ANTI-KIT ANTIBODIES AND USES THEREOF

[0001] This application claims the benefit, under 35 U.S.C. § 119(e), of U.S. Provisional Application No. 61/675,751 filed on July 25, 2012 and U.S. Provisional Application No. 61/675,762 filed on July 25, 2012, each of which is hereby incorporated by reference in its entirety.

[0002] The instant application contains a Sequence Listing, which is being concurrently submitted as an ASCII text file named "Sequence_Listing_12638-059-228.txt", created July 18, 2013, and being 152,576 bytes in size. The Sequence Listing is hereby incorporated by reference in its entirety.

1. FIELD

[0003] Provided herein are antibodies that specifically bind to a KIT polypeptide, antigen-binding fragments thereof, conjugates of such antibodies, polynucleotides encoding such antibodies, vectors and host cells for producing such antibodies, kits and pharmaceutical compositions comprising antibodies that immunospecifically bind to a KIT antigen, uses and methods for treating or managing a KIT-associated disorder, and diagnostic methods.

2. BACKGROUND

[0004] KIT (or c-Kit) is a type III receptor tyrosine kinase encoded by the *c-kit* gene. KIT comprises five extracellular immunoglobulin (Ig)-like domains, a single transmembrane region, an inhibitory cytoplasmic juxtamembrane domain, and a split cytoplasmic kinase domain separated by a kinase insert segment (see, *e.g.*, Yarden *et al.*, Nature, 1986, 323:226-232; Ullrich and Schlessinger, Cell, 1990, 61:203-212; Clifford *et al.*, J. Biol. Chem., 2003, 278:31461-31464). The human *c-kit* gene encoding the KIT receptor has been cloned as described by Yarden *et al.*, EMBO J., 1987, 6:3341-3351. KIT is also known as CD117 or stem cell factor receptor ("SCFR"), because it is the receptor for the stem cell factor ("SCF") ligand (also known as Steel Factor or Kit Ligand). SCF ligand binding to the first three extracellular Ig-like domains of KIT induces receptor dimerization, and thereby activates intrinsic tyrosine kinase activity through the phosphorylation of specific tyrosine residues in the juxtamembrane and kinase domains (see, *e.g.*, Weiss and Schlessinger, Cell, 1998, 94:277-280; Clifford *et al.*, J. Biol. Chem., 2003, 278:31461-

31464). Members of the Stat, Src, ERK, and AKT signaling pathways have been shown to be downstream signal transducers of KIT signaling.

[0005] The fourth (D4) and fifth (D5) extracellular Ig-like domains of KIT are believed to mediate receptor dimerization (see, *e.g.*, International Patent Application Publication No. WO 2008/153926; Yuzawa *et al.*, Cell, 2007, 130:323-334).

[0006] Expression of KIT has been detected in various cell types, such as mast cells, stem cells, brain cells, melanoblasts, ovary cells, and cancer cells (*e.g.*, leukemia cells). Studies of loss-of-function KIT mutations indicate that KIT is important for the normal growth of hematopoietic progenitor cells, mast cells, melanocytes, primordial germ cells, and the interstitial cells of Cajal (see, *e.g.*, Besmer, P., Curr. Opin. Cell Biol., 1991, 3:939-946; Lyman *et al.*, Blood, 1998, 91:1101-1134; Ashman, L. K., Int. J. Biochem. Cell Biol., 1999, 31:1037-1051; Kitamura *et al.*, Mutat. Res., 2001, 477:165-171; Mol *et al.*, J. Biol. Chem., 2003, 278:31461-31464). Moreover, KIT plays an important role in hematopoiesis, melanogenesis, and gametogenesis (see Ueda *et al.*, Blood, 2002, 99:3342-3349).

[0007] Abnormal KIT activity has been implicated in connection with a number of cancers. For example, gain-of-function KIT mutations resulting in SCF-independent, constitutive activation of KIT are found in certain cancer cells and are associated with certain cancers such as leukemia (*e.g.*, chronic myelogenous leukemia) and gastrointestinal stromal tumors (*see, e.g.*, Mol *et al.*, J. Biol. Chem., 2003, 278:31461-31464).

3. SUMMARY

[0008] Provided herein, are antibodies, antigen-binding fragments thereof, and conjugates thereof, that immunospecifically bind to a domain 4 (D4) (or D4 region) of the extracellular domain of KIT (*e.g.*, human KIT) and inhibit a KIT activity, as well as related compositions, reagents and methods.

[0009] In one aspect, the present invention refers to an isolated antibody, or an antigen-binding fragment thereof, which immunospecifically binds to a D4 region of human KIT, wherein (i) the light chain variable region ("VL") comprises the amino acid sequence of SEQ ID NO: 8 and the heavy chain variable region ("VH") comprises the amino acid sequence of SEQ ID NO: 4; (ii) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 3; (iii) the VL comprises the amino acid sequence of SEQ ID

NO: 8 and the VH comprises the amino acid sequence of SEQ ID NO: 6; (iv) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 5; (v) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 2; (vi) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 3; (vii) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 4; (viii) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 6; (ix) the VL comprises the amino acid sequence of SEQ ID NO: 8 and the VH comprises the amino acid sequence of SEQ ID NO: 2; (x) the VL comprises the amino acid sequence of SEQ ID NO: 8 and the VH comprises the amino acid sequence of SEQ ID NO: 3; (xi) the VL comprises the amino acid sequence of SEQ ID NO: 8 and the VH comprises the amino acid sequence of SEQ ID NO: 5; (xii) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 2; (xiii) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 3; (xiv) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 4; (xv) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 5; (xvi) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 6; (xvii) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 2; (xviii) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 4; (xix) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 5; or (xx) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 6, wherein the VL and VH are non-immunogenic in a human. In one aspect, the present invention refers to an isolated antibody, or an antigen-binding fragment thereof, which immunospecifically binds to a D4 region of human KIT, which comprises:(i) a light chain variable region ("VL") comprising the amino acid sequence: DIVMTQSPS$\mathbf{X_{K1}}$LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPK$\mathbf{X_{K2}}$LIYSASYRYSG VPDRF$\mathbf{X_{K3}}$GSGSGTDFTLTISSLQ$\mathbf{X_{K4}}$EDFA$\mathbf{X_{K5}}$Y$\mathbf{X_{K6}}$CQQYNSYPRTFGGGTKVEIK, wherein $\mathbf{X_{K1}}$ is an amino acid with an aromatic or aliphatic hydroxyl side chain, $\mathbf{X_{K2}}$ is an amino acid with

an aromatic or aliphatic hydroxyl side chain, X_{K3} is an amino acid with an aliphatic hydroxyl side chain, X_{K4} is an amino acid with an aliphatic hydroxyl side chain or is P, X_{K5} is an amino acid with a charged or acidic side chain, and X_{K6} is an amino acid with an aromatic side chain; and (ii) a heavy chain variable region ("VH") comprising a VH CDR1, VH CDR2, and VH CDR3 having the amino acid sequences of SEQ ID NO: 16, SEQ ID NO: 17, and SEQ ID NO: 18, respectively, wherein the VL and VH are non-immunogenic in a human, wherein the antibody or antigen-binding fragment thereof inhibits tyrosine phosphorylation of KIT with an IC50 of about 600 pM or less as determined by ELISA, and wherein the antibody or antigen-binding fragment thereof induces KIT receptor internalization. In another aspect, the present invention refers to an isolated antibody, or an antigen-binding fragment thereof, which immunospecifically binds to a D4 region of human KIT, which comprises: (i) a VL comprising a VL CDR1, VL CDR2, and VL CDR3 having the amino acid sequences of SEQ ID NO: 19, SEQ ID NO: 20, and SEQ ID NO: 21, respectively; and (ii) a VH comprising the amino acid sequence: QVQLVQSGAEX_{H1}KKPGASVKX_{H2}SCKASGYTFTDYYINWVX_{H3}QAPGKGLEWIARIYPGS GNTYYNEKFKGRX_{H4}TX_{H5}TAX_{H6}KSTSTAYMX_{H7}LSSLRSEDX_{H8}AVYFCARGVYYFDYW GQGTTVTVSS, wherein X_{H1} is an amino acid with an aliphatic side chain, X_{H2} is an amino acid with an aliphatic side chain, X_{H3} is an amino acid with a polar or basic side chain, X_{H4} is an amino acid with an aliphatic side chain, X_{H5} is an amino acid with an aliphatic side chain, X_{H6} is an amino acid with an acidic side chain, X_{H7} is an amino acid with an acidic or amide derivative side chain, and X_{H8} is an amino acid with an aliphatic hydroxyl side chain, wherein the VL and VH are non-immunogenic in a human, wherein the antibody or antigen-binding fragment thereof inhibits tyrosine phosphorylation of KIT with an IC50 of about 600 pM or less as determined by ELISA, and wherein the antibody or antigen-binding fragment thereof induces KIT receptor internalization. In one aspect, the present invention refers to a conjugate comprising the antibody of the present invention or a antigen-binding fragment thereof linked to an agent. Also disclosed herein is an antibody, or an antigen binding fragment thereof, which immunospecifically binds to a D4 of human KIT, comprising:

(i) a light chain variable region ("VL") comprising a VL CDR1, VL CDR2, and VL CDR3 having the amino acid sequences of SEQ ID NO: 19, SEQ ID NO: 20, and SEQ ID NO: 21, respectively; and

(ii) a heavy chain variable region ("VH") comprising VH CDR1, VH CDR2, and VH CDR3 having the amino acid sequences of SEQ ID NO: 16, SEQ ID NO: 17, and SEQ ID NO: 18, respectively.

In one example, the VL and VH of an antibody provided herein or an antigen-binding fragment thereof are non-immunogenic in a human. In a particular example, the antibody can be expressed in Chinese hamster ovary (CHO) cells at a titer of at least 0.45 μg/mL. In a particular example, the antibody can be expressed in Chinese hamster ovary (CHO) cells at a titer of at least 0.3 μg/mL, at least 0.6 μg/mL, at least 0.75 μg/mL, or at least 1 μg/mL.

[0010] In a certain example, provided herein is antibody, or an antigen-binding fragment thereof, or a conjugate thereof, which immunospecifically binds to a D4 of human KIT, comprising:

a light chain variable region ("VL") comprising the amino acid sequence: DIVMTQSPSX$_{K1}$LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPKX$_{K2}$LIYSASYRY SGVPDRFX$_{K3}$GSGSGTDFTLTISSLQX$_{K4}$EDFAX$_{K5}$YX$_{K6}$CQQYNSYPRTFGGGTKVEIK (SEQ ID NO: 11), wherein X$_{K1}$ is an amino acid with an aromatic or aliphatic hydroxyl side chain, X$_{K2}$ is an amino acid with an aromatic or aliphatic hydroxyl side chain, X$_{K3}$ is an amino acid with an aliphatic hydroxyl side chain, X$_{K4}$ is an amino acid with an aliphatic hydroxyl side chain or is P, X$_{K5}$ is an amino acid with a charged or acidic side chain, and X$_{K6}$ is an amino acid with an aromatic side chain; and

a heavy chain variable region ("VH") comprising a VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NO: 16, SEQ ID NO: 17, and SEQ ID NO: 18, respectively.

[0011] In a particular example, disclosed herein is antibody (or a fragment thereof or a conjugate thereof), which immunospecifically binds to a D4 of human KIT, comprising:

(i) a VL comprising a VL CDR1, VL CDR2, and VL CDR3 having the amino acid sequences of SEQ ID NO: 19, SEQ ID NO: 20, and SEQ ID NO: 21, respectively; and

(ii) a VH comprising the amino acid sequence: QVQLVQSGAEX$_{H1}$KKPGASVKX$_{H2}$SCKASGYTFTDYYINWVX$_{H3}$QAPGKGLEWIARIYP GSGNTYYNEKFKGRX$_{H4}$TX$_{H5}$TAX$_{H6}$KSTSTAYMX$_{H7}$LSSLRSEDX$_{H8}$AVYFCARGVYYFD YWGQGTTVTVSS (SEQ ID NO: 12), wherein X$_{H1}$ is an amino acid with an aliphatic side chain, X$_{H2}$ is an amino acid with an aliphatic side chain, X$_{H3}$ is an amino acid with a polar or basic side chain, X$_{H4}$ is an amino acid with an aliphatic side chain, X$_{H5}$ is an amino acid

with an aliphatic side chain, X_{H6} is an amino acid with an acidic side chain, X_{H7} is an amino acid with an acidic or amide derivative side chain, and X_{H8} is an amino acid with an aliphatic hydroxyl side chain.

[0012] In a particular example, X_{K1} is the amino acid F or S, X_{K2} is the amino acid A or S, X_{K3} is the amino acid T or S, X_{K4} is the amino acid S or P, X_{K5} is the amino acid D or T, and X_{K6} is the amino acid F or Y.

[0013] In a certain example, X_{K1} is the amino acid S, X_{K2} is the amino acid A, X_{K3} is the amino acid T, X_{K4} is the amino acid P, X_{K5} is the amino acid D, and X_{K6} is the amino acid F.

[0014] In a particular example, X_{K1} is the amino acid F, X_{K2} is the amino acid A, X_{K3} is the amino acid T, X_{K4} is the amino acid S, X_{K5} is the amino acid D, and X_{K6} is the amino acid F.

[0015] In a particular example, X_{K1} is the amino acid F or S, X_{K2} is the amino acid A, X_{K3} is the amino acid T, X_{K4} is the amino acid S or P, X_{K5} is the amino acid D, and X_{K6} is the amino acid F.

[0016] In a particular example, X_{K1} is the amino acid S, X_{K2} is the amino acid A, X_{K3} is the amino acid T, X_{K4} is the amino acid P, X_{K5} is the amino acid D, and X_{K6} is the amino acid F.

[0017] In a particular example, X_{K1} is the amino acid S, X_{K2} is the amino acid S, X_{K3} is the amino acid S, X_{K4} is the amino acid P, X_{K5} is the amino acid T, and X_{K6} is the amino acid Y.

[0018] In one embodiment, X_{H1} is the amino acid L or V, X_{H2} is the amino acid L or V, X_{H3} is the amino acid K or R, X_{H4} is the amino acid V or A, X_{H5} is the amino acid L or I, X_{H6} is the amino acid E or D, X_{H7} is the amino acid Q or E, and X_{H8} is the amino acid S or T.

[0019] In a specific example, X_{H1} is the amino acid V, X_{H2} is the amino acid L or V, X_{H3} is the amino acid R or Q, X_{H4} is the amino acid A, X_{H5} is the amino acid L or I, X_{H6} is the amino acid D, X_{H7} is the amino acid Q or E, and X_{H8} is the amino acid T.

[0020] In a specific example, X_{H1} is the amino acid V, X_{H2} is the amino acid L, X_{H3} is the amino acid R, X_{H4} is the amino acid A, X_{H5} is the amino acid L, X_{H6} is the amino acid D, X_{H7} is the amino acid Q, and X_{H8} is the amino acid T.

[0021] In a certain example, X_{H1} is the amino acid V, X_{H2} is the amino acid V, X_{H3} is the amino acid R, X_{H4} is the amino acid A, X_{H5} is the amino acid I, X_{H6} is the amino acid D, X_{H7} is the amino acid E, and X_{H8} is the amino acid T.

[0022] In a certain example, X_{H1} is the amino acid L, X_{H2} is the amino acid L, X_{H3} is the amino acid K, X_{H4} is the amino acid A, X_{H5} is the amino acid L, X_{H6} is the amino acid E, X_{H7} is the amino acid Q, and X_{H8} is the amino acid S.

[0023] In a certain example, X_{H1} is the amino acid V, X_{H2} is the amino acid L, X_{H3} is the amino acid K, X_{H4} is the amino acid A, X_{H5} is the amino acid L, X_{H6} is the amino acid E, X_{H7} is the amino acid Q, and X_{H8} is the amino acid T.

[0024] In a certain example, X_{H1} is the amino acid V, X_{H2} is the amino acid V, X_{H3} is the amino acid R, X_{H4} is the amino acid V, X_{H5} is the amino acid I, X_{H6} is the amino acid D, X_{H7} is the amino acid E, and X_{H8} is the amino acid T.

[0025] In a particular example, X_{K1} to X_{K6} is an amino acid set forth in Table 6A, and/or X_{H1} to X_{H8} is an amino acid set forth in Table 6B.

[0026] In a particular example, provided herein is antibody, or an antigen-binding fragment thereof, or a conjugate thereof, which immunospecifically binds to a D4 of human KIT, comprising:

i) a VL comprising an amino acid sequence that is: at least 90% identical to SEQ ID NO: 7, at least 88% identical to SEQ ID NO: 8, at least 87% identical to SEQ ID NO: 9, or at least 84% identical to SEQ ID NO: 10; and

ii) a VH comprising an amino acid sequence that is: at least 93% identical to SEQ ID NO: 2, at least 92% identical to SEQ ID NO: 3, at least 90% identical to SEQ ID NO: 4, at least 87% identical to SEQ ID NO: 5, or at least 86% identical to SEQ ID NO: 6.

[0027] In a certain example, provided herein is antibody, or an antigen-binding fragment thereof, or a conjugate thereof, which immunospecifically binds to a D4 region of human KIT, comprising:

i) a light chain variable region ("VL") comprising the amino acid sequence: DIVMTQSPS$\mathbf{X_{K1}}$LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPK$\mathbf{X_{K}}$ $_{2}$LIYSASYRYSGVPDRF$\mathbf{X_{K3}}$GSGSGTDFTLTISSLQ$\mathbf{X_{K4}}$EDFA$\mathbf{X_{K5}}$Y$\mathbf{X_{K6}}$CQQ YNSYPRTFGGGTKVEIK, wherein $\mathbf{X_{K1}}$ is an amino acid with an aromatic or aliphatic hydroxyl side chain, $\mathbf{X_{K2}}$ is an amino acid with an aromatic or aliphatic hydroxyl side chain, $\mathbf{X_{K3}}$ is an amino acid with an aliphatic hydroxyl side chain,

X_{K4} is an amino acid with an aliphatic hydroxyl side chain or is P, X_{K5} is an amino acid with a charged or acidic side chain, and X_{K6} is an amino acid with an aromatic side chain; and

ii) a VH comprising the amino acid sequence: QVQLVQSGAEX_{H1}KKPGASVKX_{H2}SCKASGYTFTDYYINWVX_{H3}QAPGK GLEWIARIYPGSGNTYYNEKFKGRX_{H4}TX_{H5}TAX_{H6}KSTSTAYMX_{H7}LSSL RSEDX_{H8}AVYFCARGVYYFDYWGQGTTVTVSS, wherein X_{H1} is an amino acid with an aliphatic side chain, X_{H2} is an amino acid with an aliphatic side chain, X_{H3} is an amino acid with a polar or basic side chain, X_{H4} is an amino acid with an aliphatic side chain, X_{H5} is an amino acid with an aliphatic side chain, X_{H6} is an amino acid with an acidic side chain, X_{H7} is an amino acid with an acidic or amide derivative side chain, and X_{H8} is an amino acid with an aliphatic hydroxyl side chain.

[0028] In a particular example, X_{K1} to X_{K6} is an amino acid set forth in Table 6A, and/or X_{H1} to X_{H8} is an amino acid set forth in Table 6B.

[0029] In a particular example, an antibody described herein specifically binds to CHO cells recombinantly expressing wild-type KIT with an EC_{50} of about 150 pM or less as determined by flow cytometry. In a particular example, an antibody described herein specifically binds to a recombinant D4/D5 region of human KIT with an EC_{50} of about 600 pM or less, or about 250 pM to about 600 pM, as determined by flow cytometry. In a certain example, an antibody described herein inhibits tyrosine phosphorylation of KIT with an IC_{50} of about 600 pM or less as determined by ELISA.

[0030] In a specific example, an antibody described herein can be expressed in CHO cells with a titer of at least 1.0 μg/mL, or at least 1.1 μg/mL, or at least 1.2 μg/mL.

[0031] In a particular example, an antibody described herein further comprises a human light chain constant region and a human heavy chain constant region. In one example, the human light chain constant region of an antibody described herein is a human kappa light chain constant region. In a particular example, the human heavy chain constant region of an antibody described herein is a human gamma heavy chain constant region.

[0032] In a certain example, an antibody described herein is a human IgG1 or IgG4 antibody. In a certain embodiment, an antibody described herein is an antigen-binding fragment or a Fab fragment. In a specific example, an antibody described herein is an antigen-binding fragment or a Fab fragment. In a particular example, an antibody described herein is a bispecific antibody. In a certain example, an antibody described herein is internalized by a cell.

[0033] In a particular example, disclosed herein is a conjugate comprising an antibody described herein, or a KIT-binding fragment thereof, linked to an agent. In a specific example, the agent is a toxin. In a certain example, the toxin is abrin, ricin A, pseudomonas exotoxin, cholera toxin, or diphtheria toxin. In one example, the conjugate is internalized by a cell.

[0034] In a certain aspect, provided herein is a pharmaceutical composition comprising a conjugate described herein and a pharmaceutically acceptable carrier.

[0035] In another aspect, provided herein is a pharmaceutical composition comprising an antibody described herein and a pharmaceutically acceptable carrier.

[0036] In a particular aspect, provided herein is a polynucleotide comprising nucleotide sequences encoding a VH chain region, a VL chain region, or both a VL chain region and a VH chain region, of an antibody described herein.

[0037] In a specific example, a polynucleotide (*e.g.*, isolated polynucleotide) provided herein comprises SEQ ID NO: 22, 23, 24, 25, or 26 encoding a VH. In a scertain embodiment, a polynucleotide (*e.g.*, isolated polynucleotide) provided herein comprises SEQ ID NO: 27, 28, 29, or 30 encoding a VL. In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 22, 23, 24, 25, or 26 encoding a VH, and SEQ ID NO: 27, 28, 29, or 30 encoding a VL.

[0038] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 22 encoding a VH, and SEQ ID NO: 27 encoding a VL.

[0039] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 22 encoding a VH, and SEQ ID NO: 28 encoding a VL.

[0040] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 22 encoding a VH, and SEQ ID NO: 29 encoding a VL.

[0041] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 22 encoding a VH, and SEQ ID NO: 30 encoding a VL.

[0042] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 23 encoding a VH, and SEQ ID NO: 27 encoding a VL.

[0043] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 23 encoding a VH, and SEQ ID NO: 28 encoding a VL.

[0044] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 23 encoding a VH, and SEQ ID NO: 29 encoding a VL.

[0045] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 23 encoding a VH, and SEQ ID NO: 30 encoding a VL.

[0046] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 24 encoding a VH, and SEQ ID NO: 27 encoding a VL.

[0047] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 24 encoding a VH, and SEQ ID NO: 28 encoding a VL.

[0048] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 24 encoding a VH, and SEQ ID NO: 29 encoding a VL.

[0049] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 24 encoding a VH, and SEQ ID NO: 30 encoding a VL.

[0050] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 25 encoding a VH, and SEQ ID NO: 27 encoding a VL.

[0051] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 25 encoding a VH, and SEQ ID NO: 28 encoding a VL.

[0052] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 25 encoding a VH, and SEQ ID NO: 29 encoding a VL.

[0053] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 25 encoding a VH, and SEQ ID NO: 30 encoding a VL.

[0054] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 26 encoding a VH, and SEQ ID NO: 27 encoding a VL.

[0055] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 26 encoding a VH, and SEQ ID NO: 28 encoding a VL.

[0056] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 26 encoding a VH, and SEQ ID NO: 29 encoding a VL.

[0057] In a particular example, a polynucleotide (*e.g.*, isolated polynucleotide) or a population of polynucleotides (*e.g.*, population of isolated polynucleotides) provided herein comprises SEQ ID NO: 26 encoding a VH, and SEQ ID NO: 30 encoding a VL.

[0058] In one aspect, provided herein is a vector comprising a polynucleotide described herein for expressing an anti-KIT antibody or a fragment thereof. In a certain example, a vector provided herein is a mammalian expression vector.

[0059] In a certain aspect, provided herein is a host cell comprising a vector provided herein or one or more polynucleotides provided herein for expressing an anti-KIT antibody or a fragment thereof.

[0060] In a particular example, disclosed herein is a cell producing an antibody described herein. In one example, a cell provided herein comprises one or more polynucleotides described herein, wherein the cell can express an antibody which specifically binds to a D4 of human KIT. In a certain example, the cell comprises a vector described herein.

[0061] In a specific example, disclosed herein is a kit comprising an antibody (or antigen-binding fragment thereof or conjugate thereof) described herein. In a particular embodiment, a kit comprises a conjugate described herein.

[0062] In a certain example, disclosed herein is a method for treating or managing a KIT-associated disorder (*e.g.*, cancer), comprising administering to a subject in need thereof a therapeutically effective amount of an antibody described herein or an antigen-binding fragment thereof or a conjugate thereof. In one further aspect, the present invention refers to the use of an antibody of the present invention from the manufacture of a medicament for treating or managing a KIT-associated disorderwherein the KIT-associated disorder is selected from the group consisting of cancer, an inflammatory condition, and fibrosis. In one further aspect, the present invention refers to the use of a conjugate of the present invention in the manufacture of a medicament for treating or managing a KIT-associated disorder, wherein the KIT-associated disorder is selected from the group consisting of cancer, inflammatory condition, and fibrosis.

[0063] In one example, disclosed herein is a method for treating or managing a KIT-associated disorder, comprising administering to a subject in need thereof a therapeutically effective amount of a conjugate described herein.

[0064] In a particular example, the KIT-associated disorder is cancer, an inflammatory condition, or fibrosis. In a specific example, the cancer is leukemia, chronic myelogenous leukemia, lung cancer, small cell lung cancer, or gastrointestinal stromal tumors. In one example, the cancer is refractory to treatment by a tyrosine kinase inhibitor. In a further example, the tyrosine kinase inhibitor is imatinib mesylate or SU11248.

[0065] In a certain example, a method provided herein further comprises administering a second agent. In a specific example, the second agent is a chemotherapeutic agent, tyrosine kinase inhibitor, a histone deacetylase inhibitor, an antibody, or a cytokine. In a particular example, the tyrosine kinase inhibitor is imatinib mesylate or SU11248.

[0066] In a specific example, provided herein is a method, such as an *in vitro* method, for diagnosing a subject with a KIT-associated disorder comprising contacting cells or a sample obtained from the subject with an antibody described herein (or an antigen-binding fragment thereof or a conjugate thereof) and detecting the expression level of KIT in the cells or the sample. For example, detection of the binding of an antibody described herein to a KIT antigen present in the cell or sample can be correlated to the expression level of KIT in the cell or sample. In a particular embodiment, the antibody is conjugated to a detectable molecule. In a certain embodiment, the detectable molecule is an enzyme, a fluorescent molecule, a luminescent molecule, or a radioactive molecule.

[0067] In a particular example, provided herein is a method, such as an *in vitro* method, for inhibiting KIT activity in a cell expressing KIT comprising contacting the cell with an effective amount of an antibody described herein (or an antigen-binding fragment thereof or a conjugate thereof).

[0068] In a particular example, provided herein is a method, such as an *in vitro* method, for inducing or enhancing apoptosis in a cell expressing KIT comprising contacting the cell with an effective amount an antibody described herein (or an antigen-binding fragment thereof or a conjugate thereof).

[0069] In a particular example, provided herein is a method, such as an *in vitro* method, for inducing cell differentiation comprising contacting a cell expressing KIT with an effective amount of an antibody described herein (or an antigen-binding fragment thereof or a conjugate thereof). In a particular embodiment, the cell is a stem cell.

[0070] In a certain aspect, provided herein is a method of making an antibody which immunospecifically binds to a D4 region of human KIT comprising culturing a cell or host cell described herein. In a certain example, provided herein is a method of making an antibody which immunospecifically binds to a D4 region of human KIT comprising expressing the antibody using a cell or host cell described herein. In a particular example, the cell is an isolated cell. In a particular example, the method further comprises the step of purifying the antibody obtained from the cell or host cell.

[0071] In one example, disclosed herein is an antibody or antigen-binding fragment thereof, which immunospecifically binds to a D4 region of human KIT, wherein said antibody or antigen-binding fragment thereof comprises:

(i) a light chain variable region ("VL") comprising a VL CDR1, VL CDR2, and VL CDR3 selected from the group set forth in Tables 10-12; and

(ii) a heavy chain variable region ("VH") comprising VH CDR1, VH CDR2, and VH CDR3 selected from the group set forth in Tables 13-15.

[0072] In a certain example, described herein is an antibody or antigen-binding fragment thereof, wherein said antibody or antigen-binding fragment thereof comprises:

(i) VL comprising a VL FR1, VL FR2, VL FR3, AND VL FR4 selected from the group set forth in Tables 20-23; and

(ii) a VH comprising Vh FR1, VH FR2, VH FR3, and VH FR4 selected from the group set forth in Tables 16-19.

[0073] In a particular example, the antibody or antigen-binding fragment described herein comprises an Fc region with an amino acid modification. In a certain example, the antibody or antigen-binding fragment described herein comprises an Fc region which is an IgG1 isotype or an IgG4 isotype. In one example, the antibody or antigen-binding fragment described herein is a humanized antibody. In a particular example, the antibody or antigen-binding fragment thereof described herein is a bispecific antibody.

[0074] In a certain example, described herein is an antibody or antigen-binding fragment thereof which is conjugated to another agent.

[0075] In one example, provided herein is a composition comprising an antibody or antigen-binding fragment thereof described herein.

[0076] In a particular example, provided herein is a polynucleotide comprising nucleotide sequences encoding a VH chain region, a VL chain region, or both a VL chain region and a VH chain region, of an antibody or antigen-binding fragment thereof described herein (e.g., antibody or antigen binding fragment thereof comprising sequences set forth in Tables 10-15). Also provided is a vector comprising the polynucleotide described herein. In one example, the vector is a mammalian expression vector.

[0077] In a certain example, provided herein is a host cell comprising a vector of or one or more polynucleotides described herein. In one example, provided herein is a cell producing an antibody or antigen-binding fragment thereof described herein (e.g., antibody or antigen binding fragment thereof comprising sequences set forth in Tables 10-15).

[0078] In a particular example, provided herein is a kit comprising an antibody or antigen-binding fragment thereof described herein (e.g., antibody or antigen binding fragment thereof comprising sequences set forth in Tables 10-15).

[0079] In a certain example, provided herein is a method for treating or managing a KIT-associated disorder, comprising administering to a subject in need thereof a therapeutically effective amount of an antibody or antigen-binding fragment thereof described herein (e.g., antibody or antigen binding fragment thereof comprising sequences set forth in Tables 10-15). In one example, the KIT-associated disorder is cancer, an inflammatory condition, or fibrosis. In a particular example, the cancer is leukemia, chronic myelogenous leukemia, lung cancer, small cell lung cancer, or gastrointestinal stromal tumors.

[0080] In a particular example, the method for treating or managing a KIT-associated disorder described herein further comprises administering a second agent. In a particular example, the second agent is a chemotherapeutic agent, tyrosine kinase inhibitor, a histone deacetylase inhibitor, an antibody, a cytokine, an HSP90 inhibitor, a PGP inhibitor, or a proteosome inhibitor.

[0081] In one example, provided herein is a method for diagnosing a subject with a KIT-associated disorder comprising contacting cells or a sample obtained from the subject with an antibody or antigen-binding fragment thereof described herein (e.g., antibody or antigen binding fragment thereof comprising sequences set forth in Tables 10-15) and detecting the expression level of KIT in the cells or the sample. In a certain example, the antibody is conjugated to a detectable molecule.

[0082] In a certain example, provided herein is a method for inhibiting KIT activity in a cell expressing KIT comprising contacting the cell with an effective amount of an antibody or antigen-binding fragment thereof described herein (e.g., antibody or antigen binding fragment thereof comprising sequences set forth in Tables 10-15).

[0083] A method for inducing or enhancing apoptosis in a cell expressing KIT comprising contacting the cell with an effective amount of an antibody or antigen-binding fragment thereof described herein (e.g., antibody or antigen binding fragment thereof comprising sequences set forth in Tables 10-15).

[0084] A method of making an antibody which immunospecifically binds to a D4 region of human KIT comprising culturing, and/or expressing the antibody using, a cell described herein.

4. BRIEF DESCRIPTION OF THE FIGURES

[0085] **Fig. 1** depicts the amino acid sequence of full length human KIT (SEQ ID NO: 1), GenBank™ accession number AAC50969. The first through fifth extracellular Ig-like domains (*i.e.*, D1, D2, D3, D4, and D5) are indicated; "{" depicts the amino-terminal residue of each domain and "}" depicts the carboxyl-terminal residue of each domain. The D1 domain is depicted at P34 to R112, the D2 domain is depicted at D113 to P206, the D3 domain is depicted at A207 to D309, the D4 domain is depicted at K310 to N410 (SEQ ID NO: 15), the hinge region between D4 and D5 is located at V409 to N410, and the D5 domain is depicted at T411 to K509. Also, the D1/D2 hinge region is located at D113 to L117; the D2/D3 hinge region is located at P206 to

A210; and the D3/D4 hinge region is located at D309 to G311. The D4/D5 region comprises K310 to K509. The transmembrane domain comprises residues F525 to Q545, and the kinase domain comprises residues K589 to S933.

[0086] **Fig. 2** depicts the amino acid sequence of a recombinant KIT D4/D5. Human KIT amino acids V308 to H515 (SEQ ID NO: 73) are depicted in bold. The polypeptide depicted (SEQ ID NO: 14) contains (i) the first 33 amino acids (*i.e.*, M1 to E33) of the amino terminus of human KIT (including the signal peptide, underlined, not bold), (ii) the D4/D5 region of human KIT (bold), and (iii) a 5xHis tag (italics) at the carboxyl terminus.

[0087] **Fig. 3A** depicts the amino acid sequence (SEQ ID NO: 2) of the H1 VH domain, and a DNA (SEQ ID NO:22) encoding the amino acid sequence. The framework regions (FR1, FR2, FR3, and FR4), and CDRs (CDR1, CDR2, and CDR3) are indicated. Both Kabat numbering and numerical numbering of the amino acid residues are indicated.

[0088] **Fig. 3B** depicts the amino acid sequence (SEQ ID NO: 3) of the H2 VH domain and a DNA (SEQ ID NO:23) encoding the amino acid sequence. The framework regions (FR1, FR2, FR3, and FR4), and CDRs (CDR1, CDR2, and CDR3) are indicated. Both Kabat numbering and numerical numbering of the amino acid residues are indicated.

[0089] **Fig. 3C** depicts the amino acid sequence (SEQ ID NO: 4) of the H3 VH domain and a DNA (SEQ ID NO:24) encoding the amino acid sequence. The framework regions (FR1, FR2, FR3, and FR4), and CDRs (CDR1, CDR2, and CDR3) are indicated. Both Kabat numbering and numerical numbering of the amino acid residues are indicated.

[0090] **Fig. 3D** depicts the amino acid sequence (SEQ ID NO: 5) of the H4 VH domain and a DNA (SEQ ID NO:25) encoding the amino acid sequence. The framework regions (FR1, FR2, FR3, and FR4), and CDRs (CDR1, CDR2, and CDR3) are indicated. Both Kabat numbering and numerical numbering of the amino acid residues are indicated.

[0091] **Fig. 3E** depicts the amino acid sequence (SEQ ID NO: 6) of the H5 VH domain and a DNA (SEQ ID NO:26) encoding the amino acid sequence. The framework regions (FR1, FR2, FR3, and FR4), and CDRs (CDR1, CDR2, and CDR3) are indicated. Both Kabat numbering and numerical numbering of the amino acid residues are indicated.

[0092] **Fig. 3F** depicts the amino acid sequence (SEQ ID NO: 7) of the L1 VL domain and a DNA (SEQ ID NO:27) encoding the amino acid sequence. The framework regions (FR1,

FR2, FR3, and FR4), and CDRs (CDR1, CDR2, and CDR3) are indicated. Both Kabat numbering and numerical numbering of the amino acid residues are indicated.

[0093] **Fig. 3G** depicts the amino acid sequence (SEQ ID NO: 8) of the K2 VL domain and a DNA (SEQ ID NO:28) encoding the amino acid sequence. The framework regions (FR1, FR2, FR3, and FR4), and CDRs (CDR1, CDR2, and CDR3) are indicated. Both Kabat numbering and numerical numbering of the amino acid residues are indicated.

[0094] **Fig. 3H** depicts the amino acid sequence (SEQ ID NO: 9) of the L3 VL domain and a DNA (SEQ ID NO:29) encoding the amino acid sequence. The framework regions (FR1, FR2, FR3, and FR4), and CDRs (CDR1, CDR2, and CDR3) are indicated. Both Kabat numbering and numerical numbering of the amino acid residues are indicated.

[0095] **Fig. 3I** depicts the amino acid sequence (SEQ ID NO: 10) of the L4 VL domain and a DNA (SEQ ID NO:30) encoding the amino acid sequence. The framework regions (FR1, FR2, FR3, and FR4), and CDRs (CDR1, CDR2, and CDR3) are indicated. Both Kabat numbering and numerical numbering of the amino acid residues are indicated.

[0096] **Fig. 4A** depicts the consensus sequence of a VH domain. $X_{H1\text{-}H8}$ indicate amino acids which can be any amino acid.

[0097] **Fig. 4B** depicts the consensus sequence of a VL domain. $X_{K1\text{-}K6}$ indicate amino acids which can be any amino acid.

[0098] **Fig. 5** depicts the binding activity of antibodies Hum17, Hum8, Hum4, and Hum10, as well as a chimera of antibody 37M ("chimera"), to a recombinant polypeptide of the D4/D5 region of human KIT as determined by solid phase ELISA. The EC_{50} value for each antibody is indicated.

[0099] **Fig. 6** depicts a graph of the results of binding assays performed by flow cytomery with CHO cells recombinantly expressing wild-type human KIT to characterize the KIT binding activity of antibodies Hum17, Hum8, Hum4, and Hum10, in comparison to a chimera of antibody 37M ("chimera"). The EC_{50} value for each antibody is indicated.

[00100] **Fig. 7** depicts a graph of the results of KIT phosphorylation inhibition assays performed by ELISA with CHO cells recombinantly expressing wild-type KIT to characterize the phosphorylation blocking activity of antibodies Hum17, Hum8, Hum4, and Hum10, in comparison to a chimera of antibody 37M ("chimera"). The IC_{50} values for each antibody are indicated.

5. DETAILED DESCRIPTION

[00101] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by one of ordinary skill in the art.

[00102] As used herein, the terms "about" or "approximately" mean within plus or minus 10% of a given value or range.

[00103] Provided herein are antibodies, and antigen-binding fragments thereof, that immunospecifically bind to a KIT polypeptide (*e.g.*, a KIT polypeptide containing a human KIT D4 domain), and conjugates thereof. Also provided are isolated nucleic acids (polynucleotides) encoding such antibodies, and antigen-binding fragments thereof. Further provided are vectors (*e.g.*, expression vectors) and cells (*e.g.*, host cells) comprising nucleic acids encoding such antibodies or antigen-binding fragments thereof. Also provided are methods of making such antibodies, cells, *e.g.*, host cells. Also provided herein are methods and uses for treating or managing a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, or fibrosis) or one or more effects of such KIT-associated disorder or disease comprising administering one or more antibodies described herein, or an antigen-binding fragment thereof or a conjugate thereof. Also provided herein is are methods for diagnosing a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, or fibrosis) comprising contacting a sample with one or more antibodies (or antigen-binding fragment thereof) described herein and determining the expression level of KIT in the sample relative to a reference sample (*e.g.*, a control sample). Further provided herein are methods and uses for inhibiting KIT activity in a cell expressing KIT comprising contacting the cell with an effective amount of an antibody or an antigen-binding fragment thereof. Also further provided herein are methods for inducing or enhancing cell differentiation or apoptosis in a cell expressing KIT comprising contacting the cell with an effective amount of an antibody or antibodies described herein.

[00104] As used herein, the terms "D4/D5 region" or "D4/D5 domain" refer to a region within a KIT polypeptide spanning the fourth Ig-like extracellular ("D4") domain, the fifth Ig-like extracellular ("D5") domain, and the hinge region in between the D4 and D5 domains ("D4-D5 hinge region"), of KIT, in the following order from the amino terminus to the carboxyl terminus: D4, D4-D5 hinge region, and D5. As used herein, amino acids V308 to H515 of Figure 1 and the polypeptide depicted at Figure 2 herein are considered examples of a D4/D5 region or domain.

[00105] As used herein, the terms "KIT" or "KIT receptor" or "KIT polypeptide" refer to any form of full-length KIT including, but not limited to, native KIT, an isoform of KIT, an interspecies KIT homolog, or a KIT variant, *e.g.*, naturally occurring (for example, allelic or splice variant, or mutant, *e.g.*, somatic mutant) or artificially constructed variant (for example, a recombinant or chemically modified variant). KIT is a type III receptor tyrosine kinase encoded by the *c-kit* gene (see, *e.g.*, Yarden *et al.*, Nature, 1986, 323:226-232; Ullrich and Schlessinger, Cell, 1990, 61:203-212; Clifford *et al.*, J. Biol. Chem., 2003, 278:31461-31464; Yarden *et al.*, EMBO J., 1987, 6:3341-3351; Mol *et al.*, J. Biol. Chem., 2003, 278:31461-31464). GenBank™ accession number NM_000222 provides an exemplary human KIT nucleic acid sequence. GenBank™ accession numbers NP_001087241, P10721, and AAC50969 provide exemplary human KIT amino acid sequences. GenBank™ accession number AAH75716 provides an exemplary murine KIT amino acid sequence. Native KIT comprises five extracellular immunoglobulin (Ig)-like domains (D1, D2, D3, D4, D5), a single transmembrane region, an inhibitory cytoplasmic juxtamembrane domain, and a split cytoplasmic kinase domain separated by a kinase insert segment (see, *e.g.*, Yarden *et al.*, Nature, 1986, 323:226-232; Ullrich and Schlessinger, Cell, 1990, 61:203-212; Clifford *et al.*, J. Biol. Chem., 2003, 278:31461-31464). An exemplary amino acid sequence of the D4/D5 region of human KIT is provided in Figure 1, at amino acid residues V308 to H515. In a specific embodiment, KIT is human KIT. In a particular embodiment, KIT can exist as a monomer, dimer, multimer, native form, or denatured form.

[00106] In the context of a peptide or a polypeptide, the term "fragment" as used herein refers to a peptide or polypeptide that comprises a less than full length amino acid sequence. Such a fragment can arise, for example, from a truncation at the amino terminus, a truncation at the carboxy terminus, and/or an internal deletion of a residue(s) from the amino acid sequence. Fragments can, for example, result from alternative RNA splicing or from *in vivo* protease activity. In certain embodiments, KIT fragments or antibody fragments (*e.g.*, antibody fragments that immunospecifically bind to a KIT polypeptide) include polypeptides comprising an amino acid sequence of at least 5 contiguous amino acid residues, at least 10 contiguous amino acid residues, at least 15 contiguous amino acid residues, at least 20 contiguous amino acid residues, at least 25 contiguous amino acid residues, at least 40 contiguous amino acid residues, at least 50 contiguous amino acid residues, at least 60 contiguous amino residues, at least 70 contiguous amino acid residues, at least 80 contiguous amino acid residues, at least 90 contiguous amino acid

residues, at least contiguous 100 amino acid residues, at least 125 contiguous amino acid residues, at least 150 contiguous amino acid residues, at least 175 contiguous amino acid residues, at least 200 contiguous amino acid residues, or at least 250 contiguous amino acid residues of the amino acid sequence of a KIT polypeptide or an antibody (*e.g.*, an antibody that immunospecifically binds to a KIT polypeptide), respectively. In a specific embodiment, a fragment of a KIT polypeptide or an antibody (*e.g.*, an antibody that immunospecifically binds to a KIT polypeptide) retains at least 1, at least 2, or at least 3 functions of the polypeptide or antibody.

[00107] As used herein, the term "host cell" refers to a particular cell that comprises an exogenous nucleic acid molecule, *e.g.*, a cell that has been transfected or transformed with a nucleic acid molecule, and the progeny or potential progeny of such a parent cell. Progeny of such a cell may not be identical to the parent cell due to mutations or environmental influences that can occur in succeeding generations or integration of the nucleic acid molecule into the host cell genome.

5.1 Antibodies

[00108] As used herein, the terms "antibody" and "immunoglobulin" and "Ig" are terms of art and can be used interchangeably herein and refer to a molecule with an antigen binding site that immunospecifically binds an antigen.

[00109] As used herein, an "antigen" is a moiety or molecule that contains an epitope, and, as such, also is specifically bound by antibody. In a specific embodiment, the antigen, to which an antibody described herein binds, is KIT (*e.g.*, human KIT), or a fragment thereof, for example, an extracellular domain of KIT (*e.g.*, human KIT) or a D4 region of KIT (*e.g.*, human KIT).

[00110] As used herein, an "epitope" is a term in the art and refers to a localized region of an antigen to which an antibody can specifically bind. A region or a polypeptide contributing to an epitope can be contiguous amino acids of the polypeptide or an epitope can come together from two or more non-contiguous regions of the polypeptide.

[00111] As used herein, the terms "antigen binding domain," "antigen binding region," "antigen binding fragment," and similar terms refer to a portion of an antibody molecule which comprises the amino acid residues that interact with an antigen and confer on the antibody molecule its specificity for the antigen (*e.g.*, the complementarity determining regions (CDR)). The antigen binding region can be derived from any animal species, such as rodents (*e.g.*, mouse, rat or hamster) and humans. The CDRs of an antibody molecule can be determined by any

method well known to one of skill in the art. In particular, the CDRs can be determined according to the Kabat numbering system (*see* Kabat *et al.* (1991) Sequences of Proteins of Immunological Interest. (U.S. Department of Health and Human Services, Washington, D.C.) 5th ed.). In certain aspects, the CDRs of an antibody can be determined according to (i) the Chothia numbering scheme, which will be referred to herein as the "Chothia CDRs" (see, e.g., Chothia and Lesk, 1987, J. Mol. Biol., 196:901-917; Al-Lazikani *et al.*, 1997, J. Mol. Biol., 273:927-948; and U.S. Patent No. 7,709,226); or (ii) the IMGT numbering system, for example, as described in Lefranc, M.-P., 1999, The Immunologist, 7:132-136 and Lefranc, M.-P. *et al.*, 1999, Nucleic Acids Res., 27:209-212.

[00112] As used herein, a "conformational epitope" or "non-linear epitope" or "discontinuous epitope" refers to one comprised of at least two amino acids which are not consecutive amino acids in a single protein chain. For example, a conformational epitope can be comprised of two or more amino acids which are separated by a stretch of intervening amino acids but which are close enough to be recognized by an antibody (*e.g.*, an anti-KIT antibody) described herein as a single epitope. As a further example, amino acids which are separated by intervening amino acids on a single protein chain, or amino acids which exist on separate protein chains, can be brought into proximity due to the conformational shape of a protein structure or complex to become a conformational epitope which can be bound by an anti-KIT antibody described herein. It will be appreciated by one of skill in the art that, in general, a linear epitope bound by an anti-KIT antibody described herein may or may not be dependent on the secondary, tertiary, or quaternary structure of the KIT receptor. For example, in some embodiments, an anti-KIT antibody described herein binds to a group of amino acids regardless of whether they are folded in a natural three dimensional protein structure. In other embodiments, an anti-KIT antibody described herein does not recognize the individual amino acid residues making up the epitope, and require a particular conformation (bend, twist, turn or fold) in order to recognize and bind the epitope.

[00113] As used herein, the term "constant region" or "constant domain" refers to an antibody portion, *e.g.*, a carboxyl terminal portion of a light and/or heavy chain which is not directly involved in binding of an antibody to antigen but which exhibits various effector functions, such as interaction with the Fc receptor. The terms refer to a portion of an

immunoglobulin molecule having a generally more conserved amino acid sequence relative to an immunoglobulin variable domain.

[00114] As used herein, the term "heavy chain" when used in reference to an antibody refers to any distinct types, *e.g.*, alpha (α), delta (δ), epsilon (ε), gamma (γ) and mu (μ), based on the amino acid sequence of the constant domain, which give rise to IgA, IgD, IgE, IgG and IgM classes of antibodies, respectively, including subclasses of IgG, *e.g.*, IgG_1, IgG_2, IgG_3 and IgG_4. In a specific embodiment, the heavy chain is a human heavy chain.

[00115] As used herein, the terms "immunospecifically binds," "immunospecifically recognizes," "specifically binds," and "specifically recognizes" are analogous terms in the context of antibodies and refer to molecules that bind to an antigen (*e.g.*, epitope or immune complex) as such binding is understood by one skilled in the art. For example, a molecule that specifically binds to an antigen may bind to other peptides or polypeptides, generally with lower affinity as determined by, *e.g.*, immunoassays, Biacore™, KinExA 3000 instrument (Sapidyne Instruments, Boise, ID), or other assays known in the art. In a specific embodiment, molecules that immunospecifically bind to an antigen bind to the antigen with a K_a that is at least 2 logs, 2.5 logs, 3 logs, 4 logs or greater than the K_a when the molecules bind to another antigen. In another specific embodiment, molecules that immunospecifically bind to an antigen do not cross react with other proteins. In another specific embodiment, molecules that immunospecifically bind to an antigen do not cross react with other non-KIT proteins.

[00116] As used herein, an "isolated" or "purified" antibody is substantially free of cellular material or other contaminating proteins from the cell or tissue source from which the antibody is derived, or substantially free of chemical precursors or other chemicals when chemically synthesized.

[00117] The terms "Kabat numbering," and like terms are recognized in the art and refer to a system of numbering amino acid residues in the heavy and light chain variable regions of an antibody, or an antigen binding portion thereof (Kabat *et al.* (1971) *Ann. NY Acad. Sci.* 190:382-391 and, Kabat *et al.* (1991) Sequences of Proteins of Immunological Interest, Fifth Edition, U.S. Department of Health and Human Services, NIH Publication No. 91-3242). Using the Kabat numbering system, CDRs within an antibody heavy chain molecule are typically present at amino acid positions 31 to 35 ("CDR1"), amino acid positions 50 to 65 ("CDR2"), and amino acid positions 95 to 102 ("CDR3"). Using the Kabat numbering system, CDRs within an antibody

light chain molecule are typically present at amino acid positions 24 to 34 (CDR1), amino acid positions 50 to 56 (CDR2), and amino acid positions 89 to 97 (CDR3).

[00118] As used herein, the term "light chain" when used in reference to an antibody refers to any distinct types, *e.g.*, kappa (κ) of lambda (λ) based on the amino acid sequence of the constant domains. Light chain amino acid sequences are well known in the art. In specific embodiments, the light chain is a human light chain.

[00119] As used herein, the term "monoclonal antibody" refers to an antibody obtained from a population of homogenous or substantially homogeneous antibodies, and each monoclonal antibody will typically recognize a single epitope on the antigen. The term "monoclonal" is not limited to any particular method for making the antibody. Generally, a population of monoclonal antibodies can be generated by cells, a population of cells, or a cell line. In specific embodiments, a "monoclonal antibody," as used herein, is an antibody produced by a single hybridoma or other cell (*e.g.*, host cell producing a recombinant antibody), wherein the antibody immunospecifically binds to a KIT epitope (*e.g.*, an epitope of a D4 of human KIT) as determined, *e.g.*, by ELISA or other antigen-binding or competitive binding assay known in the art or in the Examples provided herein. Monoclonal antibodies described herein can, for example, be made by the hybridoma method as described in Kohler *et al.*; Nature, 256:495 (1975) or can be isolated from phage libraries using the techniques as described herein, for example. Other methods for the preparation of clonal cell lines and of monoclonal antibodies expressed thereby are well known in the art (see, for example, Chapter 11 in: Short Protocols in Molecular Biology, (2002) 5th Ed., Ausubel *et al.*, eds., John Wiley and Sons, New York).

[00120] As used herein, the term "polyclonal antibodies" refers to an antibody population that includes a variety of different antibodies directed to the same and to different epitopes within an antigen or antigens. Methods for producing polyclonal antibodies are known in the art (See, *e.g.*, see, for example, Chapter 11 in: Short Protocols in Molecular Biology, (2002) 5th Ed., Ausubel *et al.*, eds., John Wiley and Sons, New York).

[00121] As used herein, the term "recombinant human antibody" includes human antibodies that are isolated, prepared, expressed, or created by recombinant means, such as antibodies expressed using a recombinant expression vector transfected into a host cell, antibodies isolated from a recombinant, combinatorial human antibody library, antibodies isolated from an animal (*e.g.*, a mouse, rabbit, goat, or cow) that is transgenic and/or transchromosomal for human

immunoglobulin genes (*see e.g.,* Taylor, L. D. *et al.* (1992) *Nucl. Acids Res.* 20:6287-6295) or antibodies prepared, expressed, created or isolated by any other means that involves creation, *e.g.*, via synthesis, genetic engineering of DNA sequences that encode human immunoglobulin sequences, or splicing of sequences that encode human immunoglobulins, *e.g.*, human immunoglobulin gene sequences, to other such sequences. Such recombinant human antibodies can have variable and constant regions derived from human germline immunoglobulin sequences. In certain embodiments, the amino acid sequences of such recombinant human antibodies have been modified such thus the amino acid sequences of the VH and/or VL regions of the recombinant antibodies are sequences that, while derived from and related to human germline VH and VL sequences, do not naturally exist within the human antibody germline repertoire *in vivo*. As a non-limiting example, a recombinant human antibody can be obtained by assembling several human sequence fragments into a composite human sequence of a recombinant human antibody.

[00122] As used herein, the terms "variable region" or "variable domain" refer to a portion of an antibody, generally, a portion of a light or heavy chain, typically about the amino-terminal 110 to 120 amino acids in the mature heavy chain and about 90 to 100 amino acids in the mature light chain, which differ extensively in sequence among antibodies and are used in the binding and specificity of a particular antibody for its particular antigen. The variability in sequence is concentrated in those regions called complementarity determining regions (CDRs) while the more highly conserved regions in the variable domain are called framework regions (FR). Without wishing to be bound by any particular mechanism or theory, it is believed that the CDRs of the light and heavy chains are primarily responsible for the interaction of the antibody with antigen. In a specific embodiment, numbering of amino acid positions of antibodies described herein is according to the EU Index, as in Kabat *et al.* (1991) Sequences of Proteins of Immunological Interest, Fifth Edition, U.S. Department of Health and Human Services, NIH Publication No. 91-3242 ("Kabat *et al.*"). In certain aspects, the CDRs of an antibody can be determined according to (i) the Chothia numbering scheme, which will be referred to herein as the "Chothia CDRs" (see, *e.g.*, Chothia and Lesk, 1987, J. Mol. Biol., 196:901-917; Al-Lazikani *et al.*, 1997, J. Mol. Biol., 273:927-948; and U.S. Patent No. 7,709,226); or (ii) the IMGT numbering system, for example, as described in Lefranc, M.-P., 1999, The Immunologist, 7:132-136 and Lefranc, M.-P. *et al.*, 1999, Nucleic Acids Res., 27:209-212. In certain embodiments, the variable region is a human variable region. In certain embodiments, the variable region comprises rodent or murine CDRs and human

framework regions (FRs). In particular embodiments, the variable region is a primate (*e.g.*, non-human primate) variable region. In certain embodiments, the variable region comprises rodent or murine CDRs and primate (*e.g.*, non-human primate) framework regions (FRs). As a non-limiting example, a variable region described herein is obtained from assembling two or more fragments of human sequences into a composite human sequence.

[00123] In specific aspects, provided herein are antibodies (including antigen-binding fragments thereof), such as humanized antibodies, that immunospecifically bind to a D4 of human KIT and a D4/D5 region of KIT, *e.g.*, human KIT. Amino acid residues V308 to H515 (SEQ ID NO: 73) of Figures 1 and 2 represent an exemplary D4/D5 region of human KIT, and amino acids K310 to N410 (SEQ ID NO: 15), as depicted in Figures 1 and 2, represent an exemplary D4 of human KIT. In another specific embodiment, an antibody described herein (or an antigen-binding fragment thereof) immunospecifically binds to a D5 domain of KIT, *e.g.*, human KIT, with lower affinity than to a D4 domain of KIT, *e.g.*, human KIT. In a particular embodiment, an antibody described herein (or an antigen-binding fragment thereof) immunospecifically binds to a D4 domain of KIT, *e.g.*, human KIT, with higher affinity than to a D5 domain of KIT, *e.g.*, human KIT; for example, the higher affinity is at least 10 fold, 20 fold, 50 fold, 100 fold, 500 fold, or 1000 fold as determined by methods known in the art, *e.g.*, ELISA or Biacore assays.

[00124] In a specific embodiment, an antibody described herein (or an antigen-binding fragment thereof) immunospecifically binds to a D4 or D4/D5 region of KIT, *e.g.*, human KIT, and has higher affinity for a KIT antigen consisting essentially of a D4 domain only than a KIT antigen consisting essentially of a D5 domain only. In a particular embodiment, an antibody described herein (or an antigen-binding fragment thereof) immunospecifically binds to a D4 or D4/D5 region of KIT, *e.g.*, human KIT, and has at least 1 fold, 2 fold, 3 fold, 4 fold, 5 fold, or 10 fold higher affinity for a KIT antigen consisting essentially of a D4 domain only than a KIT antigen consisting essentially of a D5 domain only. In a particular embodiment, an antibody described herein (or an antigen-binding fragment thereof) immunospecifically binds to a D4 or D4/D5 region of KIT, *e.g.*, human KIT, and has higher binding affinity (*e.g.*, approximately a 2 fold to 3 fold higher affinity) for a KIT antigen consisting essentially of a D4 domain only or a D4/D5 region only, than a KIT antigen consisting essentially of a D5 domain only.

[00125] In a particular embodiment, an antibody described herein (or an antigen-binding fragment thereof) immunospecifically binds to a KIT antigen comprising or consisting essentially

of the amino acid sequence of SEQ ID NO: 15. In a specific embodiment, an antibody described herein (or an antigen-binding fragment thereof) immunospecifically binds to a D4 domain of KIT, *e.g.*, human KIT. In a particular embodiment, an antibody described herein immunospecifically binds to a KIT antigen comprising or consisting essentially of a D4 of human KIT. In a particular embodiment, an antibody described herein (or an antigen-binding fragment thereof) immunospecifically binds to a KIT antigen comprising or consisting essentially of the amino acid sequence of SEQ ID NO: 14 or 73.

[00126] In particular aspects, provided herein are antibodies or antigen-binding fragments thereof, which immunospecifically bind to a KIT polypeptide (*e.g.*, a D4 region of KIT, for example, human KIT, *e.g.*, SEQ ID NO: 15 [a human D4 sequence]) and comprise an amino acid sequence as described herein.

[00127] In specific aspects, described herein are antibodies (*e.g.*, human or humanized antibodies), including antigen-binding fragments thereof, comprising:

(i) VH CDRs of a VH domain comprising the amino acid sequence of SEQ ID NO: 31 (QVQLKQSGAELVRPGASVKLSCKASGYTFTDYYINWVKQRPGQGLEWIARIYPG SGNTYYNEKFKGKATLTAEKSSSTAYMQLSSLTSEDSAVYFCARGVYYFDYWGQ GTTLTVSS) or SEQ ID NO: 69 (QVQLKQSGAELVRPGASVKLSCKASGYTFTDYYINWVKQRPGQGLEWIARIYPG SGNTYYNEKFKGKATLTAEKSSSTAYMQLSSLTSEDSAVYFCARGVYYFDYWGQ GTTLTVSA), and

(ii) VL CDRs of a VL domain comprising the amino acid sequence of SEQ ID NO: 32 (DIVMTQSQKFMSTSVGDRVS VTCKASQNVRTNVAWYQQKPGQSPKALIYSASYRYSGVPDRFTGSGSGTDFTLTI SNVQSEDLADYFCQQYNSYPRTFGGGTKLEIKR).

[00128] In a specific embodiment, an antibody (*e.g.*, a human or humanized antibody) described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises the VH CDRs (SEQ ID NOs: 16-18) and VL CDRs (SEQ ID NOs: 19-21) described in Table 1. In a specific embodiment, an antibody (*e.g.*, a human or humanized antibody) described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises the VH CDRs and VL CDRs described in Table 2 (*e.g.*, set 1 or set 2). In a certain embodiment, an antibody (*e.g.*, a human or humanized antibody) described

herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises the VH CDRs and VL CDRs described in Table 3 (AbM CDRs or Contact CDRs).

[00129] **Table 1: CDR Amino Acid Sequences**

	amino acid sequence	SEQ ID NO:
VL CDR1	KASQNVRTNVA	19
VL CDR2	SASYRYS	20
VL CDR3	QQYNSYPRT	21
VH CDR1	DYYIN	16
VH CDR2	RIYPGSGNTYYNEKFKG	17
VH CDR3	GVYYFDY	18

[00130] **Table 2: CDR Amino Acid Sequences**

	Set 1			Set 2	
	amino acid sequence	SEQ ID NO:		amino acid sequence	SEQ ID NO:
VL CDR1	KASQNVRTNVA	19		SQNVRTN	59
VL CDR2	SASYRYS	20		SAS	60
VL CDR3	QQYNSYPRT	21		YNSYPR	61
VH CDR1	GYTFTDY	56		GYTFTDY	56
VH CDR2	YPGSGN	57		PGSG	62
VH CDR3	GVYYFDYW	58		VYYFDY	63

Table 3: CDR Amino Acid Sequences

	AbM			Contact	
	amino acid sequence	SEQ ID NO:		amino acid sequence	SEQ ID NO:
VL CDR1	KASQNVRTNVA	19		RTNVAWY	66
VL CDR2	SASYRYS	20		ALIYSASYRY	67
VL CDR3	QQYNSYPRT	21		QQYNSYPR	68
VH CDR1	GYTFTDYYIN	64		TDYYIN	70
VH CDR2	RIYPGSGNTY	65		WIARIYPGSGNTY	71
VH CDR3	GVYYFDYW	58		ARGVYYFDY	72

[00131] Table 4: VL and VH domains of Antibodies Hum1-20

VH domain ▶ VL domain ▼	H1 (SEQ ID NO: 2)	H2 (SEQ ID NO: 3)	H3 (SEQ ID NO: 4)	H4 (SEQ ID NO: 5)	H5 (SEQ ID NO: 6)
L1 (SEQ ID NO: 7)	Hum1	Hum2	Hum3	Hum4	Hum5
L2 (SEQ ID NO: 8)	Hum6	Hum7	Hum8	Hum9	Hum10
L3 (SEQ ID NO: 9)	Hum11	Hum12	Hum13	Hum14	Hum15
L4 (SEQ ID NO: 10)	Hum16	Hum17	Hum18	Hum19	Hum20

[00132] In certain aspects, provided herein are VH domains (*e.g.*, H1, H2, H3, H4 and H5 comprising SEQ ID NOs: 2-6, respectively) and VL domains (*e.g.*, L1, L2, L3, and L4 comprising SEQ ID NOs: 7-10, respectively). In certain embodiments, provided herein are antibodies comprising such VH and VL domains, as set forth, for example, in Table 4 (*i.e.*, antibodies Hum1-Hum20). In particular embodiments, these antibodies comprise VH CDRs1-3 and VL CDRs 1-3 comprising SEQ ID NOs: 16-18 and 19-21, respectively.

[00133] In certain embodiments, an antibody described herein, or an antigen-binding fragment thereof, comprises a variable light (VL) chain region comprising an amino acid sequence described herein, for example, any one of SEQ ID NOs: 7-10 (*e.g.*, see Figures 3F-3I) or SEQ ID NO: 12.

[00134] In certain embodiments, an antibody described herein, or an antigen-binding fragment thereof, comprises a variable heavy (VH) chain region comprising an amino acid sequence described herein, for example any one of SEQ ID NOs: 2-6 (*e.g.*, see Figures 3A-3E) or SEQ ID NO: 11.

[00135] For example, described herein is an antibody that immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT) and comprises (i) the VH domain H1 (SEQ ID NO: 2), H2 (SEQ ID NO: 3), H3 (SEQ ID NO: 4), H4 (SEQ ID NO: 5), or H5 (SEQ ID NO: 6) and/or (ii) the VL domain L1 (SEQ ID NO: 7), L2 (SEQ ID NO: 8), L3 (SEQ ID NO: 9), or L4 (SEQ ID NO: 10). In a particular example, an antibody described herein, or an antigen-binding fragment thereof, can immunospecifically bind to a KIT polypeptide (*e.g.*, the D4 region of human KIT) and comprise a VH domain and/or a VL domain of any one of antibodies Hum1-Hum20 (see Table 4). In a particular example, an antibody described herein, or an antigen-binding fragment

thereof, comprises a VH domain and/or a VL domain of any one of antibodies Hum4, Hum8, Hum10, or Hum17.

[00136] In a particular embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H1 (SEQ ID NO: 2) and L1 (SEQ ID NO: 7). In a particular embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H1 (SEQ ID NO: 2) and L2 (SEQ ID NO: 8). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H1 (SEQ ID NO: 2) and L3 (SEQ ID NO: 9). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H1 (SEQ ID NO: 2) and L4 (SEQ ID NO: 10). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H2 (SEQ ID NO: 3) and L1 (SEQ ID NO: 7). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H2 (SEQ ID NO: 3) and L2 (SEQ ID NO: 8). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H2 (SEQ ID NO: 3) and L3 (SEQ ID NO: 9). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H2 (SEQ ID NO: 3) and L4 (SEQ ID NO: 10). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H3 (SEQ ID NO: 4) and L1 (SEQ ID NO: 7). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H3 (SEQ ID NO: 4) and L2 (SEQ ID NO: 8). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H3 (SEQ ID NO: 4) and L3 (SEQ ID NO: 9). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H3 (SEQ ID NO: 4) and L4 (SEQ ID NO: 10). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H4 (SEQ ID NO: 5) and L1 (SEQ ID NO: 7). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H4 (SEQ ID NO: 5) and L2 (SEQ ID NO: 8). In a specific embodiment, an antibody, which immunospecifically binds to a KIT

polypeptide (*e.g.*, the D4 region of human KIT), comprises H4 (SEQ ID NO: 5) and L3 (SEQ ID NO: 9). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H4 (SEQ ID NO: 5) and L4 (SEQ ID NO: 10). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H5 (SEQ ID NO: 6) and L1 (SEQ ID NO: 7). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H5 (SEQ ID NO: 6) and L2 (SEQ ID NO: 8). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H5 (SEQ ID NO: 6) and L3 (SEQ ID NO: 9). In a specific embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises H5 (SEQ ID NO: 6) and L4 (SEQ ID NO: 10).

[00137] In certain aspects, an antibody, or an antigen-binding fragment thereof, is non-immunogenic in a human. In a particular embodiment, a non-immunogenic amino acid sequence is devoid of epitopes identified to be binders to human MHC class II, *e.g.*, epitopes that are non-human germline binders to human MHC class II. In a particular embodiment, amino acid sequences substantially devoid of epitopes identified to be binders to human MHC class II, *e.g.*, epitopes that are non-human germline binders to human MHC class II. For example, *in silico* tools to identify the location of both B- and T-cell epitopes and to assess the potential for immunogenicity have been developed, and such tools provide an alternative to *in vitro* or *in vivo* immunogenicity assays. For example, computational epitope prediction methods and manually curated databases containing experimentally derived epitope data have been developed (See Bryson *et al.*, Biodrugs, 2010, 24(1): 1-8). Non-limiting examples of epitope databases include the Immune Epitope Database (IEDB) and the proprietary T Cell Epitope Database™ (TCED™). Such epitope databases can be used alone or in combination with *in vitro* assays described in the art, *e.g.*, MHC class II binding assays and T cell activation or proliferation assays. Alternatively, such *in vitro* assays can be used independently of such epitope databases. Methods for determining immunogenicity of an agent, such as an antibody, or for removing or reducing immunogenicity of an agent, such as an antibody, have been described in the art, see, *e.g.*, Altschul *et al.*, Nucleic Acids Res., 1997, 25:3389-3402; Baker *et al.*, Curr. Opin. Drug Discov. Devel., 2007, 10:219; Hill *et al.*, Arthritis Res. Ther., 2003, 1:R40-R48; Jones *et al.*, J. Thromb.

Haemost., 2005, 3:991-1000; Holgate *et al.*, IDrugs, 2009, 12:233-237; Jones *et al.*, Methods Mol. Biol., 2009, 525:405-423; and Baker *et al.*, Curr. Drug Saf., 2010, 5:308-313. In a particular embodiment, an antibody described herein which immunospecifically binds to a D4 region of human KIT comprises a VH domain and a VL domain that are not immunogenic, as determined by the T Cell Epitope Database™ (TCED™). In a certain embodiment, an antibody described herein immunospecifically binds to a D4 region of human KIT, and comprises a VH domain and a VL domain that are not immunogenic, as determined by an *in vitro* assay described in the art, see, *e.g.*, Wang *et al.*, 2008, PLoS Coomputational Biology, 2008, 4(4):e1000048; and Arnold *et al.*, 2002, J. Immunol., 169:739-749.

[00138] In certain aspects, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising a VH domain that has at least 93% sequence identity to H1 (SEQ ID NO: 2). In a particular embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain that has at least 94%, or at least 95%, or at least 96%, or at least 97%, or at least 98%, or at least 99% sequence identity to H1 (SEQ ID NO: 2). In a particular embodiment, the VH domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00139] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising a VH domain that has at least 92% sequence identity to H2 (SEQ ID NO: 3). In a particular embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), or antigen-binding fragment thereof, comprises a VH domain that has at least 93%, at least 94%, or at least 95%, or at least 96%, or at least 97%, or at least 98%, or at least 99% sequence identity to H2 (SEQ ID NO: 3). In a particular embodiment, the VH domain is non-immunogenic, for example as determined by the absence of epitopes that bind to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody, or antigen-binding fragment thereof, comprises a VH domain comprising VH CDR1,

VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00140] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising a VH domain that has at least 90% sequence identity to H3 (SEQ ID NO: 4). In a particular embodiment, an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain that has at least 92%, at least 93%, at least 94%, or at least 95%, or at least 96%, or at least 97%, or at least 98%, or at least 99% sequence identity to H3 (SEQ ID NO: 4). In a particular embodiment, the VH domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00141] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising a VH domain that has at least 87% sequence identity to H4 (SEQ ID NO: 5). In a particular embodiment, an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain that has at least 92%, at least 93%, at least 94%, or at least 95%, or at least 96%, or at least 97%, or at least 98%, or at least 99% sequence identity to H4 (SEQ ID NO: 5). In a particular embodiment, the VH domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00142] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising a VH domain that has at least 86% sequence identity to H5 (SEQ ID NO: 6). In a particular embodiment, an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a

VH domain that has at least 92%, at least 93%, at least 94%, or at least 95%, or at least 96%, or at least 97%, or at least 98%, or at least 99% sequence identity to H5 (SEQ ID NO: 6). In a particular embodiment, the VH domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00143] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising a VL domain that has at least 90% sequence identity to L1 (SEQ ID NO: 7). In a particular embodiment, an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain that has at least 92%, at least 93%, at least 94%, or at least 95%, or at least 96%, or at least 97%, or at least 98%, or at least 99% sequence identity to L1 (SEQ ID NO: 7). In a particular embodiment, the VL domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NO: 19-21, respectively.

[00144] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising a VL domain that has at least 88% sequence identity to L2 (SEQ ID NO: 8). In a particular embodiment, an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain that has at least 92%, at least 93%, at least 94%, or at least 95%, or at least 96%, or at least 97%, or at least 98%, or at least 99% sequence identity to L2 (SEQ ID NO: 8). In a particular embodiment, the VL domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NO: 19-21, respectively.

[00145] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising a VL domain that has at least 87% sequence identity to L3 (SEQ ID NO: 9). In a particular embodiment, an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain that has at least 92%, at least 93%, at least 94%, or at least 95%, or at least 96%, or at least 97%, or at least 98%, or at least 99% sequence identity to L3 (SEQ ID NO: 9). In a particular embodiment, the VL domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NO: 19-21, respectively.

[00146] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising a VL domain that has at least 84% sequence identity to L4 (SEQ ID NO: 10). In a particular embodiment, an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain that has at least 92%, at least 93%, at least 94%, or at least 95%, or at least 96%, or at least 97%, or at least 98%, or at least 99% sequence identity to L4 (SEQ ID NO: 10). In a particular embodiment, the VL domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NO: 19-21, respectively.

[00147] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 93% or at least 95% sequence identity to H1 (SEQ ID NO: 2); and (ii) a VL domain comprising an amino acid sequence that has at least 90% or at least 92% sequence identity to L1 (SEQ ID NO: 7). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC

class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00148] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 92% or at least 94% sequence identity to H2 (SEQ ID NO: 3); and (ii) a VL domain comprising an amino acid sequence that has at least 90% or at least 92% sequence identity to L1 (SEQ ID NO: 7). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00149] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 90% or at least 92% sequence identity to H3 (SEQ ID NO: 4); and (ii) a VL domain comprising an amino acid sequence that has at least 90% or at least 92% sequence identity to L1 (SEQ ID NO: 7). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00150] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 87% or at least 90% sequence identity to H4 (SEQ ID NO: 5); and (ii) a VL domain comprising an amino acid sequence that has at least 90% or at least 92%

sequence identity to L1 (SEQ ID NO: 7). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00151] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 86% or at least 88% sequence identity to H5 (SEQ ID NO: 6); and (ii) a VL domain comprising an amino acid sequence that has at least 90% or at least 92% sequence identity to L1 (SEQ ID NO: 7). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00152] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 93% or at least 95% sequence identity to H1 (SEQ ID NO: 2); and (ii) a VL domain comprising an amino acid sequence that has at least 88% or at least 90% sequence identity to L2 (SEQ ID NO: 8). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00153] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an

amino acid sequence that has at least 92% or at least 94% sequence identity to H2 (SEQ ID NO: 3); and (ii) a VL domain comprising an amino acid sequence that has at least 88% or at least 90% sequence identity to L2 (SEQ ID NO: 8). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00154] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 90% or at least 92% sequence identity to H3 (SEQ ID NO: 4); and (ii) a VL domain comprising an amino acid sequence that has at least 88% or at least 90% sequence identity to L2 (SEQ ID NO: 8). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00155] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 87% or at least 90% sequence identity to H4 (SEQ ID NO: 5); and (ii) a VL domain comprising an amino acid sequence that has at least 88% or at least 90% sequence identity to L2 (SEQ ID NO: 8). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00156] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 86% or at least 88% sequence identity to H5 (SEQ ID NO: 6); and (ii) a VL domain comprising an amino acid sequence that has at least 88% or at least 90% sequence identity to L2 (SEQ ID NO: 8). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00157] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 93% or at least 95% sequence identity to H1 (SEQ ID NO: 2); and (ii) a VL domain comprising an amino acid sequence that has at least 87% or at least 90% sequence identity to L3 (SEQ ID NO: 9). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00158] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 92% or at least 94% sequence identity to H2 (SEQ ID NO: 3); and (ii) a VL domain comprising an amino acid sequence that has at least 87% or at least 90% sequence identity to L3 (SEQ ID NO: 9). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid

sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00159] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 90% or at least 92% sequence identity to H3 (SEQ ID NO: 4); and (ii) a VL domain comprising an amino acid sequence that has at least 87% or at least 90% sequence identity to L3 (SEQ ID NO: 9). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00160] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 87% or at least 90% sequence identity to H4 (SEQ ID NO: 5); and (ii) a VL domain comprising an amino acid sequence that has at least 87% or at least 90% sequence identity to L3 (SEQ ID NO: 9). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00161] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 86% or at least 88% sequence identity to H5 (SEQ ID NO: 6); and (ii) a VL domain comprising an amino acid sequence that has at least 87% or at least 90% sequence identity to L3 (SEQ ID NO: 9). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC

class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00162] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 93% or at least 95% sequence identity to H1 (SEQ ID NO: 2); and (ii) a VL domain comprising an amino acid sequence that has at least 84% or at least 86% sequence identity to L4 (SEQ ID NO: 10). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00163] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 92% or at least 94% sequence identity to H2 (SEQ ID NO: 3); and (ii) a VL domain comprising an amino acid sequence that has at least 84% or at least 86% sequence identity to L4 (SEQ ID NO: 10). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00164] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 90% or at least 92% sequence identity to H3 (SEQ ID NO: 4); and (ii) a VL domain comprising an amino acid sequence that has at least 84% or at least 86%

sequence identity to L4 (SEQ ID NO: 10). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00165] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 87% or at least 90% sequence identity to H4 (SEQ ID NO: 5); and (ii) a VL domain comprising an amino acid sequence that has at least 84% or at least 86% sequence identity to L4 (SEQ ID NO: 10). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00166] In specific embodiments, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising (i) a VH domain comprising an amino acid sequence that has at least 86% or at least 88% sequence identity to H5 (SEQ ID NO: 6); and (ii) a VL domain comprising an amino acid sequence that has at least 84% or at least 86% sequence identity to L4 (SEQ ID NO: 10). In a particular embodiment, the VL and VH domains are non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II. In a certain embodiment, such antibody or antigen-binding fragment thereof comprises VL CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and VH CDRs 1-3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively.

[00167] To determine the percent identity of two amino acid sequences or of two nucleic acid sequences, the sequences are aligned for optimal comparison purposes (*e.g.*, gaps can be introduced in the sequence of a first amino acid or nucleic acid sequence for optimal alignment

with a second amino acid or nucleic acid sequence). The amino acid residues or nucleotides at corresponding amino acid positions or nucleotide positions are then compared. When a position in the first sequence is occupied by the same amino acid residue or nucleotide as the corresponding position in the second sequence, then the molecules are identical at that position. The percent identity between the two sequences is a function of the number of identical positions shared by the sequences (*i.e.*, % identity = number of identical overlapping positions/total number of positions X 100%). In one embodiment, the two sequences are the same length. In a certain embodiment, the percent identity is determined over the entire length of an amino acid sequence or nucleotide sequence.

[00168] The determination of percent identity between two sequences (*e.g.*, amino acid sequences or nucleic acid sequences) can also be accomplished using a mathematical algorithm. A preferred, non-limiting example of a mathematical algorithm utilized for the comparison of two sequences is the algorithm of Karlin and Altschul, 1990, Proc. Natl. Acad. Sci. U.S.A. 87:2264 2268, modified as in Karlin and Altschul, 1993, Proc. Natl. Acad. Sci. U.S.A. 90:5873 5877. Such an algorithm is incorporated into the NBLAST and XBLAST programs of Altschul *et al.*, 1990, J. Mol. Biol. 215:403. BLAST nucleotide searches can be performed with the NBLAST nucleotide program parameters set, *e.g.*, for score=100, wordlength=12 to obtain nucleotide sequences homologous to a nucleic acid molecules described herein. BLAST protein searches can be performed with the XBLAST program parameters set, *e.g.*, to score 50, wordlength=3 to obtain amino acid sequences homologous to a protein molecule described herein. To obtain gapped alignments for comparison purposes, Gapped BLAST can be utilized as described in Altschul *et al.*, 1997, Nucleic Acids Res. 25:3389 3402. Alternatively, PSI BLAST can be used to perform an iterated search which detects distant relationships between molecules (*Id.*). When utilizing BLAST, Gapped BLAST, and PSI Blast programs, the default parameters of the respective programs (*e.g.*, of XBLAST and NBLAST) can be used (see, *e.g.*, National Center for Biotechnology Information (NCBI) on the worldwide web, ncbi.nlm.nih.gov). Another preferred, non limiting example of a mathematical algorithm utilized for the comparison of sequences is the algorithm of Myers and Miller, 1988, CABIOS 4:11 17. Such an algorithm is incorporated in the ALIGN program (version 2.0) which is part of the GCG sequence alignment software package. When utilizing the ALIGN program for comparing amino acid sequences, a PAM120 weight residue table, a gap length penalty of 12, and a gap penalty of 4 can be used.

[00169] The percent identity between two sequences can be determined using techniques similar to those described above, with or without allowing gaps. In calculating percent identity, typically only exact matches are counted.

[00170] In a particular aspect, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising: (i) a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and one, two, three or four framework regions of H1, H2, H3, H4 or H5 (see Table 5A); and/or (ii) a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NO: 19-21, respectively, and one, two, three or four framework regions of L1, L2, L3, or L4 (see Table 5B).

[00171] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework region FR1 of H1, H2, H3, H4 or H5. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework region FR2 of H1, H2, H3, H4 or H5. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework region FR3 of H1, H2, H3, H4 or H5. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework region FR4 of H1, H2, H3, H4 or H5.

[00172] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR1 and FR2 of H1, H2, H3, H4 or H5. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT

polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR1, FR2, and FR3 of H1, H2, H3, H4 or H5. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR1, FR2, FR3, and FR4 of H1, H2, H3, H4 or H5.

[00173] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR1 and FR3 of H1, H2, H3, H4 or H5. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR1, FR3, and FR4 of H1, H2, H3, H4 or H5.

[00174] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR1 and FR4 of H1, H2, H3, H4 or H5.

[00175] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR1, FR2, and FR4 of H1, H2, H3, H4 or H5.

[00176] In one embodiment, a human or humanized antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR2 and FR3 of H1, H2, H3, H4 or H5. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ

ID NOs: 16-18, respectively, and framework regions FR2, FR3, and FR4 of H1, H2, H3, H4 or H5.

[00177] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR3 and FR4 of H1, H2, H3, H4 or H5.

[00178] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework region FR1 of L1, L2, L3, or L4. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework region FR2 of L1, L2, L3, or L4. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework region FR3 of L1, L2, L3, or L4. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework region FR4 of L1, L2, L3, or L4.

[00179] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR1 and FR2 of L1, L2, L3, or L4. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR1, FR2, and FR3 of L1, L2, L3, or L4. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3

comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR1, FR2, FR3, and FR4 of L1, L2, L3, or L4.

[00180] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR1 and FR3 of L1, L2, L3, or L4. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR1, FR3, and FR4 of L1, L2, L3, or L4.

[00181] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR1 and FR4 of L1, L2, L3, or L4.

[00182] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR1, FR2, and FR4 of L1, L2, L3, or L4.

[00183] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR2 and FR3 of L1, L2, L3, or L4. In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR2, FR3, and FR4 of L1, L2, L3, or L4.

[00184] In one embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively, and framework regions FR3 and FR4 of L1, L2, L3, or L4.

[00185] In a particular aspect, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising: (i) a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively, and framework regions FR1-FR4 of any one of VH domains HH257-HH281 (see Table 5C); and (ii) a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NO: 19-21, respectively, and FR1-FR4 of any one of VL domains LL65-LL76 (see Table 5D).

[00186] In a particular aspect, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising: (i) a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising a combination of amino acid sequences set forth in Table 2 or 3, and framework regions FR1-FR4 of any one of VH domains H1-H5 (Table 5A) and HH257-HH281 (see Table 5C); and (ii) a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising a combination of amino acid sequences set forth in either Table 2 (set 1 or set 2) or 3 (AbM or Contact CDRs), respectively, and FR1-FR4 of any one of VL domains L1-L4 (Table 5B) and LL65-LL76 (see Table 5D).

[00187] In a particular aspect, provided herein is an antibody or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising: (i) a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising a combination of amino acid sequences set forth in Table 2 or 3, and corresponding framework regions FR1-FR4 comprising sequences flanking the VH CDRs for example, as depicted in any one of Figures 3A-3I; and (ii) a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising a combination of amino acid sequences set forth in in either Table 2 (set 1 or set 2) or 3 (AbM or Contact CDRs), respectively, and corresponding framework regions FR1-FR4 comprising sequences flanking the VL CDRs, for example as depicted in any one of Figures 3A-3I.

[00188] **Table 5A: VH domain Framework Regions (FRs)**

	VH FR1	VH FR2	VH FR3	VH FR4
H1	QVQLVQSGAELK KPGASVKLSCKA SGYTFT (SEQ ID NO: 33)	WVKQAPGKGLE WIA (SEQ ID NO: 34)	RATLTAEKSTSTA YMQLSSLRSEDS AVYFCAR (SEQ ID NO: 35)	WGQGTTVTVSS (SEQ ID NO: 36)

H2	QVQLVQSGAEVKKPGASVKLSCKASGYTFT (SEQ ID NO: 37)	WVKQAPGKGLEWIA (SEQ ID NO: 34)	RATLTAEKSTSTAYMQLSSLRSEDTAVYFCAR (SEQ ID NO: 38)	WGQGTTVTVSS (SEQ ID NO: 36)
H3	QVQLVQSGAEVKKPGASVKLSCKASGYTFT (SEQ ID NO: 37)	WVRQAPGKGLEWIA (SEQ ID NO: 39)	RATLTADKSTSTAYMQLSSLRSEDTAVYFCAR (SEQ ID NO: 40)	WGQGTTVTVSS (SEQ ID NO: 36)
H4	QVQLVQSGAEVKKPGASVKVSCKASGYTFT (SEQ ID NO: 41)	WVRQAPGKGLEWIA (SEQ ID NO: 39)	RATITADKSTSTAYMELSSLRSEDTAVYFCAR (SEQ ID NO: 42)	WGQGTTVTVSS (SEQ ID NO: 36)
H5	QVQLVQSGAEVKKPGASVKVSCKASGYTFT (SEQ ID NO: 41)	WVRQAPGKGLEWIA (SEQ ID NO: 39)	RVTITADKSTSTAYMELSSLRSEDTAVYFCAR (SEQ ID NO: 43)	WGQGTTVTVSS (SEQ ID NO: 36)

[00189] Table 5B: VL domain Framework Regions (FRs)

	VL FR1	VL FR2	VL FR3	VL FR4
L1	DIVMTQSPSFLSASVGDRVTITC (SEQ ID NO: 44)	WYQQKPGKAPKALIY (SEQ ID NO: 45)	GVPDRFTGSGSGTDFTLTISSLQSEDFADYFC (SEQ ID NO: 46)	FGGGTKVEIK (SEQ ID NO: 47)
L2	DIVMTQSPSSLSASVGDRVTITC (SEQ ID NO: 48)	WYQQKPGKAPKALIY (SEQ ID NO: 45)	GVPDRFTGSGSGTDFTLTISSLQPEDFADYFC (SEQ ID NO: 49)	FGGGTKVEIK (SEQ ID NO: 47)
L3	DIVMTQSPSSLSASVGDRVTITC (SEQ ID NO: 48)	WYQQKPGKAPKALIY (SEQ ID NO: 45)	GVPDRFSGSGSGTDFTLTISSLQPEDFADYFC (SEQ ID NO: 50)	FGGGTKVEIK (SEQ ID NO: 47)
L4	DIVMTQSPSSLSASVGDRVTITC (SEQ ID NO: 48)	WYQQKPGKAPKSLIY (SEQ ID NO: 51)	GVPDRFSGSGSGTDFTLTISSLQPEDFATYYC (SEQ ID NO: 52)	FGGGTKVEIK (SEQ ID NO: 47)

[00190] Table 5C: Framework region sequences of VH domains HH257 to HH281

VH domain	VH FR1	VH FR2	VH FR3	VH FR4
HH257	SEQ ID NO: 33	SEQ ID NO: 39	SEQ ID NO: 35	SEQ ID NO: 36
HH258	SEQ ID NO: 33	SEQ ID NO: 34	SEQ ID NO: 38	SEQ ID NO: 36
HH259	SEQ ID NO: 33	SEQ ID NO: 39	SEQ ID NO: 38	SEQ ID NO: 36
HH260	SEQ ID NO: 33	SEQ ID NO: 34	SEQ ID NO: 40	SEQ ID NO: 36

VH domain	VH FR1	VH FR2	VH FR3	VH FR4
HH261	SEQ ID NO: 33	SEQ ID NO: 39	SEQ ID NO: 40	SEQ ID NO: 36
HH262	SEQ ID NO: 33	SEQ ID NO: 34	SEQ ID NO: 42	SEQ ID NO: 36
HH263	SEQ ID NO: 33	SEQ ID NO: 39	SEQ ID NO: 42	SEQ ID NO: 36
HH264	SEQ ID NO: 33	SEQ ID NO: 34	SEQ ID NO: 43	SEQ ID NO: 36
HH265	SEQ ID NO: 33	SEQ ID NO: 39	SEQ ID NO: 43	SEQ ID NO: 36
HH266	SEQ ID NO: 37	SEQ ID NO: 34	SEQ ID NO: 35	SEQ ID NO: 36
HH267	SEQ ID NO: 37	SEQ ID NO: 39	SEQ ID NO: 35	SEQ ID NO: 36
HH268	SEQ ID NO: 37	SEQ ID NO: 39	SEQ ID NO: 38	SEQ ID NO: 36
HH269	SEQ ID NO: 37	SEQ ID NO: 34	SEQ ID NO: 40	SEQ ID NO: 36
HH270	SEQ ID NO: 37	SEQ ID NO: 34	SEQ ID NO: 42	SEQ ID NO: 36
HH271	SEQ ID NO: 37	SEQ ID NO: 39	SEQ ID NO: 42	SEQ ID NO: 36
HH272	SEQ ID NO: 37	SEQ ID NO: 34	SEQ ID NO: 43	SEQ ID NO: 36
HH273	SEQ ID NO: 37	SEQ ID NO: 39	SEQ ID NO: 43	SEQ ID NO: 36
HH274	SEQ ID NO: 41	SEQ ID NO: 34	SEQ ID NO: 35	SEQ ID NO: 36
HH275	SEQ ID NO: 41	SEQ ID NO: 39	SEQ ID NO: 35	SEQ ID NO: 36
HH276	SEQ ID NO: 41	SEQ ID NO: 34	SEQ ID NO: 38	SEQ ID NO: 36
HH277	SEQ ID NO: 41	SEQ ID NO: 39	SEQ ID NO: 38	SEQ ID NO: 36
HH278	SEQ ID NO: 41	SEQ ID NO: 34	SEQ ID NO: 40	SEQ ID NO: 36
HH279	SEQ ID NO: 41	SEQ ID NO: 39	SEQ ID NO: 40	SEQ ID NO: 36
HH280	SEQ ID NO: 41	SEQ ID NO: 34	SEQ ID NO: 42	SEQ ID NO: 36
HH281	SEQ ID NO: 41	SEQ ID NO: 34	SEQ ID NO: 43	SEQ ID NO: 36

[00191] **Table 5D: Framework region sequences of VL domains LL65 to LL76**

VL domain	VL FR1	VL FR2	VL FR3	VL FR4
LL65	SEQ ID NO: 44	SEQ ID NO: 51	SEQ ID NO: 46	SEQ ID NO: 47
LL66	SEQ ID NO: 44	SEQ ID NO: 45	SEQ ID NO: 49	SEQ ID NO: 47
LL67	SEQ ID NO: 44	SEQ ID NO: 51	SEQ ID NO: 49	SEQ ID NO: 47
LL68	SEQ ID NO: 44	SEQ ID NO: 45	SEQ ID NO: 50	SEQ ID NO: 47
LL69	SEQ ID NO: 44	SEQ ID NO: 51	SEQ ID NO: 50	SEQ ID NO: 47

VL domain	VL FR1	VL FR2	VL FR3	VL FR4
LL70	SEQ ID NO: 44	SEQ ID NO: 45	SEQ ID NO: 52	SEQ ID NO: 47
LL71	SEQ ID NO: 44	SEQ ID NO: 51	SEQ ID NO: 52	SEQ ID NO: 47
LL72	SEQ ID NO: 48	SEQ ID NO: 45	SEQ ID NO: 46	SEQ ID NO: 47
LL73	SEQ ID NO: 48	SEQ ID NO: 51	SEQ ID NO: 46	SEQ ID NO: 47
LL74	SEQ ID NO: 48	SEQ ID NO: 51	SEQ ID NO: 49	SEQ ID NO: 47
LL75	SEQ ID NO: 48	SEQ ID NO: 51	SEQ ID NO: 50	SEQ ID NO: 47
LL76	SEQ ID NO: 48	SEQ ID NO: 45	SEQ ID NO: 52	SEQ ID NO: 47

[00192] In a particular aspect, provided herein is an antibody (*e.g.*, human or humanized antibody) or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising: (i) a VH domain comprising the amino acid sequence:

QVQLVQSGAEX_{H1}KKPGASVKX_{H2}SCKASGYTFTDYYINWVX_{H3}QAPGKGLEWIARIYPGS GNTYYNEKFKGRX_{H4}TX_{H5}TAX_{H6}KSTSTAYMX_{H7}LSSLRSEDX_{H8}AVYFCARGVYYFDYW GQGTTVTVSS (SEQ ID NO: 11), wherein X_{H1} at Kabat position 11, X_{H2} at Kabat position 20, X_{H3} at Kabat position 38, X_{H4} at Kabat position 67, X_{H5} at Kabat position 69, X_{H6} at Kabat position 72, X_{H7} at Kabat position 81, and X_{H8} at Kabat position 87 are independently selected from any amino acid; and/or (ii) a VL domain comprising the amino acid sequence DIVMTQSPSX_{K1}LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPKX_{K2}LIYSASYRYSG VPDRFX_{K3}GSGSGTDFTLTISSLQX_{K4}EDFAX_{K5}YX_{K6}CQQYNSYPRTFGGGTKVEIK (SEQ ID NO: 12), wherein X_{K1} at Kabat position 10, X_{K2} at Kabat position 46, X_{K3} at Kabat position 63, X_{K4} at Kabat position 80, X_{K5} at Kabat position 85, and X_{K6} at Kabat position 87 are independently selected from any amino acid. In a particular embodiment, the VH and/or VL domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II.

[00193] In a particular aspect, provided herein is an antibody, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprising: (i) a VH domain comprising the amino acid sequence:

QVQLVQSGAEX_{H1}KKPGASVKX_{H2}SCKASGYTFTDYYINWVX_{H3}QAPGKGLEWIARIYPGS GNTYYNEKFKGRX_{H4}TX_{H5}TAX_{H6}KSTSTAYMX_{H7}LSSLRSEDX_{H8}AVYFCARGVYYFDYW

GQGTTVTVSS (SEQ ID NO: 11), wherein X_{H1} at Kabat position 11, X_{H2} at Kabat position 20, X_{H3} at Kabat position 38, X_{H4} at Kabat position 67, X_{H5} at Kabat position 69, X_{H6} at Kabat position 72, X_{H7} at Kabat position 81, and X_{H8} at Kabat position 87 are selected from the combination of amino acids set forth in Table **6B**; and/or (ii) a VL domain comprising the amino acid sequence:

DIVMTQSPS$\mathbf{X_{K1}}$LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPK$\mathbf{X_{K2}}$LIYSASYRYSG VPDRF$\mathbf{X_{K3}}$GSGSGTDFTLTISSLQ$\mathbf{X_{K4}}$EDFA$\mathbf{X_{K5}}$Y$\mathbf{X_{K6}}$CQQYNSYPRTFGGGTKVEIK (SEQ ID NO: 12), wherein X_{K1} at Kabat position 10, X_{K2} at Kabat position 46, X_{K3} at Kabat position 63, X_{K4} at Kabat position 80, X_{K5} at Kabat position 85, and X_{K6} at Kabat position 87 are selected from the combination of amino acids set forth in Table **6A**. In a particular embodiment, the VH and/or VL domain is non-immunogenic, for example as determined by the absence of epitopes that binds to MHC class II, *e.g.*, non-human germline binders to MHC class II.

[00194] In one embodiment, X_{H1} at Kabat position 11 is an amino acid with an aliphatic side chain (*e.g.*, hydrophobic side chain, or nonpolar side chain branched-chain amino acid (BCAA)), such as L or V. In one embodiment, X_{H2} at Kabat position 20 is an amino acid with an aliphatic side chain (*e.g.*, hydrophobic side chain, or nonpolar side chain branched-chain amino acid (BCAA)), such as L or V. In one embodiment, X_{H3} at Kabat position 38 is an amino acid with a polar side chain (*e.g.*, hydrophilic side chain, basic side chain, or charged side chain, *e.g.*, positively charged side chain or negatively charged side chain), such as K or R. In one embodiment, X_{H4} at Kabat position 67 is an amino acid with an aliphatic side chain (*e.g.*, hydrophobic side chain, or nonpolar side chain branched-chain amino acid (BCAA)), such as V or A. In one embodiment, X_{H5} at Kabat position 69 is an amino acid with an aliphatic side chain (*e.g.*, hydrophobic side chain, or nonpolar side chain branched-chain amino acid (BCAA)), such as L or I. In one embodiment, X_{H6} at Kabat position 72 is an amino acid with an acidic side chain, such as E or D. In one embodiment, X_{H7} at Kabat position 81 is an amino acid with an acidic side chain or its amide derivative, such as Q (uncharged/amide derivative of E) or E. In one embodiment, X_{H8} at Kabat position 87 is an amino acid with an aliphatic hydroxyl group or a hydrophilic side chain, such as S or T.

[00195] In one embodiment, X_{H1} at Kabat position 11 is an aliphatic amino acid, such as a branched-chain amino acid (BCAA), for example V; X_{H2} at Kabat position 20 is an aliphatic amino acid, such as a branched-chain amino acid (BCAA), for example L; X_{H3} at Kabat position

38 is an amino acid with a polar side chain, such as R; X_{H4} at Kabat position 67 is an amino acid with an aliphatic side chain, such as A; X_{H5} at Kabat position 69 is an amino acid with an aliphatic side chain, such as L; X_{H6} at Kabat position 72 is an amino acid with a polar side chain, such as D; X_{H7} at Kabat position 81 is an amino acid with an an amide derivative of an acidic amino acid, such as Q; and X_{H8} at Kabat position 87 is an amino acid with an aliphatic hydroxyl side chain, such as T.

[00196] In one embodiment, X_{H1} at Kabat position 11 is an aliphatic amino acid, such as a branched-chain amino acid (BCAA), for example V; X_{H2} at Kabat position 20 is an aliphatic amino acid, such as a branched-chain amino acid (BCAA), for example V; X_{H3} at Kabat position 38 is an amino acid with a polar side chain, such as R; X_{H4} at Kabat position 67 is an amino acid with an aliphatic side chain, such as A; X_{H5} at Kabat position 69 is an amino acid with an aliphatic side chain, such as I; X_{H6} at Kabat position 72 is an amino acid with a polar side chain, such as D; X_{H7} at Kabat position 81 is an acidic amino acid, such as E; and X_{H8} at Kabat position 87 is an amino acid with an aliphatic hydroxyl side chain, such as T.

[00197] In a specific embodiment, X_{K1} at Kabat position 10 is an aromatic amino acid such as F or an amino acid with an aliphatic hydroxyl side chain such as S. In a certain embodiment, X_{K2} at Kabat position 46 is an amino acid with an aliphatic side chain (*e.g.*, hydrophobic amino acid) such as A or an amino acid with an aliphatic hydroxyl side chain such as S. In one embodiment, X_{K3} at Kabat position 63 is an amino acid with an aliphatic hydroxyl side chain such as T or S. In a specific embodiment, X_{K4} at Kabat position 80 is an amino acid with an aliphatic hydroxyl side chain such as S or an aromatic amino acid such as P. In a certain embodiment, X_{K5} at Kabat position 85 is an acidic amino acid such as D or an amino acid with an aliphatic hydroxyl side chain such as T. In one embodiment, X_{K6} at Kabat position 87 is an aromatic amino acid such as F or Y.

[00198] In a specific embodiment, X_{K1} at Kabat position 10 is an amino acid with an aliphatic hydroxyl side chain such as S; X_{K2} at Kabat position 46 is an amino acid with an aliphatic side chain (*e.g.*, hydrophobic amino acid) such as A; X_{K3} at Kabat position 63 is an amino acid with an aliphatic hydroxyl side chain such as T; X_{K4} at Kabat position 80 is an aromatic amino acid such as P; X_{K5} at Kabat position 85 is an acidic amino acid such as D; and X_{K6} at Kabat position 87 is an aromatic amino acid such as F.

[00199] In a specific embodiment, X_{K1} at Kabat position 10 is an aromatic amino acid such as F; X_{K2} at Kabat position 46 is an amino acid with an aliphatic side chain (*e.g.*, hydrophobic amino acid) such as A; X_{K3} at Kabat position 63 is an amino acid with an aliphatic hydroxyl side chain such as T; X_{K4} at Kabat position 80 is an aliphatic hydroxyl side chain such as S; X_{K5} at Kabat position 85 is an acidic amino acid such as D; and X_{K6} at Kabat position 87 is an aromatic amino acid such as F.

[00200] In a particular particular embodiment, an antibody described herein or a antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises: (i) a VH domain comprising the amino acid sequence: QVQLVQSGAE$\mathbf{X_{H1}}$KKPGASVK$\mathbf{X_{H2}}$SCKASGYTFTDYYINWV$\mathbf{X_{H3}}$QAPGKGLEWIARIYPGS GNTYYNEKFKGR$\mathbf{X_{H4}}$T$\mathbf{X_{H5}}$TA$\mathbf{X_{H6}}$KSTSTAYM$\mathbf{X_{H7}}$LSSLRSED$\mathbf{X_{H8}}$AVYFCARGVYYFDYW GQGTTVTVSS (SEQ ID NO: 11), wherein X_{H1} at Kabat position 11 is an amino acid with an aliphatic side chain such as V, X_{H2} at Kabat position 20 is an amino acid with an aliphatic side chain such as L, X_{H3} at Kabat position 38 is an amino acid with a polar side chain such as K, X_{H4} at Kabat position 67 is an amino acid with an aliphatic side chain such as A, X_{H5} at Kabat position 69 is an amino acid with an aliphatic side chain such as L, X_{H6} at Kabat position 72 is an acidic amino acid such as D, X_{H7} at Kabat position 81 is an acidic amino acid or an amide derivative thereof such as Q, and X_{H8} at Kabat position 87 is an amino acid with an aliphatic hydroxyl side chain such as T; and (ii) a VL domain comprising the amino acid sequence DIVMTQSPS$\mathbf{X_{K1}}$LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPK$\mathbf{X_{K2}}$LIYSASYRYSG VPDRF$\mathbf{X_{K3}}$GSGSGTDFTLTISSLQ$\mathbf{X_{K4}}$EDFA$\mathbf{X_{K5}}$Y$\mathbf{X_{K6}}$CQQYNSYPRTFGGGTKVEIK (SEQ ID NO: 12), wherein X_{K1} at Kabat position 10 is an amino acid with an aliphatic hydroxyl side chain such as S, X_{K2} at Kabat position 46 is an amino acid with an aliphatic side chain such as A, X_{K3} at Kabat position 63 is an amino acid with an aliphatic hydroxyl side chain such as T, X_{K4} at Kabat position 80 is an aromatic amino acid such as P, X_{K5} at Kabat position 85 is an acidic amino acid such as D, and X_{K6} at Kabat position 87 is an aromatic amino acid such as F.

[00201] In a particular particular embodiment, an antibody described herein or a antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises: (i) a VH domain comprising the amino acid sequence: QVQLVQSGAE$\mathbf{X_{H1}}$KKPGASVK$\mathbf{X_{H2}}$SCKASGYTFTDYYINWV$\mathbf{X_{H3}}$QAPGKGLEWIARIYPGS GNTYYNEKFKGR$\mathbf{X_{H4}}$T$\mathbf{X_{H5}}$TA$\mathbf{X_{H6}}$KSTSTAYM$\mathbf{X_{H7}}$LSSLRSED$\mathbf{X_{H8}}$AVYFCARGVYYFDYW

GQGTTVTVSS (SEQ ID NO: 11), wherein X_{H1} at Kabat position 11 is an amino acid with an aliphatic side chain such as V, X_{H2} at Kabat position 20 is an amino acid with an aliphatic side chain such as V, X_{H3} at Kabat position 38 is an amino acid with a polar side chain such as R, X_{H4} at Kabat position 67 is an amino acid with an aliphatic side chain such as A, X_{H5} at Kabat position 69 is an amino acid with an aliphatic side chain such as I, X_{H6} at Kabat position 72 is an acidic amino acid such as D, X_{H7} at Kabat position 81 is an acidic amino acid such as E, and X_{H8} at Kabat position 87 is an amino acid with an aliphatic hydroxyl side chain such as T; and (ii) a VL domain comprising the amino acid sequence DIVMTQSPSX_{K1}LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPKX_{K2}LIYSASYRYSG VPDRFX_{K3}GSGSGTDFTLTISSLQX_{K4}EDFAX_{K5}YX_{K6}CQQYNSYPRTFGGGTKVEIK (SEQ ID NO: 12), wherein X_{K1} at Kabat position 10 is an aromatic amino acid such as F, X_{K2} at Kabat position 46 is an amino acid with an aliphatic side chain such as A, X_{K3} at Kabat position 63 is an amino acid with an aliphatic hydroxyl side chain such as T, X_{K4} at Kabat position 80 is an amino acid with an aliphatic hydroxyl side chain such as S, X_{K5} at Kabat position 85 is an acidic amino acid such as D, and X_{K6} at Kabat position 87 is an aromatic amino acid such as F.

[00202] In a particular embodiment, an antibody described herein or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises (i) a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively; and (ii) a VL domain comprising SEQ ID NO: 7, 8, 9, or 10.

[00203] In a particular embodiment, an antibody described herein or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises (i) a VH domain comprising VH CDR1, VH CDR2, and VH CDR3 comprising the amino acid sequences of SEQ ID NOs: 16-18, respectively; and (ii) a VL domain comprising the amino acid sequence DIVMTQSPSX_{K1}LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPKX_{K2}LIYSASYRYSG VPDRFX_{K3}GSGSGTDFTLTISSLQX_{K4}EDFAX_{K5}YX_{K6}CQQYNSYPRTFGGGTKVEIK (SEQ ID NO: 12), wherein X_{K1} at Kabat position 10, X_{K2} at Kabat position 46, X_{K3} at Kabat position 63, X_{K4} at Kabat position 80, X_{K5} at Kabat position 85, and X_{K6} at Kabat position 87 are selected from the combination of amino acids set forth in Table **6A**.

[00204] In a particular embodiment, an antibody described herein or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises (i) a VH domain comprising the amino acid sequence of SEQ ID NO: 2, 3, 4, or 5; and (ii) a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively.

[00205] In a particular embodiment, an antibody described herein or an antigen-binding fragment thereof, which immunospecifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises (i) a VH domain comprising the amino acid sequence: QVQLVQSGAEX_{H1}KKPGASVKX_{H2}SCKASGYTFTDYYINWVX_{H3}QAPGKGLEWIARIYPGS GNTYYNEKFKGRX_{H4}TX_{H5}TAX_{H6}KSTSTAYMX_{H7}LSSLRSEDX_{H8}AVYFCARGVYYFDYW GQGTTVTVSS (SEQ ID NO: 11), wherein X_{H1} at Kabat position 11, X_{H2} at Kabat position 20, X_{H3} at Kabat position 38, X_{H4} at Kabat position 67, X_{H5} at Kabat position 69, X_{H6} at Kabat position 72, X_{H7} at Kabat position 81, and X_{H8} at Kabat position 87 are selected from the combination of amino acids set forth in Table **6B**; and (ii) a VL domain comprising VL CDR1, VL CDR2, and VL CDR3 comprising the amino acid sequences of SEQ ID NOs: 19-21, respectively.

[00206] Table 6A: VK domain Amino Acid Substitutions

	X_{K1}	X_{K2}	X_{K3}	X_{K4}	X_{K5}	X_{K6}
Kabat position	**10**	**46**	**63**	**80**	**85**	**87**
Numerical position of SEQ ID NO: 12	**10**	**46**	**63**	**80**	**85**	**87**
Amino acid side chain	Aromatic or aliphatic hydroxyl	Aliphatic or aliphatic hydroxyl	aliphatic hydroxyl	Proline or aliphatic hydroxyl	Charged or acidic	aromatic
L1	F	A	T	S	D	F
L2	S	A	T	P	D	F
L3	S	A	T	P	D	F
L4	S	S	S	P	T	Y
LL1	S	A	T	S	D	F
LL2	F	S	T	S	D	F
LL3	S	S	T	S	D	F
LL4	F	A	S	S	D	F

	X_{K1}	X_{K2}	X_{K3}	X_{K4}	X_{K5}	X_{K6}
Kabat position	**10**	**46**	**63**	**80**	**85**	**87**
Numerical position of SEQ ID NO: 12	**10**	**46**	**63**	**80**	**85**	**87**
LL5	S	A	S	S	D	F
LL6	F	S	S	S	D	F
LL7	S	S	S	S	D	F
LL8	F	A	T	P	D	F
LL9	S	A	T	P	D	F
LL10	F	S	T	P	D	F
LL11	S	S	T	P	D	F
LL12	F	A	S	P	D	F
LL13	S	A	S	P	D	F
LL14	F	S	S	P	D	F
LL15	S	S	S	P	D	F
LL16	F	A	T	S	T	F
LL17	S	A	T	S	T	F
LL18	F	S	T	S	T	F
LL19	S	S	T	S	T	F
LL20	F	A	S	S	T	F
LL21	S	A	S	S	T	F
LL22	F	S	S	S	T	F
LL23	S	S	S	S	T	F
LL24	F	A	T	P	T	F
LL25	S	A	T	P	T	F
LL26	F	S	T	P	T	F
LL27	S	S	T	P	T	F
LL28	F	A	S	P	T	F
LL29	S	A	S	P	T	F
LL30	F	S	S	P	T	F
LL31	S	S	S	P	T	F
LL32	S	A	T	S	D	Y
LL33	F	S	T	S	D	Y
LL34	S	S	T	S	D	Y
LL35	F	A	S	S	D	Y
LL36	S	A	S	S	D	Y
LL37	F	S	S	S	D	Y
LL38	S	S	S	S	D	Y
LL39	F	A	T	P	D	Y
LL40	S	A	T	P	D	Y
LL41	F	S	T	P	D	Y
LL42	S	S	T	P	D	Y
LL43	F	A	S	P	D	Y

	X_{K1}	X_{K2}	X_{K3}	X_{K4}	X_{K5}	X_{K6}
Kabat position	**10**	**46**	**63**	**80**	**85**	**87**
Numerical position of SEQ ID NO: 12	**10**	**46**	**63**	**80**	**85**	**87**
LL44	S	A	S	P	D	Y
LL45	F	S	S	P	D	Y
LL46	S	S	S	P	D	Y
LL47	F	A	T	S	T	Y
LL48	S	A	T	S	T	Y
LL49	F	S	T	S	T	Y
LL50	S	S	T	S	T	Y
LL51	F	A	S	S	T	Y
LL52	S	A	S	S	T	Y
LL53	F	S	S	S	T	Y
LL54	S	S	S	S	T	Y
LL55	F	A	T	P	T	Y
LL56	S	A	T	P	T	Y
LL57	F	S	T	P	T	Y
LL58	S	S	T	P	T	Y
LL59	F	A	S	P	T	Y
LL60	S	A	S	P	T	Y
LL61	F	S	S	P	T	Y
LL62	S	S	S	P	T	Y

[00207] **Table 6B: VH domain Amino Acid Substitutions**

	X_{H1}	X_{H2}	X_{H3}	X_{H4}	X_{H5}	X_{H6}	X_{H7}	X_{H8}
Kabat position	**11**	**20**	**38**	**67**	**69**	**72**	**81**	**87**
Numerical position of SEQ ID NO: 11	**11**	**20**	**38**	**68**	**70**	**73**	**82**	**91**
Amino acid side chain	Aliphatic	Aliphatic	Polar or basic	Aliphatic	Aliphatic	Acidic	Acidic or amide derivative	aliphatic hydroxyl
H1	L	L	K	A	L	E	Q	S
H2	V	L	K	A	L	E	Q	T
H3	V	L	R	A	L	D	Q	T

	X_{H1}	X_{H2}	X_{H3}	X_{H4}	X_{H5}	X_{H6}	X_{H7}	X_{H8}
Kabat position	**11**	**20**	**38**	**67**	**69**	**72**	**81**	**87**
Numerical position of SEQ ID NO: 11	**11**	**20**	**38**	**68**	**70**	**73**	**82**	**91**
H4	V	V	R	A	I	D	E	T
H5	V	V	R	V	I	D	E	T
HH1	L	L	K	A	L	E	Q	S
HH2	V	L	K	A	L	E	Q	S
HH3	L	V	K	A	L	E	Q	S
HH4	V	V	K	A	L	E	Q	S
HH5	L	L	R	A	L	E	Q	S
HH6	V	L	R	A	L	E	Q	S
HH7	L	V	R	A	L	E	Q	S
HH8	V	V	R	A	L	E	Q	S
HH9	L	L	K	V	L	E	Q	S
HH10	V	L	K	V	L	E	Q	S
HH11	L	V	K	V	L	E	Q	S
HH12	V	V	K	V	L	E	Q	S
HH13	L	L	R	V	L	E	Q	S
HH14	V	L	R	V	L	E	Q	S
HH15	L	V	R	V	L	E	Q	S
HH16	V	V	R	V	L	E	Q	S
HH17	L	L	K	A	I	E	Q	S
HH18	V	L	K	A	I	E	Q	S
HH19	L	V	K	A	I	E	Q	S
HH20	V	V	K	A	I	E	Q	S
HH21	L	L	R	A	I	E	Q	S
HH22	V	L	R	A	I	E	Q	S
HH23	L	V	R	A	I	E	Q	S
HH24	V	V	R	A	I	E	Q	S
HH25	L	L	K	V	I	E	Q	S
HH26	V	L	K	V	I	E	Q	S
HH27	L	V	K	V	I	E	Q	S
HH28	V	V	K	V	I	E	Q	S
HH29	L	L	R	V	I	E	Q	S
HH30	V	L	R	V	I	E	Q	S
HH31	L	V	R	V	I	E	Q	S
HH32	V	V	R	V	I	E	Q	S
HH33	L	L	K	A	L	D	Q	S
HH34	V	L	K	A	L	D	Q	S

	X_{H1}	X_{H2}	X_{H3}	X_{H4}	X_{H5}	X_{H6}	X_{H7}	X_{H8}
Kabat position	**11**	**20**	**38**	**67**	**69**	**72**	**81**	**87**
Numerical position of SEQ ID NO: 11	**11**	**20**	**38**	**68**	**70**	**73**	**82**	**91**
HH35	L	V	K	A	L	D	Q	S
HH36	V	V	K	A	L	D	Q	S
HH37	L	L	R	A	L	D	Q	S
HH38	V	L	R	A	L	D	Q	S
HH39	L	V	R	A	L	D	Q	S
HH40	V	V	R	A	L	D	Q	S
HH41	L	L	K	V	L	D	Q	S
HH42	V	L	K	V	L	D	Q	S
HH43	L	V	K	V	L	D	Q	S
HH44	V	V	K	V	L	D	Q	S
HH45	L	L	R	V	L	D	Q	S
HH46	V	L	R	V	L	D	Q	S
HH47	L	V	R	V	L	D	Q	S
HH48	V	V	R	V	L	D	Q	S
HH49	L	L	K	A	I	D	Q	S
HH50	V	L	K	A	I	D	Q	S
HH51	L	V	K	A	I	D	Q	S
HH52	V	V	K	A	I	D	Q	S
HH53	L	L	R	A	I	D	Q	S
HH54	V	L	R	A	I	D	Q	S
HH55	L	V	R	A	I	D	Q	S
HH56	V	V	R	A	I	D	Q	S
HH57	L	L	K	V	I	D	Q	S
HH58	V	L	K	V	I	D	Q	S
HH59	L	V	K	V	I	D	Q	S
HH60	V	V	K	V	I	D	Q	S
HH61	L	L	R	V	I	D	Q	S
HH62	V	L	R	V	I	D	Q	S
HH63	L	V	R	V	I	D	Q	S
HH64	V	V	R	V	I	D	Q	S
HH65	L	L	K	A	L	E	E	S
HH66	V	L	K	A	L	E	E	S
HH67	L	V	K	A	L	E	E	S
HH68	V	V	K	A	L	E	E	S
HH69	L	L	R	A	L	E	E	S
HH70	V	L	R	A	L	E	E	S
HH71	L	V	R	A	L	E	E	S

	X_{H1}	X_{H2}	X_{H3}	X_{H4}	X_{H5}	X_{H6}	X_{H7}	X_{H8}
Kabat position	**11**	**20**	**38**	**67**	**69**	**72**	**81**	**87**
Numerical position of SEQ ID NO: 11	**11**	**20**	**38**	**68**	**70**	**73**	**82**	**91**
HH72	V	V	R	A	L	E	E	S
HH73	L	L	K	V	L	E	E	S
HH74	V	L	K	V	L	E	E	S
HH75	L	V	K	V	L	E	E	S
HH76	V	V	K	V	L	E	E	S
HH77	L	L	R	V	L	E	E	S
HH78	V	L	R	V	L	E	E	S
HH79	L	V	R	V	L	E	E	S
HH80	V	V	R	V	L	E	E	S
HH81	L	L	K	A	I	E	E	S
HH82	V	L	K	A	I	E	E	S
HH83	L	V	K	A	I	E	E	S
HH84	V	V	K	A	I	E	E	S
HH85	L	L	R	A	I	E	E	S
HH86	V	L	R	A	I	E	E	S
HH87	L	V	R	A	I	E	E	S
HH88	V	V	R	A	I	E	E	S
HH89	L	L	K	V	I	E	E	S
HH90	V	L	K	V	I	E	E	S
HH91	L	V	K	V	I	E	E	S
HH92	V	V	K	V	I	E	E	S
HH93	L	L	R	V	I	E	E	S
HH94	V	L	R	V	I	E	E	S
HH95	L	V	R	V	I	E	E	S
HH96	V	V	R	V	I	E	E	S
HH97	L	L	K	A	L	D	E	S
HH98	V	L	K	A	L	D	E	S
HH99	L	V	K	A	L	D	E	S
HH100	V	V	K	A	L	D	E	S
HH101	L	L	R	A	L	D	E	S
HH102	V	L	R	A	L	D	E	S
HH103	L	V	R	A	L	D	E	S
HH104	V	V	R	A	L	D	E	S
HH105	L	L	K	V	L	D	E	S
HH106	V	L	K	V	L	D	E	S
HH107	L	V	K	V	L	D	E	S
HH108	V	V	K	V	L	D	E	S

	X_{H1}	X_{H2}	X_{H3}	X_{H4}	X_{H5}	X_{H6}	X_{H7}	X_{H8}
Kabat position	**11**	**20**	**38**	**67**	**69**	**72**	**81**	**87**
Numerical position of SEQ ID NO: 11	**11**	**20**	**38**	**68**	**70**	**73**	**82**	**91**
HH109	L	L	R	V	L	D	E	S
HH110	V	L	R	V	L	D	E	S
HH111	L	V	R	V	L	D	E	S
HH112	V	V	R	V	L	D	E	S
HH113	L	L	K	A	I	D	E	S
HH114	V	L	K	A	I	D	E	S
HH115	L	V	K	A	I	D	E	S
HH116	V	V	K	A	I	D	E	S
HH117	L	L	R	A	I	D	E	S
HH118	V	L	R	A	I	D	E	S
HH119	L	V	R	A	I	D	E	S
HH120	V	V	R	A	I	D	E	S
HH121	L	L	K	V	I	D	E	S
HH122	V	L	K	V	I	D	E	S
HH123	L	V	K	V	I	D	E	S
HH124	V	V	K	V	I	D	E	S
HH125	L	L	R	V	I	D	E	S
HH126	V	L	R	V	I	D	E	S
HH127	L	V	R	V	I	D	E	S
HH128	V	V	R	V	I	D	E	S
HH129	L	L	K	A	L	E	Q	T
HH130	V	L	K	A	L	E	Q	T
HH131	L	V	K	A	L	E	Q	T
HH132	V	V	K	A	L	E	Q	T
HH133	L	L	R	A	L	E	Q	T
HH134	V	L	R	A	L	E	Q	T
HH135	L	V	R	A	L	E	Q	T
HH136	V	V	R	A	L	E	Q	T
HH137	L	L	K	V	L	E	Q	T
HH138	V	L	K	V	L	E	Q	T
HH139	L	V	K	V	L	E	Q	T
HH140	V	V	K	V	L	E	Q	T
HH141	L	L	R	V	L	E	Q	T
HH142	V	L	R	V	L	E	Q	T
HH143	L	V	R	V	L	E	Q	T
HH144	V	V	R	V	L	E	Q	T
HH145	L	L	K	A	I	E	Q	T

	X_{H1}	X_{H2}	X_{H3}	X_{H4}	X_{H5}	X_{H6}	X_{H7}	X_{H8}
Kabat position	**11**	**20**	**38**	**67**	**69**	**72**	**81**	**87**
Numerical position of SEQ ID NO: 11	**11**	**20**	**38**	**68**	**70**	**73**	**82**	**91**
HH146	V	L	K	A	I	E	Q	T
HH147	L	V	K	A	I	E	Q	T
HH148	V	V	K	A	I	E	Q	T
HH149	L	L	R	A	I	E	Q	T
HH150	V	L	R	A	I	E	Q	T
HH151	L	V	R	A	I	E	Q	T
HH152	V	V	R	A	I	E	Q	T
HH153	L	L	K	V	I	E	Q	T
HH154	V	L	K	V	I	E	Q	T
HH155	L	V	K	V	I	E	Q	T
HH156	V	V	K	V	I	E	Q	T
HH157	L	L	R	V	I	E	Q	T
HH158	V	L	R	V	I	E	Q	T
HH159	L	V	R	V	I	E	Q	T
HH160	V	V	R	V	I	E	Q	T
HH161	L	L	K	A	L	D	Q	T
HH162	V	L	K	A	L	D	Q	T
HH163	L	V	K	A	L	D	Q	T
HH164	V	V	K	A	L	D	Q	T
HH165	L	L	R	A	L	D	Q	T
HH166	V	L	R	A	L	D	Q	T
HH167	L	V	R	A	L	D	Q	T
HH168	V	V	R	A	L	D	Q	T
HH169	L	L	K	V	L	D	Q	T
HH170	V	L	K	V	L	D	Q	T
HH171	L	V	K	V	L	D	Q	T
HH172	V	V	K	V	L	D	Q	T
HH173	L	L	R	V	L	D	Q	T
HH174	V	L	R	V	L	D	Q	T
HH175	L	V	R	V	L	D	Q	T
HH176	V	V	R	V	L	D	Q	T
HH177	L	L	K	A	I	D	Q	T
HH178	V	L	K	A	I	D	Q	T
HH179	L	V	K	A	I	D	Q	T
HH180	V	V	K	A	I	D	Q	T
HH181	L	L	R	A	I	D	Q	T
HH182	V	L	R	A	I	D	Q	T

	X_{H1}	X_{H2}	X_{H3}	X_{H4}	X_{H5}	X_{H6}	X_{H7}	X_{H8}
Kabat position	**11**	**20**	**38**	**67**	**69**	**72**	**81**	**87**
Numerical position of SEQ ID NO: 11	**11**	**20**	**38**	**68**	**70**	**73**	**82**	**91**
HH183	L	V	R	A	I	D	Q	T
HH184	V	V	R	A	I	D	Q	T
HH185	L	L	K	V	I	D	Q	T
HH186	V	L	K	V	I	D	Q	T
HH187	L	V	K	V	I	D	Q	T
HH188	V	V	K	V	I	D	Q	T
HH189	L	L	R	V	I	D	Q	T
HH190	V	L	R	V	I	D	Q	T
HH191	L	V	R	V	I	D	Q	T
HH192	V	V	R	V	I	D	Q	T
HH193	L	L	K	A	L	E	E	T
HH194	V	L	K	A	L	E	E	T
HH195	L	V	K	A	L	E	E	T
HH196	V	V	K	A	L	E	E	T
HH197	L	L	R	A	L	E	E	T
HH198	V	L	R	A	L	E	E	T
HH199	L	V	R	A	L	E	E	T
HH200	V	V	R	A	L	E	E	T
HH201	L	L	K	V	L	E	E	T
HH202	V	L	K	V	L	E	E	T
HH203	L	V	K	V	L	E	E	T
HH204	V	V	K	V	L	E	E	T
HH205	L	L	R	V	L	E	E	T
HH206	V	L	R	V	L	E	E	T
HH207	L	V	R	V	L	E	E	T
HH208	V	V	R	V	L	E	E	T
HH209	L	L	K	A	I	E	E	T
HH210	V	L	K	A	I	E	E	T
HH211	L	V	K	A	I	E	E	T
HH212	V	V	K	A	I	E	E	T
HH213	L	L	R	A	I	E	E	T
HH214	V	L	R	A	I	E	E	T
HH215	L	V	R	A	I	E	E	T
HH216	V	V	R	A	I	E	E	T
HH217	L	L	K	V	I	E	E	T
HH218	V	L	K	V	I	E	E	T
HH219	L	V	K	V	I	E	E	T

	X_{H1}	X_{H2}	X_{H3}	X_{H4}	X_{H5}	X_{H6}	X_{H7}	X_{H8}
Kabat position	**11**	**20**	**38**	**67**	**69**	**72**	**81**	**87**
Numerical position of SEQ ID NO: 11	**11**	**20**	**38**	**68**	**70**	**73**	**82**	**91**
HH220	V	V	K	V	I	E	E	T
HH221	L	L	R	V	I	E	E	T
HH222	V	L	R	V	I	E	E	T
HH223	L	V	R	V	I	E	E	T
HH224	V	V	R	V	I	E	E	T
HH225	L	L	K	A	L	D	E	T
HH226	V	L	K	A	L	D	E	T
HH227	L	V	K	A	L	D	E	T
HH228	V	V	K	A	L	D	E	T
HH229	L	L	R	A	L	D	E	T
HH230	V	L	R	A	L	D	E	T
HH231	L	V	R	A	L	D	E	T
HH232	V	V	R	A	L	D	E	T
HH233	L	L	K	V	L	D	E	T
HH234	V	L	K	V	L	D	E	T
HH235	L	V	K	V	L	D	E	T
HH236	V	V	K	V	L	D	E	T
HH237	L	L	R	V	L	D	E	T
HH238	V	L	R	V	L	D	E	T
HH239	L	V	R	V	L	D	E	T
HH240	V	V	R	V	L	D	E	T
HH241	L	L	K	A	I	D	E	T
HH242	V	L	K	A	I	D	E	T
HH243	L	V	K	A	I	D	E	T
HH244	V	V	K	A	I	D	E	T
HH245	L	L	R	A	I	D	E	T
HH246	V	L	R	A	I	D	E	T
HH247	L	V	R	A	I	D	E	T
HH248	V	V	R	A	I	D	E	T
HH249	L	L	K	V	I	D	E	T
HH250	V	L	K	V	I	D	E	T
HH251	L	V	K	V	I	D	E	T
HH252	V	V	K	V	I	D	E	T
HH253	L	L	R	V	I	D	E	T
HH254	V	L	R	V	I	D	E	T
HH255	L	V	R	V	I	D	E	T
HH256	V	V	R	V	I	D	E	T

[00208] In a specific embodiment, the position (*i.e.*, boundary) of a VL chain region described herein relative to the constant region may change by one, two, three, or four amino acid positions so long as immunospecific binding to KIT (*e.g.*, the D4 region of human KIT) is maintained (*e.g.*, substantially maintained, for example, at least 50%, at least 60%, at least 70%, at least 80%, at least 90%, at least 95%). In a specific embodiment, the position (*i.e.*, boundary) of a VH chain region described herein relative to the constant region may change by one, two, three, or four amino acid positions so long as immunospecific binding to KIT (*e.g.*, the D4 region of human KIT) is maintained (*e.g.*, substantially maintained, for example, at least 50%, at least 60%, at least 70%, at least 80%, at least 90%, at least 95%).

[00209] In specific aspects, provided herein is a moiety comprising VH CDRs and/or VL CDRs described herein, for example as set forth in Tables 1-3 and 10-15, wherein the VH CDRs and VL CDRs are arranged in a spatial orientation that confers specific binding to a D4 region of human KIT.

[00210] In specific aspects, provided herein is a moiety comprising VH CDRs comprising the amino acid sequences of SEQ ID NOs: 16-18 and VL CDRs comprising the amino acid sequences of SEQ ID NOs: 19-21, VH CDRs comprising the amino acid sequences of SEQ ID NOs: 56, 62 and 63 and VL CDRs comprising the amino acid sequences of SEQ ID NOs: 59-61, VH CDRs comprising the amino acid sequences of SEQ ID NOs: 70-72 and VL CDRs comprising the amino acid sequences of SEQ ID NOs: 66-68, wherein the VH CDRs and VL CDRs are arranged in a spatial orientation that confers specific binding to a D4 region of human KIT. In certain embodiments, the moiety is an antibody or an antigen-binding fragment thereof. In a particular embodiment, the moiety is a protein, such as a fusion protein comprising an Fc region.

[00211] In specific aspects, provided herein is a moiety comprising VH CDRs selected from Tables 13-15 and/or VL CDRs selected from Tables 10-12, wherein the VH CDRs and VL CDRs are arranged in a spatial orientation that confers specific binding to a D4 region of human KIT. In certain embodiments, the moiety is an antibody or an antigen-binding fragment thereof. In a particular embodiment, the moiety is a protein, such as a fusion protein comprising an Fc region.

[00212] In specific aspects, provided herein is a moiety, such as an antibody or an antigen-binding fragment thereof, comprising VH CDRs 1-3 and VL CDRs 1-3 selected from the ones

presented in Tables 10-15, wherein the VH CDRs and VL CDRs are arranged in a spatial orientation that confers specific binding to a D4 region of human KIT. In particular aspects, a moiety described herein comprises linkers, such as peptide linkers, that link the VH CDRs 1-3 and/or VL CDRs 1-3 in the spatial orientation that confers specific binding to a D4 region of human KIT.

[00213] In particular aspects, a moiety described herein comprises linkers, such as peptide linkers, that links the VH CDRs and/or VL CDRs in a spatial orientation that confers specific binding to a D4 region of human KIT.

[00214] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof comprising VL CDRs 1-3 and VH CDRs 1-3 selected from the ones presented in Tables 10-15, wherein the antibody or antigen-binding fragment thereof immunospecifically binds a D4 region of KIT, such as human KIT.

[00215] In a specific embodiment, the "X" amino acid of a CDR in any one of Tables 10-15 is any naturally occurring amino acid that maintains specific binding affinity to a D4 region of human KIT. In a specific embodiment, the "X" amino acid of a CDR in any one of Tables 10-15 is a non-natural amino acid that maintains specific binding affinity to a D4 region of human KIT. In a specific embodiment, the "X" amino acid of a CDR in any one of Tables 10-15 is a conservative substitution of the corresponding amino acid of the CDRs having the amino acid sequences of SEQ ID NOs: 16-21, wherein specific binding affinity to a D4 region of human KIT is maintained.

[00216] In a specific embodiment, the "X" amino acid of a CDR in any one of Tables 10-15 is, independently, amino acid A, G, T, K, or L. In a particular embodiment, the "X" amino acid of a CDR in any one of Tables 10-15 is amino acid A, G, T, Y, C, or S. In certain aspects of these embodiments, specific binding affinity to a D4 region of human KIT is maintained.

[00217] In a certain embodiment, an antibody described herein or an antigen-binding fragment thereof comprises VH CDRs and/or VL CDRs selected from those presented in Tables 10-15.

[00218] In a particular embodiment, a CDR, such as any one of VL CDRs 1-3 and VH CDRs 1-3 depicted in Tables 10-15, comprises one or more (*e.g.*, two, three, four, or five) "X" amino acids, wherein each "X" amino acid can be any amino acid which can maintain specific binding of the antibody or fragment thereof to a D4 region of human KIT.

Table 10: VL CDR1

VL CDR1	SEQ ID NO:
K A S Q N V R T N V A	19
X A S Q N V R T N V A	74
K X S Q N V R T N V A	75
K A X Q N V R T N V A	76
K A S X N V R T N V A	77
K A S Q X V R T N V A	78
K A S Q (A/G/T/Y/C/S) V R T N V A	79
K A S Q N X R T N V A	80
K A S Q N V X T N V A	81
K A S Q N V R X N V A	82
K A S Q N V R T X V A	83
K A S Q N V R T (A/G/T/Y/C/S) V A	84
K A S Q N V R T N X A	85
K A S Q N V R T N V X	86
C K A S Q N V R T N V	87
I C K A S Q N V R T N	88
A S Q N V R T N V A W	89
S Q N V R T N V A W Y	90
Q N V R T N V A W Y Q	91

Table 11: VL CDR2

VL CDR2	SEQ ID NO:
S A S Y R Y S	20
X A S Y R Y S	92
S X S Y R Y S	93
S A X Y R Y S	94
S A S X R Y S	95
S A S Y X Y S	96
S A S Y R X S	97
S A S Y R Y X	98
Y S A S Y R Y	99
I Y S A S Y R	100
L I Y S A S Y	101
A S Y R Y S G	102
S Y R Y S G V	103
Y R Y S G V P	104

Table 12: VL CDR3

VL CDR3	SEQ ID NO:
Q Q Y N S Y P R T	21
Q X Y N S Y P R T	105
Q Q X N S Y P R T	106

VL CDR3	SEQ ID NO:
Q Q Y X S Y P R T	107
Q Q Y N X Y P R T	108
Q Q Y N S X P R T	109
Q Q Y N S Y X R T	110
Q Q Y N S Y P X T	111
Q Q Y N S Y P R X	112
Q Q Y N S Y P R	113
C Q Q Y N S Y P	114
F C Q Q Y N S Y	115
Y F C Q Q Y N S	116
Q Y N S Y P R F	117
Y N S Y P R F G	118
S Y P R F G G	119

Table 13: VH CDR1

VH CDR1	SEQ ID NO:
D Y Y I N	16
X Y Y I N	120
D X Y I N	121
D Y X I N	122
D Y Y X N	123
D Y Y I X	124
T D Y Y I	125
F T D Y Y	126
T F T D Y	127
Y Y I N W	128
Y Y I N W V	129
I N W V R	130

Table 14: VH CDR2

VH CDR2	SEQ ID NO:
R I Y P G S G N T Y Y N E K F K G	17
X I Y P G S G N T Y Y N E K F K G	131
R X Y P G S G N T Y Y N E K F K G	132
R I X P G S G N T Y Y N E K F K G	133
R I Y X G S G N T Y Y N E K F K G	134
R I Y P X S G N T Y Y N E K F K G	135
R I Y P G X G N T Y Y N E K F K G	136
R I Y P G S X N T Y Y N E K F K G	137
R I Y P G S G X T Y Y N E K F K G	138
R I Y P G S G N X Y Y N E K F K G	139
R I Y P G S G N T X Y N E K F K G	140
R I Y P G S G N T Y X N E K F K G	141
R I Y P G S G N T Y Y X E K F K G	142

VH CDR2	SEQ ID NO:
R I Y P G S G N T Y Y N **X** K F K G	143
R I Y P G S G N T Y Y N E **X** F K G	144
R I Y P G S G N T Y Y N E K **X** K G	145
R I Y P G S G N T Y Y N E K F **X** G	146
R I Y P G S G N T Y Y N E K F K **X**	147
A R I Y P G S G N T Y Y N E K F	148
I A R I Y P G S G N T Y Y N E K	149
W I A R I Y P G S G N T Y Y N E	150
I Y P G S G N T Y Y N E K F K G R	151
Y P G S G N T Y Y N E K F K G R A	152
P G S G N T Y Y N E K F K G R A T	153

Table 15: VH CDR3

VH CDR3	SEQ ID NO:
G V Y Y F D Y	18
X V Y Y F D Y	154
G **X** Y Y F D Y	155
G V **X** Y F D Y	156
G V Y **X** F D Y	157
G V Y Y **X** D Y	158
G V Y Y F **X** Y	159
G V Y Y F D **X**	160
R G V Y Y F D	161
A R G V Y Y F	162
C A R G V Y Y	163
G V Y Y F D Y W	164
V Y Y F D Y W G	165
Y Y F D Y W G Q	166

[00219] In certain aspects, provided herein is an antibody or an antigen-binding fragment thereof comprising VL FRs 1-4 selected from the ones presented in Tables 20-23 and/or VH FRs 1-4 selected from the ones presented in Tables 16-19, wherein the antibody or antigen-binding fragment thereof immunospecifically binds a D4 region of KIT, such as human KIT.

[00220] In a specific embodiment, the "X" amino acid of an FR in any one of Tables 16-23 is any naturally occurring amino acid that maintains specific binding affinity to a D4 region of human KIT. In a specific embodiment, the "X" amino acid of a CDR in any one of Tables 16-23 is a non-natural amino acid that maintains specific binding affinity to a D4 region of human KIT. In a specific embodiment, the "X" amino acid of a CDR in any one of Tables 16-23 is a conservative substitution of the corresponding amino acid of the CDRs having the amino acid

sequences of SEQ ID NOs: 16-21, wherein specific binding affinity to a D4 region of human KIT is maintained.

[00221] In a specific embodiment, the "X" amino acid of a CDR in any one of Tables 16-23 is amino acid A, G, T, K, or L. In a particular embodiment, the "X" amino acid of a CDR in any one of Tables 16-23 is amino acid A, G, T, Y, C, or S. In certain aspects of these embodiments, specific binding affinity to a D4 region of human KIT is maintained.

In a certain embodiment, an antibody described herein or an antigen-binding fragment thereof comprises VH CDRs and/or VL CDRs selected from those presented in Tables 16-23.

[00222] In a particular embodiment, an FR, such as any one of VL FRs 1-4 and VH FRs 1-4 depicted in Tables 16-23, comprises one or more (*e.g.*, two, three, four, or five) "X" amino acids, wherein each "X" amino acid can be any amino acid which can maintain specific binding of the antibody or fragment thereof to a D4 region of human KIT.

Table 16: VH FR1

	VH FR1	SEQ ID NO:
H1	QVQLVQSGAELKKPGASVKLSCKASGYTFT	33
H2/H3	QVQLVQSGAEVKKPGASVKLSCKASGYTFT	37
H4/H5	QVQLVQSGAEVKKPGASVKVSCKASGYTFT	41
	XVQLVQSGAE(L/V)KKPGASVK(L/V)SCKASGYTFT	167
	QXQLVQSGAE(L/V)KKPGASVK(L/V)SCKASGYTFT	168
	QVXLVQSGAE(L/V)KKPGASVK(L/V)SCKASGYTFT	169
	QVQXVQSGAE(L/V)KKPGASVK(L/V)SCKASGYTFT	170
	QVQLXQSGAE(L/V)KKPGASVK(L/V)SCKASGYTFT	171
	QVQLVXSGAE(L/V)KKPGASVK(L/V)SCKASGYTFT	172
	QVQLVQXGAE(L/V)KKPGASVK(L/V)SCKASGYTFT	173
	QVQLVQSXAE(L/V)KKPGASVK(L/V)SCKASGYTFT	174
	QVQLVQSGXE(L/V)KKPGASVK(L/V)SCKASGYTFT	175
	QVQLVQSGAX(L/V)KKPGASVK(L/V)SCKASGYTFT	176
	QVQLVQSGAEXKKPGASVK(L/V)SCKASGYTFT	177
	QVQLVQSGAE(L/V)XKPGASVK(L/V)SCKASGYTFT	178
	QVQLVQSGAE(L/V)KXPGASVK(L/V)SCKASGYTFT	179
	QVQLVQSGAE(L/V)KKXGASVK(L/V)SCKASGYTFT	180
	QVQLVQSGAE(L/V)KKPXASVK(L/V)SCKASGYTFT	181
	QVQLVQSGAE(L/V)KKPGXSVK(L/V)SCKASGYTFT	182
	QVQLVQSGAE(L/V)KKPGAXVK(L/V)SCKASGYTFT	183
	QVQLVQSGAE(L/V)KKPGASXK(L/V)SCKASGYTFT	184
	QVQLVQSGAE(L/V)KKPGASVX(L/V)SCKASGYTFT	185
	QVQLVQSGAE(L/V)KKPGASVKXSCKASGYTFT	186
	QVQLVQSGAE(L/V)KKPGASVK(L/V)XCKASGYTFT	187
	QVQLVQSGAE(L/V)KKPGASVK(L/V)SXKASGYTFT	188

	QVQLVQSGAE(L/V)KKPGASVK(L/V)SC**X**ASGYTFT	189
	QVQLVQSGAE(L/V)KKPGASVK(L/V)SCK**X**SGYTFT	190
	QVQLVQSGAE(L/V)KKPGASVK(L/V)SCKA**X**GYTFT	191
	QVQLVQSGAE(L/V)KKPGASVK(L/V)SCKAS**X**YTFT	192
	QVQLVQSGAE(L/V)KKPGASVK(L/V)SCKASG**X**TFT	193
	QVQLVQSGAE(L/V)KKPGASVK(L/V)SCKASGY**X**FT	194
	QVQLVQSGAE(L/V)KKPGASVK(L/V)SCKASGYT**X**T	195
	QVQLVQSGAE(L/V)KKPGASVK(L/V)SCKASGYTF**X**	196

Table 17: VH FR2

	VH FR2	SEQ ID NO:
H1/H2	WVKQAPGKGLEWIA	34
H3/H4/H5	WVRQAPGKGLEWIA	39
	XV(R/K)QAPGKGLEWIA	197
	W**X**(R/K)QAPGKGLEWIA	198
	WV**X**QAPGKGLEWIA	199
	WV(R/K)**X**APGKGLEWIA	200
	WV(R/K)Q**X**PGKGLEWIA	201
	WV(R/K)QA**X**GKGLEWIA	202
	WV(R/K)QAP**X**KGLEWIA	203
	WV(R/K)QAPG**X**GLEWIA	204
	WV(R/K)QAPGK**X**LEWIA	205
	WV(R/K)QAPGKG**X**EWIA	206
	WV(R/K)QAPGKGL**X**WIA	207
	WV(R/K)QAPGKGLE**X**IA	208
	WV(R/K)QAPGKGLEW**X**A	209
	WV(R/K)QAPGKGLEWI**X**	210

Table 18: VH FR3

	VH FR3	SEQ ID NO:
H1	RATLTAEKSTSTAYMQLSSLRSEDSAVYFCAR	35
H2	RATLTAEKSTSTAYMQLSSLRSEDTAVYFCAR	38
H3	RATLTADKSTSTAYMQLSSLRSEDTAVYFCAR	40
H4	RATITADKSTSTAYMELSSLRSEDTAVYFCAR	42
H5	RVTITADKSTSTAYMELSSLRSEDTAVYFCAR	43
	X(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)AVYFCAR	211
	R**X**T(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)AVYFCAR	212
	R(A/V)**X**(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)AVYFCAR	213
	R(A/V)T**X**TADKSTSTAYM(E/Q)LSSLRSED(S/T)AVYFCAR	214
	R(A/V)T(I/L)**X**ADKSTSTAYM(E/Q)LSSLRSED(S/T)AVYFCAR	215
	R(A/V)T(I/L)T**X**DKSTSTAYM(E/Q)LSSLRSED(S/T)AVYFCAR	216
	R(A/V)T(I/L)TA**X**KSTSTAYM(E/Q)LSSLRSED(S/T)AVYFCAR	217

	VH FR3	SEQ ID NO:
	R(A/V)T(I/L)TAD**X**STSTAYM(E/Q)LSSLRSED(S/T)AVYFCAR	218
	R(A/V)T(I/L)TADK**X**TSTAYM(E/Q)LSSLRSED(S/T)AVYFCAR	219
	R(A/V)T(I/L)TADKS**X**STAYM(E/Q)LSSLRSED(S/T)AVYFCAR	220
	R(A/V)T(I/L)TADKST**X**TAYM(E/Q)LSSLRSED(S/T)AVYFCAR	221
	R(A/V)T(I/L)TADKSTS**X**AYM(E/Q)LSSLRSED(S/T)AVYFCAR	222
	R(A/V)T(I/L)TADKSTST**X**YM(E/Q)LSSLRSED(S/T)AVYFCAR	223
	R(A/V)T(I/L)TADKSTSTA**X**M(E/Q)LSSLRSED(S/T)AVYFCAR	224
	R(A/V)T(I/L)TADKSTSTAY**X**(E/Q)LSSLRSED(S/T)AVYFCAR	225
	R(A/V)T(I/L)TADKSTSTAYM**X**LSSLRSED(S/T)AVYFCAR	226
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)**X**SSLRSED(S/T)AVYFCAR	227
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)L**X**SLRSED(S/T)AVYFCAR	228
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LS**X**LRSED(S/T)AVYFCAR	229
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSS**X**RSED(S/T)AVYFCAR	230
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSL**X**SED(S/T)AVYFCAR	231
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLR**X**ED(S/T)AVYFCAR	232
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRS**X**D(S/T)AVYFCAR	233
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSE**X**(S/T)AVYFCAR	234
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSED**X**AVYFCAR	235
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)**X**VYFCAR	236
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)A**X**YFCAR	237
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)AV**X**FCAR	238
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)AVY**X**CAR	239
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)AVYF**X**AR	240
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)AVYFC**X**R	241
	R(A/V)T(I/L)TADKSTSTAYM(E/Q)LSSLRSED(S/T)AVYFCA**X**	242

Table 19: VH FR4

	VH FR4	SEQ ID NO:
H1-H5	WGQGTTVTVSS	36
	XGQGTTVTVSS	243
	W**X**QGTTVTVSS	244
	WG**X**GTTVTVSS	245
	WGQ**X**TTVTVSS	246
	WGQG**X**TVTVSS	247
	WGQGT**X**VTVSS	248
	WGQGTT**X**TVSS	249
	WGQGTTV**X**VSS	250
	WGQGTTVT**X**SS	251
	WGQGTTVTV**X**S	252
	WGQGTTVTVS**X**	253

Table 20: VL FR1

	VL FR1	SEQ ID NO:
L1	DIVMTQSPSFLSASVGDRVTITC	44
L2/L3/L4	DIVMTQSPSSLSASVGDRVTITC	48
	XIVMTQSPS(F/S)LSASVGDRVTITC	254
	D**X**VMTQSPS(F/S)LSASVGDRVTITC	255
	DI**X**MTQSPS(F/S)LSASVGDRVTITC	256
	DIV**X**TQSPS(F/S)LSASVGDRVTITC	257
	DIVM**X**QSPS(F/S)LSASVGDRVTITC	258
	DIVMT**X**SPS(F/S)LSASVGDRVTITC	259
	DIVMTQ**X**PS(F/S)LSASVGDRVTITC	260
	DIVMTQS**X**S(F/S)LSASVGDRVTITC	261
	DIVMTQSP**X**(F/S)LSASVGDRVTITC	262
	DIVMTQSPS**X**LSASVGDRVTITC	263
	DIVMTQSPS(F/S)**X**SASVGDRVTITC	264
	DIVMTQSPS(F/S)L**X**ASVGDRVTITC	265
	DIVMTQSPS(F/S)LS**X**SVGDRVTITC	266
	DIVMTQSPS(F/S)LSA**X**VGDRVTITC	267
	DIVMTQSPS(F/S)LSAS**X**GDRVTITC	268
	DIVMTQSPS(F/S)LSASV**X**DRVTITC	269
	DIVMTQSPS(F/S)LSASVG**X**RVTITC	270
	DIVMTQSPS(F/S)LSASVGD**X**VTITC	271
	DIVMTQSPS(F/S)LSASVGDR**X**TITC	272
	DIVMTQSPS(F/S)LSASVGDRV**X**ITC	273
	DIVMTQSPS(F/S)LSASVGDRVT**X**TC	274
	DIVMTQSPS(F/S)LSASVGDRVTI**X**C	275
	DIVMTQSPS(F/S)LSASVGDRVTIT**X**	276

Table 21: VL FR2

	VL FR2	SEQ ID NO:
L1/L2/L3	WYQQKPGKAPKALIY	45
L4	WYQQKPGKAPKSLIY	51
	XYQQKPGKAPK(S/A)LIY	277
	W**X**QQKPGKAPK(S/A)LIY	278
	WY**X**QKPGKAPK(S/A)LIY	279
	WYQ**X**KPGKAPK(S/A)LIY	280
	WYQQ**X**PGKAPK(S/A)LIY	281
	WYQQK**X**GKAPK(S/A)LIY	282
	WYQQKP**X**KAPK(S/A)LIY	283
	WYQQKPG**X**APK(S/A)LIY	284
	WYQQKPGK**X**PK(S/A)LIY	285
	WYQQKPGKA**X**K(S/A)LIY	286
	WYQQKPGKAP**X**(S/A)LIY	287
	WYQQKPGKAPK**X**LIY	288

	VL FR2	SEQ ID NO:
	WYQQKPGKAPK(S/A)**X**IY	289
	WYQQKPGKAPK(S/A)L**X**Y	290
	WYQQKPGKAPK(S/A)LI**X**	291

Table 22: VL FR3

	VL FR3	SEQ ID NO:
L1	GVPDRFTGSGSGTDFTLTISSLQSEDFADYFC	46
L2	GVPDRFTGSGSGTDFTLTISSLQPEDFADYFC	49
L3	GVPDRFSGSGSGTDFTLTISSLQPEDFADYFC	50
L4	GVPDRFSGSGSGTDFTLTISSLQPEDFATYYC	52
	XVPDRF(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	292
	G**X**PDRF(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	293
	GV**X**DRF(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	294
	GVP**X**RF(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	295
	GVPD**X**F(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	296
	GVPDR**X**(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	297
	GVPDRF**X**GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	298
	GVPDRF(S/T)**X**SGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	299
	GVPDRF(S/T)G**X**GSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	300
	GVPDRF(S/T)GS**X**SGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	301
	GVPDRF(S/T)GSG**X**GTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	302
	GVPDRF(S/T)GSGS**X**TDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	303
	GVPDRF(S/T)GSGSG**X**DFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	304
	GVPDRF(S/T)GSGSGT**X**FTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	305
	GVPDRF(S/T)GSGSGTD**X**TLTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	306
	GVPDRF(S/T)GSGSGTDF**X**LTISSLQ(P/S)EDFA(D/T)Y(F/Y)C	307
	GVPDRF(S/T)GSGSGTDFT**X**TISSLQ(P/S)EDFA(D/T)Y(F/Y)C	308
	GVPDRF(S/T)GSGSGTDFTL**X**ISSLQ(P/S)EDFA(D/T)Y(F/Y)C	309
	GVPDRF(S/T)GSGSGTDFTLT**X**SSLQ(P/S)EDFA(D/T)Y(F/Y)C	310
	GVPDRF(S/T)GSGSGTDFTLTI**X**SLQ(P/S)EDFA(D/T)Y(F/Y)C	311
	GVPDRF(S/T)GSGSGTDFTLTIS**X**LQ(P/S)EDFA(D/T)Y(F/Y)C	312
	GVPDRF(S/T)GSGSGTDFTLTISS**X**Q(P/S)EDFA(D/T)Y(F/Y)C	313
	GVPDRF(S/T)GSGSGTDFTLTISSL**X**(P/S)EDFA(D/T)Y(F/Y)C	314
	GVPDRF(S/T)GSGSGTDFTLTISSLQ**X**EDFA(D/T)Y(F/Y)C	315
	GVPDRF(S/T)GSGSGTDFTLTISSLQ(P/S)**X**DFA(D/T)Y(F/Y)C	316
	GVPDRF(S/T)GSGSGTDFTLTISSLQ(P/S)E**X**FA(D/T)Y(F/Y)C	317
	GVPDRF(S/T)GSGSGTDFTLTISSLQ(P/S)ED**X**A(D/T)Y(F/Y)C	318
	GVPDRF(S/T)GSGSGTDFTLTISSLQ(P/S)EDF**X**(D/T)Y(F/Y)C	319
	GVPDRF(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA**X**Y(F/Y)C	320
	GVPDRF(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)**X**(F/Y)C	321
	GVPDRF(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y**X**C	322
	GVPDRF(S/T)GSGSGTDFTLTISSLQ(P/S)EDFA(D/T)Y(F/Y)**X**	323

Table 23: VL FR4

	VL FR4	SEQ ID NO:
L1-L4	FGGGTKVEIK	47
	XGGGTKVEIK	324
	F**X**GGTKVEIK	325
	FG**X**GTKVEIK	326
	FGG**X**TKVEIK	327
	FGGG**X**KVEIK	328
	FGGGT**X**VEIK	329
	FGGGTK**X**EIK	330
	FGGGTKV**X**IK	331
	FGGGTKVE**X**K	332
	FGGGTKVEI**X**	333

[00223] In one aspect, an antibody described herein comprises an Fc region that comprises one or more amino acid deletions, additions and/or modifications.

[00224] An "Fc region," as used herein, includes polypeptides comprising a constant region of an antibody excluding the first constant region immunoglobulin domain, and thus refers to the last two constant region immunoglobulin domains of IgA, IgD, and IgG, the last three constant region immunoglobulin domains of IgE and IgM, and the flexible hinge N-terminal to these domains. For IgA and IgM, an Fc region may include the J chain. For IgG, an Fc region may comprise immunoglobulin domains Cgamma2 and Cgamma3 (Cγ2 and Cγ3) and the hinge between Cgamma1 (Cγ1) and Cgamma2 (Cγ2). Although the boundaries of an Fc region may vary, the human IgG heavy chain Fc region generally comprises residues C226 or P230 to its carboxyl-terminus, wherein the numbering is according to the EU index as in Kabat *et al.* (1991, NIH Publication 91-3242, National Technical Information Service, Springfield, VA). The "EU index as set forth in Kabat" refers to the residue numbering of the human IgG1 EU antibody as described in Kabat *et al. supra.* In a certain embodiment, an Fc region comprises a non-naturally occurring Fc region. In certain aspects, one or more polymorphisms are present one or more Fc positions, including but not limited to Kabat 270, 272, 312, 315, 356, and 358.

[00225] In one aspect, provided herein is an antibody, as described herein, which specifically binds to a D4 region of KIT, or an antigen-binding fragment thereof, comprising an Fc region which has altered binding properties for an Fc ligand (*e.g.*, an Fc receptor, such as C1q) relative to a comparable antibody (*e.g.*, one having the same amino acid sequence except having a wild type Fc region).

[00226] The affinities and binding properties of an Fc region for its ligand, may be determined by a variety of *in vitro* assay methods (biochemical or immunological based assays) known in the art for determining Fc-FcγR interactions, *i.e.*, specific binding of an Fc region to an FcγR including but not limited to, equilibrium methods (*e.g.*, enzyme-linked immunoabsorbent assay (ELISA), or radioimmunoassay (RIA)), or kinetics (*e.g.*, BIACORE® analysis), and other methods such as indirect binding assays, competitive inhibition assays, fluorescence resonance energy transfer (FRET), gel electrophoresis and chromatography (*e.g.*, gel filtration). These and other methods may utilize a label on one or more of the components being examined and/or employ a variety of detection methods including but not limited to chromogenic, fluorescent, luminescent, or isotopic labels.

[00227] In one embodiment, an Fc region of an antibody described herein has enhanced binding to one or more Fc ligand relative to a comparable molecule. In a specific embodiment, an Fc region of an antibody described herein has enhanced binding to an Fc receptor. In another specific embodiment, an Fc region of an antibody described herein has enhanced binding to the Fc receptor FcγRIIIA. In one specific embodiment, an Fc region of an antibody described herein has enhanced binding to the Fc receptor FcRn. In another specific embodiment, an Fc region of an antibody described herein has enhanced binding to C1q relative to a comparable molecule.

[00228] In a certain aspect, the serum half-life of proteins comprising Fc regions may be increased by increasing the binding affinity of the Fc region for FcRn. In one embodiment, an Fc region of an antibody described herein has enhanced serum half-life relative to comparable molecule.

[00229] "Antibody-dependent cell-mediated cytotoxicity" or "ADCC" refers to a form of cytotoxicity in which secreted Ig bound onto Fc receptors (FcRs) present on certain cytotoxic cells (*e.g.*, Natural Killer (NK) cells, neutrophils, and macrophages) enables these cytotoxic cells to bind specifically to an antigen-bearing target cell and subsequently kill the target cell with cytotoxins. Specific high-affinity IgG antibodies directed to the surface of target cells "arm" the cytotoxic cells, for such killing. Lysis of the target cell involves direct cell-to-cell contact, and does not involve complement. It is contemplated that, in addition to antibodies, other proteins comprising Fc regions, specifically Fc fusion proteins, having the capacity to bind specifically to an antigen-bearing target cell will be able to effect cell-mediated cytotoxicity. For simplicity, the

cell-mediated cytotoxicity resulting from the activity of an Fc fusion protein is also referred to herein as ADCC activity.

[00230] The ability of any particular protein, *e.g.*, antibody, comprising an Fc region to mediate lysis of the target cell by ADCC can be assayed. To assess ADCC activity, of an Fc region, a target cell-binding antibody comprising the Fc region is added to target cells in combination with immune effector cells, which may be activated by the antigen-antibody complexes resulting in cytolysis of the target cell. Cytolysis is generally detected by the release of label (*e.g.* radioactive substrates, fluorescent dyes or natural intracellular proteins) from the lysed cells. Useful effector cells for such assays include peripheral blood mononuclear cells (PBMC) and Natural Killer (NK) cells. Specific examples of *in vitro* ADCC assays are described in Wisecarver *et al.*, 1985 79:277-282; Bruggemann *et al.*, 1987, J Exp. Med. 166:1351-1361; Wilkinson *et al.*, 2001, J Immunol. Methods 258:183-191; Patel *et al.*, 1995 J Immunol. Methods 184:29-38. Alternatively, or additionally, ADCC activity of a protein comprising an Fc region may be assessed *in vivo*, *e.g.*, in a animal model such as that disclosed in Clynes *et al.*, 1998, Proc. Natl. Acad. Sci. USA 95:652-656.

[00231] In one embodiment, a protein, *e.g.*, an antibody described herein, comprising an Fc region has enhanced ADCC activity relative to a comparable protein, *e.g.*, antibody. In another specific embodiment, an antibody described herein comprising an Fc region has enhanced binding to the Fc receptor FcγRIIIA and has enhanced ADCC activity relative to a comparable antibody. In some embodiments, an antibody described herein comprising an Fc region has both enhanced ADCC activity and enhanced serum half-life relative to a comparable antibody.

[00232] "Complement dependent cytotoxicity" and "CDC" refer to the lysing of a target cell in the presence of complement. The complement activation pathway is initiated by the binding of the first component of the complement system (C1q) to a molecule, an antibody for example, complexed with a cognate antigen. To assess complement activation, a CDC assay, as described in Gazzano-Santoro *et al.*, 1996, J. Immunol. Methods, 202:163, may be performed, for example. In one embodiment, an antibody described herein comprising an Fc region has enhanced CDC activity relative to a comparable antibody. In other embodiments, an antibody described herein comprising an Fc region has both enhanced CDC activity and enhanced serum half life relative to a comparable antibody.

[00233] In one embodiment, an antibody described herein comprises an Fc region that comprises an amino acid modification (*e.g.*, substitution, deletion or addition, or a non-naturally occurring amino acid residue) at one or more positions (*e.g.*, at one, two, three, or four positions) selected from the group consisting of 234, 235, 236, 239, 240, 241, 243, 244, 245, 247, 252, 254, 256, 262, 263, 264, 265, 266, 267, 269, 296, 297, 298, 299, 313, 325, 326, 327, 328, 329, 330, 332, 333, and 334 as numbered by the EU index as set forth in Kabat. Optionally, the Fc region may comprise an amino acid modification (*e.g.*, substitution, deletion or addition) or a non-naturally occurring amino acid residue at additional and/or alternative positions known to one skilled in the art (see, *e.g.*, U.S. Patents 5,624,821; 6,277,375; 6,737,056; PCT Patent Publications WO 01/58957;WO 04/016750; WO 04/029207; WO 04/035752 and WO 05/040217, each of which is incorporated herein in its entirety, but particularly for the disclosure of such modifications). In a further embodiment, one or more functions of an Fc region is maintained (*e.g.*, substantially maintained, for example, at least 50%, at least 60%, at least 70%, at least 80%, at least 90%, at least 95%) by the Fc region comprising an amino acid modification (*e.g.*, substitution, deletion or addition) or a non-naturally occurring amino acid residue at one or more positions. For example, such Fc functions can include effector function, such as CDC or ADCC, or binding affinity to an Fc receptor. In a certain embodiment, the Fc region, comprising an amino acid modification (*e.g.*, substitution, deletion or addition) or a non-naturally occurring amino acid residue at one or more positions, exhibits at least one or more enhanced Fc activity, *e.g.*, enhanced half-life, or enhanced effector function, such as ADCC or CDC. In a particular embodiment, the Fc region, comprising an amino acid modification (*e.g.*, substitution, deletion or addition) or a non-naturally occurring amino acid residue at one or more positions, exhibits decreased Fc activity, *e.g.*, decreased stability/half-life, or decreased effector function, such as ADCC or CDC.

[00234] In a specific embodiment, an antibody described herein comprises an Fc region, wherein the Fc region comprises at least one (*e.g.*, one, two, three, or four) amino acid modification (*e.g.*, substitution, deletion or addition) or at least one non-naturally occurring amino acid residue (*e.g.*, one, two, three, or four) selected from the group consisting of 234D, 234E, 234N, 234Q, 234T, 234H, 234Y, 234I, 234V, 234F, 235A, 235D, 235R, 235W, 235P, 235S, 235N, 235Q, 235T, 235H, 235Y, 235I, 235V, 235F, 236E, 239D, 239E, 239N, 239Q, 239F, 239T, 239H, 239Y, 240I, 240A, 240T, 240M, 241W, 241 L, 241Y, 241E, 241 R. 243W, 243L 243Y, 243R, 243Q, 244H, 245A, 247V, 247G, 252Y, 254T, 256E, 262I, 262A, 262T, 262E, 263I, 263A,

263T, 263M, 264L, 264I, 264W, 264T, 264R, 264F, 264M, 264Y, 264E, 265G, 265N, 265Q, 265Y, 265F, 265V, 265I, 265L, 265H, 265T, 266I, 266A, 266T, 266M, 267Q, 267L, 269H, 269Y, 269F, 269R, 296E, 296Q, 296D, 296N, 296S, 296T, 296L, 296I, 296H, 269G, 297S, 297D, 297E, 298H, 298I, 298T, 298F, 299I, 299L, 299A, 299S, 299V, 299H, 299F, 299E, 313F, 325Q, 325L, 325I, 325D, 325E, 325A, 325T, 325V, 325H, 327G, 327W, 327N, 327L, 328S, 328M, 328D, 328E, 328N, 328Q, 328F, 328I, 328V, 328T, 328H, 328A, 329F, 329H, 329Q, 330K, 330G, 330T, 330C, 330L, 330Y, 330V, 330I, 330F, 330R, 330H, 332D, 332S, 332W, 332F, 332E, 332N, 332Q, 332T, 332H, 332Y, and 332A as numbered by the EU index as set forth in Kabat. Optionally, the Fc region may comprise additional and/or alternative non-naturally occurring amino acid residues known to one skilled in the art (see, *e.g.*, U.S. Patents 5,624,821; 6,277,375; 6,737,056; PCT Patent Publications WO 01/58957; WO 04/016750; WO 04/029207; WO 04/035752 and WO 05/040217).

[00235] In a certain aspect, provided herein is an antibody comprising an Fc region, wherein the Fc region comprises at least a non-naturally occurring amino acid at one or more positions selected from the group consisting of 239, 330 and 332, as numbered by the EU index as set forth in Kabat. In a specific embodiment, provided herein is an antibody comprising an Fc region, wherein the Fc region comprises at least one non-naturally occurring amino acid selected from the group consisting of 239D, 330L and 332E, as numbered by the EU index as set forth in Kabat. Optionally, the Fc region may further comprise additional non-naturally occurring amino acid at one or more positions selected from the group consisting of 252, 254, and 256, as numbered by the EU index as set forth in Kabat. In a specific embodiment, provided herein is an antibody comprising an Fc region, wherein the Fc region comprises at least one non-naturally occurring amino acid selected from the group consisting of 239D, 330L and 332E, as numbered by the EU index as set forth in Kabat and at least one non-naturally occurring amino acid at one or more positions are selected from the group consisting of 252Y, 254T and 256E, as numbered by the EU index as set forth in Kabat. In one embodiment, an Fc region comprising such sequence exhibits one or more Fc activity, for example, binding affinity to an Fc receptor or effector function, such as ADCC or CDC. In a specific embodiment, an Fc region comprising such sequence exhibits reduced Fc activity, for example, reduced binding affinity to an Fc receptor or reduced effector function, such as ADCC or CDC. In a particular embodiment, an Fc region comprising such sequence exhibits enhanced Fc activity, for example, enhanced half-life,

enhanced binding affinity to an Fc receptor, or enhanced effector function, such as ADCC or CDC.

[00236] Non-limiting examples of Fc region modifications are provided in Ghetie *et al.*, 1997, Nat Biotech. 15:637-40; Duncan et al, 1988, Nature 332:563-564; Lund *et al.*, 1991, J. Immunol 147:2657-2662; Lund et al, 1992, Mol Immunol 29:53-59; Alegre et al, 1994, Transplantation 57:1537-1543; Hutchins *et al.*, 1995, Proc Natl. Acad Sci U S A 92:11980-11984; Jefferis et al, 1995, Immunol Lett. 44:111-117; Lund *et al.*, 1995, Faseb J 9:115-119; Jefferis et al, 1996, Immunol Lett 54:101-104; Lund et al, 1996, J Immunol 157:4963-4969; Armour *et al.*, 1999, Eur J Immunol 29:2613-2624; Idusogie et al, 2000, J Immunol 164:4178-4184; Reddy et al, 2000, J Immunol 164:1925-1933; Xu *et al.*, 2000, Cell Immunol 200:16-26; Idusogie et al, 2001, J Immunol 166:2571-2575; Shields *et al.*, 2001, J Biol Chem 276:6591-6604; Jefferis et al, 2002, Immunol Lett 82:57-65; Presta *et al.*, 2002, Biochem Soc Trans 30:487-490); U.S. Patent Nos. 5,624,821; 5,885,573; 5,677,425; 6,165,745; 6,277,375; 5,869,046; 6,121,022; 5,624,821; 5,648,260; 6,528,624; 6,194,551; 6,737,056; 6,821,505; 6,277,375; 8,163,882; 7,355,008; 7,960,512; 8,039,592; 8,039,359; 8,101,720; 7,214,775; 7,682,610; 7,741,442; U.S. Patent Publication Nos. 2004/0002587 and PCT Publications WO 94/29351; WO 99/58572; WO 00/42072; WO 04/029207; WO 04/099249; WO 04/063351.

[00237] In a particular embodiment, an antibody described herein comprises one or more (*e.g.*, one, two, three, or four) modifications to an IgG1 Fc region, such as a human IgG1 Fc region. In a certain embodiment, an antibody described herein comprises one or more (*e.g.*, one, two, three, or four) modifications to an IgG2 Fc region, such as a human IgG2 Fc region. In one embodiment, an antibody described herein comprises one or more (*e.g.*, one, two, three, or four) modifications to an IgG4 Fc region, such as a human IgG4 Fc region.

[00238] In some aspects, an antibody described herein comprises an Fc region, wherein the Fc region comprises one or more (*e.g.*, one, two, three, or four) glycoform modifications (*e.g.*, removal or substitution of one or more glycoforms), such as engineered glycoforms, *i.e.*, a carbohydrate composition that is covalently attached to a molecule comprising an Fc region. Engineered glycoforms may be useful for a variety of purposes, including but not limited to enhancing or reducing effector function. Engineered glycoforms may be generated by any method known to one skilled in the art, for example by using engineered or variant expression strains, by co-expression with one or more enzymes, for example DI N-acetylglucosaminyltransferase III

(GnTI11), by expressing a molecule comprising an Fc region in various organisms or cell lines from various organisms, or by modifying carbohydrate(s) after the molecule comprising Fc region has been expressed. Methods for generating engineered glycoforms are known in the art, and include but are not limited to those described in Umana et al, 1999, Nat. Biotechnol 17:176-180; Davies *et al.*, 20017 Biotechnol Bioeng 74:288-294; Shields et al, 2002, J Biol Chem 277:26733-26740; Shinkawa *et al.*, 2003, J Biol Chem 278:3466-3473) U.S. Pat. No. 6,602,684; U.S. Application No. 10/277,370; U.S. Application No. 10/113,929; PCT WO 00/61739A1; PCT WO 01/292246A1; PCT WO 02/311140A1; PCT WO 02/30954A1; WO 00061739; US 20030115614; and Okazaki *et al.*, 2004, JMB, 336: 1239-49. Methods for generating modified glycoforms of an antibody described herein are described in the art, and include but are not limited to those described in U.S. Pat. No. 7,517,670; U.S. Pat. No. 8,021,856; U.S. Pat. No. 8,080,415; U.S. Pat. No. 8,084,222; U.S. Pat. No. 7,700,321; and U.S. Pat. No. 8,071,336.

[00239] In a particular embodiment, glycosylation of an Fc region can be modified to increase or decrease effector function. Accordingly, in one embodiment, an Fc region of an antibody described herein comprises modified glycosylation of amino acid residues. In another embodiment, the modified glycosylation of amino acid residues results in lowered effector function, such as ADCC or CDC. In another embodiment, the modified glycosylation of the amino acid residues results in increased effector function. In some embodiments, the glycosylation patterns of the antibodies provided herein are modified to enhance ADCC and CDC effector function (see, for example, Shields *et al.*, (2002) JBC. 277:26733; Shinkawa *et al.*, (2003) JBC. 278:3466 and Okazaki *et al.*, (2004) J. Mol. Biol., 336: 1239). In a specific embodiment, such modified glycosylation is different than glycosylation of an Fc region found naturally *in vivo*, or such modified glycosylation is a non-naturally occurring glycosylation of an Fc region. For example, modified glycosylation of an Fc region can be achieved by modifying an amino acid or by expressing the protein/antibody in a cell that has been engineered to contain a different glycosylation machinery than its parental cell that has not been modified. In this regard, such a cell can be engineered to not express a certain glycosylation enzyme or to express a certain glycosylation enzyme that is not present in the parental cell.

[00240] Methods for generating non-naturally occurring Fc regions are known in the art. For example, amino acid substitutions and/or deletions can be generated by mutagenesis methods, including, but not limited to, site-directed mutagenesis (Kunkel, Proc. Natl. Acad. Sci. USA

82:488-492 (1985)), PCR mutagenesis (Higuchi, in "PCR Protocols: A Guide to Methods and Applications", Academic Press, San Diego, pp. 177-183 (1990)), and cassette mutagenesis (Wells *et al.*, Gene 34:315-323 (1985)). Site-directed mutagenesis can be performed by the overlap-extension PCR method (Higuchi, in "PCR Technology: Principles and Applications for DNA Amplification", Stockton Press, New York, pp. 61-70 (1989)). Alternatively, the technique of overlap-extension PCR (Higuchi, ibid.) can be used to introduce any desired mutation(s) into a target sequence (the starting DNA). Other methods useful for the generation of Fc region modifications are known in the art (see, *e.g.*, U.S. Patent Nos.5,624,821; 5,885,573; 5,677,425; 6,165,745; 6,277,375; 5,869,046; 6,121,022; 5,624,821; 5,648,260; 6,528,624; 6,194,551; 6,737,056; 6,821,505; 6,277,375; U.S. Patent Publication Nos. 2004/0002587 and PCT Publications WO 94/29351; WO 99/58572; WO 00/42072; WO 02/060919; WO 04/029207; WO 04/099249; WO 04/063351).

[00241] In a specific embodiment, the Fc region has reduced fucosylation. In another embodiment, the Fc region is afucosylated (see for examples, U.S. Patent Application Publication No. 2005/0226867).

[00242] In a certain aspect, an antibody described herein is a non-fucosylated antibody, for example an Fc region of the antibody does not contain sugar chains with a fucose, *e.g.*, a fucose bound to N-acetylglucosamines (see, *e.g.*, U.S. Pat. Nos. 7,214,775; 7,682,610; and 7,741,442). Methods for making non-fucosylated antibodies are known in the art, see, *e.g.*, U.S. Pat. No. 7,708,992. For example, non-fucosylated antibodies can be generated using engineered host cells, see, *e.g.*, U.S. Pat. No. 6,946,292; 7,425,446; 8,067,232; 7,846,725; and 7,393,683. Knock-out animals for generating non-fucosylated antibodies also have been described, see, *e.g.*, U.S. Pat. No. 7,737,325. In a particular embodiment, a non-fucosylated antibody described herein, which specifically binds to a D4 region of human KIT, exhibits increased ADCC.

[00243] In a particular aspect, an antibody described herein comprises a fucose content of less than 100%, for example, less than 65%, relative to the fucose content of a reference antibody (see, *e.g.*, U.S. Pat. Nos. 7,931,895 and 7,846,434). In a certain embodiment, an antibody described herein is characterized by a fucose content wherein at least about 60% of the N-linked oligosaccharides, *e.g.* N-linked oligosaccharides in the CH2-derived domains, contain no fucose. In specific embodiments, the percentage of N-linked oligosaccharides, *e.g.* N-linked oligosaccharides in the CH2-derived domains, that contain no fucose is at least about 65%, about

70%, about 75%, about 80%, about 85%, about 90%, about 95% or more, and exhibits altered effector function, for example enhanced ADCC or reduced ADCC. In a particular embodiment, an antibody described herein, which specifically binds to a D4 region of human KIT, comprises a fucose content of less than 65% and exhibits increased ADCC.

[00244] In particular aspects, an antibody described herein comprises an Fc region with altered FcγR binding activity displaying reduced binding to an FcγR and comprises an amino acid modification at any one or more (*e.g.*, one, two, three, or four) of amino acid positions 238, 239, 248, 249, 252, 254, 265, 268, 269, 270, 272, 278, 289, 292, 293, 294, 295, 296, 298, 301, 303, 322, 324, 327, 329, 333, 335, 338, 340, 373, 376, 382, 388, 389, 414, 416, 419, 434, 435, 437, 438 or 439 of the Fc region, wherein the numbering of the residues in the Fc region is that of the EU index as in Kabat (see, *e.g.*, U.S. Pat. No. 7,183,387). For example, an antibody described herein comprising an Fc region displays reduced binding to an FcγRI and comprise an amino acid modification at any one or more (one, two, three, or four) of amino acid positions 238, 265, 269, 270, 327 or 329 of the Fc region, wherein the numbering of the residues in the Fc region is that of the EU index as in Kabat.

[00245] In a particular embodiment, an antibody described herein comprising an Fc region displays reduced binding to an FcγRII and comprises an amino acid modification at any one or more (*e.g.*, one, two, three, or four) of amino acid positions 238, 265, 269, 270, 292, 294, 295, 298, 303, 324, 327, 329, 333, 335, 338, 373, 376, 414, 416, 419, 435, 438 or 439 of the Fc region, wherein the numbering of the residues in the Fc region is that of the EU index as in Kabat.

[00246] In a specific embodiment, an antibody described herein comprising an Fc region displays reduced binding to an FcγRIII and comprises an amino acid modification at one or more (*e.g.*, one, two, three, or four) of amino acid positions 238, 239, 248, 249, 252, 254, 265, 268, 269, 270, 272, 278, 289, 293, 294, 295, 296, 301, 303, 322, 327, 329, 338, 340, 373, 376, 382, 388, 389, 416, 434, 435 or 437 of the Fc region, wherein the numbering of the residues in the Fc region is that of the EU index as in Kabat.

[00247] In certain aspects, the serum half-life of a protein, such as an antibody described herein, comprising an Fc region, is increased by increasing the binding affinity of an Fc region for FcRn.

[00248] In a particular embodiment, an antibody described herein or an antigen-binding fragment thereof specifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT) with

an EC_{50} (half maximal effective concentration) value of about 50 nM or less as determined by ELISA.

[00249] In a particular embodiment, an antibody described herein or an antigen-binding fragment thereof specifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT) with an EC_{50} value of about 150 pM or less as determined by FACs with CHO-WT-KIT cells (CHO cells engineered to recombinantly express wild-type human KIT).

[00250] In a particular embodiment, an antibody described herein or an antigen-binding fragment thereof, which specifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), is capable of blocking KIT phosphorylation with IC_{50} (50% inhibition concentration) value of about 600 pM or less.

[00251] In a particular embodiment, an antibody described herein or an antigen-binding fragment thereof, which specifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), be recombinently expressed in CHO cells at an average titer of at least 0.5 μg/mL. In a particular embodiment, an antibody described herein or an antigen-binding fragment thereof, which specifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), be recombinently expressed in CHO cells at an average titer of at least 1.0 μg/mL.

[00252] In a specific embodiment, an antibody described herein or an antigen-binding fragment thereof, which specifically binds to a KIT polypeptide (*e.g.*, the D4 region of human KIT), comprises a VH domain and a VL domain that are non-immunogenic, for example, the VH domain and VL domain do not contain T cell epitopes.

[00253] In particular embodiments, an antibody described herein (or an antigen-binding fragment thereof) does not bind the extracellular ligand binding site of KIT, *e.g.*, the SCF binding site of KIT. In particular embodiments, an antibody described herein (or an antigen-binding fragment thereof) does not inhibit ligand binding to KIT, *e.g.*, does not inhibit KIT ligand (*e.g.*, SCF) binding to KIT.

[00254] In specific aspects, antibodies (*e.g.*, human or humanized antibodies) described herein are inhibitory antibodies, that is, antibodies that inhibit (*e.g.*, partially inhibit) KIT activity, *i.e.*, one or more KIT activities. In a specific embodiment, partial inhibition of a KIT activity results in, for example, about 25% to about 65% or 75% inhibition. In a specific embodiment, partial inhibition of a KIT activity results in, for example, about 35% to about 85% or 95% inhibition. Non-limiting examples of KIT activities include KIT dimerization, KIT

phosphorylation (*e.g.*, tyrosine phosphorylation), signaling downstream of KIT (*e.g.*, Stat, AKT, MAPK, or Ras signaling), induction or enhancement of gene transcription (*e.g.*, c-Myc), induction or enhancement of cell proliferation or cell survival. In a particular embodiment, an antibody described herein inhibits KIT phosphorylation (*e.g.*, ligand-induced phosphorylation). In a specific embodiment, an antibody described herein inhibits KIT tyrosine phosphorylation in the KIT cytoplasmic domain. In another particular embodiment, an antibody described herein inhibits cell proliferation. In yet another particular embodiment, an antibody described herein inhibits cell survival. In a specific embodiment, an antibody described herein induces apoptosis. In another specific embodiment, an antibody described herein induces cell differentiation, *e.g.*, cell differentiation in a cell expressing KIT, *e.g.*, human KIT. In a particular embodiment, an antibody described herein inhibits KIT activity but does not inhibit KIT dimerization. In another particular embodiment, an antibody described herein inhibits KIT activity and does not inhibit ligand binding to KIT, *e.g.*, does not inhibit KIT ligand (*e.g.*, SCF) binding to KIT, but does inhibit KIT dimerization.

[00255] In a particular embodiment, an antibody described herein inhibits a KIT activity, such as ligand-induced tyrosine phosphorylation of a KIT cytoplasmic domain, by about 25% to about 65% or 75%, as determined by a cell-based phosphorylation assay well known in the art, for example, the cell-based phosphorylation assay described herein. In a certain embodiment, an antibody described herein inhibits a KIT activity, such as ligand-induced tyrosine phosphorylation of a KIT cytoplasmic domain, by about 35% to about 85% or 95%, as determined by a cell-based phosphorylation assay well known in the art, for example, the cell-based phosphorylation assay described herein. In a particular embodiment, an antibody described herein, or an antigen-binding fragment thereof or a conjugate thereof, inhibits a KIT activity, such as ligand-induced tyrosine phosphorylation of a KIT cytoplasmic domain, with a 50% inhibition concentration (IC_{50}) of less than about 600 pM, or less than about 500 pM, or less than about 250 pM, as determined by a cell-based phosphorylation assay well known in the art, for example, the cell-based phosphorylation assay described herein. In a specific embodiment, the IC_{50} is less than about 550 pM or 200 pM. In a specific embodiment, the IC_{50} is in the range of about 50 pM to about 225 pM, or in the range of 100 pM to about 600 pM. In a specific embodiment, the IC_{50} is in the range of about 50 pM to about 550 pM, or about 50 pM to about 600 pM, or about 150 pM to about 550 pM.

[00256] In a specific embodiment, an antibody described herein, or an antigen-binding fragment thereof or a conjugate thereof, (i) immunospecifically binds to a KIT polypeptide comprising the D4 region of human KIT, (ii) inhibits KIT phosphorylation (*e.g.*, tyrosine phosphorylation), and (iii) does not affect KIT ligand (*e.g.*, SCF) binding to KIT. In yet another specific embodiment, such an antibody does not inhibit KIT dimerization. In yet another specific embodiment, such an antibody can be recombinently expressed by CHO cells at an average titer of at least 0.5 μg/mL, for example at least 1.0 μg/mL. In a further specific embodiment, such an antibody comprises a VH domain and a VL domain that are non-immunogenic, for example, the VH domain and VL domain do not contain T cell epitopes.

[00257] In other specific embodiments, an antibody described herein, or an antigen-binding fragment thereof or a conjugate thereof, immunospecifically binds to a monomeric form of KIT (*e.g.*, human KIT). In particular embodiments, an antibody described herein does not immunospecifically bind to a monomeric form of KIT (*e.g.*, human KIT). In specific embodiments, an antibody described herein, or an antigen-binding fragment thereof or a conjugate thereof, immunospecifically binds to a dimeric form of KIT (*e.g.*, human KIT). In specific embodiments, an antibody described herein, or an antigen-binding fragment thereof or a conjugate thereof, does not bind to a monomeric form of KIT and specifically binds to a dimeric form of KIT or multimeric form of KIT. In certain embodiments, an antibody has higher affinity for a KIT monomer than a KIT dimer. In certain embodiments, an antibody has higher affinity for a KIT monomer than a KIT multimer.

[00258] In specific embodiments, an anti-KIT antibody described herein (or an antigen-binding fragment thereof or a conjugate thereof) specifically binds to a native isoform or native variant of KIT (that is a naturally occurring isoform or variant of KIT in an animal (*e.g.*, monkey, mouse, goat, donkey, dog, cat, rabbit, pig, rat, human, frog, or bird) that can be isolated from an animal, preferably a human). In particular embodiments, an antibody described herein immunospecifically binds to human KIT or a fragment thereof. In specific embodiments, an anti-KIT antibody described herein (or an antigen-binding fragment thereof or a conjugate thereof) specifically binds to human KIT or a fragment thereof and does not specifically bind to a non-human KIT (*e.g.*, monkey, mouse, goat, donkey, dog, cat, rabbit, pig, rat, or bird) or a fragment thereof. In specific embodiments, an anti-KIT antibody described herein (or an antigen-binding fragment thereof or a conjugate thereof) specifically binds to human KIT or a fragment thereof

and does not specifically bind to murine KIT. In certain embodiments, an anti-KIT antibody described herein specifically binds to human KIT or a fragment thereof (*e.g.*, a D4 region of human KIT) and to canine (dog) and non-human primate (*e.g.*, monkey) KIT. In certain embodiments, an anti-KIT antibody described herein specifically binds to human KIT or a fragment thereof (*e.g.*, a D4 region of human KIT) and to canine (dog) KIT. In certain embodiments, an anti-KIT antibody described herein specifically binds to human KIT or a fragment thereof (*e.g.*, a D4 region of human KIT) and to non-human primate (*e.g.*, monkey) KIT. In certain embodiments, an anti-KIT antibody described herein specifically binds to human KIT or a fragment thereof (*e.g.*, a D4 region of human KIT) and to canine (dog) and non-human primate (*e.g.*, monkey) KIT, but does not specifically bind to murine KIT or a fragment thereof (*e.g.*, a D4 region of murine KIT).

[00259] In certain embodiments, an antibody described herein or antigen-binding fragment thereof binds to an extracellular domain of human KIT comprising a mutation, for example a somatic mutation associated with cancer (*e.g.*, GIST), such as a mutation in exon 9 of human KIT wherein the Ala and Tyr residues at positions 502 and 503 are duplicated. In certain embodiments, an antibody described herein or antigen-binding fragment thereof binds to an extracellular domain of wild-type human KIT and an extracellular domain of human KIT comprising a mutation, for example a somatic mutation associated with cancer (*e.g.*, GIST), such as a mutation in exon 9 of human KIT wherein the Ala and Tyr residues at positions 502 and 503 are duplicated (see, *e.g.*, Marcia *et al.*, (2000) Am. J. Pathol. 156(3):791-795; and Debiec-Rychter *et al.*, (2004) European Journal of Cancer. 40:689-695, which are both incorporated herein by reference in their entireties, describing KIT mutations).

[00260] In certain embodiments, an antibody described herein or antigen-binding fragment thereof binds to an extracellular domain of human KIT which is glycosylated. In certain embodiments, an antibody described herein or antigen-binding fragment thereof binds to two different glycosylated forms of an extracellular domain of human KIT. For example, two forms of human KIT with different molecular weights, indicating different glycosylation patterns, have been observed by immunoblotting. In certain embodiments, an antibody described herein may specifically bind to both of these forms of human KIT which have different glycosylation patterns, *e.g.*, one form is more glycosylated than the other. In certain embodiments, an antibody described

herein or antigen-binding fragment thereof binds to an extracellular domain of human KIT which is not glycosylated.

[00261] In a particular embodiment, an antibody described herein does not immunospecifically bind to a KIT epitope described by International Patent Application No. WO 2008/153926, for example an epitope consisting essentially of the amino acid sequence SELHLTRLKGTEGGTYT (SEQ ID NO: 38) or LTRLKGTEGG (SEQ ID NO: 39).

[00262] In certain embodiments, an anti-KIT antibody described herein is not an antibody selected from the group consisting of: SR-1 antibody (see U.S. Patent Application Publication No. US 2007/0253951 A1; International Patent Application Publication No. WO 2007/127317); anti-KIT antibody obtained from hybridoma cell lines DSM ACC 2007, DSM ACC 2008, or DSM ACC 2009, which have been deposited at the Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH, DSM, Mascheroder Weg 1 b, D-38124 Braumschweig, Germany (see U.S. Patent No. 5,545,533; International Patent Application Publication No. WO 92/ 021766); antibody produced by hybridoma cell line DSM ACC 2247 (or A3C6E2; Deposit No. DSM ACC 2247, at the Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH, DSM, Mascheroder Weg 1 b, D-38124 Braumschweig, Germany) (see U.S. Patent No. 5,808,002); and anti-KIT antibodies designated K27, K44, K45, K49, K57, K69, and K94 (see, *e.g.*, Blechman *et al.*, Stem Cells, 1993, 11:12-21; Blechman *et al.*, Cell, 1995, 80:103-113; Lev *et al.*, Mol. Cell. Biol., 1993, 13:2224-2234; and European Patent Application Publication No. EP0548867 A2). In certain embodiments, an anti-KIT antibody described herein does not comprise a CDR of an antibody selected from such group. In particular embodiments, an anti-KIT antibody described herein does not comprise one or more (*e.g.*, two, three, four, five, or six) CDRs (*e.g.*, 3 VL CDRs and/or 3 VH CDRs) of an antibody selected from such group. In another embodiment, an antibody described herein is not competitively blocked (*e.g.*, competitively blocked in a dose-dependent manner) by one of those antibodies, for example, as determined by competition binding assays (*e.g.*, ELISAs). In certain embodiments, an anti-KIT antibody described herein is not antibody Ab1 or Ab21, which is described in U.S. Provisional Application No. 61/426,387, filed December 22, 2010. In certain embodiments, an anti-KIT antibody described herein is not an antibody selected from the group consisting of: Ab1, Ab2, Ab3, Ab4, Ab5, Ab6, Ab7, Ab8, Ab9, Ab10, Ab11, Ab12, Ab13, Ab14, Ab15, Ab16, Ab17, Ab18, Ab19, Ab20, and Ab21, as described in U.S. Provisional Application No. 61/426,387, filed December 22, 2010 and Ab24-Ab192 as described in PCT International

Patent Application No. PCT/US2011/29980 filed March 25, 2011. In certain embodiments, an anti-KIT antibody described herein does not comprise a CDR, or one or more CDRs (*e.g.*, 3 VL CDRs and/or 3VH CDRs), of an antibody selected from the group consisting of: Ab1, Ab2, Ab3, Ab4, Ab5, Ab6, Ab7, Ab8, Ab9, Ab10, Ab11, Ab12, Ab13, Ab14, Ab15, Ab16, Ab17, Ab18, Ab19, Ab20, and Ab21, as described in U.S. Provisional Application No. 61/426,387, filed December 22, 2010, and Ab24-Ab192 as described in PCT International Patent Application No. PCT/US2011/29980 filed March 25, 2011. In particular embodiments, an anti-KIT antibody described herein does not comprise a CDR, or one or more CDRs (*e.g.*, 3 VL CDRs and/or 3VH CDRs), VL chain region, or VH chain region of an antibody selected from the antibodies (*e.g.*, antibodies Ab1-Ab21 and Ab24-Ab192) described in U.S. Provisional Application No. 61/426,387 filed December 22, 2010 or PCT International Patent Application No. PCT/US2011/29980 filed March 25, 2011. In certain embodiments, an anti-KIT antibody described herein is not antibody Ab1 or Ab21, or an antibody comprising CDRs (*e.g.*, one, two, three, four, five, or six CDRs) of antibody Ab1 or Ab21, as described in U.S. Provisional Application No. 61/426,387, filed December 22, 2010. In a particular embodiment, an antibody described herein is not antibody 37M or 37C as described in PCT International Patent Application No. PCT/US2012/022471 filed January 25, 2012. In a certain embodiment, an antibody described herein does not comprise a VL domain comprising SEQ ID NO: 32 or a VH domain comprising SEQ ID NO: 31.

[00263] In a particular embodiment, an antibody described herein or antigen-binding fragment thereof, which immunospecifically bind to a KIT polypeptide (*e.g.*, the D4 region of KIT, for example, human KIT), does not comprise one or more (*e.g.*, two, three, four, five, or six) CDRs (*e.g.*, VL CDR1, VL CDR2, VL CDR3, VH CDR1, VH CDR2, and VH CDR3) of an antibody described in US Patent Application Publication NO. US 2008/0287309, for example antibody 36C1, 84H7, 63C10, or 65A12.

[00264] In a specific embodiment, an antibody described herein is not a human or humanized version of an antibody produced by the hybridoma (BA7.3C.9) having the American Type Culture Collection (ATCC) Accession number HB10716, as described for example in U.S. Patent No. 5,919,911 or U.S. Patent No. 5,489,516. In another specific embodiment, an antibody described herein does not comprise the CDRs (*e.g.*, VL CDR1, VL CDR2, VL CDR3, VH CDR1, VH CDR2, and/or VH CDR3) of the antibody produced by the hybridoma (BA7.3C.9) having the

American Type Culture Collection (ATCC) Accession number HB10716, as described for example in U.S. Patent No. 5,919,911 or U.S. Patent No. 5,489,516. In another specific embodiment, an antibody described herein does not comprise the CDRs of the SR-1 antibody described for example in U.S. Patent No. 5,919,911 or U.S. Patent No. 5,489,516 or U.S. Patent Application Publication No. US 2007/0253951 A1 (see, *e.g.*, ¶ [0032] or ¶ [0023]). In a further embodiment, an antibody described herein is not an antibody of the antibody produced by the hybridoma (BA7.3C.9) having the American Type Culture Collection (ATCC) Accession number HB10716, as described for example in U.S. Patent No. 5,919,911 or U.S. Patent No. 5,489,516.

[00265] In a specific embodiment, an antibody described herein is not the humanized antibodies of the SR-1 antibody as described in U.S. Patent Application Publication No. US 2007/0253951 A1. In a specific embodiment, an antibody described herein does not comprise one or more amino acid sequences selected from the group consisting of: SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, and SEQ ID NO: 10 referenced in U.S. Patent Application Publication No. US 2007/0253951 A1. In a particular embodiment, an antibody described herein does not comprise the amino acid sequences of SEQ ID NOs: 2 and 4 or of SEQ ID NOs: 2 and 6 referenced in U.S. Patent Application Publication No. US 2007/0253951 A1. In a specific embodiment, an antibody described herein does not comprise one or more amino acid sequence that is at least 90% identical to the amino acid sequence selected from the group consisting of: SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, and SEQ ID NO: 10 referenced in U.S. Patent Application Publication No. US 2007/0253951 A1. In a particular embodiment, an antibody described herein does not comprise one or more CDRs described in U.S. Patent Application Publication No. US 2007/0253951 A1, for example, amino acids 44 to 58 of SEQ ID NO: 8 (VL CDR1 of antibody SR-1; RASESVDIYGNSFMH), amino acids 74 to 80 of SEQ ID NO: 8 (VL CDR2 of antibody SR-1; LASNLES), amino acids 111 to 121 of SEQ ID NO: 8 (VL CDR3 of antibody SR-1; QQNNEDPYT), amino acids 50 to 54 of SEQ ID NO: 10 (VH CDR1 of antibody SR-1; SYNMH), amino acids 69 to 85 of SEQ ID NO: 10 (VH CDR2 of antibody SR-1; VIYSGNGDTSYNQKFKG), and/or amino acids 118 to 125 of SEQ ID NO: 10 (VH CDR3 of antibody SR-1; RDTRFGN), where SEQ ID NOs: 8 and 10 are those referenced in U.S. Patent Application Publication No. US 2007/0253951 A1 (see, *e.g.*, ¶ [0032] or ¶ [0023]). In a particular embodiment, an antibody described herein does not comprise one or more CDRs described in U.S. Patent Application Publication No. US 2007/0253951 A1, for example, amino acids 43 to 58 of

SEQ ID NO: 2 (VL CDR1), amino acids 74 to 80 of SEQ ID NO: 2 (VL CDR2), amino acids 113 to 121 of SEQ ID NO: 2 (VL CDR3), amino acids 50 to 54 of SEQ ID NO: 4 (VH CDR1), amino acids 69 to 85 of SEQ ID NO: 4 (VH CDR2), and/or amino acids 118 to 125 of SEQ ID NO: 4 (VH CDR3), where SEQ ID NOs: 2 and 4 are those referenced in U.S. Patent Application Publication No. US 2007/0253951 A1. In a particular embodiment, an antibody described herein is not an antibody of antibody SR-1 as described in U.S. Patent Application Publication No. US 2007/0253951 A1.

[00266] In a specific embodiment, an antibody described herein is not an antibody selected from the group consisting of: antibody Anti-S100, ACK2, and ACK4 as described in U.S. Patent No. 6,989,248 or U.S. Patent No. 7,449,309. In a particular embodiment, an antibody described herein is not a human or humanized version of an antibody selected from such group. In a specific embodiment, an antibody described herein is not an antibody comprising one or more CDRs (*e.g.*, 3 VL CDRs and/or 3 VH CDRs) of an antibody selected from the group consisting of: antibody Anti-S100, ACK2, and ACK4 as described in U.S. Patent No. 6,989,248 or U.S. Patent No. 7,449,309.

[00267] In certain aspects, competition binding assays can be used to assist in identifying a target epitope of an antibody or to determine whether an antibody is competitively blocked, *e.g.*, in a dose dependent manner, by another antibody for example, an antibody that binds essentially the same epitope, or overlapping epitopes, as a reference antibody, when the two antibodies recognize identical or sterically overlapping epitopes in competition binding assays such as competition ELISA assays, which can be configured in all number of different formats, using either labeled antigen or labeled antibody. Numerous types of competitive binding assays are known, for example: solid phase direct or indirect radioimmunoassay (RIA), solid phase direct or indirect enzyme immunoassay (EIA), sandwich competition assay (see Stahli *et al.*, (1983) Methods in Enzymology 9:242); solid phase direct biotin-avidin EIA (see Kirkland *et al.*, (1986) J. Immunol. 137:3614); solid phase direct labeled assay, solid phase direct labeled sandwich assay (see Harlow and Lane, (1988) Antibodies: A Laboratory Manual, Cold Spring Harbor Press); solid phase direct label RIA using I-125 label (see Morel *et al.*, (1988) Mol. Immunol. 25(1):7); solid phase direct biotin-avidin EIA (Cheung *et al.*, (1990) Virology 176:546); and direct labeled RIA. (Moldenhauer *et al.*, (1990) Scand J. Immunol. 32:77). Typically, such an assay involves the use of purified antigen (*e.g.*, KIT, such as extracellular domain of KIT or a D4 region of KIT) bound

to a solid surface or cells bearing either of these, an unlabeled test immunoglobulin and a labeled reference immunoglobulin. Competitive inhibition can be measured by determining the amount of label bound to the solid surface or cells in the presence of the test immunoglobulin. Usually the test immunoglobulin is present in excess. In certain aspects, when a competing antibody is present in excess, it will inhibit specific binding of a reference antibody to a common antigen by at least 50-55%, 55-60%, 60-65%, 65-70% 70-75% or more. In a common version of this assay, the antigen is immobilized on a 96-well plate. The ability of unlabeled antibodies to block the binding of labeled antibodies to the antigen is then measured using radioactive or enzyme labels. For further details see, for example, Wagener *et al.*, J. Immunol., 1983, 130:2308-2315; Wagener *et al.*, J. Immunol. Methods, 1984, 68:269-274; Kuroki *et al.*, Cancer Res., 1990, 50:4872-4879; Kuroki *et al.*, Immunol. Invest., 1992, 21:523-538; Kuroki *et al.*, Hybridoma, 1992, 11:391-407, and Using Antibodies: A Laboratory Manual, Ed Harlow and David Lane editors (Cold Springs Harbor Laboratory Press, Cold Springs Harbor, N.Y., 1999), pp. 386-389.

[00268] In certain aspects, an antibody described herein which immunospecifically binds to a D4 region of a KIT polypeptide (*e.g.*, human KIT polypeptide) may be described by its VL chain region (*e.g.*, any one of SEQ ID NOs: 7-10) or VH chain region (*e.g.*, any one of SEQ ID NOs: 2-6), or by its 3 VL CDRs or its 3 VH CDRs. See, for example, Rader *et al.*, 1998, Proc. Natl. Acad. Sci. USA, 95: 8910-8915, which is incorporated herein by reference in its entirety, which describes the humanization of the mouse anti-αvβ3 antibody by identifying a complementing light chain or heavy chain from a human light chain or heavy chain library, respectively, resulting in humanized antibody variants having affinities as high or higher than the affinity of the original antibody. See also, Clackson *et al.*, 1991, Nature, 352:624-628, which is incorporated herein by reference in its entirety, describing methods of producing antibodies that bind a specific antigen by using a specific VL (or VH) domain and screening a library for the complimentary variable domains. The screen produced 14 new partners for a specific VH domains and 13 new partners for a specific VL domain, which were strong binders as determined by ELISA.

[00269] Thus, in certain aspects, provided herein is an antibody, which immunospecifically binds to a D4 region of a KIT polypeptide (*e.g.*, human KIT polypeptide), comprising a VL domain comprising the amino acid sequence of SEQ ID NO: 7 or 8. In some embodiments, provided herein is an antibody, which immunospecifically binds to a D4 region of a KIT

polypeptide (*e.g.*, human KIT polypeptide), comprising a VH domain comprising the amino acid sequence of SEQ ID NO: 4 or 5.

[00270] In certain aspects, the CDRs of an antibody described herein is determined according to the method of Chothia and Lesk, 1987, J. Mol. Biol., 196:901-917, which will be referred to herein as the "Chothia CDRs" (see also, *e.g.*, U.S. Patent No. 7,709,226). Using the Kabat numbering system of numbering amino acid residues in the VH chain region and VL chain region, Chothia CDRs within an antibody heavy chain molecule are typically present at amino acid positions 26 to 32 ("CDR1"), amino acid positions 53 to 55 ("CDR2"), and amino acid positions 96 to 101 ("CDR3"). Using the Kabat numbering system of numbering amino acid residues in the VH chain region and VL chain region, Chothia CDRs within an antibody light chain molecule are typically present at amino acid positions 26 to 33 (CDR1), amino acid positions 50 to 52 (CDR2), and amino acid positions 91 to 96 (CDR3).

[00271] In a specific embodiment, the position of a CDR along the VH and/or VL region of an antibody described herein may vary by one, two, three or four amino acid positions so long as immunospecific binding to KIT (*e.g.*, the D4 region of human KIT) is maintained (*e.g.*, substantially maintained, for example, at least 50%, at least 60%, at least 70%, at least 80%, at least 90%, at least 95%). For example, in one embodiment, the position defining a CDR of an antibody described herein may vary by shifting the N-terminal and/or C-terminal boundary of the CDR by one, two, three, or four, amino acids, relative to the CDR position depicted in Figures 3A-3I, so long as immunospecific binding to KIT (*e.g.*, the D4 region) is maintained (*e.g.*, substantially maintained, for example, at least 50%, at least 60%, at least 70%, at least 80%, at least 90%, at least 95%).

[00272] In specific aspects, provided herein is an antibody comprising an antibody light chain and heavy chain, *e.g.*, a separate light chain and heavy chain. With respect to the light chain, in a specific embodiment, the light chain of an antibody described herein is a kappa light chain. In another specific embodiment, the light chain of an antibody described herein is a lambda light chain. In yet another specific embodiment, the light chain of an antibody described herein is a human kappa light chain or a human lambda light chain. In a particular embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, a KIT polypeptide comprising a D4 region of KIT, for example human KIT (*e.g.*, SEQ ID NO: 15)) comprises a light chain wherein the amino acid sequence of the VL chain region comprises any

amino acid sequence described herein (*e.g.*, SEQ ID NO: 7, 8, 9, or 10), and wherein the constant region of the light chain comprises the amino acid sequence of a human kappa light chain constant region. Non-limiting examples of human light chain constant region sequences have been described in the art, *e.g.*, see U.S. Patent No. 5,693,780 and Kabat *et al.* (1991) Sequences of Proteins of Immunological Interest, Fifth Edition, U.S. Department of Health and Human Services, NIH Publication No. 91-3242.

[00273] With respect to the heavy chain, in a specific embodiment, the heavy chain of an antibody described herein can be an alpha (α), delta (δ), epsilon (ε), gamma (γ) or mu (μ) heavy chain. In another specific embodiment, the heavy chain of an antibody described can comprise a human alpha (α), delta (δ), epsilon (ε), gamma (γ) or mu (μ) heavy chain. In a particular embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, a KIT polypeptide comprising a KIT polypeptide comprising a D4 region of KIT, for example human KIT (*e.g.*, SEQ ID NO: 15)), comprises a heavy chain wherein the amino acid sequence of the VH chain region can comprise any amino acid sequence described herein (*e.g.*, any of SEQ ID NOs: 2-6), and wherein the constant region of the heavy chain comprises the amino acid sequence of a human gamma (γ) heavy chain constant region. Non-limiting examples of human heavy chain constant region sequences have been described in the art, *e.g.*, see U.S. Patent No. 5,693,780 and Kabat *et al.* (1991) Sequences of Proteins of Immunological Interest, Fifth Edition, U.S. Department of Health and Human Services, NIH Publication No. 91-3242.

[00274] In a specific embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, a D4 region of KIT, for example human KIT) comprises a VL chain region and a VH chain region comprising any amino acid sequences described herein, and wherein the constant regions comprise the amino acid sequences of the constant regions of an IgG, IgE, IgM, IgD, IgA or IgY immunoglobulin molecule, or a human IgG, IgE, IgM, IgD, IgA or IgY immunoglobulin molecule. In another specific embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, a D4 region of KIT, for example human KIT) comprises a VL chain region and a VH chain region comprising any amino acid sequences described herein, and wherein the constant regions comprise the amino acid sequences of the constant regions of an IgG, IgE, IgM, IgD, IgA or IgY immunoglobulin molecule, any class (*e.g.*, IgG1, IgG2, IgG3, IgG4, IgA1 and IgA2), or any subclass (*e.g.*, IgG2a and IgG2b) of immunoglobulin molecule. In a particular embodiment, the

constant regions comprise the amino acid sequences of the constant regions of a human IgG, IgE, IgM, IgD, IgA or IgY immunoglobulin molecule, any class (*e.g.*, IgG1, IgG2, IgG3, IgG4, IgA1 and IgA2), or any subclass (*e.g.*, IgG2a and IgG2b) of immunoglobulin molecule.

[00275] In yet another specific embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, a D4 region of KIT, for example human KIT), comprises a VL chain region and a VH chain region comprising any amino acid sequences described herein (*e.g.*, any one of SEQ ID NOs: 2-6 and/or any one of SEQ ID NOs: 7-10), and wherein the constant regions comprise the amino acid sequences of the constant regions of a human IgG1 or human IgG4. In a particular embodiment, an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, a D4 region of KIT, for example human KIT) comprises a VL chain region and a VH chain region comprising any amino acid sequences described herein, and wherein the constant regions comprise the amino acid sequences of the constant region of a human IgG1.

[00276] In specific embodiments, an antibody described herein, which immunospecifically bind to a KIT polypeptide, *e.g.*, a human KIT polypeptide, for example, a D4 region of KIT (*e.g.*, human KIT, for example SEQ ID NO: 15), comprises framework regions (*e.g.*, framework regions of the VL domain and/or VH domain) that are human framework regions or derived from human framework regions. Non-limiting examples of human framework regions are described in the art, *e.g.*, see Kabat *et al.* (1991) Sequences of Proteins of Immunological Interest, Fifth Edition, U.S. Department of Health and Human Services, NIH Publication No. 91-3242). In a certain embodiment, an antibody described herein comprises framework regions (*e.g.*, framework regions of the VL domain and/or VH domain) that are primate (*e.g.*, non-human primate) framework regions or derived from primate (*e.g.*, non-human primate) framework regions.

[00277] In certain examples, an antibody described herein comprises framework regions (*e.g.*, framework regions of the VL domain and/or VH domain) that are not primate (*e.g.*, non-human primate, for example, ape such as Old World ape) framework regions or derived from primate (*e.g.*, non-human primate) framework regions.

[00278] In certain examples, with respect to any of these antibodies described herein, the VL chain region does not comprise non-human primate (*e.g.*, ape such as Old World ape) framework regions or is derived from non-human primate (*e.g.*, ape such as Old World ape) framework regions. In certain other embodiments, the VH chain region does not comprise non-

human primate (*e.g.*, ape such as Old World ape) framework regions or is derived from non-human primate (*e.g.*, ape such as Old World ape) framework regions.

[00279] Non-limiting examples of non-human primate framework regions include those from Old World apes, *e.g.*, Pan troglodytes, Pan paniscus or Gorilla gorilla; chimpanzee Pan troglodytes; Old World monkey such as Old World monkey from the genus Macaca; and cynomolgus monkey Macaca cynomolgus. Non-limiting examples of non-human primate framework sequences are described in U.S. Patent Application Publication No. US 2005/0208625.

[00280] In certain aspects, also provided herein are antibodies, which immunospecifically binds to a KIT polypeptide (*e.g.*, a D4 region of KIT, for example human KIT), comprising one or more amino acid residue substitutions, *e.g.*, in the VL chain region or VH chain region, for example, the CDRs or FRs. In specific embodiments, none of the amino acid residue substitutions are located within the CDRs. In specific embodiments, all of the amino acid substitutions are in the FRs (see, *e.g.*, Tables 5A-6B). In a certain embodiment, an amino acid substitution is a conservative amino acid substitution.

[00281] As used herein, a "conservative amino acid substitution" is one in which the amino acid residue is replaced with an amino acid residue having a side chain with a similar charge. Families of amino acid residues having side chains with similar charges have been defined in the art. These families include amino acids with basic side chains (*e.g.*, lysine, arginine, histidine), acidic side chains (*e.g.*, aspartic acid, glutamic acid), uncharged polar side chains (*e.g.*, glycine, asparagine, glutamine, serine, threonine, tyrosine, cysteine), nonpolar side chains (*e.g.*, alanine, valine, leucine, isoleucine, proline, phenylalanine, methionine, tryptophan), beta-branched side chains (*e.g.*, threonine, valine, isoleucine) and aromatic side chains (*e.g.*, tyrosine, phenylalanine, tryptophan, histidine).

[00282] In particular embodiments, the glycosylation of antibodies described herein is modified. For example, an aglycoslated antibody can be made (*i.e.*, the antibody lacks glycosylation) or an antibody comprising a mutation or substitution at one or more glycosylation sites to eliminate glycosylation at the one or more glycosylation sites can be made. Glycosylation can be altered to, for example, increase the affinity of the antibody for a target antigen (*e.g.*, human KIT, for example, a D4 region of human KIT). Such carbohydrate modifications can be accomplished by, for example, altering one or more sites of glycosylation within the antibody sequence. For example, one or more amino acid substitutions can be made that result in

elimination of one or more variable region (*e.g.*, VL and/or VH CDRs or VL and/or VH FRs) glycosylation sites to thereby eliminate glycosylation at that site. Such aglycosylation can increase the affinity of the antibody for antigen (*e.g.*, human KIT, for example, a D4 region of human KIT). Such an approach is described in further detail in U.S. Patent Nos. 5,714,350 and 6,350,861.

[00283] Glycosylation can occur via N-linked (or asparagine-linked) glycosylation or O-linked glycosylation. N-linked glycosylation involves carbohydrate modification at the side-chain NH_2 group of an asparagine amino acid in a polypeptide. O-linked glycosylation involves carbohydrate modification at the hydroxyl group on the side chain of a serine, threonine, or hydroxylysine amino acid.

[00284] In specific embodiments, an asparagine (N) residue within a VH (*e.g.*, SEQ ID NO: 2, 3, 4, 5, or 6) or VL region (*e.g.*, SEQ ID NO: 7, 8, 9, or 10) of an antibody described herein is substituted with a serine (S) or another amino acid (*e.g.*, alanine, glycine, glutamine, threonine, tyrosine, cysteine). In other specific embodiments, an asparagine (N) residue within a VH CDR (*e.g.*, VH CDR1, VH CDR2, and/or VH CDR3 comprising the sequences of SEQ ID NOs: 16-18, respectively) and/or a VL CDR (*e.g.*, VL CDR1, VL CDR2, and/or VL CDR3 comprising the sequences of SEQ ID NOs: 19-21, respectively) of an antibody described herein is substituted with a serine (S) or another amino acid (*e.g.*, alanine, glycine, glutamine, threonine, tyrosine, cysteine). In other specific embodiments, an asparagine (N) residue within a VH FR (*e.g.*, VH FR1, VH FR2, VH FR3 and/or VH FR4 as set forth in Tables 5A, 5C, and 6B) and/or a VL FR (*e.g.*, VL FR1, VL FR2, VL FR3, and/or VL FR4 as set forth in Table 5B, 5D, and 6A) of an antibody described herein is substituted with a serine (S) or another amino acid (*e.g.*, alanine, glycine, glutamine, threonine, tyrosine, cysteine).

[00285] In certain embodiments, aglycosylated antibodies can be produced in bacterial cells which lack the necessary glycosylation machinery. Cells with altered glycosylation machinery have been described in the art and can be used as host cells in which to express recombinant antibodies described herein to thereby produce an antibody with altered glycosylation. See, for example, Shields, R.L. *et al.* (2002) J. Biol. Chem. 277:26733-26740; Umana *et al.* (1999) Nat. Biotech. 17:176-1, as well as, European Patent No: EP 1,176,195; PCT Publications WO 03/035835; WO 99/54342.

[00286] In certain embodiments, one or more modifications can be made to the Fc region of an antibody described here, generally, to alter one or more functional properties of the antibody, such as serum half-life, complement fixation, Fc receptor binding, and/or antibody-dependent cellular cytotoxicity. These modifications are described, for example, in International Patent Application Publication No. WO 2008/153926 A2.

[00287] In specific embodiments, an asparagine (N) residue within the constant region of a heavy chain and/or the constant region of a light region of an antibody described herein is substituted with a serine (S) or another amino acid (*e.g.*, alanine, glycine, glutamine, threonine, tyrosine, cysteine).

[00288] In specific embodiments, an asparagine (N) residue within a heavy chain and/or a light region of an antibody described herein is substituted with a serine (S) or another amino acid (*e.g.*, alanine, glycine, glutamine, threonine, tyrosine, cysteine).

[00289] Provided herein are antibodies that immunospecifically bind to KIT antigen and that can modulate KIT activity. In certain embodiments, an antibody provided herein immunospecifically binds to a KIT polypeptide, *e.g.*, a human KIT polypeptide, and inhibits a KIT activity. KIT activity can relate to any activity of KIT known or described in the art, *e.g.*, KIT receptor dimerization, KIT receptor phosphorylation (tyrosine phosphorylation), signaling downstream of the KIT receptor (*e.g.*, AKT, MAPK/ERK, Ras, Stat1, Stat3, or Stat5 signaling), KIT ligand (*e.g.*, SCF) induced transcriptional regulation (*e.g.*, SCF-induced transcriptional activation of c-Myc), induction or enhancement of cell proliferation, or cell survival. KIT activity or KIT function are used interchangeably herein. In certain aspects, KIT activity is induced by KIT ligand (*e.g.*, SCF) binding to KIT receptor. In particular aspects, KIT activity can be induced or enhanced by gain-of-function mutations which can result, for example, in dimerization and constitutively active KIT signaling (*see, e.g.*, Mol *et al.*, J. Biol. Chem., 2003, 278:31461-31464; Hirota *et al.*, J. Pathology, 2001, 193:505-510). Such gain-of-function can allow for KIT receptor dimerization and KIT signaling to occur in the absence of KIT ligand (*e.g.*, SCF) binding to KIT receptor. In certain embodiments, an increase in KIT activity or signaling can occur, in the absence of KIT ligand (*e.g.*, SCF) binding KIT receptor, due to high (or overexpression) expression of KIT receptors. High or overexpression of KIT in a cell refers to an expression level which is at least about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% more than the expression level of a reference cell known to have normal KIT expression or KIT activity or more

than the average expression level of KIT in a population of cells or samples known to have normal KIT expression or KIT activity. Expression levels of KIT can be assessed by methods described herein or known to one of skill in the art (*e.g.*, Western blotting or immunohistochemistry). In particular embodiments, KIT activity that is higher than normal KIT activity can lead to cellular transformation, neoplasia, and tumorogenesis. In particular embodiments, KIT activity that is higher than normal KIT activity can lead to other KIT-associated disorders or diseases.

[00290] In certain embodiments, an anti-KIT antibody described herein does not block or inhibit binding of KIT ligand (*e.g.*, SCF) to KIT receptor. In certain embodiments, an anti-KIT antibody described herein only negligibly (*e.g.*, less than about 2% or 3%) inhibits or reduces binding of KIT ligand (*e.g.*, SCF) to KIT receptor. In certain embodiments, an anti-KIT antibody described herein does not induce or enhance dissociation of KIT ligand (*e.g.*, SCF) from the KIT receptor. In certain embodiments, an anti-KIT antibody described herein only negligibly (*e.g.*, less than about 2% or 3%) induces or enhances dissociation of KIT ligand (*e.g.*, SCF) from the KIT receptor.

[00291] In certain embodiments, an anti-KIT antibody described herein does not block or inhibit KIT receptor dimerization. In certain embodiments, an anti-KIT antibody described herein only negligibly (*e.g.*, less than about 2% or 3% or within a standard of error or deviation) inhibits or reduces KIT receptor dimerization. In certain embodiments, an anti-KIT antibody described herein does not induce or enhance KIT receptor dimer dissociation. In certain embodiments, an anti-KIT antibody described herein only negligibly (*e.g.*, less than about 2% or 3% or within a standard of error or deviation) induces or enhances KIT receptor dimer dissociation. In a particular embodiment, an anti-KIT antibody described herein can specifically bind to a KIT receptor dimer and do not block or inhibit KIT receptor dimerization. In a particular embodiment, an anti-KIT antibody described herein can specifically bind to a KIT receptor monomer and do not block or inhibit KIT receptor dimerization.

[00292] In certain aspects, as an inhibitor of KIT activity, an antibody described herein can block or inhibit (*e.g.*, partially inhibit) dimerization of KIT. Generally, KIT receptor dimerization is induced when KIT ligand binds to KIT. Thus, in specific embodiments, antibodies described herein specifically bind to KIT and block or inhibit (*e.g.*, partially inhibit) dimerization of KIT receptors by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or

known to one of skill in the art, *e.g.*, immunoprecipitation assay, relative to dimerization of KIT receptors in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In a specific embodiment, antibodies described herein specifically bind to KIT and partially inhibit dimerization of KIT receptors by about 25% to 75%. Blocking or inhibition (*e.g.*, partial inhibition) of dimerization of KIT receptors by antibodies described herein can be assessed in the presences of KIT ligand stimulation. For example, cells expressing KIT are contacted with KIT ligand in the presence or absence of anti-KIT antibodies described herein, and the level of KIT receptor dimerization is determined. In certain embodiments, KIT ligand induced KIT receptor dimerization in the absence of anti-KIT antibody is at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold higher than KIT receptor dimerization in the presence of anti-KIT antibody as assessed by methods described herein or known to one of skill in the art (*e.g.*, immunoprecipitation assays). Tyrosine phosphorylation of one or more residues in the cytoplasmic domain of KIT can be an indicator of KIT receptor dimerization.

[00293] In certain embodiments, an antibody described herein can inhibit (*e.g.*, partially inhibit) KIT activity by at least about 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein and/or known to one of skill in the art, relative to KIT activity in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In certain embodiments, an antibody described herein can inhibit (*e.g.*, partially inhibit) KIT activity by at least about 25% to about 65% as assessed by methods described herein and/or known to one of skill in the art, relative to KIT activity in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). Non-limiting examples of KIT activity can include KIT receptor phosphorylation, KIT receptor signaling, KIT ligand (*e.g.*, SCF) mediated cell proliferation, KIT ligand (*e.g.*, SCF) mediated cell survival, and transcriptional activation of a KIT target gene (*e.g.*, c-Myc).

[00294] As an inhibitor of KIT activity, an antibody described herein (or an antigen-binding fragment thereof, or a conjugate thereof) can block (*e.g.*, partially block) or inhibit (*e.g.*,

partially inhibit) phosphorylation of KIT, specifically tyrosine phosphorylation of one or more residues in the cytoplasmic domain of KIT. Generally, KIT receptor dimerization and phosphorylation is induced when KIT ligand binds to KIT. However, in certain aspects, KIT receptor dimerization and/or phosphorylation can occur independently of KIT ligand binding to KIT receptor. For example KIT receptor dimerization and/or phosphorylation can occur due to gain-of-function mutations or overexpression of KIT.

[00295] Non-limiting examples of tyrosine residues in the cytoplasmic domain of murine KIT that can be phosphorylated, *e.g.*, upon ligand stimulation, include 544, 546, 552, 567, 569, 577, 608, 645, 671, 674, 702, 719, 728, 745, 772, 821, 844, 853, 868, 878, 898, and 934 (see Ueda *et al.*, Blood, 2002, 99:3342-3349). The corresponding tyrosine residues in the cytoplasmic domain of human KIT can be readily determined. Non-limiting examples of tyrosine residues in the cytoplasmic domain of human KIT (*e.g.*, GenBank Accession No. P10721) that can be phosphorylated, *e.g.*, upon ligand stimulation, include residues 568, 570, 703, 721, 730, 747, 823, 900, and 936. In a specific embodiment, an anti-KIT antibody described herein can inhibit receptor phosphorylation at tyrosine residue 719 of murine KIT. In another specific embodiment, an anti-KIT antibody described herein can inhibit receptor phosphorylation at tyrosine residue 703 or 721 of human KIT.

[00296] Thus, in specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and block or inhibit tyrosine phosphorylation in the cytoplasmic domain of KIT by at least about 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art, *e.g.*, ELISA assay as described in section 6 or immunoblotting assay, relative to phosphorylation in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In particular embodiments, antibodies described herein specifically bind to KIT and block or inhibit tyrosine phosphorylation in the cytoplasmic domain of KIT by at least about 25%, optionally to about 65% or 75%, as assessed by methods described herein or known to one of skill in the art, *e.g.*, ELISA assay as described in section 6 or immunoblotting assay. In certain embodiments, antibodies described herein specifically bind to KIT and block or inhibit tyrosine phosphorylation of the cytoplasmic domain of KIT by at least about 25% to about 80% as assessed by methods described herein or known to one of skill in the

art, *e.g.*, ELISA assay as described in section 6 or immunoblotting assay. In specific embodiments, antibodies described herein specifically bind to KIT and block or inhibit tyrosine phosphorylation of the cytoplasmic domain of KIT with an IC_{50} of less than about 600 pM, or less than about 550 pM, or less than about 500 pM, or less than about 400 pM or less than about 300 pM as assessed by methods described herein (*e.g.*, phosphorylation inhibition assay with CHO cells expressing wild-type KIT as described in Section 6 below) or known to one of skill in the art. In specific embodiments, antibodies described herein specifically bind to KIT and block or inhibit tyrosine phosphorylation of the cytoplasmic domain of KIT with an IC_{50} of less than about 600 pM. In specific embodiments, antibodies described herein specifically bind to KIT and block or inhibit tyrosine phosphorylation of the cytoplasmic domain of KIT with an IC_{50} of less than about 550 pM. In specific embodiments, antibodies described herein specifically bind to KIT and block or inhibit tyrosine phosphorylation of the cytoplasmic domain of KIT with an IC_{50} in the range of about 100 pM to about 500 pM, about 25 pM to about 550 pM, or about 40 pM to about 600 pM, or about 50 pM to about 350 pM. For example, an IC_{50} for inhibition of tyrosine phosphorylation can be determined by assaying lysates from cells, *e.g.*, CHO cells, recombinantly expressing KIT, in ELISA which detects tyrosine phosphorylation, for example, as described in Section 6 below. In certain embodiments, cells, *e.g.*, CHO cells, recombinantly expressing KIT, are sorted, *e.g.*, sorted to select for cells highly expressing KIT, prior to use in the phosphorylation inhibition assays. In some embodiments, the cells are not sorted prior to use in the phosphorylation inhibition assays.

[00297] In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and reduce tyrosine phosphorylation of the cytoplasmic domain of KIT by at least about 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art, *e.g.*, ELISA assay as described in section 6 or immunoblotting assay, relative to phosphorylation in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and reduce tyrosine phosphorylation of the cytoplasmic domain of KIT by at least about 25% or 35%, optionally to about 75% as assessed by methods described herein or known to one of skill in the

art, *e.g.*, ELISA assay as described in section 6 or immunoblotting assay, relative to phosphorylation in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT).

[00298] In specific embodiments, antibodies described herein specifically bind to KIT and block or inhibit phosphorylation of one or more tyrosine residues in the cytoplasmic domain of KIT by at least about 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art, *e.g.*, immunoblotting assay, relative to phosphorylation in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In specific embodiments, blocking or inhibition (*e.g.*, partial inhibition) of phosphorylation of one or more tyrosine residues of the cytoplasmic domain of KIT by antibodies described herein can be assessed upon KIT ligand stimulation. For example, cells expressing KIT are contacted with KIT ligand in the presence or absence of anti-KIT antibodies described herein, and the level of phosphorylation of one or more tyrosine residues in the cytoplasmic domain of KIT can be determined. In certain embodiments, KIT ligand induced phosphorylation of one or more tyrosine residues of the cytoplasmic domain of KIT the absence of anti-KIT antibody is at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold higher than KIT ligand induced phosphorylation of one or more tyrosine residues of the cytoplasmic domain of KIT in the presence of anti-KIT antibody, as assessed by methods described herein or known to one of skill in the art (*e.g.*, immunoblotting assays), relative to phosphorylation in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT).

[00299] In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and induce or enhance KIT receptor internalization by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art, relative to internalization in the presence of an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate

thereof) specifically bind to KIT and induce or enhance KIT receptor internalization by at least about 25% or 35%, optionally to about 75%, as assessed by methods described herein or known to one of skill in the art, relative to internalization in the presence of an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In specific embodiments, antibodies described herein specifically bind to KIT and induce or enhance KIT receptor internalization by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art, relative to internalization in the presence of an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). Techniques for the quantitation or visualization of cell surface receptors are well known in the art and include a variety of fluorescent and radioactive techniques. For example, one method involves incubating the cells with a radiolabeled anti-receptor antibody. Alternatively, the natural ligand of the receptor can be conjugated to a fluorescent molecule or radioactive-label and incubated with the cells. Additional receptor internalization assays are well known in the art and are described in, for example, Jimenez *et al.*, Biochemical Pharmacology, 1999, 57:1125-1131; Bernhagen *et al.*, Nature Medicine, 2007, 13:587-596; and Conway *et al.*, J. Cell Physiol., 2001, 189:341-55.

[00300] In specific embodiments, antibodies described herein specifically bind to KIT and induce or enhance KIT receptor turnover by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, pulse-chase assay), relative to turnover in the presence of an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and induce or enhance KIT receptor turnover by at least about 25% or 35%, optionally to about 75%, as assessed by methods described herein or known to one of skill in the art (*e.g.*, pulse-chase assay), relative to turnover in the presence of an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In specific embodiments, antibodies described herein specifically bind to KIT and induce or enhance KIT receptor turnover by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90

fold, or 100 fold as assessed by methods described herein or known to one of skill in the art (*e.g.*, pulse-chase assay), relative to turnover in the presence of an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). Methods for the determining receptor turnover are well known in the art. For example, cells expressing KIT can be pulse-labeled using ^{35}S-EXPRESS Protein Labeling mix (NEG772, NEN Life Science Products), washed and chased with unlabeled medium for a period of time before protein lysates from the labeled cells are immunoprecipitated using an anti-KIT antibody and resolved by SDS-PAGE and visualized (*e.g.*, exposed to a PhosphoImager screen (Molecular Dynamics), scanned using the Typhoon8600 scanner (Amersham), and analyzed using ImageQuant software (Molecular Dynamics)) (see, *e.g.*, Chan *et al.*, Development, 2004, 131:5551-5560).

[00301] In specific embodiments, antibodies described herein specifically bind to KIT and induce or enhance KIT receptor degradation by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, pulse-chase assays), relative to degradation in the presence of an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In specific embodiments, antibodies described herein specifically bind to KIT and induce or enhance KIT receptor degradation by at least about 25% or 35%, optionally to about 75%, as assessed by methods described herein or known to one of skill in the art (*e.g.*, pulse-chase assays), relative to degradation in the presence of an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In specific embodiments, antibodies described herein specifically bind to KIT and induce or enhance KIT receptor degradation by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art (*e.g.*, pulse-chase assays), relative to degradation in the presence of an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). Techniques for quantitating or monitoring ubiquitination and/or degradation (*e.g.*, kinetics or rate of degradation) of cell surface receptors are well known in the art and involve a variety of fluorescent and radioactive techniques (see, *e.g.*, International Patent Application Publication No. WO 2008/153926 A2). For example, pulse chase experiments or experiments using radiolabeled ligands such as ^{125}I-SCF can be carried out to quantitatively measure degradation of KIT.

[00302] Moreover, signaling events downstream of KIT receptor phosphorylation can serve as indicators of KIT activity. For example, KIT ligand (*e.g.*, SCF) binding to its receptor KIT stimulates several distinct signaling pathways, including for example members of Src family kinases, phosphatidylinositol (PI) 3-kinases, and Ras mitogen-activated protein kinase (MAPK) (see Munugalavadla *et al.*, Mol. Cell. Biol., 2005, 25:6747-6759). Phosphorylated tyrosines in the cytoplasmic domain of KIT can provide for binding sites for SH2 domain-containing proteins, which include, but are not limited to, proteins of the p21Ras–mitogen activated protein kinase (MAPK) pathway, the p85 subunit of PI 3-kinase, phospholipase C-gamma$_1$, the Grb2 adaptor protein, the Src family kinases (SFKs), Cbl, CRKL, p62Dok-1, SHP1, and SHP2 (see Ueda *et al.*, Blood, 2002, 99:3342-3349).

[00303] Thus, in certain aspects, anti-KIT antibodies described herein which act as inhibitors of KIT activity can inhibit signaling of a member of the Src family kinases, PI 3-kinases, or Ras-MAPK. In particular embodiments, anti-KIT antibodies described herein which act as inhibitors of KIT activity can inhibit binding (or inhibit interaction), to the cytoplasmic domain of KIT, of one or more SH2 domain-containing proteins, such as proteins of the p21Ras–MAPK pathway, the p85 subunit of PI 3-kinase, phospholipase C-gamma1, the Grb2 adaptor protein, a member of the SFK, Cbl, CRKL, p62Dok-1, SHP1, and SHP2. In certain embodiments, anti-KIT antibodies described herein which act as inhibitors of KIT activity can inhibit activation by KIT of one or more SH2 domain-containing proteins, such as proteins of the p21Ras–MAPK pathway, the p85 subunit of PI 3-kinase, phospholipase C-gamma1, the Grb2 adaptor protein, a member of the SFK, Cbl, CRKL, p62Dok-1, SHP1, and SHP2.

[00304] In particular embodiments, anti-KIT antibodies described herein which act as inhibitors of KIT activity can inhibit downstream signaling such as phosphorylation of MAPK, phosphorylation of AKT, or phosphorylation of Stat1, Stat3, or Stat5. Thus, in certain embodiments, an anti-KIT antibody described herein can inhibit or reduce phosphorylation of MAPK (*e.g.*, KIT ligand (*e.g.*, SCF) induced phosphorylation of MAPK) by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art, *e.g.*, Western blot or ELISA assay as described in section 6 or immunoblotting assay, relative to phosphorylation in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In certain

embodiments, an anti-KIT antibody described herein can inhibit or reduce phosphorylation of AKT (*e.g.*, KIT ligand (*e.g.*, SCF) induced phosphorylation of AKT) by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art, *e.g.*, Western blot or ELISA assay as described in section 6 or immunoblotting assay, relative to phosphorylation in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In particular embodiments, an anti-KIT antibody described herein can inhibit or reduce phosphorylation of Stat3 (*e.g.*, KIT ligand (*e.g.*, SCF) induced phosphorylation of Stat3) by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art, *e.g.*, Western blot or ELISA assay as described in section 6 or immunoblotting assay, relative to phosphorylation in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT). In particular embodiments, an anti-KIT antibody described herein can inhibit or reduce phosphorylation of Stat1 or Stat5 (*e.g.*, KIT ligand (*e.g.*, SCF) induced phosphorylation) by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art, *e.g.*, Western blot or ELISA assay as described in section 6 or immunoblotting assay, relative to phosphorylation in the presence of KIT ligand stimulation without any antibody or with an unrelated antibody (*e.g.*, an antibody that does not immunospecifically bind to KIT).

[00305] In certain aspects, an anti-KIT antibody described herein which can act as an inhibitor of KIT activity or activity can inhibit cellular proliferation of cells (*e.g.*, cancer cells such as TF-1 cells) that express KIT and that respond to KIT signaling (*e.g.*,. cells that proliferate in response to KIT ligand stimulation and KIT signaling). Cell proliferation assays are described in the art and can be readily carried out by one of skill in the art. For example, cell proliferation can be assayed by measuring Bromodeoxyuridine (BrdU) incorporation (see, *e.g.*, Hoshino *et al.*, 1986, Int. J. Cancer 38, 369; Campana *et al.*, 1988, J. Immunol. Meth. 107:79) or (3H) thymidine incorporation (see, *e.g.*, Blechman *et al.*, Cell, 1995, 80:103-113; Chen, J., 1996, Oncogene 13:1395-403; Jeoung, J., 1995, J. Biol. Chem. 270:18367 73), by direct cell count at various time intervals (*e.g.*, 12-hour or 24-hour intervals), or by detecting changes in transcription, translation

or activity of known genes such as proto-oncogenes (*e.g.*, fos, myc) or cell cycle markers (Rb, cdc2, cyclin A, D1, D2, D3, E, etc). The levels of such protein and mRNA and activity can be determined by any method well known in the art. For example, protein can be quantitated by known immunodiagnostic methods such as ELISA, Western blotting or immunoprecipitation using antibodies, including commercially available antibodies. mRNA can be quantitated using methods that are well known and routine in the art, for example, using northern analysis, RNase protection, or polymerase chain reaction in connection with reverse transcription.

[00306] In specific embodiments, antibodies described herein specifically bind to KIT and inhibit cell proliferation by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, BrdU incorporation assay). In specific embodiments, antibodies described herein specifically bind to KIT and inhibit cell proliferation by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art (*e.g.*, BrdU incorporation assay).

[00307] In certain aspects, an anti-KIT antibody described herein, which can act as an inhibitor of KIT activity, can reduce or inhibit survival of cells that express KIT and that respond to KIT signaling (*e.g.*,. cells that proliferate in response to KIT ligand stimulation and KIT signaling). Cell survival assays are described in the art and can be readily carried out by one of skill in the art. For example, cell viability can be assessed by using trypan-blue staining or other cell death or viability markers known in the art. In a specific embodiment, the level of cellular ATP is measured to determined cell viability. In specific embodiments, cell viability is measured in three-day and seven-day periods using an assay standard in the art, such as the CellTiter-Glo Assay Kit (Promega) which measures levels of intracellular ATP. A reduction in cellular ATP is indicative of a cytotoxic effect. In another specific embodiment, cell viability can be measured in the neutral red uptake assay. In other embodiments, visual observation for morphological changes can include enlargement, granularity, cells with ragged edges, a filmy appearance, rounding, detachment from the surface of the well, or other changes. These changes are given a designation of T (100% toxic), PVH (partially toxic–very heavy–80%), PH (partially toxic–heavy–60%), P (partially toxic–40%), Ps (partially toxic–slight–20%), or 0 (no toxicity–0%), conforming to the

degree of cytotoxicity seen. A 50% cell inhibitory (cytotoxic) concentration (IC_{50}) is determined by regression analysis of these data.

[00308] In specific embodiments, antibodies described herein specifically bind to KIT and inhibit (e.g, partially inhibit) cell (*e.g.*, cancer cell) survival by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, trypan blue exclusion assay). In specific embodiments, antibodies described herein specifically bind to KIT and inhibit cell (*e.g.*, cancer cell) survival by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art (*e.g.*, trypan blue assay).

[00309] In certain aspects, an anti-KIT antibody described herein, which can act as an inhibitor of KIT activity, is capable of inducing apoptosis (*i.e.*, programmed cell death) of cells (*e.g.*, cancer cells, such as MO7E cells) that express KIT and that respond to KIT signaling (*e.g.*,. cells that proliferate in response to KIT ligand stimulation and KIT signaling). Apoptosis is described in the art and can be readily carried out by one of skill in the art. For example, flow cytometry can be used to detect activated caspase 3, an apoptosis-mediating enzyme, in cells undergoing apoptosis, or Western blotting can be used to detect cleavage of poly(ADP-ribose) polymerase (PARP) (see, *e.g.*, Smolich *et al.*, Blood, 2001, 97:1413-1421). Cleavage of PARP is an indicator of apoptosis. In specific embodiments, antibodies described herein specifically bind to KIT and induce or enhance apoptosis by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, flow cytometry to detect activated caspase 3). In specific embodiments, antibodies described herein specifically bind to KIT and induce or enhance apoptosis by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art (*e.g.*, flow cytometry to detect activated caspase 3).

[00310] In certain aspects, an anti-KIT antibody described herein, which can act as an inhibitor of KIT activity, is capable of inhibiting or decreasing anchorage independent cell growth

(*e.g.*, colony formation) by cells (*e.g.*, H526 cells or CHO cells expressing exogenous KIT) that express KIT and that respond to KIT signaling (*e.g.*,. cells that proliferate in response to KIT ligand stimulation and KIT signaling), as measured by methods commonly known in the art, *e.g.*, soft agar assay. In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and inhibit or decrease anchorage independent cell growth by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, soft agar assay). In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and inhibit or decrease anchorage independent cell growth by at least about 25% or 35%, optionally to about 75%, as assessed by methods described herein or known to one of skill in the art (*e.g.*, soft agar assay). In specific embodiments, antibodies described herein specifically bind to KIT and inhibit or decrease anchorage independent cell growth by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art (*e.g.*, soft agar assay).

[00311] Cells and cell lines which are appropriate for use in the assays described herein relating to KIT activity are readily available (*e.g.*, ATCC) or can be readily identified using methods known in the art. For example, cells and/or cell lines that express KIT endogenously or that possess KIT signaling or activity are known to one of skill in the art. In certain embodiments, cells or cell lines that are appropriate for use in the assays described herein can express KIT, either endogenously or recombinantly. In particular embodiments, cells or cell lines for use in cell proliferation assays can express KIT, endogenously or recombinantly, and proliferate or increase proliferation in response to KIT ligand (*e.g.*, SCF) stimulation. Cells or cell lines for use in cell viability assays can express KIT, endogenously or recombinantly, and exert changes in cell viability in response to KIT ligand (*e.g.*, SCF) stimulation. Cells or cell lines for use in apoptosis assays can express KIT, endogenously or recombinantly, and exert changes in apoptosis in response to KIT ligand (*e.g.*, SCF) stimulation.

[00312] Non-limiting examples of cells that can be used in the methods and assays described herein include primary cells, cancer cells, transformed cells, stem cells, mast cells,

primordial germ cells, oocytes, spermatocytes, embryonic stem cells, hematopoietic cells, erythroleukemia cells (*e.g.*, F36P and TF-1 cell lines), human myeloid leukemia cell lines, such as MO7E cells; gastrointestinal stromal tumor cell lines such as ST-882, GIST-T1, GIST48, GIST48B, GIST430, and GIST882; neuroblastoma cell lines such as SK-N-SH, SK-SY5Y, H-EP1, SK-N-BE(2), SK-N-BE(ZkM17), SK-N-BE(2)C, LA-N-l, or LA-N-1-5s; Ewing's sarcoma cell lines such as TC71, TC32, RD-ES, 5838, A4573, EWS-925, NCI-EWS-94, and NCI-EWS-95; and small cell lung carcinoma cell lines such as H526, ECC12, TMK1, MKN7, GCIY, and HGC27.

[00313] Alternatively, cells and cell lines that express KIT, *e.g.*, human KIT, can routinely be generated recombinantly. Non-limiting examples of cells that can be engineered to express KIT recombinantly include COS cells, HEK 293 cells, CHO cells, fibroblasts (*e.g.*, human fibroblasts) such as NIH3T3 cells, and MEFS. In a specific embodiment, cells for use in the methods described herein are CHO cells, for example CHO cells from the CHO GS System™ (Lonza). In a particular embodiment, these engineered cells exogenously expressing full-length human KIT (*e.g.*, SEQ ID NO: 1).

[00314] In certain aspects, an anti-KIT antibody described herein, which can act as an inhibitor of KIT activity, is capable of inhibiting tumor growth or inducing tumor regression in mouse model studies. For example, tumor cell lines can be introduced into nude mice, and the mice can be administered with anti-KIT antibodies described herein one or more times, and tumor progression of the injected tumor cells can be monitored over a period of weeks and/or months. In some cases, administration of anti-KIT antibodies to the nude mice can occur prior to introduction of the tumor cell lines. Any appropriate tumor cell line (*e.g.*, tumor cell line expressing KIT) can be used in the mouse xenograft models described herein. Non-limiting examples of tumor cell lines for use in these xenograft mouse models include megakaryoblastic leukemia cell lines such as MO7e; gastrointestinal stromal tumor cell lines such as ST-882, GIST-T1, GIST430, GIST48, GIST48B and GIST882; human erythroleukemic cell lines such as HEL and TF-1; human promyelocytic leukemia cell line, HL60; neuroblastoma cell lines such as SK-N-SH, SK-SY5Y, H-EP1, SK-N-BE(2), SK-N-BE(ZkM17), SK-N-BE(2)C, LA-N-l, or LA-N-1-5s; Ewing's sarcoma cell lines such as TC71, TC32, RD-ES, 5838, A4573, EWS-925, NCI-EWS-94, and NCI-EWS-95; and small cell lung carcinoma cell lines such as H526, DMS153, DMS79, ECC12, TMK1, MKN7, GCIY, and HGC27. In a specific embodiments, a tumor cell line for use in a

xenograft mouse model is the GIST882, GIST430, GIST48, GIST48B, HEL, HL60, H526, DMS153, or DMS79 cell line. In certain embodiments, suitable cell lines for use in xenograft tumor models can be generated by recombinantly expressing KIT in cell. In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and inhibit tumor grow or induce tumor regression in a mouse model by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art. In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and inhibit tumor grow or induce tumor regression in a mouse model by at least about 25% or 35%, optionally to about 75%, as assessed by methods described herein or known to one of skill in the art. In specific embodiments, antibodies described herein specifically bind to KIT and inhibit tumor grow or induce tumor regression in a mouse model by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art. Determining tumor growth inhibition or tumor regression can be assessed by monitoring tumor size over a period of time, such as by physical measurement of palpable tumors, or other visual detection methods. For example, tumor cell lines can be generated to recombinantly express a visualization agent, such as green fluorescent protein (GFP) or luciferase, then *in vivo* visualization of GFP can be carried out by microscopy, and *in vivo* visualization of luciferase can be carried out by administering luciferase substrate to the xenograft mice and detecting luminescent due to the luciferase enzyme processing the luciferase substrate. The degree or level of detection of GFP or luciferase correlates to the size of the tumor in the xenograft mice.

[00315] In certain aspects, anti-KIT antibodies described herein bind specifically to KIT antigen and can increase survival of animals in tumor xenograft models. In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof, or a conjugate thereof) specifically bind to KIT and increase survival of mice in tumor xenograft models by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art. In specific embodiments, antibodies described herein (or an antigen-binding fragment thereof,

or a conjugate thereof) specifically bind to KIT and increase survival of mice in tumor xenograft models by at least about 25% or 35%, optionally to about 75%, as assessed by methods described herein or known to one of skill in the art. In specific embodiments, antibodies described herein specifically bind to KIT and increase survival of mice in tumor xenograft models by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art. Survival can be determined by plotting a survival curve of number of surviving mice against time (*e.g.*, days or weeks) after tumor cell line injection.

[00316] Provided herein are antibodies that immunospecifically bind a KIT polypeptide, *e.g.*, a human KIT polypeptide, *e.g.*, a D4 region of KIT, for example, human KIT, with a particular affinity.

[00317] "Affinity" of an antibody described herein for an epitope (*e.g.*, KIT epitope) is a term well understood in the art and refers to the extent, or strength, of binding of an antibody to an epitope. Affinity can be measured and/or expressed in a number of ways known in the art, including, but not limited to, equilibrium dissociation constant (K_D or K_d), apparent equilibrium dissociation constant (K_D' or K_d'), and IC_{50} (amount needed to effect 50% inhibition in a competition assay). It is understood that, for purposes described herein, an affinity is an average affinity for a given population of antibodies which bind to an epitope. Values of K_D' described herein in terms of milligram (mg) Ig per mL or mg/mL indicate mg Ig per mL of serum, although plasma can be used. When antibody affinity is used as a basis for administration of the treatment methods described herein, or selection for the treatment methods described herein, antibody affinity can be measured before and/or during treatment, and the values obtained can be used by a clinician in assessing whether a human patient is an appropriate candidate for treatment.

[00318] In specific aspects, provided herein are antibodies (or antigen-binding fragments thereof, or conjugates thereof) that have a high binding affinity (*e.g.*, antibodies having a K_D of less than 250 nM, 100 nM, 50 nM, 10 nM, 1 nM, 500 pM, 200 pM, 100 pM, or 50 pM) for a KIT antigen, preferably a human KIT antigen, in particular the D4/D5 region of a human KIT.

[00319] In specific embodiments, an antibody described herein (or an antigen-binding fragment thereof, or a conjugate thereof) immunospecifically binds to a KIT antigen (*e.g.*, a D4/D5 region of KIT, for example human KIT), and has a dissociation constant (K_D) of less than

500,000 pM (500 nM), less than 100,000 pM (100 nM), less than 50,000 pM (50 nM), less than 10,000 pM (10 nM), less than 3,000 pM (3 nM), less than 2,500 pM (2.5 nM), less than 2,000 pM, less than 1,500 pM, less than 1,000 pM, less than 750 pM, less than 500 pM, less than 250 pM, less than 200 pM, less than 150 pM, less than 100 pM, less than 75 pM as assessed using an assay described herein or known to one of skill in the art (*e.g.*, a Biacore™ assay) (Biacore™ International AB, Uppsala, Sweden). In a specific embodiment, an antibody described herein (or an antigen-binding fragment thereof, or a conjugate thereof) immunospecifically binds to a KIT antigen (*e.g.*, a D4/D5 region of KIT, for example human KIT), and has a K_D in the range of from 25 to 100,000 pM, 25 to 75,000 pM, 25 to 50,000 pM, 25 to 40,000 pM, 25 to 30,000 pM, 25 to 20,000 pM, 25 to 10,000 pM, 25 to 1,000 pM, 25 to 500 pM, 25 to 250 pM, 25 to 100 pM, or 25 to 50 pM as assessed using methods described herein or known to one of skill in the art (*e.g.*, a Biacore™ assay, assay using KinExA 3000 instrument). In a particular embodiment, an antibody described herein (or an antigen-binding fragment thereof, or a conjugate thereof) immunospecifically binds to a KIT antigen (*e.g.*, a D4 region of KIT, for example human KIT), and has a K_D of about 100 pM to about 250 nM, or any value in between, as assessed using methods described herein or known to one of skill in the art (*e.g.*, a Biacore™ assay, assay using KinExA 3000 instrument).

[00320] In specific embodiments, an anti-KIT antibody (or an antigen-binding fragment thereof, or a conjugate thereof) immunospecifically binds to a KIT antigen (*e.g.*, a D4 region of KIT, for example human KIT), and has a concentration at 50% binding to antigen of less than 3000 pM (3 nM), less than 2500 pM (2.5 nM), less than 2000 pM, less than 1500 pM, less than 1000 pM, less than 750 pM, less than 500 pM, less than 250 pM, less than 200 pM, less than 150 pM, less than 100 pM, less than 75 pM as assessed using an assay described herein or known to one of skill in the art (*e.g.*, solid phase ELISA as described in section 6). In a specific embodiment, an antibody described herein (or an antigen-binding fragment thereof, or a conjugate thereof) immunospecifically binds to a KIT antigen (*e.g.*, a D4 region of KIT, for example human KIT), and has a concentration at 50% binding to antigen in the range of from 25 to 500,000 pM (500 nM), 25 to 250,000 pM (250 nM), 25 to 100,000 pM (100 nM), 25 to 75,000 pM (75 nM), 25 to 50,000 pM (50 nM), 25 to 40,000 pM (40 nM), 25 to 30,000 pM (30 nM), 25 to 20,000 pM (20 nM), 25 to 10,000 pM (10 nM), 25 to 1,000 pM (1 nM), 25 to 500 pM, 25 to 250 pM, 25 to 100 pM, or 25 to 50 pM as assessed using methods described herein or known to one of skill in the art

(*e.g.*, solid phase ELISA as described in section 6). In a particular embodiment, an antibody described herein (or an antigen-binding fragment thereof, or a conjugate thereof) immunospecifically binds to a KIT antigen (*e.g.*, a D4 region of KIT, for example human KIT), and has a concentration at 50% binding to antigen of about 1 nM to about 25 nM, or any value in between, as assessed using methods described herein or known to one of skill in the art (*e.g.*, solid phase ELISA as described in section 6). In a particular embodiment, an antibody described herein (or an antigen-binding fragment thereof, or a conjugate thereof) immunospecifically binds to a KIT antigen (*e.g.*, a D4 region of KIT, for example human KIT), and has a concentration at 50% binding to antigen of about 50 pM to about 500 pM, or any value in between, as assessed using methods described herein or known to one of skill in the art (*e.g.*, solid phase ELISA as described in section 6). In a particular embodiment, an antibody described herein (or an antigen-binding fragment thereof, or a conjugate thereof) immunospecifically binds to KIT antigen (*e.g.*, a D4 region of KIT, for example human KIT), and has a concentration at 50% binding of about 0.5 nM, 0.25 nM, 0.1 nM, 1 nM, 1.5 nM, 2 nM, 2.5 nM, 3 nM, 3.5 nM, 4 nM, 4.5 nM, 5 nM, 5.5 nM, 6 nM, 6.5 nM, 7 nM, 8 nM, 9 nM, 10 nM, 11 nM, 12 nM, 13 nM, 14 nM, 15 nM, 16 nM, 17 nM, 18 nM, 19 nM, 20 nM, 30 nM, 40 nM, 50 nM, 60 nM, 70 nM, 80 nM, 90 nM, 100 nM, 150 nM, 200 nM, 250 nM, 300 nM, 350 nM, 400 nM, or 500 nM, or less, as assessed using methods described herein or known to one of skill in the art (*e.g.*, solid phase ELISA as described in section 6). In a particular embodiment, antibodies described herein immunospecifically bind to KIT antigen (*e.g.*, a D4 region of KIT, for example human KIT), and have a concentration at 50% binding from about 100 pM to about 10 nM, as assessed using methods described herein or known to one of skill in the art (*e.g.*, ELISA, assay using KinExA 3000 instrument, or Biacore™ assay).

[00321] Methods for determining affinity of an antibody to its target antigen are readily available and described in the art. For example, the affinities and binding properties of an antibody for its target antigen, can be determined by a variety of *in vitro* assay methods (biochemical or immunological based assays) known in the art such as equilibrium methods (*e.g.*, enzyme-linked immunoabsorbent assay (ELISA), or radioimmunoassay (RIA)), or kinetics (*e.g.*, Biacore™ analysis), and other methods such as indirect binding assays, competitive inhibition assays, fluorescence resonance energy transfer (FRET), immunoprecipitation, gel electrophoresis and chromatography (*e.g.*, gel filtration). These and other methods can utilize a label on one or more of the components being examined and/or employ a variety of detection methods including

but not limited to chromogenic, fluorescent, luminescent, or isotopic labels. In certain embodiments, use of labels is not necessary, *e.g.*, Biacore™ systems utilize the natural phenomenon of surface plasmon resonance (SPR) to deliver data in real time, without the use of labels. A detailed description of binding affinities and kinetics can be found in Paul, W.E., ed., Fundamental Immunology, 4th Ed. (Lippincott-Raven, Philadelphia 1999), which focuses on antibody-immunogen interactions.

[00322] In certain aspects, the affinity of an antibody described herein for a KIT antigen, *e.g.*, human KIT, for example a D4 region of KIT (*e.g.*, human KIT), can be characterized indirectly using cell-based assays. For example, cells expressing KIT on their cell membrane surface can be contacted with anti-KIT antibodies, and cellular activities downstream of KIT can be determined using assays known in the art. For examples, phosphorylation of the cytoplasmic domain of KIT can be determined by immunoblotting (or Western blotting) following contacting the cells with an anti-KIT antibody; cellular extracts are obtained and processed for immunoblotting (*e.g.*, subjecting the cellular extracts to sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) and transferring the proteins separated on the gel to a membrane (*e.g.*, nitrocellulose or polyvinylidene fluoride (PVDF)) with an antibody that specifically binds to a phosphorylated tyrosine in the cytoplasmic domain of KIT, but does not bind an unphosphorylated tyrosine.

[00323] In certain embodiments, an anti-KIT antibody described herein specifically binds to a KIT antigen, *e.g.*, human KIT, for example a D4 region of KIT (*e.g.*, human KIT), and induces or enhances dimerization and phosphorylation of KIT, in the presence or absence of the KIT ligand SCF. In some embodiments, an anti-KIT antibody described herein can inhibit or decrease KIT ligand, *e.g.*, SCF, binding to KIT (*i.e.*, an anti-KIT antibody can compete with a KIT ligand, *e.g.*, SCF, for binding to KIT). In such case, cells can be contacted with an anti-KIT antibody and a KIT ligand, and the degree of inhibition of KIT phosphorylation can be determined as an indication of the degree of the anti-KIT antibody competing with the KIT ligand for binding to KIT.

[00324] Antibodies include, but are not limited to, monoclonal antibodies, recombinantly produced antibodies, multispecific antibodies (including bi-specific antibodies), human antibodies, humanized antibodies, chimeric antibodies, synthetic antibodies, tetrameric antibodies comprising two heavy chain and two light chain molecule, an antibody light chain monomer, an antibody

heavy chain monomer, an antibody light chain dimer, an antibody heavy chain dimer, an antibody light chain- antibody heavy chain pair, intrabodies, heteroconjugate antibodies, single domain antibodies, monovalent antibodies, single chain antibodies or single-chain Fvs (scFv) (*e.g.*, including monospecific, bispecific, *etc.*), camelized antibodies, affybodies, Fab fragments, F(ab') fragments, disulfide-linked Fvs (sdFv), anti-idiotypic (anti-Id) antibodies (including, *e.g.*, anti-anti-Id antibodies), and epitope-binding fragments of any of the above. In certain embodiments, antibodies described herein refer to polyclonal antibody populations. Antibodies can be of any type (*e.g.*, IgG, IgE, IgM, IgD, IgA or IgY), any class, (*e.g.*, IgG_1, IgG_2, IgG_3, IgG_4, IgA_1 or IgA_2), or any subclass (*e.g.*, IgG2a or IgG2b) of immunoglobulin molecule. In certain embodiments, antibodies described herein are IgG antibodies, or a class (*e.g.*, human IgG_1 or IgG_4) or subclass thereof. In specific embodiments, a monoclonal antibody is an antibody produced by a single hybridoma or other cell, wherein the antibody immunospecifically binds to a D4 region of human KIT epitope as determined, *e.g.*, by ELISA or other antigen-binding or competitive binding assay known in the art or in the Examples provided herein. The term "monoclonal" is not limited to any particular method for making the antibody.

[00325] In a particular embodiment, an antibody provided herein is a Fab fragment that immunospecifically binds to a KIT polypeptide, such as the D4 region of KIT. In a specific embodiment, antibodies described herein are monoclonal antibodies or isolated monoclonal antibodies. In another specific embodiment, an antibody described herein is a humanized monoclonal antibody. In a particular embodiment, an antibody described herein is a recombinant antibody, for example, a recombinant human antibody, recombinant humanized antibody or a recombinant monoclonal antibody. In certain embodiments, an antibody described herein contains non-human amino acid sequences, *e.g.*, non-human CDRs or non-human (*e.g.*, non-human primate) framework residues.

[00326] In particular embodiments provided herein, recombinant antibodies can be isolated, prepared, expressed, or created by recombinant means, such as antibodies expressed using a recombinant expression vector transfected into a host cell, antibodies isolated from a recombinant, combinatorial antibody library, or antibodies prepared, expressed, created or isolated by any other means that involves creation, *e.g.*, via synthesis, genetic engineering of DNA sequences that encode human immunoglobulin sequences, or splicing of sequences that encode human immunoglobulins, *e.g.*, human immunoglobulin gene sequences, to other such sequences.

In certain embodiments, the amino acid sequences of such recombinant antibodies have been modified such thus the amino acid sequences of such antibodies, *e.g.*, VH and/or VL regions, are sequences that do not naturally exist within an organism's antibody germline repertoire *in vivo*, for example a murine or human germline repertoire. In a particular embodidment, a recombinant antibody can be obtained by assembling several sequence fragments that naturally exist in an organism (*e.g.*, primate, such as human) into a composite sequence of a recombinant antibody, wherein the composite sequence does not naturally exist within an organism (*e.g.*, primate such as human).

[00327] Antibodies provided herein include immunoglobulin molecules of any type (*e.g.*, IgG, IgE, IgM, IgD, IgA and IgY), class (*e.g.*, IgG1, IgG2, IgG3, IgG4, IgA1 and IgA2) or subclass of immunoglobulin molecule. In a specific embodiment, an antibody provided herein is an IgG antibody (*e.g.*, human IgG antibody), or a class (*e.g.*, human IgG1 or IgG4) or subclass thereof. In another specific embodiment, an antibody described herein is an IgG1 (*e.g.*, human IgG1 (isotype a, z, or f)) or IgG4 antibody. In certain embodiments, an antibody described herein is a whole or entire antibody, *e.g.*, a whole or entire humanized, human, or composite human antibody.

[00328] Antibodies provided herein can include antibody fragments that retain the ability to specifically bind to an antigen, *e.g.*, KIT epitope (*e.g.*, a KIT epitope within a KIT polypeptide containing a D4 region of human KIT). In a specific embodiment, fragments include Fab fragments (an antibody fragment that contains the antigen-binding domain and comprises a light chain and part of a heavy chain (*i.e.*, the VH and CH1 domains of a heavy chain) bridged by a disulfide bond); Fab' (an antibody fragment containing a single antigen-binding domain comprising an Fab and an additional portion of the heavy chain through the hinge region); $F(ab')_2$ (two Fab' molecules joined by interchain disulfide bonds in the hinge regions of the heavy chains; the Fab' molecules can be directed toward the same or different epitopes); a bispecific Fab (a Fab molecule having two antigen binding domains, each of which can be directed to a different epitope); a single chain Fab chain comprising a variable region, also known as a sFv (the variable, antigen-binding determinative region of a single light and heavy chain of an antibody linked together by a chain of 10-25 amino acids); a disulfide-linked Fv, or dsFv (the variable, antigen-binding determinative region of a single light and heavy chain of an antibody linked together by a disulfide bond); a camelized VH (the variable, antigen-binding determinative region of a single

heavy chain of an antibody in which some amino acids at the VH interface are those found in the heavy chain of naturally occurring camel antibodies); a bispecific sFv (a sFv or a dsFv molecule having two antigen-binding domains, each of which can be directed to a different epitope); a diabody (a dimerized sFv formed when the VH domain of a first sFv assembles with the VL domain of a second sFv and the VL domain of the first sFv assembles with the VH domain of the second sFv; the two antigen-binding regions of the diabody can be directed towards the same or different epitopes); and a triabody (a trimerized sFv, formed in a manner similar to a diabody, but in which three antigen-binding domains are created in a single complex; the three antigen binding domains can be directed towards the same or different epitopes). Antibodies provided herein can also include one or more CDR sequences of an antibody. The CDR sequences can be linked together on a scaffold when two or more CDR sequences are present. In certain embodiments, an antibody comprises a single-chain Fv ("scFv"). scFvs are antibody fragments comprising the VH and VL domains of an antibody, wherein these domains are present in a single polypeptide chain. Generally, the scFv polypeptide further comprises a polypeptide linker between the VH and VL domains which enables the scFv to form the desired structure for antigen binding. For a review of scFvs, see Pluckthun in The Pharmacology of Monoclonal Antibodies, vol. 113, Rosenburg and Moore eds. Springer-Verlag, New York, pp. 269-315 (1994). Without being bound by any particular theories, Fv molecules can be able to penetrate tissues because of their small size. A whole antibody can be enzymatically cleaved by pepsin to produce a $F(ab')_2$ fragment, or can be enzymatically cleaved by papain to produce two Fab fragments.

[00329] In certain embodiments, antibodies described herein are human, composite human, or humanized monoclonal antibodies. In a particular embodiment, an antibody described herein is an engineered antibody, for example, antibody produced by recombinant methods. In a specific embodiment, an antibody described herein is a humanized antibody comprising one or more non-human (*e.g.*, rodent or murine) CDRs and one or more human framework regions (FR), and optionally human heavy chain constant region and/or light chain constant region. In a specific embodiment, an antibody described herein comprises one or more primate (or non-human primate) framework regions. In a specific embodiment, an antibody described herein does not comprise non-human primate framework regions.

[00330] Antibodies provided herein can include antibodies comprising chemical modifications, for example, antibodies which have been chemically modified, *e.g.*, by covalent

attachment of any type of molecule to the antibody. For example, but not by way of limitation, an anti-KIT antibody can be glycosylated, acetylated, pegylated, phosphorylated, or amidated, can be derivitized via protective/blocking groups, or can further comprise a cellular ligand and or other protein or peptide, *etc.* For example, an antibody provided herein can be chemically modified, *e.g.,* by glycosylation, acetylation, pegylation, phosphorylation, amidation, derivatization by known protecting/blocking groups, proteolytic cleavage, linkage to a cellular ligand or other protein, *etc.* Further, an anti-KIT antibody described herein can contain one or more non-classical amino acids.

[00331] In a particular embodiment, provided herein is an anti-KIT antibody which has been modified in a manner suitable for large scale manufacturing, *e.g.*, the manufacturing platform of Lonza (Basel, Switzerland). For example, the BI-HEX® technology platform (Boehringer Ingleheim, Germany) can be used to adapt the anti-KIT antibodies described herein for suitable large scale manufacturing in recombinant mammalian cell expression systems. Such adaptation can involve cloning polynucleotide sequences encoding the necessary domains of an anti-KIT antibody, such as one or more CDRs or FRs, into a suitable expression vector which also contains polynucleotide sequences encoding suitable constant regions, so that an entire antibody is produced. The polynucleotide sequences provided by the expression vectors are nucleotide sequences which can be optimized to maximize antibody yield and stability for cell culture manufacturing conditions and purification processes.

5.1.1. Conjugates

[00332] In some embodiments, provided herein are antibodies (*e.g.*, human or humanized antibodies), or antigen-binding fragments thereof, conjugated or recombinantly fused to a diagnostic, detectable or therapeutic agent or any other molecule. The conjugated or recombinantly fused antibodies can be useful, *e.g.,* for monitoring or prognosing the onset, development, progression and/or severity of a KIT-associated disorder or disease, for example, as part of a clinical testing procedure, such as determining the efficacy of a particular therapy. The conjugated or recombinantly fused antibodies can be useful, *e.g.*, for treating or managing a KIT-associated disorder (*e.g.*, cancer), or for treating or managing effects of a KIT-associated disorder (*e.g.*, cancer). Antibodies described herein can also be conjugated to a molecule (*e.g.*, polyethylene glycol) which can affect one or more biological and/or molecular properties of the antibodies, for example, stability (*e.g.*, in serum), half-life, solubility, and antigenicity.

[00333] In a particular aspect, provided herein is a conjugate comprising an agent (*e.g.*, therapeutic agent) linked to an antibody described herein (or an antigen-binding fragment thereof), which antibody immunospecifically binds to a D4 region of human KIT (*e.g.*, SEQ ID NO: 15). In a specific embodiment, a conjugated antibody specifically binds a D4 region of KIT (*e.g.*, human KIT), and comprises an antibody comprising the CDRs set forth in Table 1, or Table 2, or Table 3. In a specific embodiment, a conjugated antibody specifically binds a D4 region of KIT (*e.g.*, human KIT) and comprises a VL chain region comprising VL CDR1, VL CDR2, and VL CDR3 having the amino acid sequence of SEQ ID NO: 19, 20, and 21, respectively, and/or a VH chain region comprising VH CDR1, VH CDR2, and VH CDR3 having the amino acid sequence of SEQ ID NO: 16, 17, and 18, respectively. In a specific embodiment, a conjugated antibody specifically binds a D4 region of KIT (*e.g.*, human KIT), and comprises any one of antibodies Hum1-Hum20. In a specific embodiment, a conjugated antibody provided herein specifically binds a D4 region of KIT (*e.g.*, human KIT), and comprises an antibody comprising a VL and/or VH comprising CDRs selected from Table 1, or Table 2, or Table 3, and FRs selected from Tables 5A-5D. In a specific embodiment, a conjugated antibody provided herein specifically binds a D4 region of KIT (*e.g.*, human KIT), and comprises an antibody comprising a VL comprising SEQ ID NO: 12 and/or VH comprising SEQ ID NO: 11. In one embodiment, an antibody that is conjugated is one that binds a D4 region of human KIT with an affinity, for example, an EC50 of about 200 pM or less. In another embodiment, an antibody that is conjugated is one that inhibits a biological activity of KIT. In specific embodiments, a conjugate comprises an antibody described herein and a molecule (*e.g.*, therapeutic or drug moiety), wherein the antibody is linked directly to the molecule, or by way of one or more linkers. In certain embodiments, an antibody is covalently conjugated to a molecule. In a particular embodiment, an antibody is noncovalently conjugated to a molecule. In specific embodiments, an antibody described herein, *e.g.*, an antibody conjugated to an agent, binds to wild-type human KIT. In certain embodiments, an antibody described herein, *e.g.*, antibody conjugated to an agent, binds to an extracellular domain of human KIT comprising a mutation, for example a somatic mutation associated with cancer (*e.g.*, GIST), such as a mutation in exon 9 of human KIT wherein the Ala and Tyr residues at positions 502 and 503 are duplicated.

[00334] Such diagnosis and detection can be accomplished, for example, by coupling the antibody to detectable molecules or substances including, but not limited to, various enzymes, such as, but not limited to, horseradish peroxidase, alkaline phosphatase, beta-galactosidase, or

acetylcholinesterase; prosthetic groups, such as, but not limited to, streptavidin/biotin and avidin/biotin; fluorescent materials, such as, but not limited to, umbelliferone, fluorescein, fluorescein isothiocynate, rhodamine, dichlorotriazinylamine fluorescein, dansyl chloride or phycoerythrin; luminescent materials, such as, but not limited to, luminol; bioluminescent materials, such as but not limited to, luciferase, luciferin, and aequorin; radioactive materials, such as, but not limited to, iodine (^{131}I, ^{125}I, ^{123}I, and ^{121}I,), carbon (^{14}C), sulfur (^{35}S), tritium (^{3}H), indium (^{115}In, ^{113}In, ^{112}In, and ^{111}In,), technetium (^{99}Tc), thallium (^{201}Ti), gallium (^{68}Ga, ^{67}Ga), palladium (^{103}Pd), molybdenum (^{99}Mo), xenon (^{133}Xe), fluorine (^{18}F), ^{153}Sm, ^{177}Lu, ^{159}Gd, ^{149}Pm, ^{140}La, ^{175}Yb, ^{166}Ho, ^{90}Y, ^{47}Sc, ^{186}Re, ^{188}Re, ^{142}Pr, ^{105}Rh, ^{97}Ru, ^{68}Ge, ^{57}Co, ^{65}Zn, ^{85}Sr, ^{32}P, ^{153}Gd, ^{169}Yb, ^{51}Cr, ^{54}Mn, ^{75}Se, ^{113}Sn, and ^{117}Sn; and positron emitting metals using various positron emission tomographies, and non-radioactive paramagnetic metal ions.

[00335] Provided are antibodies described herein, or antigen-binding fragments thereof, conjugated or recombinantly fused to a therapeutic moiety (or one or more therapeutic moieties) and uses of such antibodies. The antibody can be conjugated or recombinantly fused to a therapeutic moiety, such as a cytotoxin, *e.g.,* a cytostatic or cytocidal agent, a therapeutic agent or a radioactive metal ion, *e.g.,* alpha-emitters. A cytotoxin or cytotoxic agent includes any agent that is detrimental to cells. Therapeutic moieties include, but are not limited to, auristatin or a derivative thereof, *e.g.,* monomethyl auristatin E (MMAE), monomethyl auristatin F (MMAF), auristatin PYE, and auristatin E (AE) (see, *e.g.,* U.S. Pat. No. 7,662,387 and U.S. Pat. Application Publication Nos. 2008/0300192 and 2008/0025989, each of which is incorporated herein by reference); a microtubule-disrupting agent, *e.g.,* maytansine or a derivative thereof, *e.g.,* maytansinoid DM1 (see, *e.g.,* U.S. Pat. Nos. 7,851,432, 7,575,748, and 5,416,064, each of which is incorporated herein by reference); a prodrug, *e.g.,* a prodrug of a CC-1065 (rachelmycin) analogue; antimetabolites (*e.g.,* methotrexate, 6-mercaptopurine, 6-thioguanine, cytarabine, 5-fluorouracil decarbazine); alkylating agents (*e.g.,* mechlorethamine, thioepa chlorambucil, melphalan, carmustine (BCNU) and lomustine (CCNU), cyclothosphamide, busulfan, dibromomannitol, streptozotocin, mitomycin C, and cisdichlorodiamine platinum (II) (DDP), and cisplatin); minor-groove-binding alkylating agent; anthracyclines (*e.g.,* daunorubicin (formerly daunomycin) and doxorubicin); antibiotics (*e.g.,* d actinomycin (formerly actinomycin), bleomycin, mithramycin, and anthramycin (AMC)); Auristatin molecules (*e.g.,* auristatin PHE, bryostatin 1, and solastatin 10; see Woyke *et al.*, Antimicrob. Agents Chemother. 46:3802-8

(2002), Woyke *et al.*, Antimicrob. Agents Chemother. 45:3580-4 (2001), Mohammad *et al.*, Anticancer Drugs 12:735-40 (2001), Wall *et al.*, Biochem. Biophys. Res. Commun. 266:76-80 (1999), Mohammad *et al.*, Int. J. Oncol. 15:367-72 (1999), all of which are incorporated herein by reference); hormones (*e.g.,* glucocorticoids, progestins, androgens, and estrogens), DNA-repair enzyme inhibitors (*e.g.,* etoposide or topotecan), kinase inhibitors (*e.g.,* compound ST1571, imatinib mesylate (Kantarjian *et al.*, Clin Cancer Res. 8(7):2167-76 (2002)); cytotoxic agents (*e.g.,* paclitaxel, cytochalasin B, gramicidin D, ethidium bromide, emetine, mitomycin, etoposide, tenoposide, vincristine, vinblastine, colchicin, doxorubicin, daunorubicin, dihydroxy anthracin dione, mitoxantrone, mithramycin, actinomycin D, 1-dehydrotestosterone, glucorticoids, procaine, tetracaine, lidocaine, propranolol, and puromycin and analogs or homologs thereof and those compounds disclosed in U.S. Patent Nos. 6,245,759, 6,399,633, 6,383,790, 6,335,156, 6,271,242, 6,242,196, 6,218,410, 6,218,372, 6,057,300, 6,034,053, 5,985,877, 5,958,769, 5,925,376, 5,922,844, 5,911,995, 5,872,223, 5,863,904, 5,840,745, 5,728,868, 5,648,239, 5,587,459, each of which is incorporated herein by reference with respect to such compound disclosure); farnesyl transferase inhibitors (*e.g.,* R115777, BMS-214662, and those disclosed by, for example, U.S. Patent Nos: 6,458,935, 6,451,812, 6,440,974, 6,436,960, 6,432,959, 6,420,387, 6,414,145, 6,410,541, 6,410,539, 6,403,581, 6,399,615, 6,387,905, 6,372,747, 6,369,034, 6,362,188, 6,342,765, 6,342,487, 6,300,501, 6,268,363, 6,265,422, 6,248,756, 6,239,140, 6,232,338, 6,228,865, 6,228,856, 6,225,322, 6,218,406, 6,211,193, 6,187,786, 6,169,096, 6,159,984, 6,143,766, 6,133,303, 6,127,366, 6,124,465, 6,124,295, 6,103,723, 6,093,737, 6,090,948, 6,080,870, 6,077,853, 6,071,935, 6,066,738, 6,063,930, 6,054,466, 6,051,582, 6,051,574, and 6,040,305, each of which is incorporated herein by reference with respect to such inhibitor disclosure); topoisomerase inhibitors (*e.g.,* camptothecin; irinotecan; SN-38; topotecan; 9-aminocamptothecin; GG-211 (GI 147211); DX-8951f; IST-622; rubitecan; pyrazoloacridine; XR-5000; saintopin; UCE6; UCE1022; TAN-1518A; TAN 1518B; KT6006; KT6528; ED-110; NB-506; ED-110; NB-506; and rebeccamycin); bulgarein; DNA minor groove binders such as Hoescht dye 33342 and Hoechst dye 33258; nitidine; fagaronine; epiberberine; coralyne; beta-lapachone; BC-4-1; bisphosphonates (*e.g.,* alendronate, cimadronte, clodronate, tiludronate, etidronate, ibandronate, neridronate, olpandronate, risedronate, piridronate, pamidronate, zolendronate) HMG-CoA reductase inhibitors, (*e.g.,* lovastatin, simvastatin, atorvastatin, pravastatin, fluvastatin, statin, cerivastatin, lescol, lupitor, rosuvastatin and atorvastatin); antisense

oligonucleotides (*e.g.,* those disclosed in the U.S. Patent Nos. 6,277,832, 5,998,596, 5,885,834, 5,734,033, and 5,618,709, each of which is incorporated herein by reference with respect to such oligonucleotides); adenosine deaminase inhibitors (*e.g.,* Fludarabine phosphate and 2-Chlorodeoxyadenosine); ibritumomab tiuxetan (Zevalin®); tositumomab (Bexxar®)) and pharmaceutically acceptable salts, solvates, clathrates, and prodrugs thereof. In one embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that binds a D4 region of human KIT with an affinity of less than about 200 pM. In another embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that inhibits a biological activity of KIT. In a specific embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that comprises the CDRs set forth in Table 1 (*e.g.*, VL CDR1, VL CDR2, and VL CDR3 having the amino acid sequence of SEQ ID NO: 19, 20, and 21, respectively, and/or a VH chain region comprising VH CDR1, VH CDR2, and VH CDR3 having the amino acid sequence of SEQ ID NO: 16, 17, and 18, respectively), or Table 2, or Table 3. In a specific embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that comprises a VL comprising SEQ ID NO: 7, 8, 9, 10, or 12 or a sequence set forth in Tables 5B and 5D, and/or VH comprising SEQ ID NO: 2, 3, 4, 5, 6, or 11 or a sequence set forth in Tables 5A and 5C.

[00336] In particular embodiments, a therapeutic moiety or drug moiety is an antitubulin drug, such as an auristatin or a derivative thereof. Non-limiting examples of auristatins include monomethyl auristatin E (MMAE), monomethyl auristatin F (MMAF), auristatin PYE, and auristatin E (AE) (see, *e.g.*, U.S. Pat. No. 7,662,387 and U.S. Pat. Application Publication Nos. 2008/0300192 and 2008/0025989, each of which is incorporated herein by reference). In certain embodiments, a therapeutic moiety or drug moiety is a microtubule-disrupting agent such as maytansine or a derivative thereof, *e.g.*, maytansinoid DM1 or DM4 (see, *e.g.*, U.S. Pat. Nos. 7,851,432, 7,575,748, and 5,416,064, each of which is incorporated herein by reference). In certain embodiments, a therapeutic moiety or drug moiety is a prodrug, *e.g.*, a prodrug of a CC-1065 (rachelmycin) analogue (see, *e.g.*, U.S. Patent Application Publication No. 2008/0279868, and PCT International Patent Application Publication Nos. WO 2009/017394, WO 2010/062171, and WO 2007/089149, each of which is incorporated herein by reference). In one embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that binds a D4 region of human KIT with an affinity of less than about 200 pM. In another embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that inhibits a biological activity of KIT. In a

specific embodiment, an antibody (*e.g.*, human or humanized antibody) that is conjugated to such therapeutic/drug moiety is one that comprises the CDRs set forth in Table 1 (*e.g.*, VL CDR1, VL CDR2, and VL CDR3 having the amino acid sequence of SEQ ID NO: 19, 20, and 21, respectively, and/or a VH chain region comprising VH CDR1, VH CDR2, and VH CDR3 having the amino acid sequence of SEQ ID NO: 16, 17, and 18, respectively), or Table 2, or Table 3. In a specific embodiment, an antibody (*e.g.*, human or humanized antibody) that is conjugated to such therapeutic/drug moiety is one that comprises a VL comprising SEQ ID NO: 7, 8, 9, 10, or 12 or a sequence set forth in Tables 5B and 5D, and/or VH comprising SEQ ID NO: 2, 3, 4, 5, 6, or 11 or a sequence set forth in Tables 5A and 5C.

[00337] In a specific embodiment, the antibody and therapeutic/drug agent are conjugated by way of one or more linkers. In another specific embodiment, the antibody and therapeutic/drug agent are conjugated directly.

[00338] In specific embodiments, non-limiting examples of therapeutic moieties or drug moieties for conjugation to an antibody described herein include calicheamicins (*e.g.*, LL-E33288 complex, for example, gamma-calicheamicin, see, *e.g.*, U.S. Patent No. 4,970,198) and derivatives thereof (*e.g.*, gamma calichcamicin hydrazide derivatives), ozogamicins, duocarmycins and derivatives thereof (*e.g.*, CC-1065 (NSC 298223), or an achiral analogue of duocarmycin (for example AS-1-145 or centanamycin)), taxanes and derivatives thereof, and enediynes and derivatives thereof (See, *e.g.*, PCT International Patent Application Publication Nos. WO 2009/017394, WO 2010/062171, WO 2007/089149, WO 2011/021146, WO 2008/150261, WO 2006/031653, WO 2005/089809, WO 2005/089807, and WO 2005/089808, each of which is incorporated by reference herein in its entirety). In a specific embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that comprises the CDRs set forth in Table 1 (*e.g.*, VL CDR1, VL CDR2, and VL CDR3 having the amino acid sequence of SEQ ID NO: 20, 21, and 22, respectively, and/or a VH chain region comprising VH CDR1, VH CDR2, and VH CDR3 having the amino acid sequence of SEQ ID NO: 23, 24, and 25, respectively). In a specific embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that comprises a VL comprising SEQ ID NO: 7, 8, 9, 10, or 12 or a sequence set forth in Tables 5B and 5D, and/or VH comprising SEQ ID NO: 2, 3, 4, 5, 6, or 11 or a sequence set forth in Tables 5A and 5C. In a specific embodiment, the antibody and therapeutic agent are conjugated by way of one or

more linkers. In another specific embodiment, the antibody and therapeutic agent are conjugated directly.

[00339] Non-limiting examples of calicheamicins suitable for conjugation to an antibody described herein are disclosed, for example, in U.S. Patent Nos. 4,671,958; 5,053,394; 5,037,651; 5,079,233; and 5,108,912; and PCT International Patent Application Publication Nos. WO 2011/021146, WO 2008/150261, WO 2006/031653, WO 2005/089809, WO 2005/089807, and WO 2005/089808; each of which is incorporated herein by reference for such calicheamcin disclosure. In particular embodiments, these compounds may contain a methyltrisulfide that reacts with appropriate thiols to form disulfides, and at the same time introduces a functional group such as a hydrazide or other functional group that may be useful for conjugating calicheamicin to an antibody described herein. In certain embodiments, stabilizing the disulfide bond that is present in calicheamicin conjugates by adding dimethyl substituents may yield an improved antibody/drug conjugate. In specific embodiments, the calicheamicin derivative is N-acetyl gamma calicheamicin dimethyl hydrazide, or NAc-gamma DMH (CL-184,538), as one of the optimized derivatives for conjugation. Disulfide analogs of calicheamicin which can be conjugated to an antibody described herein are described, for example, in U.S. Patent Nos. 5,606,040 and 5,770,710, each of which is incorporated herein by reference for such compound disclosure. In a certain embodiment, a moiety (*e.g.*, calicheamicin or a derivative thereof) is conjugated to an antibody by a linker. In a particular embodiment, a moiety (*e.g.*, calicheamicin or a derivative thereof) is hydrolyzed from the antibody-drug conjugate at the linker. In one embodiment, a moiety (*e.g.*, calicheamicin or a derivative thereof) is hydrolyzed from an antibody conjugate at the linker between about a pH of 3.0 and pH 4.0 for 1-24 hours at a temperature from 20 to 50°C, preferably 37 °C.

[00340] In specific embodiments, non-limiting examples of therapeutic moieties or drug moieties for conjugation to an antibody described herein include pyrrolobenzodiazepines (PBDs) and derivatives thereof, for example, PBD dimers (*e.g.*, SJG-136 or SG2000), C2-unsaturated PBD dimers, pyrrolobenzodiazepine dimers bearing C2 aryl substitutions (*e.g.*, SG2285), PBD dimer pro-drug that is activated by hydrolysis (*e.g.*, SG2285), and polypyrrole-PBD (*e.g.*, SG2274) (see, *e.g.*, PCT International Patent Application Publication Nos. WO 2000/012507, WO 2007/039752, WO 2005/110423, WO 2005/085251, and WO 2005/040170, and U.S. Patent No. 7,612,062, each of which is incorporated herein by reference for such compound disclosure). In a

specific embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that comprises the CDRs set forth in Table 1 (*e.g.*, VL CDR1, VL CDR2, and VL CDR3 having the amino acid sequence of SEQ ID NO: 19, 20, and 21, respectively, and/or a VH chain region comprising VH CDR1, VH CDR2, and VH CDR3 having the amino acid sequence of SEQ ID NO: 16, 17, and 18, respectively), or Table 2, or Table 3. In a specific embodiment, an antibody that is conjugated to such therapeutic/drug moiety is one that comprises a VL comprising SEQ ID NO: 7, 8, 9, 10, or 12 or a sequence set forth in Tables 5B and 5D, and/or VH comprising SEQ ID NO: 2, 3, 4, 5, 6, or 11 or a sequence set forth in Tables 5A and 5C. In a specific embodiment, the antibody and therapeutic agent is conjugated by way of one or more linkers.

[00341] Further, an antibody described herein can be conjugated or recombinantly fused to a therapeutic moiety or drug moiety that modifies a given biological response. Therapeutic moieties or drug moieties are not to be construed as limited to classical chemical therapeutic agents. For example, the drug moiety can be a protein, peptide, or polypeptide possessing a desired biological activity. Such proteins can include, for example, a toxin such as abrin, ricin A, pseudomonas exotoxin, cholera toxin, or diphtheria toxin; a protein such as tumor necrosis factor, γ-interferon, α-interferon, nerve growth factor, platelet derived growth factor, tissue plasminogen activator, an apoptotic agent, *e.g.*, TNF-γ, TNF-γ, AIM I (see, International Publication No. WO 97/33899), AIM II (see, International Publication No. WO 97/34911), Fas Ligand (Takahashi *et al.*, 1994, J. Immunol., 6:1567-1574), and VEGF (see, International Publication No. WO 99/23105), an anti-angiogenic agent, *e.g.*, angiostatin, endostatin or a component of the coagulation pathway (*e.g.*, tissue factor); or, a biological response modifier such as, for example, a lymphokine (*e.g.*, interferon gamma, interleukin-1 ("IL-1"), interleukin-2 ("IL-2"), interleukin-5 ("IL-5"), interleukin-6 ("IL-6"), interleukin-7 ("IL-7"), interleukin 9 ("IL-9"), interleukin-10 ("IL-10"), interleukin-12 ("IL-12"), interleukin-15 ("IL-15"), interleukin-23 ("IL-23"), granulocyte macrophage colony stimulating factor ("GM-CSF"), and granulocyte colony stimulating factor ("G-CSF")), or a growth factor (*e.g.*, growth hormone ("GH")), or a coagulation agent (*e.g.*, calcium, vitamin K, tissue factors, such as but not limited to, Hageman factor (factor XII), high-molecular-weight kininogen (HMWK), prekallikrein (PK), coagulation proteins-factors II (prothrombin), factor V, XIIa, VIII, XIIIa, XI, XIa, IX, IXa, X, phospholipid, and fibrin monomer).

[00342] Provided herein are antibodies recombinantly fused or chemically conjugated (covalent or non-covalent conjugations) to a heterologous protein or polypeptide (or fragment thereof, preferably to a polypeptide of about 10, about 20, about 30, about 40, about 50, about 60, about 70, about 80, about 90 or about 100 amino acids) to generate fusion proteins. In particular, provided herein are fusion proteins comprising an antigen-binding fragment of an antibody described herein (*e.g.*, a Fab fragment, Fd fragment, Fv fragment, $F(ab)_2$ fragment, a VH domain, a VH CDR, a VL domain or a VL CDR) and a heterologous protein, polypeptide, or peptide. In one embodiment, the heterologous protein, polypeptide, or peptide that the antibody is fused to is useful for targeting the antibody to a particular cell type, such as a cell that expresses KIT. For example, an antibody that immunospecifically binds to a cell surface receptor expressed by a particular cell type (*e.g.*, an immune cell) can be fused or conjugated to a modified antibody described herein. In specific embodiments, the heterologous protein or polypeptide (or fragment thereof) binds to a second target (*e.g.*, a target other than KIT) (see, *e.g.*, PCT International Patent Application Publication No. WO 2009/088805 and U.S. Patent Application Publication No. US 2009/0148905).

[00343] Provided herein is a conjugated or fusion protein comprising any antibody described herein, or an antigen-binding fragment thereof, and a heterologous polypeptide (*e.g.*, a polypeptide other than KIT). In one embodiment, a conjugated or fusion protein described herein comprises an anti-KIT antibody described herein, and a heterologous polypeptide. In another embodiment, a conjugated or fusion protein provided herein comprises an antigen-binding fragment of an anti-KIT antibody described herein, and a heterologous polypeptide. In another embodiment, a conjugated or fusion protein described herein comprises a VH domain having the amino acid sequence of any one of the VH domains of an anti-KIT antibody described herein, and/or a VL domain having the amino acid sequence of any one of the VL domains of an anti-KIT antibody described herein, and a heterologous polypeptide. In another embodiment, a conjugated or fusion protein described herein comprises one or more VH CDRs having the amino acid sequence of any one of SEQ ID NO: 16, 17, and 18 (see, *e.g.*, Table 1), or the amino acid sequence of any one of the CDRs set forth in Table 2 or 3, and a heterologous polypeptide. In another embodiment, a conjugated or fusion protein comprises one or more VL CDRs having the amino acid sequence of any one of the VL CDRs of an anti-KIT antibody described herein (*e.g.*, VL CDRs in Table 1, SEQ ID NOs: 19, 20, and 21, or VL CDRs of Table 2 or Table 3), and a

heterologous polypeptide. In another embodiment, a conjugated or fusion protein described herein comprises at least one VH domain and at least one VL domain of an anti-KIT antibody described herein, and a heterologous polypeptide. In another embodiment, a conjugated or fusion protein described herein comprises at least one VH domain and at least a VL domain comprising SEQ ID NO: 7, 8, 9, 10, or 12 or a sequence set forth in Tables 5B and 5D, and/or VH domain comprising SEQ ID NO: 2, 3, 4, 5, 6, or 11 or a sequence set forth in Tables 5A and 5C, and a heterologous polypeptide. In yet another embodiment, a conjugated or fusion protein described herein comprises at least one VH CDR and at least one VL CDR of an anti-KIT antibody described herein (*e.g.*, VL CDRs and VH CDRs in Table 1 or Table 2 or Table 3), and a heterologous polypeptide.

[00344] In addition, an antibody described herein can be conjugated to therapeutic moieties such as a radioactive metal ion, such as alpha-emitters such as ^{213}Bi or macrocyclic chelators useful for conjugating radiometal ions, including but not limited to, ^{131}In, ^{131}LU, ^{131}Y, ^{131}Ho, ^{131}Sm, to polypeptides. In certain embodiments, the macrocyclic chelator is 1,4,7,10-tetraazacyclododecane-N,N',N'',N'''-tetraacetic acid (DOTA) which can be attached to the antibody via a linker molecule. Such linker molecules are commonly known in the art and described in Denardo *et al.*, 1998, Clin Cancer Res. 4(10):2483-90; Peterson *et al.*, 1999, Bioconjug. Chem. 10(4):553-7; and Zimmerman *et al.*, 1999, Nucl. Med. Biol. 26(8):943-50, each incorporated by reference in their entireties.

[00345] In certain embodiments, an antibody described herein, or an antigen-binding fragment thereof, is conjugated to one or more molecules (*e.g.*, therapeutic or drug moiety) directly or indirectly via one or more linker molecules. In particular embodiments, a linker is an enzyme-cleavable linker or a disulfide linker. In a specific embodiment, the cleavable linker is cleavable via an enzyme such an aminopeptidase, an aminoesterase, a dipeptidyl carboxy peptidase, or a protease of the blood clotting cascade. In particular embodiments, a linker comprises 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 20 amino acid residues. In certain embodiments, a linker consists of 1 to 10 amino acid residues, 1 to 15 amino acid residues, 5 to 20 amino acid residues, 10 to 25 amino acid residues, 10 to 30 amino acid residues, or 10 to 50 amino acid residues.

[00346] In certain embodiments, a moiety is conjugated to an antibody by one or more linkers. In a particular embodiment, a moiety is hydrolyzed from the antibody-drug conjugate at

the linker. In one embodiment, a moiety is hydrolyzed from the antibody conjugate at the linker between about a pH of 3.0 and pH 4.0 for about 1-24 hours, and at a temperature from about 20 to 50°C, preferably 37 °C. In a specific embodiment, a linker is stable in the blood stream but releases the conjugated moiety once it is inside the targeted cells. In certain embodiments, a moiety is conjugated to an antibody described herein via one or more triazole-containing linkers (see, *e.g.*, International Patent Application Publication No. WO 2007/018431, which is incorporated herein by reference). Non-limiting examples of linkers and spacers for incorporation into antibody-drug conjugates described herein are disclosed in PCT International Patent Application Publication Nos. WO 2007/018431, WO 2004/043493, and WO 2002/083180.

[00347] Moreover, antibodies described herein can be fused to marker sequences, such as a peptide to facilitate purification. In preferred embodiments, the marker amino acid sequence is a hexa-histidine peptide, such as the tag provided in a pQE vector (QIAGEN, Inc.), among others, many of which are commercially available. As described in Gentz *et al.*, 1989, Proc. Natl. Acad. Sci. USA 86:821-824, for instance, hexa-histidine provides for convenient purification of the fusion protein. Other peptide tags useful for purification include, but are not limited to, the hemagglutinin ("HA") tag, which corresponds to an epitope derived from the influenza hemagglutinin protein (Wilson *et al.*, 1984, Cell 37:767), and the "FLAG" tag.

[00348] Methods for fusing or conjugating therapeutic moieties (including polypeptides) to antibodies are well known, see, *e.g.*, Arnon *et al.*, "Monoclonal Antibodies For Immunotargeting Of Drugs In Cancer Therapy", in Monoclonal Antibodies And Cancer Therapy, Reisfeld *et al.* (eds.), pp. 243-56 (Alan R. Liss, Inc. 1985); Hellstrom *et al.*, "Antibodies For Drug Delivery", in Controlled Drug Delivery (2nd Ed.), Robinson *et al.* (eds.), pp. 623-53 (Marcel Dekker, Inc. 1987); Thorpe, "Antibody Carriers Of Cytotoxic Agents In Cancer Therapy: A Review", in Monoclonal Antibodies 84: Biological And Clinical Applications, Pinchera *et al.* (eds.), pp. 475-506 (1985); "Analysis, Results, And Future Prospective Of The Therapeutic Use Of Radiolabeled Antibody In Cancer Therapy", in Monoclonal Antibodies For Cancer Detection And Therapy, Baldwin *et al.* (eds.), pp. 303-16 (Academic Press 1985), Thorpe *et al.*, 1982, Immunol. Rev. 62:119-58; U.S. Pat. Nos. 5,336,603, 5,622,929, 5,359,046, 5,349,053, 5,447,851, 5,723,125, 5,783,181, 5,908,626, 5,844,095, and 5,112,946; EP 307,434; EP 367,166; EP 394,827; PCT publications WO 91/06570, WO 96/04388, WO 96/22024, WO 97/34631, and WO 99/04813; Ashkenazi *et al.*, Proc. Natl. Acad. Sci. USA, 88: 10535-10539, 1991; Traunecker *et al.*, Nature,

331:84-86, 1988; Zheng *et al.*, J. Immunol., 154:5590-5600, 1995; Vil *et al.*, Proc. Natl. Acad. Sci. USA, 89:11337-11341, 1992, which are incorporated herein by reference in their entireties.

[00349] Fusion proteins can be generated, for example, through the techniques of gene-shuffling, motif-shuffling, exon-shuffling, and/or codon-shuffling (collectively referred to as "DNA shuffling"). DNA shuffling can be employed to alter the activities of antibodies described herein (*e.g.,* antibodies with higher affinities and lower dissociation rates). See, generally, U.S. Patent Nos. 5,605,793, 5,811,238, 5,830,721, 5,834,252, and 5,837,458; Patten *et al.*, 1997, Curr. Opinion Biotechnol. 8:724-33; Harayama, 1998, Trends Biotechnol. 16(2):76-82; Hansson *et al.*, 1999, J. Mol. Biol. 287:265-76; and Lorenzo and Blasco, 1998, Biotechniques 24(2):308- 313 (each of these patents and publications is hereby incorporated by reference). Antibodies, or the encoded antibodies, can be altered by being subjected to random mutagenesis by error-prone PCR, random nucleotide insertion or other methods prior to recombination. A polynucleotide encoding an antibody described herein can be recombined with one or more components, motifs, sections, parts, domains, fragments, *etc.* of one or more heterologous molecules.

[00350] An antibody described herein can also be conjugated to a second antibody to form an antibody heteroconjugate as described in U.S. Patent No. 4,676,980, which is incorporated herein by reference.

[00351] The therapeutic moiety or drug conjugated or recombinantly fused to an antibody described herein that immunospecifically binds to a KIT antigen can be chosen to achieve the desired prophylactic or therapeutic effect(s), *e.g.*, reducing tumor size or burden, reducing cancer cell growth or proliferation, or inducing death of cancer cells. In certain embodiments, the antibody is a modified antibody. A clinician or other medical personnel should consider the following when deciding on which therapeutic moiety or drug to conjugate or recombinantly fuse to an antibody described herein: the nature of the disease, the severity of the disease, and the condition of the subject.

[00352] Antibodies described herein can also be attached to solid supports, which are particularly useful for immunoassays or purification of the target antigen. Such solid supports include, but are not limited to, glass, cellulose, polyacrylamide, nylon, polystyrene, polyvinyl chloride or polypropylene.

[00353] In a certain aspect, an antibody described herein or an antigen-binding fragment thereof is an extracellular drug conjugate (ECD) comprising an antibody linked to a drug,

optionally by a linker (see, *e.g.*, PCT International Patent Application Publication No. WO 2011/031870). The drug can act outside of the cell, and thus internalization of the conjugate is not required. After an ECD binds a target cell, the drug sends a signal into the cell.

[00354] In one embodiment, the linker of the ECD is a non-cleavable linker. Examples of non-cleavable linkers include linkers that contain polyethylene glycol chains or polyethylene chains that are not acid or base sensitive (such as hydrazone containing linkers), are not sensitive to reducing or oxidizing agents (such as those containing disulfide linkages), and are not sensitive to enzymes that may be found in cells or circulatory system. Specific examples of non-cleavable linkers include SMCC linker (US Patent Application 20090202536). For illustrative purposes, examples of cleavable linkers include linkers that contain non-hindered glutathione sensitive disulfides, esters, peptide sequences sensitive to the peptidases such as cathepsin or plasmin, pH sensitive hydrazones (see Bioconjugate Chem., 2010, 21 (1), pp 5-13) and non-hindered disulfide linker SPP (US Patent Application 20090202536).

[00355] In certain aspects, an ECD comprises a drug or agent that is a cardiac glycoside, for example, proscillaridin or a sugar-enhanced proscillaridin. In one embodiment, the agent is composed from a cardiac glycoside which is void a sugar. In various embodiments, the cardiac glycoside is a compound identified in PCT Pub. No. WO 2010/017480 (PCT/US2009/053159).

5.2 Polynucleotides

[00356] In certain aspects, provided herein are polynucleotides comprising a nucleotide sequence encoding an antibody (*e.g.*, human or humanized antibody) described herein or a fragment thereof (*e.g.*, a variable light chain region and/or variable heavy chain region) that immunospecifically binds to a KIT antigen, and vectors, *e.g.*, vectors comprising such polynucleotides for recombinant expression in host cells (*e.g.*, *E. coli* and mammalian cells). Provided herein are polynucleotides comprising nucleotide sequences encoding any of the antibodies provided herein, as well as vectors comprising such polynucleotide sequences, *e.g.*, expression vectors for their efficient expression in host cells, *e.g.*, mammalian cells. Also provided herein are polynucleotides encoding KIT antigens (*e.g.*, SEQ ID NO: 14 or 15) for generating anti-KIT antibodies described herein.

[00357] As used herein, an "isolated" polynucleotide or nucleic acid molecule is one which is separated from other nucleic acid molecules which are present in the natural source (*e.g.*, in a human) of the nucleic acid molecule. Moreover, an "isolated" nucleic acid molecule, such as a

cDNA molecule, can be substantially free of other cellular material, or culture medium when produced by recombinant techniques, or substantially free of chemical precursors or other chemicals when chemically synthesized. For example, the language "substantially free" includes preparations of polynucleotide or nucleic acid molecule having less than about 15%, 10%, 5%, 2%, 1%, 0.5%, or 0.1% (in particular less than about 10%) of other material, *e.g.*, cellular material, culture medium, other nucleic acid molecules, chemical precursors and/or other chemicals. In a specific embodiment, a nucleic acid molecule(s) encoding an antibody described herein is isolated or purified.

[00358] In particular aspects, provided herein are polynucleotides comprising nucleotide sequences encoding antibodies (*e.g.*, a humanized antibody) or antigen-binding fragments thereof, which immunospecifically bind to a KIT polypeptide (*e.g.*, the D4 region of KIT, for example, human KIT) and comprises an amino acid sequence as described herein, as well as antibodies which compete with such antibodies for binding to a KIT polypeptide (*e.g.*, in a dose-dependent manner), or which binds to the same epitope as that of such antibodies.

[00359] In certain aspects, provided herein are polynucleotides comprising a nucleotide sequence encoding the light chain or heavy chain of an antibody described herein. The polynucleotides can comprise nucleotide sequences encoding a light chain comprising the VL FRs and CDRs of antibodies described herein (see, *e.g.*, Tables 1 and 5B). The polynucleotides can comprise nucleotide sequences encoding a heavy chain comprising the VH FRs and CDRs of antibodies described herein (see, *e.g.*, Tables 1 and 5A). In specific embodiments, a polynucleotide described herein encodes a VL chain region comprising the amino acid sequence of SEQ ID NO: 7, 8, 9 or 10. In specific embodiments, a polynucleotide described herein encodes a VH chain region comprising the amino acid sequence of any one of SEQ ID NOs: 2-6.

[00360] In particular embodiments, a polynucleotide described herein encodes a VL chain region, wherein the polynucleotide comprises the nucleic acid sequence of SEQ ID NO: 27, 28, 29, or 30. In particular embodiments, a polynucleotide described herein encodes a VH chain region, wherein the polynucleotide comprises the nucleic acid sequence of SEQ ID NO: 22, 23, 24, 25, or 26. In particular embodiments, a polynucleotide encodes an antibody described herein, wherein the polynucleotide comprises the nucleic acid sequence of SEQ ID NO: 28 encoding a L2 VL chain region and the nucleic acid sequence of SEQ ID NO: 24 encoding a H3 VH chain region. In particular embodiments, one or more polynucleotides comprise the nucleic acid

sequence of SEQ ID NO: 28 encoding a VL chain region and the nucleic acid sequence of SEQ ID NO: 24 encoding a VH chain region. In particular embodiments, a polynucleotide encodes an antibody described herein, wherein the polynucleotide comprises the nucleic acid sequence of SEQ ID NO: 27 encoding a L1 VL chain region and the nucleic acid sequence of SEQ ID NO: 25 encoding a H4 VH chain region. In particular embodiments, one or more polynucleotides comprise the nucleic acid sequence of SEQ ID NO: 27 encoding a VL chain region and the nucleic acid sequence of SEQ ID NO: 25 encoding a VH chain region. In particular embodiments, a polynucleotide described herein encodes a VL chain region, wherein the polynucleotide comprises a nucleic acid sequence that is at least 80%, at least 85%, at least 90%, at least 95%, or at least 98% identical to the nucleic acid sequence of SEQ ID NO: 27, 28, 29, or 30. In particular embodiments, a polynucleotide described herein encodes a VH chain region, wherein the polynucleotide comprises a nucleic acid sequence that is at least 80%, at least 85%, at least 90%, at least 95%, or at least 98% identical to the nucleic acid sequence of SEQ ID NO: 22, 23, 24, 25, or 26.

[00361] In particular embodiments, provided herein are polynucleotides comprising a nucleotide sequence encoding an anti-KIT antibody comprising a VL chain region, *e.g.*, containing FR1-CDR1-FR2-CDR2-FR3-CDR3-FR4, comprising an amino acid sequences described herein (*e.g.*, see Tables 1, 5A-5B, and 6A-6B). In specific embodiments, provided herein are polynucleotides comprising a nucleotide sequence encoding an anti-KIT antibody comprising a VH chain region, *e.g.*, containing FR1-CDR1-FR2-CDR2-FR3-CDR3-FR4, comprising an amino acid sequence described herein (*e.g.*, see Tables 1, 5A-5B, and 6A-6B).

[00362] In certain embodiments, a polynucleotide described herein comprises a nucleotide sequence encoding an antibody provided herein comprising a variable light (VL) chain region comprising an amino acid described herein (*e.g.*, see Figures 3A-3I), wherein the antibody immunospecifically binds to a KIT polypeptide, *e.g.*, a human KIT polypeptide, for example, a D4 region of KIT (*e.g.*, human KIT), for example SEQ ID NO: 15.

[00363] In certain embodiments, a polynucleotide described herein comprises a nucleotide sequence encoding an antibody provided herein comprising a variable heavy (VH) chain region comprising an amino acid sequence described herein (*e.g.*, see Figures 3A-3I), wherein the antibody immunospecifically binds to a KIT polypeptide, *e.g.*, a human KIT polypeptide, for example, a D4 region of KIT (*e.g.*, human KIT), for example SEQ ID NO: 15.

[00364] In certain aspects, a polynucleotide comprises a nucleotide sequence encoding an antibody (*e.g.*, human or humanized antibody) described herein comprising a VL chain region comprising one or more VL FRs having the amino acid sequence described herein (*e.g.*, see Tables 5B and 5D), wherein the antibody immunospecifically binds to a KIT polypeptide, *e.g.*, a human KIT polypeptide, for example, a D4 region of KIT (*e.g.*, human KIT), for example SEQ ID NO: 15. In certain aspects, a polynucleotide comprises a nucleotide sequence encoding an antibody described herein comprising a VH chain region comprising one or more VH FRs having the amino acid sequence described herein (*e.g.*, see Tables 5A and 5C), wherein the antibody immunospecifically binds to a KIT polypeptide, *e.g.*, a human KIT polypeptide, for example, a D4 region of KIT (*e.g.*, human KIT), for example SEQ ID NO: 15.

[00365] In specific embodiments, a polynucleotide provided herein comprises a nucleotide sequence encoding an antibody (*e.g.*, human or humanized antibody) described herein comprising: framework regions (*e.g.*, framework regions of the VL domain and VH domain) that are human framework regions, wherein the antibody immunospecifically binds to a KIT polypeptide, *e.g.*, a human KIT polypeptide, for example, a D4 region of KIT (*e.g.*, human KIT, for example SEQ ID NO: 15).

[00366] In specific aspects, provided herein is a polynucleotide comprising a nucleotide sequence encoding an antibody comprising a light chain and a heavy chain, *e.g.*, a separate light chain and heavy chain. With respect to the light chain, in a specific embodiment, a polynucleotide provided herein comprises a nucleotide sequence encoding a kappa light chain. In another specific embodiment, a polynucleotide provided herein comprises a nucleotide sequence encoding a lambda light chain. In yet another specific embodiment, a polynucleotide provided herein comprises a nucleotide sequence encoding an antibody described herein comprising a human kappa light chain or a human lambda light chain. In a particular embodiment, a polynucleotide provided herein comprises a nucleotide sequence encoding an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, a KIT polypeptide comprising a D4 region of KIT, for example human KIT (*e.g.*, SEQ ID NO: 15)), wherein the antibody comprises a light chain, and wherein the amino acid sequence of the VL chain region can comprise any amino acid sequence described herein (*e.g.*, SEQ ID NO: 7, 8, 9, or 10 or 12), and wherein the constant region of the light chain comprises the amino acid sequence of a human kappa light chain constant region. In a particular embodiment, the light chain comprises the amino acid sequence of SEQ ID

NO: 12. In another particular embodiment, a polynucleotide provided herein comprises a nucleotide sequence encoding an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, a KIT polypeptide comprising a KIT polypeptide comprising a D4 region of KIT, for example human KIT (*e.g.*, SEQ ID NO: 15)), and comprises a light chain, wherein the amino acid sequence of the VL chain region can comprises any amino acid sequence described herein (*e.g.*, SEQ ID NO: 7, 8, 9, or 10 or 12), and wherein the constant region of the light chain comprises the amino acid sequence of a human lambda light chain constant region. For example, human constant region sequences can be those described in U.S. Patent No. 5,693,780.

[00367] In a particular embodiment, a polynucleotide provided herein comprises a nucleotide sequence encoding an antibody described herein, which immunospecifically binds to a KIT polypeptide (*e.g.*, a KIT polypeptide comprising a KIT polypeptide comprising a D4 region of KIT, for example human KIT (*e.g.*, SEQ ID NO: 15)), wherein the antibody comprises a heavy chain, wherein the amino acid sequence of the VH chain region can comprise any amino acid sequence described herein (*e.g.*, SEQ ID NO: 2, 3, 4, 5, or 6 or 11), and wherein the constant region of the heavy chain comprises the amino acid sequence of a human gamma (γ) heavy chain constant region.

[00368] In yet another specific embodiment, a polynucleotide provided herein comprises a nucleotide sequence encoding an antibody described herein (or an antigen-binding fragment thereof), which immunospecifically binds to a KIT polypeptide (*e.g.*, a D4 region of KIT, for example human KIT), wherein the antibody comprises a VL chain region and a VH chain region comprising any amino acid sequences described herein, and wherein the constant regions comprise the amino acid sequences of the constant regions of a human IgG1 (*e.g.*, isotype a, z, or f) or human IgG4.

[00369] In a specific embodiment, provided herein are polynucleotides comprising a nucleotide sequence encoding an anti-KIT antibody, or an antigen-binding fragment or domain thereof, designated herein, *see, e.g.*, Tables 1-6B and Figures 3A-3I, for example antibody Hum1-Hum20.

[00370] Also provided herein are polynucleotides encoding an anti-KIT antibody or a fragment thereof that are optimized, *e.g.*, by codon/RNA optimization, replacement with heterologous signal sequences, and elimination of mRNA instability elements. Methods to generate optimized nucleic acids encoding an anti-KIT antibody or a fragment thereof (*e.g.*, light

chain, heavy chain, VH domain, or VL domain) for recombinant expression by introducing codon changes and/or eliminating inhibitory regions in the mRNA can be carried out by adapting the optimization methods described in, *e.g.*, U.S. Patent Nos. 5,965,726; 6,174,666; 6,291,664; 6,414,132; and 6,794,498, accordingly. For example, potential splice sites and instability elements (*e.g.*, A/T or A/U rich elements) within the RNA can be mutated without altering the amino acids encoded by the nucleic acid sequences to increase stability of the RNA for recombinant expression. The alterations utilize the degeneracy of the genetic code, *e.g.*, using an alternative codon for an identical amino acid. In some embodiments, it can be desirable to alter one or more codons to encode a conservative mutation, *e.g.*, a similar amino acid with similar chemical structure and properties and/or function as the original amino acid. Such methods can increase expression of an anti-KIT antibody or fragment thereof by at least 1 fold, 2 fold, 3 fold, 4 fold, 5 fold, 10 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold or more relative to the expression of an anti-KIT antibody encoded by polynucleotides that have not been optimized.

[00371] In certain embodiments, an optimized polynucleotide sequence encoding an anti-KIT antibody described herein or a fragment thereof (*e.g.*, VL domain and/or VH domain) can hybridize to an antisense (*e.g.*, complementary) polynucleotide of an unoptimized polynucleotide sequence encoding an anti-KIT antibody described herein or a fragment thereof (*e.g.*, VL domain and/or VH domain). In specific embodiments, an optimized nucleotide sequence encoding an anti-KIT antibody described herein or a fragment hybridizes under high stringency conditions to antisense polynucleotide of an unoptimized polynucleotide sequence encoding an anti-KIT antibody described herein or a fragment thereof. In a specific embodiment, an optimized nucleotide sequence encoding an anti-KIT antibody described herein or a fragment thereof hybridizes under high stringency, intermediate or lower stringency hybridization conditions to an antisense polynucleotide of an unoptimized nucleotide sequence encoding an anti-KIT antibody described herein or a fragment thereof. Information regarding hybridization conditions have been described, see, *e.g.*, U.S. Patent Application Publication No. US 2005/0048549 (*e.g.*, paragraphs 72-73), which is incorporated herein by reference.

[00372] In certain embodiments, an optimized polynucleotide sequence encoding a VL region of an antibody described herein is at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 98% identical to the nucleotide sequence of SEQ ID NO: 27, 28, 29, or 30. In

certain embodiments, an optimized polynucleotide sequence encoding a VH region of an antibody described herein is at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 98% identical to the nucleotide sequence of SEQ ID NO: 22, 23, 24, 25, or 26.

[00373] The polynucleotides can be obtained, and the nucleotide sequence of the polynucleotides determined, by any method known in the art. Nucleotide sequences encoding antibodies described herein, *e.g.*, antibodies described in Tables 1-6B and Figures 3A-3I, and modified versions of these antibodies can be determined using methods well known in the art, *i.e.*, nucleotide codons known to encode particular amino acids are assembled in such a way to generate a nucleic acid that encodes the antibody. Such a polynucleotide encoding the antibody can be assembled from chemically synthesized oligonucleotides (*e.g.*, as described in Kutmeier *et al.*, 1994, BioTechniques 17:242), which, briefly, involves the synthesis of overlapping oligonucleotides containing portions of the sequence encoding the antibody, annealing and ligating of those oligonucleotides, and then amplification of the ligated oligonucleotides by PCR.

[00374] Alternatively, a polynucleotide encoding an antibody described herein can be generated from nucleic acid from a suitable source (*e.g.*, a hybridoma) using methods well known in the art (*e.g.*, PCR and other molecular cloning methods). For example, PCR amplification using synthetic primers hybridizable to the 3' and 5' ends of a known sequence can be performed using genomic DNA obtained from hybridoma cells producing the antibody of interest. Such PCR amplification methods can be used to obtain nucleic acids comprising the sequence encoding the light chain and/or heavy chain of an antibody. Such PCR amplification methods can be used to obtain nucleic acids comprising the sequence encoding the variable light chain region and/or the variable heavy chain region of an antibody. The amplified nucleic acids can be cloned into vectors for expression in host cells and for further cloning, for example, to generate chimeric and humanized antibodies.

[00375] If a clone containing a nucleic acid encoding a particular antibody is not available, but the sequence of the antibody molecule is known, a nucleic acid encoding the immunoglobulin can be chemically synthesized or obtained from a suitable source (*e.g.*, an antibody cDNA library or a cDNA library generated from, or nucleic acid, preferably poly A+ RNA, isolated from, any tissue or cells expressing the antibody, such as hybridoma cells selected to express an antibody described herein) by PCR amplification using synthetic primers hybridizable to the 3' and 5' ends of the sequence or by cloning using an oligonucleotide probe specific for the particular gene

sequence to identify, *e.g.*, a cDNA clone from a cDNA library that encodes the antibody. Amplified nucleic acids generated by PCR can then be cloned into replicable cloning vectors using any method well known in the art.

[00376] DNA encoding anti-KIT antibodies described herein can 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 anti-KIT antibodies). Hybridoma cells can serve as a source of such DNA. Once isolated, the DNA can 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 (*e.g.*, CHO cells from the CHO GS System™ (Lonza)), or myeloma cells that do not otherwise produce immunoglobulin protein, to obtain the synthesis of anti-KIT antibodies in the recombinant host cells.

[00377] To generate whole antibodies, PCR primers including VH or VL nucleotide sequences, a restriction site, and a flanking sequence to protect the restriction site can be used to amplify the VH or VL sequences in scFv clones. Utilizing cloning techniques known to those of skill in the art, the PCR amplified VH domains can be cloned into vectors expressing a heavy chain constant region, *e.g.*, the human gamma 4 constant region, and the PCR amplified VL domains can be cloned into vectors expressing a light chain constant region, *e.g.*, human kappa or lambda constant regions. In certain embodiments, the vectors for expressing the VH or VL domains comprise an EF-1α promoter, a secretion signal, a cloning site for the variable domain, constant domains, and a selection marker such as neomycin. The VH and VL domains can also be cloned into one vector expressing the necessary constant regions. The heavy chain conversion vectors and light chain conversion vectors are then co-transfected into cell lines to generate stable or transient cell lines that express full-length antibodies, *e.g.*, IgG, using techniques known to those of skill in the art.

[00378] The DNA also can be modified, for example, by substituting the coding sequence for human heavy and light chain constant domains in place of the murine sequences, or by covalently joining to the immunoglobulin coding sequence all or part of the coding sequence for a non-immunoglobulin polypeptide.

[00379] Also provided are polynucleotides that hybridize under high stringency, intermediate or lower stringency hybridization conditions to polynucleotides that encode an antibody described herein. In specific embodiments, polynucleotides described herein hybridize

under high stringency, intermediate or lower stringency hybridization conditions to polynucleotides encoding a VH chain region (*e.g.*, SEQ ID NO: 2, 3, 4, 5, or 6) and/or VL chain region (*e.g.*, SEQ ID NO: 7, 8, 9, or 10) provided herein. In specific embodiments, polynucleotides described herein hybridize under high stringency or intermediate stringency hybridization conditions to polynucleotides which are complements to polynucleotides encoding a VH chain region (*e.g.*, SEQ ID NO: 3 or 5) and/or VL chain region (*e.g.*, a SEQ ID NO: 2) provided herein.

[00380] In specific embodiments, polynucleotides described herein hybridize under high stringency, intermediate or lower stringency hybridization conditions to polynucleotides which are complements to a polynucleotide comprising SEQ ID NO: 27, 28, 29, or 30 encoding a VL domain. In specific embodiments, polynucleotides described herein hybridize under high stringency or intermediate stringency hybridization conditions to polynucleotides which are complements to a polynucleotide comprising SEQ ID NO: 22, 23, 24, 25, or 26 encoding a VH domain.

[00381] Hybridization conditions have been described in the art and are known to one of skill in the art. For example, hybridization under stringent conditions can involve hybridization to filter-bound DNA in 6x sodium chloride/sodium citrate (SSC) at about 45° C followed by one or more washes in 0.2xSSC/0.1% SDS at about 50-65° C; hybridization under highly stringent conditions can involve hybridization to filter-bound nucleic acid in 6xSSC at about 45° C followed by one or more washes in 0.1xSSC/0.2% SDS at about 68° C. Hybridization under other stringent hybridization conditions are known to those of skill in the art and have been described, see, for example, Ausubel, F.M. *et al.*, eds., 1989, Current Protocols in Molecular Biology, Vol. I, Green Publishing Associates, Inc. and John Wiley & Sons, Inc., New York at pages 6.3.1-6.3.6 and 2.10.3.

5.3 Host Cells and Recombinant Expression of Antibodies

[00382] In certain aspects, provided herein are host cells recombinantly expressing the antibodies described herein (or an antigen-binding fragment thereof) and related expression vectors. Provided herein are vectors (*e.g.*, expression vectors) comprising polynucleotides comprising nucleotide sequences encoding anti-KIT antibodies or a fragment for recombinant expression in host cells, preferably in mammalian cells. Also provided herein are host cells comprising such vectors for recombinantly expressing anti-KIT antibodies described herein (*e.g.*,

human or humanized antibody). In a particular aspect, provided herein are methods for producing an antibody described herein, comprising expressing such antibody from a host cell.

[00383] Recombinant expression of an antibody described herein (*e.g.*, a full-length antibody, heavy and/or light chain of an antibody, or a single chain antibody described herein) that immunospecifically binds to a KIT antigen involves construction of an expression vector containing a polynucleotide that encodes the antibody. Once a polynucleotide encoding an antibody molecule, heavy and/or light chain of an antibody, or fragment thereof (preferably, but not necessarily, containing the heavy and/or light chain variable domain) described herein has been obtained, the vector for the production of the antibody molecule can be produced by recombinant DNA technology using techniques well-known in the art. Thus, methods for preparing a protein by expressing a polynucleotide containing an antibody encoding nucleotide sequence are described herein. Methods which are well known to those skilled in the art can be used to construct expression vectors containing antibody coding sequences and appropriate transcriptional and translational control signals. These methods include, for example, *in vitro* recombinant DNA techniques, synthetic techniques, and *in vivo* genetic recombination. Also provided are replicable vectors comprising a nucleotide sequence encoding an antibody molecule described herein, a heavy or light chain of an antibody, a heavy or light chain variable domain of an antibody or a fragment thereof, or a heavy or light chain CDR, operably linked to a promoter. Such vectors can, for example, include the nucleotide sequence encoding the constant region of the antibody molecule (see, *e.g.*, International Publication Nos. WO 86/05807 and WO 89/01036; and U.S. Patent No. 5,122,464) and the variable domain of the antibody can be cloned into such a vector for expression of the entire heavy, the entire light chain, or both the entire heavy and light chains.

[00384] An expression vector can be transferred to a cell (*e.g.*, host cell) by conventional techniques and the resulting cells can then be cultured by conventional techniques to produce an antibody described herein or a fragment thereof. Thus, provided herein are host cells containing a polynucleotide encoding an antibody described herein or fragments thereof, or a heavy or light chain thereof, or fragment thereof, or a single chain antibody described herein, operably linked to a promoter for expression of such sequences in the host cell. In certain embodiments, for the expression of double-chained antibodies, vectors encoding both the heavy and light chains, individually, can be co-expressed in the host cell for expression of the entire immunoglobulin

molecule, as detailed below. In certain embodiments, a host cell contains a vector comprising a polynucleotide encoding both the heavy chain and light chain of an antibody described herein, or a fragment thereof. In specific embodiments, a host cell contains two different vectors, a first vector comprising a polynucleotide encoding a heavy chain of an antibody described herein, or a fragment thereof, and a second vector comprising a polynucleotide encoding a light chain of an antibody described herein, or a fragment thereof. In other embodiments, a first host cell comprises a first vector comprising a polynucleotide encoding a heavy chain of an antibody described herein, or a fragment thereof, and a second host cell comprises a second vector comprising a polynucleotide encoding a light chain of an antibody described herein.

[00385] A variety of host-expression vector systems can be utilized to express antibody molecules described herein (see, *e.g.,* U.S. Patent No. 5,807,715). Such host-expression systems represent vehicles by which the coding sequences of interest can be produced and subsequently purified, but also represent cells which can, when transformed or transfected with the appropriate nucleotide coding sequences, express an antibody molecule described herein *in situ.* These include but are not limited to microorganisms such as bacteria (*e.g., E. coli* and *B. subtilis*) transformed with recombinant bacteriophage DNA, plasmid DNA or cosmid DNA expression vectors containing antibody coding sequences; yeast (*e.g., Saccharomyces Pichia*) transformed with recombinant yeast expression vectors containing antibody coding sequences; insect cell systems infected with recombinant virus expression vectors (*e.g.,* baculovirus) containing antibody coding sequences; plant cell systems (*e.g.,*green algae such as *Chlamydomonas reinhardtii*) infected with recombinant virus expression vectors (*e.g.,* cauliflower mosaic virus, CaMV; tobacco mosaic virus, TMV) or transformed with recombinant plasmid expression vectors (*e.g.,* Ti plasmid) containing antibody coding sequences; or mammalian cell systems (*e.g.,* COS, CHO, BHK, MDCK, HEK 293, NS0, PER.C6, VERO, CRL7O3O, HsS78Bst, HeLa, and NIH 3T3 cells) harboring recombinant expression constructs containing promoters derived from the genome of mammalian cells (*e.g.,* metallothionein promoter) or from mammalian viruses (*e.g.,* the adenovirus late promoter; the vaccinia virus 7.5K promoter). In a specific embodiment, cells for expressing antibodies described herein (*e.g.*, Hum1-Hum20) or an antigen-binding fragment thereof are CHO cells, for example CHO cells from the CHO GS System™ (Lonza). In a specific embodiment, a mammalian expression vector is pOptiVEC™ or pcDNA3.3. Preferably, bacterial cells such as *Escherichia coli*, and more preferably, eukaryotic cells, especially for the expression of whole

recombinant antibody molecule, are used for the expression of a recombinant antibody molecule. For example, mammalian cells such as Chinese hamster ovary (CHO) cells, in conjunction with a vector such as the major intermediate early gene promoter element from human cytomegalovirus is an effective expression system for antibodies (Foecking *et al.*, 1986, Gene 45:101; and Cockett *et al.*, 1990, Bio/Technology 8:2). In certain embodiments, antibodies described herein are produced by CHO cells or NS0 cells. In a specific embodiment, the expression of nucleotide sequences encoding antibodies described herein which immunospecifically bind to a KIT antigen is regulated by a constitutive promoter, inducible promoter or tissue specific promoter.

[00386] In bacterial systems, a number of expression vectors can be advantageously selected depending upon the use intended for the antibody molecule being expressed. For example, when a large quantity of such an antibody is to be produced, for the generation of pharmaceutical compositions of an antibody molecule, vectors which direct the expression of high levels of fusion protein products that are readily purified can be desirable. Such vectors include, but are not limited to, the *E. coli* expression vector pUR278 (Ruther *et al.*, 1983, EMBO 12:1791), in which the antibody coding sequence can be ligated individually into the vector in frame with the lac Z coding region so that a fusion protein is produced; pIN vectors (Inouye & Inouye, 1985, Nucleic Acids Res. 13:3101-3109; Van Heeke & Schuster, 1989, J. Biol. Chem. 24:5503-5509); and the like. pGEX vectors can also be used to express foreign polypeptides as fusion proteins with glutathione 5-transferase (GST). In general, such fusion proteins are soluble and can easily be purified from lysed cells by adsorption and binding to matrix glutathione agarose beads followed by elution in the presence of free glutathione. The pGEX vectors are designed to include thrombin or factor Xa protease cleavage sites so that the cloned target gene product can be released from the GST moiety.

[00387] In an insect system, *Autographa californica* nuclear polyhedrosis virus (AcNPV) is used as a vector to express foreign genes. The virus grows in *Spodoptera frugiperda* cells. The antibody coding sequence can be cloned individually into non-essential regions (for example the polyhedrin gene) of the virus and placed under control of an AcNPV promoter (for example the polyhedrin promoter).

[00388] In mammalian host cells, a number of viral-based expression systems can be utilized. In cases where an adenovirus is used as an expression vector, the antibody coding sequence of interest can be ligated to an adenovirus transcription/translation control complex, *e.g.*,

the late promoter and tripartite leader sequence. This chimeric gene can then be inserted in the adenovirus genome by *in vitro* or *in vivo* recombination. Insertion in a non-essential region of the viral genome (*e.g.*, region El or E3) will result in a recombinant virus that is viable and capable of expressing the antibody molecule in infected hosts (*e.g.*, see Logan & Shenk, 1984, Proc. Natl. Acad. Sci. USA 8 1:355-359). Specific initiation signals can also be required for efficient translation of inserted antibody coding sequences. These signals include the ATG initiation codon and adjacent sequences. Furthermore, the initiation codon must be in phase with the reading frame of the desired coding sequence to ensure translation of the entire insert. These exogenous translational control signals and initiation codons can be of a variety of origins, both natural and synthetic. The efficiency of expression can be enhanced by the inclusion of appropriate transcription enhancer elements, transcription terminators, *etc.* (see, *e.g.*, Bittner *et al.*, 1987, Methods in Enzymol. 153:51-544).

[00389] In addition, a host cell strain can be chosen which modulates the expression of the inserted sequences, or modifies and processes the gene product in the specific fashion desired. Such modifications (*e.g.*, glycosylation) and processing (*e.g.*, cleavage) of protein products can be important for the function of the protein. Different host cells have characteristic and specific mechanisms for the post-translational processing and modification of proteins and gene products. Appropriate cell lines or host systems can be chosen to ensure the correct modification and processing of the foreign protein expressed. To this end, eukaryotic host cells which possess the cellular machinery for proper processing of the primary transcript, glycosylation, and phosphorylation of the gene product can be used. Such mammalian host cells include but are not limited to CHO, VERO, BHK, Hela, COS, MDCK, HEK 293, NIH 3T3, W138, BT483, Hs578T, HTB2, BT2O and T47D, NS0 (a murine myeloma cell line that does not endogenously produce any immunoglobulin chains), CRL7O3O and HsS78Bst cells. In certain embodiments, humanized monoclonal anti-KIT antibodies described herein are produced in mammalian cells, such as CHO cells.

[00390] For long-term, high-yield production of recombinant proteins, stable expression is preferred. For example, cell lines which stably express the antibody molecule can be engineered. Rather than using expression vectors which contain viral origins of replication, host cells can be transformed with DNA controlled by appropriate expression control elements (*e.g.*, promoter, enhancer, sequences, transcription terminators, polyadenylation sites, *etc.*), and a selectable

marker. Following the introduction of the foreign DNA, engineered cells can be allowed to grow for 1-2 days in an enriched media, and then are switched to a selective media. The selectable marker in the recombinant plasmid confers resistance to the selection and allows cells to stably integrate the plasmid into their chromosomes and grow to form foci which in turn can be cloned and expanded into cell lines. This method can advantageously be used to engineer cell lines which express the antibody molecule. Such engineered cell lines can be particularly useful in screening and evaluation of compositions that interact directly or indirectly with the antibody molecule.

[00391] A number of selection systems can be used, including but not limited to, the herpes simplex virus thymidine kinase (Wigler *et al.*, 1977, Cell 11:223), hypoxanthineguanine phosphoribosyltransferase (Szybalska & Szybalski, 1992, Proc. Natl. Acad. Sci. USA 48:202), and adenine phosphoribosyltransferase (Lowy *et al.*, 1980, Cell 22:8-17) genes can be employed in tk-, hgprt- or aprt-cells, respectively. Also, antimetabolite resistance can be used as the basis of selection for the following genes: *dhfr*, which confers resistance to methotrexate (Wigler *et al.*, 1980, Natl. Acad. Sci. USA 77:357; O'Hare *et al.*, 1981, Proc. Natl. Acad. Sci. USA 78:1527); *gpt*, which confers resistance to mycophenolic acid (Mulligan & Berg, 1981, Proc. Natl. Acad. Sci. USA 78:2072); neo, which confers resistance to the aminoglycoside G-418 (Wu and Wu, 1991, Biotherapy 3:87-95; Tolstoshev, 1993, Ann. Rev. Pharmacol. Toxicol. 32:573-596; Mulligan, 1993, Science 260:926-932; and Morgan and Anderson, 1993, Ann. Rev. Biochem. 62:191-217; May, 1993, TIB TECH 11(5):155-2 15); and *hygro*, which confers resistance to hygromycin (Santerre *et al.*, 1984, Gene 30:147). Methods commonly known in the art of recombinant DNA technology can be routinely applied to select the desired recombinant clone, and such methods are described, for example, in Ausubel *et al.* (eds.), Current Protocols in Molecular Biology, John Wiley & Sons, NY (1993); Kriegler, Gene Transfer and Expression, A Laboratory Manual, Stockton Press, NY (1990); and in Chapters 12 and 13, Dracopoli *et al.* (eds.), Current Protocols in Human Genetics, John Wiley & Sons, NY (1994); Colberre-Garapin *et al.*, 1981, J. Mol. Biol. 150:1, which are incorporated by reference herein in their entireties.

[00392] The expression levels of an antibody molecule can be increased by vector amplification (for a review, see Bebbington and Hentschel, The use of vectors based on gene amplification for the expression of cloned genes in mammalian cells in DNA cloning, Vol. 3 (Academic Press, New York, 1987)). When a marker in the vector system expressing antibody is amplifiable, increase in the level of inhibitor present in culture of host cell will increase the

number of copies of the marker gene. Since the amplified region is associated with the antibody gene, production of the antibody will also increase (Crouse *et al.*, 1983, Mol. Cell. Biol. 3:257).

[00393] The host cell can be co-transfected with two or more expression vectors described herein, the first vector encoding a heavy chain derived polypeptide and the second vector encoding a light chain derived polypeptide. The two vectors can contain identical selectable markers which enable equal expression of heavy and light chain polypeptides. The host cells can be co-transfected with different amounts of the two or more expression vectors. For example, host cells can be transfected with any one of the following ratios of a first expression vector and a second expression vector: 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, 1:7, 1:8, 1:9, 1:10, 1:12, 1:15, 1:20, 1:25, 1:30, 1:35, 1:40, 1:45, or 1:50.

[00394] Alternatively, a single vector can be used which encodes, and is capable of expressing, both heavy and light chain polypeptides. In such situations, the light chain should be placed before the heavy chain to avoid an excess of toxic free heavy chain (Proudfoot, 1986, Nature 322:52; and Kohler, 1980, Proc. Natl. Acad. Sci. USA 77:2197-2199). The coding sequences for the heavy and light chains can comprise cDNA or genomic DNA. The expression vector can be monocistronic or multicistronic. A multicistronic nucleic acid construct can encode 2, 3, 4, 5, 6, 7, 8, 9, 10 or more, or in the range of 2-5, 5-10 or 10-20 genes/nucleotide sequences. For example, a bicistronic nucleic acid construct can comprise in the following order a promoter, a first gene (*e.g.*, heavy chain of an antibody described herein), and a second gene and (*e.g.*, light chain of an antibody described herein). In such an expression vector, the transcription of both genes can be driven by the promoter, whereas the translation of the mRNA from the first gene can be by a cap-dependent scanning mechanism and the translation of the mRNA from the second gene can be by a cap-independent mechanism, *e.g.*, by an IRES.

[00395] Once an antibody molecule described herein has been produced by recombinant expression, it can be purified by any method known in the art for purification of an immunoglobulin molecule, for example, by chromatography (*e.g.,* ion exchange, affinity, particularly by affinity for the specific antigen after Protein A, and sizing column chromatography), centrifugation, differential solubility, or by any other standard technique for the purification of proteins. Further, the antibodies described herein can be fused to heterologous polypeptide sequences described herein or otherwise known in the art to facilitate purification.

[00396] In specific embodiments, an antibody described herein is isolated or purified. Generally, an isolated antibody is one that is substantially free of other antibodies with different antigenic specificities than the isolated antibody. For example, in a particular embodiment, a preparation of an antibody described herein is substantially free of cellular material and/or chemical precursors. The language "substantially free of cellular material" includes preparations of an antibody in which the antibody is separated from cellular components of the cells from which it is isolated or recombinantly produced. Thus, an antibody that is substantially free of cellular material includes preparations of antibody having less than about 30%, 20%, 10%, 5%, 2%, 1%, 0.5%, or 0.1% (by dry weight) of heterologous protein (also referred to herein as a "contaminating protein") and/or variants of an antibody, for example, different post-translational modified forms of an antibody or other different versions of an antibody (*e.g.*, antibody fragments). When the antibody is recombinantly produced, it is also generally substantially free of culture medium, *i.e.*, culture medium represents less than about 20%, 10%, 2%, 1%, 0.5%, or 0.1% of the volume of the protein preparation. When the antibody is produced by chemical synthesis, it is generally substantially free of chemical precursors or other chemicals, *i.e.*, it is separated from chemical precursors or other chemicals which are involved in the synthesis of the protein. Accordingly, such preparations of the antibody have less than about 30%, 20%, 10%, or 5% (by dry weight) of chemical precursors or compounds other than the antibody of interest. In a specific embodiment, antibodies described herein are isolated or purified.

5.4 Methods of Producing Antibodies

[00397] Antibodies (*e.g.*, human or humanized antibodies) described herein (or an antigen-binding fragment thereof) that immunospecifically bind to a KIT antigen can be produced by any method known in the art for the synthesis of antibodies, for example, by chemical synthesis or by recombinant expression techniques. The methods described herein employs, unless otherwise indicated, conventional techniques in molecular biology, microbiology, genetic analysis, recombinant DNA, organic chemistry, biochemistry, PCR, oligonucleotide synthesis and modification, nucleic acid hybridization, and related fields within the skill of the art. These techniques are described in the references cited herein and are fully explained in the literature. See, *e.g.*,, Maniatis *et al.* (1982) Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press; Sambrook *et al.* (1989), Molecular Cloning: A Laboratory Manual, Second Edition, Cold Spring Harbor Laboratory Press; Sambrook *et al.* (2001) Molecular Cloning: A

Laboratory Manual, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY; Ausubel *et al.*, Current Protocols in Molecular Biology, John Wiley & Sons (1987 and annual updates); Current Protocols in Immunology, John Wiley & Sons (1987 and annual updates) Gait (ed.) (1984) Oligonucleotide Synthesis: A Practical Approach, IRL Press; Eckstein (ed.) (1991) Oligonucleotides and Analogues: A Practical Approach, IRL Press; Birren *et al.* (eds.) (1999) Genome Analysis: A Laboratory Manual, Cold Spring Harbor Laboratory Press.

[00398] For example, humanized antibodies can be produced using a variety of techniques known in the art, including but not limited to, CDR-grafting (European Patent No. EP 239,400; International publication No. WO 91/09967; and U.S. Patent Nos. 5,225,539, 5,530,101, and 5,585,089), veneering or resurfacing (European Patent Nos. EP 592,106 and EP 519,596; Padlan, 1991, Molecular Immunology 28(4/5):489-498; Studnicka *et al.*, 1994, Protein Engineering 7(6):805-814; and Roguska *et al.*, 1994, PNAS 91:969-973), chain shuffling (U.S. Patent No. 5,565,332), and techniques disclosed in, *e.g.,* U.S. Pat. No. 6,407,213, U.S. Pat. No. 5,766,886, WO 9317105, Tan *et al.*, J. Immunol. 169:1119 25 (2002), Caldas *et al.*, Protein Eng. 13(5):353-60 (2000), Morea *et al.*, Methods 20(3):267 79 (2000), Baca *et al.*, J. Biol. Chem. 272(16):10678-84 (1997), Roguska *et al.*, Protein Eng. 9(10):895 904 (1996), Couto *et al.*, Cancer Res. 55 (23 Supp):5973s- 5977s (1995), Couto *et al.*, Cancer Res. 55(8):1717-22 (1995), Sandhu JS, Gene 150(2):409-10 (1994), and Pedersen *et al.*, J. Mol. Biol. 235(3):959-73 (1994). *See* also U.S. Patent Pub. No. US 2005/0042664 A1 (Feb. 24, 2005), which is incorporated herein by reference.

[00399] In specific aspects, a humanized antibody is capable of binding to a predetermined antigen and which comprises a framework region having substantially the amino acid sequence of a human immunoglobulin and CDRs having substantially the amino acid sequence of a non-human immunoglobulin (*e.g.*, a murine immunoglobulin). In particular embodiments, a humanized antibody also comprises at least a portion of an immunoglobulin constant region (Fc), typically that of a human immunoglobulin. The antibody also can include the CH1, hinge, CH2, CH3, and CH4 regions of the heavy chain. A humanized antibody can be selected from any class of immunoglobulins, including IgM, IgG, IgD, IgA and IgE, and any isotype, including IgG_1, IgG_2, IgG_3 and IgG_4.

[00400] Monoclonal antibodies can be prepared using a wide variety of techniques known in the art including the use of hybridoma, recombinant, and phage display technologies, or a combination thereof. For example, monoclonal antibodies can be produced using hybridoma

techniques including those known in the art and taught, for example, in Harlow *et al.*, Antibodies: A Laboratory Manual, (Cold Spring Harbor Laboratory Press, 2nd ed. 1988); Hammerling *et al.*, in: Monoclonal Antibodies and T-Cell Hybridomas 563 681 (Elsevier, N.Y., 1981). The term "monoclonal antibody" as used herein is not limited to antibodies produced through hybridoma technology. For example, monoclonal antibodies can be produced by recombinant techonology, *e.g.*, recombinant monoclonal antibodies expressed by a host cell, such as a mammalian host cell.

[00401] Methods for producing and screening for specific antibodies using hybridoma technology are routine and well known in the art. For example, in the hybridoma method, a mouse or other appropriate host animal, such as a sheep, goat, rabbit, rat, hamster or macaque monkey, is immunized to elicit lymphocytes that produce or are capable of producing antibodies that will specifically bind to the protein (*e.g.*, D4 region of human KIT) used for immunization. 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)). Additionally, a RIMMS (repetitive immunization multiple sites) technique can be used to immunize an animal (Kilptrack *et al.*, 1997 Hybridoma 16:381-9, which is incorporated herein by reference).

[00402] Non-limiting examples of myeloma cell lines include 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, CA, USA, and SP-2 or X63-Ag8.653 cells available from the American Type Culture Collection, Rockville, MD, USA. Human myeloma and mouse-human heteromyeloma cell lines also have 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)).

[00403] Antibodies described herein include antibody fragments which recognize specific KIT antigens and can be generated by any technique known to those of skill in the art. For example, Fab and $F(ab')_2$ fragments described herein can be produced by proteolytic cleavage of immunoglobulin molecules, using enzymes such as papain (to produce Fab fragments) or pepsin (to produce $F(ab')_2$ fragments). A Fab fragment corresponds to one of the two identical arms of an antibody molecule and contains the complete light chain paired with the VH and CH1 domains of

the heavy chain. A $F(ab')_2$ fragment contains the two antigen-binding arms of an antibody molecule linked by disulfide bonds in the hinge region.

[00404] In one aspect, to generate whole antibodies, PCR primers including VH or VL nucleotide sequences, a restriction site, and a flanking sequence to protect the restriction site can be used to amplify the VH or VL sequences from a template, *e.g.*, scFv clones. Utilizing cloning techniques known to those of skill in the art, the PCR amplified VH domains can be cloned into vectors expressing a VH constant region, and the PCR amplified VL domains can be cloned into vectors expressing a VL constant region, *e.g.*, human kappa or lambda constant regions. The VH and VL domains can also be cloned into one vector expressing the necessary constant regions. The heavy chain conversion vectors and light chain conversion vectors are then co-transfected into cell lines to generate stable or transient cell lines that express full-length antibodies, *e.g.*, IgG, using techniques known to those of skill in the art.

[00405] Single domain antibodies, for example, antibodies lacking the light chains, can be produced by methods well-known in the art. See Riechmann *et al.*, 1999, J. Immunol. 231:25-38; Nuttall *et al.*, 2000, Curr. Pharm. Biotechnol. 1(3):253-263; Muylderman, 2001, J. Biotechnol. 74(4):277302; U.S. Patent No. 6,005,079; and International Publication Nos. WO 94/04678, WO 94/25591, and WO 01/44301.

[00406] In certain aspects, antibodies described herein, such as heteroconjugate antibodies, single chain antibodies, and bispecific antibodies, can be produced through recombinant technology known in the art. For example, mammalian host cells comprising vectors expressing an antibody described herein are cultured under conditions suitable for antibody production.

[00407] Further, antibodies that immunospecifically bind to a KIT antigen can, in turn, be utilized to generate anti-idiotype antibodies that "mimic" an antigen using techniques well known to those skilled in the art. (See, *e.g.*, Greenspan & Bona, 1989, FASEB J. 7(5):437-444; and Nissinoff, 1991, J. Immunol. 147(8):2429-2438).

5.5 Pharmaceutical Compositions and Kits

[00408] Provided herein are compositions, pharmaceutical compositions, and kits comprising one or more antibodies (*e.g.*, humanized antibodies) described herein, or antigen-binding fragments thereof, or conjugates thereof. In particular aspects, compositions described herein can be for *in vitro*, *in vivo*, or *ex vivo* uses. In specific embodiments, provided herein is a

pharmaceutical composition comprising an antibody (*e.g.*, a humanized antibody) described herein (or an antigen-binding fragment thereof) and a pharmaceutically acceptable carrier or excipient.

[00409] As used herein, the term "pharmaceutically acceptable" means being approved by a regulatory agency of the Federal or a state government, or listed in the U.S. Pharmacopeia, European Pharmacopeia or other generally recognized Pharmacopeia for use in animals, and more particularly in humans.

[00410] Therapeutic formulations containing one or more antibodies (*e.g.*, humanized antibodies) provided herein can be prepared for storage by mixing the antibody having the desired degree of purity with optional physiologically acceptable carriers, excipients or stabilizers (Remington's Pharmaceutical Sciences (1990) Mack Publishing Co., Easton, PA; Remington: The Science and Practice of Pharmacy, 21st ed. (2006) Lippincott Williams & Wilkins, Baltimore, MD), in the form of lyophilized formulations or aqueous solutions. Acceptable carriers, excipients, or stabilizers are nontoxic to recipients at the dosages and concentrations employed, and include buffers such as phosphate, citrate, and other organic acids; and/or non-ionic surfactants such as TWEEN™, PLURONICS™ or polyethylene glycol (PEG).

[00411] Formulations, such as those described herein, can also contain more than one active compounds (for example, molecules, *e.g.*, antibody or antibodies described herein) as necessary for the particular indication being treated. In certain embodiments, formulations comprise an antibody provided herein and one or more active compounds with complementary activities that do not adversely affect each other. Such molecules are suitably present in combination in amounts that are effective for the purpose intended. For example, an antibody described herein can be combined with one or more other therapeutic agents (*e.g.*, a tyrosine kinase inhibitor such as imatinib mesylated or sunitinib, or a histone deacetylase inhibitor such as vorinostat). Such combination therapy can be administered to the patient serially or simultaneously or in sequence.

[00412] The formulations to be used for *in vivo* administration can be sterile. This is readily accomplished by filtration through, *e.g.,* sterile filtration membranes.

[00413] In specific aspects, the pharmaceutical compositions provided herein contain therapeutically effective amounts of one or more of the antibodies (*e.g.*, humanized antibodies) provided herein, and optionally one or more additional prophylactic of therapeutic agents, in a pharmaceutically acceptable carrier. Such pharmaceutical compositions are useful in the

prevention, treatment, management or amelioration of a KIT-associated disorder or disease, such as cancer (*e.g.*, GIST) or an inflammatory bowl disease, or one or more of the symptoms thereof.

[00414] Pharmaceutical carriers suitable for administration of the antibodies provided herein include any such carriers known to those skilled in the art to be suitable for the particular mode of administration.

[00415] In addition, the antibodies described herein can be formulated as the sole pharmaceutically active ingredient in the composition or can be combined with other active ingredients (such as one or more other prophylactic or therapeutic agents).

[00416] The compositions can contain one or more antibodies provided herein. In one embodiment, the antibodies are formulated into suitable pharmaceutical preparations, such as solutions, suspensions, tablets, dispersible tablets, pills, capsules, powders, sustained release formulations or elixirs, for oral administration or in sterile solutions or suspensions for parenteral administration, as well as transdermal patch preparation and dry powder inhalers.

[00417] In the compositions, one or more antibodies provided herein (or conjugates thereof) is (are) mixed with a suitable pharmaceutical carrier. The concentrations of the antibody or antibodies in the compositions can, for example, be effective for delivery of an amount, upon administration, that treats, prevents, or ameliorates a KIT-associated disorder or disease or a symptom thereof. In particular embodiments, concentrations of an antibody-drug conjugate or antibody-drug conjugates in the compositions can, for example, be effective for delivery of an amount of a drug(s), upon administration, that treats, prevents, or ameliorates a KIT-associated disorder or disease or a symptom thereof.

[00418] In one embodiment, the compositions are formulated for single dosage administration. To formulate a composition, the weight fraction of compound is dissolved, suspended, dispersed or otherwise mixed in a selected carrier at an effective concentration such that the treated condition is relieved, prevented, or one or more symptoms are ameliorated.

[00419] In certain aspects, an antibody (*e.g.*, a humanized antibody) provided herein (or an antibody-drug conjugate thereof) is included in the pharmaceutically acceptable carrier in an effective amount sufficient to exert a therapeutically useful effect in the absence of, or with minimal or negligible, undesirable side effects on the patient treated. A therapeutically effective concentration can be determined empirically by testing the compounds in *in vitro* and *in vivo* systems using routine methods and then extrapolated therefrom for dosages for humans.

[00420] The concentration of antibody in the pharmaceutical composition will depend on, *e.g.*, the physicochemical characteristics of the antibody, the dosage schedule, and amount administered as well as other factors known to those of skill in the art. In certain aspects, the concentration of antibody-drug conjugate in the pharmaceutical composition will depend on, *e.g.*, the physicochemical characteristics of the antibody and/or the drug, the dosage schedule, and amount administered as well as other factors known to those of skill in the art.

[00421] In one embodiment, a therapeutically effective dosage produces a serum concentration of antibody of from about 0.1 ng/ml to about 50-100 μg/ml. The pharmaceutical compositions, in another embodiment, provide a dosage of from about 0.001 mg to about 2000 mg of antibody per kilogram of body weight for administration over a period of time, *e.g.*, every day, every week, every 2 weeks, or every 3 weeks. Pharmaceutical dosage unit forms can be prepared to provide from about 0.01 mg to about 2000 mg, and in one embodiment from about 10 mg to about 500 mg of the antibody and/or a combination of other optional essential ingredients per dosage unit form.

[00422] In a particular embodiment, an antibody-drug conjugate described herein is administered at an effective dosage of about 1 to 100 mg of antibody-drug conjugate per kilogram of body weight for administration over a period of time, *e.g.*, every day, every week, every 2 weeks, or every 3 weeks.

[00423] The antibody can be administered at once, or can be divided into a number of smaller doses to be administered at intervals of time. It is understood that the precise dosage and duration of treatment is a function of the disease being treated and can be determined empirically using known testing protocols or by extrapolation from *in vivo* or *in vitro* test data. It is to be noted that concentrations and dosage values can also vary with the severity of the condition to be alleviated. It is to be further understood that for any particular subject, specific dosage regimens can be adjusted over time according to the individual need and the professional judgment of the person administering or supervising the administration of the compositions, and that the concentration ranges set forth herein are exemplary only and are not intended to limit the scope or practice of the claimed compositions.

[00424] Upon mixing or addition of the antibody, the resulting mixture can be a solution, suspension, emulsion or the like. The form of the resulting mixture depends upon a number of factors, including the intended mode of administration and the solubility of the compound in the

selected carrier or vehicle. The effective concentration is sufficient for ameliorating the symptoms of the disease, disorder or condition treated and can be empirically determined.

[00425] The pharmaceutical compositions are provided for administration to humans and animals in unit dosage forms, such as sterile parenteral (*e.g.*, intravenous) solutions or suspensions containing suitable quantities of the compounds or pharmaceutically acceptable derivatives thereof. Pharmaceutical compositions are also provided for administration to humans and animals in unit dosage form, such as tablets, capsules, pills, powders, granules, and oral solutions or suspensions, and oil-water emulsions containing suitable quantities of the compounds or pharmaceutically acceptable derivatives thereof. The antibody is, in one embodiment, formulated and administered in unit-dosage forms or multiple-dosage forms. Unit-dose forms as used herein refers to physically discrete units suitable for human and animal subjects and packaged individually as is known in the art. Each unit-dose contains a predetermined quantity of the antibody sufficient to produce the desired therapeutic effect, in association with the required pharmaceutical carrier, vehicle or diluent. Examples of unit-dose forms include ampoules and syringes and individually packaged tablets or capsules. Unit-dose forms can be administered in fractions or multiples thereof. A multiple-dose form is a plurality of identical unit-dosage forms packaged in a single container to be administered in segregated unit-dose form. Examples of multiple-dose forms include vials, bottles of tablets or capsules or bottles of pints or gallons. Hence, multiple dose form is a multiple of unit-doses which are not segregated in packaging.

[00426] In certain embodiments, one or more anti-KIT antibodies described herein are in a liquid pharmaceutical formulation. Liquid pharmaceutically administrable compositions can, for example, be prepared by dissolving, dispersing, or otherwise mixing an active compound as defined above and optional pharmaceutical adjuvants in a carrier, such as, for example, water, saline, aqueous dextrose, glycerol, glycols, ethanol, and the like, to thereby form a solution or suspension. If desired, the pharmaceutical composition to be administered can also contain minor amounts of nontoxic auxiliary substances such as wetting agents, emulsifying agents, solubilizing agents, and pH buffering agents and the like.

[00427] Actual methods of preparing such dosage forms are known, or will be apparent, to those skilled in this art; for example, *see, e.g.*, Remington's Pharmaceutical Sciences (1990) Mack Publishing Co., Easton, PA; Remington: The Science and Practice of Pharmacy, 21st ed. (2006) Lippincott Williams & Wilkins, Baltimore, MD.

[00428] Dosage forms or compositions containing antibody in the range of 0.005% to 100% with the balance made up from non-toxic carrier can be prepared. Methods for preparation of these compositions are known to those skilled in the art.

[00429] Parenteral administration, in one embodiment, is characterized by injection, either subcutaneously, intramuscularly or intravenously is also contemplated herein. Injectables can be prepared in conventional forms, either as liquid solutions or suspensions, solid forms suitable for solution or suspension in liquid prior to injection, or as emulsions. The injectables, solutions and emulsions also contain one or more excipients. Suitable excipients are, for example, water, saline, dextrose, glycerol or ethanol. In addition, if desired, the pharmaceutical compositions to be administered can also contain minor amounts of non-toxic auxiliary substances such as wetting or emulsifying agents, pH buffering agents, stabilizers, solubility enhancers, and other such agents. Other routes of administration may include, enteric administration, intracerebral administration, nasal administration, intraarterial administration, intracardiac administration, intraosseous infusion, intrathecal administration, and intraperitoneal administration.

[00430] Preparations for parenteral administration include sterile solutions ready for injection, sterile dry soluble products, such as lyophilized powders, ready to be combined with a solvent just prior to use, including hypodermic tablets, sterile suspensions ready for injection, sterile dry insoluble products ready to be combined with a vehicle just prior to use and sterile emulsions. The solutions can be either aqueous or nonaqueous.

[00431] If administered intravenously, suitable carriers include physiological saline or phosphate buffered saline (PBS), and solutions containing thickening and solubilizing agents, such as glucose, polyethylene glycol, and polypropylene glycol and mixtures thereof.

[00432] Pharmaceutically acceptable carriers used in parenteral preparations include aqueous vehicles, nonaqueous vehicles, antimicrobial agents, isotonic agents, buffers, antioxidants, local anesthetics, suspending and dispersing agents, emulsifying agents, sequestering or chelating agents and other pharmaceutically acceptable substances.

[00433] Pharmaceutical carriers also include ethyl alcohol, polyethylene glycol and propylene glycol for water miscible vehicles; and sodium hydroxide, hydrochloric acid, citric acid or lactic acid for pH adjustment.

[00434] Illustratively, intravenous or intraarterial infusion of a sterile aqueous solution containing an active compound is an effective mode of administration. Another embodiment is a

sterile aqueous or oily solution or suspension containing an active material injected as necessary to produce the desired pharmacological effect.

[00435] The antibody can be suspended in micronized or other suitable form. The form of the resulting mixture depends upon a number of factors, including the intended mode of administration and the solubility of the compound in the selected carrier or vehicle. The effective concentration is sufficient for ameliorating the symptoms of the condition and can be empirically determined.

[00436] In other embodiments, the pharmaceutical formulations are lyophilized powders, which can be reconstituted for administration as solutions, emulsions and other mixtures. They can also be reconstituted and formulated as solids or gels.

[00437] The lyophilized powder is prepared by dissolving a antibody provided herein, in a suitable solvent. In some embodiments, the lyophilized powder is sterile. The solvent can contain an excipient which improves the stability or other pharmacological component of the powder or reconstituted solution, prepared from the powder. Excipients that can be used include, but are not limited to, dextrose, sorbital, fructose, corn syrup, xylitol, glycerin, glucose, sucrose or other suitable agent. The solvent can also contain a buffer, such as citrate, sodium or potassium phosphate or other such buffer known to those of skill in the art at, in one embodiment, about neutral pH. Subsequent sterile filtration of the solution followed by lyophilization under standard conditions known to those of skill in the art provides the desired formulation. In one embodiment, the resulting solution will be apportioned into vials for lyophilization. Each vial will contain a single dosage or multiple dosages of the compound. The lyophilized powder can be stored under appropriate conditions, such as at about 4 °C to room temperature.

[00438] Reconstitution of this lyophilized powder with water for injection provides a formulation for use in parenteral administration. For reconstitution, the lyophilized powder is added to sterile water or other suitable carrier. The precise amount depends upon the selected compound. Such amount can be empirically determined.

[00439] Antibodies provided herein can be formulated for local or topical application, such as for topical application to the skin and mucous membranes, such as in the eye, in the form of gels, creams, and lotions and for application to the eye or for intracisternal or intraspinal application. Topical administration is contemplated for transdermal delivery and also for administration to the eyes or mucosa, or for inhalation therapies. Nasal solutions of the active

compound alone or in combination with other pharmaceutically acceptable excipients can also be administered.

[00440] The antibodies and other compositions provided herein can also be formulated to be targeted to a particular tissue, receptor, or other area of the body of the subject to be treated. Many such targeting methods are well known to those of skill in the art. All such targeting methods are contemplated herein for use in the instant compositions. For non-limiting examples of targeting methods, see, *e.g.,* U.S. Patent Nos. 6,316,652, 6,274,552, 6,271,359, 6,253,872, 6,139,865, 6,131,570, 6,120,751, 6,071,495, 6,060,082, 6,048,736, 6,039,975, 6,004,534, 5,985,307, 5,972,366, 5,900,252, 5,840,674, 5,759,542 and 5,709,874. In some embodiments, the anti-KIT antibodies described herein are targeted (or otherwise administered) to the bone marrow, such as in a patient having or at risk of having leukemia. In some embodiments, anti-KIT antibodies described herein are targeted (or otherwise administered) to the gastrointestinal tract, such as in a patient having or at risk of having gastrointestinal stromal tumors. In some embodiments, anti-KIT antibodies described herein are targeted (or otherwise administered) to the lungs, such as in a patient having or at risk of lung cancer (*e.g.*, small cell lung cancer). In some embodiments, anti-KIT antibodies described herein are targeted (or otherwise administered) to the brain, such as in a patient having or at risk of having neuroblastoma. In specific embodiments, an anti-KIT antibody described herein is capable of crossing the blood-brain barrier.

[00441] Provided herein is a pharmaceutical pack or kit comprising one or more containers filled with one or more of the ingredients of the pharmaceutical compositions described herein, such as one or more antibodies provided herein. Optionally associated with such container(s) can be a notice in the form prescribed by a governmental agency regulating the manufacture, use or sale of pharmaceuticals or biological products, which notice reflects approval by the agency of manufacture, use or sale for human administration.

[00442] Also provided herein are kits that can be used in the above methods. In one embodiment, a kit comprises an antibody described herein, preferably a purified antibody, in one or more containers. In a specific embodiment, the kits described herein contain a substantially isolated KIT antigen as a control. In another specific embodiment, the kits described herein further comprise a control antibody which does not react with the KIT antigen. In another specific embodiment, the kits described herein contain one or more elements for detecting the binding of a modified antibody to a KIT antigen (*e.g.,* the antibody can be conjugated to a detectable substrate

such as a fluorescent compound, an enzymatic substrate, a radioactive compound or a luminescent compound, or a second antibody which recognizes the first antibody can be conjugated to a detectable substrate). In specific embodiments, the kit can include a recombinantly produced or chemically synthesized KIT antigen. The KIT antigen provided in the kit can also be attached to a solid support. In a more specific embodiment the detecting means of the above described kit includes a solid support to which KIT antigen is attached. Such a kit can also include a non-attached reporter-labeled anti-human antibody. In this embodiment, binding of the antibody to the KIT antigen can be detected by binding of the said reporter-labeled antibody.

5.6 Methods

[00443] Provided herein are methods for impeding, preventing, treating and/or managing a KIT-associated disorder or disease (*e.g.*, cancer). Such methods comprise administering to a subject in need thereof a therapeutically effective amount of an anti-KIT antibody described herein (*e.g.*, humanized antibodies, and antigen-binding fragments thereof, or conjugates thereof). In certain aspects, also provided herein are methods for preventing, impeding, treating or managing one or more symptoms of a KIT-associated disorder or disease.

[00444] As used herein, "administer" or "administration" refers to the act of injecting or otherwise physically delivering a substance (*e.g.*, a humanized anti-KIT antibody provided herein or an antigen-binding fragment thereof or a conjugate thereof) to a subject or a patient (*e.g.*, human) , such as by mucosal, topical, intradermal, intravenous, intramuscular delivery and/or any other method of physical delivery described herein or known in the art.

[00445] As used herein, the terms "effective amount" or "therapeutically effective amount" refer to an amount of a therapy (*e.g.*, a humanized antibody or pharmaceutical composition provided herein) which is sufficient to reduce and/or ameliorate the severity and/or duration of a given disease and/or a symptom related thereto. These terms also encompass an amount necessary for the reduction or amelioration of the advancement or progression of a given disease, reduction or amelioration of the recurrence, development or onset of a given disease, and/or to improve or enhance the prophylactic or therapeutic effect(s) of another therapy (*e.g.*, a therapy other than an anti-KIT antibody provided herein). In some embodiments, "effective amount" as used herein also refers to the amount of an antibody described herein to achieve a specified result (*e.g.*, inhibition (*e.g.*, partial inhibition) of a KIT biological activity of a cell, such

as inhibition of cell proliferation or cell survival, or enhancement or induction of apoptosis or cell differentiation).

[00446] As used herein, the term "in combination" in the context of the administration of other therapies refers to the use of more than one therapy. The use of the term "in combination" does not restrict the order in which therapies are administered. The therapies may be administered, *e.g.*, serially, sequentially, concurrently, or concomitantly.

[00447] As used herein, the terms "manage," "managing," and "management" refer to the beneficial effects that a subject derives from a therapy (*e.g.,* a prophylactic or therapeutic agent), which does not result in a cure of a KIT-associated disease or disorder. In certain embodiments, a subject is administered one or more therapies (*e.g.,* prophylactic or therapeutic agents, such as an antibody described herein) to "manage" a KIT-associated disease (*e.g.,* cancer, inflammatory condition, or fibrosis), one or more symptoms thereof, so as to prevent the progression or worsening of the disease.

[00448] As used herein, the terms "impede" or "impeding" in the context of a KIT-associated disorder or disease refer to the total or partial inhibition (*e.g.*, less than 100%, 95%, 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20%, 10%, or 5%) or blockage of the development, recurrence, onset or spread of a KIT-associated disease and/or symptom related thereto, resulting from the administration of a therapy or combination of therapies provided herein (*e.g.,* a combination of prophylactic or therapeutic agents, such as an antibody described herein).

[00449] As used herein, the term "prophylactic agent" refers to any agent that can totally or partially inhibit the development, recurrence, onset or spread of a KIT-associated disease and/or symptom related thereto in a subject. In certain embodiments, the term "prophylactic agent" refers to an antibody described herein. In certain other embodiments, the term "prophylactic agent" refers to an agent other than an antibody described herein. Generally, a prophylactic agent is an agent which is known to be useful to or has been or is currently being used to prevent a KIT-associated disease and/or a symptom related thereto or impede the onset, development, progression and/or severity of a KIT-associated disease and/or a symptom related thereto. In specific embodiments, the prophylactic agent is a human anti-KIT antibody, such as a humanized or a fully human anti-KIT monoclonal antibody.

[00450] As used herein, the term "side effects" encompasses unwanted and adverse effects of a therapy (*e.g.,* a prophylactic or therapeutic agent). Unwanted effects are not necessarily

adverse. An adverse effect from a therapy (*e.g.*, a prophylactic or therapeutic agent) can be harmful or uncomfortable or risky. Examples of side effects include, diarrhea, cough, gastroenteritis, wheezing, nausea, vomiting, anorexia, abdominal cramping, fever, pain, loss of body weight, dehydration, alopecia, dyspenea, insomnia, dizziness, mucositis, nerve and muscle effects, fatigue, dry mouth, and loss of appetite, rashes or swellings at the site of administration, flu-like symptoms such as fever, chills and fatigue, digestive tract problems and allergic reactions. Additional undesired effects experienced by patients are numerous and known in the art. Many are described in the Physician's Desk Reference (63rd ed., 2009).

[00451] As used herein, the terms "subject" and "patient" are used interchangeably. As used herein, a subject is preferably a mammal such as a non-primate (*e.g.*, cows, pigs, horses, cats, dogs, goats, rabbits, rats, mice, *etc.*) or a primate (*e.g.*, monkey and human), most preferably a human. In one embodiment, the subject is a mammal, preferably a human, having a KIT-associated disorder or disease. In another embodiment, the subject is a mammal, preferably a human, at risk of developing a KIT-associated disorder or disease. In another embodiment, the subject is a non-human primate. In a specific embodiment, the subject is an adult human subject at least 18 years old.

[00452] As used herein, the terms "therapies" and "therapy" can refer to any protocol(s), method(s), compositions, formulations, and/or agent(s) that can be used in the prevention, treatment, management, or amelioration of a condition or disorder or symptom thereof (*e.g.*, cancer or one or more symptoms or condition associated therewith; inflammatory condition or one or more symptoms or condition associated therewith; fibrosis or one or more symptoms or condition associated therewith). In certain embodiments, the terms "therapies" and "therapy" refer to drug therapy, adjuvant therapy, radiation, surgery, biological therapy, supportive therapy, and/or other therapies useful in treatment, management, prevention, or amelioration of a condition or disorder or one or more symptoms thereof (*e.g.*, cancer or one or more symptoms or condition associated therewith; inflammatory condition or one or more symptoms or condition associated therewith; fibrosis or one or more symptoms or condition associated therewith). In certain embodiments, the term "therapy" refers to a therapy other than an anti-KIT antibody described herein or pharmaceutical composition thereof. In specific embodiments, an "additional therapy" and "additional therapies" refer to a therapy other than a treatment using an anti-KIT antibody described herein or pharmaceutical composition. In a specific embodiment, a therapy includes the

use of an anti-KIT antibody described herein as an adjuvant therapy. For example, using an anti-KIT antibody described herein in conjunction with a drug therapy, biological therapy, surgery, and/or supportive therapy.

[00453] As used herein, the term "therapeutic agent" refers to any agent that can be used in the treatment, management or amelioration of a KIT-associated disease and/or a symptom related thereto. In certain embodiments, the term "therapeutic agent" refers to an anti-KIT antibody described herein (*e.g.*, any one of antibodies Hum1-Hum20), an antigen-binding fragment thereof, or a conjugate thereof. In certain other embodiments, the term "therapeutic agent" refers to an agent other than an antibody described herein. Preferably, a therapeutic agent is an agent which is known to be useful for, or has been or is currently being used for the treatment, management or amelioration of a KIT-associated disease or one or more symptoms related thereto. In specific embodiments, the therapeutic agent is a human anti-KIT antibody, such as a fully human anti-KIT monoclonal antibody.

[00454] As used herein, the terms "KIT-associated disorder" or "KIT-associated disease" are used interchangeably and refer to any disease that is completely or partially caused by, associated with, or is the result of, KIT expression and/or activity or lack thereof. In one aspect, a KIT-associated disorder or disease can be known to one of skill in the art or can be ascertained by one of skill in the art. In a certain embodiment, a KIT-associated disease or disorder is associated with KIT expression and/or activity. For example, KIT expression and/or activity may contribute, in combination with one or more other factors (*e.g.*, mutation or expression and/or activity of another gene), to development and/or progression of a KIT-associated disease or disorder. In a certain embodiment, a KIT-associated disease or disorder is associated with one or more mutations of KIT.

[00455] In certain embodiments, a KIT-associated disease is fibrosis or an inflammatory disorder, *e.g.*, inflammatory bowel disease (IBD), such as Crohn's disease (CD) or ulcerative colitis (UC). In other embodiments, a KIT-associated disease is cancer, such as lung cancer (*e.g.*, small cell lung cancer), leukemia, neuroblastoma, melanoma, sarcoma (*e.g.*, Ewing's sarcoma) or gastrointestinal stromal tumor (GIST).

[00456] As used herein, the terms "treat," "treatment" and "treating" refer to the reduction or amelioration of the progression, severity, and/or duration of a KIT-associated disease (*e.g.*, cancer, inflammatory disorder, or fibrosis) resulting from the administration of one or more

therapies (including, but not limited to, the administration of one or more prophylactic or therapeutic agents, such as an antibody provided herein).

[00457] In specific embodiments, methods described herein for treating a KIT-associated disorder or disease provide for the reduction or amelioration of the progression, severity, and/or duration of a KIT-associated disorder or disease (*e.g.,* cancer, inflammatory condition, or fibrosis) resulting from the administration of one or more therapies (including, but not limited to, the administration of one or more prophylactic or therapeutic agents, such as an anti-KIT antibody described herein). In further specific embodiments, methods described herein for treating a KIT-associated disorder or disease relate to reducing one or more symptoms of a KIT-associated disorder or disease. In specific embodiments, an antibody described herein, for example any one of antibodies Hum1-Hum20, *e.g.*, antibody Hum8 or Hum4 or Hum17 or Hum10, or an antigen-binding fragment thereof, or a conjugate thereof, is for use in treating or managing a KIT-associated disorder (*e.g.*, cancer). In a particular embodiment, a KIT-associated disease or disorder being treated or managed with an anti-KIT antibody described herein, or an antigen-binding fragment thereof, or a conjugate thereof, is associated with KIT expression and/or activity, *e.g.*, involves cells expressing KIT and/or exhibiting KIT activity, but is not caused by or the result of KIT expression or activity.

[00458] In a particular embodiment, provided herein is an antibody (*e.g.*, a humanized anti-KIT antibody), for example any one of antibodies Hum1-Hum20, or Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof, for use in treating or managing a KIT-associated disorder (*e.g.*, cancer), wherein the antibody comprises (i) a VL chain region having the amino acid sequence of SEQ ID NO: 7, 8, 9, or 10, and/or (ii) a VH chain region having the amino acid sequence of SEQ ID NO: 2, 3, 4, 5, or 6. In another particular embodiment, provided herein is an antibody, or an antigen-binding fragment thereof, for use in treating or managing a KIT-associated disorder (*e.g.*, cancer), wherein the antibody comprises a combination of VH domain (*e.g.*, H1-H5, SEQ ID NOs: 2-6) and VL domain (L1-L4, SEQ ID NOs: 7-10) selected from the group presented in Table 4. In a particular embodiment, provided herein is an antibody (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof, for use in treating or managing a KIT-associated disorder (*e.g.*, cancer), wherein the antibody comprises (i) a VL chain region comprising the amino acid sequence of SEQ ID NO: 12

(see, *e.g.*, Figure 4A), and/or (ii) a VH chain region comprising the consensus amino acid sequence of SEQ ID NO: 11 (see, *e.g.*, Figure 4B). In a particular embodiment, provided herein is an antibody (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof, for use in treating or managing a KIT-associated disorder (*e.g.*, cancer), wherein the antibody comprises (i) a VL chain region comprising an amino acid sequence set forth in Table 6A (*e.g.*, L1-L4 and LL1-LL62), and/or (ii) a VH chain region comprising the amino acid sequence set forth in Table 6B (*e.g.*, H1-H5 and HH1-HH256).

[00459] In a specific embodiment, the antibody used in the methods described herein is internalized by the cell to which it binds. In a particular embodiment, a conjugate is used in the methods described herein, wherein the conjugate comprises an antibody described herein (*e.g.*, a humanized anti-KIT antibody, for example Hum4 or Hum8), or a KIT-binding fragment thereof. In a specific embodiment, the conjugate comprises an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or a KIT-binding fragment thereof, linked, covalently or non-covalently, to a therapeutic agent, such as a toxin. In a certain embodiment, the conjugate used in the methods described herein is internalized into a cell to which it binds.

[00460] In certain embodiments, KIT is aberrantly (*e.g.*, highly) expressed by cells, for example, KIT is overexpressed. In particular embodiments, KIT expression (e.g., on the cell surface) is at least about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% higher than KIT expression on the surface of a control cell (*e.g.*, a cell expressing normal levels of KIT, for example, a normal, *e.g.*, human, mast cell, stem cell, brain cell, melanoblast, or ovary cell). In particular embodiments, KIT expression yields at least about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% higher cell surface KIT expression than the average KIT expression on the surface of a control cell population (*e.g.*, a cell population expressing normal levels of KIT, for example, a normal, *e.g.*, human, mast cell population, stem cell population, brain cell population, melanoblast population, or ovary cell population). In specific embodiments, such control cells can be obtained or derived from a healthy individual (*e.g.*, healthy human). In some embodiments, KIT can be aberrantly upregulated in a particular cell type, whether or not KIT is aberrantly expressed on the cell surface. In particular embodiments, KIT signaling or activity can be aberrantly upregulated in a particular cell type, whether or not KIT is aberrantly expressed on the

cell surface. In particular embodiments, KIT signaling is at least about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% higher than KIT signaling of a control cell (*e.g.*, a cell containing normal KIT signaling, for example, a mast cell, stem cell, brain cell, melanoblast, or ovary cell). In particular embodiments, KIT signaling is at least about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% higher than average KIT signaling of a control cell population (*e.g.*, a cell population exhibiting normal KIT signaling, for example, a normal, *e.g.*, human, mast cell population, stem cell population, brain cell population, melanoblast population, or ovary cell population). In certain embodiments, normal, aberrant or excessive cell signaling is caused by binding of KIT to a KIT ligand. In other embodiments, aberrant or excessive cell signaling occurs independent of binding of KIT to a KIT ligand.

[00461] In certain aspects, a KIT-associated disorder or disease can be characterized by gain-of-function KIT activity, increase in KIT activity, or overexpression of KIT. In one embodiment, a KIT-associated disorder or disease is completely or partially caused by or is the result of gain-of-function KIT activity or expression, *e.g.*, overexpression, of KIT. In certain embodiments, the gain-of-function KIT activity can occur independent of KIT ligand (*e.g.*, SCF) binding KIT receptor. In particular aspects, high or overexpression of KIT in a cell refers to an expression level which is at least about 35%, 45%, 55%, or 65% more than the expression level of a reference cell known to have normal KIT expression or KIT activity or more than the average expression level of KIT in a population of cells or samples known to have normal KIT expression or KIT activity. Expression levels of KIT can be assessed by methods described herein or known to one of skill in the art (*e.g.*, Western blotting or immunohistorychemistry). In particular embodiments, a KIT-associated disorder or disease is characterized by KIT activity which is higher than normal KIT activity and contributes to cellular transformation, neoplasia, and tumorogenesis. In particular aspects, high or increase of KIT activity in a cell refers to a KIT activity level which is at least about 35%, 45%, 55%, or 65% more than the expression level of a reference cell known to have normal KIT activity or more than the average level of KIT activity in a population of cells or samples known to have normal KIT activity. Non-limiting examples of a KIT activity includes tyrosine phosphorylation of the cytoplasmic domain of KIT, and signaling downstream of KIT, such as Stat or Akt signaling.

[00462] Non-limiting examples of disorders or KIT-associated disorders or diseases include cancers such as breast cancer, leukemia (*e.g.*, chronic myelogenous leukemia, acute

myeloid leukemia, mast cell leukemia), lung cancer (*e.g.*, small cell lung cancer), neuroblastoma, gastrointestinal stromal tumors (GIST), melanoma, colorectal cancer, sarcoma (*e.g.*, Ewing's sarcoma), and germ cell tumors (*e.g.*, seminoma). In a particular embodiment, a cancer which is treated or managed by the methods provided herein is characterized by a gain-of-function KIT mutation or overexpression of KIT.

[00463] In a specific embodiment, a method described herein is for treating cancer (*e.g.*, GIST, lung cancer, or sarcoma (*e.g.*, Ewing's sarcoma)), wherein said method comprises administering to a subject in need thereof a therapeutically effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In certain aspects, also provided herein are methods for preventing, treating or managing one or more symptoms of cancer, wherein said methods comprise administering to a subject in need thereof a therapeutically effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody), for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In a specific embodiment, an antibody for use in the methods of treating cancer described herein comprises a VL domain comprising the amino acid sequence of SEQ ID NO: 8 (L2), and/or a VH domain comprising the amino acid sequence of SEQ ID NO: 4 (H3). In a specific embodiment, an antibody for use in the methods of treating cancer described herein comprises a VL domain comprising the amino acid sequence of SEQ ID NO: 7 (L1), and/or a VH domain comprising the amino acid sequence of SEQ ID NO: 5 (H4).

[00464] In a specific embodiment, a method described herein is for treating GIST, wherein said method comprises administering to a subject in need thereof a therapeutically effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In certain aspects, also provided herein are methods for preventing, treating or managing one or more symptoms of GIST, wherein said methods comprise administering to a subject in need thereof a therapeutically effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In a specific embodiment, an antibody for use in the methods of treating GIST

described herein comprises a VL domain comprising the amino acid sequence of SEQ ID NO: 8 (L2), and/or a VH domain comprising the amino acid sequence of SEQ ID NO: 4 (H3). In a specific embodiment, an antibody for use in the methods of treating GIST described herein comprises a VL domain comprising the amino acid sequence of SEQ ID NO: 7 (L1), and/or a VH domain comprising the amino acid sequence of SEQ ID NO: 5 (H4).

[00465] In a specific embodiment, a method described herein is for treating lung cancer (*e.g.*, small cell lung carcinoma), wherein said method comprises administering to a subject in need thereof a therapeutically effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In certain aspects, also provided herein are methods for preventing, treating or managing one or more symptoms of lung cancer (*e.g.*, small cell lung carcinoma), wherein said methods comprise administering to a subject in need thereof a therapeutically effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In a specific embodiment, an antibody for use in the methods of treating lung cancer (*e.g.*, small cell lung cancer) comprises a VL domain comprising the amino acid sequence of SEQ ID NO: 8 (L2), and/or a VH domain comprising the amino acid sequence of SEQ ID NO: 4 (H3). In a specific embodiment, an antibody for use in the methods of treating lung cancer (*e.g.*, small cell lung cancer) comprises a VL domain comprising the amino acid sequence of SEQ ID NO: 7 (L1), and/or a VH domain comprising the amino acid sequence of SEQ ID NO: 5 (H4).

[00466] In a specific embodiment, a method described herein is for treating melanoma, wherein said method comprises administering to a subject in need thereof a therapeutically effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In certain aspects, also provided herein are methods for preventing, treating or managing one or more symptoms of melanoma, wherein said methods comprise administering to a subject in need thereof a therapeutically effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In a specific embodiment, an antibody for use in the

methods of treating melanoma described herein comprises a VL domain comprising the amino acid sequence of SEQ ID NO: 8 (L2), and/or a VH domain comprising the amino acid sequence of SEQ ID NO: 4 (H3). In a specific embodiment, an antibody for use in the methods of treating melanoma described herein comprises a VL domain comprising the amino acid sequence of SEQ ID NO: 7 (L1), and/or a VH domain comprising the amino acid sequence of SEQ ID NO: 5 (H4).

[00467] In specific embodiments, a cancer treated in accordance with the methods described herein can be any type of cancer which comprises cancer or tumor cells expressing cell surface KIT or a mutated form thereof, which can be confirmed by any histologically or cytologically method known to one of skill in the art.

[00468] In certain embodiments, a cancer is metastatic. In certain embodiments, a cancer is an advanced cancer which has spread outside the site or organ of origin, either by local invasion or metastasis.

[00469] In particular embodiments, a cancer is a recurrent cancer which has regrown, either at the initial site or at a distant site, after a response to initial therapy (*e.g.*, after surgery to remove the tumor and adjuvant therapy following surgery). In some embodiments, a cancer is a refractory cancer which progresses even though an anti-tumor agent, such as a chemotherapeutic agent, is being administered, or has been administered, to the cancer patient. A non-limiting example of a refractory cancer is one which is refractory to a tyrosine kinase inhibitor, such as GLEEVEC® (imatinib mesylate), SUTENT® (SU11248 or sunitinib), IRESSA™ (gefitinib), TARCEVA® (erlotinib), NEXAVAR® (sorafenib), or VOTRIENT™ (pazopanib). In some embodiments, a cancer is a refractory cancer which progresses even though radiation or chemotherapy is being administered, or has been administered, to the cancer patient.

[00470] In specific embodiments, provided herein are methods for treating a refractory cancer in a patient in need thereof comprising administering to the patient a therapeutically effective amount of an antibody described herein, wherein the refractory cancer is refractory or resistant to an anti-cancer agent such as a tyrosine kinase inhibitor (*e.g.*, GLEEVEC® (imatinib mesylate) or SUTENT® (SU11248 or Sunitinib)). Other non-limiting examples of tyrosine kinse inhibitors include 706 and AMNI07 (nilotinib). RAD00I, PKC412, gefitinib (IRESSA™), erlotinib (TARCEVA®), sorafenib (NEXAVAR®), pazopanib (VOTRIENT™), axitinib, bosutinib, cediranib (RECENTIN®), SPRYCEL® (dasatinib), lapatinib (TYKERB®), lestaurtinib, neratinib, nilotinib (TASIGNA®), semaxanib, toceranib (PALLADIA™), vandetanib (ZACTIMA ™), and

vatalanib. In certain embodiments, the refractory cancer was initially responsive to an anti-cancer agent, such as a tyrosine kinase inhibitor (*e.g.*, GLEEVEC® or SU11248 (*i.e.*, sunitinib)), but has developed resistance the anti-cancer agent. In certain embodiments, a subject has one or more mutations in KIT that confers resistance to an anti-cancer agent such as a tyrosine kinase inhibitor.

[00471] In particular embodiments, an antibody described herein is administered to a patient who has previously received, or is currently receiving, one or more anti-cancer therapies, for example, a chemotherapeutic agent, or a tyrosine kinase inhibitor (*e.g.*, GLEEVEC® (imatinib mesylate), SUTENT® (SU11248 or sunitinib), IRESSA™ (gefitinib), TARCEVA® (erlotinib), NEXAVAR® (sorafenib), or VOTRIENT™ (pazopanib)) or a histone deacetylase inhibitor (*e.g.*, vorinostat or suberoylanilide hydroxamic acid (SAHA)). In other particular embodiments, an antibody described herein is administered to a patient who is, or is suspected of being, resistant or refractory to an anti-cancer therapy, for example, a tyrosine kinase inhibitor, *e.g.*, GLEEVEC® (imatinib mesylate), SUTENT® (SU11248 or sunitinib), IRESSA™ (gefitinib), TARCEVA® (erlotinib), NEXAVAR® (sorafenib), or VOTRIENT™ (pazopanib).

[00472] In particular embodiments, an antibody described herein (*e.g.*, any one of antibodies Hum1-Hum20, or an antigen binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or a conjugate thereof) is administered to a patient who has previously received, or is currently receiving, one or more anti-cancer therapies, for example, an anti-growth factor receptor antibody (*e.g.*, anti-HER2 antibody, anti-EGFR antibody, anti-VEGFR antibody, or anti-KIT antibody), or anti-growth factor antibody (*e.g.*, anti-EGF antibody, anti-VEGF antibody). In other particular embodiments, an antibody described herein is administered to a patient who is, or is suspected of being, resistant or refractory to an anti-cancer therapy, for example, an anti-growth factor receptor antibody (*e.g.*, anti-HER2 antibody, anti-EGFR antibody, anti-VEGFR antibody, or anti-KIT antibody) or anti-growth factor antibody (*e.g.*, anti-EGF antibody, anti-VEGF antibody).

[00473] In a particular embodiment, a method described herein for treating or managing cancer in a subject in need thereof, can achieve at least one, two, three, four or more of the following effects due to administration of a therapeutically effective amount of an anti-KIT antibody described herein: (i) the reduction or amelioration of the severity of cancer (*e.g.*, leukemia, lung cancer, or gastrointestinal stromal cancer) and/or one or more symptoms associated therewith; (ii) the reduction in the duration of one or more symptoms associated with a cancer (*e.g.*, leukemia, lung cancer, or gastrointestinal stromal cancer); (iii) the prevention in the

recurrence of a tumor (*e.g.*, lung tumor or gastrointestinal stromal tumor); (iv) the regression of a cancer (*e.g.*, leukemia, lung cancer, or gastrointestinal stromal tumor) and/or one or more symptoms associated therewith; (v) the reduction in hospitalization of a subject; (vi) the reduction in hospitalization length; (vii) the increase in the survival of a subject; (viii) the inhibition of the progression of a cancer (*e.g.*, leukemia, lung cancer, or gastrointestinal stromal tumor) and/or one or more symptoms associated therewith; (ix) the enhancement or improvement of the therapeutic effect of another therapy (*e.g.*, surgery, radiation, chemotherapy, or another tyrosine kinase inhibitor); (x) a reduction or elimination in the cancer cell population (*e.g.*, leukemia cell population, lung cancer cell population, gastrointestinal stromal tumor cell population); (xi) a reduction in the growth of a tumor or neoplasm; (xii) a decrease in tumor size (*e.g.*, volume or diameter); (xiii) a reduction in the formation of a newly formed tumors; (xiv) eradication, removal, or control of primary, regional and/or metastatic cancer; (xv) ease in removal of a tumor by reducing tumor and/or edema-related vascularization prior to surgery; (xvi) a decrease in the number or size of metastases; (xvii) a reduction in mortality; (xviii) an increase in tumor-free survival rate of patients; (xvix) an increase in relapse-free survival; (xx) an increase in the number of patients in remission; (xxi) a decrease in hospitalization rate; (xxii) the size of the tumor is maintained and does not increase or increases by less than the increase of a tumor after administration of a standard therapy as measured by conventional methods available to one of skill in the art, such as computed tomography (CT) scan, magnetic resonance imaging (MRI), dynamic contrast-enhanced MRI (DCE-MRI), or a positron emission tomography (PET) scan; (xxiii) the prevention of the development or onset of one or more symptoms associated cancer; (xxiv) an increase in the length of remission in patients; (xxv) the reduction in the number of symptoms associated with cancer; (xxvi) an increase in symptom-free survival of cancer patients; (xxvii) a decrease in the concentration of one or more inflammatory mediators (*e.g.*, cytokines or interleukins) in biological specimens (*e.g.*, plasma, serum, cerebral spinal fluid, urine, or any other biofluids) of a subject with a cancer (*e.g.*, leukemia, lung cancer, or gastrointestinal stromal cancer); (xxviii) a decrease in circulating tumor cells (CTCs) in the blood of a subject with cancer (*e.g.*, leukemia, lung cancer, or gastrointestinal stromal cancer); (xxix) inhibition (*e.g.*, partial inhibition) or decrease in tumor metabolism or perfusion; and (xxx) improvement in the quality of life as assessed by methods well known in the art, *e.g.*, questionnaires.

[00474] In certain aspects, provided herein are methods for killing cancer cells in an individual, wherein said method comprises administering to an individual in need thereof an effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In certain aspects, provided herein are methods for inhibiting growth or proliferation of cancer cells in an individual, wherein said method comprises administering to an individual in need thereof an effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof. In certain embodiments, partial inhibition of growth or proliferation of cancer cells is achieved, for example, inhibition of at least about 20% to about 55% of growth or proliferation of cancer cells.

[00475] In certain aspects, provided herein are methods for reducing tumor size or load in an individual in need thereof, wherein said method comprises administering to said individual an effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum17, Hum10, Hum8 or Hum4, or an antigen-binding fragment thereof, or a conjugate thereof.

[00476] Other non-limiting examples of KIT-associated disorders or diseases include systemic mast cell disorders (*e.g.*, mastocytosis), hematologic disorders, fibrosis (*e.g.*, idiopathic pulmonary fibrosis (TPF), scleroderma, or myelofibrosis) and inflammatory conditions such as asthma, rheumatoid arthritis, inflammatory bowel disease, and allergic inflammation.

[00477] In a particular embodiment, a method described herein for treating or managing a KIT-associated disorder, *e.g.*, fibrosis or an inflammatory condition (*e.g.*, asthma, rheumatoid arthritis, inflammatory bowel disease, and allergic inflammation), in a subject in need thereof, can achieve at least one, two, three, four or more of the following effects due to administration of a therapeutically effective amount of an anti-KIT antibody described herein: (i) the reduction or amelioration of the severity of fibrosis or an inflammatory condition (*e.g.*, asthma, rheumatoid arthritis, inflammatory bowel disease, and allergic inflammation) and/or one or more symptoms associated therewith; (ii) the reduction in the duration of one or more symptoms associated with fibrosis or an inflammatory condition (*e.g.*, asthma, rheumatoid arthritis, inflammatory bowel disease, and allergic inflammation); (iii) the prevention in the recurrence of fibrosis or an

inflammatory condition (*e.g.*, asthma, rheumatoid arthritis, inflammatory bowel disease, and allergic inflammation); (iv) the reduction in hospitalization of a subject; (v) the reduction in hospitalization length; (vi) the inhibition (*e.g.*, partial inhibition) of the progression of fibrosis or an inflammatory condition (*e.g.*, asthma, rheumatoid arthritis, inflammatory bowel disease, and allergic inflammation) and/or one or more symptoms associated therewith; (vii) the enhancement or improvement of the therapeutic effect of another therapy (*e.g.*, anti-inflammatory therapy such as steriods); (viii) an increase in the number of patients in remission (*i.e.*, a time period characterized by no or minimal symptoms associated with the inflammatory condition); (ix) an increase in the length of remission in patients; (x) a decrease in hospitalization rate; (xi) the reduction in the number of symptoms associated with fibrosis or an inflammatory condition (*e.g.*, asthma, rheumatoid arthritis, inflammatory bowel disease, and allergic inflammation); (xii) a decrease in the concentration of one or more inflammatory mediators (*e.g.*, cytokines or interleukins) in biological specimens (*e.g.*, plasma, serum, cerebral spinal fluid, urine, or any other biofluids) of a subject with fibrosis or an inflammatory condition (*e.g.*, asthma, rheumatoid arthritis, inflammatory bowel disease, and allergic inflammation); and (xiii) improvement in the quality of life as assessed by methods well known in the art, *e.g.*, questionnaires.

[00478] In certain embodiments, an anti-KIT antibody described herein may be administered by any suitable method to a subject in need thereof. Non-limiting examples of administration methods include mucosal, intradermal, intravenous, intratumoral, subcutaneous, intramuscular delivery and/or any other method of physical delivery described herein or known in the art. In one embodiment, an anti-KIT antibody or a pharmaceutical composition thereof is administered systemically (*e.g.*, parenterally) to a subject in need thereof. In another embodiment, an anti-KIT antibody or a pharmaceutical composition thereof is administered locally (*e.g.*, intratumorally) to a subject in need thereof. Each dose may or may not be administered by an identical route of administration. In some embodiments, an anti-KIT antibody described herein can be administered via multiple routes of administration simultaneously or subsequently to other doses of the same or a different an anti-KIT antibody described herein.

[00479] When a disease, or a symptom thereof, is being treated, administration of the substance typically occurs after the onset of the disease or symptoms thereof. When a disease, or symptoms thereof, are being prevented, administration of the substance typically occurs before the onset of the disease or symptoms thereof. In certain embodiments, an anti-KIT antibody described

herein is administered prophylactically or therapeutically to a subject. An anti-KIT antibody described herein can be prophylactically or therapeutically administered to a subject so as to prevent, lessen or ameliorate a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis) or symptom thereof.

[00480] The dosage and frequency of administration of an anti-KIT antibody described herein or a pharmaceutical composition thereof is administered to a subject in need thereof in accordance with the methods for treating a KIT-associated disorder or disease provided herein will be efficacious while minimizing side effects. The exact dosage of an anti-KIT antibody described herein to be administered to a particular subject or a pharmaceutical composition thereof can be determined by a practitioner, in light of factors related to the subject that requires treatment. Factors which can be taken into account include the severity of the disease state, general health of the subject, age, and weight of the subject, diet, time and frequency of administration, combination(s) with other therapeutic agents or drugs, reaction sensitivities, and tolerance/response to therapy. The dosage and frequency of administration of an anti-KIT antibody described herein or a pharmaceutical composition thereof can be adjusted over time to provide sufficient levels of the anti-KIT antibody or to maintain the desired effect.

[00481] The precise dose to be employed in the formulation will also depend on the route of administration, and the seriousness of a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis), and should be decided according to the judgment of the practitioner and each patient's circumstances.

[00482] In one embodiment, for the anti-KIT antibodies described herein, the dosage administered to a patient, to manage a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis) is typically 0.1 mg/kg to 100 mg/kg of the patient's body weight. Generally, human antibodies have a longer half-life within the human body than antibodies from other species due to the immune response to the foreign polypeptides. Thus, lower dosages of human antibodies and less frequent administration is often possible. Further, the dosage and frequency of administration of the antibodies described herein can be reduced by enhancing uptake and tissue penetration of the antibodies by modifications such as, for example, lipidation.

[00483] In one embodiment, approximately 0.001 mg/kg (mg of antibody per kg weight of a subject) to approximately 500 mg/kg of an anti-KIT antibody described herein is administered to manage a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis).

[00484] In some embodiments, an effective amount of an antibody provided herein is from about 0.01 mg to about 1,000 mg. In specific embodiments, an "effective amount" of an anti-KIT antibody described herein refers to an amount of an anti-KIT antibody described herein which is sufficient to achieve at least one, two, three, four or more of the following effects: (i) the reduction or amelioration of the severity of a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis) and/or one or more symptoms associated therewith; (ii) the reduction in the duration of one or more symptoms associated with a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis); (iii) the prevention in the recurrence of a tumor (*e.g.*, gastrointestinal stromal tumor); (iv) the regression of a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis) and/or one or more symptoms associated therewith; (v) the reduction in hospitalization of a subject; (vi) the reduction in hospitalization length; (vii) the increase in the survival of a subject; (viii) the inhibition (*e.g.*, partial inhibition) of the progression of a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis) and/or one or more symptoms associated therewith; (ix) the enhancement or improvement of the therapeutic effect of another therapy; (x) a reduction or elimination in the cancer cell population (*e.g.*, leukemia cell population, lung cancer cell population, gastrointestinal stromal cancer cell population); (xi) a reduction in the growth of a tumor or neoplasm; (xii) a decrease in tumor size (*e.g.*, volume or diameter); (xiii) a reduction in the formation of a newly formed tumors; (xiv) eradication, removal, or control of primary, regional and/or metastatic cancer; (xv) ease in removal of a tumor by reducing tumor and/or edema-related vascularization prior to surgery; (xvi) a decrease in the number or size of metastases; (xvii) a reduction in mortality; (xviii) an increase in tumor-free survival rate of patients; (xvix) an increase in relapse-free survival; (xx) an increase in the number of patients in remission; (xxi) a decrease in hospitalization rate; (xxii) the size of the tumor is maintained and does not increase or increases by less than the increase of a tumor after administration of a standard therapy as measured by conventional methods available to one of skill in the art, such as computed tomography (CT) scan, magnetic resonance imaging (MRI), dynamic contrast-enhanced MRI (DCE-MRI), or a positron emission tomography (PET) scan; (xxiii) the prevention of the development or onset of one or more symptoms associated cancer; (xxiv) an increase in the length of remission in patients; (xxv) the reduction in the number of symptoms associated with cancer; (xxvi) an increase in symptom-free survival of cancer patients; (xxvii) a decrease in the concentration of one or more inflammatory mediators (*e.g.*, cytokines or

interleukins) in biological specimens (*e.g.*, plasma, serum, cerebral spinal fluid, urine, or any other biofluids) of a subject with a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis); (xxviii) a decrease in circulating tumor cells (CTCs) in the blood of a subject with cancer; (xxix) inhibition (*e.g.*, partial inhibition) or decrease in tumor metabolism or perfusion; and (xxx) improvement in the quality of life as assessed by methods well known in the art, *e.g.*, questionnaires. In some embodiments, "effective amount" as used herein also refers to the amount of an antibody described herein to achieve a specified result (*e.g.*, inhibition of one or more KIT biological activities of a cell, such as inhibition of cell proliferation).

[00485] In some embodiments, an anti-KIT antibody described herein is administered as necessary, *e.g.*, weekly, biweekly (*i.e.*, once every two weeks), monthly, bimonthly, trimonthly, *etc.*, as determined by a physician.

[00486] In some embodiments, a single dose of an anti-KIT antibody described herein is administered one or more times to a patient to impede, prevent, manage, treat and/or ameliorate a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis).

[00487] In particular embodiments, an anti-KIT antibody or pharmaceutical composition thereof is administered to a subject in accordance with the methods for treating a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis) presented herein in cycles, wherein the anti-KIT antibody or pharmaceutical composition is administered for a period of time, followed by a period of rest (*i.e.*, the anti-KIT antibody or pharmaceutical composition is not administered for a period of time).

[00488] Also, presented herein are combination therapies for the treatment of a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis) which involve the administration of an anti-KIT antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof in combination with one or more additional therapies (*e.g.*, chemotherapeutic agent, tyrosine kinase inhibitor, PGP inhibitors, HSP-90 inhibitors, proteosome inhibitors, or histone deacetylase inhibitor) to a subject in need thereof. In a specific embodiment, presented herein are combination therapies for the treatment of a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis) which involve the administration of an amount (*e.g.*, a therapeutically effective amount or a sub-optimal amount) of an anti-KIT antibody described

herein in combination with an amount (*e.g.*, a therapeutically effective amount or a sub-optimal amount) of another therapy (*e.g.*, chemotherapeutic agent, tyrosine kinase inhibitor, or histone deacetylase inhibitor) to a subject in need thereof.

[00489] In combination therapies, one or more anti-KIT antibodies provided herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof can be administered prior to, concurrently with, or subsequent to the administration of one or more additional therapies (*e.g.*, agents, surgery, or radiation) for use in treating, managing, and/or ameoliorating a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis). The use of the term "in combination" does not restrict the order in which one or more anti-KIT antibodies and one or more additional therapies are administered to a subject. In specific embodiments, the therapies can be administered serially or sequentially.

[00490] In specific embodiments, one or more anti-KIT antibodies provided herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof can be administered prior to, concurrently with, or subsequent to the administration of one or more additional therapies such as anticancer agents, for example, tyrosine kinase inhibitors (*e.g.*, imatinib myselyate (Gleevec®) or sunitinib (SUTENT), or histone deacetylase inhibitors (*e.g.*, vorinostat or suberoylanilide hydroxamic acid (SAHA)), for treating, managing, and/or ameoliorating a KIT-associated disorder or disease (*e.g.*, cancer, for example, GIST, melanoma, or lung cancer).

[00491] In another specific embodiment, presented herein are combination therapies for the treatment of a KIT-associated disorder or disease (*e.g.*, cancer, inflammatory condition, fibrosis) which involve the administration of an amount of an anti-KIT antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof in combination with an amount of another therapy (*e.g.*, chemotherapeutic agent, tyrosine kinase inhibitor, or histone deacetylase inhibitor) to a subject in need thereof. In a specific embodiment, the combination therapies result in a synergistic effect. In certain embodiments, the combination therapies result in an additive effect.

[00492] In a specific embodiment, presented herein are combination therapies for the treatment of cancer which involve the administration of an amount of an anti-KIT antibody described herein in combination with an amount of another therapy (*e.g.*, surgery, radiation, stem cell transplantation, or chemotherapy) to a subject in need thereof. In a specific embodiment, the combination therapies result in a synergistic effect. In another specific embodiment, the combination therapies result in an additive effect.

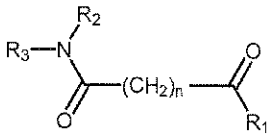
[00493] In a specific embodiment, presented herein are combination therapies for the treatment of an inflammatory condition which involve the administration of an amount of an anti-KIT antibody described herein in combination with an amount of another therapy (*e.g.*, anti-inflammatory therapy, for example, steroid therapy) to a subject in need thereof. In a specific embodiment, the combination therapies result in a synergistic effect. In another specific embodiment, the combination therapies result in an additive effect.

[00494] Non-limiting examples of another therapy for use in combination with antibodies described herein include, another anti-KIT antibody that immunospecifically binds to a different epitope of KIT, one or more other antibodies (*e.g.*, anti-HER2 antibody, anti-EGFR antibody, anti-VEGF antibody), anti-inflammatory therapy, chemotherapy (*e.g.*, microtubule disassembly blocker, antimetabolite, topisomerase inhibitor, and DNA crosslinker or damaging agent), radiation, surgery, PGP inhibitors (*e.g.*, cyclosporine A, Verapamil), HSP-90 inhibitors (*e.g.*, 17-AAG, STA-9090), proteosome inhibitors (*e.g.*, Bortezomib), and tyrosine kinase inhibitors (*e.g.*, imatinib mesylate (GLEEVEC®), sunitinib (SUTENT® or SU11248), gefitinib (IRESSA™), erlotinib (TARCEVA®), sorafenib (NEXAVAR®), pazopanib (VOTRIENT™), axitinib, bosutinib, cediranib (RECENTIN®), SPRYCEL® (dasatinib), lapatinib (TYKERB®), lestaurtinib, neratinib, nilotinib (TASIGNA®), semaxanib, toceranib (PALLADIA™), vandetanib (ZACTIMA ™), and vatalanib). In a specific embodiment, another therapy for use in combination with antibodies described herein is imatinib mesylate.

[00495] Other non-limiting examples of another therapy for use in combination with antibodies described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof include a histone deacetylase inhibitor, such as vorinostat or suberoylanilide hydroxamic acid (SAHA) or a compound having the chemical formula (I), (II), or (III) as set forth below. In a specific

embodiment, provided herein is a method for treating cancer (*e.g.*, GIST or lung cancer) comprising (i) administering an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof; and (ii) a histone deacetylase inhibitor, for example, vorinostat or suberoylanilide hydroxamic acid (SAHA) or a compound having the chemical formula (I), (II), or (III) as set forth below.

[00496] In one embodiment, provided herein for use in the methods described herein in combination with anti-KIT antibodies are compounds of Formula (I)



Formula (I)

or a pharmaceutically acceptable salt, hydrate, or solvate thereof, wherein

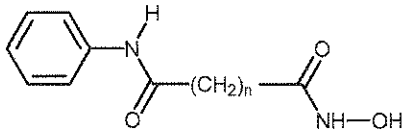
R_1 is hydroxylamino;

each of R_2 and R_3 are independently the same as or different from each other, substituted or unsubstituted, branched or unbranched, and are hydrogen, hydroxyl, alkyl, alkenyl, cycloalkyl, aryl, alkyloxy, aryloxy, arylalkyloxy or pyridine; or R_2 and R_3 are bonded together to form a piperidine; and

n is an integer from 5 to 7.

[00497] In one embodiment, R_2 is hydrogen atom and R_3 is substituted or unsubstituted phenyl. In a certain embodiment, R_3 is phenyl substituted with methyl, cyano, nitro, trifluoromethyl, amino, aminocarbonyl, methylcyano, chloro, fluoro, bromo, iodo, 2,3-difluoro, 2,4-difluoro, 2,5-difluoro, 3,4-difluoro, 3,5-difluoro, 2,6-difluoro, 1,2,3-trifluoro, 2,3,6-trifluoro, 2,4,6-trifluoro, 3,4,5-trifluoro, 2,3,5,6-tetrafluoro, 2,3,4,5,6-pentafluoro, azido, hexyl, t-butyl, phenyl, carboxyl, hydroxyl, methoxy, phenyloxy, benzyloxy, phenylaminooxy, phenylaminocarbonyl, methoxycarbonyl, methylaminocarbonyl, dimethylamino, dimethylaminocarbonyl, or hydroxylaminocarbonyl. In another embodiment, R_3 is unsubstituted phenyl. In a further embodiment, n is 6.

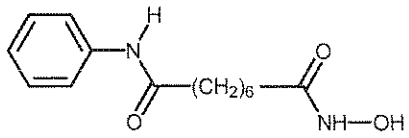
[00498] In one embodiment, provided herein for use in the methods described herein in combination with anti-KIT antibodies are compounds of Formula (II)



Formula (II)

or a pharmaceutically acceptable salt, or solvate thereof, wherein n is an integer from 5 to 8. In one embodiment n is 6.

[00499] In one embodiment, provided herein for use in the methods described herein in combination with anti-KIT antibodies is a compound of Formula (III) (SAHA)



Formula (III) (SAHA)

or a pharmaceutically acceptable salt, hydrate or solvate thereof.

[00500] Compounds of Formulae I-III can be synthesized according to the methods described in U.S. Reissued Patent No. RE38,506 and U.S. Patent No. 6,087,367, each of which is herewith incorporated by reference in its entirety.

[00501] In one embodiment, provided herein for use in the methods described herein in combination with anti-KIT antibodies is a Form I polymorph of SAHA characterized by an X-ray diffraction pattern substantially similar to that set forth in Figure 13A of U.S. Patent No. 7,456,219, which is herewith incorporated by reference in its entirety. In one embodiment the Form I polymorph of SAHA is characterized by an X-ray diffraction pattern including characteristic peaks at about 9.0, 9.4, 17.5, 19.4, 20.0, 24.0, 24.4, 24.8, 25.0, 28.0, and 43.3 degrees 2θ, as measured with a Siemens D500 Automated Powder Diffractometer (range: 4-40 degrees 2θ ; source: Cu; λ=1.54 Angstrom, 50kV, 40mA).

[00502] In a certain embodiment, the Form I polymorph of SAHA is characterized by a Differential Scanning Calorimetry (DSC) thermogram having a single maximum value at about 164.4±2.0°C, as measured by a Perkins Elmer DSC 6 Instrument at a heating rate of 10°C/min from 50°C to at least 30°C above the observed melting temperature.

[00503] The Form I polymorph of SAHA can be synthesized according to the methods described in U.S. Patent No. 7,456,219.

[00504] In one embodiment, provided herein is a crystalline composition comprising Lysine and SAHA characterized by an X-ray diffraction pattern substantially similar to that set forth in Figure 1 of International Patent Application Publication No. WO2008/042146, which is herewith incorporated by reference in its entirety. In another embodiment, the crystalline composition is characterized by an X-ray diffraction pattern including characteristic peaks at about 6.8, 20.1 and 23.2 degrees 2θ, as measured with a PANanalytical X'Pert Pro X-ray powder diffractometer (range: 2-40 degrees 2θ; source: Cu Kα1 and Kα2). In another embodiment, the crystalline composition is characterized by an X-ray diffraction pattern including characteristic peaks at about 6.8, 12.6, 18.7, 20.1 23.2, and 24.0 degrees 2θ, as measured with a PANanalytical X'Pert Pro X-ray powder diffractometer (range: 2-40 degrees 2θ; source: Cu Kα1 and Kα2). In another embodiment, the crystalline composition is characterized by an X-ray diffraction pattern including characteristic peaks at about 6.8, 12.0, 12.6, 16.4, 18.7, 20.1 23.2, 24.0, 29.3 degrees 2θ, as measured with a PANanalytical X'Pert Pro X-ray powder diffractometer (range: 2-40 degrees 2θ; source: Cu Kα1 and Kα2).

[00505] In a certain embodiment, the crystalline composition comprising Lysine and SAHA is characterized by a Differential Scanning Calorimetry (DSC) thermogram, wherein the endotherm of the crytalline composition exhibits an extrapolated onset temperature of approximately 182°C, as measured by a TA Instruments Q1000 differential scanning calorimeter at a heating rate of 10°C/min from room temperature to 300°C.

[00506] The crystalline composition comprising Lysine and SAHA can be synthesized according to the methods described in International Patent Application Publication No. WO2008/042146.

[00507] In certain embodiments, combination therapies described herein result in synergy or a synergistic effect. In a specific embodiment, a synergistic effect of a combination therapy permits the use of lower dosages (*e.g.*, sub-optimal doses) of an anti-KIT antibody described herein and/or an additional therapy and/or less frequent administration of an anti-KIT antibody described herein or an additional therapy to a subject. In certain embodiments, the ability to utilize lower dosages of an anti-KIT antibody and/or of an additional therapy and/or to administer an anti-KIT antibody or said additional therapy less frequently reduces the toxicity associated with the administration of an anti-KIT antibody or of said additional therapy, respectively, to a subject without reducing the efficacy of an anti-KIT antibody or of said additional therapy, respectively,

in the treatment of a KIT-associated disorder or disease. In some embodiments, a synergistic effect results in improved efficacy of an anti-KIT antibody described herein and/or of said additional therapies in treating a KIT-associated disorder or disease. In some embodiments, a synergistic effect of a combination of an anti-KIT antibody described herein and one or more additional therapies avoids or reduces adverse or unwanted side effects associated with the use of any single therapy.

[00508] Provided herein are methods for inhibiting KIT activity in a cell expressing KIT comprising contacting the cell with an effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof. Also provided herein are methods for inducing or enhancing apoptosis in a cell expressing KIT comprising contacting the cell with an effective amount of an antibody described herein. Also provided herein are methods for inducing or enhancing cell differentiation in a cell expressing KIT comprising contacting the cell with an effective amount of an antibody described herein.

[00509] KIT activity and, for example, the effect of an antibody on KIT activity can routinely be assessed using, *e.g.*, cell-based assays such as those described herein.

[00510] Non-limiting examples of KIT activity which can be inhibited by the methods provided herein can include any activity of KIT known or described in the art, *e.g.*, KIT receptor dimerization, KIT receptor phosphorylation (tyrosine phosphorylation), signaling downstream of the KIT receptor (*e.g.*, Stat, AKT, MAPK, or Ras signaling), KIT ligand (*e.g.*, SCF) induced transcriptional regulation (*e.g.*, SCF-induced transcriptional activation of c-Myc), induction or enhancement of cell proliferation, or cell survival.

[00511] In certain embodiments, a method for inhibiting (*e.g.*, partially inhibiting) KIT activity in a cell expressing KIT comprises contacting the cell with an effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof, sufficient to inhibit or antagonize KIT activity by at least about 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein and/or known to one of skill in the art (*e.g.*, ELISA). In certain

embodiments, a method for inhibiting (*e.g.*, partially inhibiting) KIT activity in a cell expressing KIT comprises contacting the cell with an effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof, sufficient to inhibit or antagonize KIT activity by at least about 25%, 35%, 45%, 50%, 55%, or 65%, as assessed by methods described herein and/or known to one of skill in the art (*e.g.*, ELISA). Non-limiting examples of KIT activity can include KIT receptor phosphorylation, KIT receptor signaling, KIT ligand (*e.g.*, SCF) mediated cell proliferation, KIT ligand (*e.g.*, SCF) mediated cell survival, and transcriptional activation of a KIT target gene (*e.g.*, c-Myc).

[00512] In a particular embodiment, a method for inhibiting KIT activity in a cell expressing KIT comprises contacting the cell with an effective amount of an antibody described herein (*e.g.*, a humanized anti-KIT antibody) for example, any one of antibodies Hum1-Hum20, such as Hum10, Hum17, Hum8 or Hum4, or an antigen-binding fragment thereof (*e.g.*, KIT-binding fragment thereof), or an antibody conjugate thereof, sufficient to inhibit (*e.g.*, partially inhibit) or antagonize downstream KIT signaling, for example, signaling of a member of the Src family kinases, PI3-kinases, or Ras-MAPK.

[00513] In another particular embodiment, a method for inhibiting (*e.g.*, partially inhibiting) one or more KIT activities in a cell expressing KIT, comprises contacting the cell with an effective amount of an antibody described herein sufficient to inhibit or antagonize downstream KIT signaling such as phosphorylation of MAPK, phosphorylation of AKT, or phosphorylation of Stat1, Stat3, or Stat5.

[00514] In certain embodiments, a method for inhibiting (*e.g.*, partially inhibiting) KIT activity in a cell expressing KIT comprises contacting the cell with an effective amount of an antibody described herein sufficient to inhibit or to reduce phosphorylation of AKT (*e.g.*, KIT ligand (*e.g.*, SCF) induced phosphorylation of AKT) by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art, *e.g.*, Western blot or ELISA assay as described in section 6 or immunoblotting assay. In certain embodiments, a method for inhibiting *e.g.*, partially inhibiting) KIT activity in a cell expressing KIT comprises contacting the cell with an effective amount of an antibody described herein sufficient to inhibit or

to reduce phosphorylation of AKT (*e.g.*, KIT ligand (*e.g.*, SCF) induced phosphorylation of AKT) by at least about 25%, 35%, 45%, 55%, or 65%, as assessed by methods described herein or known to one of skill in the art, *e.g.*, Western blot or ELISA assay as described in section 6 or immunoblotting assay.

[00515] In certain aspects, a method for inhibiting (*e.g.*, partially inhibiting) KIT activity in a cell (*e.g.*, cancer cell) expressing KIT comprises contacting the cell with an effective amount of an antibody described herein sufficient to inhibit proliferation of the cell. Cell proliferation assays are described in the art and can be readily carried out by one of skill in the art. For example, cell proliferation can be assayed by measuring Bromodeoxyuridine (BrdU) incorporation (see, *e.g.*, Hoshino *et al.*, 1986, Int. J. Cancer 38, 369; Campana *et al.*, 1988, J. Immunol. Meth. 107:79) or (3H) thymidine incorporation (see, *e.g.*, Blechman *et al.*, Cell, 1995, 80:103-113; Chen, J., 1996, Oncogene 13:1395-403; Jeoung, J., 1995, J. Biol. Chem. 270:18367 73), by direct cell count at various time intervals (*e.g.*, 12-hour or 24-hour intervals), or by detecting changes in transcription, translation or activity of known genes such as proto-oncogenes (*e.g.*, fos, myc) or cell cycle markers (Rb, cdc2, cyclin A, D1, D2, D3, E, etc). The levels of such protein and mRNA and activity can be determined by any method well known in the art. For example, protein can be quantitated by known immunodiagnostic methods such as ELISA, Western blotting or immunoprecipitation using antibodies, including commercially available antibodies. mRNA can be quantitated using methods that are well known and routine in the art, for example, using northern analysis, RNase protection, or polymerase chain reaction in connection with reverse transcription.

[00516] In specific embodiments, a method for inhibiting (*e.g.*, partially inhibiting) KIT activity in cells (*e.g.*, cancer cells) expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to inhibit cell proliferation by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, BrdU incorporation assay). In specific embodiments, a method for inhibiting (*e.g.*, partially inhibiting) KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to inhibit cell proliferation by at least about 25%, 35%, 45%, 55%, or 65%, as assessed by methods described herein or known to one of skill in the art (*e.g.*, BrdU incorporation assay). In specific embodiments, a method for an inhibiting or

antagonizing KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to inhibit cell proliferation by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art (*e.g.*, BrdU incorporation assay).

[00517] In certain aspects, a method provided herein for inhibiting KIT activity in a cell (*e.g.*, cancer cell) expressing KIT comprises contacting the cell with an effective amount of an antibody described herein sufficient to reduce or to inhibit survival of the cell. Cell survival assays are described in the art and can be readily carried out by one of skill in the art. For example, cell viability can be assessed by using trypan-blue staining or other cell death or viability markers known in the art. In a specific embodiment, the level of cellular ATP is measured to determined cell viability. In specific embodiments, cell viability is measured in three-day and seven-day periods using an assay standard in the art, such as the CellTiter-Glo Assay Kit (Promega) which measures levels of intracellular ATP. A reduction in cellular ATP is indicative of a cytotoxic effect. In another specific embodiment, cell viability can be measured in the neutral red uptake assay. In other embodiments, visual observation for morphological changes can include enlargement, granularity, cells with ragged edges, a filmy appearance, rounding, detachment from the surface of the well, or other changes. These changes are given a designation of T (100% toxic), PVH (partially toxic–very heavy–80%), PH (partially toxic–heavy–60%), P (partially toxic–40%), Ps (partially toxic–slight–20%), or 0 (no toxicity–0%), conforming to the degree of cytotoxicity seen. A 50% cell inhibitory (cytotoxic) concentration (IC_{50}) is determined by regression analysis of these data.

[00518] In specific embodiments, a method provided herein for inhibiting (*e.g.*, partially inhibiting) KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to reduce or to inhibit survival of the cells by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, trypan blue exclusion assay). In specific embodiments, a method provided herein for inhibiting (*e.g.*, partially inhibiting) KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to reduce

or to inhibit survival of the cells by at least about 25%, 35%, 45%, 55%, or 65%, as assessed by methods described herein or known to one of skill in the art (*e.g.*, trypan blue exclusion assay). In specific embodiments, a method provided herein for inhibiting KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to reduce or to inhibit survival of the cells by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art (*e.g.*, trypan blue assay).

[00519] In a specific embodiment, a method provided herein for inhibiting (*e.g.*, partially inhibiting) KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to induce apoptosis (*i.e.*, programmed cell death). Methods for detecting apoptosis are described in the art and can be readily carried out by one of skill in the art. For example, flow cytometry can be used to detect activated caspase 3, an apoptosis-mediating enzyme, in cells undergoing apoptosis, or Western blotting can be used to detect cleavage of poly(ADP-ribose) polymerase (PARP (see, *e.g.*, Smolich *et al.*, Blood, 2001, 97:1413-1421). Cleavage of PARP is an indicator of apoptosis. In specific embodiments, a method provided herein for an inhibiting or antagonizing KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to induce or enhance apoptosis by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, flow cytometry to detect activated caspases 3). In specific embodiments, a method provided herein for an inhibiting or antagonizing KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to induce or enhance apoptosis by at least about 25%, 35%, 45%, 55%, or 65%, as assessed by methods described herein or known to one of skill in the art (*e.g.*, flow cytometry to detect activated caspases 3). In specific embodiments, antibodies a method provided herein for inhibiting KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to induce or enhance apoptosis by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods

described herein or known to one of skill in the art (*e.g.*, flow cytometry to detect activated caspase 3).

[00520] In a specific embodiment, a method provided herein for inhibiting (*e.g.*, partially inhibiting) KIT activity in a cell expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to induce differentiation. Methods for detecting differentiation are described in the art and can be readily carried out by one of skill in the art. For example, flow cytometry can be used to detect expression of one or more differentiation markers, or the lack of expression of one or more undifferentiated markers, in a cell contacted with an antibody described herein. Similarly, Western blotting can also be used to detect differentiation markers. Suitable differentiation markers and undifferentiated markers have been described and are one of skill in the art.

[00521] In specific embodiments, a method provided herein for inhibiting (*e.g.*, partially inhibiting) KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to induce differentiation by at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, or 99% as assessed by methods described herein or known to one of skill in the art (*e.g.*, flow cytometry). In specific embodiments, a method provided herein for inhibiting (*e.g.*, partially inhibiting) KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to induce differentiation by at least about 25%, 35%, 45%, 55%, or 65%, as assessed by methods described herein or known to one of skill in the art (*e.g.*, flow cytometry). In specific embodiments, a method provided herein for inhibiting KIT activity in cells expressing KIT comprises contacting the cells with an effective amount of an antibody described herein sufficient to induce differentiation by at least about 1 fold, 1.2 fold, 1.3 fold, 1.4 fold, 1.5 fold, 2 fold, 2.5 fold, 3 fold, 3.5 fold, 4 fold, 4.5 fold, 5 fold, 6 fold, 7 fold, 8 fold, 9 fold, 10 fold, 15 fold, 20 fold, 30 fold, 40 fold, 50 fold, 60 fold, 70 fold, 80 fold, 90 fold, or 100 fold as assessed by methods described herein or known to one of skill in the art (*e.g.*, flow cytometry).

[00522] Non-limiting examples of cells which can be differentiated by the methods described herein include stem cells (*e.g.*, embryonic stem cells, hematopoietic stem cells) and progenitor cells. Exemplary hematopoietic stem cell markers include CD38, CD34, CD59, CD133, Sca-1, and ABCG2. Non-limiting examples of neural stem cell markers include Nestin,

PSA-NCAM, p75 Neurotrophin R, and Vimentin. Other non-limiting examples of stem cell markers include, Oct4, Sox2, Klf4, LIN28, Nanog, SSEA-3, SSEA-4, Notch, and Wnt.

5.7 Diagnostic Methods

[00523] Labeled or otherwise detectable antibodies, which immunospecifically bind to a KIT antigen (*e.g.*, the D4 region of KIT, for example, human KIT) can be used for diagnostic purposes to detect, diagnose, or monitor a KIT-associated disease.

[00524] Provided herein are methods for detecting KIT expression in samples obtained from patients with a KIT-associated disorder or disease. In a particular embodiment, a method for detecting KIT expression in a sample obtained from a patient comprises contacting the sample with an anti-KIT antibody described herein and detecting the expression level of KIT in the samples, for example, by correlating the binding of anti-KIT antibody to KIT with KIT expression levels. Methods for detection are known to one of skill in the art.

[00525] In certain aspects, provided herein are methods for diagnosing a patient with a KIT-associated disorder or disease. In a certain aspect, a method for diagnosing a subject with a KIT-associated disorder or disease comprises contacting a sample obtained from the subject with an anti-KIT antibody described herein (or an antigen-binding fragment thereof) and detecting the expression level of KIT in the sample. In certain embodiments, a method for diagnosing a patient with a KIT-associated disorder or disease is an *in vitro* method. In particular embodiments, a method for diagnosing a patient with a KIT-associated disorder or disease is an *ex vivo* method.

[00526] In certain aspects, provided herein are methods for the detection of a KIT-associated disease comprising: (a) assaying the expression of a KIT antigen in cells or a tissue sample of a subject using one or more antibodies described herein; and (b) comparing the level of the KIT antigen with a control level, *e.g.,* levels in normal tissue samples (*e.g.,* from a patient not having a KIT-associated disease, or from the same patient before disease onset), whereby an increase in the assayed level of KIT antigen compared to the control level of the KIT antigen is indicative of a KIT-associated disease.

[00527] Methods for detection are known to one of skill in the art. For example, the anti-KIT antibody can be conjugated to a detectable molecule (*e.g.*, as described in section 5.1.1), and the detectable molecule can be visualized using standard techniques (*e.g.*, microscopy). Antibodies described herein can be used to assay KIT antigen levels in a biological sample using classical immunohistological methods as described herein or as known to those of skill in the art

(*e.g.*, see Jalkanen *et al.*, 1985, J. Cell. Biol. 101:976-985; and Jalkanen *et al.*, 1987, J. Cell . Biol. 105:3087-3096). Other antibody-based methods useful for detecting protein gene expression include immunoassays, such as ELISA and the radioimmunoassay (RIA). Suitable antibody assay labels are known in the art and include enzyme labels, such as, glucose oxidase; radioisotopes, such as iodine (^{125}I, ^{121}I), carbon (^{14}C), sulfur (^{35}S), tritium (^{3}H), indium (^{121}In), and technetium (^{99}Tc); luminescent labels, such as luminol; and fluorescent labels, such as fluorescein and rhodamine, and biotin. In specific embodiments, diagnostic methods described herein involve using naked or unlabeled antibodies not conjugated to a detectable marker, and the naked or unlabeled antibodies are detected indirectly, *e.g.*, by using a secondary antibody, which can be labeled.

[00528] In certain embodiments, high expression of KIT in a sample relative to a normal control sample (*e.g.*, sample obtained from a healthy patient not suffering from a KIT-associated disorder or disease) indicates that the patient is suffering from a KIT-associated disorder or disease.

[00529] A method for diagnosing a patient with a KIT-associated disorder or disease, such as cancer, in a sample obtained from a patient comprises contacting the sample with an anti-KIT antibody described herein and detecting the expression level of KIT in the sample. In certain embodiments, high expression of KIT in a sample relative to a normal control sample (*e.g.*, sample obtained from a healthy patient not suffering from a KIT-associated disorder or disease) indicates that the patient is suffering from a KIT-associated disorder or disease.

[00530] In certain embodiments, a sample can be a tumor sample derived from, or comprising tumor cells from, a patient's tumor. Examples of tumor samples herein include, but are not limited to, tumor biopsies, circulating tumor cells, circulating plasma proteins, ascitic fluid, primary cell cultures or cell lines derived from tumors or exhibiting tumor-like properties, as well as preserved tumor samples, such as formalin-fixed, paraffin-embedded tumor samples or frozen tumor samples. In certain embodiments, a sample is a fixed tumor sample which has been histologically preserved using a fixative. In some embodiments, a sample is a formalin-fixed tumor sample which has been preserved using formaldehyde as the fixative. In certain embodiments, a sample is an embedded tumor sample which is surrounded by a firm and generally hard medium such as paraffin, wax, celloidin, or a resin. Embedding makes possible the cutting of thin sections for microscopic examination or for generation of tissue microarrays (TMAs). In

particular embodiments, a sample is a paraffin-embedded tumor sample which is surrounded by a purified mixture of solid hydrocarbons derived from petroleum. In certain embodiments, a sample is a frozen tumor sample which is, or has been, frozen. In a specific embodiment, a sample, for example, a paraffin-embedded sample or frozen sample, is sectioned.

[00531] In certain aspects, a cancer or biological sample which displays KIT expression, amplification, or activation is one which, in a diagnostic test, expresses (including overexpresses) a KIT receptor, has amplified KIT gene, and/or otherwise demonstrates activation or phosphorylation of a KIT receptor.

[00532] Also provided herein is the detection and diagnosis of a KIT-associated disease in a human. In one embodiment, diagnosis comprises: a) administering (for example, parenterally, subcutaneously, or intraperitoneally) to a subject an effective amount of a labeled antibody described herein; b) waiting for a time interval following the administering for permitting the labeled antibody to preferentially concentrate at sites in the subject where the KIT antigen is expressed (and for unbound labeled molecule to be cleared to background level); c) determining background level; and d) detecting the labeled antibody in the subject, such that detection of labeled antibody above the background level indicates that the subject has a KIT -mediated disease. Background level can be determined by various methods including, comparing the amount of labeled molecule detected to a standard value previously determined for a particular system.

[00533] It will be understood in the art that the size of the subject and the imaging system used will determine the quantity of imaging moiety needed to produce diagnostic images. In the case of a radioisotope moiety, for a human subject, the quantity of radioactivity injected will normally range from about 5 to 20 millicuries of ^{99}Tc. The labeled antibody will then preferentially accumulate at the location of cells which contain the specific protein. *In vivo* tumor imaging is described in S.W. Burchiel *et al.*, "Immunopharmacokinetics of Radiolabeled Antibodies and Their Fragments." (Chapter 13 in Tumor Imaging: The Radiochemical Detection of Cancer, S.W. Burchiel and B.A. Rhodes, eds., Masson Publishing Inc. (1982)).

[00534] Depending on several variables, including the type of label used and the mode of administration, the time interval following the administration for permitting the labeled antibody to preferentially concentrate at sites in the subject and for unbound labeled antibody to be cleared

to background level is 6 to 48 hours or 6 to 24 hours or 6 to 12 hours. In another embodiment the time interval following administration is 5 to 20 days or 5 to 10 days.

[00535] In one embodiment, monitoring of a KIT -mediated disease is carried out by repeating the method for diagnosing the a KIT -mediated disease, for example, one month after initial diagnosis, six months after initial diagnosis, one year after initial diagnosis, *etc.*

[00536] Presence of the labeled molecule can be detected in the subject using methods known in the art for *in vivo* scanning. These methods depend upon the type of label used. Skilled artisans will be able to determine the appropriate method for detecting a particular label. Methods and devices that can be used in the diagnostic methods of the invention include, but are not limited to, computed tomography (CT), whole body scan such as position emission tomography (PET), magnetic resonance imaging (MRI), and sonography.

[00537] In a specific embodiment, the molecule is labeled with a radioisotope and is detected in the patient using a radiation responsive surgical instrument (Thurston *et al.*, U.S. Patent No. 5,441,050). In another embodiment, the molecule is labeled with a fluorescent compound and is detected in the patient using a fluorescence responsive scanning instrument. In another embodiment, the molecule is labeled with a positron emitting metal and is detected in the patient using positron emission-tomography. In yet another embodiment, the molecule is labeled with a paramagnetic label and is detected in a patient using magnetic resonance imaging (MRI).

6. EXAMPLES

[00538] The examples in this section (*i.e.*, section 6) are offered by way of illustration, and not by way of limitation.

6.1 Example 1: Generating anti-KIT antibodies

[00539] Anti-KIT antibodies were designed using Composite Human Antibody™ technology (Antitope Ltd., Cambridge, United Kingdom) and the amino acid sequence of the mouse antibody 37M (U.S. Patent Application No. 13/358,210 filed January 25, 2012) which immunospecifically binds to a human KIT D4 region, to produce anti-KIT antibodies with human amino acid sequences, wherein the antibodies bind a human KIT D4 region. Five heavy chain variable region sequences (H1, H2, H3, H4 and H5) and four light chain variable region sequences (L1, L2, L3 and L4) were selected to be used for gene synthesis, expression in mammalian cells and testing for direct binding to recombinant KIT domains as well as activity in blocking stem cell

factor (SCF)-induced phosphorylation. Amino acid sequences for H1-H5, L1-L4 and nucleic acid sequences encoding them are shown in Figures 3A-3I.

[00540] Nucleic acid molecules encoding the H (heavy chain) and L (light chain) variable region amino acid sequences were cloned directly into expression vectors for human IgG1 VH chains and human Vκ chains. All constructs were confirmed by sequencing. Vectors encoding IgG1 VH (H1-H5) and Vκ (L1-L4) chains were transfected into CHO cells (*e.g.*, CHOdhfr- cells) in different combinations to produce twenty antibodies (see Table 4, antibodies Hum1-Hum20). Vectors encoding the chimeric antibody 37C, a chimeric antibody with human constant domains and mouse 37M variable domains (U.S. Patent Application No. 13/358,210 filed January 25, 2012), were also transfected into CHO cells. Cells transiently transfected with non-linearized DNA were incubated for four days prior to harvesting supernatants which were used directly in assays or for purification. Stable transfections to establish cell lines expressing the antibodies were carried out using linearized DNA and were subsequently drug-selected. Supernatants from drug-resistant colonies for each construct were tested for IgG titre using an IgG1 ELISA, and the best expressing lines were selected based on an above-background (usually >0.1 μg/ml) IgG titre in the supernatant, and expanded in the presence of drug selection through 24-well and 6-well plates, T75 and T175 tissue culture flasks, with screening for IgG expression at every stage. Titers of 0.1-1 μg/ml are typical for non-optimised CHOdhfr- cell lines. Antibody expression was confirmed by Coomassie Blue stained SDS –PAGE.

[00541] In these particular cells, a majority of the antibodies were expressed with a titer in the range of 0.1-1.0 μg/ml, and in particular, antibody Hum4 was expressed at a titer of 1.2 μg/ml.

6.2 Example 2: Binding affinity to human KIT Ig-like domains D4/D5

[00542] The binding affinity of the anti-KIT antibodies to the target antigen KIT Ig-like domains D4/D5 was assessed by direct binding ELISA. A dilution series (three-fold) of chimeric antibody 37C and Hum1-Hum20 antibodies from approximately $1x10^{-8}$ M to $4.7x10^{-13}$ M was incubated for 1 hour at room temperature on a flat bottom microtitre plate pre-coated with 50 ng/well recombinant c-Kit Ig-like domains D4/D5 (see Figure 2) diluted in borate buffer and pre-blocked for 1 hour with 1% BSA. Bound antibody was detected with anti-human Ig-HRP followed by detection using TMB substrate. Results are presented in Table 7 below.

[00543] **Table 7: Binding characterization of anti-KIT antibodies.**

Antibody	Relative binding activity assay #1 (sup)	Relative binding activity assay #2 (sup)	Relative binding activity assay #3 (purified)	Relative binding activity assay #4 (purified)
Hum1		0.64		
Hum2		0.79		
Hum3		0.88		
Hum4		0.91	1.07	0.83
Hum5		0.93		
Hum6	1.15	0.70		
Hum7	1.12	0.80		
Hum8	1.02	0.62	0.89	0.75
Hum9	1.08	1.00	0.85	
Hum10	1.10	0.88	0.87	0.72
Hum11		0.74		
Hum12	1.23	0.72		
Hum13	1.11	0.78		
Hum14	1.14	1.03	0.74	
Hum15	0.87	0.76	0.87	
Hum16	1.2	1.02		
Hum17	1.17	0.76	0.98	0.72
Hum18	1.22	0.79	0.99	
Hum19	1.11	1.05	0.95	0.85
Hum20	0.80	0.70		
EC_{50} (pM) chimeric (replicates)	380.74±18.3 (x4)	411.66±183.7 (x5)	462.35±28 (x2)	567.76 (x1)

EC50 values (pM) were calculated for anti-KIT antibodies Hum1-20, and values for antibodies were normalized against those for the chimeric antibody 37C in the corresponding experiment. Higher values indicate stronger binding activity. Actual EC_{50} values for the chimeric antibody in each experiment are shown at the foot of the table along with the number of replicates averaged to achieve that value. (sup) = supernatant containing antibody; (purified) = antibody purified from supernatant.

[00544] The binding activity of certain of the antibodies as well as chimeric antibody 37C was further characterized by solid phase ELISA using an antigen containing the D4/D5 region (*see* Figure 2) of human KIT. The general protocol used for the solid phase ELISA experiments is described below.

[00545] Materials:

- Recombinant antigen: Recombinant IG domain four and five of the extracellular region of KIT
- TBS-T: 50 mM Tris pH 7.4, 150 mM NaCl, 0.1% Tween 20
- TBS: 50 mM Tris pH 7.4, 150 mM NaCl
- Blocking solution: 1% bovine serum albumin (BSA) in TBS
- Dilution buffer: 1% BSA in TBS-T
- Detection antibody solution: Goat anti-mouse IgG HRP antibody and Pierce goat anti - human $F(ab')_2$ specific conjugated with horseradish peroxidase (Thermo scientific 31414)
- Detection Substrate: TMB (3,3',5,5' – tetramethylbenzidine) Substrate kit (Thermo scientific # 34021)

[00546] Recombinant antigen corresponding to the D4/D5 region of the KIT extracellular domain (see Figure 2) was absorbed onto 96-well microtiter plates. In particular, recombinant antigen (5 μg) were diluted into 10 mL of borate buffer, and 100 μL of the antigen solution were added to each well of a 96 well plate and were incubated at 4°C overnight.

[00547] Serial dilutions of antibody samples were prepared with dilution buffer for ELISA.

[00548] ELISA: Following one rinse with TBS-T, blocking buffer (200 μL) was added to each well of the plate with the adsorbed antigen and was incubate at room temperature for one hour. Then, the blocking buffer was removed, and the serially diluted solutions of test antibodies and controls were added to the plate in a volume of 50 μL and incubated at room temperature for one hour. The antibody solutions were removed, and the plate was washed three times with 100 μL of wash buffer on a plate washer. After the last wash, the plate was blotted dry. Secondary antibody solution was diluted 1:8000 and was added to each well in a volume of 100 μL and allowed to incubate for one hour at room temperature. The diluted secondary antibody solution was removed, and the plate was washed three times with 100 μL of wash buffer on a plate washer. Then, freshly mixed TMB substrate solution was added to each well in a volume of 100 μL and was allowed to incubate at room temperature for 30 minutes. Subsequently, 100 μL of 2N H_2SO_4

were added to each well and immediately read on the plate reader. An irrelevant antibody served as the negative control, and an anti-KIT antibody against the D4 and/or D5 domain of the extracellular region of KIT served as the positive control. OD values for each sample were obtained at a wavelength of 450 nm.

[00549] Results were analyzed using Graph Pad Prism and Excel to obtain the concentration of antibodies at 50% binding to antigen.

[00550] Figure 5 depicts a graph plotting OD_{450} versus log concentration (M) of anti-KIT antibodies. The effective concentration at 50% binding (EC_{50}) for the binding affinity of a chimera of antibody 37M and antibodies Hum17, Hum8, Hum4, and Hum10 to the D4/D5 region of human KIT was calculated to be approximately 12 pM, 6.6 pM, 11 pM, 7.5 pM, and 23 pM, respectively.

[00551] The results presented in Figure 5 show that the binding affinities of a chimera of antibody 37M and and antibodies Hum17, Hum8, Hum4, and Hum10 are comparable.

[00552] Additional binding assays demonstrated that Hum17, Hum8, Hum4, and Hum10 exhibited specific binding to canine KIT and monkey KIT, in addition to human KIT, but they did not exhibit specific binding to murine KIT.

6.3 Example 3: Binding affinity of anti-KIT antibodies for human KIT expressed on CHO cells

[00553] To confirm that the anti-KIT antibodies can bind to KIT expressed on the surface of cells, flow cytometry assays were carried out using CHO cells that do (CHO/KIT-WT) and do not (parental CHO cells) exogenously express the full-length, wild-type human KIT receptor. Briefly, parental CHO cells and CHO/KIT-WT cells were washed and incubated with 0.01 nM, 0.1 nM, 1 nM or 10 nM of a chimeric (human-mouse) 37M antibody, antibody Hum17, Hum8, Hum4, or Hum10, a negative control isotype IgG antibody, or a commercial anti-KIT antibody as a positive control. The samples were processed for flow cytometry analysis. More specifically, cells were removed from the culture flasks using EDTA, and washed with PBS. Then, the cells were resuspended in media and counted. Each sample containing approximately 200,000 to 250,000 cells was spun, the media was removed, and the cells were resuspended in FC buffer (1% BSA, 0.01% sodium azide in 1XPBS) for the blocking step. The cells were incubated in FC buffer for 1 hour on ice. Then, primary antibody (*e.g.*, a chimeric (human-mouse) 37M antibody, Hum17, Hum8, Hum4, Hum10, positive control anti-KIT antibody, or negative control antibody) was added to the cells in FC buffer as described above. The samples were mixed and incubated on

ice for 1 hour, followed by washing the cells with 0.5-1 mL FC buffer. The FC buffer was removed by spinning the cells at 1200 rpm for 3 minutes at 4°C, decanting the liquid. The cell pellets were resuspended in 200 μL FC buffer, and secondary antibody (DyLight 488 AffiniPure Goat Anti-Mouse IgG Jackson Laboratories) was added to the cells at a 1:1000 to 1:2000 dilution. The samples were mixed and incubated on ice for 1 hour, and then washed as described above. The samples were run on a fluorescence activated cell sorter (FACS) machine (Accuri FlowCytometer C6). Samples were analyzed by following channel FLA-1 for DyLight-conjugated samples.

[00554] Figure 6 summarizes the results from the flow cytometry analysis. The effective concentration at 50% binding (EC_{50}) for the binding affinity of a chimera (human-mouse) of antibody 37M and antibodies Hum17, Hum8, Hum4, and Hum10 to the D4/D5 region of human KIT was calculated to be approximately 47 pM, 139 pM, 83 pM, 106 pM, and 132 pM, respectively.

[00555] The results presented in Figure 6 show that the binding affinities of the chimeric 37M antibody and antibodies Hum17, Hum8, Hum4, and Hum10 for cell surface expressed human KIT are comparable.

6.4 Example 4: Inhibition of KIT phosphorylation induced by SCF in cell-based phospho-KIT assays

[00556] The inhibition of stem cell factor (SCF)-mediated phosphorylation of cell-surface KIT by anti-KIT chimeric 37M antibody and certain anti-KIT antibodies described herein was assessed in a cell-based assay as follows: CHO-KIT cells, sorted for high cell surface antigen expression, were cultured overnight in 24-well or 96-well plates in the absence of serum before addition of a three-fold dilution series from $1x10^{-8}$ M - $1.4x10^{-11}$ M of test antibody (chimeric or anti-KIT antibodies described herein purified from supernatant) or control blocking antibody (BioLegend, clone A3C6E2).

[00557] Following incubation for 2 hours at 37°C, cells were stimulated with 30 ng/mL SCF (R&D Systems, cat. no. 255-SC/CF) for 10 min at 37°C, lysed in the presence of protease and phosphatase inhibitors, and KIT protein was captured from whole lysates onto white-walled 96-well Maxisorp plates pre-coated with KIT capture antibody (Thermo Scientific, cat. no. LVMS289-PABX). For the 96-well format, duplicate wells were set up for each condition and lysed and transferred separately to the capture plate whilst for the 24-well format, duplicate samples of lysate were taken from the same well. Following overnight incubation at 4°C and

extensive washing of the plate, tyrosine phosphorylated KIT was detected using HRP-conjugated anti-phosphotyrosine clone 4G10 (Millipore, cat. no. 16-105) and West PICO chemiluminescent substrate (Fisher, cat. no. PN34087). The results are presented in Table 8 below.

[00558] **Table 8: Blocking Assays**

Antibody	Relative blocking activity, assay #1 (24-well)	Relative blocking activity, assay #2 (24-well)	Relative blocking activity, assay #3 (96-well)	Relative blocking activity, assay #4 (96-well)
Hum4		1.2		0.86
Hum8			1.01	1.12
Hum9			1.05	
Hum10		0.82		0.86
Hum13			1.00	
Hum14		0.94		
Hum15	0.98		0.99	
Hum17		1.39		1.07
Hum18		1.22		
Hum19	1.09		0.98	1.40

IC_{50} values (pM) were calculated for these antibodies and values for were normalized against those for the chimeric 37M antibody in the corresponding experiment. Higher values indicate stronger blocking activity. "(96-well)" refers to assays carried out in 96-well plate format as opposed to 24-well format (24-well).

[00559] The results in Table 8 shows that the blocking activities of antibodies Hum4, Hum8, Hum9, Hum10, Hum13, Hum14, Hum15, Hum17, Hum18, and Hum19 are comparable to the blocking activity of a chimera of antibody 37M.

[00560] To further characterize the effect of these antibodies on KIT activity, specifically, SCF-induced tyrosine phosphorylation of the cytoplasmic domain of KIT, cell-based phospho-KIT assays were carried out as follows.

[00561] Materials:

- CHO cells stably transfected with a plasmid encoding full-length human KIT (see Figure 1), which was cloned from a human ovary cDNA library (OriGene, Rockville, Maryland)
- Complete cell culture media (see Table 9)

- Starving media: Cell culture media described in Table 9 without FBS
- Trypsin-EDTA
- PBS
- SCF solution: rhSCF (RD Systems 255-SC/CF); final concentration 30 ng/mL
- Lysis buffer: 50 mM Tris pH 7.4, 150 mM NaCl, 1 mM EDTA, 1% Triton X-100, protease inhibitor cocktail tables EDTA free (Roche Diagnostics 04693132001), 1 mM $NaVO_4$
- TBS-T: 50 mM Tris pH 7.4, 150 mM NaCl, 0.1% Tween 20
- Blocking solution: 5% bovine serum albumin (BSA) in TBS-T
- Dilution buffer: 1% BSA in TBS-T containing 1 mM $NaVO_4$
- Detection antibody solution: anti-phospho-tyrosine antibody conjugated with horse radish peroxidase (Millipore, 4G10); dilution factor 1:500
- Capture antibody: anti-KIT antibody Ab3 from Thermo Scientific (MS-289-PABX)

[00562] **Table 9: Cell Culture Media**

Cell line	CHO (parental or KIT transfected)
Basic medium	Gibco F12 Nutrient Mixture (Ham) 1X 11765
Penicillin/Streptomycin (Cellgro 30-001-CI)	50 IU/mL penicillin 50 µg/mL streptomycin
100X GlutaMAX™-I (Gibco 35050)	1X GlutaMAX™
Geneticin (Invitrogen 10131027)	1 mg/mL Geneticin (for selection of transfected cells only)

[00563] Passaging of CHO/KIT-WT cells: Confluent cells were washed once with sterile PBS, incubated with 0.25% Trypsin-EDTA at room temperature until cells detached from the plastic tissue culture plates. Complete culture medium, which contains FBS, was added to the plate to end the tryptic digestion.

[00564] Counting Cells: Ten microliters of cell suspension were mixed with 10 µL of 0.4% trypan blue. Half of this mixture (10 µL) was transferred into a cell counting chamber (Invitrogen), and the cells were counted. Cells (200,000 per well) were transferred into a 24-well cell culture plate, and were cultivated in complete medium (Table 9) for 24 hours under normal cell culture conditions (*i.e.*, humidified 95% air and 5% CO_2 atmosphere at 37°C).

[00565] Cell Treatment: After the cells were plated in the 24-well plates and cultured overnight, the medium was removed, and the cell monolayer was washed once with starvation

medium. The cells were then cultured for 24 hours in starvation medium under normal cell culture conditions. Then the cells were treated with a chimeric (human-mouse) 37M antibody, Hum4, Hum8, Hum10, Hum17, or control antibody solutions for 2 hours under normal cell culture conditions. The final concentration for the antibody solution was 100 nM (5 μg/mL) or less. Subsequently, SCF solution was added to the cells pretreated with anti-KIT antibodies or control antibody at a final concentration of 30 ng/mL for 10 minutes under normal cell culture conditions.

[00566] Controls:

- Negative controls: starved, untreated and non-stimulated cells
- Positive control: starved, untreated and SCF-stimulated cells
- Drug control: starved cells, treated with 1 μM Gleevec and stimulated with SCF
- Antibody control: cells starved, treated with 100 nM blocking antibody (purified mouse anti-human KIT antibody (BioLegend A3C6E2) that binds to the SCF binding site)

[00567] Preparation of cell lysates: After stimulation, cells in the 24-well plate were placed on ice immediately, the cells were washed once with cold PBS, and lysed with 100 μL of cold lysis buffer.

[00568] Preparation of 96-well ELISA plate with capture antibody: Capture antibody (5 μL) was diluted in 10 mL 50 mM Borate buffer, and the capture antibody solution (100 μL or 50 ng/well) was added to each well of the 96-well ELISA plate. The 96-well plate was incubated at room temperature for 5-6 hours or overnight at 4°C. The capture antibody solution was removed prior to the blocking step. Blocking was carried out by adding 100 μL of blocking solution to each well and allowed to incubate at room temperature for 1 hour. The blocking solution was removed, the wells were washed once with dilution buffer, and 50 μL of dilution buffer were added to each well.

[00569] Phospho-KIT assay: 50 μL of the cell lysates of each sample from a well of the 24-well plate were transferred into 1 well of the prepared 96-well plate containing 50 μL dilution buffer, and the 96-well plate was incubated overnight at 4°C. Following the overnight incubation, the supernatant was removed, and the plate was washed 3 times (5 minute incubation each time) with TBS-T. Detection antibody dilution (100 μL) was added to each well and incubated for 1 hour at room temperature in the dark. The plate was washed 3 times with TBS-T, washed once with TBS, and the TBS was removed. The "SuperSignal West Dura Extended Duration

Substrate" reagents (Thermo Scientific) were mixed (1:1), and 100 µL of the mix were added to each well.

[00570] Luminescence was detected in the ELISA plate reader using the GEN5™ protocol "Luminescence Glow" and the data were analyzed using Microsoft Excel.

[00571] Figure 7 depicts a graph plotting the data from these experiments. The graph is a plot of arbitrary luminescence units versus log concentration (M) of either a chimera (human-mouse) of antibody 37M or antibody Hum17, Hum8, Hum4, or Hum10. The 50% inhibition concentrations (IC_{50}) of the chimera 37M, Hum17, Hum8, Hum4, and Hum10 antibodies were calculated to be approximately 344 pM, 510 pM, 542 pM, 470 pM, and 510 pM, respectively. The results indicate that antibodies Hum17, Hum8, Hum4, and Hum10, like the 37M chimera antibody, are effective inhibitors of ligand (SCF)-induced tyrosine phosphorylation of the cytoplasmic domain of KIT.

[00572] These anti-KIT antibodies can be expressed in a variety of different cell types without substantially affecting the properties of the antibody, for example, binding activity and blocking activity. For example, anti-KIT antibodies Hum17, Hum8, Hum4, and Hum10 were expressed in a different recombinant expression system based on HEK293-Freestyle (293F) cells, and exhibited blocking activity as determined by KIT phosphorylation inhibition assays. These results indicate that a variety of cell systems can be used for expressing anti-KIT antibodies described herein, such as antibodies Hum1-Hum20, without compromising antibody activity.

6.5 Example 5: Antibody internalization by CHO cells expressing wild-type KIT

[00573] Immunofluorescence staining assays were carried out to assess internalization of antibodies Hum4, Hum10, Hum17, and Hum8 by CHO cells expressing wild-type KIT ("CHO/KIT-WT").

[00574] The immunofluorescence staining assays were carried out essentially as described below. Materials and reagents for the immunofluorescence assays included the following:

- Primary antibodies: antibodies Hum4, Hum8, Hum10, Hum17, 37M, and β-Tubulin (9F3) rabbit monoclonal antibody(mAb) (Cell Signaling #2128).
- Secondary antibodies: goat anti-mouse antibody conjugated to Oregon Green® 488 (Invitrogen #011038), goat anti-rabbit antibody conjugated to Texas Red (Invitrogen #T2767), and goat anti-human antibody conjugated to Alexa Fluor 488 (Invitrogen #A11013).

- Fixative: 4% paraformaldehyde (PFA) (store 40% PFA microscopy grade in fridge and dilute 1:10 with PBS just before use)
- Permeabilization solution: PBS with 0.1% Triton X-100 and 0.5% BSA, sterile filtered
- Blocking/dilution solution: 2% BSA in PBS, sterile filtered
- Mounting media: ProLong® Gold antifade reagent with DAPI (P36931 Invitrogen) (4',6-diamidino-2-phenylindole)
- CHO cells engineered to express exogenous human, wild-type KIT (full-length) ("CHO/KIT-WT")

[00575] CHO cells (*e.g.*, 75,000 cells per well) were seeded into a 24-well tissue culture plate containing one round glass coverslip per well. The cells were cultivated for at least 6 hours before overnight starvation in media containing no fetal bovine serum. Following starvation, the culture media was removed from the cells and antibody 37M, Hum4, Hum10, Hum17, or Hum8 diluted to 33.3 nM in starvation media containing 1% bovine serum albumin, was transferred onto the cell layer at time 0 minute, 30 minutes, 45 minutes or 55 minutes to generate a time course. Cells were incubated for the indicated times under standard culture conditions (37°C and 5% CO_2). Cell layers were washed once with PBS (room temperature) 5 to 60 minutes after addition of the antibody. Cell layers were fixed for 20 minutes with 4% PFA at room temperature, and were washed 3 times with PBS. Cell membranes were permeabilized by the addition of permeabilization solution for 3 minutes followed by 3 washes with PBS. Blocking solution was added to each well, and cells were blocked for 20 minutes at room temperature. The β-Tubulin (9F3) rabbit mAb was diluted 1:100 in dilution solution and incubated with the cell layers for 1 hour at room temperature followed by 2 washes with PBS and one with blocking solution. Both secondary antibodies were diluted together at 1:200 in dilution solution before being added to the cells. Cells were incubated in secondary antibody in the dark at room temperature for 1 hour followed by 3 PBS washes. The cells on the coverslips were mounted against the glass slides using one drop of ProLong® Gold antifade reagent with DAPI and were kept at room temperature overnight. Internalization of the antibody was analyzed by fluorescence microscopy at various time point, *e.g.*, 5 minutes and 60 minutes of exposure to antibody 37M, Hum4, Hum10, Hum17, or Hum8.

[00576] The immunofluorescence staining assays demonstrated that, in CHO/KIT-WT cells, antibodies Hum4, Hum10, Hum17, and Hum8, similarly to antibody 37M, bound to the surface of these cells, and were internalized by these cells. In particular, images of cells exposed to these antibodies show staining of membrane-associated structures at early time points, such as at 5 minutes after exposure to anti-KIT antibodies, and show staining of internal structures (*e.g.*, vesicles) at later time points, such as at 60 minutes after exposure to antibody. In contrast, images of cells exposed with anti-β-Tubulin antibody, as a control, showed staining of elongated structures throughout the cytoplasm of the cells. These results indicate that antibodies Hum4, Hum10, Hum17, and Hum8 are internalized by cells expressing KIT. Effective internalization of antibodies is useful, *e.g.*, for delivering toxins to cells, for example cancer cells, expressing KIT.

6.6 Example 6: Stability Data

[00577] Successful development of therapeutic antibodies is, in part, dependent on the characterization of the antibody stability *in vivo*. To this end, both the relative thermal stability and relative stability under mimicked physiological conditions (*i.e.*, serum, 37°C) of a subset of anti-KIT antibodies described herein was characterized.

[00578] Differential Scanning Calorimetry:

Differential Scanning Calorimetry (DSC) is a thermoanalytical technique used to determine the point at which a sample of interest undergoes phase transition, such as melting or crystallization. Therefore, DSC is a useful tool to compare the relative thermal stability of multiple antibodies. To this end, a subset of anti-KIT antibodies described herein (*e.g.*, antibodies Hum1-Hum20) were analyzed using DSC, and the melting temperatures of these antibodies were determined. The melting profiles of each anti-KIT antibody revealed one major melting peak, and one or two minor peaks. The prevalent melting points ranged from 85.7°C to 86.6°C, while the minor peaks were calculated to be from 71.6°C-71.9°C. These results, showing that the melting temperatures are significantly higher than 37°C, indicate that these anti-KIT antibodies can be stable in a therapeutic setting, for example, at 37°C.

[00579] Serum Stability:

To better understand the stability of anti-KIT antibodies described herein under physiological conditions, antibody activity was assessed following long-term incubation in fetal calf serum at 37°C. Briefly, anti-KIT antibodies were diluted to 0.2 mg/mL in serum-free media or media containing 50% fetal calf serum. Samples were incubated at 37°C for 1, 2 and 3 weeks, at which

point aliquots were compared to antibody stored at 4°C for the same duration in both binding ELISA and cell-based phosphorylation assays as described in earlier examples. Using the 4°C antibody as a reference, binding ELISA assays revealed that following one week, the maximum change in EC_{50} value was 4-fold, but was as low as 1.1-fold, while after two weeks, the maximum change was 4-fold, using the 4°C antibody as a control. Consistently, IC_{50} values in cell-based phosphorylation assays for these same anti-KIT antibodies stored at 37°C with or without serum varied by less than two-fold from those of the antibodies stored at 4°C.

[00580] Together, these data suggest long-term stability of anti-KIT antibodies described herein, as the binding and blocking activity of each antibody is maintained following incubation both in serum and at an elevated temperature. These results indicate that anti-KIT antibodies described herein (*e.g.*, Hum1-Hum20) can exhibit maintained activity and can, for example, be used in a less-frequent dosing regimen.

6.7 Example 7: Blocking ligand-induced AKT phosphorylation

[00581] Anti-KIT antibodies described herein (*e.g.*, Hum1-Hum20) are assayed for the ability to inhibit or block AKT phosphorylation, which is a downstream signaling event of KIT signaling. The assay is carried out as described above with the following modifications. First, a mouse anti-AKT antibody is immobilized on ELISA plates as a capture antibody. Second, the detection of AKT phosphorylation (phospho-AKT) is performed using a two-step method. After incubation of the cell lysates with the coated ELISA plate, a biotinylated mouse monoclonal antibody recognizing phospho-AKT (Ser473) is added to each well for 1 hour at room temperature at a dilution of 1:500. Following this incubation and subsequent washes, the phospho-AKT antibody is detected with Protein Western C Streptavidin-HRP antibody (BioRad) at a dilution of 1:2500. The final detection step with TMB substrate solution is performed as described herein (*e.g.*, sections 6.2 and 6.4).

6.8 Example 8: Animal model study of anti-KIT antibodies in treating cancer

[00582] The anti-tumor effects of anti-KIT antibodies described herein are confirmed using mouse models, such as xenograft mouse models, of human tumors. Various mouse models for studying cancer have been described (see, *e.g.*, Fernandez *et al.*, J. Clin. Invest., 2007, 117(12): 4044-4054). Below, mouse models, *e.g.*, xenograft mouse models, derived from a variety of patient-derived, human cell lines are described. Mouse models for assessing toxicity are also described below.

Gastrointestional stromal tumor (GIST)

[00583] Mouse models of GIST have been described, for example, see, Fernández et al, J. Clin. Invest., 2007, 117(12): 4044–4054. For example, GIST cells are harvested from subconfluent cultures by a brief exposure to 0.05% trypsin-EDTA (Invitrogen). Trypsinization is stopped with medium containing 10% FBS. The cells are then washed twice in serum-free medium and resuspended in serum-free HBSS (Invitrogen). Single-cell suspensions with greater than 95% viability, as determined by Trypan blue exclusion, are used for the injections. To produce tumors, $1x10^5$ to $1x10^7$ GIST cells, for example 6×10^6 GIST cells per 100 µl are injected subcutaneously into the unilateral flank of each SCID mouse (*e.g.*, female C.B-17/IcrHsd-Prkdc^{SCID} mice purchased from Harlan Sprague Dawley Inc.; housed in facilities approved by and in accordance with the American Association for Assessment and Accreditation of Laboratory Animal Care, the United States Department of Agriculture, the United States Department of Health and Human Services, and the NIH; and used according to institutional guidelines). Five to ten mice per group in the vehicle and anti-KIT antibody groups are used. Once tumors are palpable (*e.g.*, approximately 8-11 weeks from injection), mice are started on therapy with injections of normal saline (vehicle) or anti-KIT antibodies (*e.g.*, antibodies Hum1-Hum20 or antibody-drug conjugates thereof), for example, daily, weekly, or bi-weekly intraperitoneal injections. Treatment is continued for a period of time, *e.g.*, approximately 6 weeks, with weekly 2-dimensional measurements of tumor size. Imaging methods for detecting tumor size can also be used, *e.g.*, MRI. All mice are sacrificed when the tumor size approach approximately 1.5 cm in the control group. Tumors are collected, are fixed in formalin, and are analyzed by H&E staining. Representative images are taken from each tumor using a light microscope at ×40 and ×100 magnification.

[00584] A graph of tumor size or volume of each mouse plotted against time (*e.g.*, days or weeks) after tumor injection is generated to ascertain the effect of the anti-KIT antibodies on tumor growth in the mice relative to the vehicle negative control.

[00585] Non-limiting examples of GIST cells which may be used in these mouse models include, GIST 430 cells (human GIST cells that express mutated KIT having a deletion of exon 11 (V560-L576) and V654A mutation in exon 13) and GIST882 cells (immortal GIST cells that possess a homozygous exon 13 missense mutation (*i.e.*, K642E) in KIT (see, *e.g.*, Tuveson *et al.*, Oncogene, 2001, 20: 5054 –5058)).

Leukemia

[00586] To study the effects of anti-KIT antibodies on leukemia, a xenograft mouse model using human leukemia cells (*e.g.*, K562, HEL, or HL60 cells) is established essentially as described above, except that leukemia cells (*e.g.*, K562, HEL, or HL60 cells) are injected into the mice instead of GIST cells. In particular, the tumor cells are collected from subconfluent suspensions. To produce tumors, 1×10^5 to 1×10^7 tumor cells per 100 μl are injected into each SCID mouse. The mice are then randomized into the following groups (n = 5-10 per group): (a) normal saline daily; and (b) anti-KIT antibodies (*e.g.*, antibodies Hum1-Hum20 or antibody-drug conjugates thereof). The mice are started on therapy (*e.g.*, at day 0, 7, or 14 or when tumors are detectable) with injections of normal saline (vehicle) or anti-KIT antibodies (*e.g.*, daily, weekly, or bi-weekly intraperitoneal injections). Treatment is continued for a period of time, *e.g.*, approximately 6 weeks, with weekly 2-dimensional measurements of tumor size. Imaging methods for detecting tumor size can also be used, *e.g.*, MRI. Tumors are measured weekly during treatment and at necropsy.

[00587] A graph of tumor size or volume of each mouse plotted against time (*e.g.*, days or weeks) after tumor injection is generated to ascertain the effect of the anti-KIT antibodies on tumor growth in the mice relative to the vehicle negative control.

[00588] Mouse models of human leukemia also can be generated by injecting human leukemia cells into nude mice or irradiated mice, via other routes, such as intravenous route, and monitoring animal death as an indication of progression of leukemia in the presence or absence of treatment with anti-KIT antibodies. A survival curve is generated for each mouse to ascertain the effect of anti-KIT antibodies on survival.

Lung cancer (*e.g.*, small cell lung cancer)

[00589] A xenograft mouse model using human lung cancer cells, *e.g.*, human small cell lung carcinoma cells (*e.g.*, H526 cells, WBA cells, or NCI-H209 cells) is established essentially as described above, except for a few modifications. For example, lung cancer cells (*e.g.*, small cell lung cancer cells) are injected into mice instead of GIST cells. Lung cancer cells, *e.g.*, H526 tumor cells, are collected, and 1×10^5 to 1×10^7 lung cancer cells per 100 μl are injected into each mouse (*e.g.*, SCID mouse). The mice are then randomized into the following groups (*e.g.* n =

5-10 per group): (a) normal saline daily; and (b) anti-KIT antibodies (*e.g.*, antibodies Hum1-Hum20 or antibody-drug conjugates thereof). The mice are started on therapy (*e.g.*, at day 0, 7, or 14 or when tumors are detectable) with injections (*e.g.*, daily, weekly, or bi-weekly intraperitoneal injections) of normal saline (vehicle) or anti-KIT antibodies. Treatment is continued for a period of time (*e.g.*, approximately 6 weeks or more), with weekly 2-dimensional measurements of tumor size. Imaging methods for detecting tumor size can also be used, *e.g.*, MRI. Tumors are measured weekly during treatment and at necropsy.

[00590] A graph of tumor size or volume of each mouse plotted against time (*e.g.*, days or weeks) after tumor injection is generated to ascertain the effect of the anti-KIT antibodies on tumor growth in the mice relative to the vehicle negative control. A survival curve is generated to ascertain the effect of the anti-KIT antibodies (*e.g.*, any one of antibodies Hum1-Hum20, or an antigen-binding fragment thereof, or a conjugate thereof) on animal survival.

[00591] Mouse models for lung cancer (*e.g.*, small cell lung cancer) have been described (see, *e.g.*, Garton *et al.*, 2006, Cancer Res. 66(2):1015-24; and Wolff *et al.*, 2004, Clin Cancer Res. 10:3528-3534), and may be adapted accordingly to study the effects of anti-KIT antibodies described herein.

Sarcoma

[00592] Xenograft models are established using cell lines derived from Ewing's family of tumors, such as RD-ES, SK-ES-1 or SK-N-MC, or rhabdomyosarcomas, such as A-673. Cell lines are available from the American Type Culture Collection (ATCC; Manassas, VA). Generally, methods similar to those described above are utilized. For example, 2.5-5 x 10^6 cells are suspended with trypsin/EDTA or re-suspended in 100-200μL growth medium and implanted subcutaneously into the flank of 6-8 week old immunodeficient mice (NuNu, SCID) (Charles River Laboratories, Wilmington, MA). Five to ten mice per group in both the vehicle and anti-KIT antibody groups are used. Once tumors are palpable or have reached 100-200 mm^3, mice are started on therapy with injections (*e.g.*, daily, weekly, or bi-weekly intraperitoneal injections) of normal saline (vehicle) or anti-KIT antibodies (*e.g.*, antibodies Hum1-Hum20 or antibody-drug conjugates thereof). Treatment is continued for a period of time, *e.g.*, approximately 6 weeks or more, and tumor size is evaluated (*e.g.*, twice weekly by way of 2-dimensional measurements). Imaging methods for detecting tumor size can be used, *e.g.*, MRI. Mice are sacrificed when the

tumor size approach a certain size (, *e.g.*, approximately 1.5 cm) in the control group. Tumors are collected, are fixed in formalin, and are analyzed by H&E staining. Representative images are taken from each tumor using a light microscope at, *e.g.*, at ×40 and ×100 magnification.

[00593] A graph of tumor size or volume of each mouse plotted against time (*e.g.*, days or weeks) after tumor injection is generated to ascertain the effect of the anti-KIT antibodies on tumor growth in the mice relative to the vehicle negative control.

[00594] Mouse models for sarcoma (*e.g.*, Ewing's sarcoma) have been described, for example, see the following list of publications, and may be adapted accordingly to evaluate the effects of anti-KIT antibodies (*e.g.*, any one of antibodies Hum1-Hum20):

[00595] González *et al.*, 2004, Clin Cancer Res.10(2):751-61;

[00596] Landuzzi *et al.*, 2000, Am J Pathol. 157(6):2123-31 (6647 cells);

[00597] Merchant *et al.*, 2002, JNCI 94(22):1673-1679 (TC71 cells);

[00598] Sturla *et al.*, 2000, Cancer Res. 60(21):6160-70 (TC32 and RD-ES cells);

[00599] Powis *et al.*, 2006, Mol Cancer Ther. 5(3):630-636 (A-673 cells);

[00600] Watanabe *et al.*, 2008, Hum Gene Ther. 19(3):300-10 (A-673 cells);

[00601] Rouleau *et al.*, 2008, Clin Cancer Res. 14(22):7223-7236 (A-673 cells);

[00602] Karmakar et al, 2011, World J Oncol. 2(2):53-63 (RD-ES and SK-N-MC cells);

[00603] Wang *et al.*, 2009, *In vivo* 23(6):903-9 (TC71 cells); and

[00604] Ikeda *et al.*, 2010, Mol Cancer Ther. (3):653-60 (TC71 cells and A4573 cells).

Humanized mouse model

[00605] Studies with anti-KIT antibodies, including anti-KIT antibody drug conjugates, for example, Hum1-Hum20 antibodies, including antibody-drug conjugates thereof are carried out with mouse models generated by engraftment of immunodeficient mice with components of human immune system, *e.g.*, humanized NSG mice (The Jackson Laboratory, Bar Harbor, Maine). Humanized NSG mice are NOD *scid* IL-2 receptor gamma chain knockout mice (NSG) engrafted with human hematopoietic stem cells ($hCD34^+$ cells) to reconstitute a human immune system.

[00606] These mice can serve as a platform for studying toxicity of anti-KIT antibodies. For example, groups of mice (*e.g.*, 1-5 mice) are injected with various concentrations of anti-KIT antibodies over a period of time (*e.g.*, 4-16 weeks). The mice are assessed for toxicity indicators, *e.g.*, body weight, survival length.

6.9 Example 9: Inhibition of colony formation by KIT expressing CHO cells in soft agar assays

[00607] Anti-KIT antibodies described herein, for example Hum1-Hum20, are tested for their ability to inhibit anchorage independent cell growth in soft agar assays of CHO/KIT-WT cells. Soft agar assay for colony formation is an anchorage independent growth assay, which is a useful assay for detecting malignant transformation of cells. *In vitro* transformation is associated with certain phenotypic changes such as loss of contact inhibition (cells can grow over one another) and anchorage independence (cells form colonies in soft agar). In general, nontransformed cells fail to grow when suspended in a viscous fluid or gel (*e.g.* agar or agarose), however when these cells are transformed, they are able to grow in a viscous fluid or gel and become anchorage-independent. The process by which these phenotypic changes occur, is assumed to be closely related to the process of *in vivo* carcinogenesis.

[00608] The soft agar assays are carried out as follows. Base agar layer (containing agar and cell culture medium) is added to each well of a 96 well plate. Cell agar layer (containing agar, cell culture medium and cell suspension) is added on top of the base agar layer. Anti-KIT antibodies are diluted in cell culture medium and pipetted on top of the layers. The control samples do not contain any antibodies. Plates are incubated at 37°C and 5% CO_2 for 5-8 days in the presence or absence of 30 ng/mL SCF. The ligand SCF and anti-KIT antibodies (100 nM) are added concurrently to the agar.

[00609] When treatment is completed, the agar is solubilized and the cells are lysed. The green fluorescent Cyquant® GR dye is mixed with the lysates. This dye exhibits fluorescence when bound to cellular nucleic acids. Fluorescence is measured at 480 nm excitation and 520 nm emission.

[00610] The embodiments described herein are intended to be merely exemplary, and those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, numerous equivalents to the specific procedures described herein. All such equivalents are considered to be within the scope of the present invention and are covered by the following claims. Furthermore, as used in this specification and claims, the singular forms "a," "an" and "the" include plural forms unless the content clearly dictates otherwise. Thus, for example, reference to "an antibody" includes a mixture of two or more such antibodies, and the like. Additionally, ordinarily skilled artisans will recognize that operational sequences must be set

forth in some specific order for the purpose of explanation and claiming, but the present invention contemplates various changes beyond such specific order.

[00611] All references (including patent applications, patents, and publications) cited herein are incorporated herein by reference in their entirety and for all purposes to the same extent as if each individual publication or patent or patent application was specifically and individually indicated to be incorporated by reference in its entirety for all purposes.

WHAT IS CLAIMED:

1. An isolated antibody, or an antigen-binding fragment thereof, which immunospecifically binds to a D4 region of human KIT, wherein

(i) the light chain variable region ("VL") comprises the amino acid sequence of SEQ ID NO: 8 and the heavy chain variable region ("VH") comprises the amino acid sequence of SEQ ID NO: 4;

(ii) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 3;

(iii) the VL comprises the amino acid sequence of SEQ ID NO: 8 and the VH comprises the amino acid sequence of SEQ ID NO: 6;

(iv) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 5;

(v) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 2;

(vi) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 3;

(vii) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 4;

(viii) the VL comprises the amino acid sequence of SEQ ID NO: 7 and the VH comprises the amino acid sequence of SEQ ID NO: 6;

(ix) the VL comprises the amino acid sequence of SEQ ID NO: 8 and the VH comprises the amino acid sequence of SEQ ID NO: 2;

(x) the VL comprises the amino acid sequence of SEQ ID NO: 8 and the VH comprises the amino acid sequence of SEQ ID NO: 3;

(xi) the VL comprises the amino acid sequence of SEQ ID NO: 8 and the VH comprises the amino acid sequence of SEQ ID NO: 5;

(xii) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 2;

(xiii) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 3;

(xiv) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 4;

(xv) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 5;

(xvi) the VL comprises the amino acid sequence of SEQ ID NO: 9 and the VH comprises the amino acid sequence of SEQ ID NO: 6;

(xvii) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 2;

(xviii) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 4;

(xix) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 5; or

(xx) the VL comprises the amino acid sequence of SEQ ID NO: 10 and the VH comprises the amino acid sequence of SEQ ID NO: 6,

wherein the VL and VH are non-immunogenic in a human.

2. An isolated antibody, or an antigen-binding fragment thereof, which immunospecifically binds to a D4 region of human KIT, which comprises:

(i) a light chain variable region ("VL") comprising the amino acid sequence: DIVMTQSPS$\mathbf{X_{K1}}$LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPK$\mathbf{X_{K2}}$LIYSASYR YSGVPDRF$\mathbf{X_{K3}}$GSGSGTDFTLTISSLQ$\mathbf{X_{K4}}$EDFA$\mathbf{X_{K5}}$Y$\mathbf{X_{K6}}$CQQYNSYPRTFGGGTKVEI K, wherein $\mathbf{X_{K1}}$ is an amino acid with an aromatic or aliphatic hydroxyl side chain, $\mathbf{X_{K2}}$ is an amino acid with an aromatic or aliphatic hydroxyl side chain, $\mathbf{X_{K3}}$ is an amino acid with an aliphatic hydroxyl side chain, $\mathbf{X_{K4}}$ is an amino acid with an aliphatic hydroxyl side chain or is P, $\mathbf{X_{K5}}$ is an amino acid with a charged or acidic side chain, and $\mathbf{X_{K6}}$ is an amino acid with an aromatic side chain; and

(ii) a heavy chain variable region ("VH") comprising a VH CDR1, VH CDR2, and VH CDR3 having the amino acid sequences of SEQ ID NO: 16, SEQ ID NO: 17, and SEQ ID NO: 18, respectively,

wherein the VL and VH are non-immunogenic in a human,

wherein the antibody or antigen-binding fragment thereof inhibits tyrosine phosphorylation of KIT with an IC50 of about 600 pM or less as determined by ELISA, and

wherein the antibody or antigen-binding fragment thereof induces KIT receptor internalization.

3. An isolated antibody, or an antigen-binding fragment thereof, which immunospecifically binds to a D4 region of human KIT, which comprises:

(i) a VL comprising a VL CDR1, VL CDR2, and VL CDR3 having the amino acid sequences of SEQ ID NO: 19, SEQ ID NO: 20, and SEQ ID NO: 21, respectively; and

(ii) a VH comprising the amino acid sequence: QVQLVQSGAEX_{H1}KKPGASVKX_{H2}SCKASGYTFTDYYINWVX_{H3}QAPGKGLEWIARIYPGSGNTYYNEKFKGRX_{H4}TX_{H5}TAX_{H6}KSTSTAYMX_{H7}LSSLRSEDX_{H8}AVYFCARGVYYFDYWGQGTTVTVSS, wherein X_{H1} is an amino acid with an aliphatic side chain, X_{H2} is an amino acid with an aliphatic side chain, X_{H3} is an amino acid with a polar or basic side chain, X_{H4} is an amino acid with an aliphatic side chain, X_{H5} is an amino acid with an aliphatic side chain, X_{H6} is an amino acid with an acidic side chain, X_{H7} is an amino acid with an acidic or amide derivative side chain, and X_{H8} is an amino acid with an aliphatic hydroxyl side chain,

wherein the VL and VH are non-immunogenic in a human,

wherein the antibody or antigen-binding fragment thereof inhibits tyrosine phosphorylation of KIT with an IC50 of about 600 pM or less as determined by ELISA, and

wherein the antibody or antigen-binding fragment thereof induces KIT receptor internalization.

4. The antibody of claim 2 or 3, which comprises:

(i) a light chain variable region ("VL") comprising the amino acid sequence:
DIVMTQSPSX_{K1}LSASVGDRVTITCKASQNVRTNVAWYQQKPGKAPKX_{K2}LIYSASYRYSGVPDRFX_{K3}GSGSGTDFTLTISSLQX_{K4}EDFAX_{K5}YX_{K6}CQQYNSYPRTFGGGTKVEIK, wherein X_{K1} is an amino acid with an aromatic or aliphatic hydroxyl side chain, X_{K2} is an amino acid with an aromatic or aliphatic hydroxyl side chain, X_{K3} is an

amino acid with an aliphatic hydroxyl side chain, X_{K4} is an amino acid with an aliphatic hydroxyl side chain or is P, X_{K5} is an amino acid with a charged or acidic side chain, and X_{K6} is an amino acid with an aromatic side chain; and

(ii) a VH comprising the amino acid sequence: QVQLVQSGAEX_{H1}KKPGASVKX_{H2}SCKASGYTFTDYYINWVX_{H3}QAPGKGLEWIARIYPGSGNTYYNEKFKGRX_{H4}TX_{H5}TAX_{H6}KSTSTAYMX_{H7}LSSLRSEDX_{H8}AVYFCARGVYYFDYWGQGTTVTVSS, wherein X_{H1} is an amino acid with an aliphatic side chain, X_{H2} is an amino acid with an aliphatic side chain, X_{H3} is an amino acid with a polar or basic side chain, X_{H4} is an amino acid with an aliphatic side chain, X_{H5} is an amino acid with an aliphatic side chain, X_{H6} is an amino acid with an acidic side chain, X_{H7} is an amino acid with an acidic or amide derivative side chain, and X_{H8} is an amino acid with an aliphatic hydroxyl side chain.

5. The antibody of claim 4, wherein X_{K1} is the amino acid F or S, X_{K2} is the amino acid A or S, X_{K3} is the amino acid T or S, X_{K4} is the amino acid S or P, X_{K5} is the amino acid D or T, and X_{K6} is the amino acid F or Y.

6. The antibody of claim 4, wherein X_{H1} is the amino acid L or V, X_{H2} is the amino acid L or V, X_{H3} is the amino acid K or R, X_{H4} is the amino acid V or A, X_{H5} is the amino acid L or I, X_{H6} is the amino acid E or D, X_{H7} is the amino acid Q or E, and X_{H8} is the amino acid S or T.

7. The antibody of any one of claims 1 to 6, wherein the antibody specifically binds to CHO cells recombinantly expressing wild-type KIT with an EC50 of about 150 pM or less as determined by flow cytometry.

8. The antibody of any one of claims 1 to 6, which can be expressed in CHO cells at a titer of at least 1.0 μg/mL, or at least 1.1 μg/mL, or at least 1.2 μg/mL.

9. The antibody of any one of claims 1 to 6, wherein the antibody further comprises a human kappa light chain constant region and a human gamma heavy chain constant region.

10. The antibody of any one of claims 1 to 6, wherein the antibody is a human IgG1 or IgG4 antibody.

11. The antibody of any one of claims 1 to 6, which is a monoclonal antibody.

12. The antibody of any one of claims 1 to 6, which is an antigen-binding fragment or a Fab fragment.

13. The antibody of any one of claims 1 to 6, which is a bispecific antibody.

14. The antibody of any one of claims 1 to 6, which is fused to a heterologous polypeptide.

15. A conjugate comprising the antibody of any one of claims 1 to 6 or a antigen-binding fragment thereof linked to an agent.

16. The conjugate of claim 15, wherein the agent is a toxin.

17. The conjugate of claim 16, wherein the toxin is abrin, ricin A, pseudomonas exotoxin, cholera toxin, or diphtheria toxin.

18. The conjugate of claim 15, wherein the conjugate is internalized by a cell.

19. A pharmaceutical composition comprising the conjugate of claim 15 and a pharmaceutically acceptable carrier.

20. A pharmaceutical composition comprising the antibody of any one of claims 1 to 6 and a pharmaceutically acceptable carrier.

21. A polynucleotide comprising nucleotide sequences encoding a VH chain region, a VL chain region, or both a VL chain region and a VH chain region, of an antibody of any one of claims 1 to 6.

22. The polynucleotide of claim 21, which comprises SEQ ID NO: 22, 23, 24, 25, or 26 encoding a VH.

23. The polynucleotide of claim 21, which comprises SEQ ID NO: 27, 28, 29, or 30 encoding a VL.

24. The polynucleotide of claim 21, which comprises SEQ ID NO: 22, 23, 24, 25, or 26 encoding a VH, and SEQ ID NO: 27, 28, 29, or 30 encoding a VL.

25. A vector comprising the polynucleotide of claim 21.

26. The vector of claim 25, which is a mammalian expression vector.

27. A host cell comprising the vector of claim 25 or one or more polynucleotides of claim 21.

28. An isolated cell producing an antibody according to any one of claims 1 to 6.

29. An isolated cell comprising one or more polynucleotides of claim 21, wherein the cell can express an antibody which specifically binds to a D4 of human KIT.

30. A cell comprising the vector of claim 25.

31. A kit comprising the antibody of any one of claims 1 to 6.

32. A kit comprising the conjugate of claim 15.

33. Use of an antibody of any one of claims 1 to 6 in the manufacture of a medicament for treating or managing a KIT-associated disorderwherein the KIT-associated disorder is selected from the group consisting of cancer, an inflammatory condition, and fibrosis.

34. Use of a conjugate of claim 15 in the manufacture of a medicament for treating or managing a KIT-associated disorder, wherein the KIT-associated disorder is selected from the group consisting of cancer, an inflammatory condition, and fibrosis.

35. The use of claim 33 or 34, wherein the cancer is leukemia, chronic myelogenous leukemia, lung cancer, small cell lung cancer, or gastrointestinal stromal tumors.

36. The use of claim 35, wherein the cancer is refractory to treatment by a tyrosine kinase inhibitor.

37. The use of claim 36, wherein the tyrosine kinase inhibitor is imatinib mesylate or SU11248.

38. The use of claim 33 or 34, wherein the use further comprises administration of a second therapeutic agent.

39. The use of claim 38, wherein the second therapeutic agent is a chemotherapeutic agent, tyrosine kinase inhibitor, a histone deacetylase inhibitor, an antibody, or a cytokine.

40. The use of claim 39, wherein the tyrosine kinase inhibitor is imatinib mesylate or SU11248.

41. An *in vitro* method for diagnosing a subject with a KIT-associated disorder comprising contacting cells or a sample obtained from the subject with the antibody of any one of claims 1 to 6 and detecting the expression level of KIT in the cells or the sample.

42. The method of claim 41, wherein the antibody is conjugated to a detectable molecule.

43. The method of claim 42, wherein the detectable molecule is an enzyme, a fluorescent molecule, a luminescent molecule, or a radioactive molecule.

44. An *in vitro* method for inhibiting KIT activity in a cell expressing KIT comprising contacting the cell with an effective amount of the antibody of any one of claims 1 to 6.

45. An *in vitro* method for inducing or enhancing apoptosis in a cell expressing KIT comprising contacting the cell with an effective amount of the antibody of any one of claims 1 to 6.

46. An *in vitro* method for inducing cell differentiation comprising contacting a cell expressing KIT with an effective amount of the antibody of any one of claims 1 to 6.

47. The method of claim 46, wherein the cell is a stem cell.

48. A method of making an antibody which immunospecifically binds to a D4 region of human comprising culturing, and/or expressing the antibody using, the cell of claim 27.

49. The method claim 48 further comprising purifying the antibody obtained from said cell.