Siglec-9 antibodies are selected that target the IgV domain (amino acid residues 20-140) of Siglec-9. The IgV domain binds to sialic acid targets, and this binding can be blocked with the antibody. Thus, amino acid residues 20-140 correspond to a Siglec-9 peptide target for antibodies that will block binding of Siglec-9 to one or more endogenous targets (*e.g.*, ligands).

[0457] Another approach for identifying a useful site within human Siglec-9 protein is by selecting antibodies targeting sites that are not present on Siglec-9m as compared to Siglec-9M, which are generally found within the IgV domain. Siglec-9m is not able to inhibit clearance of the amyloid beta peptide. Another approach for identifying useful antibodies is to select for antibodies that decrease the level of Siglec-9 on the cell surface of monocytes, macrophages, neutrophils, NK cells, dendritic cells, microglia, and/or T cells.

[0458] As described herein, nine anti-Siglec-9 antibodies were identified and characterized.

Results

Anti-Siglec-9 antibody production

Immunization procedure

[0459] Rapid prime method: Four 50-day old female BALB/c mice were immunized using the following procedure. A series of subcutaneous aqueous injections containing human Siglec-9 antigen but no adjuvant was given over a period of 19 days. Mice were housed in a ventilated rack system from Lab Products. All four mice were euthanized on Day 19 and lymphocytes were harvested for hybridoma cell line generation.

[0460] Standard method: Four 50-day old female BALB/c or NZB/W mice were immunized using the following procedure. Mice were housed in a ventilated rack system from Lab Products. Mice were injected intraperitoneally every 3 weeks with a human Siglec-9 antigen mixed in CpG-ODN adjuvant at 25 μg protein antigen per mouse (total volume 125 μL per mouse). Test bleeds were done by saphenous vein lancing seven days after the second boost. The test bleed (immune sera) was tested by indirect ELISA assay to determine the best two responding mice for the fusion. The mice may require a 3rd and 4th boost and another test bleed 7 days after boost to assess titre before fusion.

When the antibody titre is high enough the best two responding mice are given a final intravenous boost via lateral tail vein. Four days after the IV boost the mice were euthanized for fusion. The spleens were harvested and lymphocytes isolated from the spleen were used in the fusion process to produce hybridomas.

Hybridoma development

[0461] Lymphocytes were isolated and fused with murine SP2/0 myeloma cells in the presence of poly-ethylene glycol (PEG 1500) as per standard Roche Protocol. Fused cells were cultured using a single-step cloning method (HAT selection). This method uses a semi-solid methylcellulose-based HAT selective medium to combine the hybridoma selection and cloning into one step. Single cell-derived hybridomas grow to form monoclonal colonies on the semi-solid media. Ten days after the fusion event, 948 of the resulting hybridoma clones were transferred to 96-well tissue culture plates and grown in HT containing medium until mid-log growth was reached (5 days).

Hybridoma screening

[0462] Tissue culture supernatants from the 948 hybridomas were tested by indirect ELISA on screening antigen (Primary Screening) and probed for both IgG and IgM antibodies using a Goat anti-IgG/IgM(H&L)-HRP secondary and developed with TMB substrate. Clones >0.2 OD in this assay were taken to the next round of testing. Positive cultures were retested on screening antigen to confirm secretion and on an irrelevant antigen (Human Transferrin) to eliminate non-specific or "sticky" mAbs and rule out false positives. All clones of interest were isotyped by antibody trapping ELISA to determine if they are IgG or IgM isotype.

Hybridoma cell culture

[0463] The hybridoma cell lines of interest were maintained in culture in 24-well culture plates for 32 days post transfer to 96-well plates. This is referred to as the stability period and tests whether clones remain stable and secreting. During this stability period time temporary frozen cell line back up is made of all the clones of interest for -80°C storage (viable 6 months). Hybridomas were periodically tested during this time period for secretion and specificity.

Subcloning

[0464] The top hybridoma cell lines (clones) were subcloned to ensure monoclonality. Subcloning was performed by plating parental clones out again using the single-step cloning system. Between 24 and 90 subclones were transferred to 96-well culture plates. Subclones were screened by indirect ELISA and antibody trapping ELISA. The top subclones for each parent were taken for expansion in culture. Any parental clones that were <50% clonal had a second round of subcloning performed.

[0465] The antibodies were then screened for Siglec-9 binding. Antibodies that were positive for binding to human Siglec-9 were tested for ability to block ligand binding and ability to reduce surface

levels of Siglec-9 in multiple cell types. Six Siglec-9 antibodies were identified. The bin and isotype category are listed in **Table 1**.

Table 1: Anti-Siglec-9 antibodies

Ab ID	Bin	Ab Isotype
2D4	1	mIgG1
2D5	5	mIgG1
5B1	4	mIgG1
6B2	3	mIgG1/2b*
6D8	3	mIgG2b
7H12	5	mIgG1/2a*

Antibody heavy chain and light chain variable domain sequences

[0466] Using standard techniques, the amino acid sequences encoding the light chain variable and the heavy chain variable domains of the generated antibodies were determined. The EU or Kabat light chain HVR sequences of the antibodies are set forth in **Table 2**. The EU or Kabat heavy chain HVR sequences of the antibodies are set forth in **Table 3**. The EU or Kabat light chain framework (FR) sequences of the antibodies are set forth in **Table 4A**. The EU or Kabat heavy chain framework (FR) sequences of the antibodies are set forth in **Table 4B**.

Table 2: EU or Kabat light chain HVR sequences of anti-Siglec-9 antibodies

Ab	HVR L1	HVR L2	HVR L3
2D4	RASQEISGYLG (SEQ ID NO:6)	STSTLDS (SEQ ID NO:10)	LQYASYPPT (SEQ ID NO:14)
2D5	KSSQSLLDSDGKTYLN (SEQ ID NO:7)	LVCKLDS (SEQ ID NO:11)	WQGTHFPQT (SEQ ID NO:15)
5B1	KSSQSLLYTNGKTYLN (SEQ ID NO:8)	LVSKLES (SEQ ID NO:12)	LQATHFPLT (SEQ ID NO:16)
6D8	HTTRGIYWYKG (SEQ ID NO:9)	CARNGEG (SEQ ID NO:13)	AQFYQFPWT (SEQ ID NO:17)
7H12	KSSQSLLYTNGKTYLN (SEQ ID NO:8)	LVSKLES (SEQ ID NO:12)	LQAPHFPLT (SEQ ID NO:18)
5C6	SSSQSLVHSNGNTYLH (SEQ ID NO:172)	KVSNRFS (SEQ ID NO:174)	SQNTHVPLT (SEQ ID NO:176)
12B12	RASENVDSYGISFMH (SEQ ID NO:173)	RASNLES (SEQ ID NO:175)	QQSNEDPWT (SEQ ID NO:177)
17C2	SSSQSLVHSNGNTYLH (SEQ ID NO:172)	KVSNRFS (SEQ ID NO:174)	SQNTHVPLT (SEQ ID NO:176)

Table 3: EU or Kabat heavy chain HVR sequences of anti-Siglec-9 antibodies

Ab	HVR H1	HVR H2	HVR H3
2D4	FTFSNYAMS (SEQ ID NO:19)	VATINNGGSYTYYS (SEQ ID NO:22)	VRRDYGTSDFDY (SEQ ID NO:26)
2D5	YAFSSYWMN (SEQ ID NO:20)	IGRIYPRDGDTNYN (SEQ ID NO:23)	ARWLLRFAY (SEQ ID NO:27)
5B1	YTFTSYWMH (SEQ ID NO:21)	IGEINPRDGVSNCN (SEQ ID NO:24)	TIWEDYFDY (SEQ ID NO:28)
6D8	YTFTSYWMH (SEQ ID	IGEIDPSDSYTYYN	AAYYSNYVRAY

Ab	HVR H1	HVR H2	HVR H3
	NO:21)	(SEQ ID NO:25)	(SEQ ID NO:29)
7H12	YTFTSYWMH (SEQ ID NO:21)	IGEINPRDGVSNCN (SEQ ID NO:24)	TIWEDYFDY (SEQ ID NO:28)
5C6	GYTFTDYNIH (SEQ ID NO:178)	YIYPYNGDTG (SEQ ID NO:180)	GNYLYYYAMDY (SEQ ID NO:182)
12B12	GFTFSNYGMS (SEQ ID NO:179)	TINSNGGRTY (SEQ ID NO:181)	YYRYDSYAMDY (SEQ ID NO:183)
17C2	GYTFTDYNIH (SEQ ID NO:178)	YIYPYNGDTG (SEQ ID NO:180)	GNYLYYYAMDY (SEQ ID NO:182)

Table 4A: EU or Kabat light chain Framework sequences of anti-Siglec-9 antibodies

Ab	VL FR1	VL FR2	VL FR3	VL FR4
2D4	DIQMTQSPSSLSA SLGERVSLTC (SEQ ID NO:30)	WLQQKPDGTIKRLIF (SEQ ID NO:35)	GVPKRFSGSRSGSDYSLT ISSLESEDFADYYC (SEQ ID NO:39)	FGGGTKLEIK (SEQ ID NO:44)
2D5	DVVMTQTPLTLS VTIGQPASISC (SEQ ID NO:31)	WLLQRPGQSPKRLIY (SEQ ID NO:36)	GVPDRFTGSGSGTDFTL KISRVEAEDLGVYYC (SEQ ID NO:40)	FGGGTKLEIK (SEQ ID NO:44)
5B1	NVVMTQTPLTLS VTLGQPASISC (SEQ ID NO:32)	WLLQRPGQSPKLLIY (SEQ ID NO:37)	GVPDRFSGSGSGTDFTL KINRVEAEDLGVYYC (SEQ ID NO:41)	FGAGTKLELK (SEQ ID NO:45)
6D8	DIQKPQSPFYMC VSGGETISISS (SEQ ID NO:33)	GSAEKPEKPFKLEIY (SEQ ID NO:38)	GAPSRFSGRGSGTDFSLT INRGESEDCAEYYC (SEQ ID NO:42)	FGGGTKLEIK (SEQ ID NO:44)
7H12	NVZMTQTPLTLS VTLGQPASISC (SEQ ID NO:34)	WLLQRPGQSPKLLIY (SEQ ID NO:37)	GVPDRFSGSGSGTDFTL KINRVEAEDLGVYFC (SEQ ID NO:43)	FGGGTKLEMK (SEQ ID NO:46)
5C6	DVVMTQTPLSLP VSLGDQVSISC (SEQ ID NO:184)	WYLQKSGQSPKLLIY (SEQ ID NO:186)	GVPDRFRGSGSGTDFTL KISRVEAEDLGVYFC (SEQ ID NO:188)	FGAGTKLELK (SEQ ID NO:45)
12B12	DIVLTQSPASLAV SLGQRATISC (SEQ ID NO:185)	WYQQKPGQPPKLLIY (SEQ ID NO:187)	GIPARFSGSGSRTDFTLTI NPVEADDVATYYC (SEQ ID NO:189)	FGGGTKLEIK (SEQ ID NO:44)
17C2	DVVMTQTPLSLP VSLGDQVSISC (SEQ ID NO:184)	WYLQKSGQSPKLLIY (SEQ ID NO:186)	GVPDRFRGSGSGTDFTL KISRVEAEDLGVYFC (SEQ ID NO:188)	FGAGTKLELK (SEQ ID NO:45)

Table 4B: EU or Kabat heavy chain Framework sequences of anti-Siglec-9 antibodies

Ab	VH FR1	VH FR2	VH FR3	VH FR4
2D4	EVKLVESGGALV KPGGSLKLSCAAS G (SEQ ID NO:47)	WVRQTPEKRLEW (SEQ ID NO:51)	DSVKGRFAISRDNAKNT LYLQMSNLRSEDTALYY C (SEQ ID NO:54)	WGQGTTLTVS S (SEQ ID NO:58)
2D5	QVQLQQSGPELV KPGASVKISCKAS G (SEQ ID NO:48)	WVKQRPGKGLEW (SEQ ID NO:52)	GKFKGKATLTADKSSST AYMQLSSLTSEDSAVYF C (SEQ ID NO:55)	WGQGTLVTVS A (SEQ ID NO:59)
5B1	QVQLQQSGAEVV KPGASVKLSCKA FG (SEQ ID NO:49)	WVKQRPGQGLEW (SEQ ID NO:53)	EKFTSKATLTVDTSSNT AYMQLNNLTSEDSAVY YC (SEQ ID NO:56)	WGQGTTLTVS T (SEQ ID NO:60)
6D8	VQLQQSGAELVK PGASVKLSCKAS G (SEQ ID NO:50)	WVKQRPGQGLEW (SEQ ID NO:53)	QKFKGKATLTVDKSSST AYMQLSSLTSEDSAVYY C (SEQ ID NO:57)	WGQGTLVTVS A (SEQ ID NO:59)
7H12	QVQLQQSGAEVV KPGASVKLSCKA	WVKQRPGQGLEW (SEQ ID NO:53)	EKFTSKATLTVDTSSNT AYMQLNNLTSEDSAVY	WGQGTTLTVS T (SEQ ID

	FG (SEQ ID NO:49)		YC (SEQ ID NO:56)	NO:60)
5C6	EVQLQQSGPELV KPGASVRISCKAS (SEQ ID NO:190)	WVKQSQGKSLEWIG (SEQ ID NO:192)	YNQKFQNKATLTVDNSS STAYMELRSLTSEDSAV YYCAN (SEQ ID NO:194)	WGQGTSVTVS S (SEQ ID NO:196)
12B12	EVQLVESGGGLV QPGGSLKLSCAAS (SEQ ID NO:191)	WVRQILDKRLELVA (SEQ ID NO:193)	YPDSVKGRFTISRDNAK NTLYLQMSSLRSEDTAIY YCVT (SEQ ID NO:195)	WGQGTSVTVS S (SEQ ID NO:196)
17C2	EVQLQQSGPELV KPGASVRISCKAS (SEQ ID NO:190)	WVKQSQGKSLEWIG (SEQ ID NO:192)	YNQKFQNKATLTVDNSS STAYMELRSLTSEDSAV YYCAN (SEQ ID NO:194)	WGQGTSVTVS S (SEQ ID NO:196)

Characterization of Siglec-9 antibody binding

[0467] Initial characterization of Siglec-9 antibodies involved determining their ability to bind Siglec-9 expressed on human primary monocytes, human primary macrophages, human primary dendritic cells, human primary neutrophils, and human primary natural killer (NK) cells. Cells were harvested, plated at 10^6/ml in a 96 well plate, and incubated in 100ul PBS containing 2% FBS, 2mM EDTA and 10 µg/ml Mab and Fc blocking reagent for 1 hour in ice. Cells were washed twice and incubated in 100ul PBS containing 2% FBS, 2mM EDTA and 5ug/ml PE-conjugated secondary antibody for 30 minutes on ice. Cells were washed twice in cold PBS and analyze by flow cytometry on a BD FACS Canto. Data analysis and calculation of MFI values was performed with FlowJo (TreeStar) software version 10.0.7.

[0468] FACS staining analysis indicates that Siglec-9 is expressed on primary myeloid and lymphoid cells, including human primary monocytes, macrophages, dendritic cells, neutrophils, and NK cells (**FIG. 4**).

[0469] **Table 5** demonstrates antibody binding to human primary cells expressing Siglec-9. Percent positive binding and mean fluorescent intensity (MFI) values for cell types bound by Siglec-9 antibodies are listed in **Table 5**. Binding is compared to an isotype control. The antibodies bind to human primary monocytes, human primary dendritic cells, and human primary macrophages. In **Table 5**, "Buffer" refers to cells that were treated only with the PBS buffer described supra; "Secondary Ab" refers to cells that were treated only with the PE-conjugated secondary antibody; and "mIgG1," "mIgG2a," and "mIgG2b" refer to isotype control antibodies. **FIG. 5** demonstrates antibody binding to human primary dendritic cells.

Table 5: Siglec-9 antibody binding to human primary cells

Antibody	Monocytes		Dendritic Cells		Macrophages	
	% Positive	MFI	% Positive	MFI	% Positive	MFI
2D4	95.0	538	99.3	757	99.10	849
2D5	9.1	145	34.2	252	93.20	692
5B1	75.9	310	97.8	646	98.70	621
6B2	93.6	430	69.2	412	99.00	932
6D8	29.6	198	27.6	197	93.50	473
7H12	38.3	216	60.5	331	94.80	467
Controls						

Antibody	Monocytes		Dendritic Cells		Macrophages	
	% Positive	MFI	% Positive	MFI	% Positive	MFI
Buffer	0.1	63	1.62	67.4	0.39	74
Secondary Ab	2.6	105	7.05	90.1	3.58	153
mIgG1	2.6	104	12.3	132	3.01	115
mIgG2a	3.5	127	8.45	121	22.60	164
mIgG2b	4.0	145	26.4	319	12.60	180

[0470] The binding affinity of each anti-Siglec-9 antibody was determined by measuring their K_D by surface plasmon resonance (SPR) assays. SPR data was collected at a rate of 10 Hz at 25°C on a BiaCore T200 instrument. Data analysis was performed using BiaCore T200 Evaluation Software, version 2.0. HBS-EP+ (100 mM HEPES, 1.5 M NaCl, 30 mM EDTA, 0.5% v/v Surfactant P20, pH 7.4) was used as running buffer and for preparing reagents.

[0471] Mouse-derived antibodies (25 nM) against Siglec-9 were captured (60 s contact time, 30 uL/min flow rate, 0 s stabilization time) on a CM5 sensor chip (GE Healthcare) immobilized with anti-mouse IgG. Histidine-tagged human Siglec-9 (NovoProtein) was then flowed over the captured anti-Siglec-9 surface (120 s contact time, 30 uL/min flow rate, 300 s dissociation time). Concentration of antigen ranged from 5 nM to 100 nM, depending on information obtained from an initial screen. Duplicate single-concentration trials were performed and bracketed by a blank (0 nM antigen) sample. The chip surface was regenerated in between cycles using 10 mM glycine-HCl, pH 1.7 (60 s contact time, 30 uL/min flow rate, 60 s stabilization time). The resulting SPR signal was obtained as the difference in response from measurements performed on a blank flow cell.

[0472] Single-concentration kinetic analysis (Canziani, *et al.* (2004) Analytical Biochemistry 325:301-307) was performed using a 1:1 interaction model to extract association and dissociation rate constants (k_a and k_d, respectively) for each antibody. Affinity constants (K_D) were calculated from the ratio k_d/k_a. We validated the single-concentration analysis with a multiple-concentration approach (five concentrations of antigen used, plus one blank).

[0473] The results are listed in **Table 6A**. **FIG. 6A**shows SPR sensograms depicting antibody affinity.

Table 6A: Siglec-9 antibody affinities

Antibody	mAb nM	Siglec-9 nM	K_D
2D4	25	25	0.3 nM
2D5	25	100	5.1 nM
5B1	25	100	2.7 nM
6B2	25	200	6.5 nM
6D8	25	200	6.7 nM
7H12	25	200	9.0 nM

[0474] The binding affinity of anti-Siglec-9 antibodies 2D4, 5C6, and 12B12 was also determined by measuring their K_D using a Fortebio Octet RED96 system, with all steps performed in 0.25% casein in PBS. Antibodies were captured on anti-mouse IgG Fc capture (AMC) biosensor tips, after which a baseline was run for 60 seconds. A 15 minute association step was performed in a dilution series of His-tagged Siglec 9 antigen, ranging from 3.13 nM to 50 nM, after which dissociation was measured over 60 minutes. Affinity constants (K_D) were calculated from the ratio k_d/k_a.

[0475] The Fortebio Octet RED96results are listed in **Table 6B**. **FIG. 6B** shows sensograms depicting antibody affinity.

Table 6B: Siglec-9 antibody affinity

Antibody	Assay	K_a (1/Ms)	K_d (1/S)	K_D (nM)
2D4	1	$7.55E^{+04}$	$1.22E^{-05}$	$1.62E^{-10}$
2D4	2	$7.52E^{+04}$	$2.21E^{-05}$	$2.94E^{-10}$
2D4	**Avg.**	**$7.54E^{+04}$**	**$1.72E^{-05}$**	**0.23 nM**
5C6	1	$2.31E^{+05}$	$1.23E^{-04}$	$5.32E^{-10}$
5C6	2	$2.09E^{+05}$	$1.16E^{-04}$	$5.57E^{-10}$
5C6	**Avg.**	**$2.20E^{+05}$**	**$1.20E^{-04}$**	**0.54 nM**
12B12	1	$1.17E^{+05}$	$7.45E^{-05}$	$6.39E^{-10}$
12B12	2	$1.12E^{+05}$	$9.85E^{-05}$	$8.79E^{-10}$
12B12	**Avg.**	**$1.14E^{+05}$**	**$8.65E^{-05}$**	**0.76 nM**

Antibody humanization

[0476] Antibody humanization is used to transform antibodies generated in a different species to best resemble a human antibody through sequence and structural relationships in order to prevent immunogenicity in human administration. Antibodies from different species share characteristic sequence and structural features that allow the grafting of the specificity-determining regions (SDRs) of the non-human antibody onto a human antibody framework. This results in retention of the specificity of the non-human antibody. The humanization process involves identification of the non-human antibody sequence and features, including the framework regions and SDRs. The following criteria are used to humanize an antibody: 1) percent similarity in framework regions between non-human and known human antibodies, 2) length similarity in SDRs between non-human and known human antibodies, 3) genes used to generate the framework regions of the human antibody, and 4) previous use of human antibody frameworks in humanizations and as therapeutics. Similarity in framework regions and SDR lengths are important because differences can generate structural differences in the antibody that can alter the specificity of the antibody. Specific genes used to generate the framework of human antibodies are known to be beneficial or detrimental to the stability or specificity of the antibody and are selectively used or avoided, accordingly. Lastly, previously

successful humanization frameworks, including those used in human therapeutics, which are well tolerated with good half-lives, are likely candidates for future successful humanizations.

[0477] As shown in **Tables 7A and 7B**, 10 humanized light chain and 10 humanized heavy variable region sequences were identified for each of the antibodies 2D4, 2D5, 5B1, 6D8, and 7H12; three light chain variable regions sequences and four heavy chain variable region sequences were identified for antibody 5C6; and three light chain variable regions sequences and two heavy chain variable region sequences were identified for antibody 12B12. In **Tables 7A and 7B**, bolded letters indicate HVR sequences.

Table 7A: Humanized light chain variable regions

Antibody variant	Humanized sequences
Antibody 2D4	**2D4**
Wild-type	DIQMTQSPSSLSASLGERVSLTC**RASQEISGYLG**WLQQKPDGTIKRLIF**STSTLDS**GV PKRFSGSRSGSDYSLTISSLESEDFADYYC**LQYASYPPT**FGGGTKLEIK (SEQ ID NO:61)
2D4V1-9	DIQLTQSPSFLSASVGDRVTITC**RASQEISGYLG**WYQQKPGKAPKLLIY**STSTLDS**G VPSRFSGSGSGTEFTLTISSLQPEDFATYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:62)
2D4V1-39	DIQMTQSPSSLSASVGDRVTITC**RASQEISGYLG**WYQQKPGKAPKLLIY**STSTLDS**G VPSRFSGSGSGTDFTLTISSLQPEDFATYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:63)
2D4V1-5	DIQMTQSPSTLSASVGDRVTITC**RASQEISGYLG**WYQQKPGKAPKLLIY**STSTLDS**G VPSRFSGSGSGTEFTLTISSLQPDDFATYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:64)
2D4V1-33	DIQMTQSPSSLSASVGDRVTITC**RASQEISGYLG**WYQQKPGKAPKLLIY**STSTLDS**G VPSRFSGSGSGTDFTFTISSLQPEDIATYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:65)
2D4V3-15	EIVMTQSPATLSVSPGERATLSC**RASQEISGYLG**WYQQKPGQAPRLLIY**STSTLDS**GI PARFSGSGSGTEFTLTISSLQSEDFAVYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:66)
2D4V3-11	EIVLTQSPATLSLSPGERATLSC**RASQEISGYLG**WYQQKPGQAPRLLIY**STSTLDS**GI PARFSGSGSGTDFTLTISSLEPEDFAVYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:67)
2D4V3-20	EIVLTQSPGTLSLSPGERATLSC**RASQEISGYLG**WYQQKPGQAPRLLIY**STSTLDS**GI PDRFSGSGSGTDFTLTISRLEPEDFAVYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:68)
2D4V2-30	DVVMTQSPLSLPVTLGQPASISC**RASQEISGYLG**WFQQRPGQSPRRLIY**STSTLDS**G VPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:69)
2D4V4-1	DIVMTQSPDSLAVSLGERATINC**RASQEISGYLG**WYQQKPGQPPKLLIY**STSTLDS**G VPDRFSGSGSGTDFTLTISSLQAEDVAVYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:70)
2D4V2-28	DIVMTQSPLSLPVTPGEPASISC**RASQEISGYLG**WYLQKPGQSPQLLIY**STSTLDS**GV PDRFSGSGSGTDFTLKISRVEAEDVGVYYC**LQYASYPPT**FGQGTKVEIK (SEQ ID NO:71)
Antibody 2D5	**2D5**
Wild-type	DVVMTQTPLTLSVTIGQPASISC**KSSQSLLDSDGKTYLN**WLLQRPGQSPKRLIY**LVC KLDS**GVPDRFTGSGSGTDFTLKISRVEAEDLGVYYC**WQGTHFPQT**FGGGTKLEIK (SEQ ID NO:72)
2D5V2-30	DVVMTQSPLSLPVTLGQPASISC**KSSQSLLDSDGKTYLN**WFQQRPGQSPRRLIY**LV CKLDS**GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**WQGTHFPQT**FGQGTKVEI K (SEQ ID NO:73)

Antibody variant	Humanized sequences
2D5V2-28	DIVMTQSPLSLPVTPGEPASISC**KSSQSLLDSDGKTYLN**WYLQKPGQSPQLLIY**LVC KLDS**GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**WQGTHFPQT**FGQGTKVEIK (SEQ ID NO:74)
2D5V4-1	DIVMTQSPDSLAVSLGERATINC**KSSQSLLDSDGKTYLN**WYQQKPGQPPKLLIY**LV CKLDS**GVPDRFSGSGSGTDFTLTISSLQAEDVAVYYC**WQGTHFPQT**FGQGTKVEIK (SEQ ID NO:75)
2D5V1-5	DIQMTQSPSTLSASVGDRVTITC**KSSQSLLDSDGKTYLN**WYQQKPGKAPKLLIY**LV CKLDS**GVPSRFSGSGSGTEFTLTISSLQPDDFATYYC**WQGTHFPQT**FGQGTKVEIK (SEQ ID NO:76)
2D5V1-39	DIQMTQSPSSLSASVGDRVTITC**KSSQSLLDSDGKTYLN**WYQQKPGKAPKLLIY**LV CKLDS**GVPSRFSGSGSGTDFTLTISSLQPEDFATYYC**WQGTHFPQT**FGQGTKVEIK (SEQ ID NO:77)
2D5V1-9	DIQLTQSPSFLSASVGDRVTITC**KSSQSLLDSDGKTYLN**WYQQKPGKAPKLLIY**LVC KLDS**GVPSRFSGSGSGTEFTLTISSLQPEDFATYYC**WQGTHFPQT**FGQGTKVEIK (SEQ ID NO:78)
2D5V1-33	DIQMTQSPSSLSASVGDRVTITC**KSSQSLLDSDGKTYLN**WYQQKPGKAPKLLIY**LV CKLDS**GVPSRFSGSGSGTDFTFTISSLQPEDIATYYC**WQGTHFPQT**FGQGTKVEIK (SEQ ID NO:79)
2D5V3-11	EIVLTQSPATLSLSPGERATLSC**KSSQSLLDSDGKTYLN**WYQQKPGQAPRLLIY**LVC KLDS**GIPARFSGSGSGTDFTLTISSLEPEDFAVYYC**WQGTHFPQT**FGQGTKVEIK (SEQ ID NO:80)
2D5V3-15	EIVMTQSPATLSVSPGERATLSC**KSSQSLLDSDGKTYLN**WYQQKPGQAPRLLIY**LV CKLDS**GIPARFSGSGSGTEFTLTISSLQSEDFAVYYC**WQGTHFPQT**FGQGTKVEIK (SEQ ID NO:81)
2D5V3-20	EIVLTQSPGTLSLSPGERATLSC**KSSQSLLDSDGKTYLN**WYQQKPGQAPRLLIY**LVC KLDS**GIPDRFSGSGSGTDFTLTISRLEPEDFAVYYC**WQGTHFPQT**FGQGTKVEIK (SEQ ID NO:82)
Antibody 5B1	**5B1**
Wild-type	NVVMTQTPLTLSVTLGQPASISC**KSSQSLLYTNGKTYLN**WLLQRPGQSPKLLIY**LV SKLES**GVPDRFSGSGSGTDFTLKINRVEAEDLGVYYC**LQATHFPLT**FGAGTKLELK (SEQ ID NO:83)
5B1V2-30	DVVMTQSPLSLPVTLGQPASISC**KSSQSLLYTNGKTYLN**WFQQRPGQSPRRLIY**LVS KLES**GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:84)
5B1V2-28	DIVMTQSPLSLPVTPGEPASISC**KSSQSLLYTNGKTYLN**WYLQKPGQSPQLLIY**LVS KLES**GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:85)
5B1V4-1	DIVMTQSPDSLAVSLGERATINC**KSSQSLLYTNGKTYLN**WYQQKPGQPPKLLIY**LV SKLES**GVPDRFSGSGSGTDFTLTISSLQAEDVAVYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:86)
5B1V1-5	DIQMTQSPSTLSASVGDRVTITC**KSSQSLLYTNGKTYLN**WYQQKPGKAPKLLIY**LV SKLES**GVPSRFSGSGSGTEFTLTISSLQPDDFATYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:87)
5B1V1-39	DIQMTQSPSSLSASVGDRVTITC**KSSQSLLYTNGKTYLN**WYQQKPGKAPKLLIY**LV SKLES**GVPSRFSGSGSGTDFTLTISSLQPEDFATYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:88)
5B1V1-9	DIQLTQSPSFLSASVGDRVTITC**KSSQSLLYTNGKTYLN**WYQQKPGKAPKLLIY**LVS KLES**GVPSRFSGSGSGTEFTLTISSLQPEDFATYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:89)
5B1V1-33	DIQMTQSPSSLSASVGDRVTITC**KSSQSLLYTNGKTYLN**WYQQKPGKAPKLLIY**LV SKLES**GVPSRFSGSGSGTDFTFTISSLQPEDIATYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:90)
5B1V3-11	EIVLTQSPATLSLSPGERATLSC**KSSQSLLYTNGKTYLN**WYQQKPGQAPRLLIY**LVS KLES**GIPARFSGSGSGTDFTLTISSLEPEDFAVYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:91)
5B1V3-15	EIVMTQSPATLSVSPGERATLSC**KSSQSLLYTNGKTYLN**WYQQKPGQAPRLLIY**LV**

Antibody variant	Humanized sequences
	SKLESGIPARFSGSGSGTEFTLTISSLQSEDFAVYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:92)
5B1V3-20	EIVLTQSPGTLSLSPGERATLSC**KSSQSLLYTNGKTYLN**WYQQKPGQAPRLLIY**LVS KLES**GIPDRFSGSGSGTDFTLTISRLEPEDFAVYYC**LQATHFPLT**FGQGTKVEIK (SEQ ID NO:93)
Antibody 6D8	**6D8**
Wild-type	DIQKPQSPFYMCVSGGETISISS**HTTRGIYWYKG**GSAEKPEKPFKLEIY**CARNGEG**G APSRFSGRGSGTDFSLTINRGESEDCAEYYC**AQFYQFPWT**FGGGTKLEIK (SEQ ID NO:94)
6D8V1-33	DIQMTQSPSSLSASVGDRVTITC**HTTRGIYWYKG**WYQQKPGKAPKLLIY**CARNGE G**GVPSRFSGSGSGTDFTFTISSLQPEDIATYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:95)
6D8V1-9	DIQLTQSPSFLSASVGDRVTITC**HTTRGIYWYKG**WYQQKPGKAPKLLIY**CARNGE G**GVPSRFSGSGSGTEFTLTISSLQPEDFATYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:96)
6D8V1-39	DIQMTQSPSSLSASVGDRVTITC**HTTRGIYWYKG**WYQQKPGKAPKLLIY**CARNGE G**GVPSRFSGSGSGTDFTLTISSLQPEDFATYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:97)
6D8V3-11	EIVLTQSPATLSLSPGERATLSC**HTTRGIYWYKG**WYQQKPGQAPRLLIY**CARNGEG** GIPARFSGSGSGTDFTLTISSLEPEDFAVYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:98)
6D8V1-5	DIQMTQSPSTLSASVGDRVTITC**HTTRGIYWYKG**WYQQKPGKAPKLLIY**CARNGE G**GVPSRFSGSGSGTEFTLTISSLQPDDFATYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:99)
6D8V3-15	EIVMTQSPATLSVSPGERATLSC**HTTRGIYWYKG**WYQQKPGQAPRLLIY**CARNGE G**GIPARFSGSGSGTEFTLTISSLQSEDFAVYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:100)
6D8V3-20	EIVLTQSPGTLSLSPGERATLSC**HTTRGIYWYKG**WYQQKPGQAPRLLIY**CARNGEG** GIPDRFSGSGSGTDFTLTISRLEPEDFAVYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:101)
6D8V2-28	DIVMTQSPLSLPVTPGEPASISC**HTTRGIYWYKG**WYLQKPGQSPQLLIY**CARNGEG** GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:102)
6D8V4-1	DIVMTQSPDSLAVSLGERATINC**HTTRGIYWYKG**WYQQKPGQPPKLLIY**CARNGE G**GVPDRFSGSGSGTDFTLTISSLQAEDVAVYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:103)
6D8V2-30	DVVMTQSPLSLPVTLGQPASISC**HTTRGIYWYKG**WFQQRPGQSPRRLIY**CARNGE G**GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**AQFYQFPWT**FGQGTKVEIK (SEQ ID NO:104)
Antibody 7H12	**Antibody 7H12**
Wild-type	NVZMTQTPLTLSVTLGQPASISC**KSSQSLLYTNGKTYLN**WLLQRPGQSPKLLIY**LVS KLES**GVPDRFSGSGSGTDFTLKINRVEAEDLGVYFC**LQAPHFPLT**FGGGTKLEMK (SEQ ID NO:105)
7H12V2-30	DVVMTQSPLSLPVTLGQPASISC**KSSQSLLYTNGKTYLN**WFQQRPGQSPRRLIY**LVS KLES**GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:106)
7H12V2-28	DIVMTQSPLSLPVTPGEPASISC**KSSQSLLYTNGKTYLN**WYLQKPGQSPQLLIY**LVS KLES**GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:107)
7H12V4-1	DIVMTQSPDSLAVSLGERATINC**KSSQSLLYTNGKTYLN**WYQQKPGQPPKLLIY**LV SKLES**GVPDRFSGSGSGTDFTLTISSLQAEDVAVYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:108)
7H12V1-5	DIQMTQSPSTLSASVGDRVTITC**KSSQSLLYTNGKTYLN**WYQQKPGKAPKLLIY**LV SKLES**GVPSRFSGSGSGTEFTLTISSLQPDDFATYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:109)
7H12V1-9	DIQLTQSPSFLSASVGDRVTITC**KSSQSLLYTNGKTYLN**WYQQKPGKAPKLLIY**LVS**

Antibody variant	Humanized sequences
	KLESGVPSRFSGSGSGTEFTLTISSLQPEDFATYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:110)
7H12V1-33	DIQMTQSPSSLSASVGDRVTITC**KSSQSLLYTNGKTYLN**WYQQKPGKAPKLLIY**LV SKLES**GVPSRFSGSGSGTDFTFTISSLQPEDIATYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:111)
7H12V1-39	DIQMTQSPSSLSASVGDRVTITC**KSSQSLLYTNGKTYLN**WYQQKPGKAPKLLIY**LV SKLES**GVPSRFSGSGSGTDFTLTISSLQPEDFATYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:112)
7H12V3-11	EIVLTQSPATLSLSPGERATLSC**KSSQSLLYTNGKTYLN**WYQQKPGQAPRLLIY**LVS KLES**GIPARFSGSGSGTDFTLTISSLEPEDFAVYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:113)
7H12V3-15	EIVMTQSPATLSVSPGERATLSC**KSSQSLLYTNGKTYLN**WYQQKPGQAPRLLIY**LV SKLES**GIPARFSGSGSGTEFTLTISSLQSEDFAVYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:114)
7H12V3-20	EIVLTQSPGTLSLSPGERATLSC**KSSQSLLYTNGKTYLN**WYQQKPGQAPRLLIY**LVS KLES**GIPDRFSGSGSGTDFTLTISRLEPEDFAVYYC**LQAPHFPLT**FGQGTKVEIK (SEQ ID NO:115)
Antibody 5C6	**Antibody 5C6**
Wild-type	DVVMTQTPLSLPVSLGDQVSISC**SSSQSLVHSNGNTYLH**WYLQKSGQSPKLLIY**KV SNRFS**GVPDRFRGSGSGTDFTLKISRVEAEDLGVYFC**SQNTHVPLT**FGAGTKLELK (SEQ ID NO:197)
5C6-L1	DVVMTQSPLSLPVTLGQPASISC**SSSQSLVHSNGNTYLH**WFQQRPGQSPRRLIY**KVS NRFS**GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**SQNTHVPLT**FGQGTKLEIK (SEQ ID NO:198)
5C6-L2	DVVMTQSPLSLPVTLGQPVSISC**SSSQSLVHSNGNTYLH**WYQQRPGQSPRLLIY**KVS NRFS**GVPDRFSGSGSGTDFTLKISRVEAEDVGVYYC**SQNTHVPLT**FGQGTKLEIK (SEQ ID NO:199)
5C6-L3	DVVMTQSPLSLPVTLGQPVSISC**SSSQSLVHSNGNTYLH**WYQQRPGQSPRLLIY**KVS NRFS**GVPDRFSGSGSGTDFTLKISRVEAEDLGVYYC**SQNTHVPLT**FGQGTKLELK (SEQ ID NO:200)
Antibody 12B12	**Antibody 12B12**
Wild-type	DIVLTQSPASLAVSLGQRATISC**RASENVDSYGISFMH**WYQQKPGQPPKLLIY**RASN LES**GIPARFSGSGSRTDFTLTINPVEADDVATYYC**QQSNEDPWT**FGGGTKLEIK (SEQ ID NO:201)
12B12-L1	DIQMTQSPSSLSASVGDRVTITC**RASENVDSYGISFMH**WYQQKPGKAPKLLIY**RAS NLES**GVPSRFSGSGSGTDFTLTISSLQPEDFATYYC**QQSNEDPWT**FGQGTKLEIK (SEQ ID NO:202)
12B12-L2	DIQLTQSPSSLSASVGDRVTITC**RASENVDSYGISFMH**WYQQKPGKAPKLLIY**RASN LES**GIPSRFSGSGSGTDFTLTISSLQPEDFATYYC**QQSNEDPWT**FGQGTKLEIK (SEQ ID NO:203)
12B12-L3	DIQLTQSPSSLSASVGDRATITC**RASENVDSYGISFMH**WYQQKPGKAPKLLIY**RASN LES**GIPSRFSGSGSGTDFTLTISSVQPEDFATYYC**QQSNEDPWT**FGQGTKLEIK (SEQ ID NO:204)

Table 7B: Humanized heavy chain variable regions

Antibody variant	Humanized sequences
Antibody 2D4	**2D4**
Wild-type	EVKLVESGGALVKPGGSLKLSCAASG**FTFSNYAMS**WVRQTPEKRLEW**VATINNGG SYTYYS**DSVKGRFAISRDNAKNTLYLQMSNLRSEDTALYYC**VRRDYGTSDFDY**WG QGTTLTVSS (SEQ ID NO:116)
2D4V3-23	EVQLLESGGGLVQPGGSLRLSCAASG**FTFSNYAMS**WVRQAPGKGLEW**VATINNGG SYTYYS**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**VRRDYGTSDFDY**WG QGTLVTVSS (SEQ ID NO:117)
2D4V3-7	EVQLVESGGGLVQPGGSLRLSCAASG**FTFSNYAMS**WVRQAPGKGLEW**VATINNG GSYTYYS**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**VRRDYGTSDFDY**

Antibody variant	Humanized sequences
	WGQGTLVTVSS (SEQ ID NO:118)
2D4V3-30	QVQLVESGGGVVQPGRSLRLSCAASG**FTFSNYAMS**WVRQAPGKGLEW**VATINNG GSYTYYS**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**VRRDYGTSDFDY**W GQGTLVTVSS (SEQ ID NO:119)
2D4V3-48	EVQLVESGGGLVQPGGSLRLSCAASG**FTFSNYAMS**WVRQAPGKGLEW**VATINNG GSYTYYS**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**VRRDYGTSDFDY** WGQGTLVTVSS (SEQ ID NO:120)
2D4V1-46	QVQLVQSGAEVKKPGASVKVSCKASG**FTFSNYAMS**WVRQAPGQGLEW**VATINNG GSYTYYS**QKFQGRVTMTRDTSTSTVYMELSSLRSEDTAVYYC**VRRDYGTSDFDY** WGQGTLVTVSS (SEQ ID NO:121)
2D4V1-69	QVQLVQSGAEVKKPGSSVKVSCKASG**FTFSNYAMS**WVRQAPGQGLEW**VATINNG GSYTYYS**QKFQGRVTITADESTSTAYMELSSLRSEDTAVYYC**VRRDYGTSDFDY**W GQGTLVTVSS (SEQ ID NO:122)
2D4V5-51	EVQLVQSGAEVKKPGESLKISCKGSG**FTFSNYAMS**WVRQMPGKGLEW**VATINNG GSYTYYS**PSFQGQVTISADKSISTAYLQWSSLKASDTAMYYC**VRRDYGTSDFDY**W GQGTLVTVSS (SEQ ID NO:123)
2D4V4-59	QVQLQESGPGLVKPSETLSLTCTVSG**FTFSNYAMS**WIRQPPGKGLEW**VATINNGGS YTYYS**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**VRRDYGTSDFDY**WGQ GTLVTVSS (SEQ ID NO:124)
2D4V3-15	EVQLVESGGGLVKPGGSLRLSCAASG**FTFSNYAMS**WVRQAPGKGLEW**VATINNG GSYTYYS**APVKGRFTISRDDSKNTLYLQMNSLKTEDTAVYYC**VRRDYGTSDFDY**W GQGTLVTVSS (SEQ ID NO:125)
2D4V4-39	QLQLQESGPGLVKPSETLSLTCTVSG**FTFSNYAMS**WIRQPPGKGLEW**VATINNGGS YTYYS**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**VRRDYGTSDFDY**WGQ GTLVTVSS (SEQ ID NO:126)
Antibody 2D5	**2D5**
Wild-type	QVQLQQSGPELVKPGASVKISCKASG**YAFSSYWMN**WVKQRPGKGLEW**IGRIYPRD GDTNYN**GKFKGKATLTADKSSSTAYMQLSSLTSEDSAVYFC**ARWLLRFAY**WGQG TLVTVSA (SEQ ID NO:127)
2D5V5-51	EVQLVQSGAEVKKPGESLKISCKGSG**YAFSSYWMN**WVRQMPGKGLEW**IGRIYPR DGDTNYN**PSFQGQVTISADKSISTAYLQWSSLKASDTAMYYC**ARWLLRFAY**WGQ GTLVTVSS (SEQ ID NO:128)
2D5V1-46	QVQLVQSGAEVKKPGASVKVSCKASG**YAFSSYWMN**WVRQAPGQGLEW**IGRIYPR DGDTNYN**QKFQGRVTMTRDTSTSTVYMELSSLRSEDTAVYYC**ARWLLRFAY**WG QGTLVTVSS (SEQ ID NO:129)
2D5V1-69	QVQLVQSGAEVKKPGSSVKVSCKASG**YAFSSYWMN**WVRQAPGQGLEW**IGRIYPR DGDTNYN**QKFQGRVTITADESTSTAYMELSSLRSEDTAVYYC**ARWLLRFAY**WGQ GTLVTVSS (SEQ ID NO:130)
2D5V3-23	EVQLLESGGGLVQPGGSLRLSCAASG**YAFSSYWMN**WVRQAPGKGLEW**IGRIYPRD GDTNYN**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**ARWLLRFAY**WGQG TLVTVSS (SEQ ID NO:131)
2D5V3-48	EVQLVESGGGLVQPGGSLRLSCAASG**YAFSSYWMN**WVRQAPGKGLEW**IGRIYPR DGDTNYN**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**ARWLLRFAY**WGQ GTLVTVSS (SEQ ID NO:132)
2D5V3-7	EVQLVESGGGLVQPGGSLRLSCAASG**YAFSSYWMN**WVRQAPGKGLEW**IGRIYPR DGDTNYN**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**ARWLLRFAY**WGQ GTLVTVSS (SEQ ID NO:133)
2D5V3-30	QVQLVESGGGVVQPGRSLRLSCAASG**YAFSSYWMN**WVRQAPGKGLEW**IGRIYPR DGDTNYN**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**ARWLLRFAY**WGQ GTLVTVSS (SEQ ID NO:134)
2D5V4-59	QVQLQESGPGLVKPSETLSLTCTVSG**YAFSSYWMN**WIRQPPGKGLEW**IGRIYPRDG DTNYN**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**ARWLLRFAY**WGQGTL VTVSS (SEQ ID NO:135)
2D5V3-15	EVQLVESGGGLVKPGGSLRLSCAASG**YAFSSYWMN**WVRQAPGKGLEW**IGRIYPR DGDTNYN**APVKGRFTISRDDSKNTLYLQMNSLKTEDTAVYYC**ARWLLRFAY**WGQ GTLVTVSS (SEQ ID NO:136)

Antibody variant	Humanized sequences
2D5V4-30-4	QVQLQESGPGLVKPSQTLSLTCTVSG**YAFSSYWMN**WIRQPPGKGLEW**IGRIYPRD GDTNYN**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**ARWLLRFAY**WGQGT LVTVSS (SEQ ID NO:137)
Antibody 5B1	**5B1**
Wild-type	QVQLQQSGAEVVKPGASVKLSCKAFG**YTFTSYWMH**WVKQRPGQGLEW**IGEINPR DGVSNCN**EKFTSKATLTVDTSSNTAYMQLNNLTSEDSAVYYC**TIWEDYFDY**WGQ GTTLTVST (SEQ ID NO:138)
5B1V1-46	QVQLVQSGAEVKKPGASVKVSCKASG**YTFTSYWMH**WVRQAPGQGLEW**IGEINPR DGVSNCN**QKFQGRVTMTRDTSTSTVYMELSSLRSEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:139)
5B1V5-51	EVQLVQSGAEVKKPGESLKISCKGSG**YTFTSYWMH**WVRQMPGKGLEW**IGEINPR DGVSNCN**PSFQGQVTISADKSISTAYLQWSSLKASDTAMYYC**TIWEDYFDY**WGQG TLVTVSS (SEQ ID NO:140)
5B1V1-69	QVQLVQSGAEVKKPGSSVKVSCKASG**YTFTSYWMH**WVRQAPGQGLEW**IGEINPR DGVSNCN**QKFQGRVTITADESTSTAYMELSSLRSEDTAVYYC**TIWEDYFDY**WGQG TLVTVSS (SEQ ID NO:141)
5B1V3-7	EVQLVESGGGLVQPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:142)
5B1V3-30	QVQLVESGGGVVQPGRSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:143)
5B1V3-23	EVQLLESGGGLVQPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:144)
5B1V3-48	EVQLVESGGGLVQPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:145)
5B1V4-59	QVQLQESGPGLVKPSETLSLTCTVSG**YTFTSYWMH**WIRQPPGKGLEW**IGEINPRD GVSNCN**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**TIWEDYFDY**WGQGTL VTVSS (SEQ ID NO:146)
5B1V3-15	EVQLVESGGGLVKPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**APVKGRFTISRDDSKNTLYLQMNSLKTEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:147)
5B1V4-39	QLQLQESGPGLVKPSETLSLTCTVSG**YTFTSYWMH**WIRQPPGKGLEW**IGEINPRDG VSNCN**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**TIWEDYFDY**WGQGTLV TVSS (SEQ ID NO:148)
Antibody 6D8	**6D8**
Wild-type	VQLQQSGAELVKPGASVKLSCKASG**YTFTSYWMH**WVKQRPGQGLEW**IGEIDPSD SYTYYN**QKFKGKATLTVDKSSSTAYMQLSSLTSEDSAVYYC**AAYYSNYVRAY**WG QGTLVTVSA (SEQ ID NO:149)
6D8V1-46	QVQLVQSGAEVKKPGASVKVSCKASG**YTFTSYWMH**WVRQAPGQGLEW**IGEIDPS DSYTYYN**QKFQGRVTMTRDTSTSTVYMELSSLRSEDTAVYYC**AAYYSNYVRAY**W GQGTLVTVSS (SEQ ID NO:150)
6D8V5-51	EVQLVQSGAEVKKPGESLKISCKGSG**YTFTSYWMH**WVRQMPGKGLEW**IGEIDPSD SYTYYN**PSFQGQVTISADKSISTAYLQWSSLKASDTAMYYC**AAYYSNYVRAY**WGQ GTLVTVSS (SEQ ID NO:151)
6D8V3-7	EVQLVESGGGLVQPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEIDPSD SYTYYN**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**AAYYSNYVRAY**WG QGTLVTVSS (SEQ ID NO:152)
6D8V3-23	EVQLLESGGGLVQPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEIDPSD SYTYYN**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**AAYYSNYVRAY**WG QGTLVTVSS (SEQ ID NO:153)
6D8V3-30	QVQLVESGGGVVQPGRSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEIDPS DSYTYYN**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**AAYYSNYVRAY**W GQGTLVTVSS (SEQ ID NO:154)

Antibody variant	Humanized sequences
6D8V3-48	EVQLVESGGGLVQPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEIDPSD SYTYYN**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**AAYYSNYVRAY**WG QGTLVTVSS (SEQ ID NO:155)
6D8V1-69	QVQLVQSGAEVKKPGSSVKVSCKASG**YTFTSYWMH**WVRQAPGQGLEW**IGEIDPS DSYTYYN**QKFQGRVTITADESTSTAYMELSSLRSEDTAVYYC**AAYYSNYVRAY**WG QGTLVTVSS (SEQ ID NO:156)
6D8V4-59	QVQLQESGPGLVKPSETLSLTCTVSG**YTFTSYWMH**WIRQPPGKGLEW**IGEIDPSDS YTYYN**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**AAYYSNYVRAY**WGQG TLVTVSS (SEQ ID NO:157)
6D8V3-15	EVQLVESGGGLVKPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEIDPSD SYTYYN**APVKGRFTISRDDSKNTLYLQMNSLKTEDTAVYYC**AAYYSNYVRAY**WG QGTLVTVSS (SEQ ID NO:158)
6D8V4-30-4	QVQLQESGPGLVKPSQTLSLTCTVSG**YTFTSYWMH**WIRQPPGKGLEW**IGEIDPSDS YTYYN**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**AAYYSNYVRAY**WGQG TLVTVSS (SEQ ID NO:159)
Antibody 7H12	**Antibody 7H12**
Wild-type	QVQLQQSGAEVVKPGASVKLSCKAFG**YTFTSYWMH**WVKQRPGQGLEW**IGEINPR DGVSNCN**EKFTSKATLTVDTSSNTAYMQLNNLTSEDSAVYYC**TIWEDYFDY**WGQ GTTLTVST (SEQ ID NO:160)
7H12V1-46	QVQLVQSGAEVKKPGASVKVSCKASG**YTFTSYWMH**WVRQAPGQGLEW**IGEINPR DGVSNCN**QKFQGRVTMTRDTSTSTVYMELSSLRSEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:161)
7H12V5-51	EVQLVQSGAEVKKPGESLKISCKGSG**YTFTSYWMH**WVRQMPGKGLEW**IGEINPR DGVSNCN**PSFQGQVTISADKSISTAYLQWSSLKASDTAMYYC**TIWEDYFDY**WGQG TLVTVSS (SEQ ID NO:162)
7H12V1-69	QVQLVQSGAEVKKPGSSVKVSCKASG**YTFTSYWMH**WVRQAPGQGLEW**IGEINPR DGVSNCN**QKFQGRVTITADESTSTAYMELSSLRSEDTAVYYC**TIWEDYFDY**WGQG TLVTVSS (SEQ ID NO:163)
7H12V3-7	EVQLVESGGGLVQPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:164)
7H12V3-30	QVQLVESGGGVVQPGRSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:165)
7H12V3-23	EVQLLESGGGLVQPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**DSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:166)
7H12V3-48	EVQLVESGGGLVQPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**DSVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:167)
7H12V4-59	QVQLQESGPGLVKPSETLSLTCTVSG**YTFTSYWMH**WIRQPPGKGLEW**IGEINPRD GVSNCN**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**TIWEDYFDY**WGQGTL VTVSS (SEQ ID NO:168)
7H12V3-15	EVQLVESGGGLVKPGGSLRLSCAASG**YTFTSYWMH**WVRQAPGKGLEW**IGEINPR DGVSNCN**APVKGRFTISRDDSKNTLYLQMNSLKTEDTAVYYC**TIWEDYFDY**WGQ GTLVTVSS (SEQ ID NO:169)
7H12V4-39	QLQLQESGPGLVKPSETLSLTCTVSG**YTFTSYWMH**WIRQPPGKGLEW**IGEINPRDG VSNCN**PSLKSRVTISVDTSKNQFSLKLSSVTAADTAVYYC**TIWEDYFDY**WGQGTLV TVSS (SEQ ID NO:170)
Antibody 5C6	**Antibody 5C6**
Wild-type	EVQLQQSGPELVKPGASVRISCKAS**GYTFTDYNIH**WVKQSQGKSLEWIG**YIYPYNG DTG**YNQKFQNKATLTVDNSSSTAYMELRSLTSEDSAVYYCAN**GNYLYYYAMDY** WGQGTSVTVSS (SEQ ID NO:205)
5C6-H1	QVQLVQSGAEVKKPGASVKVSCKAS**GYTFTDYNIH**WVRQAPGQGLEWMG**YIYPY NGDTG**YAQKLQGRVTMTTDTSTSTAYMELRSLRSDDTAVYYCAR**GNYLYYYAM DY**WGQGTLVTVSS (SEQ ID NO:206)

Antibody variant	Humanized sequences
5C6-H2	QVQLVQSGAEVKKPGASVKVSCKAS**GYTFTDYNIH**WVRQAPGQGLEWMG**YIYPY NGDTG**YAQKLQGRVTMTVDTSTSTAYMELRSLRSDDTAVYYCAN**GNYLYYYAM DY**WGQGTLVTVSS (SEQ ID NO:207)
5C6-H3	QVQLVQSGAEVKKPGASVKISCKAS**GYTFTDYNIH**WVRQAPGQGLEWIG**YIYPYN GDTG**YAQKFQGRATMTVDTSTSTAYMELRSLRSDDTAVYYCAN**GNYLYYYAMD Y**WGQGTLVTVSS (SEQ ID NO:208)
5C6-H4	QVQLVQSGAEVKKPGASVKISCKAS**GYTFTDYNIH**WVRQAPGQGLEWIG**YIYPYN GDTG**YAQKFQGRATMTVDNSTSTAYMELRSLRSDDTAVYYCAN**GNYLYYYAMD Y**WGQGTLVTVSS (SEQ ID NO:209)
Antibody 12B12	**Antibody 12B12**
Wild-type	EVQLVESGGGLVQPGGSLKLSCAAS**GFTFSNYGMS**WVRQILDKRLELVA**TINSNG GRTY**YPDSVKGRFTISRDNAKNTLYLQMSSLRSEDTAIYYCVT**YYRYDSYAMDY**W GQGTSVTVSS (SEQ ID NO:210)
12B12-H1	EVQLVESGGGLVQPGGSLRLSCAAS**GFTFSNYGMS**WVRQAPGKGLEWVS**TINSNG GRTY**YADSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYCAK**YYRYDSYAMDY** WGQGTLVTVSS (SEQ ID NO:211)
12B12-H2	EVQLVESGGGLVQPGGSLRLSCAAS**GFTFSNYGMS**WVRQAPGKGLELVA**TINSNG GRTY**YADSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYCVT**YYRYDSYAMDY** WGQGTLVTVSS (SEQ ID NO:212)

Humanization of antibody 5C6

[0478] The heavy chain variable region (VH) and light chain variable region (VL) sequences of murine anti-Siglec-9 antibody 5C6 (S9-5C6.3) was compared to a library of known human germline sequences. The databases used were IMGT human VH genes (F+ORF, 273 germline sequences) and IMGT human VLkappa genes (F+ORF, 74 germline sequences).

[0479] For the 5C6 antibody VL, human germline IGKV2-30 (allele 1) was chosen as the acceptor sequence and human light chain IGKJ2 (allele 1) joining region (IGKJ gene) was chosen from human joining region sequences compiled at *IMGT® the international ImMunoGeneTics information system®* (**FIG. 6C**). For the 5C6 antibody VH, human germline IGHV1-18 (allele 1) was chosen as the acceptor sequence and the human heavy chain IGHJ4 (allele 1) joining region (IGHJ gene) was chosen from human joining region sequences compiled at *IMGT® the international ImMunoGeneTics information system®* (**FIG. 6D**). Complementarity determining regions (CDRs) for the antibody VL and VH were defined according to the AbM definition (*AbM* antibody modeling software).

[0480] Alteration of human germline framework (i.e., non-CDR residues in the VH and VL) positions to corresponding parental murine sequences may be required to optimize binding of the humanized antibody. Potential changes for each humanized sequence are noted in **FIG. 6C and 6D**. **FIG. 6C and 6D** show sequences of humanized versions of anti-Siglec-9 antibody 5C6 (5C6.3).

[0481] In the VL domain of antibody 5C6, in CDR-L1, Asp30c-Gly30d-Asn30d-Thr30e has a high potential for deamidation at both Asn followed by isoaspartate formation at position 30c-30d. Post-translational modification at this site could affect binding of the antibody to target. The parental mouse antibody may be analyzed to determine the level of post-translational modification (**FIG. 6C**).

Alternatively antibody 5C6 may be humanized and then in a final step the NG may be modified, to e.g., SG, QG, or AG, to determine if binding is maintained; separately, the NT may be altered to, e.g., QT or ST. In the CDR-L2, Asn53 has a low potential for deamidation based on sequence and conformation and may show a low level of this post-translational modification (**FIG. 6C**). In CDR-L3, Asn91 has a medium potential for deamidation based on sequence and conformation and may show a low level of this post-translational modification (**FIG. 6C**). Variant VL sequences based on the above are listed in **Table 7A**.

[0482] In the VH domain of antibody 5C6 (5C6.3), Asn33 and Asn 96 in the CDR-H1 have low potential for deamidation based on sequence and conformation and may show a low level of post-translational modifications (**FIG. 6D**). In the CDR-H2, Asn54-Gly55 has a low/medium potential for deamidation followed by isoaspartate formation (**FIG. 6D**). Post-translational modification at this site may affect binding of the antibody to target. The parental mouse antibody may be analyzed to determine the level of post-translational modification. Alternatively 5C6 may be humanized and then in a final NG may be altered to e.g., QG, to determine if binding is maintained. Variant VH sequences based on the above are listed in **Table 7B**.

Humanization of antibody 12B12

[0483] The heavy chain variable region (VH) and light chain variable region (VL) sequences of murine anti-Siglec-9 antibody 12B12 (S9-12B12.2) was compared to a library of known human germline sequences. The databases used were IMGT human VH genes (F+ORF, 273 germline sequences) and IMGT human VLkappa genes (F+ORF, 74 germline sequences).

[0484] For the 12B12 antibody VL, human germline IGKV1-39 (allele 1) was chosen as the acceptor sequence and human light chain IGKJ2 (allele 1) joining region (IGKJ gene) was chosen from human joining region sequences compiled at *IMGT® the international ImMunoGeneTics information system®* (**FIG. 6E**). For the 12B12 antibody VH, human germline IGHV3-23 (allele 4) was chosen as the acceptor sequence and the human heavy chain IGHJ4 (allele 1) joining region (IGHJ gene) was chosen from human joining region sequences compiled at *IMGT® the international ImMunoGeneTics information system®* (**FIG. 6F**). Complementarity determing regions (CDRs) for the antibody VL and VH were defined according to the AbM definition (*AbM* antibody modeling software).

[0485] Alteration of human germline framework (i.e., non-CDR residues in the VH and VL) positions to corresponding parental murine sequences may be required to optimize binding of the humanized antibody. Potential changes for each humanized sequence are noted in **FIG. 6E and 6F**. **FIG. 6E and 6F** show sequences of humanized versions of anti-Siglec-9 antibody 12B12 (12B12.2).

[0486] In the VL domain of antibody 12B12, Asn29, Asn53, and Asn92 in the CDR-L1 have a low potential for deamidation based on sequence and conformation and may show a low level of

post-translational modification (**FIG. 6E**). In the CDR-L3, Trp96 is likely to be at least partially solvent-exposed and hence may undergo oxidation under stress conditions (**FIG. 6E**). Variant VL sequences based on the above are listed in **Table 7A**.

[0487] In the VH domain of antibody 12B12 (12B12.2), Asn31 in the CDR-H1 has a low potential for deamidation based on sequence and conformation and may show a low level of posttranslational modification, while Asn52 in the CDR-H1 has a medium potential for deamidation based on sequence and conformation and may show a low level of post-translational modification (**FIG. 6F**). In the CDR-H2, Asn53-Gly54-Gly55 has a medium/high potential for deamidation followed by isoaspartate formation (**FIG. 6E**). Post-translational modification at this site may affect binding of the antibody to target. The parental mouse antibody may be analyzed to determine the level of post-translational modification. Alternatively antibody 12B12 can be humanized and then in a final step the NGG may be altered to, e.g., QGG or AGG, to determine if binding is maintained. Variant VH sequences based on the above are listed in **Table 7B**.

Example 2: Epitope mapping of Siglec-9 antibodies

[0488] Siglec-9 antibodies were tested for their ability to bind 15 or 25-mer peptides spanning the entire human Siglec-9. The Siglec-9 antibodies were also compared to a reference Siglec-9 antibody by determining their Siglec-9 binding region.

Methodology

[0489] Linear 15-mer peptides were synthesized based on the sequence of human Siglec-9 (SEQ ID NO: 1), with a 14 residue overlap. In addition, linear 25-mer peptides were synthesized based on sequence of human Siglec-9 (SEQ ID NO: 1) with a single residue shift. The binding of Siglec-9 antibodies to each of the synthesized peptides was tested in an ELISA based method. In this assay, the peptide arrays were incubated with primary antibody solution (overnight at 4°C). After washing, the peptide arrays were incubated with a 1/1000 dilution of an antibody peroxidase conjugate (SBA, cat. nr. 2010-05) for one hour at 25°C. After washing, the peroxidase substrate 2,2'- azino-di-3-ethylbenzthiazoline sulfonate (ABTS) and 2 µl/ml of 3% H_2O_2 were added. After one hour, the color development was measured. The color development was quantified with a charge coupled device (CCD) camera and an image processing system.

[0490] Epitope binning of the antibodies was performed on a Forte Bio Octet Red384 system (Pall Forte Bio Corporation, Menlo Park, CA) using a standard sandwich format binning assay (see Estep *et al*, (2013) *MAbs* 5(2):270-8). Control anti-target IgG was loaded onto AHQ sensors and unoccupied Fc-binding sites on the sensor were blocked with a non-relevant human IgG1 antibody. The sensors were then exposed to 100 nM target antigen followed by a second anti-target antibody. Data was processed using ForteBio's Data Analysis Software 7.0. Additional binding by the second

antibody after antigen association indicates an unoccupied epitope (non-competitor), while no binding indicates epitope blocking (competitor).

[0491] Alternatively, to reconstruct epitopes of the target molecule, libraries of looped and combinatorial peptides were synthesized. An amino functionalized polypropylene support was obtained by grafting with a proprietary hydrophilic polymer formulation, followed by reaction with t-butyloxycarbonyl- hexamethylenediamine (BocHMDA) using dicyclohexylcarbodiimide (DCC) with *N*-hydroxybenzotriazole (HOBt) and subsequent cleavage of the Boc-groups using trifluoroacetic acid (TFA). Standard Fmoc-peptide synthesis was used to synthesize peptides on the amino-functionalized solid support by custom modified JANUS liquid handling stations (Perkin Elmer).

[0492] Synthesis of structural mimics was done using Pepscan's proprietary Chemically Linked Peptides on Scaffolds (CLIPS) technology. CLIPS technology allows to structure peptides into single loops and double-loops. CLIPS templates are coupled to cysteine residues. The side-chains of multiple cysteines in the peptides are coupled to one or two CLIPS templates. For example, a 0.5 mM solution of the mP2 CLIPS (2,6-bis(bromomethyl)pyridine) is dissolved in ammonium bicarbonate (20 mM, pH 7.8)/acetonitrile (1:3(v/v)). This solution is added onto the peptide arrays. The CLIPS template will bind to side-chains of two cysteines as present in the solid-phase bound peptides of the peptide- arrays (455 wells plate with 3 µl wells). The peptide arrays are gently shaken in the solution for 30 to 60 minutes while completely covered in solution. Finally, the peptide arrays are washed extensively with excess of H_2O and sonicated in disrupt-buffer containing 1 % SDS/0.1 % β-mercaptoethanol in PBS (pH 7.2) at 70°C for 30 minutes, followed by sonication in H_2O for another 45 minutes. The T3 CLIPS (2,4,6-tris(bromomethyl)pyridine) carrying peptides were made in a similar way but now with three cysteines.

[0493] Looped peptides: constrained peptides of length 17. Positions 2-16 are 15-mers derived from the target sequence. Native Cys residues are protected by acetamidomethyl group (ACM). Positions 1 and 17 are Cys that are linked by mP2 CLIPS moieties. Combinatorial peptides (discontinuous mimics): constrained peptides of length 33. Positions 2-16 and 18-32 are 15-mer peptides derived from the target sequence with native Cys residues protected by ACM. Positions 1, 17 and 33 are Cys that are linked by T3 CLIPS moieties.

[0494] The binding of antibody to each of the synthesized peptides is tested in a PEPSCAN-based ELISA. The peptide arrays are incubated with test antibody solution composed of the experimentally optimized concentration of the test antibody and blocking solution (for example 4% horse serum, 5% ovalbumin (w/v) in PBS/1% Tween80). The peptide arrays are incubated with the test antibody solution overnight at 4°C. After extensive washing with washing buffer (1×PBS,

0.05% Tween80), the peptide arrays are incubated with a 1/1000 dilution of an appropriate antibody peroxidase conjugate for one hour at 25°C. After washing with the washing buffer, the peroxidase substrate 2,2′-azino-di-3- ethylbenzthiazoline sulfonate (ABTS) and 2 µl/ml of 3% H_2O_2 are added. After one hour, the color development is measured. The color development is quantified with a charge coupled device (CCD) - camera and an image processing system.

Results

[0495] The Siglec-9 binding region was determined for 3 anti-Siglec-9 antibodies. The binding region is listed in **Table 8A**.

Table 8A: Siglec-9 antibody binding region

Antibody	Siglec-9 binding region	Amino acid region of SEQ ID:1
6B2	^{107}RDARRSDAGR^{115}	107-115
7H12		
2D4	^{185}VSPLDPSTTR^{194}	185-194
2D5	^{62}FREGANTDQDAPVAT^{76} and ^{86}ETRDRFH^{92}	62-76 and 86-92
5B1	^{86}ETRDRFHLLGD^{96} and ^{105}IRDARRSDAGR^{116}	86-96 and 105-116
6B2		

[0496] As indicated in **Table 8A**, antibodies 6B2, 7H12, 2D5, and 5B1 showed robust binding exclusively for peptides within the extracellular IgV domain of Siglec-9. As indicated in **Table 8A**, the peptide recognized by antibodies 6B2 and 7H12 corresponds to amino acid residues 107-115 of SEQ ID NO: 1 and has the amino acid sequence of: RDARRSDAGR. The peptides recognized by antibody 2D5 correspond to amino acid residues 62-76 and 86-92 of SEQ ID NO: 1 and have the amino acid sequences of: FREGANTDQDAPVAT and ETRDRFH. The peptides recognized by antibodies 5B1 and 6B2 correspond to amino acid residues 86-96 and 105-116 of SEQ ID NO: 1 and have the amino acid sequences of: ETRDRFHLLGD and IRDARRSDAGR.

[0497] As further indicated in **Table 8A**, antibody 2D4 showed robust binding exclusively for a peptide within the extracellular Ig-like C2-type domain of Siglec-9. As indicated in **Table 8A**, the peptide recognized by antibody 2D4 corresponds to amino acid residues 185-194 of SEQ ID NO: 1 and has the amino acid sequences of: VSPLDPSTTR.

Functional mapping

[0498] Shotgun mutagenesis epitope mapping of anti-siglec-9 antibodies was performed using an alanine-scanning library for the siglec-9 protein. A siglec-9 expression construct encoding a C-terminal V5 epitope tag was subjected to high-throughput alanine scanning mutagenesis (outlined in Davidson and Doranz, 2014 Immunology 143, 13-20) to generate a comprehensive mutation library. Each of the residues representing the Siglec-9 extracellular domain was mutated, most to alanine, while alanine codons were mutated to serine.

[0499] The Siglec-9 mutation library clones, arrayed in a 384-well microplate, were transfected individually into HEK-293T cells and allowed to express for 22 hours. Antibodies were digested to generate Fabs, after which cells were incubated with Fabs diluted in 10% normal goat serum (NGS) (Sigma-Aldrich, St. Louis, MO). Prior to library screening, primary Fab concentrations were determined using an independent immunofluorescence titration curve against cells expressing wild-type Siglec-9 to ensure that signals were within the linear range of detection. Fabs were detected using 7.5 µg/ml AlexaFluor488-conjugated secondary antibody (Jackson ImmunoResearch Laboratories, Westgrove, PA) in 10% NGS. Cells were washed twice with PBS -/- and resuspended in Cellstripper (Cellgro, Manassas, VA) with 0.1% BSA (Sigma-Aldrich, St. Louis, MO). In some cases, higher stringency conditions were used, including increased pH, increased temperature, and increased dissociation time. Mean cellular fluorescence was detected using the Intellicyt high throughput flow cytometer (HTFC, Intellicyt, Albuquerque, NM). Fab reactivities against each mutant clone were calculated relative to wild-type Siglec-9 protein reactivity by subtracting the signal from mock-transfected controls, and normalizing to the signal from wild-type Siglec-9 transfected controls.

[0500] Mutated residues within critical clones were identified as critical to the Fab epitope if they did not support reactivity of the test Fab but did support reactivity of commercially available reference Mab MAB1139 (R&D Systems, Cat#: 191240), or additional anti-Siglec-9 Fabs. This counter-screen strategy facilitated the exclusion of Siglec-9 mutants that were locally misfolded or that had an expression defect.

[0501] **FIG. 1B** depicts the mean binding reactivities and ranges for all critical residues identified in the screens. Primary critical residues were identified as residues where mutations were negative for test antibody binding (<30% of binding to WT) but positive for the control antibody (>80% WT). **FIG. 1C-1E** depict crystal structure models of Siglec-9 (PDB ID 2ZG2; Zhuravleva et al., 2008) indicating the critical residues as red spheres for anti-Siglec-9 antibodies 2D4, 5C6, and 12B12. The amino acid residues critical for antibody binding are listed in **Table 8B**.

Table 8B: Residues involved in anti-Siglec-9 antibody binding

Antibody	Critical Siglec-7 residues
2D4 Fab	D_{189}; P_{190}; and R_{194}
12B12 Fab	H_{48}; W_{50}; I_{51}; Y_{52}; and I_{126}
5C6 Fab	L_{22}; H_{48}; W_{50}; I_{51}; Y_{52}; and K_{123}

[0502] As indicated in **Table 8B**, the critical Siglec-9 residues involved in binding by antibody 2D4 corresponded to amino acid residues D_{189}, P_{190}, and R_{194} of SEQ ID NO: 1. The critical Siglec-9 residues involved in binding by antibody 12B12 corresponded to amino acid residues H_{48}, W_{50}, I_{51},

Y_{52}, and I_{126} of SEQ ID NO: 1. The critical Siglec-9 residues involved in binding by antibody 5C6 corresponded to amino acid residues L_{22}, H_{48}, W_{50}, I_{51}, Y_{52}, and K_{123} of SEQ ID NO: 1.

Example 3: Siglec-9 antibody-induced decrease in cell surface levels of Siglec-9 *in vitro* and *in vivo*

In vitro expression of Siglec-9

[0503] The purpose of the following Example was to test whether anti-Siglec-9 and/or Siglec-9 bispecific antibodies reduce the cell surface level of Siglec-9 on monocytes, macrophages, neutrophils, NK cells, dendritic cells, T cells, and/or microglia.

[0504] The ability of anti-Siglec-9 antibodies to reduce cell surface levels of Siglec-9 on the acute monocytic leukemia cell line THP-1, as well as human primary monocytes, human primary dendritic cells (DC) derived from peripheral blood monocytes, human primary macrophages, and human primary microglia was evaluated. Cell samples were plated in 24-well plates at 200,000 cells per ml or in 6-well dishes at 500,000 cells in 2 ml of RPMI supplemented with 10% Hyclone FBS, 2 mM glutamine, pen/strep, and non-essential amino acids. Siglec-9 antibodies or control isotypes were added at 1.0 µg/ml, and incubated for 24 hours at 37°C with 5% CO_2.

[0505] To assess receptor dynamics, antibodies were allowed to bind cells for one hour, washed out and surface levels of Siglec-9 were determined 24 and 48 hours later.

[0506] Cell surface receptor expression was detected by FACS analysis. Cells were incubated with anti-Siglec-9-FITC clone HIM3-4, as well as a control surface marker (U937: Siglec-5, human monocytes: CD14, human dendritic cells: CD11c, human macrophages: CD11b) for 30 minutes on ice in the dark. Cells were washed 2X in FACS buffer (PBS +2% FBS, 2mM EDTA) and flow cytometry was performed on a BD FACS Canto. Data was analyzed using TreeStar FlowJo software. Data was calculated as a percent of receptor expression in the absence of antibody using MFI values for the respective fluorophores.

[0507] **Table 9A and 9B** depict the results of Siglec-9 cell surface levels from human cells. In **Table 9A and 9B**, "No Ab" refers to cells that were that were not treated with an antibody; and "mIgG1," "mIgG2a," and "mIgG2b" refer to isotype control antibodies.

Table 9A: Siglec-9 antibodies reduce cell surface level of Siglec-9 in a human cell line and in human primary cells

	Percent Siglec-9 Surface Expression					
	THP-1 cells		Monocytes		DCs	
Ab	%Siglec-9	% control	%Siglec-9	%control	%Siglec-9	% control
2D4	56.2	96.0	5.4	60.3	16.6	93.2
2D5	81.1	95.0	84.4	81.8	94.3	102.2
5B1	61.6	91.1	31.2	62.4	39.2	98.1
6B2	60.3	95.6	16.9	62.6	27.4	88.2
6D8	62.6	96.7	42.2	68.7	60.2	90.3
7H12	68.9	92.8	48.4	72.9	66.2	90.6
No Ab	100	100	100	100	100	100

	Percent Siglec-9 Surface Expression					
	THP-1 cells		Monocytes		DCs	
Ab	%Siglec-9	% control	%Siglec-9	%control	%Siglec-9	% control
mIgG1	100	99.5	100.5	97.8	96.5	100.3
mIgG2a	95.9	95.9	101.1	95.2	98.6	96.6
mIgG2b	98.0	96.0	98.9	103.7	93.4	93.5

Table 9B: Siglec-9 antibodies reduce cell surface level of Siglec-9 in human primary cells

	Percent Siglec-9 Surface Expression			
	Macrophages		Microglia	
Ab	%Siglec-9	% control	%Siglec-9	% control
2D4	14.0	70.3	12.8	91.9
2D5	94.6	77.6	90.6	89.3
5B1	24.8	67.7	27.5	102.6
6B2	17.6	64.9	25.8	105.3
6D8	21.3	68.7	45.4	95.3
7H12	34.2	67.5	54.7	88.8
No Ab	100	100	100	100
mIgG1	99.3	95.3	90.3	85.6
mIgG2a	97.8	100.7	91.2	90.1
mIgG2b	97.2	93.9	91.7	85.7

[0508] As shown in **Table 9A and 9B**, a majority of the antibodies were able to decrease cell surface levels of Siglec-9 on multiple types of human cells. However, using a threshold value of 80% or higher cell surface expression levels of Siglec-9, it was found that antibody 2D5 does not decrease cell surface levels of Siglec-9 on any of the tested human cells.

[0509] **FIG. 7A-7E** further demonstrates that a majority of the antibodies were able to decrease cell surface levels of Siglec-9 on THP-1 cells (**FIG. 7A**), human primary monocytes (**FIG. 7B**), human primary microglia (**FIG. 7C**), human primary macrophages (**FIG. 7D**), and human primary dendritic cells (**FIG. 7E**). **FIG. 7F** demonstrates that surface levels of Siglec-9 on human primary dendritic cells are decreased in a concentration-dependent manner when treated with Siglec-9 antibodies 2D4 and 6B2.

[0510] Additionally, *in vitro* surface Siglec-9 downregulation studies were performed in which Siglec-9 antibodies 5C6, 12B12, and 17C2, and isotype control antibody (mIgG2a) were titrated 2-fold. Primary human macrophages were harvested and plated as described above. Siglec-9 antibodies were titrated 10-fold with a concentration range of 1 nM to 0.001 μg/mL to assess binding. Antibodies were serially diluted and incubated with cells as described above. As shown in **FIG. 7I**, anti-Siglec-9 antibodies 5C6, 12B12, and 17C2 were capable of downregulating cell surface expression of Siglec-9 on primary human macrophages. Cell surface expression of control receptor CD11b was not affected by treatment with Sigliec-9 antibodies (**FIG. 7J**).

In vivo expression of Siglec-9

[0511] To test the ability of Siglec-9 antibodies to reduce cell surface level of Siglec-9 *in vivo*, humanized NSG mice (hu-NSG) were utilized. Hu-NSG mice are NOD-scid IL2Rγnull mice engrafted with human CD34+ hematopoietic stem cells. Female Hu-NSG mice were purchased from Jax and utilized 15 weeks after engraftment with human cells. Mice received an intraperitoneal injection of 40 mg/kg anti-Siglec-9 antibody 2D4 or an isotype control mouse IgG1 antibody (clone MOPC-21) at day 0. At day 1, blood samples were drawn from mice into heparin and processed for FACS analysis. Briefly, blood samples were first incubated for 5 minutes in ice-cold ACK lysis buffer to lyse red blood cells and then washed extensively with cold PBS. This procedure was repeated twice. Cells were then incubated in FACS buffer (PBS +2% FBS, 2mM EDTA) in the presence of anti-human-CD45-Pe-Cy7, anti-mouse-CD45-APC-Cy7, anti- human-CD3-PerCP-Cy5.5, anti-human-CD14-FITC, anti-human-CD11c-PB, anti-Siglec-9-APC, anti-CD33-PE, and a viability die (Life Technologies, Cat# L34957) for 30 min. on ice in the presence of Fc block solution, then washed twice with cold FACS buffer. 4% PFA-fixed samples were then acquired. Data were acquired on a BD FACS CANTO™ II cytometer (Becton Dickinson) and analyzed with FlowJo software. The level of expression of Siglec 9 and control receptor CD33 was determined in a hCD45+, hCD14+ cell population at day -7, 1, 7, 14, and 21 post antibody treatment.

[0512] As shown in **FIG. 7G and 7H**, treatment with the anti-Siglec-9 antibody 2D4 was able to decrease cell surface levels of Siglec-9 in cells of peripheral blood of the treated hu-NSG mice, when compared to control mIgG1 antibody treatment. Siglec-9 expression was decreased by ~80% as early as 1 day post antibody treatment (**FIG. 7G**). As a comparison, cell surface expression of the unrelated surface receptor CD33 did not decrease significantly after anti-Siglec-9 antibody treatment, as compared to cell surface levels of CD33 after treatment with mIgG1 control antibody (**FIG. 7H**).

[0513] As shown in **FIG. 7K-7N**, treatment with the anti-Siglec-9 antibody 2D4 was able to decrease cell surface levels of Siglec-9 in cells of peripheral blood of the treated hu-NSG mice, when compared to isotype control MOPC21 antibody treatment. Siglec-9 expression was decreased by ~80% as early as 1 day post antibody treatment with antibody 2D4 (**FIG. 7L**). This decrease in Siglec-9 expression was sustained for 21 days post treatment (**FIG. 7K and 7L**). As a comparison, cell surface expression of the unrelated surface receptor CD33 did not decrease significantly after anti-Siglec-9 antibody treatment, as compared to cell surface levels of CD33 after treatment with mIgG1 control antibody (**FIG. 7K and 7M**).

[0514] These results demonstrate that when utilizing humanized mice, Siglec-9 antibodies engage the Siglec-9 *in vivo* and functionally downregulate Siglec-9 on human immune cells. The results further demonstrate that Siglec-9 antibody 2D4, when injected into humanized mice, engage Siglec-9 on peripheral $hCD45^+$ $hCD14^+$ myeloid cells circulating in the blood of the mice. Antibody

engagement of Siglec-9 leads to receptor downregulation specifically for Siglec-9 and not a control receptor, CD33. After a single injection of 2D4 antibody, 80% of Siglec-9 expressed on human monocytes is downregulated 1 day after treatment. Receptor loss is sustained for 21 days after treatment with a single treatment of antibody 2D4.

Effect of Siglec-9 antibody on expression of TREM2

[0515] To test the ability of Siglec-9 antibodies that decrease cell surface levels of Siglec-9 to modulate TREM2 expression, human monocyte-derived dendritic cells differentiated with GM-CSF and IL-4 were harvested at day 6, and were plated at 500,000 cells per well in a 24 well dish overnight with 1.0 µg/ml anti-Silglec-9 antibody 2D4, isotype control antibody, or left untreated. Cell surface receptor expression for CD11c, TREM2, and Siglec-9 was detected the following day by FACS analysis. Cells were incubated with biotinylated anti-TREM2 antibody 10A9 for 20 minutes on ice. After one wash, cells were incubated in FACS buffer with APC conjugated Streptavidin (BD Biosciences, 1:150 dilution), anti- Siglec-9-PE, clone K8 (Biolegend), and anti-CD11c-PECy7 (BD Biosciences), for 30 minutes on ice in the dark. Cells were washed 3X in FACS buffer (PBS + 2% FBS, 2mM EDTA) and flow cytometry was performed on a BD FACS Canto. Data was analyzed using TreeStar FlowJo software. Data was calculated as a percent of receptor expression in the absence of antibody using MFI values for the respective fluorophores.

[0516] As shown in **FIG. 7O and 7P**, anti-Siglec-9 antibody 2D4, which was able to able to decrease cell surface levels of Siglec-9, did not affect TREM2 expression.

[0517] Loss-of-function mutations in TREM2 have been associated with severe neurodegeneration, including Nasu-Hakola disease, frontotemporal dementia, and Alzheimer's disease. It is believed that modulation of ITIM-containing Siglec receptors may affect TREM2 expression. Therefore, anti-Siglec-9 antibodies that do not decrease TREM2 expression on human immune cells may be key to positive therapeutic outcomes. The results in **FIG. 7O and 7P** demonstrate that anti-Siglec-9 antibody clone 2D4, which robustly decreases cell surface levels Siglec-9, does not reduce TREM2 expression on human dendritic cells.

Example 4: Determining whether Siglec-9 antibodies compete with Siglec-9 ligand for binding to human Siglec-9

[0518] The purpose of the following Example was to test whether anti-Siglec-9 antibodies recognize the ligand-binding site on Siglec-9 and compete with ligand binding on Siglec-9 receptors on cells.

[0519] To determine whether Siglec-9 antibodies block binding to sialic acid ligands, U937 cells, which robustly express sialic acid ligands that predominantly bind to Siglec-9, were utilized in a FACS-based protocol. Briefly, 25 µg/ml Siglec-9 antibodies were pre-coupled with 25 µg/ml Siglec-9-Fc (R&D Systems, catalog number 1139-SL-050) for 20 minutes on ice in binding buffer

(PBS with 0.25% BSA and 1 mM $CaCl_2$) in 96-well round bottom plates. The U937 cells that were pre-blocked with anti-human CD64 antibody (10 µg/ml, Affymetrix catalog number 16-0649-85 clone 10.1) were added to each well, mixed, and incubated on ice for 45 minutes. Cells were pelleted and resuspended in goat anti-human IgG-PE (SouthernBiotech catalog number 2040-09) secondary antibody at 1:2000 dilution in binding buffer for 30 minutes. Cells were then washed three times and analyzed by flow cytometry on a BD FACS Canto. Data were analyzed on FlowJo version 10.0.6 (TreeStar).

[0520] The results of the ligand competition assay are depicted in **Table 10**. In **Table 10**, "Siglec-9-Fc" refers to cells that were treated only with Siglec-9-Fc; "Isotype" refers to an isotype control antibody; and "Secondary Ab" refers to cells that were treated only with the PE-conjugated secondary antibody.

Table 10: Siglec-9 antibodies do not block Siglec-9-Fc binding to U937 cells

Antibody	Percent Siglec-9-Fc Binding
2D4	99.2
2D5	97.8
5B1	97.8
6B2	97.8
6D8	97.8
7H12	97.8
Siglec-9-Fc	100
Isotype	0.021
Secondary Ab	0

[0521] As shown in **Table 10**, the Siglec-9 antibodies were not able to block Siglec-9-Fc binding to U937 cells, thus indicating that the antibodies do not compete for binding to the ligand-binding site on Siglec-9, and do not inhibit the interaction between Siglec-9 and one or more Siglec-9 ligands (i.e., do not block ligand binding to Siglec-9).

[0522] In a separate experiment, U937 cells were cultured and passaged a few times before experimental analysis. U937 cells were harvested with trypsin or EDTA and plated ~100,000 per well in U-Bottom 96-well plate. Cells were washed 1X in binding buffer (PBS +0.25%BSA and 1mM$CaCl_2$), cells were resuspended in 100 µl binding buffer. In a separate 96-well plate, Siglec-9-Fc was pre-incubated with anti-Siglec-9 antibody 2D4, 5C6, 12B12, 17C2, or isotype control. Siglec-9-Fc fusion protein was stored at a stock concentration of 50 µg/ml, rhIgG1-Fc serves as negative control, and used 10 µl stock/well for 0.5 µg/well. Siglec-9 antibodies were stored at 4°C in 1.0 mg/ml stocks in PBS, and used 1 µl/well for 1.0 µg/well total antibody. Fc fusion + antibody were added to same well, allowed to bind on ice 10 minutes. Fc+/-mab was transferred to U937 cells, incubated on ice 30 minutes. Cells were washed 1X with 100ul Binding Buffer, pelleted at 1200rpm for 5 minutes. Cells were resuspended in 100 µl/well Binding buffer with Secondary Mouse anti-

Human 1:2000 PE, and incubated with secondary on ice 30 minutes, washed 2X with binding buffer. FACS analysis for PE signal detection was performed on a FACSCanto (BD) and data analyzed with FlowJo (TreeStar) to compared MFI.

[0523] As shown in **FIG. 7Q**, Siglec-9 antibodies 5C6, 12B12, and 17C2 were able to block receptor binding to endogenous sialic acid ligands expressed by U937 cells. Consistent with the results in **Table 10**, antibody 2D4 was not able to block ligand binding, and instead appeared to enhance the ligand-receptor interaction (**FIG. 7Q**). The results indicate that ligand blocking may be one approach to prevent ITIM signaling and inhibit Siglec-9 receptor function.

Example 5: Summary of Siglec-9 antibody functional studies.

[0524] **Table 11** summarizes results of the cell surface expression and ligand binding studies described in Examples 3 and 4 above. As indicated in **Table 11**, there were three general classes of Siglec-9 antibodies. One class of antibodies decreases cell surface level of Siglec-9 without inhibiting the interaction between Siglec-9 and one or more Siglec-9 ligands. Antibodies in this class of antibodies include: 2D4, 5B1, 6B2, 6D8, 7H12.

[0525] The second class of antibodies does not decrease cell surface level of Siglec-9 and does not inhibit the interaction between Siglec-9 and one or more Siglec-9 ligands. Antibodies in this class of antibodies include 2D5.

[0526] The third class of antibodies decreases cell surface level of Siglec-9 and inhibits the interaction between Siglec-9 and one or more Siglec-9 ligands. Antibodies in this class of antibodies include: 5C6, 12B12, and 17C2.

Table 11: Siglec-9 antibody functional studies

Antibody	Reduces Siglec-9 Cell Surface Expression	Blocks Ligand Binding
2D4	X	
2D5		
5B1	X	
6B2	X	
6D8	X	
7H12	X	
5C6	X	X
12B12	X	X
17C2	X	X

Example 6: Ligand binding to Siglec-9 on dendritic cells inhibits T cell proliferation and phagocytosis

[0527] Human dendritic cells (DCs) were differentiated from peripheral blood monocytes with GM-CSF and IL-4 and cultured for 5 days. Immature (suspension) DCs were harvested and plated at

a density of 200,000 cells per ml in a 12 well dish. DCs were activated with a cytokine cocktail of TNFa (50 µg/ml), IL-1b (50 µg/ml), IL-6 (150 ng/ml), and Prostaglandin E2 (1 µg/ml) for 24 hours. Dendritic cell maturation was determined by flow cytometry with commercially available antibodies for LIN, CD11c, HLA-DR, CD86, and CD83 (BD Biosciences). Immediately prior to co-culture with allogenic isolated T cells, activated DCs were sialidase treated, or left untreated, for 2 hours at 37°C with 100 mU/ml neuraminidase from *Vibrio cholera* in serum free media. Enzymatic activity was quenched by addition of serum-containing media, cells pelleted and resuspended in complete media. Sialidased activated, untreated activated, or unactivated DCs were co-cultured at a ratio of 1:10 with allogenic CFSE labeled T cells. CD3/CD28 Dynal beads were added to T cells alone as a positive control. Five days later T cell proliferation was measured by CFSE dilution on a BD FACS Canto.

[0528] **FIG. 8 and 9** show that sialic acids on dendritic cells restrict T cell proliferation during mixed lymphocyte reaction (MLR). **FIG. 9** shows that DCs that normally express inhibitory ligands induce low levels of T cell proliferation (left panel), while the removal of the inhibitory ligands on DCs increases T cell proliferation (right panel).

[0529] As shown in **FIG. 8 and 9**, enzymatic removal of sialic acids from activated DCs increased T cell proliferation when compared to untreated activated DCs. These results indicate that sialic acids present on DCs act on T cells in a suppressive manner to restrict T cell proliferation when co-cultured with allogenic DCs. These results indicate that antibodies that block Siglec-9 on T cells or dendritic cells enhance T cell and/or dendritic cell functionality. CD3/CD28 Dynal beads were used as a positive control. Furthermore, these results indicate that blocking sialic acid interactions with DCs or any other cellular or biological source may increase T cell function.

Example 7: Inflammatory conditions induce Siglec-9 sialic acid ligand expression in myeloid cells

[0530] Human dendritic cells (DCs) were differentiated from peripheral blood monocytes with GM-CSF and IL-4 and cultured for 5 days. Immature human DCs were harvested on day 5 and co-cultured with sterile-filtered supernatant from B16, Lewis lung, MC38 tumor supernatant or 10 ng/ml LPS. 24 hours later Siglec-9 expression was determined by flow cytometry with a directly conjugated Siglec-9-PE antibody. Sialic acid ligand expression was assessed by incubation for 30 minutes on ice with 50 µg/ml soluble Siglec-9 fused to human IgG1-Fc, IgG1-Fc alone was used a negative control in the presence of human Fc block. Binding of the soluble receptor to sialic acids on cells was detected after a wash step and incubation for 30 minutes on ice with anti-human secondary conjugated to PE. Flow cytometry analysis was performed on a BD FACS Canto.

[0531] To elicit primary macrophages, human monocytes from peripheral human blood samples are isolated and either used directly or differentiated into macrophages with 50 µg/ml M-CSF for 5 days. In order to determine the role of Siglec-9 in inflammatory cytokine production, human macrophages are cultured with various inflammatory mediators, and cytokine levels are measured in

the culture supernatants. To generate human macrophages, monocytes from peripheral human blood samples are isolated and either used directly or differentiated into macrophages with 50 µg/ml M-CSF or dendritic cells with 100 µg/ml GM-CSF and 100 µg/ml IL-4 for 5 days. Cells are cultured for 5 days, and adherent cells were detached with 1mM EDTA in PBS. Cells are plated on 96-well plates at 10^5 cells/well and allowed to adhere for 4 h at 37°C. Cells are then stimulated with TLR agonists LPS (*Salmonella abortus equi*) or zymosan (*Saccharomyces cerevisiae*) at concentrations ranging from 0.01-100ng/ml (LPS) or 0.01-100 µg/ml (zymosan). Alternatively, macrophages are cultured in the presence of 10 ng/ml of the cytokine IL-4 or 50 ng/ml of IFN-γ. Cell culture supernatant are collected 24 or 48 hours after stimulation and the levels of TNFa, IL-6, IL-10, and MCP-1 cytokines are measured by using Cytometric Bead Array Inflammation Kit (BD) according to manufacturer's protocol. Macrophages stimulated with the inflammatory mediators LPS or zymosan are expected to secrete more inflammatory cytokines TNFa, IL-6, IL-10, and MCP-1 when treated with Siglec-9 antagonistic antibodies or with enzymes that remove the inhibitory glycol ligands.

[0532] **FIG. 10A and 10B** show that Siglec-9 expression is maintained on human dendritic cells after exposure to tumor supernatant. **FIG. 10C and 10D** show that tumor supernatant increases expression of sialic acid (a Siglec-9 ligand). **FIG. 10E and 10F** show that Siglec-9 expression is maintained on human dendritic cells during LPS-induced inflammation. **FIG. 10G and 10H** show that LPS-induced inflammation increases expression of sialic acid (a Siglec-9 ligand).

[0533] These results indicate that inflammatory conditions and tumor environment lead to upregulation of both Siglec-9 and sialic acid ligands. The results also demonstrate that increased Siglec-9 function can immunosuppress human primary dendritic cells. These results indicate that inhibiting Siglec-9 with downregulating or blocking antibodies may relieve immunosuppressed myeloid-derived or tumor-associated myeloid cells and restore immune function. These results further indicate that antibodies that block Siglec-9 on myeloid cells enhance myeloid cell functionality.

Example 8: Increased *E.coli* phagocytosis by dendritic cells with sialidase treatment

[0534] The purpose of the following Example was to test whether antagonistic anti-Siglec-9 antibodies and/or Siglec-9 bispecific antibodies induce phagocytosis of apoptotic neurons, nerve tissue debris, non-nerve tissue debris, bacteria, other foreign bodies, and disease-causing proteins, such as A beta peptide, alpha synuclain protein, Tau protein, TDP-43 protein, prion protein, huntingtin protein, RAN, translation products antigene, including the DiPeptide Repeats,(DPRs peptides) composed of glycine-alanine (GA), glycine-proline (GP), glycine-arginine (GR), proline-alanine (PA), or proline-arginine (PR) in cells from the myeloid lineage, such as monocytes, dendritic cells macrophages and microglia. The bispecific antibodies may be antibodies that recognize the Siglec-9 antigen and a second antigen that includes, without limitation, CD3, A beta peptide, antigen

or an alpha synuclain protein antigene or, Tau protein antigene or, TDP-43 protein antigene or, prion protein antigene or, huntingtin protein antigene, or RAN, translation Products antigene, including the DiPeptide Repeats,(DPRs peptides) composed of glycine-alanine (GA), glycine-proline (GP), glycine-arginine (GR), proline-alanine (PA), or proline-arginine (PR).

[0535] Monocytes from peripheral human blood samples were isolated using the RosetteSep™ monocyte isolation antibody cocktail (StemCell Technologies), and differentiated into dendritic cells with GM-CSF and IL-4 (PeproTech) and cultured for 5 days. Cells were plated on culture dishes in RPMI medium (Invitrogen) containing 10% fetal calf serum (Hyclone) and cultured at 37°C in 5% CO_2. Non-adherent cells were collected and used for phagocytosis experiments.

[0536] To conduct bacterial phagocytosis assay, dendritic cells were harvested and plated in 96 well flat bottom plates without cytokine for 2 hours. pHrodo-labeled *E. coli* BioParticles were resuspended according to manufacturer's protocol and were treated with 0.2 U/ml or 0.4 U/ml sialidase from *Vibro cholera*, or PBS alone for 2.5 hours at 37°C. BioParticles were washed, resuspended in RPMI and added 20 ug/well. Dendritic cells and *E. coli* cells were mixed, pelleted, and incubated at 37°C for 30 minutes. Cytochalasin D was added at 10 uM to control wells. Immediately prior to FACS analysis, cells were transferred to ice and washed 2X in FACS buffer at 4°C. pHrodo-labeled *E.coli* phagocytosis was detected in the PE channel by flow cytometry on a BD FACS Canto.

[0537] **FIG. 11** shows that sialidase treatment increased dendritic cell-mediated phagocytosis of *E. coli*. These results indicate that antagonistic anti-Siglec-9 antibodies and/or Siglec-9 bispecific antibodies that, for example, decrease cell surface expression of Siglec-9 and/or inhibit the binding of one or more Siglec-9 ligands to Siglec-9 can also be used to induce or otherwise increase phagocytosis.

Example 9: Increased expression of Siglec-9 ligand in brain sections of Alzheimer's disease patients

[0538] Sialic acid ligand expression was detected in the brains of normal and Alzheimer's disease (AD) patients by immunohistochemistry with biotinylated Siglec-9-Fc (R&D). The Siglec-9-Fc protein was biotinylated with the EZ-Link Sulfo-NHS-Biotin (Thermo Scientific) according to manufacturer's instructions. The IHC procedure, with the exception of the overnight incubation, was performed on a shaker. Samples were incubated for 15 minutes in 10% MeOH, 3% H_2O_2 in PBS, followed by 3 washes in PBS with 4% serum. Next, samples were incubated for 30 minutes in 0.2% Triton™-X100, 4% serum, 0.019% L-lysine in PBS, followed by an hour in primary antibody then overnight at 4°C in PBS with 4% serum. The next day samples were placed on a shaker for one hour followed by 3 washes, then samples were incubated for one hour in ABC buffer and washed 3 times. Samples were developed with a Vector DAB peroxidase kit, washed 3 times and dehydrated and

imaged with a Nikon 90i microscope with color camera, magnification of 200X. The quantification was performed using Nikon Elements BR image analysis software.

[0539] **FIG. 12** shows that sialic acid Siglec-9 ligands are upregulated in brain sections from two AD patients (Donor 1 and Donor 2). Data from 5 AD and 5 non-AD human brains show a statistically significant increase in expression of Siglec-9 sialic acid ligands by one way ANOVA, p=0.0159 (**FIG. 12**).

[0540] These results indicate that antibodies that remove Siglec-9 from the cell surface or block increased ligand interactions may relieve inhibitory Siglec-9-dependent signaling on microglia or other myeloid cells in the brain and restore normal functions to these cells, with beneficial effects for Alzheimer's disease.

Example 10: Increased expression of Siglec-9 ligand in cancer cells

In vitro studies

[0541] Mouse melanoma (B16), Lewis lung tumor cells, or colon carcinoma (MC38) were cultured and incubated with 50 µg/ml Siglec-9-Fc or an IgG1-Fc control on ice for 30 minutes to determine the level of Siglec-9 binding sialic acid ligand expression on these cell types. Binding interactions were performed in PBS with 0.25% BSA, 1mM $CaCl_2$. To detect Siglec-9 receptor binding, a goat anti-human Fc-PE secondary antibody was incubated for 30 minutes on ice after washing off unbound Siglec-9-Fc. Cells were washed three times in Binding Buffer and analyzed by flow cytometry on a BD FACS Canto.

[0542] **FIG. 13** shows that the expression of an inhibitory Siglec-9 ligand is increased at least 20-fold over background in melanoma cells, lung tumor cells, and colon cancer cells. Without wishing to be bound by theory, identification of inhibitory sialic acid ligand expression on these tumor cells indicates a contributing mechanism by which cancer cells evade immune recognition and clearance. Sialic acid ligands on tumor cells can mediate immunosuppressive interactions via Siglec-9 expressed on myeloid and lymphoid immune cells. These results indicate that antibodies that remove Siglec-9 from the cell surface or block increased ligand interactions may relieve inhibitory effects of tumors on the immune system and enhance cancer therapy.

In vivo studies

[0543] Four week-old female Taconic NOG mice were myeloablated approximately 24hours before engraftment with human fetal liver $CD34^+$ cells (100,000 cells/mouse) by intravenous injection. Reconstitution of immune cells was monitored by flow cytometry of peripheral blood. Twelve weeks after engraftment, the Champions tumorgraft melanoma model was implanted subcutaneously. Approximately 8-10 weeks later, when the tumor reached a size of 150-200 mm^3, blood, spleen and tumors were harvested and processed for analysis by flow cytometry on a BD FACS Canto. Flow cytometric analysis was performed to determine the expression of Siglec-9

in different compartments of the human ($hCD45^+$) immune system. Specifically, expression was analyzed in $CD3^+$ T cells, $CD14^+$ monocyte/macrophages and other CD3-CD14- human immune cells. Data were analyzed with FlowJo software version 10.0.6 by TreeStar.

[0544] As depicted in **FIG. 14**, the results indicated that Siglec-9 is expressed in peripheral blood, spleen, and tumor infiltrating immune cells in transplanted melanoma tumors of humanized mice. Importantly, Siglec-9 is significantly upregulated in human immune cells infiltrating melanoma tumors. This demonstrates the relevance of this mouse model to assessing the therapeutic ability of Siglec-9 antibodies.

Example 11: Reduction of the anti-inflammatory cytokine IL-10 in myeloid cells by antagonistic and/or bispecific Siglec-9 antibodies

[0545] The purpose of this Example is to test whether bone marrow-derived myeloid cells show a decrease in the anti-inflammatory cytokine IL-10 and other anti-inflammatory mediators following treatment with antagonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies and stimulation with 100 ng/ml LPS (Sigma), by co-culturing with apoptotic cells, or by a similar stimulus.

[0546] Isolation of human myeloid precursor cells is performed as previously described. Medium is changed after 5 d and cells are cultured for an additional 10-11 d. Supernatant is collected after 24 h, and the level of IL-10 and other anti-inflammatory cytokines released from the cells is determined by IL-10 ELISA according to manufacturer's instructions (R&D Systems) (JEM (2005), 201; 647–657; and PLoS Medicine (2004), 4 | Issue 4 | e124).

Example 12: Induction of phagocytosis in cells from the myeloid lineage by antagonistic and/or bispecific Siglec-9 antibodies

[0547] The purpose of this Example is to test whether antagonistic anti-Siglec-9 antibodies and/or Siglec-9 bispecific antibodies induce phagocytosis of apoptotic neurons, nerve tissue debris, non-nerve tissue debris, bacteria, other foreign bodies, and disease-causing proteins, such as A beta peptide, alpha synuclain protein, Tau protein, TDP-43 protein, prion protein, huntingtin protein, RAN, translation products antigene, including the DiPeptide Repeats,(DPRs peptides) composed of glycine-alanine (GA), glycine-proline (GP), glycine-arginine (GR), proline-alanine (PA), or proline-arginine (PR) in cells from the myeloid lineage, such as monocytes, Dendritic cells macrophages and microglia. The bispecific antibodies may be antibodies that recognize the Siglec-9 antigen and a second antigen that includes, without limitation, A beta peptide, antigen or an alpha synuclain protein antigene or, Tau protein antigene or, TDP-43 protein antigene or, prion protein antigene or, huntingtin protein antigene, or RAN, translation Products antigene, including the DiPeptide Repeats,(DPRs peptides) composed of glycine-alanine (GA), glycine-proline (GP), glycine-arginine (GR), proline-alanine (PA), or proline-arginine (PR).

[0548] Monocytes from peripheral human blood samples are isolated using the RosetteSep monocyte isolation antibody cocktail (StemCell Technologies) and differentiated into macrophages, neutrophils, and NK cells with 50 µg/ml M-CSF (PeproTech) for 5 days. Cells are plated on culture dishes in RPMI medium (Invitrogen) containing 10% fetal calf serum (Hyclone) and cultured at 37°C in 5% CO_2. Adherent cells are collected by gentle scraping and used for phagocytosis experiments.

[0549] Human microglial cells are prepared from peripheral blood monocytes by culture in serum-free RPMI with 1% Pen/Strep, 10 ng/ml GM-CSF, 10 ng/ml M-CSF, 10 ng/ml beta-NGF, 100 ng/ml CCL-2, 100ng/ml IL-34 according to protocols described in Etemad et al., *JI* (2012), and Ohgidani et al., *Scientific Reports* (2014). Cells were harvested at day 7-10 when ramified morphology appeared.

[0550] To conduct phagocytosis assays microglia, macrophages, neutrophils, NK cells or dendritic cells are cultured with apoptotic neurons, nerve tissue debris, non-nerve tissue debris, bacteria, other foreign bodies, and disease-causing proteins. Neurons are cultured for 5-10 d, and okadaic acid is then added at the final concentration of 30 nM for 3 h to induce apoptosis. Neuronal cell membranes are labeled with CellTracker CM-DiI membrane dye (Molecular Probes). After incubation, apoptotic neurons or other targets of phagocytosis are washed two times and added to the transduced microglial culture at an effector/target ratio of 1:20. At 1 and 24 h after addition of apoptotic neurons, the number of microglia having phagocytosed neuronal cell membranes is counted under a confocal fluorescence microscope (Leica). Apoptotic cells are counted in three different areas at a magnification of 60. The amount of phagocytosis is confirmed by flow cytometry. Moreover, 24, 48, or 72 h after the addition of apoptotic neurons, cells are collected and used for RT-PCR of cytokines.

[0551] To conduct microsphere bead or bacterial phagocytosis assay, microglia, macrophages, neutrophils, NK cells, or dendritic cells are treated with anti-Siglec-9 agonistic antibodies. Cells are harvested and plated in 96 well flat bottom plates without cytokine for 2 hours. pHrodo-labeled *E. coli* BioParticles are resuspended according to manufacturer's protocol and are treated with 0.2 U/ml or 0.4 U/ml sialidase from *Vibro cholera*, or PBS alone for 2.5 hours at 37°C. BioParticles are washed, resuspended in RPMI and added 20 µg/well. Cells and *E. coli* were mixed, pelleted, and incubated at 37°C for 30 minutes. Cytochalasin D is added at 10uM to control wells. Immediately prior to FACS analysis, cells are transferred to ice and washed 2X in FACS buffer at 4°C. The pHrodo-labeled *E.coli* phagocytosis is detected in the PE channel by flow cytometry on a BD FACS Canto.

[0552] After 24 h, 1.00 µm of red fluorescent microsphere beads (Fluoresbrite Polychromatic Red Mi-crospheres; Polysciences Inc.) are added for 1 h. Phagocytosis of microsphere beads by microglia is analyzed by fluorescence microscopy. Furthermore, microglia are collected from the culture plates and analyzed by flow cytometry. The percentage of microglia having phagocytosed

beads is determined. Because phagocytosis varies from one experiment to the other, the relative change in phagocytosis is also determined. Data are shown as the relative change in phagocytosis between microglia cultured with agonistic antibodies and control antibody.

[0553] To conduct RT-PCR for analysis of inflammatory gene transcripts, microglia are transduced with a Siglec-9 vector or a GFP1 control vector. Cells are then cultured on dishes and treated with anti-Siglec-9 agonistic antibodies. After 24, 48, and 72 h, RNA is isolated from microglia using an RNeasy Mini Kit (QIAGEN). RNA is also collected from microglia that have been transduced with sh-Siglec-9 RNA, sh-control RNA, wSiglec-9, GFP2, mtDAP12-GFP, and GFP1 vector and co-cultured with apoptotic neurons for 48 h.

[0554] Reverse transcription of RNA is then performed. Quantitative RT-PCR by SYBR Green is performed on an ABI Prism 5700 Sequence Detection System (PerkinElmer). Amplification of GAPDH is used for sample normalization. The amplification protocol followed the GeneAmp 5700 Sequence Detection System Software (version 1.3). For detection of GAPDH, TNF-alpha, IL-1, NOS2, and TGF-beta transcripts, the following forward and reverse primers were used at final concentrations of 200 nM:

GAPDH forward primer: 5'-CTCCACTCACGGCAAATTCAA-3' (SEQ ID NO: 241), and GAPDH reverse primer: 5'-GATGACAAGCTTCCCATTCTCG-3' (SEQ ID NO: 242);

TNF-α forward primer: 5'-CCGTCAGCCGATTTGCTATCT-3' (SEQ ID NO: 243), and TNF-α reverse primer: 5'-ACGGCAGAGAGGAGGTTGACTT-3' (SEQ ID NO: 244);

IL-1α forward primer: 5'-ACAA- CAAAAAAGCCTCGTGCTG-3' (SEQ ID NO: 245), and IL-1α reverse primer: 5'-CCATTGAGGTGGAGAGCTTTCA-3' (SEQ ID NO: 246);

NOS2 forward primer: 5'-GGCAAACCCAAGGTCTACGTTC-3' (SEQ ID NO: 247), NOS2 reverse primer: 5'-TACCTCATTGGCCAGCTGCTT-3' (SEQ ID NO: 248); and

TGF-β1 forward primer: 5'-AGGACCTGGGTTGGAAGTGG-3' (SEQ ID NO: 249), and TGF-β1reverse primer: 5'-AGTTGGCATGGTAGCCCTTG-3' (SEQ ID NO: 250).

[0555] To conduct amyloid phagocytosis assay, HiLyteFluor™ 647 (Anaspec)-Abeta-(1–40) is resuspended in Tris/EDTA (pH 8.2) at 20 mM and then incubated in the dark for 3 d at 37°C to promote aggregation. Microglia, macrophages, neutrophils, NK cells, or dendritic cells are pretreated in low serum (0.5% FBS supplemented with insulin), LPS (50 ng/ml), IFNc (100 units/ml), and anti-Siglec-9 antagonistic antibodies for 24 h prior to the addition of aggregated fluorescently labeled a beta peptide. Amyloid phagocytosis and surface expression of Siglec-9 are determined by flow cytometric analysis 5 h post-addition of 100 nM aggregated HiLyteFluor™ 647–Ab-(1–40) (ASN NEURO (2010) 2(3): 157-170). Phagocytosis of other disease-causing proteins is conducted in a similar manner.

Example 13: Induction of SYK and/or ERK activation by antagonistic Siglec-9 antibodies and/or bispecific antibodies

[0556] The purpose of this Example is to test whether agonistic anti-Siglec-9 antibodies and/or Siglec-9 bispecific antibodies induce Syk and ERK activation.

[0557] Microglia, macrophages, neutrophils, NK cells, or dendritic cells are exposed to agonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies for 1 h. After stimulation, cells are lysed in reducing sample buffer for Western blot analysis. Phosphorylation of ERK and total amount of Syk and/or ERK are determined by immuno-detection with anti-phospho-Syk or ERK and anti- Syk or ERK antibodies, respectively (both from Cell Signaling Technology) by Western blot analysis (JEM (2005), 201, 647–657).

Example 14: Siglec-9 antibodies and/or bispecific antibodies induce Syk phosphorylation

[0558] Spleen tyrosine kinase (Syk) is an intracellular signaling molecule that functions downstream of Siglec-9 by phosphorylating several substrates, thereby facilitating the formation of a signaling complex leading to cellular activation and inflammatory processes. The ability of agonist Siglec-9 antibodies to induce Syk activation is determined by culturing human macrophages, human neutrophils, human NK cells, and human primary dendritic cells and measuring the phosphorylation state of Syk protein in cell extracts.

[0559] Human primary dendritic cells are starved for 4 hours in 1% serum RPMI and then removed from tissue culture dishes with PBS-EDTA, washed with PBS, and counted. The cells are coated with full-length agonist Siglec-9 antibodies, or control antibodies for 15 minutes on ice. After washing with cold PBS, cells are incubated at 37°C for the indicated period of time in the presence of goat anti-human IgG. After stimulation, cells are lysed with lysis buffer (1% v/v NP-40%, 50 Mm Tris-HCl (pH 8.0), 150 mM NaCl, 1 mM EDTA, 1.5 mM $MgCl_2$, 10% glycerol, plus protease and phosphatase inhibitors) followed by centrifugation at 16,000 *g* for 10 min at 4°C to remove insoluble materials. Lysates are then immunoprecipitated with anti-Syk Ab (4D10 for human DCs, Santa Cruz Biotechnology). Precipitated proteins are fractionated by SDS-PAGE, transferred to PVDF membranes and probed with anti-phosphotyrosine Ab (4G10, Millipore). To confirm that all substrates are adequately immunoprecipitated, immunoblots are reprobed with anti-Syk (Novus Biological, for human DCs). Visualization is performed with the enhanced chemiluminescence (ECL) system (GE healthcare), as described (*e.g.*, Peng et al., (2010) Sci Signal., 3(122): ra38).

Example 15: Induction of CCR7 and migration toward CCL19 and CCL21 in microglia, macrophages, neutrophils, NK cells, and dendritic cells by antagonistic Siglec-9 antibodies and/or bispecific antibodies

[0560] The purpose of this Example is to test whether anti-Siglec-9 antibodies and/or Siglec-9 bispecific antibodies induce CCR7 and migration toward CCL19 and CCL21 in microglial cells, macrophages, neutrophils, NK cells, and dendritic cells.

[0561] Microglial, macrophages or dendritic cells are either cultured with agonistic anti-Siglec-9 and/or Siglec-9/DAP12 bispecific antibodies, or with a control antibody. Cells are collected after 72 h, immuno-labeled with CCR7 specific anti-bodies, and analyzed by flow cytometry.

[0562] To determine any functional consequences of increased CCR7 expression, a chemotaxis assay is performed. Microglia, macrophages, neutrophils, NK cells, or dendritic cells are stimulated via Siglec-9 with the antagonistic anti-Siglec-9 and/or Siglec-9/DAP12 bispecific antibodies and placed in a two-chamber system. The number of microglial cells migrating toward the chemokine ligands CCL19 and CCL21 is quantified (JEM (2005), 201, 647–657).

[0563] For the chemotaxis assay, microglial, macrophages, neutrophils, NK cells, or dendritic cells are exposed to the antagonistic anti-Siglec-9 antibodies or Siglec-9 bispecific antibodies and treated with 1 µg/ml LPS. Microglia, macrophages, neutrophils, NK cells, or dendritic cells are transferred into the upper chamber of a transwell system (3 µm pore filter; Millipore) containing 450µl medium with 100 ng/ml CCL19 or CCL21 (both from PeproTech) in the lower chamber. After a 1 h incubation period, the number of microglial macrophages, neutrophils, NK cells, or dendritic cells that have migrated to the lower chamber is counted in three independent areas by microscopy (JEM (2005), 201, 647–657).

Example 16: Induction of F-actin in microglia, macrophages, neutrophils, NK cells, and dendritic cells by antagonistic Siglec-9 antibodies and/or bispecific antibodies

[0564] The purpose of this Example is to test whether antagonistic anti-Siglec-9 antibodies, or Siglec-9 bispecific antibodies induce F-actin in microglial cells, macrophages, neutrophils, NK cells, and dendritic cells.

[0565] Microglia, macrophages, neutrophils, NK cells, or dendritic cells and other cells of interest that are transduced with Siglec-9 or that express Siglec-9 are added to culture plates and then exposed to antagonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies, or a control antibody. Cells are fixed, blocked, and then stained with Alexa Fluor 546-conjugated phalloidin (Molecular Probes) after 1 h and F-actin is labeled with a fluorescence dye. Images are collected by confocal laser scanning microscopy with a 40x objective lens (Leica). (JEM (2005), 201, 647–657).

Example 17: Induction of osteoclast production and increased rate of osteoclastogenesis by antagonistic Siglec-9 antibodies and/or bispecific antibodies

[0566] The purpose of this Example is to test whether antagonistic anti-Siglec-9 antibodies and/or Siglec-9 bispecific antibodies induce osteoclast production and increase the rate of osteoclastogenesis.

[0567] Human monocyte derived monocyte/macrophage are maintained in RPMI-1640 medium (Mediatech), or another appropriate medium, supplemented with 10% FBS (Atlantic Biologics, Atlanta, GA, USA) and penicillin-streptomycin-glutamine (Mediatech). Cells are seeded in 96-well plates with 3000 cells/well in alpha-MEM medium supplemented with 10% FBS, penicillin-streptomycin-glutamine, 50 ng/ml RANKL, and 20 ng/ml M-CSF. The medium is changed every 3 days, exposed to anti-Siglec-9 antagonistic antibodies and the number of multinucleated (at least three nuclei) $TRACP^+$ osteoclasts are counted and scored by light microscopy. To determine complexity and size, osteoclasts are counted by number of nuclei (>10 or 3–10 nuclei). The surface area of osteoclasts is also measured by using Image J software (NIH). In addition, expression levels of osteoclasts genes are determined. Total RNA is extracted from osteoclastogenic cultures at different time points using TRIzol reagent (Invitrogen). After first-strand cDNA synthesis using a SuperScript III kit (Invitrogen), real-time quantitative PCR reactions are performed for Nfatc1, Acp5, Ctsk, Calcr, and Ccnd1. Relative quantification of target mRNA expression is calculated and normalized to the expression of cyclophilin and expressed as (mRNA of the target gene/mRNA of cyclophilin) 3 $X10^6$. (J. OF BONE AND MINERAL RESEARCH (2006), 21, 237–245; *J Immunol* 2012; 188:2612-2621).

[0568] Alternatively, macrophages, neutrophils, or NK cells are seeded onto the plates in triplicate wells and treated with RANKL, M-CSF, and with an anti-Siglec-9 and/or Siglec-9 bispecific antibody, or an isotype-matched control monoclonal antibody. The medium is changed every 3 days until large multinucleated cells are visible. After 3 to 5 days in culture, cells are fixed with 3.7% formaldehyde in PBS for 10 min. Plates are then washed twice in PBS, incubated for 30 s in a solution of 50% acetone and 50% ethanol, and washed with PBS. Cells are stained for tartrate-resistant acid phosphatase (TRAP) with a kit from Sigma (product 435). Multinucleated (more than two nuclei), TRAP-positive cells are then counted by light microscopy, as described (*e.g.*, Peng et al., (2010) Sci Signal., 3(122): ra38).

Example 18: *In vivo* protection from EAE and cuprizone in a whole animal

[0569] Adult 7-9 week-old female C57BL/6 mice (obtained from Charles River Laboratories) are injected in the tail base bilaterally with 200 µl of an innoculum containing 100 µg of myelin oligodendrocyte glycoprotein peptide 35–55 (amino acids MEVGWYRSPFSRVVHLYRNGK (SEQ

ID NO: 251); Seqlab) and 1 mg of Mycobacterium tuberculosis H37 Ra (Difco) in incomplete Freund adjuvant (Difco). Pertussis toxin (200 ng; List Bio- logical Laboratories) is injected at day 0 and at day 2 after immunization. Clinical signs are scored as follows: 0, no clinical signs; 1, complete limp tail; 2, complete limp tail and abnormal gait; 3, one hind-limb paraparesis; 4, complete hindlimb paraparesis; and 5, fore- and hind-limb paralysis or moribund. Only mice having disease onset (clinical score of 1 or more) at day 14 are used for experiments. Agonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies are injected intraperitoneally or intravenously in EAE-diseased mice at the day of the first clinical symptoms or at any other desired time (PLoS Med (2007) 4(4): e124).

[0570] Young or aged wild-type (WT) mice are fed a standard diet (Harlan) containing 0.2 % cuprizone (CPZ) powdered oxalic bis(cyclohexylidenehydrazide) (Sigma-Aldrich) for 4, 6 or 12 weeks. For Histological and immunohistochemical analyses brains are removed after mouse perfusion with 4 % paraformaldehyde (PFA), fixed in 4 % PFA for 24 h, followed by immersion in 30 % sucrose for 24–48 h. To evaluate myelin integrity and damage, as well as cell proliferation and inflammation sections or mouse brain are stained with anti-MBP (1:100; Abcam, ab7349), -dMBP (1:2000; Millipore, ab5864), -β APP (1:100; Invitrogen, 51-2700), -SMI-31 (1:1000;Covance, smi-31R), -Iba1 (1:600; Wako, 019-19741),-BrdU (1:250; Abcam, ab1893), -GFAP (1:200; Invitrogen,13-0300), -iNOS (1:100; BD Pharmingen, 610329), -LPL(1:400, from Dr. G. Olivecrona) and -MHC II (1:100; BD Pharmingen, 553549). For behavioral effects of the antibodies, mice are analyzed for locomotor activity using transparent polystyrene enclosures and computerized photobeam instrumentation. General activity variables (total ambulations, vertical rearings), along with indices of emotionality including time spent, distance traveled and entries, are analyzed. A battery of sensorimotor tests is performed to assess balance (ledge and platform), strength (inverted screen), coordination (pole and inclined screens) and initiation of movement (walking initiation). Motor coordination and balance are studied using a rotarod protocol (Cantoni et al., Acta Neuropathol (2015)129(3):429-47).

Example 19: Characterization of the therapeutic use of antagonistic Siglec-9 antibodies and/or Siglec-9 bispecific antibodies in established animal models of traumatic brain injury

[0571] The therapeutic utility of antagonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies is tested in established animal models of traumatic brain injury (Tanaka, Y et al. (2013) Neuroscience 231 49-60). Either regular mice or mice that express the human Siglec-9 gene under a bacterial artificial chromosome or under a myeloid promoter can be used. For example, a model of traumatic brain injury that induces the activation of microglia and astrocytes is used. Eight or nine week-old male C57BL/6J WT mice are used (purchased from Charles River Laboratories or Jackson Laboratories). Mice are anesthetized by intraperitoneal administration of xylazine hydrochloride (8 mg/kg) and chloral hydrate (300 mg/kg) dissolved in sterile saline, and subsequently placed in a

stereotaxic apparatus (Narishige, Tokyo, Japan). An incision is made in the scalp and the cranium is exposed. The periosteum is cleaned from the skull, a hole is drilled over the right cerebral hemisphere with a dental drill, and the duramater is removed with a needle tip. A stainless steel cannula, with a 0.5 mm outer diameter, is used to make a longitudinal stab wound in the right hemisphere. The cannula is positioned at 1.3 mm lateral to the midline, and 1 mm posterior to bregma, and introduced into the brain until the tip reaches a depth of 2 mm. The cannula is then shifted 2 mm caudally (bregma 3 mm), and then shifts back 2 mm rostrally to its initial position. Finally, the cannula is removed from the brain, and the scalp wound is sutured. Mice are then treated with antagonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies according to standard procedures and then analyzed by histology and immunofluorescence staining and behavioral tests. Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 20: Characterization of therapeutic use of antagonistic Siglec-9 antibodies and/or Siglec-9 bispecific antibodies in a model of neuro-inflammation and neuron loss following toxin-induced injury

[0572] The therapeutic utility of agonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies is tested in a model of neuro-inflammation and neuron loss following toxin-induced injury (Martens, LH et al., (2012) The Journal of Clinical Investigation, 122, 3955). Three-month-old regular mice, are treated with 4 intraperitoneal injections of MPTP (1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine) per day for 2 days (4 μg/g body weight) (Sigma-Aldrich) or PBS. Mice are treated with agonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies according to standard protocols and then analyzed using Stereological counting to quantify dopamine neurons and microglia in the substantia nigra pars compacta (SNpc), as described. Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 21: Characterization of the therapeutic use of antagonistic Siglec-9 antibodies and/or Siglec-9 bispecific antibodies in animal models of aging, seizures, spinal cord injury, retinal dystrophy, frontotemporal dementia, and Alzheimer's disease

[0573] The therapeutic utility of antagonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies is tested in animal models for aging, seizures, spinal cord injury, retinal dystrophy, frontotemporal dementia, Huntington disease, Parkinson's disease amyotrophic lateral sclerosis and Alzheimer's disease, as previously described (*e.g.*, Beattie, MS et al., (2002) Neuron 36, 375-386; Volosin, M et al., (2006) J. Neurosci. 26, 7756-7766; Nykjaer, A et al., (2005) Curr. Opin. Neurobiol. 15, 49-57;

Jansen, P et al., (2007) Nat. Neurosci. 10, 1449-1457; Volosin, M et al., (2008) J. Neurosci. 28, 9870-9879; Fahnestock, M et al., (2001) Mol. Cell Neurosci. 18, 210-220; Nakamura, K et al., (2007) Cell Death. Differ. 14, 1552-1554; Yune, T et al., (2007) Brain Res. 1183, 32-42; Wei, Y et al., (2007) Neurosci. Lett. 429, 169-174; Provenzano, MJ et al., (2008) Laryngoscope 118, 87-93; Nykjaer, A et al., (2004) Nature 427, 843-848; Harrington, AW et al., (2004) Proc. Natl. Acad. Sci. U.S.A. 101, 6226-6230; Teng, HK et al., (2005) J. Neurosci. 25, 5455-5463; Jansen, P et al., (2007) Nat. Neurosci. 10, 1449-1457; Volosin, M et al., (2008) J. Neurosci. 28, 9870-9879; Fan, YJ et al., (2008) Eur. J. Neurosci. 27, 2380-2390; Al-Shawi, R et al., (2008) Eur. J. Neurosci. 27, 2103-2114; and Yano, H et al., (2009) J. Neurosci. 29, 14790-14802). Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 22: Characterization of the therapeutic use of antagonistic Siglec-9 antibodies and/or Siglec-9 bispecific antibodies in a model of infection

[0574] The therapeutic utility of antagonistic anti-Siglec-9 antibodies and/or Siglec-9 bispecific antibodies is tested in a model of infection. For example, *Listeria monocytogenes* or other infection in normal mice can be used, as previously described (*e.g.*, Yin, F et al., (2009) J. Exp. Med, 207, 117-128). Either regular mice or mice that express the human Siglec-9 gene under a bacterial artificial chromosome or under a myeloid promoter can be used.

Example 23: Characterization of the therapeutic use of antagonistic Siglec-9 antibodies and/or Siglec-9 bispecific antibodies in a model of inflammatory diseases

[0575] The therapeutic utility of antagonistic anti-Siglec-9 and/or Siglec-9 bispecific antibodies is tested in a model of inflammatory diseases. For example rheumatoid arthritis or in an established model of another inflammatory disease (Mizoguchi (2012) Prog Mol Biol Transl Sci.,105:263-320; and Asquith et al., (2009) Eur J Immunol. 39:2040-4). Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 24: Screening for anti-Siglec-9 antibodies and/or Siglec-9 bispecific antibodies that induce or inhibit phosphorylation of Siglec-9 and downstream signaling molecules.

[0576] Cells (J774, RAW 264.7, BMM cells, human primary monocytes, macrophages, neutrophils, NK cells, dendritic cells, T cells, microglia, or osteoclasts) are removed from tissue culture dishes with PBS-EDTA, washed with PBS, and counted. Cells are incubated with an anti-

Siglec-9 antibodies and/or Siglec-9 bispecific antibody or with an isotype-matched control antibody at 1 μg/10^6 cells for 20 min on ice or under other conditions. Cells are lysed in ice-cold radioimmunoprecipitation assay (RIPA) buffer for 20 min followed by centrifugation at 16,000 *g* for 10 min at 4°C to remove insoluble materials. The resulting supernatant is subjected to immunoprecipitation reactions with the indicated antibodies (DAP12, ERK, or AKT) and protein A- or protein G-agarose (Sigma). The beads are extensively washed with RIPA buffer and the proteins are separated by SDS-polyacrylamide gel electrophoresis (SDS-PAGE). The proteins are then transferred to nitrocellulose membranes by Western blotting, incubated with the appropriate antibodies (antibodies that specifically recognize phosphorylated tyrosine or phosphorylated form of DAP12, ERK, Syk, LCK, FYN, C-Cbl, VAV, or AKT) and visualized with the enhanced chemiluminescence (ECL) system (Pierce), as described (*e.g.*, Peng et al., (2010) Sci Signal., 3(122): ra38).

Example 25: Screening for anti-Siglec-9 and/or Siglec-9 bispecific antibodies that induce or inhibit calcium flux

[0577] BMM cells are washed twice with HEPES-containing buffer [20 mM HEPES (pH 7.3), 120 mM NaCl, 1 mM CaCl, 1 mM MgCl, 5 mM KCl, glucose (1 mg/ml), bovine serum albumin (1 mg/ml)] followed by incubation in 0.05% Pluronic F-127 (Invitrogen) and 1 μM Indo-1 AM (Invitrogen) for 20 min at 37°C. Cells are washed twice with HEPES buffer and are then stimulated with an anti-Siglec-9 antibodies and/or Siglec-9 bispecific antibody (16 μg/ml) or with a control antibody (16 μg/ml) and monitored by spectrophotometer (PTL Photon Technology International). The Indo-1 fluorescence emission is converted to calcium (Ca^{2+}) according to manufacturer's instructions (*e.g.*, Peng et al., (2010) Sci Signal., 3(122): ra38).

Example 26: Siglec-9 increases the survival of macrophages, neutrophils, NK cells, and dendritic cells

[0578] To evaluate the role of Siglec-9 in cell survival, human or mouse macrophages, neutrophils, NK cells, microglia, T cells, and dendritic cells are cultured in the presence of inflammatory mediators, and cell survival is measured.

[0579] Murine bone marrow precursor cells from Siglec-9-expressing or WT mice are obtained by flushing tibial and femoral marrow cells with cold PBS. After one wash with PBS, erythrocytes are lysed using ACK Lysing Buffer (Lonza), washed twice with PBS and suspended at 0.5x10^6 cells/ml in complete RPMI media (10% FCS, Pen/Strep, Gln, neAA) with the indicated amounts of 50ng/ml M-CSF to produce macrophages, neutrophils, or NK cells, or 10ng/ml GM-CSF to produce dendritic cells. For M2-type macrophages, 10ng/ml IL-4 is added to the cultured cells. For M1-type macrophages, 50 ng/ml IFN is added. In some experiments LPS or zymosan is added to the cell

culture at day 5 at a concentration range of 1 µg/ml-0.01 ng/ml. Recombinant cytokines are purchased from Peprotech.

[0580] To analyze viability of bone marrow-derived macrophages, neutrophils, or NK cells, cells are prepared as above and cultured in MCSF. Cells are either plated at 10^5/200 ul in a 96-well plate (for viability analysis using a luciferase based-assay) or at $0.5x10^6$/1ml in a 6-well plate (for Tripan Blue exclusion cell count) in non-tissue culture treated plates. Media containing fresh M-CSF is added at day 3. At the indicated time points cells are gently detached from the plates with 3 mM EDTA and counted using a Burker chamber. For FACS analysis of live cells, macrophages are cultured either in 50 ng/ml MCSF for 6 days (+MCSF) or in 50 ng/ml MCSF for 4 days before MCSF is removed for an additional 36 hrs (-MCSF). Cells are stained using CD11b antibody and DAPI. For luciferase viability assays, cell viability is measured at day 5 of culture in graded concentrations of growth factors GMCSF (dendritic cells), MCSF (M1 macrophages), or MCSF+IL-4 (M2 macrophages). Cells are directly incubated with ToxGlo reagent (Promega) and luciferase activity (luminescence) is determined. For FACS analysis of viable macrophages cultured in the presence of inflammatory mediators IFN, LPS, or zymosan, cells are collected at day 5 and stained using CD11b antibody and DAPI.

Example 27: Siglec-9 increases the expression of inflammatory cell surface markers on macrophages, neutrophils, or NK cells

[0581] In order to determine the role of Siglec-9 in inflammatory marker expression, macrophages, neutrophils, and NK cells are cultured with various inflammatory mediators, and the expression of surface markers (e.g., CD86 and CD206) is measured in the presence or absence of Siglec-9 antibodies.

[0582] Macrophages, neutrophils, and NK cells are plated and allowed to adhere for 4 h at 37°C, and TLR agonists LPS (*Salmonella abortus equi*) and zymosan (*Saccharomyces cerevisiae*) are added at concentrations ranging from 0.01-100 ng/ml (LPS) or 0.01-10 µg/ml (zymosan). Alternatively, macrophages, neutrophils, and NK cells are cultured in the presence of the cytokines IL-4 (10 ng/ml) or IFN (0.5-50 ng/ml). FACS analysis of CD86 and CD206 is performed on a BD FACS Canto 48 hours later. Data analysis is performed with FlowJo (TreeStar) software version 10.0.7.

Example 28: Analysis of the anti-cancer effect of Siglec-9 antibodies and/or bispecific antibodies

[0583] Groups of 10 C57Bl6/NTac mice at 8 weeks (+/- 2 weeks) of age, either regular mice or mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a myeloid promoter, are challenged subcutaneously with tumor cells (e.g. $1x10^5$ to $1x10^6$ MC38, Lewis Lung, or B16 cells) suspended in 100ul PBS. Animals are anesthetized with isoflurane prior to implant. Starting at day 2, groups of mice are injected i.p. every 3 days for 4 doses with 200ug of each of

antagonistic anti-Siglec-9 antibodies. Tumor growth is monitored with a caliper biweekly to measure tumor growth starting at day 4. The endpoint of the experiment is a tumor volume of 2000 mm^3 or 60 days. Tumor growth and % survival are the outcome measures. Reduced tumor take and growth rate, reduced number of tumor infiltrating immune suppressor macrophages, neutrophils, and/or NK cells, and increased effector T cell influx into the tumor indicate the anti-cancer effects of blocking anti-Siglec-9 antibodies.

[0584] Immunodeficient mice or immunodeficient transgenic mice that express human IL-3, human GM-CSF, human IL-6, human IL-2, and were seeded with human immune cells from human placenta, fetal liver, peripheral blood or another source can also be used for such studies (Ito M et al., (2008) Curr Top Microbiol Immunol.;324:53-76; Ito R., et al., (2012) *Cellular & Molecular Immunology* 9, 208–214; Brehm et al., (2010) Curr Opin Endocrinol Diabetes Obes. 17(2): 120–125; Zhou et al., (2013) Cancer Letters. 344,13–19). Such mice can be used in conjunction with either cell line tumors or patient-derived human tumor xenografts (Siolas et al., (2013) Cancer Res.; 73(17): 5315–5319).

[0585] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 29: Analysis of additive anti-tumor effect of combination therapy that combines Siglec-9 antibodies and/or bispecific antibodies with antibodies against inhibitory checkpoint proteins or inhibitory cytokines/chemokines and their receptors

[0586] Groups of 15 C57Bl6/NTac mice at 8 weeks (+/- 2 weeks) of age are challenged subcutaneously with tumor cells as described in Example 28. Animals are anesthetized with isoflurane prior to implant. Starting at day 2, mice are injected i.p. every 3 days for 4 doses with 200ug anti-Siglec-9 antibodies alone or in combination with antibodies against checkpoint proteins (e.g. anti-PDL1 mAb clone 10F.9G2 and/or anti-CTLA4 mAb clone UC10-4F10-11) at day 3, 6, and 9. Treatment groups include anti-Siglec-9; anti-CTLA4; anti-PDL1; anti-Siglec-9+anti-CTLA4; anti-Siglec-9+anti-PDL1; and isotype control. Tumor growth is monitored with a caliper biweekly to measure tumor growth starting at day 4. The endpoint of the experiment is a tumor volume of 2000 mm^3 or 60 days. Tumor growth and % survival are the outcome measures. A decrease in tumor growth and an increase in % survival with combination therapy indicate that anti-Siglec-9 antibodies have additive or synergistic therapeutic effects with anti-checkpoint antibodies. Antagonistic antibodies against checkpoint molecules include antibodies against PDL1, PDL2, PD1, CTLA4, B7-H3, B7-H4, HVEM, LIGHT, BTLA, KIR, GAL9, TIM1, TIM3, TIM4, CD39, CD73, TIGIT, VISTA, A2AR, LAG-3, and Phosphatidyl Serine. Antagonist antibodies against inhibitory cytokines include antibodies against CCL2, CSF-1, and IL-2. Immuno-deficient mice or immuno-deficient transgenic

mice that express human IL-3, human GM CSF, human IL-6, human IL-2, and were seeded with human immune cells from human placenta, fatal liver, peripheral blood or another source can also be used for such studies (Ito M et al., (2008) Curr Top Microbiol Immunol.;324:53-76; Ito R., et al., (2012) *Cellular & Molecular Immunology* 9, 208–214; Brehm et al., (2010) Curr Opin Endocrinol Diabetes Obes. 17(2): 120–125; Zhou et al., (2013) Cancer Letters. 344,13–19). Such mice can be used in conjunction with either cell line tumors or Patient derived human tumors xenografts (Siolas et al., (2013) Cancer Res.; 73(17): 5315–5319).

[0587] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 30: Analysis of additive anti-tumor effect of combination therapy that combines Siglec-9 antibodies and/or bispecific antibodies with antibodies that activate stimulatory checkpoint proteins

[0588] Groups of 15 C57Bl6/NTac mice at 8 weeks (+/- 2 weeks) of age are challenged subcutaneously with tumor cells as described in Example 28. Animals are anesthetized with isoflurane prior to implant. Starting at day 2, mice are injected i.p. every 3 days for 4 doses with 200 ug anti-Siglec-9 antibodies alone or in combination with agonistic antibodies that activate stimulatory checkpoint proteins (e.g. OX40 or ICOS mAb) at day 3, 6, and 9. Tumor growth is monitored with a caliper biweekly to measure tumor growth starting at day 4. The endpoint of the experiment is a tumor volume of 2000 mm^3 or 60 days. Tumor growth and % survival are the outcome measures. A decrease in tumor growth and an increase in % survival with combination therapy indicate that anti-Siglec-9 antibodies have additive or synergistic therapeutic effects with stimulatory checkpoint antibodies. Stimulatory checkpoint antibodies include agonistic/stimulatory antibodies against CD28, ICOS, CD137, CD27, CD40, and GITR.

[0589] Immuno-deficient mice or immuno-deficient transgenic mice that express human IL-3, human GM CSF, human IL-6, human Il2, and were seeded with human immune cells from human placenta, fatal liver, peripheral blood or another source can also be used for such studies (Ito M et al., (2008) Curr Top Microbiol Immunol.;324:53-76; Ito R., et al., (2012) *Cellular & Molecular Immunology* 9, 208–214; Brehm et al., (2010) Curr Opin Endocrinol Diabetes Obes. 17(2): 120–125; Zhou et al., (2013) Cancer Letters. 344,13–19). Such mice can be used in conjunction with either cell line tumors or Patient derived human tumors xenografts (Siolas et al., (2013) Cancer Res.; 73(17): 5315–5319).

[0590] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lentivirus or AAV virus containing human Siglec-9 cDNA.

Example 31: Analysis of additive anti-tumor effect of combination therapy that combines Siglec-9 antibodies and/or bispecific antibodies with stimulatory cytokines

[0591] Groups of 15 C57Bl6/NTac mice at 8 weeks (+/- 2 weeks) of age are challenged subcutaneously with tumor cells as described in Example 28. Animals are anesthetized with isoflurane prior to implant. Starting at day 2, mice are injected i.p. every 3 days for 4 doses with 200ug anti-Siglec-9 antibodies alone or in combination with stimulatory cytokines (e.g. IL-12, IFN-a). Tumor growth is monitored with a caliper biweekly to measure tumor growth starting at day 4. The endpoint of the experiment is a tumor volume of 2000 mm^3 or 60 days. Tumor growth and % survival are the outcome measures. A decrease in tumor growth and an increase in % survival with combination therapy indicate that anti-Siglec-9 antibodies have additive or synergistic therapeutic effects with immune-stimulatory cytokines. Stimulatory cytokines include IFN-a/b, IL-2, IL-12, IL-18, GM-CSF, and G-CSF.

[0592] Immuno-deficient mice or immuno-deficient transgenic mice that express human IL-3, human GM CSF, human IL-6, human Il2, and were seeded with human immune cells from human placenta, fatal liver, peripheral blood or another source can also be used for such studies (Ito M et al., (2008) Curr Top Microbiol Immunol.;324:53-76; Ito R., et al., (2012) *Cellular & Molecular Immunology* 9, 208–214; Brehm et al., (2010) Curr Opin Endocrinol Diabetes Obes. 17(2): 120–125; Zhou et al., (2013) Cancer Letters. 344,13–19). Such mice can be used in conjunction with either cell line tumors or Patient derived human tumors xenografts (Siolas et al., (2013) Cancer Res.; 73(17): 5315–5319).

[0593] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 32: Analysis of ability of Siglec-9 antibody and/or bispecific antibody Fabs to stimulate viability of innate immune cells

[0594] The agonistic functionality of plate bound, cross-linked anti-Siglec-9 antibody Fab fragments is evaluated in innate immune cells (e.g., macrophages, neutrophils, and NK cells).

[0595] Macrophages, neutrophils, and NK cells are cultured in the presence of M-CSF and plate bound Siglec-9 antibody Fabs, and cell viability is measured.

[0596] Macrophages, neutrophils, NK cells, and DC derived from human monocytes, as well as T cells and human microglia derived from human monocytes are plated on non-tissue-culture-treated 96-well plates, pre-coated with either 12.5nM or 100nM of cross-linked Siglec-9 Fabs. Cells are cultured for 48 hours in the presence of 10ng/ml M-CSF. Analysis of viability is performed using

CellTiter-Glo® kit (Promega). Plates are read with a BioTek Synergy Microplate Reader using GEN5 2.04 software.

Example 33: Analysis of the ability of Siglec-9 antibodies and/or bispecific antibodies to modulate NFAT-dependent genes

[0597] The ability of antagonistic anti-Siglec-9 antibodies activate NFAT-dependent genes is evaluate using a luciferase reporter gene under the control of an NFAT (nuclear factor of activated T cells) promoter.

[0598] A cell line derived from mouse T lymphocytes BW5147.G.1.4 (ATCC® TIB48™) that express the ITAM motif containing co-receptor DAP12 and its ligand binding partner TREM2 is infected with human Siglec-9, and with Cignal Lenti NFAT-Luciferase virus (Qiagen). Luciferase signaling is activated by plate bound anti-TREM2 antibodies. Full-length and Fab fragment anti-Siglec-9 antibodies are either co-plated with the TREM2 antibodies or applied in solution. For plate binding, antibodies are applied at 10 µg/ml in DPBS on tissue-culture treated clear bottom white 96well plates (100ul/well), overnight at 4°C. Wells are rinsed three times with DPBS and subsequently plated at 100,000 cells/well in media with 1% serum. As a positive control for signaling, PMA (0.05ug/ml) and ionomycin (0.25uM) are added together. Cells are incubated for 6 hours and luciferase activity is measured by adding ONE-Glo™ reagent (Promega) to each well and incubating 3min at RT on a plate shaker. Luciferase signal is measured using a BioTek plate reader.

Example 34: Analysis of anti-stroke effect of Siglec-9 antibodies and/or bispecific antibodies

[0599] Transient occlusion of the middle cerebral artery (MCAO) – a model that closely resembles human stroke is used to induce cerebral infarction in mice. Monofilament (70SPRe, Doccol Corp, USA) is introduced into the internal carotid artery through an incision of the right common carotid artery. The middle cerebral artery is occluded for 30 minutes with a range of reperfusion times (6 h, 12 h, 24 h, 2 d, 7 d and 28 d). The effect of surgery is controlled using sham animals at 12 h and at 7 d. Sham animals undergo the same surgical procedure without occlusion of the middle cerebral artery. MCAO animals treated with antagonistic anti-Siglec-9 antibodies or control antibodies are tested for infarct volumetry, acute inflammatory response (12 h reperfusion), transcription of pro-inflammatory cytokines TNFa, IL-1a, and IL-1b, microglial activity (CD68, Iba1), transcription of chemokines CCL2 (MCP1), CCL3 (MIP1a and the chemokine receptor CX3CR1 and invasion of CD3-positive T cells (Sieber et al. (2013) PLoS ONE 8(1): e52982. doi:10.1371/journal.pone.0052982.). Such experiment can be conducted in regular mice or alternatively in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 35: Analysis of anti-Alzheimer's disease effect of anti-Siglec-9 antibodies and/or bispecific antibodies

[0600] To evaluate the ability of antagonistic anti-Siglec-9 antibodies to delay, prevent, or reverse the development of Alzheimer's disease (AD), 5X FAD mice are used. 5X FAD mice overexpress mutant human APP (695) with the Swedish (K670N, M671L), Florida (I716V), and London (V717I) familial Alzheimer's disease (FAD) mutations, along with human PS1 harboring two FAD mutations, M146L and L286V. Both transgenes are regulated by the mouse Thy1 promoter to drive over expression on the brain and recapitulate major features of AD. Mice treated with the agonistic anti-Siglec-9 antibodies or with control antibodies are tested for A beta plaque load with immunohistochemistry and by ELISA of tissue extracts. They are further tested for the number of microglia in the brain, and for reduction in cognitive deficit using Morris Water maze, a spatial learning and memory task, Radial Arm Water Maze, a spatial learning and memory task, Y Maze (quantifies spontaneous alternation as a measure of spatial cognition), novelty preference in in an open field, operant learning to assess learning and memory, and fear conditioning (mousebiology.org website; Wang et al.,(2015) Cell. pii: S0092-8674(15)00127-0). Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 36: Analysis of the protective effect of Siglec-9 antibodies and/or bispecific antibodies in respiratory tract infections

[0601] To evaluate the ability of antagonist Siglec-9 antibodies to delay, prevent, or treat bacterial respiratory tract infections, a preclinical mouse model involving challenge of C57Bl6 mice with *Streptococcus pneumoniae* is used. This model involves intranasal (i.n.) administration of 105 CFU *S. pneumoniae* serotype 3 (ATCC 6303) as described (see, e.g., Sharif O et al, 2014 *PLoS Pathog*. 2014 Jun; 10(6): e1004167; and Schabbauer G et al, 2010 *J Immunol* 185: 468–476). In this model ~90% WT C57Bl6 mice succumb to infection within 6 days post infection.

[0602] Ten to fifteen mice/group are challenged with *S. pneumoniae* and concomitantly are treated with antagonist anti-Siglec-9 antibodies every other day starting from day 0. The first dose of anti-Siglec-9 antibodies is administered 3 hours prior to challenge with *S. pneumonia*. Mice are monitored daily for 15 days to check for death events. % of mice surviving *bacteria* challenge is determined.

[0603] In separate experiments, count of bacterial load and cytokine expression in the blood and in the lungs is also determined. 24 or 48 hours after infection blood is collected in EDTA-containing tubes and plated on agar plates to enumerate bacterial CFU in the plasma. Plasma is stored at -20°C

for cytokine analysis by ELISA. Lungs are harvested, homogenized and plated on agar plates to enumerate bacterial CFU, or incubated for 30 min in lysis buffer and supernatants analyzed for cytokine measurements.

[0604] In separate experiments, lungs are collected 40 hours post bacterial infection, fixed in 10% formalin, and embedded in paraffin for H&E pathology analysis.

[0605] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 37: Analysis of the protective effect of Siglec-9 antibodies and/or bispecific antibodies in sepsis

[0606] To evaluate the ability of antagonist Siglec-9 antibodies to delay, prevent, or treat sepsis, a preclinical mouse model involving systemic challenge of C57Bl6 mice with LPS is used. This model involves intraperitoneal (i.p.) administration of 37 mg/ml LPS as described *(see, e.g.*, Gawish R et al, 2014 *FASEB J*). In this model >95% WT C57Bl6 mice succumb infection within 40 hours post LPS injection.

[0607] Cohorts of mice are challenged with LPS and concomitantly are treated with antagonist anti-Siglec-9 antibodies every day starting from day 0. The first dose of anti-Siglec-9 antibodies is administered 3 hours prior to challenge with LPS. Mice are monitored every ~4 hours during daytime, to check for death events. Percentage of mice surviving LPS challenge is determined.

[0608] In separate experiments, peritoneal lavage fluid (PLF) is collected. Supernatants are stored at -20°C for cytokine analysis by ELISA; pelleted cells are counted to quantify inflammatory cells recruited in the peritoneal cavity. Similar studies can be conducted to test the efficacy of Siglec-9 antibodies in other models of infection (*see, e.g.*, Sun et al., (2013) *Invest Ophthalmol Vis Sci*. 17;54(5):3451-62).

[0609] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 38: Analysis of the protective effect of Siglec-9 antibodies and/or bispecific antibodies in acute and chronic colitis

[0610] To evaluate the ability of antagonist anti-Siglec-9 antibodies to delay, prevent, or treat colitis, preclinical mouse models of acute or chronic colitis are used. For DSS-induced colitis, mice receive 3% DSS in drinking water *ad libitum* for 8 days. For TNBS-induced colitis, mice are anesthetized and treated with an intra-rectal injection of 3 mg TNBS in 20% ethanol (vol/vol) or vehicle alone as a control. For the chronic colitis model, all mice are treated with 3 cycles of 2% DSS

for 5 days, followed by a 10-day recovery period. For all models, weight loss, stool consistency, and presence of fecal occult blood are monitored daily and used to calculate the disease activity index, as described (*see, e.g.*, Correale C, 2013, *Gastroenterology*, February 2013, pp. 346-356.e3).

[0611] Cohorts of mice are treated with antagonist anti-Siglec-9 antibodies every day starting from day 0 and subjected to DSS or TNBS administration. Mice are monitored every day, to check for weight loss, stool consistency, and presence of fecal occult blood were monitored daily and used to calculate the disease activity index, as described (*see, e.g.*, S. Vetrano, *Gastroenterology*, 135 (2008), pp. 173–184).

[0612] In separate experiments, endoscopic and histological images of mucosal damage are collected to evaluate inflammatory cell infiltration and mucosal damage. Similar studies can be conducted to test the benefit of Siglec-9 antibodies in other models of autoimmunity including Crohn's disease, inflammatory bowel disease ,and ulcerative colitis (*see, e.g.*, Low et al., (2013) *Drug Des Devel Ther.*; 7: 1341-1357; and Sollid et al., (2008) *PLoS Med* 5(9): e198).

[0613] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 39: Analysis of the protective effect of Siglec-9 antibodies and/or bispecific antibodies in wound healing

[0614] To evaluate the ability of agonistic anti-Siglec-9 antibodies to increase colonic wound repair following injury, a mouse model of biopsy injury in the colon is used. In this model, the endoscope with outer operating sheath is inserted to the mid-descending colon and the mucosa is surveyed to the ano-rectal junction. Then, a single full thickness area of the entire mucosa and submucosa is removed with flexible biopsy forceps with a diameter of 3 French, avoiding penetration of the muscularis propria. Each mouse is biopsy injured at 3–5 sites along the dorsal side of the colon (*see, e.g.*, Seno H, 2008, *Proc Natl Acad Sci U S A*. 2009 Jan 6; 106(1): 256-261).

[0615] Cohorts of mice are treated with agonist anti-Siglec-9 antibodies 2 or 3 days after biopsy injury. Mice are monitored every day for 15 days, to check for weight loss and wound healing by measuring the surface area of lesions.

[0616] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 40: Analysis of the protective effect of Siglec-9 antibodies and/or bispecific antibodies in retinal degeneration

[0617] AMD is a degenerative disease of the outer retina. It is thought that inflammation, particularly inflammatory cytokines and macrophages, neutrophils, and/or NK cells contribute to AMD disease progression.

[0618] The presence of macrophages, neutrophils, and NK cells in the proximity of AMD lesions is documented, in the drusen, Bruch's membrane, choroid and retina. Macrophages, neutrophils, and NK cells release tissue factor (TF) and vascular endothelial growth factor (VEGF), which triggers the expansion of new blood vessels formation in patients showing choroidal neovasulcarization.

[0619] The type of macrophage present in the macular choroid changes with age, displaying elevated levels of M2 macrophages, neutrophils, and NK cells in older eyes compared to younger eyes. However, advanced AMD maculae had higher M1 to M2 rations compared to normal autopsied eyes of similar age. (*see, e.g.*, Cao X et al, (2011), *Pathol Int* 61(9): pp528-35). This suggests a link between classical M1 macrophage activation in the eye in the late onset of AMD progression.

[0620] Retinal microglia cells are tissue-resident macrophages that are also normally present in the inner retina. In the event of damage, microglia can be activated and act as mediator of inflammation. Activated microglia has been detected in the AMD tissue samples and has been proposed as one potential contributor of inflammatory processed that lead to AMD pathogenesis (Gupta et al., (2003) *Exp Eye Res.*, 76(4):463-71.). The ability of Siglec-9 antibodies to prevent, delay, or reverse AMD is tested in one or more of AMD models (*see, e.g.*, Pennesi et al., (2012) *Mol Aspects Med.*; 33(4): 487–509).

[0621] Overall inflammatory macrophages, neutrophils, and NK cells (either M1 and/or activated microglia) are documented to correlate with AMD disease progression and therefore represent a therapeutic target for antagonist Siglec-9 antibodies. Similar therapeutic benefit can be achieved in glaucoma and genetic forms or retinal degeneration such as retinitis pigmentosa.

[0622] The ability of Siglec-9 antibodies to prevent, delay, or reverse retinal ganglion cell degeneration in glaucoma is tested in a glaucoma model (*see, e.g.*, El-Danaf et al., (2015) *.J Neurosci.* 11;35(6):2329-43). Likewise, the therapeutic benefit of REM2 in genetically induced retinal degeneration and retinitis pigmentosa is tested as described in Chang et al., (2002) Vision Res.; 42(4):517-25, and in "Retinal Degeneration Rat Model Resource Availability of P23H and S334ter Mutant Rhodopsin Transgenic Rats and RCS Inbred and RCS Congenic Strains of Rats," MM LaVail, June 30, 2011.

[0623] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 41: Analysis of the protective effect of Siglec-9 antibodies and/or bispecific antibodies in adipogenesis and diet-induced obesity

[0624] To test the effect of Siglec-9 antibodies in adipogenesis and obesity, a mouse model of high-fat diet (HFD) is used (*see, e.g.*, Park et al., (2015) *Diabetes*. 64(1):117-27).

[0625] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 42: Analysis of the protective effect of antagonist Siglec-9 antibodies and/or bispecific antibodies in osteoporosis

[0626] Bone is a dynamic organ constantly remodeled to support calcium homeostasis and structural needs. The osteoclast is the cell responsible for removing both the organic and inorganic components of bone. The osteoclast is derived from hematopoietic progenitors in the macrophage lineage and differentiates in response to the tumor necrosis factor family cytokine receptor activators of NFκB ligand. Osteoclasts, the only bone-resorbing cells, are central to the pathogenesis of osteoporosis and osteoporosis (Novack et al., (2008) *Annual Rev Pathol*., 3:457-84).

[0627] Osteoporosis is a progressive bone disease that is characterized by a decrease in bone mass and density which can lead to an increased risk of fracture. It is mostly manifested in the first years following menopause, when bone turnover is accelerated, with increased activity of both osteoclasts and osteoblasts. Owing to an imbalance in the processes of resorption and synthesis, however, the net effect is bone loss, which is largely trabecular. Thus, the most prevalent sites of fracture in osteoporosis are the wrist, femoral neck, and vertebral bodies, in which the trabecular structure is key to overall bone strength.

[0628] Reduced osteoclast function results in osteoporosis, with increased bone mass and elimination of bone marrow space, as observed in animal models lacking DAP12 ITAM signaling adapter and resulting in a significant defect in differentiation of osteoclast-like cells (Koga, et al., (2004) *Nature* 428: 758–763).

[0629] Thus, administering an antagonist anti-Siglec-9 antibody of the present disclosure can prevent, reduce the risk of, and/or treat osteoporosis. In some embodiments, administering an agonist anti-Siglec-9 antibody may induce one or more Siglec-9 activities in an individual having osteoporosis (*e.g.*, DAP12 phosphorylation, Syk activation, and accelerated differentiation into

osteoclasts) (Peng et al (2010). *Sci Signal.* 2010 18;3 122; and Humphrey et al., (2006) *J Bone Miner Res.*,21(2):237-45).

[0630] Such experiment can be also conducted in in mice that express the human Siglec-9 gene from a bacterial artificial chromosome or from a cDNA driven by a myeloid promoter or in mice that were transduced with lenti or AAV virus containing hSiglec-9 cDNA.

Example 43: Analysis of the ability of Siglec-9 antibodies and/or bispecific antibodies to modulate binding of Siglec-9 to SHP1, SHP2 and other signaling molecules

[0631] Human primary monocytes, macrophages, neutrophils, NK cells, dendritic cells, T cells, microglia or osteoclasts are removed from tissue culture dishes with PBS-EDTA, washed with PBS, and counted. Cells are incubated with an anti-Siglec-9 and/or Siglec-9 bispecific antibody or with an isotype-matched control antibody at 1μg/10^6 cells for 20 min on ice or under other conditions. Cells are lysed in ice-cold radioimmunoprecipitation assay (RIPA) buffer for 20 min followed by centrifugation at 16,000 *g* for 10 min at 4°C to remove insoluble materials. The resulting supernatant is subjected to immunoprecipitation reactions with the indicated antibodies (SHP1, SHP2, c-Cbl., Vav, Syk, LcK, Fyn, GRb2, PLC-gamma. Toll like receptor, DAMP receptors, pattern recognition receptor) and protein A- or protein G-agarose (Sigma). The beads are extensively washed with RIPA buffer and the proteins are separated by SDS-polyacrylamide gel electrophoresis (SDS-PAGE). The proteins are then transferred to nitrocellulose membranes by Western blotting, incubated with the appropriate Siglec-9 antibodies and visualized with the enhanced chemiluminescence (ECL) system (Pierce), as described (*e.g.*, Peng et al., (2010) Sci Signal., 3(122): ra38). Alternatively, the cells are incubated with an anti-Siglec-9 and/or Siglec-9 bispecific antibody or with an isotype-matched control antibody at 1 μg/10^6 cells for 20 min on ice or under other conditions. Cells are lysed in ice-cold radioimmunoprecipitation assay (RIPA) buffer for 20 min followed by centrifugation at 16,000 *g* for 10 min at 4°C to remove insoluble materials. The resulting supernatant is subjected to immunoprecipitation reactions with a second Siglec-9 antibody. The proteins are then transferred to nitrocellulose membranes by Western blotting and incubated with the indicated antibodies (SHP1, SHP2, c-Cbl., Vav, Syk, LcK, Fyn, GRb2, PLC-gamma. Toll like receptors, DAMP receptors, and pattern recognition receptors).

Example 44: Analysis of the ability of Siglec-9 antibodies and/or bispecific antibodies to enhance tumor cell killing by NK cells

[0632] Natural killer cells are isolated from human blood using RosetteSep Human NK Cell Enrichment Cocktail (STEMCELL Technologies). Isolated cells are cultured in RPMI 1640 (Mediatech) supplemented with 10% Hyclone Fetal Bovine Serum (GE Healthcare), 2% Hepes, 2% GlutaMAX, 2% penicillin-streptomycin, 2% sodium pyruvate, and 2% MEM non-essential amino

acids (Life Technologies). NK cells are plated 1 x 10^6 cells/well with 25 ng/ml IL-2 (R&D) and 25 ng/ml IL-21 (Peprotech) in 24-well plates and incubated at 37°C with 5% CO_2 for 7 days. NK cells are phenotyped at isolation and day 7 with APC anti-human CD56 (Biolegend) PE-Cy7 anti-human CD3 (Biolegend), and V500 mouse anti-human CD16 (BD Biosciences).

[0633] Day 7 post culture, NK cells are harvested and resuspended at 1 x 10^6 cells/ml. NK effector cells are plated at Effector:Target ratios of 12:1, 4:1, 2:1, 0.5:1 and at 120,000 cells for effector only control wells in 96-well U-bottom plates. Cells are centrifuged and resuspended in 100 ul media (50 ul 100% EtOH and 50 ul media are added to positive control wells to serve as 100% killing). 10 µg/ml Siglec-7 antibodies/mIgG1 isotype control are added, mixed, and incubated on ice for 20 mins. 10,000 CFSE-labeled K562 target cells are added to each well, excluding effector only control wells. The plate is centrifuged at 1500 rpm for 1 min and incubated at 37°C with 5% CO_2 for 2 hr. Following incubation, the cells are stained with 50 ul NucBlue Fixed Cell ReadyProbes Reagent (Life Technologies), incubated at RT protected from light for 5 mins and analyzed by flow cytometry on FACS Canto (BD Biosciences) immediately.

Example 45: Analysis of Siglec-9 antibody binning

[0634] Monocytes were isolated from human blood samples using RosetteSep™ Human Monocyte Enrichment Cocktail (STEMCELL Technologies, Vancouver, Canada). Isolated cells were cultured in RPMI 1640 (Mediatech) supplemented with 10% HyClone™ FBS (GE Healthcare Life Sciences), 20 mM HEPES, 4 mM GlutaMAX, 200 U/ml Penicillin-Streptomycin, 2 mM Sodium Pyruvate, and 2% MEM NEAA (Life Technologies). Cells were at plated 1 x 10^6 cells/ml with 8% human serum (Sigma-Adrich) and 50 ng/ml recombinant human M-CSF (PeproTech) in T150 tissue culture flasks and incubated at 37°C with 5% CO_2 for 5 days.

[0635] At day 5, adherent monocyte-derived macrophages were harvested and plated at 100,000 cells/well in a 96-well U-bottom non-TC treated plate. 5 µg/ml purified Siglec-9 antibodies were incubated with cells in the presence of human Fc receptor binding inhibitor (eBioscience) in PBS with 1% BSA and 2 mM EDTA. Samples were incubated on ice for 30 min and washed 2X in buffer. Direct fluorophore conjugated Siglec-9 antibodies were added at 5 µg/ml and incubated on ice for 30 min followed by 2 washes in buffer. Ability of the conjugated Siglec-9 antibody clones to bind cell surface receptor in the presence of bound Siglec-9 antibodies, isotypes, or untreated were determined by flow cytometry on an iQue Screener (IntelliCyt) and analyzed with FlowJo software (TreeStar) to determine competition of the clones. The conjugated anti-Siglec-9 antibodies used were: E10286 (BD Biosciences), K8 (BioLegend), and 191240 (R&D Systems). Bound anti-Siglec-9 antibodies used were: 2D4, 2D5, 5B1, 6B2, 6D8, 7H12, 5C6, 12B12, and 17C2.

[0636] The results are depicted in **Table 12**.

Table 12: Siglec-9 antibody binning

	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5
	Competes with E10286	Competes with K8	Competes with 191240	Competes with E10286, K8, and 191240	Does not compete with any tested antibody
Ab	**2D4**	**5C6**	**6B2**	**5B1**	**2D5**
		12B12	**6D8**		**7H12**
		17C2	**5C6**		
			17C2		

[0637] The results indicate that Siglec-9 antibodies 5C6, 12B12, and 17C2 are in a distinct bin from antibodies 2D4, 2D5, 5B1, and 7H12. The results are consistent with those in **Example 1**.

Example 46: *In vivo* effects of anti-Siglec-9 and anti-PD1 antibody combination treatment

[0638] A CTG-0202 patient-derived melanoma tumor was first passaged in pre-study animals prior to implantation to humanized mice. When tumors reached 1-1.5 cm^3 in stock animals, they were harvested for re-implantation into pre-study animals. Pre-study animals were implanted unilaterally on the left flank with tumor fragments. The CTG-0202 melanoma tumors were used at passage number 6.

[0639] Immunocompromised female mice (Taconic NOG) were humanized with fetal liver-derived $CD34^+$ hematopoietic cells. Mice were housed on irradiated papertwist-enriched 1/8" corncob bedding (Sheperd) in individual HEPA ventilated cages (Innocage® IVC, Innovive USA) on a 12-hour light-dark cycle at 68-74°F (20-23°C) and 30-70% humidity. Mice were fed water ad libitum (reverse osmosis, 2 ppm Cl_2) and an irradiated test rodent diet (Teklad 2919) consisting of 19% protein, 9% fat, and 4% fiber. 48 humanized mice were implanted, and pre-study tumor volumes were recorded for each experiment beginning seven to ten days after implantation. When tumors reached approximately 80-200 mm^3 in volume, mice were matched by tumor volume into treatment or control groups to be used for dosing, and dosing was initiated on Day 0. Test groups were administered anti-PD-1 antibody Keytruda® (pembrolizumab) in combination with a control monoclonal antibody (Group 1), or in combination with anti-Siglec-9 antibody 2D4 (Group 2). **Table 13** and **FIG. 15A** depict the dosing schedule, dosing amounts, and route of administration.

Table 13: Antibody dosing schedule and route of administration for the *in vivo* cancer efficacy study of the Siglec-9 antibody 2D4

Group	n	Antibody Treatment	Dose Volume (mg/kg)	ROA	Schedule	Total # of Doses
1	8	Keytruda	5/2.5	IP	q5dx6	6
		CTR mAb	40	IP	q5dx6	6
2	8	Keytruda	5/2.5	IP	q5dx6	6
		2D4	40	IP	q5dx6	6

[0640] In **Table 13**, "n" refers to the number of mice in each treatment group; "CTR mAb" refers to an isotype control antibody; "2D4" refers to anti-Siglec-9 antibody 2D4; "ROA" refers to route of administration; "IP" refers to intraperitoneal; "q5dx6" refers to a dosing schedule of administration every five days for a total of six doses.

[0641] Beginning at Day 0, mice were observed daily and weighed twice weekly using a digital scale. Tumor dimensions were measured twice weekly by digital caliper and data including individual and mean estimated tumor volumes (Mean TV ± SEM) was recorded for each group. Tumor volume was calculated using the formula (1): *TV= width2 x length x 0.52*. The study was concluded when the mean tumor volume of the control group reached 1500 mm^3 at day 28.

[0642] At study termination harvested tumors were shipped overnight in media on ice packs and processed the following day. Tumor samples were treated with collagenase for 30 min at 37°C. Samples were dissociated through a cell strainer and resuspended in 2% FBS in PBS. Red blood cells in whole blood samples were lysed using ACK lysing buffer and cells were then washed in 2% FBS in PBS twice. Cells were counted using a hemocytometer and one million cells were stained with fluorochrome-conjugated antibodies for 30 minutes on ice, then washed with 2% FBS in PBS. Cells were fixed with 4% paraformaldehyde in PBS. All the stained cells were analyzed on a FACS Canto (BD Biosciences) and the data analyzed with FlowJo software (TreeStar). To identify tumor-infiltrating immune cells, hCD45, hCD3, hCD4, hCD8, and hCD14 antibodies were used to gate on populations according to standard procedures.

[0643] As shown in **FIG. 15B and 15C**, the combination treatment with the Siglec-9 antibody 2D4 and the anti-PD-1 antibody Keytruda® (pembrolizumab) reduced cell surface levels of Siglec-9 in peripheral blood $hCD45^+$ $CD14^+$ myeloid cells in a mouse tumor model that was engrafted with human immune stem cells and the patient-derived xenograft CTG-0202 melanoma tumors. 2D4 treatment did not impact the levels of cell surface CD33. A similar reduction in cell-surface Siglec-9 levels was also observed on intratumoral $hCD45^+$ $CD14^+$ myeloid cells.

[0644] As shown in **FIG. 15D** the combination treatment with the Siglec-9 antibody 2D4 and the anti-PD-1 antibody Keytruda® (pembrolizumab) reduced the percentage of peripheral blood $hCD45^+$ $CD14^+$ myeloid cells in a mouse tumor model that was engrafted with human immune stem cells and the patient-derived xenograft CTG-0202 melanoma tumors.

[0645] As shown in **FIG. 15E** the combination treatment with the Siglec-9 antibody 2D4 and the anti-PD-1 antibody Keytruda® (pembrolizumab) increased the percentage of peripheral blood $hCD45^+$ $CD3^+$ T cells in a mouse tumor model that was engrafted with human immune stem cells and the patient-derived xenograft CTG-0202 melanoma tumors.

[0646] As shown in **FIG. 15F**, the combination treatment with the Siglec-9 antibody 2D4 and the anti-PD-1 antibody Keytruda® (pembrolizumab) reduced the number of tumor infiltrating

hCD45$^+$ CD14$^+$ myeloid cells in a mouse tumor model that was engrafted with human immune stem cells and the patient-derived xenograft CTG-0202 melanoma tumors.

[0647] As shown in **FIG. 15G**, the combination treatment with the Siglec-9 antibody 2D4 and the anti-PD-1 antibody Keytruda® (pembrolizumab) increased the number of tumor infiltrating hCD45$^+$ CD3$^+$ T cells in a mouse tumor model that was engrafted with human immune stem cells and the patient-derived xenograft CTG-0202 melanoma tumors.

[0648] As shown in **FIG. 15H-15J**, the combination treatment with the Siglec-9 antibody 2D4 and the anti-PD-1 antibody Keytruda® (pembrolizumab) inhibited tumor growth *in vivo* in a patient-derived melanoma tumor model that was implanted in mice engrafted with human immune stem cells from two different human donors (Donor # 165547112, and 17509112), while 2D4 treatment did not impact the growth of tumors in mice engrafted with immune cells from a third donor (Donor # 984480112).

[0649] Importantly for the results described herein, both the tumor and the immune system responding to the tumor were human. The immune system of the mouse was humanized using a method whereby the mouse immune system was genetically ablated and myeloablated with irradiation, then replaced with human donor CD34$^+$ hematopoietic stem and progenitor cells that repopulated and developed myeloid and lymphoid immune cells. The tumor was a patient-derived melanoma. The human-specific Siglec-9 antibody 2D4 displayed target specific engagement and downregulation of human Siglec-9. Receptor downregulation was significant on peripheral and tumor CD14$^+$ myeloid cells. Therefore any effects on tumor growth, increased tumor infiltration of CD3$^+$ T-cells, and reduced CD14+ cells were the result of 2D4 antibody-mediated downregulation of Siglec-9 on human myeloid immune cells.

[0650] The data presented above showed that the Siglec-9 antibody 2D4 was a potent and significant receptor-downregulating antibody on peripheral and tumor infiltrating myeloid cells. Analysis of both circulating and tumor infiltrating immune cell populations demonstrated an increase of CD3$^+$ T-cells. Additionally, myeloid cell populations were also affected by Siglec-9 antibody treatment. A decrease in CD14$^+$ myeloid cells was observed in tumors, as well as in peripheral blood cell populations. This data suggested that downregulation of Siglec-9 functionally altered tumor infiltrating immune cell populations. Taken together, these studies supported the pre-clinical efficacy of anti-Siglec-9 antibodies as a therapeutic for treating human cancer.

CLAIMS

What is claimed is:

1. An isolated anti-Siglec-9 antibody, wherein the anti-Siglec-9 antibody decreases cell surface levels of Siglec-9, as determined by a fluorescence-activated cell sorting (FACS) assay using a threshold value of 21% or higher reduction of Siglec-9 cell surface levels to indicate a decrease, and does not inhibit interaction between Siglec-9 and sialic acid-containing glycoproteins, as determined by a FACS assay using a threshold value of 80% or higher Siglec-9-Fc binding to U937 cells to indicate non-inhibition.

2. The anti-Siglec-9 antibody of claim 1, wherein the antibody decreases cell surface levels of Siglec-9 *in vivo*.

3. The anti-Siglec-9 antibody of any one of claims 1-2, wherein the anti-Siglec-9 antibody inhibits one or more Siglec-9 activities.

4. The anti-Siglec-9 antibody of any one of claims 1-3, wherein the cell surface levels of Siglec-9 are measured on primary cells or cell lines selected from the group consisting of dendritic cells, bone marrow-derived dendritic cells, monocytes, microglia, macrophages, neutrophils, and NK cells.

5. The anti-Siglec-9 antibody of any one of claims 1-4, wherein the anti-Siglec-9 antibody does not reduce TREM2 expression.

6. The anti-Siglec-9 antibody of any one of claims 1-5, wherein the anti-Siglec-9 antibody binds to amino acid residues selected from the group consisting of:

i. amino acid residues 185-194 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 185-194 of SEQ ID NO: 1;

ii. amino acid residues 86-96 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 of SEQ ID NO: 1;

iii. amino acid residues 86-96 and 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 86-96 and 105-116 of SEQ ID NO: 1;

iv. amino acid residues 105-116 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 105-116 of SEQ ID NO: 1; and

v. amino acid residues 107-115 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to amino acid residues 107-115 of SEQ ID NO: 1.

7. The anti-Siglec-9 antibody of any one of claims 1-5, wherein the anti-Siglec-9 antibody binds to amino acid residues D189, P190, and R194 of SEQ ID NO: 1, or amino acid residues on a mammalian Siglec-9 protein corresponding to D189, P190, and R194 of SEQ ID NO: 1.

8. The anti-Siglec-9 antibody of any one of claims 1-7, wherein the anti-Siglec-9 antibody competes with one or more antibodies selected from the group consisting of:

(a) an antibody comprising a light chain variable domain comprising an HVR-L1 comprising the amino acid sequence of SEQ ID: NO 6, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 10, an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 14, and a heavy chain variable domain comprising an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 19, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 22, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 26;

(b) an antibody comprising a light chain variable domain comprising an HVR-L1 comprising the amino acid sequence of SEQ ID: NO 8, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 12, an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 16, and a heavy chain variable domain comprising an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28;

(c) an antibody comprising a light chain variable domain comprising an HVR-L1 comprising the amino acid sequence of SEQ ID: NO 9, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 13, an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 17, and a heavy chain variable domain comprising an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 25, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 29;

(d) an antibody comprising a light chain variable domain comprising an HVR-L1 comprising the amino acid sequence of SEQ ID: NO 8, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 12, an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 18, and a heavy chain variable domain comprising an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28;

and any combination thereof for binding to Siglec-9.

9. The anti-Siglec-9 antibody of any one of claims 1-8, wherein the anti-Siglec-9 antibody comprises a light chain variable domain and a heavy chain variable domain, wherein:

(a) the light chain variable domain comprises an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 6 or the amino acid sequence of SEQ ID NO: 6 having one

or more conservative amino acid substitutions, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 10 or the amino acid sequence of SEQ ID NO: 10 having one or more conservative amino acid substitutions, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 14 or the amino acid sequence of SEQ ID NO: 14 having one or more conservative amino acid substitutions, and the heavy chain variable domain comprises an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 19 or the amino acid sequence of SEQ ID NO: 19 having one or more conservative amino acid substitutions, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 22 or the amino acid sequence of SEQ ID NO: 22 having one or more conservative amino acid substitutions, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 26 or the amino acid sequence of SEQ ID NO: 26 having one or more conservative amino acid substitutions; or

(b) the light chain variable domain comprises an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 8 or the amino acid sequence of SEQ ID NO: 8 having one or more conservative amino acid substitutions, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 12 or the amino acid sequence of SEQ ID NO: 12 having one or more conservative amino acid substitutions, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 16 or the amino acid sequence of SEQ ID NO: 16 having one or more conservative amino acid substitutions, and the heavy chain variable domain comprises an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21 or the amino acid sequence of SEQ ID NO: 21 having one or more conservative amino acid substitutions, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24 or the amino acid sequence of SEQ ID NO: 24 having one or more conservative amino acid substitutions, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28 or the amino acid sequence of SEQ ID NO: 28 having one or more conservative amino acid substitutions; or

(c) the light chain variable domain comprises an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 9 or the amino acid sequence of SEQ ID NO: 9 having one or more conservative amino acid substitutions, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 13 or the amino acid sequence of SEQ ID NO: 13 having one or more conservative amino acid substitutions, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 17 or the amino acid sequence of SEQ ID NO: 17 having one or more conservative amino acid substitutions, and the heavy chain variable domain comprises, an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21 or the amino acid sequence of SEQ ID NO: 21 having one or more conservative amino acid substitutions, an HVR-H2 comprising the amino

acid sequence of SEQ ID NO: 25 or the amino acid sequence of SEQ ID NO: 25 having one or more conservative amino acid substitutions, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 29 or the amino acid sequence of SEQ ID NO: 29 having one or more conservative amino acid substitutions; or

(d) the light chain variable region comprises an HVR-L1 comprising the amino acid sequence of SEQ ID NO: 8 or the amino acid sequence of SEQ ID NO: 8 having one or more conservative amino acid substitutions, an HVR-L2 comprising the amino acid sequence of SEQ ID NO: 12 or the amino acid sequence of SEQ ID NO: 12 having one or more conservative amino acid substitutions, and an HVR-L3 comprising the amino acid sequence of SEQ ID NO: 18 or the amino acid sequence of SEQ ID NO: 18 having one or more conservative amino acid substitutions, and the heavy chain variable domain comprises an HVR-H1 comprising the amino acid sequence of SEQ ID NO: 21 or the amino acid sequence of SEQ ID NO: 21 having one or more conservative amino acid substitutions, an HVR-H2 comprising the amino acid sequence of SEQ ID NO: 24 or the amino acid sequence of SEQ ID NO: 24 having one or more conservative amino acid substitutions, and an HVR-H3 comprising the amino acid sequence of SEQ ID NO: 28 or the amino acid sequence of SEQ ID NO: 28 having one or more conservative amino acid substitutions.

10. The anti-Siglec-9 antibody of any one of claims 1-9, wherein the antibody is of the IgG class the IgM class, or the IgA class.

11. The anti-Siglec-9 antibody of claim 10, wherein the anti-Siglec-9 antibody has an IgG1, IgG2, IgG3, or IgG4 isotype.

12. The anti-Siglec-9 antibody of claim 11, wherein:

(a) the anti-Siglec-9 antibody has a human or mouse IgG1 isotype and comprises one or more amino acid substitutions in the Fc region at a residue position selected from the group consisting of: N297A, D265A, D270A, L234A, L235A, G237A, P238D, L328E, E233D, G237D, H268D, P271G, A330R, C226S, C229S, E233P, L234V, L234F, L235E, P331S, S267E, L328F, A330L, M252Y, S254T, T256E, N297Q, P238S, P238A, A327Q, A327G, P329A, K322A, T394D, and any combination thereof, wherein the numbering of the residues is according to EU numbering, or comprises an amino acid deletion in the Fc region at a position corresponding to glycine 236, wherein the numbering of the residues is according to EU numbering;

(b) the anti-Siglec-9 antibody has an IgG1 isotype and comprises an IgG2 isotype heavy chain constant domain 1(CH1) and hinge region, optionally wherein the IgG2 isotype CH1 and hinge region comprises the amino acid sequence of ASTKGPSVFP LAPCSRSTSE STAALGCLVK DYFPEPVTVS WNSGALTSGVHTFPAVLQSS

GLYSLSSVVT VPSSNFGTQT YTCNVDHKPS NTKVDKTVERKCCVECPPCP (SEQ ID NO: 171), and optionally wherein the antibody Fc region comprises a S267E amino acid substitution, a L328F amino acid substitution, or both, and/or a N297A or N297Q amino acid substitution, wherein the numbering of the residues is according to EU numbering;

(c) the anti-Siglec-9 antibody has an IgG2 isotype and comprises one or more amino acid substitutions in the Fc region at a residue position selected from the group consisting of: P238S, V234A, G237A, H268A, H268Q, V309L, A330S, P331S, C214S, C232S, C233S, S267E, L328F, M252Y, S254T, T256E, H268E, N297A, N297Q, A330L, and any combination thereof, wherein the numbering of the residues is according to EU numbering;

(d) the anti-Siglec-9 antibody has a human or mouse IgG4 isotype and comprises one or more amino acid substitutions in the Fc region at a residue position selected from the group consisting of: L235A, G237A, S228P, L236E, S267E, E318A, L328F, M252Y, S254T, T256E, E233P, F234V, L234A/F234A, S228P, S241P, L248E, T394D, N297A, N297Q, L235E, and any combination thereof, wherein the numbering of the residues is according to EU numbering; or

(e) the anti-Siglec-9 antibody has a hybrid IgG2/4 isotype, and optionally wherein the antibody comprises an amino acid sequence comprising amino acids 118 to 260 of human IgG2 and amino acids 261 to 447 of human IgG4, wherein the numbering of the residues is according to EU numbering.

13. The anti-Siglec-9 antibody of any one of claims 1-12, wherein the Siglec-9 protein is a mammalian protein or a human protein.

14. The anti-Siglec-9 antibody of any one of claims 1-13, wherein the anti-Siglec-9 antibody binds Siglec-9 in a pH dependent manner.

15. The anti-Siglec-9 antibody of any one of claims 1-14, wherein the anti-Siglec-9 antibody is an antibody fragment that binds to an epitope comprising amino acid residues on human Siglec-9 or a mammalian Siglec-9 protein.

16. The anti-Siglec-9 antibody of claim 15, wherein the fragment is an Fab, Fab', Fab'-SH, F(ab')2, Fv, or scFv fragment.

17. The anti-Siglec-9 antibody of any one of claims 1-16, wherein the anti-Siglec-9 antibody is a murine antibody, a humanized antibody, a bispecific antibody, a monoclonal antibody, a multivalent antibody, a conjugated antibody, or a chimeric antibody.

18. The anti-Siglec-9 antibody of any one of the preceding claims, wherein the anti-Siglec-9 antibody has dissociation constant (K_D) for human Siglec-9 and mammalian Siglec-9 that ranges from about 10 nM to about10 pM, or less than 10 pM, wherein the K_D is determined at a temperature of approximately 25ºC.

19. The anti-Siglec-9 antibody of any one of the preceding claims, wherein the anti-Siglec-9 antibody has dissociation constant (K_D) for human Siglec-9 that ranges from about 9 nM to about 230 pM, or less than 230 pM, wherein the K_D is determined at a temperature of approximately 25ºC.

20. An isolated nucleic acid comprising a nucleic acid sequence encoding the anti-Siglec-9 antibody of any one of the preceding claims.

21. A vector comprising the nucleic acid of claim 20.

22. An isolated host cell comprising the vector of claim 21.

23. A method of producing an anti-Siglec-9 antibody, comprising culturing the host cell of claim 22 so that the anti-Siglec-9 antibody is produced.

24. A pharmaceutical composition comprising the anti-Siglec-9 antibody of any one of claims 1-19, and a pharmaceutically acceptable carrier.