

ANTAGONISTIC CD40 MONOCLONAL ANTIBODIES AND USES THEREOF**CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims the benefit of U.S. Provisional Application No.
5 62/769,514, filed November 19, 2018, which is hereby incorporated in its entirety for all purposes.

SEQUENCE LISTING

[0002] The instant application contains a Sequence Listing which has been submitted electronically in ASCII format and is hereby incorporated by reference in its entirety. Said
10 ASCII copy, created on November 13, 2019, is named 200896-0015-00-WO-592417_SL.txt and is 170,111 bytes in size.

FIELD

[0003] The disclosure provides antibodies that bind CD40. The antibody polypeptides bind CD40 and do not exhibit CD40 agonist activity. The antibodies may
15 comprise a modified IgG1 Fc domain, and exhibit minimal activation of immature dendritic cells. Compositions comprising antibodies, methods of use for treatment of diseases involving CD40 activity, and use in the preparation of a medicament for treatment of a disease involving CD40 activity are provided.

BACKGROUND

20 [0004] CD40 is a co-stimulatory molecule belonging to the tumor necrosis factor (TNF) receptor superfamily that is present on antigen presenting cells (APC), including dendritic cells, B cells, and macrophages. APCs are activated when CD40 binds its ligand, CD154 (CD40L), on T_H cells. CD40-mediated APC activation is involved in a variety of immune responses, including cytokine production, up-regulation of co-stimulatory molecules
25 (such as CD86), and enhanced antigen presentation and B cell proliferation. CD40 can also be expressed by endothelial cells, smooth muscle cells, fibroblasts, and epithelial cells.

[0005] CD40 activation is also involved in a variety of undesired T cell responses related to autoimmunity, transplant rejection, or allergic responses, for example. One strategy for controlling undesirable T cell responses is to target CD40 with an antagonistic
30 antibody. For example, monoclonal antibody HCD122 (Lucatumumab), formerly known as

Chiron 1212, is currently in clinical trials for the treatment of certain CD40-mediated inflammatory diseases. *See* “Study of HCD122 (Lucatumumab) and Bendamustine Combination Therapy in CD40⁺ Rituximab-Refractory Follicular Lymphoma,” Clinical Trials Feeds, on the Internet at [hypertext transfer protocol: clinicaltrialsfeeds.org/clinical-trials/show/NCT01275209](http://hypertexttransferprotocol:clinicaltrialsfeeds.org/clinical-trials/show/NCT01275209) (last updated January 11, 2011). Monoclonal antibodies, however, can display agonist activity. For example, the usefulness of the anti-CD40 antibody, Chi220, is limited by its weak stimulatory potential. *See* Adams, et al., “Development of a chimeric anti-CD40 monoclonal antibody that synergizes with LEA29Y to prolong islet allograft survival,” *J. Immunol.* 174: 542-50 (2005).

10 SUMMARY

[0006] In a first embodiment, the present invention provides an isolated antibody, or antigen binding portion thereof, that specifically binds to human CD40, wherein the antibody comprises a first polypeptide portion comprising a heavy chain variable region, and a second polypeptide portion comprising a light chain variable region, wherein:

15 the heavy chain variable region comprises one of (i) a CDR1 comprising SYWMH (SEQ ID NO: 1), a CDR2 comprising QINPTTGRSQYNEKFKT (SEQ ID NO: 2), a CDR3 comprising WGLQPFAY (SEQ ID NO: 3); and (ii) a CDR1 comprising SYWMH (SEQ ID NO: 1), a CDR2 comprising QINPSQGRSQYNEKFKT (SEQ ID NO: 12), a CDR3 comprising WGLQPFAY (SEQ ID NO: 3); and

20 the light chain variable region comprises a CDR1 comprising KASQDVSTAVA (SEQ ID NO: 7), a CDR2 comprising SASYRYT (SEQ ID NO: 8), and a CDR3 comprising QQHYSTPWT (SEQ ID NO: 9).

[0007] The present invention further provides an isolated antibody or antigen binding portion thereof, that specifically binds to human CD40, wherein the antibody comprises a first polypeptide portion comprising a heavy chain variable region, and a second polypeptide portion comprising a light chain variable region, wherein:

25 the heavy chain variable region comprises one of (i) a CDR1 consisting of SYWMH (SEQ ID NO: 1), a CDR2 consisting of QINPTTGRSQYNEKFKT (SEQ ID NO: 2), a CDR3 consisting of WGLQPFAY (SEQ ID NO: 3); and (ii) a CDR1 consisting of SYWMH (SEQ ID NO: 1), a CDR2 consisting of QINPSQGRSQYNEKFKT (SEQ ID NO: 12), a CDR3 consisting of WGLQPFAY (SEQ ID NO: 3); and

the light chain variable region comprises a CDR1 consisting of

KASQDVSTAVA (SEQ ID NO: 7), a CDR2 consisting of SASYRYT (SEQ ID NO: 8), and a CDR3 consisting of QQHYSTPWT (SEQ ID NO: 9).

[0008] The present invention further provides an isolated antibody or antigen binding portion thereof, that specifically binds to human CD40, wherein the antibody comprises a first polypeptide portion comprising a heavy chain variable region, and a second polypeptide portion comprising a light chain variable region, wherein:

the heavy chain variable region comprises a CDR1 consisting of SYWMH (SEQ ID NO: 1), a CDR2 consisting of QINPTTGRSQYNEKFKT (SEQ ID NO: 2), a CDR3 consisting of WGLQPFAY (SEQ ID NO: 3); and

the light chain variable region comprises a CDR1 consisting of KASQDVSTAVA (SEQ ID NO: 7), a CDR2 consisting of SASYRYT (SEQ ID NO: 8), and a CDR3 consisting of QQHYSTPWT (SEQ ID NO: 9).

[0009] The present invention further provides an isolated antibody or antigen binding portion thereof, that specifically binds to human CD40, wherein the antibody comprises a first polypeptide portion comprising a heavy chain variable region, and a second polypeptide portion comprising a light chain variable region, wherein:

the heavy chain variable region comprises the amino acid sequence of QVQLVQSGAEVKKPGSSVKVSCKASGYAFTSYWMHWVRQAPGQGLEWMGQINPTTGRSQYNEKFKTRVTTITADKSTSTAYMELSSLRSED~~TAVYYCAR~~WGLQPFAYWGQ

GTLVTVSS (SEQ ID NO: 4),

and the light chain variable region comprises the amino acid sequence of DIQMTQSPSFLSASVGDRVTITCKASQDVSTAVAWYQQKPGKAPKLLIYSASYRYTGVPSRFSGSGSGTDFTLTISLQPEDFATYYCQQHYSTPWTFGGGTKVEIK (SEQ ID NO: 10).

[0010] The present invention further provides an isolated antibody or antigen binding portion thereof, that specifically binds to human CD40, wherein the antibody comprises a first polypeptide portion comprising a heavy chain variable region, and a second polypeptide portion comprising a light chain variable region, wherein the heavy chain variable region comprises the amino acid sequence of

QVQLVQSGAEVKKPGSSVKVSCKASGYAFTSYWMHWVRQAPGQGLEWMGQINPSQGRSQYNEKFKTRVTTITADKSTSTAYMELSSLRSED~~TAVYYCAR~~WGLQPFAYWGQGTLVTVSS (SEQ ID NO: 13),

and the light chain variable region comprises the amino acid sequence of

EIVMTQSPATLSVSPGERATLSCKASQDVSTAVAWYQQKPGQAPRLLI
YSASYRYTGIPARFSGSGSGTEFTLTISSLQSEDFAVYYCQOHYSTPWTFGGGTKVEI
K (SEQ ID NO: 16).

- 5 [0011] The present invention further provides an isolated antibody or antigen binding portion thereof, that specifically binds to human CD40, wherein the antibody comprises a first polypeptide portion comprising a heavy chain variable region, and a second polypeptide portion comprising a light chain variable region, wherein the heavy chain variable region comprises the amino acid sequence of

10 QVQLVQSGAEVKKPGSSVKVSCKASGYAFTSYWMHWVRQAPGQGL
EWMGQINPTTGRSQYNEKFKTRVTTITADKSTSTAYMELSSLRSEDFAVYYCARWG
LQPFAYWGQGLTVTVSS (SEQ ID NO: 4),

and the light chain variable region comprises the amino acid sequence of

EIVMTQSPATLSVSPGERATLSCKASQDVSTAVAWYQQKPGQAPRLLI
15 YSASYRYTGIPARFSGSGSGTEFTLTISSLQSEDFAVYYCQOHYSTPWTFGGGTKVEI
K (SEQ ID NO: 16).

[0012] In certain embodiments, the isolated antibody or antigen binding portion thereof comprises the first polypeptide portion comprising a human heavy chain constant region; and the second polypeptide portion comprising a human light chain constant region.

- 20 The isolated antibody or antigen binding portion thereof described herein can comprise a human IgG1 Fc domain comprising either (1) a mutation at Kabat position 238 that reduces binding to Fc-gamma-receptors (FcγRs), wherein proline 238 (P238) is mutated to one of the residues selected from the group consisting of lysine, serine, alanine, arginine, and tryptophan, and wherein the antibody or antigen binding portion thereof has reduced FcγR
25 binding; or (2) an alanine substituted at Kabat position 297.

[0013] The isolated antibody or antigen binding portion thereof described herein can comprise a human IgG1 Fc domain comprising a mutation at Kabat position 238 that reduces binding to Fc-gamma-receptors (FcγRs), wherein proline 238 (P238) is mutated to one of the residues selected from the group consisting of lysine, serine, alanine, arginine, and tryptophan, and wherein the antibody or antigen binding portion has reduced FcγR binding.
30 In certain embodiments, P238 is mutated to lysine.

[0014] The isolated antibody or antigen binding portion thereof described herein can comprise an Fc domain which comprises an amino acid sequence selected from:

EPKSCDKTHTCPPCPAPELLGGK^SSVFLFPPKPKDTLMISRTPEVTCV^VV
DVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKE
5 YKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSD
IAVEWESNGQPENNYKTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEAL
HNHYTQKSLSLSPG (SEQ ID NO: 22 ;IgG1-P238K (-C-term Lys)),

EPKSCDKTHTCPPCPAPELLGGK^SSVFLFPPKPKDTLMISRTPEVTCV^VV
DVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKE
10 YKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSD
IAVEWESNGQPENNYKTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEAL
HNHYTQKSLSLSPGK (SEQ ID NO: 23;IgG1-P238K),

ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTS
GVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKRV
15 EPKSCDK
THTCPPCPAPELLGGK^SSVFLFPPKPKDTLMISRTPEVTCV^VVVDVSHEDPEVKFNWYV
DGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEK
TISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNY
KTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPG
(SEQ ID NO: 24;CH1-IgG1-P238K (-C-term Lys)),

20 ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTS
GVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKRV
EPKSCDK
THTCPPCPAPELLGGK^SSVFLFPPKPKDTLMISRTPEVTCV^VVVDVSHEDPEVKFNWYV
DGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEK
TISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNY
25 KTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK
(SEQ ID NO: 25;CH1-IgG1-P238K),

EPKSCDKTHTCPPCPAPELLGGK^SSVFLFPPKPKDTLMISRTPEVTCV^VV
DVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKE
YKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSD
30 IAVEWESNGQPENNYKTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEAL
HNHYTQKSLSLSPG (SEQ ID NO: 26; IgG1f-P238K (-C-term Lys)),

EPKSCDKTHTCPPCPAPELLGGK^SSVFLFPPKPKDTLMISRTPEVTCV^VV
DVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKE

YKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSD
IAVEWESNGQPENNYKTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEAL
HNHYTQKSLSLSPGK (SEQ ID NO: 27; IgG1f-P238K),

ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTS
5 GVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKRVEPKSCDK
THTCPPCPAPELLGGKSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYV
DGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEK
TISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNY
KTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPG
10 (SEQ ID NO: 28; CH1-IgG1f-P238K (-C-term Lys)),

or

ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTS
GVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKRVEPKSCDK
THTCPPCPAPELLGGKSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYV
15 DGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEK
TISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNY
KTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK
(SEQ ID No: 29; CH1-IgG1f-P238K).

[0015] In certain embodiments, the isolated antibody or antigen binding portion
20 thereof described herein comprises a human IgG1 Fc domain comprising either (1) a
mutation at Kabat position 238 that reduces binding to Fc-gamma-receptors (FcγRs), wherein
proline 238 (P238) is mutated to one of the residues selected from the group consisting of
lysine, serine, alanine, arginine, and tryptophan, and wherein the antibody or antigen binding
portion thereof has reduced FcγR binding; or (2) an alanine substituted at Kabat position 297,
25 comprises a heavy chain variable region comprising a CDR1 comprising SYWMH (SEQ ID
NO: 1), a CDR2 comprising QINPTTGRSQYNEKFKT (SEQ ID NO: 2), a CDR3
comprising WGLQPFAY (SEQ ID NO: 3); and a light chain variable region comprising a
CDR1 comprising KASQDVSTAVA (SEQ ID NO: 7), a CDR2 comprising SASYRYT
(SEQ ID NO: 8), and a CDR3 comprising QQHYSTPWT (SEQ ID NO: 9).

30 **[0016]** The isolated antibody or antigen binding portion thereof can comprise a
human IgG1 Fc domain comprising the amino acid sequence of SEQ ID NO: 22 or SEQ ID
NO: 23.

[0017] In some embodiments of the isolated antibody or antigen binding portion thereof described herein, the first polypeptide portion comprises or consists of an amino acid sequence selected from the group consisting of:

QVQLVQSGAEVKKPGSSVKVSCKASGYAFTSYWMHWVRQAPGQGL
 5 EWMGQINPTTGRSQYNEKFKTRVTITADKSTSTAYMELSSLRSED~~TA~~VYYCARWG
LOPFAYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTISWN
 SGALTSGVHTFPAVLQSSGLYSLSSVVPSSSLGTQTYICNVNHKPSNTKVDKRVEPKSCD
 KTHTCPPCPAPELLGGKSVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEVKFNWY
 VDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIE
 10 KTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENN
 YKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVFCFSVMHEALHNHYTQKSLSLSPG
 (SEQ ID NO: 5; HC_Y12XX-hz28-CH1-IgG1-P238K- no terminal lysine),

QVQLVQSGAEVKKPGSSVKVSCKASGYAFTSYWMHWVRQAPGQGL
 EWMGQINPTTGRSQYNEKFKTRVTITADKSTSTAYMELSSLRSED~~TA~~VYYCARWG
 15 LOPFAYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTISWN
 SGALTSGVHTFPAVLQSSGLYSLSSVVPSSSLGTQTYICNVNHKPSNTKVDKRVEPKSCD
 KTHTCPPCPAPELLGGKSVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEVKFNWY
 VDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIE
 KTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENN
 20 YKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVFCFSVMHEALHNHYTQKSLSLSPG
 K (SEQ ID NO: 6; HC_Y12XX-hz28-CH1-IgG1-P238K- with terminal lysine),

QVQLVQSGAEVKKPGSSVKVSCKASGYAFTSYWMHWVRQAPGQGL
 EWMGQINPTTGRSQYNEKFKTRVTITADKSTSTAYMELSSLRSED~~TA~~VYYCARWG
LOPFAYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTISWN
 25 SGALTSGVHTFPAVLQSSGLYSLSSVVPSSSLGTQTYICNVNHKPSNTKVDKRVEPKSCD
 KTHTCPPCPAPELLGGKSVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEVKFNWY
 VDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIE
 KTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENN
 YKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVFCFSVMHEALHNHYTQKSLSLSPG
 30 (SEQ ID NO: 30; HC_Y12XX-hz28-CH1-IgG1f-P238K- no terminal lysine), and

QVQLVQSGAEVKKPGSSVKVSCKASGYAFTSYWMHWVRQAPGQGL
 EWMGQINPTTGRSQYNEKFKTRVTITADKSTSTAYMELSSLRSED~~TA~~VYYCARWG
LOPFAYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTISWN

SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKRVEPKSCD
 KTHTCPPCPAPELLGGKSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWY
 VDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIE
 KTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENN
 5 YKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPG
 K (SEQ ID NO: 31; HC_Y12XX-hz28-CH1-IgG1f-P238K- with terminal lysine);
 and

the second polypeptide portion comprises or consists of the amino acid
 sequence of

10 DIQMTQSPSFLSASVGDRVTTITCKASQDVSTAVAWYQQKPGKAPKLLIYSASYRYT
 GVPSRFSGSGSGTDFTLTISLQPEDFATYYCQQHYSTPWTFGGGTKVEIKRTVAAPS
 VFIFPPSDEQLKSGTASVVCLLNFPYREAKVQWKVDNALQSGNSQESVTEQDSKDYSL
 SSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC (SEQ ID NO: 11; LC_Y12XX-
 hz28-CL).

15 **[0018]** In some embodiments of the isolated antibody or antigen binding portion
 thereof described herein, the first polypeptide portion comprises or consists of an amino acid
 sequence of

QVQLVQSGAEVKKPGSSVKVSCKASGYAFTSYWMHWVRQAPGQGLEWMG
QINPTTGRSQYNEKFKTRVTTITADKSTSTAYMELSSLRSEDTAVYYCARWGLOPF
 20 AYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALT
 SGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKRVEPKSCDKTHT
 CPPCPAPELLGGKSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGV
 EVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISK
 AKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTTP
 25 PVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPG (SEQ ID
 NO: 5; HC_Y12XX-hz28-CH1-IgG1-P238K- no terminal lysine);
 and

the second polypeptide portion comprises or consists of the amino acid sequence of

DIQMTQSPSFLSASVGDRVTTITCKASQDVSTAVAWYQQKPGKAPKLLIYSASYRYT
 30 GVPSRFSGSGSGTDFTLTISLQPEDFATYYCQQHYSTPWTFGGGTKVEIKRTVAAPS
 VFIFPPSDEQLKSGTASVVCLLNFPYREAKVQWKVDNALQSGNSQESVTEQDSKDYSL

SSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC (SEQ ID NO: 11; LC_Y12XX-hz28-CL).

[0019] In certain embodiments, the isolated antibody or antigen binding portion thereof described herein comprises a human IgG1 Fc domain comprising an alanine substituted at Kabat position 297.

[0020] The isolated antibody or antigen binding portion thereof as described herein can antagonize activities of CD40. The isolated antibody or antigen binding portion thereof described herein can be a chimeric antibody. The isolated antibody or antigen binding portion thereof described herein can be a humanized antibody. The isolated antibody or antigen binding portion thereof described herein can comprise a human heavy chain constant region and a human light chain constant region.

[0021] The antibody or antigen binding portion thereof disclosed herein, is an antigen binding portion selected from the group consisting of Fv, Fab, F(ab')₂, Fab', dsFv, scFv, sc(Fv)₂, diabodies, and scFv-Fc. The isolated antibody or antigen binding portion thereof as described herein is an scFv-Fc.

[0022] The antibody or antigen binding portion thereof disclosed herein can be linked to a therapeutic agent.

[0023] The antibody or antigen binding portion thereof disclosed herein can be linked to a second functional moiety having a different binding specificity than said antibody or antigen binding portion thereof.

[0024] The antibody or antigen binding portion thereof disclosed herein can further comprise an additional moiety.

[0025] A nucleic acid molecule encoding an isolated antibody or antigen binding portion thereof is disclosed herein. An expression vector comprising the nucleic acid molecule is disclosed herein. Also contemplated is a cell transformed with the expression vector. Also disclosed is a method of preparing an anti-human CD40 antibody, or antigen binding portion thereof, comprising:

- a) expressing the antibody, or antigen binding portion thereof, in the cell transformed with the expression vector comprising the nucleic acid molecule encoding an isolated antibody or antigen binding portion thereof disclosed herein; and
- b) isolating the antibody, or antigen binding portion thereof, from the cell.

[0026] Also provided is a pharmaceutical composition comprising: a) the antibody, or antigen binding portion thereof disclosed herein; and b) a pharmaceutically acceptable carrier.

[0027] A method is provided of treating or preventing an immune response in a subject comprising administering to the subject the antibody, or the antigen binding portion thereof, disclosed herein. Further provided is a method of treating or preventing an autoimmune or inflammatory disease in a subject, comprising administering to the subject the antibody, or the antigen binding portion, disclosed herein. Optionally, the antibody, or the antigen binding portion thereof, is administered with an immunosuppressive/immunomodulatory and/or anti-inflammatory agent. Administration may be simultaneous or sequential. An exemplary agent is a CTLA4 mutant molecule, such as L104EA29Y-Ig (belatacept). In such method of treating or preventing an immune response in the subject, and in such method of treating or preventing an autoimmune or inflammatory disease in a subject, preferably the subject has a disease selected from the group consisting of: Addison's disease, allergies, anaphylaxis, ankylosing spondylitis, asthma, atherosclerosis, atopic allergy, autoimmune diseases of the ear, autoimmune diseases of the eye, autoimmune hepatitis, autoimmune parotitis, bronchial asthma, coronary heart disease, Crohn's disease, diabetes, epididymitis, glomerulonephritis, Graves' disease, Guillain-Barre syndrome, Hashimoto's disease, hemolytic anemia, idiopathic thrombocytopenic purpura, inflammatory bowel disease, immune response to recombinant drug products (e.g., Factor VII in hemophiliacs), lupus nephritis, lupus nephritis, systemic lupus erythematosus, multiple sclerosis, myasthenia gravis, pemphigus, psoriasis, rheumatic fever, rheumatoid arthritis, sarcoidosis, scleroderma, Sjogren's syndrome, spondyloarthropathies, thyroiditis, transplant rejection, vasculitis, and ulcerative colitis.

[0028] Also contemplated is an antibody, or antigen binding portion thereof as disclosed here, for use as a medicament. Further contemplated is an antibody, or antigen binding portion thereof as disclosed here, or a medicament comprising the same, for use to treat a subject in need thereof. Further contemplated is an antibody, or antigen binding portion thereof as disclosed herein in a therapeutically-effective amount, for use in treating or preventing an immune response, wherein the antibody or antigen binding portion thereof is for administering to a patient in need thereof.

BRIEF DESCRIPTION OF THE FIGURES

[0029] **FIGURE 1**, comprising Figures 1A-1D, depicts SPR sensorgram data of binding of antibodies to human FcγRs. Figure 1A depicts data for a control antibody, control IgG1. Figure 1B depicts data for Y12XX-hx28-IgG1-P238K, control IgG1. Figure 1C depicts data for a control antibody, Antibody B. Figure 1D is a table summarizing the KD values for Antibody/FcγRs interactions. The KD values were obtained from either a 1:1 Langmuir fit (hCD64) or 1:1 steady state fit (hCD32a-H131, hCD32a-R131, hCD32b, hCD16a-V158, and hCD16a-F158).

[0030] **FIGURE 2**, comprising Figures 2A-2C, depicts iDC activation data for treatment of iDCs with humanized Y12XX antibodies or control antibodies with or without the addition of CD32a-expressing CHO cells. Increases in IL-6 (interleukin-6) from the cell culture media and cell surface marker expression, as indicated by flow cytometry mean fluorescence staining with anti-CD86 and anti-CD54 antibodies, were assessed. Figure 2A depicts IL-6 data. Figure 2B depicts CD86 data. Figure 2C depicts CD54 data. The mean fluorescence intensity (MFI) is measured on the Y-axis in both Figure 2B and Figure 2C. Each symbol represents data for iDC from an individual donor. Y12XX-hz42-P238K was tested in cells from 4 donors, Y12XX-hz40-P238K was tested in cells from 6 donors, and Y12XX-hz28-P238K was tested in 10 donors. Concentration of antibody in μg/ml is indicated (10, 30, or 100 μg/ml). Inclusion of CHO-CD32 cells in the assay is as indicated to mediate FcγR mediated cross-linking or clustering. Ly6-IgG was used as a negative control. Partial CD40 agonist 2141 and BMS986090-100 were used as positive controls.

[0031] **FIGURE 3**, comprising Figures 3A and 3B, depicts exemplary data from complement dependent cytotoxicity (CDC) analysis of humanized Y12XX antibodies, CD40 antibodies, and control antibodies. The CDC assay was performed twice. In the second assay, freshly thawed human complement serum was used. Figure 3A depicts the data from the first iteration of the assay, and Figure 3B depicts the data from the second iteration of the assay.

[0032] **FIGURE 4**, comprising Figures 4A and 4B, depicts exemplary data from antibody dependent cellular phagocytosis (ADCP) analysis of humanized Y12XX antibodies or control antibodies, using CD14+ monocytes from two different donors as effector cells.

Figure 4A depicts data obtained with donor #8 CD14+ monocytes as effector cells. Figure 4B depicts data obtained with donor #65 CD14+ monocytes as effector cells.

[0033] **FIGURE 5**, comprising Figures 5A and 5B, depicts exemplary data from antibody dependent cellular cytotoxicity (ADCC) analysis of humanized Y12XX antibodies or control antibodies, using NK cells from two different donors as effector cells. Figure 5A depicts data obtained with donor #38 NK cells as effector cells. Figure 5B depicts data obtained with donor #55 NK cells as effector cells.

[0034] **FIGURE 6**, comprising Figures 6A, 6B, 6C, and 6D, depicts data from an assay designed to assess the NF- κ B/AP-1 inducible SEAP activity on Ramos Blues Cells upon stimulation with different anti-CD40 antibodies. Representative results from three independent studies for the activity of CD40 mAbs are shown in Figures 6A and 6b. Figures 6C and 6D depict data for the positive control, CD40L-IZ. AIMV: AIM VTM medium (1 $\times$) (Thermo Fisher Scientific, Waltham, MA).

DETAILED DESCRIPTION

[0035] The present disclosure is directed to anti-CD40 antibodies, and in particular, antagonistic anti-CD40 antibodies. For therapeutic targets such as CD40, Fc γ R-mediated cross-linking of anti-CD40 antibodies has the potential to lead to undesirable agonist signaling and potential for toxicity. The present disclosure also describes antagonistic anti-CD40 antibodies having reduced engagement of the “low affinity” Fc γ Rs: hCD32a/Fc γ RIIa, hCD32b/Fc γ RIIb, and hCD16a/Fc γ RIIIa, as well as reduced engagement to “high affinity” Fc γ R hCD64. Reduced engagement of low affinity Fc γ Rs is expected to reduce the likelihood of undesirable agonist signaling and undesirable potential for toxicity.

Definitions & Abbreviations

[0036] Further abbreviations and definitions are provided below.

25	APC	antigen presenting cells
	CD54	also referred to as ICAM-1
	CDR	complementarity determining regions
	C _H or CH	constant heavy chain
	C _L or CL	constant light chain
30	CHO cell	Chinese hamster ovary cell

	dAb	domain antibody
	DC	dendritic cell
	FcγR	interchangeable with FcγR
	FcγR	Fc-gamma-receptor
5	FR	Framework region
	GM-CSF	granulocyte macrophage colony stimulating factor
	HC	heavy chain
	ICAM-1	intracellular adhesion molecule 1
	iDC	immature dendritic cells
10	IFN	interferon
	IgG	immunoglobulin G
	IL-6	interleukin-6
	LC	light chain
	mAb	monoclonal antibody
15	mg	milligram
	ml or mL	milliliter
	ng	nanogram
	nM	nanomolar
	pI	isoelectric point
20	SPR	surface plasmon resonance
	TNF	tumor necrosis factor
	μg	microgram
	μM	micromolar
	V _L or VL	variable light chain domain
25	V _k or VK	kappa variable light chain domain
	V _H or VH	variable heavy chain domain

[0037] In accordance with this detailed description, the following abbreviations and definitions apply. It must be noted that as used herein, the singular forms “a”, “an”, and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “an antibody” includes a plurality of such antibodies and reference to “the dosage” includes reference to one or more dosages and equivalents thereof known to those skilled in the art, and so forth.

[0038] As used here, the term “about” is understood by persons of ordinary skill in the art and will vary to some extent on the context in which it is used. Generally, “about” encompasses a range of values that are plus/minus 10% of a referenced value unless indicated otherwise in the specification.

- 5 **[0039]** It is understood that any and all whole or partial integers between the ranges set forth are included herein.

[0040] CD40 is also known and referred to as B-cell surface antigen CD40, Bp50, CD40L receptor, CDw40, CDW40, MGC9013, p50, TNFRSF5, and Tumor necrosis factor receptor superfamily member 5. “Human CD40” refers to the CD40 comprising the

- 10 following amino acid sequence:

MVRLPLQCVL WGCLLTAVHP EPPTACREKQ YLINSQCCSL CQPGQKLVSD
CTEFTETECL PCGESEFLDT WNRETHCHQH KYCDPNLGLR VQQKGTSETD
TICTCEEGWH CTSEACESCV LHRSCSPGFG VKQIATGVSD TICEPCPVGF
FSNVSSAFEK CHPWTSCETK DLVVQQAGTN KTDVVCGPQD RLRALVVIPI
15 IFGILFAILL VLVFIKKVAK KPTNKAPHPK QEPQEINFPD DLPGSNTAAP
VQETLHGCQP VTQEDGKESR ISVQERQ (SEQ ID NO: 20).

[0041] As used herein, the term “variable domain” refers to immunoglobulin variable domains defined by Kabat et al., Sequences of Immunological Interest, 5th ed., U.S. Dept. Health & Human Services, Washington, D.C. (1991). The numbering and positioning of
20 CDR amino acid residues within the variable domains is in accordance with the well-known Kabat numbering convention. VH, “variable heavy chain” and “variable heavy chain domain” refer to the variable domain of a heavy chain. VL, “variable light chain” and “variable light chain domain” refer to the variable domain of a light chain.

- [0042]** The term “human,” when applied to antibodies, means that the antibody has a
25 sequence, e.g., FR and/or CH domains, derived from a human immunoglobulin. A sequence is “derived from” a human immunoglobulin coding sequence when the sequence is either: (a) isolated from a human individual or from a cell or cell line from a human individual; (b) isolated from a library of cloned human antibody gene sequences or of human antibody variable domain sequences; or (c) diversified by mutation and selection from one or more of
30 the polypeptides above.

[0043] An “isolated” compound as used herein means that the compound is removed from at least one component with which the compound is naturally associated with in nature.

[0044] The anti-CD40 antibody of the present disclosure comprise a variable heavy chain and a variable light chain, each of which contains three complementarity-determining regions (CDRs) and four framework regions (FRs), arranged from amino-terminus to carboxy-terminus in the following order: FR1, CDR1, FR2, CDR2, FR3, CDR3, FR4. The CDRs contain most of the residues that form specific interactions with the antigen and are primarily responsible for antigen recognition.

[0045] The anti-CD40 antibody of the present disclosure can comprise CDRs of humanized antibody Y12XX-hz28 (Vh-hz14;Vk-hz2), Y12XX-hz40 (Vh-hz12;Vk-hz3), or Y12XX-hz42 (Vh-hz14;Vk-hz3). An overview of the amino acid sequences of the heavy chain variable region and light chain variable region is provided in Table 1. The table includes a short hand name and a more detailed name for each amino acid sequence, as well as the sequence identifiers.

15

TABLE 1

Antibody	HC Variable Region	LC Variable Region
Y12XX-hz28	Vh-hz14 (Y1268_IGHV1.6908-S54T-N55T-Vh) (SEQ ID NO: 4)	Vk-hz2 (Y1258_IGKV1.3902-Vk) (SEQ ID NO: 10)
Y12XX-hz40	Vy-hz12 (Y1268_IGHV1.6908-N55Q-Vh) (SEQ ID NO: 13)	Vk-hz3 (Y1258_IGKV3.1501-Vk) (SEQ ID NO: 16)
Y12XX-hz42	Vh-hz14 (Y1268_IGHV1.6908-S54T-N55T-Vh) (SEQ ID NO: 4)	Vk-hz3 (Y1258_IGKV3.1501-Vk) (SEQ ID NO: 16)

[0046] In a specific embodiment, the anti-CD40 antibodies of the present disclosure comprises the CDRs of humanized antibody Y12XX-hz28 (Vh-hz14;Vk-hz2). Detail of the amino acid sequences of Y12XX-hz28 is provided in Table 2.

TABLE 2
Y12XX-hz28 sequences (Vh-hz14; Vk-hz2)

Heavy chain variable region	QVQLVQSGAEVKKPGSSVKVSCASGYAFT <u>SYWMH</u> WVRQ APGQGLEWMG <u>QINPTTGRSQYNEKF</u> KT RVTITADKSTST AYMELSSLRSEDTAVYYCAR <u>WGLQPFAY</u> WGQGLVTVSS SEQ ID NO: 4)	Vh-hz14 (SEQ ID NO: 4; CDRs underlined)
VH-CDR1	SYWMH (SEQ ID NO: 1)	Amino acids 31-35 of SEQ ID NO: 4
VH-CDR2	QINPTTGRSQYNEKF (SEQ ID NO: 2)	Amino acids 50-66 of SEQ ID NO: 4
VH-CDR3	WGLQPFAY (SEQ ID NO: 3)	Amino acids 99-106 of SEQ ID NO: 4
HC_Y12XX-hz28-CH1-IgG1-P238K (is IgG1 with and without C-terminal lysine)	QVQLVQSGAEVKKPGSSVKVSCASGYAFT <u>SYWMH</u> WVRQ APGQGLEWMG <u>QINPTTGRSQYNEKF</u> KT RVTITADKSTST AYMELSSLRSEDTAVYYCAR <u>WGLQPFAY</u> WGQGLVTVSS <i>ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVT SWNSGALTSGVHTFPAVLQSSGLYSLSSVTVPSSSLGT QTYICNVNHKPSNTKVDKRVPEKSCDKTHTCPPCPAPEL LGGSVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEV KFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQD WLNKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTL PPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENN YKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVSCSVMH EALHNHYTQKSLSLSPG</i> (SEQ ID NO: 5)	CDRs underlined; CH1=amino acids 118- 215 (italicized); IgG1- P238K=amino acids 216-446; P238K underlined; no C- terminal lysine
	QVQLVQSGAEVKKPGSSVKVSCASGYAFT <u>SYWMH</u> WVRQ APGQGLEWMG <u>QINPTTGRSQYNEKF</u> KT RVTITADKSTST AYMELSSLRSEDTAVYYCAR <u>WGLQPFAY</u> WGQGLVTVSS <i>ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVT SWNSGALTSGVHTFPAVLQSSGLYSLSSVTVPSSSLGT QTYICNVNHKPSNTKVDKRVPEKSCDKTHTCPPCPAPEL LGGSVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEV KFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQD WLNKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTL PPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENN YKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVSCSVMH EALHNHYTQKSLSLSPGK</i> (SEQ ID NO: 6)	CDRs underlined; CH1=amino acids 118- 215 (italicized); IgG1- P238K=amino acids 216-447; P238K underlined; C-terminal lysine present
Light chain variable region	DIQMTQSPSFLSASVGDRVTITC <u>KASQDVSTAVA</u> WYQQK PGKAPKLLIY <u>SASYRYT</u> GVPSRFSGSGSGTDFLTISL QPEDFATYYC <u>QQHYSTPWT</u> FGGGTKVEIK (SEQ ID NO: 10)	Vk-hz2 (SEQ ID NO: 10; CDRs underlined)
VL-CDR1	KASQDVSTAVA (SEQ ID NO: 7)	Amino acids 24-34 of SEQ ID NO: 10
VL-CDR2	SASYRYT (SEQ ID NO: 8)	Amino acids 50-56 of SEQ ID NO: 10
VL-CDR3	QQHYSTPWT (SEQ ID NO: 9)	Amino acids 89-97 of SEQ ID NO: 10
LC_Y12XX-hz28	DIQMTQSPSFLSASVGDRVTITC <u>KASQDVSTAVA</u> WYQQK PGKAPKLLIY <u>SASYRYT</u> GVPSRFSGSGSGTDFLTISL QPEDFATYYC <u>QQHYSTPWT</u> FGGGTKVEIKRTVAAPSVFI	CDRs underlined; CL=amino acids 108- 214 (italicized)

	<p><i>FPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQS</i> <i>GNSQESVTEQDSKDYSLSSLTLSKADYEKHKVYACE</i> <i>VTHQGLSSPVTKSFNRGEC</i> (SEQ ID NO: 11)</p>	
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[0047] In a specific embodiment, the anti-CD40 antibody of the present disclosure comprises the CDRs of humanized antibody Y12XX-hz40 (Vh-hz12;Vk-hz3). Amino acid sequences of Y12XX-hz40 are provided in Table 3.

TABLE 3

Y12XX-hz40 sequences (Vh-hz12;Vk-hz3)

Heavy chain variable region	<p>QVQLVQSGAEVKKPGSSVKVSKASGYAFT<u>SYWMH</u>WVRQ APGQGLEWMG<u>QINPSQGRSQYNEKF</u>KT RVTITADKSTST AYMESSLRSED TAVYYCAR <u>WGLQPFAY</u>WGQGLVTVSS (SEQ ID NO: 13)</p>	Vh-hz12 (SEQ ID NO: 13; CDRs underlined)
VH-CDR1	SYWMH (SEQ ID NO: 1)	Amino acids 31-35 of SEQ ID NO: 13
VH-CDR2	QINPSQGRSQYNEKF (SEQ ID NO: 12)	Amino acids 50-66 of SEQ ID NO: 13
VH-CDR3	WGLQPFAY (SEQ ID NO: 3)	Amino acids 99-106 of SEQ ID NO: 13
HC_Y12XX-hz40-P238K – IgG1a with and without C-terminal lysine	<p>QVQLVQSGAEVKKPGSSVKVSKASGYAFT<u>SYWMH</u>WVRQ APGQGLEWMG<u>QINPSQGRSQYNEKF</u>KT RVTITADKSTST AYMESSLRSED TAVYYCAR <u>WGLQPFAY</u>WGQGLVTVSS <i>ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVT</i> <i>SWNSGALTSGVHTFPAVLQSSGLYSLSSVTVPS</i> <i>SLGTQTYICNVNHKPSNTKVDKRV</i> <i>EPKCDKTHTCPPCPAPEL</i> <i>LGGK</i>SVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEV KFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQD WLNQKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTL PPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENN YKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVSCSVMH EALHNHYTQKSLSLSPG (SEQ ID NO: 14)</p>	CDRs underlined; CH1=amino acids 118-215 (italicized); IgG1-P238K=amino acids 216-446; P238K underlined; no C-terminal lysine
	<p>QVQLVQSGAEVKKPGSSVKVSKASGYAFT<u>SYWMH</u>WVRQ APGQGLEWMG<u>QINPSQGRSQYNEKF</u>KT RVTITADKSTST AYMESSLRSED TAVYYCAR <u>WGLQPFAY</u>WGQGLVTVSS <i>ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVT</i> <i>SWNSGALTSGVHTFPAVLQSSGLYSLSSVTVPS</i> <i>SLGTQTYICNVNHKPSNTKVDKRV</i> <i>EPKCDKTHTCPPCPAPEL</i> <i>LGGK</i>SVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEV KFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQD WLNQKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTL PPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENN YKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVSCSVMH EALHNHYTQKSLSLSPGK (SEQ ID NO: 15)</p>	CDRs underlined; CH1=amino acids 118-215 (italicized); IgG1-P238K=amino acids 216-447; P238K underlined; C-terminal lysine present
Light chain variable region	<p>EIVMTQSPATLSVSPGERATLSC<u>KASQDVSTAVA</u>WYQQK PGQAPRLLIY<u>SASYRYT</u>GIPARFSGSGSGTEFTLTISL QSEDFAVYYC<u>QOHYSTPW</u>TFGGGTKVEIK</p>	Vk-hz3 (SEQ ID NO: 16; CDRs underlined)

	(SEQ ID NO: 16)	
VL-CDR1	KASQDVSTAVA (SEQ ID NO: 7)	Amino acids 24-34 of SEQ ID NO: 16
VL-CDR2	SASYRYT (SEQ ID NO: 8)	Amino acids 50-56 of SEQ ID NO: 16
VL-CDR3	QQHYSTPWT (SEQ ID NO: 9)	Amino acids 89-97 of SEQ ID NO: 16
LC_Y12XX-hz40	EIVMTQSPATLSVSPGERATLSC <u>KASQDVSTAVA</u> WYQQKPGQAPRLLIY <u>SASYRYT</u> GIPARFSGSGSGTEFTLTISLQSEDFAVYYC <u>QQHYSTPWT</u> FGGGTKVEIKRTVAAPSVFI <i>FPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDYSLSSLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC</i> (SEQ ID NO: 17)	CDRs underlined; CL=amino acids 108-214 (italicized)

[0048] In a specific embodiment, the anti-CD40 antibody of the present disclosure comprises the CDRs of humanized antibody Y12XX-hz42 (Vh-hz14; Vk-hz3). Detail of the amino acid sequences of Y12XX-hz42 is provided in Table 4.

TABLE 4

Y12XX-hz42 sequences (Vh-hz14; Vk-hz3)

Heavy chain variable region	QVQLVQSGAEVKKPGSSVKVSKASGYAFT <u>SYWMH</u> WVRQAPGQGLEWMG <u>QINPTTGRSQYNEKF</u> KT RVTITADKSTSTAYMELSSLRSEDTAVYYCAR <u>WGLQPFAY</u> WGQGLTVTVSS (SEQ ID NO: 4)	Vh-hz14 (SEQ ID NO: 4; CDRs underlined)
VH-CDR1	SYWMH (SEQ ID NO: 1)	Amino acids 31-35 of SEQ ID NO: 4
VH-CDR2	QINPTTGRSQYNEKF (SEQ ID NO: 2)	Amino acids 50-66 of SEQ ID NO: 4
VH-CDR3	WGLQPFAY (SEQ ID NO: 3)	Amino acids 99-106 of SEQ ID NO: 4
HC_Y12XX-hz42-P238K – IgG1a with and without C-terminal lysine	QVQLVQSGAEVKKPGSSVKVSKASGYAFT <u>SYWMH</u> WVRQAPGQGLEWMG <u>QINPTTGRSQYNEKF</u> KT RVTITADKSTSTAYMELSSLRSEDTAVYYCAR <u>WGLQPFAY</u> WGQGLTVTVSS <i>ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVPSSSLGTQTYICNVNHKPSNTKVDKRVKPKCDKTHTCPPCPAPELGGK</i> SVFLFPPKPKDITLMISRTPEVTCVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVSVLTIVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVSCSVMHEALHNHYTQKSLSLSPG (SEQ ID NO: 5)	CDRs underlined; CH1=amino acids 118-215 (italicized); IgG1-P238K=amino acids 216-446; P238K underlined; no C-terminal lysine
	QVQLVQSGAEVKKPGSSVKVSKASGYAFT <u>SYWMH</u> WVRQAPGQGLEWMG <u>QINPTTGRSQYNEKF</u> KT RVTITADKSTSTAYMELSSLRSEDTAVYYCAR <u>WGLQPFAY</u> WGQGLTVTVSS <i>ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVPSSSLGT</i>	CDRs underlined; CH1=amino acids 118-215 (italicized); IgG1-P238K=amino acids 216-447; P238K

	QTYICNVNHHKPSNTKVDRVEPKSCDKTHTCPPCPAPEL LGGKSVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEV KFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQD WLNQKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTL PPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENN YKTTTPVLDSDGSFFLYSKLTVDKSRWQQGNVFSQSVMH EALHNHYTQKSLSLSPGK (SEQ ID NO: 6)	underlined; C-terminal lysine present
Light chain variable region	EIVMTQSPATLSVSPGERATLSC <u>KASQDVSTAVA</u> WYQQK PGQAPRLLIY <u>SASYRYT</u> GIPARFSGSGSGTEFTLTISL QSEDFAVYYC <u>QQHYSTPWT</u> FGGGTKVEIK (SEQ ID NO: 16)	Vk-hz3 (SEQ ID NO: 16; CDRs underlined)
VL-CDR1	KASQDVSTAVA (SEQ ID NO: 7)	Amino acids 24-34 of SEQ ID NO: 16
VL-CDR2	SASYRYT (SEQ ID NO: 8)	Amino acids 50-56 of SEQ ID NO: 16
VL-CDR3	QQHYSTPWT (SEQ ID NO: 9)	Amino acids 89-97 of SEQ ID NO: 16
LC_Y12XX- hz42	EIVMTQSPATLSVSPGERATLSC <u>KASQDVSTAVA</u> WYQQK PGQAPRLLIY <u>SASYRYT</u> GIPARFSGSGSGTEFTLTISL QSEDFAVYYC <u>QQHYSTPWT</u> FGGGTKVEIKRTVAAPSVFI <i>FPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQS</i> <i>GNSQESVTEQDSKDYSLSSLTLSKADYEKHKVYACE</i> <i>VTHQGLSSPVTKSFNRGEC</i> (SEQ ID NO: 17)	CDRs underlined; CL=amino acids 108- 214 (italicized)

[0049] In one embodiment, the antibodies of the disclosure can comprise the amino acid sequences of the CDR1, CDR2, and CDR3 regions of the humanized Y12XX-hz28 variable heavy and light chains sequences (*see e.g.*, SEQ ID NOS: 4 and 10 respectively, as an example). Monoclonal antibodies contain all 6 CDRs (3 for the V_H and 3 for the V_L), for example, SYWMH (SEQ ID NO: 1), QINPTTGRSQYNEKFKT (SEQ ID NO: 2), and WGLQPFAY (SEQ ID NO: 3) for the variable heavy chain CDRs 1-3 respectively and KASQDVSTAVA (SEQ ID NO: 7), SASYRYT (SEQ ID NO: 8), and QQHYSTPWT (SEQ ID NO: 9) for the variable light chain CDRs 1-3 respectively.

[0050] In one embodiment, the antibodies of the disclosure can comprise the amino acid sequences of the CDR1, CDR2, and CDR3 regions of the humanized Y12XX-hz40 variable heavy and light chains sequences (*see e.g.*, SEQ ID NOS: 13 and 16 respectively, as an example). Monoclonal antibodies contain all 6 CDRs (3 for the V_H and 3 for the V_L), for example, SYWMH (SEQ ID NO: 1), QINPSQGRSQYNEKFKT (SEQ ID NO: 12), and WGLQPFAY (SEQ ID NO: 3) for the variable heavy chain CDRs 1-3 respectively and KASQDVSTAVA (SEQ ID NO: 7), SASYRYT (SEQ ID NO: 8), and QQHYSTPWT (SEQ ID NO: 9) for the variable light chain CDRs 1-3 respectively.

[0051] In one embodiment, the antibodies of the disclosure can comprise the amino acid sequences of the CDR1, CDR2, and CDR3 regions of the humanized Y12XX-hz42 variable heavy and light chains sequences (*see e.g.*, SEQ ID NOS: 4 and 16 respectively, as an example). Monoclonal antibodies contain all 6 CDRs (3 for the V_H and 3 for the V_L), for example, SYWMH (SEQ ID NO: 1), QINPTTGRSQYNEKFKT (SEQ ID NO: 2), and WGLQPFAY (SEQ ID NO: 3) for the variable heavy chain CDRs 1-3 respectively and KASQDVSTAVA (SEQ ID NO: 7), SASYRYT (SEQ ID NO: 8), and QQHYSTPWT (SEQ ID NO: 9) for the variable light chain CDRs 1-3 respectively.

[0052] An “antibody” (Ab) shall include, without limitation, an immunoglobulin which binds specifically to an antigen and comprises at least two heavy (H) chains and two light (L) chains interconnected by disulfide bonds, or an antigen-binding portion thereof. Each H chain comprises a heavy chain variable region (abbreviated herein as V_H) and a heavy chain constant region. The heavy chain constant region comprises three constant domains, C_{H1}, C_{H2} and C_{H3}. Each light chain comprises a light chain variable region (abbreviated herein as V_L) and a light chain constant region. The light chain constant region comprises one constant domain, C_L. The V_H and V_L regions can be further subdivided into regions of hypervariability, termed complementarity determining regions (CDRs), interspersed with regions that are more conserved, termed framework regions (FR). Each V_H and V_L comprises three CDRs and four FRs, arranged from amino-terminus to carboxy-terminus in the following order: FR1, CDR1, FR2, CDR2, FR3, CDR3, FR4. The variable regions of the heavy and light chains contain a binding domain that interacts with an antigen.

[0053] An “antigen binding portion” of an Ab (also called an “antigen-binding fragment”) or antigen binding portion thereof refers to one or more sequences of an Ab (full length or fragment of the full length antibody) that retain the ability to bind specifically to the antigen bound by the whole Ab. Examples of an antigen-binding fragment include Fab, F(ab')₂, scFv (single-chain variable fragment), Fab', dsFv, sc(Fv)₂, and scFv-Fc.

[0054] A “humanized” antibody refers to an Ab in which some, most or all of the amino acids outside the CDR domains of a non-human Ab are replaced with corresponding amino acids derived from human immunoglobulins. In one embodiment of a humanized form of an Ab, some, most or all of the amino acids outside the CDR domains have been replaced with amino acids from human immunoglobulins, whereas some, most or all amino acids within one or more CDR regions are unchanged. Small additions, deletions, insertions,

substitutions or modifications of amino acids are permissible as long as they do not abrogate the ability of the Ab to bind to a particular antigen. A “humanized” Ab retains an antigenic specificity similar to that of the original Ab.

[0055] A “chimeric antibody” refers to an Ab in which the variable regions are
5 derived from one species and the constant regions are derived from another species, such as an Ab in which the variable regions are derived from a mouse Ab and the constant regions are derived from a human Ab.

[0056] As used herein, “specific binding” refers to the binding of an antigen by an antibody with a dissociation constant (K_d) of about 1 μ M or lower as measured, for example,
10 by surface plasmon resonance (SPR). Suitable assay systems include the BIAcore™ (GE Healthcare Life Sciences, Marlborough, MA) surface plasmon resonance system and BIAcore™ kinetic evaluation software (e.g., version 2.1).

[0057] Binding of the present antibodies to CD40 antagonizes at least one CD40 activity. “CD40 activities” include, but are not limited to, T cell activation (e.g., induction of
15 T cell proliferation or cytokine secretion), macrophage activation (e.g., the induction of reactive oxygen species and nitric oxide in the macrophage), and B cell activation (e.g., B cell proliferation, antibody isotype switching, or differentiation to plasma cells). CD40 activities can be mediated by interaction with other molecules. “CD40 activities” include the functional interaction between CD40 and the following molecules, which are identified by
20 their Uniprot Accession Number is parentheses:

	CALR	(P27797);
	ERP44	(Q9BS26);
	FBL	(P22087);
	POLR2H	(P52434);
25	RFC5	(P40937);
	SGK1	(O00141);
	SLC30A7	(Q8NEW0);
	SLC39A7	(Q92504);
	TRAF2	(Q5T1L5);
30	TRAF3	(Q13114);

TRAF6 (Q9Y4K3);
 TXN (Q5T937);
 UGGT1 (Q9NYU2); and
 USP15 (Q9Y4E8).

5 [0058] For example, a CD40 “activity” includes an interaction with TRAF2. CD40/TRAF2 interaction activates NF- κ B and JNK. See Davies et al., Mol. Cell Biol. 25: 9806-19 (2005). This CD40 activity thus can be determined by CD40-dependent cellular NF- κ B and JNK activation, relative to a reference.

[0059] As used herein, the terms “activate,” “activates,” and “activated” refer to an
 10 increase in a given measurable CD40 activity by at least 10% relative to a reference, for example, at least 10%, 25%, 50%, 75%, or even 100%, or more. A CD40 activity is “antagonized” if the CD40 activity is reduced by at least 10%, and in an exemplary embodiment, at least about 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 95%, 97%, or even 100% (i.e., no detectable activity), relative to the absence of the antagonist. For example, an
 15 antibody may antagonize some or all CD40 activity, while not activating CD40. For example, the antibody may not activate B cell proliferation. The antibody may not activate cytokine secretion by T cells, where the cytokine is at least one cytokine selected from the group consisting of IL-2, IL-6, IL-10, IL-13, TNF- α , and IFN- γ .

[0060] Variable domains may comprise one or more framework regions (FR) with the
 20 same amino acid sequence as a corresponding framework region encoded by a human germline antibody gene segment. Preferred framework sequences for use in the antibodies described herein are those that are structurally similar to the framework sequences used by antibodies described herein. The V_H CDR1, 2 and 3 sequences, and the V_L CDR1, 2 and 3 sequences, can be grafted onto framework regions that have the identical sequence as that
 25 found in the germline immunoglobulin gene from which the framework sequence derive, or the CDR sequences can be grafted onto framework regions that contain up to 20, preferably conservative, amino acid substitutions as compared to the germline sequences. For example, it has been found that in certain instances it is beneficial to mutate residues within the framework regions to maintain or enhance the antigen binding ability of the antibody (see
 30 *e.g.*, U.S. Patent Nos. 5,530,101; 5,585,089; 5,693,762 and 6,180,370 to Queen *et al.*).

[0061] Exemplary framework regions include but are not limited to those in Tables 5 and 6 below.

TABLE 5

Heavy Framework Region	Sequence
FR1	Amino acid residues 1-30 of any VH sequence in Table 8 (SEQ ID NOs: 53-75) or Table 10 (SEQ ID NOs: 4, 13, and 99-113) in the Examples
FR2	Amino acid residues 36-49 of any VH sequence in Table 8 (SEQ ID NOs: 53-75) or Table 10 (SEQ ID NOs: 4, 13, and 99-113) in the Examples
FR3	Amino acid residues 67-98 of any VH sequence in Table 8 (SEQ ID NOs: 53-75) or Table 10 (SEQ ID NOs: 4, 13, and 99-113) in the Examples
FR4	Amino acid residues 107-117 of any VH sequence in Table 8 (SEQ ID NOs: 53-75) or Table 10 (SEQ ID NOs: 4, 13, and 99-113) in the Examples

5

TABLE 6

Light Framework Region	Sequence
FR1	Amino acid residues 1-23 of any VL sequence in Table 8 (SEQ ID NOs: 76-98) or Table 10 (SEQ ID NOs: 10, 16, and 114-116) in the Examples
FR2	Amino acid residues 35-49 of any VL sequence in Table 8 (SEQ ID NOs: 76-98) or Table 10 (SEQ ID NOs: 10, 16, and 114-116) in the Examples
FR3	Amino acid residues 57-88 of any VL sequence in Table 8 (SEQ ID NOs: 76-98) or Table 10 (SEQ ID NOs: 10, 16, and 114-116) in the Examples
FR4	Amino acid residues 98-107 of any VL sequence in Table 8 (SEQ ID NOs: 76-98) or Table 10 (SEQ ID NOs: 10, 16, and 114-116) in the Examples

[0062] A variant variable domain may differ from the variable domain of the humanized Y12XX-hz28, Y12XX-hz40, or Y12XX-hz42 sequence by up to 10 amino acids or any integral value between, where the variant variable domain specifically binds CD40.

- 10 Alternatively, the variant variable domain may have at least 90% sequence identity (e.g., at least 92%, 95%, 98%, or 99% sequence identity) relative to the sequence of the humanized Y12XX-hz28, Y12XX-hz40, or Y12XX-hz42 sequence, respectively. Non-identical amino acid residues or amino acids that differ between two sequences may represent amino acid substitutions, additions, or deletions. Residues that differ between two sequences appear as
- 15 non-identical positions, when the two sequences are aligned by an appropriate amino acid

sequence alignment algorithm, such as BLAST® (a registered trademark of the U.S. National Library of Medicine).

[0063] Exemplary CD40 antibodies of the present invention can include an isolated antibody, or antigen binding portion thereof, that specifically binds to human CD40, wherein
5 said antibody comprises a first polypeptide portion comprising a heavy chain variable region, and a second polypeptide portion comprising a light chain variable region, wherein:

said heavy chain variable region comprises one of (i) a CDR1 comprising SYWMH (SEQ ID NO: 1), a CDR2 comprising QINPTTGRSQYNEKFKT (SEQ ID NO: 2), a CDR3 comprising WGLQPFAY (SEQ ID NO: 3) and (ii) a CDR1 comprising SYWMH
10 (SEQ ID NO: 1), a CDR2 comprising QINPSQGRSQYNEKFKT (SEQ ID NO: 12), a CDR3 comprising WGLQPFAY (SEQ ID NO: 3); and

said light chain variable region comprises a CDR1 comprising KASQDVSTAVA (SEQ ID NO: 7), a CDR2 comprising SASYRYT (SEQ ID NO: 8), and a CDR3 comprising QQHYSTPWT (SEQ ID NO: 9).

15 [0064] The isolated antibody or antigen binding portion thereof can antagonize one or more activities of CD40. The isolated antibody or antigen binding portion thereof can be a chimeric antibody. Exemplary heavy and light variable chains for a chimeric antibody are in Table 8 of the Examples. The isolated antibody or antigen binding portion thereof can be a humanized antibody. Exemplary humanized heavy and light variable chains are in Table 10
20 of the Examples. The isolated antibody or antigen binding portion thereof can comprise a human heavy chain constant region and a human light chain constant region.

Fc Domain and Constant Region

[0065] The carboxyl-terminal "half" of a heavy chain defines a constant region (Fc) and which is primarily responsible for effector function. As used herein, the term "Fc
25 domain" refers to the constant region antibody sequences comprising CH2 and CH3 constant domains as delimited according to Kabat et al., *Sequences of Immunological Interest*, 5th ed., U.S. Dept. Health & Human Services, Washington, D.C. (1991). The Fc region may be derived from a human IgG. For instance, the Fc region may be derived from a human IgG1 or a human IgG4 Fc region. A heavy variable domain can be fused to an Fc domain. The
30 carboxyl terminus of the variable domain may be linked or fused to the amino terminus of the Fc CH2 domain. Alternatively, the carboxyl terminus of the variable domain may be linked

or fused to the amino terminus of a linker amino acid sequence, which itself is fused to the amino terminus of an Fc domain. Alternatively, the carboxyl terminus of the variable domain may be linked or fused to the amino terminus of a CH1 domain, which itself is fused to the Fc CH2 domain. Optionally, the protein may comprise the hinge region after the CH1 domain in whole or in part. Optionally an amino acid linker sequence is present between the variable domain and the Fc domain. The carboxyl terminus of the light variable domain may be linked or fused to the amino terminus of a CL domain.

[0066] An exemplary sequence for a heavy chain CH1 is amino acids 118-215 of SEQ ID NO: 5

10 (ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQ
SSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKRV; SEQ ID NO: 18). An
exemplary sequence for a light chain CL is amino acids 108-214 of SEQ ID NO: 11
(RTVAAPSVFIFPPSDEQLKSGTASVV
CLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDYSLSTLTLSKADYEKHKVYACE
15 VTHQGLSSPVTKSFNRGEC; SEQ ID NO: 19).

[0067] The antibody can be a fusion antibody comprising a first variable domain that specifically binds human CD40, and a second domain comprising an Fc domain.

[0068] Exemplary Fc domains used in the fusion protein can include human IgG domains. Exemplary human IgG Fc domains include IgG4 Fc domain and IgG1 Fc domain.

20 While human IgG heavy chain genes encode a C-terminal lysine, the lysine is often absent from endogenous antibodies as a result of cleavage in blood circulation. Antibodies having IgG heavy chains including a C-terminal lysine, when expressed in mammalian cell cultures, may also have variable levels of C-terminal lysine present (Cai et al, 2011, *Biotechnol Bioeng.* 108(2): 404-12). Accordingly, the C-terminal lysine of any IgG heavy chain Fc
25 domain disclosed herein may be omitted.

[0069] The isolated antibody or antigen binding portion thereof described herein, can comprise an Fc domain which comprises an amino acid sequence of:

EPKSCDKTHTCPPCPAPELLGG(P/K)SVFLFPPKPKDTLMISRTPEVTCV
V
30 VDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQY(N/A)STYRVVSVLTVLHQDWLN
GKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSR(D/E)E(L/M)TKNQVSLTC

LVKGFYPSDIAVEWESNGQPENNYKTTTPVLDSGDSFFLYSKLTVDKSRWQQGNVF
SCSVMHEALHNHYTQKSLSLSPG(K/not present) (Fc consensus; SEQ ID NO: 21). The
parenthetical notation indicates possible amino acid identities at the position. For instance,
Kabat position 238 can be either Proline (P) or Lysine (K), which is notated as (P/K).

5 Additional exemplary, non-limiting consensus sequences are SEQ ID NOs: 118-120.

[0070] The isolated antibody or antigen binding portion thereof described herein can
comprise a human IgG1 Fc domain comprising a mutation at Kabat position 238 that reduces
binding to Fc-gamma-receptors (FcγRs), wherein proline 238 (P238) is mutated to one of the
residues selected from the group consisting of lysine (K), serine (S), alanine (A), arginine (R)
10 and tryptophan (W), and wherein the antibody or antigen binding portion thereof has reduced
FcγR binding. The isolated antibody or antigen binding portion thereof described herein can
have P238 mutated to lysine in a human IgG1 Fc domain.

[0071] The isolated antibody or antigen binding portion thereof comprises an Fc
domain which comprises an amino acid sequence selected from: SEQ ID NOs: 22-29.

15 [0072] Exemplary sequences comprising the IgG1 Fc domains above include: SEQ
ID NO: 5, SEQ ID NO: 6, SEQ ID NO: 30, and SEQ ID NO: 31.

[0073] The isolated antibody or antigen binding portion thereof described herein can
comprise a human IgG1 Fc domain comprising an alanine substituted at Kabat position 297.
For example, the isolated antibody or antigen binding portion thereof comprises an Fc
20 domain which comprises an amino acid sequence selected from: SEQ ID NOs: 32-39.

[0074] The isolated antibody or antigen binding portion described herein may
comprise (1) a variable heavy chain (V_H) selected from Table 8 or Table 10 in the Examples,
or the CDRs thereof, and/or (2) a variable light chain (V_L) selected from Table 8 or Table 10
in the Examples, or the CDRs thereof.

25 [0075] The isolated antibody or antigen binding portion thereof disclosed herein may
comprise a heavy chain amino acid sequence selected from Vh-hz12 (SEQ ID NO: 13) and
Vh-hz14 (SEQ ID NO: 4).

[0076] The isolated antibody or antigen binding portion thereof disclosed herein may
comprise a light chain amino acid sequence selected from Vk-hz2 (SEQ ID NO: 10) and Vk-
30 hz3 (SEQ ID NO: 16).

[0077] The isolated antibody or antigen binding portion thereof disclosed herein may be an antibody selected from the group consisting of:

a) Y12XX-hz28-P238K having a heavy chain of SEQ ID NO: 5 or 6 and light chain of SEQ ID NO: 11;

5 b) Y12XX-hz40-P238K having a heavy chain of SEQ ID NO: 14 or 15 and light chain of SEQ ID NO: 17; and

c) Y12XX-hz42-P238K having a heavy chain of SEQ ID NO: 5 or 6 and light chain of SEQ ID NO: 17.

[0078] The antibody or antigen binding portion thereof disclosed herein, wherein the antigen binding portion is selected from the group consisting of Fv, Fab, F(ab')₂, Fab', dsFv, scFv, sc(Fv)₂, diabodies, and scFv-Fc.

[0079] The antibody or antigen binding portion thereof disclosed herein can be an immunoconjugate, wherein the antibody or antigen-binding portion thereof is linked to a therapeutic agent.

15 [0080] The antibody or antigen binding portion thereof disclosed herein can be a bispecific antibody, wherein the antibody or antigen-binding portion thereof is linked to a second functional moiety having a different binding specificity than said antibody or antigen binding portion thereof.

[0081] The antibody or antigen binding portion thereof disclosed herein can further comprise an additional moiety.

[0082] The variable regions of the present antibodies may optionally be linked to the Fc domain by an "amino acid linker" or "linker." For example, the C-terminus of a variable heavy chain domain may be fused to the N-terminus of an amino acid linker, and an Fc domain may be fused to the C-terminus of the linker. Although amino acid linkers can be any length and consist of any combination of amino acids, the linker length may be relatively short (e.g., five or fewer amino acids) to reduce interactions between the linked domains. The amino acid composition of the linker also may be adjusted to reduce the number of amino acids with bulky side chains or amino acids likely to introduce secondary structure. Suitable amino acid linkers include, but are not limited to, those up to 3, 4, 5, 6, 7, 10, 15, 20, 25 or 25 amino acids in length. Representative amino acid linker sequences include GGGGS (SEQ ID NO: 40), and a linker comprising 2, 3, 4, or 5 copies of GGGGS (SEQ ID NOs: 41

to 44, respectively). TABLE 7 lists suitable linker sequences for use in the present disclosure.

TABLE 7
Representative Linker Sequences

GGGGS	SEQ ID NO: 40
(GGGGS) ₂	SEQ ID NO: 41
(GGGGS) ₃	SEQ ID NO: 42
(GGGGS) ₄	SEQ ID NO: 43
(GGGGS) ₅	SEQ ID NO: 44
AST	SEQ ID NO: 45
TVAAPS	SEQ ID NO: 46
TVA	SEQ ID NO: 47
ASTSGPS	SEQ ID NO: 48

5

Antibody Preparation

[0083] The antibody can be produced and purified using ordinary skill in a suitable mammalian host cell line, such as CHO, 293, COS, NSO, and the like, followed by purification using one or a combination of methods, including protein A affinity chromatography, ion exchange, reverse phase techniques, or the like.

[0084] As well known in the art, multiple codons can encode the same amino acid. Nucleic acids encoding a protein sequence thus include nucleic acids having codon degeneracy. The polypeptide sequences disclosed herein can be encoded by a variety of nucleic acids. The genetic code is universal and well known. Nucleic acids encoding any polypeptide sequence disclosed herein can be readily conceived based on conventional knowledge in the art as well as optimized for production. While the possible number of nucleic acid sequence encoding a given polypeptide is large, given a standard table of the genetic code, and aided by a computer, the ordinarily skilled artisan can easily generate every possible combination of nucleic acid sequences that encode a given polypeptide.

[0085] A representative nucleic acid sequence encoding the Y12XX heavy chain variable domain of Y12XX-hz28 including a constant region CH1 and Fc domain IgG1-P238K is:

ATGAGGGCTTGGATCTTCTTTCTGCTCTGCCTGGCCGGGAGAGCGCTCGCACAGG
TGCAGCTGGTGCAGTCTGGTGCCGAGGTCAAAAAGCCAGGCTCCAGCGTGAAGG
TGAGCTGCAAGGCCTCTGGCTACGCTTTCACCTCTTATTGGATGCACTGGGTGAG
ACAGGCTCCTGGACAGGGCCTGGAGTGGATGGGCCAGATCAACCCAACCACCGG
5 CAGAAGCCAGTACAATGAGAAGTTTAAGACCCGCGTGACCATCACAGCCGACAA
GTCCACCAGCACAGCTTATATGGAGCTGTCTTCCCTGAGGTCCGAGGATACAGCC
GTGTACTATTGCGCTCGGTGGGGCCTGCAGCCTTTCGCTTACTGGGGCCAGGGCA
CCCTGGTGACAGTGAGCTCTGCTAGCACCAAGGGCCCATCGGTCTTCCCCCTGGC
ACCCTCCTCCAAGAGCACCTCTGGGGGCACAGCGGCCCTGGGCTGCCTGGTCAA
10 GGACTACTTCCCCGAACCGGTGACGGTGTCTGTGAACTCAGGCGCCCTGACCAG
CGGCGTGACACCTTCCCGGCCGTCTACAGTCCTCAGGACTCTACTCCCTCAGC
AGCGTGGTGACCGTGCCCTCCAGCAGCTTGGGCACCCAGACCTACATCTGCAAC
GTGAATCACAAGCCCAGCAACACCAAGGTGGACAAGAGAGTTGAGCCCAAATCT
TGTGACAAAACCTCACACATGCCCACCGTGCCCAGCACCTGAACTCCTGGGGGGA
15 AAGTCAGTCTTCTCTTCCCCCAAAACCCAAGGACACCCTCATGATCTCCCGGA
CCCCTGAGGTACATGCGTGGTGGTGGACGTGAGCCACGAAGACCCTGAGGTCA
AGTTCAACTGGTACGTGGACGGCGTGGAGGTGCATAATGCCAAGACAAAGCCGC
GGGAGGAGCAGTACAACAGCACGTACCGTGTGGTCAGCGTCCTACCGTCCTGC
ACCAGGACTGGCTGAATGGCAAGGAGTACAAGTGCAAGGTCTCCAACAAAGCCC
20 TCCCAGCCCCCATCGAGAAAACCATCTCCAAAGCCAAAGGGCAGCCCCGAGAAC
CACAGGTGTACACCCTGCCCCCATCCCGGGATGAGCTGACCAAGAACCAGGTCA
GCCTGACCTGCCTGGTCAAAGGCTTCTATCCCAGCGACATCGCCGTGGAGTGGGA
GAGCAATGGGCAGCCGGAGAACAACACTACAAGACCACGCCTCCCGTGCTGGACTC
CGACGGCTCCTTCTTCTCTACAGCAAGCTCACCGTGGACAAGAGCAGGTGGCA
25 GCAGGGGAACGTCTTCTCATGCTCCGTGATGCATGAGGCTCTGCACAACCACTAC
ACGCAGAAGAGCCTCTCCCTGTCTCCGGGTTGA (SEQ ID NO: 49). In this sequence,
nucleotides 1-51 encode a signal peptide (optional), nucleotides 52-402 encode the heavy
chain variable region in which nucleotides 141-155 encode CDR1, nucleotides 198-249
encode CDR2, and nucleotides 346-369 encode CDR3 of the Y12XX variable domain of the
30 heavy chain. Nucleotides 403-696 encode a CH1 domain, and nucleotides 697-1399 encode
IgG1-P238K. Nucleotides 1400-1402 are a stop codon.

[0086] A representative nucleic acid sequence encoding the Y12XX light chain variable domain of Y12XX-hz28 including a constant region CL is:

ATGAGGGCTTGGATCTTCTTTCTGCTCTGCCTGGCCGGGCGCGCCTTGGCCGACA
 TCCAGATGACCCAGTCCCCCTCCTTCCTGTCTGCCTCCGTGGGCGACAGAGTGAC
 5 CATCACCTGTAAGGCTTCCCAGGATGTGAGCACAGCCGTGGCTTGGTACCAGCA
 GAAGCCAGGCAAGGCCCCCAAGCTGCTGATCTATTCCGCCTCTTACAGGTATACC
 GGCGTGGCCTCTCGGTTCTCCGGCAGCGGCTCTGGCACAGACTTTACCCTGACAA
 TCTCCAGCCTGCAGCCTGAGGATTTGCCACCTACTATTGCCAGCAGCACTACTC
 CACCCCATGGACATTTGGCGGCGGCACCAAGGTGGAGATCAAGCGTACGGTGGC
 10 TGCACCATCTGTCTTCATCTTCCCGCCATCTGATGAGCAGTTGAAATCTGGAAT
 GCCTCTGTTGTGTGCCTGCTGAATAACTTCTATCCCAGAGAGGCCAAAGTACAGT
 GGAAGGTGGATAACGCCCTCCAATCGGGTAACTCCCAGGAGAGTGTACAGAGC
 AGGACAGCAAGGACAGCACCTACAGCCTCAGCAGCACCCCTGACGCTGAGCAAAG
 CAGACTACGAGAAACACAAAGTCTACGCCTGCGAAGTCACCCATCAGGGCCTGA
 15 GCTCGCCCGTCACAAAGAGCTTCAACAGGGGAGAGTGTTAG (SEQ ID NO: 50). In
 this sequence, nucleotides 1-51 encode a signal peptide (optional), nucleotides 52-372 encode
 the light chain variable region in which nucleotides 121-153 encode CDR1, nucleotides 199-
 219 encode CDR2, and nucleotides 316-342 encode CDR3. Nucleotides 373-693 encode a
 CL. Nucleotides 694-696 are a stop codon

20 **[0087]** The coding sequence for the heavy and/or light chain optionally may encode a
 signal peptide, such as MRAWIFFLLCLAGRALA (SEQ ID NO: 51), at the 5' end of the
 coding sequence. As described above, an exemplary nucleic acid coding sequence for this
 signal peptide is

ATGAGGGCTTGGATCTTCTTTCTGCTCTGCCTGGCCGGGAGAGCGCTCGCA (SEQ
 25 ID NO: 52).

[0088] Accordingly, a nucleic acid encoding an antibody disclosed herein is also
 contemplated. Such a nucleic acid may be inserted into a vector, such as a suitable
 expression vector, e.g., pHEN-1 (Hoogenboom et al. (1991) *Nucleic Acids Res.* 19: 4133-
 4137). Further provided is an isolated host cell comprising the vector and/or the nucleic acid.

30 **[0089]** The antibody of the disclosure can be produced and purified using only
 ordinary skill in any suitable mammalian host cell line, such as CHO (Chinese hamster ovary
 cells), 293 (human embryonic kidney 293 cells), COS cells, NSO cells, and the like, followed

by purification using one or a combination of methods, including protein A affinity chromatography, ion exchange, reverse phase techniques, or the like.

Pharmaceutical Compositions and Methods of Treatment

- [0090] A pharmaceutical composition comprises a therapeutically-effective amount of one or more antibodies and optionally a pharmaceutically acceptable carrier. Pharmaceutically acceptable carriers include, for example, water, saline, phosphate buffered saline, dextrose, glycerol, ethanol and the like, as well as combinations thereof. Pharmaceutically acceptable carriers can further comprise minor amounts of auxiliary substances, such as wetting or emulsifying agents, preservatives, or buffers that enhance the shelf-life or effectiveness of the fusion protein. The compositions can be formulated to provide quick, sustained, or delayed release of the active ingredient(s) after administration. Suitable pharmaceutical compositions and processes for preparing them are known in the art. See, e.g., Remington, *THE SCIENCE AND PRACTICE OF PHARMACY*, A. Gennaro, et al., eds., 21st ed., Mack Publishing Co. (2005).
- [0091] The pharmaceutical composition may be administered alone or in combination therapy, (i.e., simultaneously or sequentially) with an immunosuppressive/immunomodulatory and/or anti-inflammatory agent. An exemplary type of agent is a cytotoxic T lymphocyte-associated protein 4 (CTLA4) mutant molecule. An exemplary CTLA4 mutant molecule is L104EA29Y-Ig (belatacept) which is a modified CTLA4-Ig. Different immune diseases can require use of specific auxiliary compounds useful for treating immune diseases, which can be determined on a patient-to-patient basis. For example, the pharmaceutical composition may be administered in combination with one or more suitable adjuvants, e.g., cytokines (IL-10 and IL-13, for example) or other immune stimulators, e.g., chemokines, tumor-associated antigens, and peptides. Suitable adjuvants are known in the art.
- [0092] A method of treating an immune disease in a patient in need of such treatment may comprise administering to the patient a therapeutically effective amount of the antibody, or antigen binding portion thereof, as described herein. Further provided is a method of treating or preventing an autoimmune or inflammatory disease in a patient in need of such treatment may comprise administering to the patient a therapeutically effective amount of the antibody, or antigen binding portion thereof, as described herein. Also provided is the use of an antibody, or antigen binding portion thereof, of the disclosure, or a

pharmaceutically acceptable salt thereof, for treating an immune disease in a patient in need of such treatment and/or for treating or preventing an autoimmune or inflammatory disease in a patient in need of such treatment, that may comprise administering to the patient a therapeutically effective amount of the antibody, or antigen binding portion thereof.

- 5 Antagonizing CD40-mediated T cell activation could inhibit undesired T cell responses occurring during autoimmunity, transplant rejection, or allergic responses, for example. Inhibiting CD40-mediated T cell activation could moderate the progression and/or severity of these diseases.

- 10 **[0093]** The use of an antibody, or antigen binding portion thereof, of the disclosure, or a pharmaceutically acceptable salt thereof, in the preparation of a medicament for treatment of an immune disease and/or for treating or preventing an autoimmune or inflammatory disease in a patient in a patient in need of such treatment, is also provided. The medicament can, for example, be administered in combination with an immunosuppressive/immunomodulatory and/or anti-inflammatory agent.

- 15 **[0094]** As used herein, a “patient” means an animal, e.g., mammal, including a human. The patient may be diagnosed with an immune disease. “Treatment” or “treat” or “treating” refers to the process involving alleviating the progression or severity of a symptom, disorder, condition, or disease. An “immune disease” refers to any disease associated with the development of an immune reaction in an individual, including a cellular and/or a humoral immune reaction. Examples of immune diseases include, but are not limited to, inflammation, allergy, autoimmune disease, or graft-related disease. Thus, the patient may be diagnosed with an autoimmune disease or inflammatory disease. An “autoimmune disease” refers to any disease associated with the development of an autoimmune reaction in an individual, including a cellular and/or a humoral immune reaction.
- 20 An example of an autoimmune disease is inflammatory bowel disease (IBD), including, but not limited to ulcerative colitis and Crohn’s disease. Other autoimmune diseases include systemic lupus erythematosus, multiple sclerosis, rheumatoid arthritis, diabetes, psoriasis, scleroderma, and atherosclerosis. Graft-related diseases include graft versus host disease (GVHD), acute transplantation rejection, and chronic transplantation rejection.

- 30 **[0095]** Diseases that can be treated by administering the antibody of the disclosure may be selected from the group consisting of Addison’s disease, allergies, anaphylaxis, ankylosing spondylitis, asthma, atherosclerosis, atopic allergy, autoimmune diseases of the

ear, autoimmune diseases of the eye, autoimmune hepatitis, autoimmune parotitis, bronchial asthma, coronary heart disease, Crohn's disease, diabetes, epididymitis, glomerulonephritis, Graves' disease, Guillain-Barre syndrome, Hashimoto's disease, hemolytic anemia, idiopathic thrombocytopenic purpura, inflammatory bowel disease, immune response to

5 recombinant drug products (e.g., Factor VII in hemophiliacs), lupus nephritis, systemic lupus erythematosus, multiple sclerosis, myasthenia gravis, pemphigus, psoriasis, rheumatic fever, rheumatoid arthritis, sarcoidosis, scleroderma, Sjogren's syndrome, spondyloarthropathies, thyroiditis, transplant rejection, vasculitis, and ulcerative colitis.

[0096] The pharmaceutical composition may be administered alone or as a

10 combination therapy, (i.e., simultaneously or sequentially) with an immuno-suppressive/immunomodulatory and/or anti-inflammatory agent. Different immune diseases can require use of specific auxiliary compounds useful for treating immune diseases, which can be determined on a patient-to-patient basis. For example, the pharmaceutical composition may be administered in combination with one or more suitable adjuvants, e.g.,

15 cytokines (IL-10 and IL-13, for example) or other immune stimulators, e.g., chemokines, tumor-associated antigens, and peptides. Suitable adjuvants are known in the art.

[0097] Any suitable method or route can be used to administer the antibody, or antigen binding portion thereof, or the pharmaceutical composition. Routes of administration include, for example, intravenous, intraperitoneal, subcutaneous, or

20 intramuscular administration. A therapeutically effective dose of administered antibody depends on numerous factors, including, for example, the type and severity of the immune disease being treated, the use of combination therapy, the route of administration of the antibody, or antigen binding portion thereof, or pharmaceutical composition, and the weight of the patient. A non-limiting range for a therapeutically effective amount of a domain

25 antibody is 0.1-20 milligram/kilogram (mg/kg), and in an aspect, 1-10 mg/kg, relative to the body weight of the patient.

Kits

[0098] A kit useful for treating an immune disease in a human patient is provided. A kit useful for treating or preventing an autoimmune disease or inflammatory disease in a

30 human patient is also provided. The kit can comprise (a) a dose of an antibody, or antigen binding portion thereof, of the present disclosure and (b) instructional material for using the

antibody, or antigen binding portion thereof, in the method of treating an immune disease, or for using the antibody, or antigen binding portion thereof, in the method of treating or preventing an autoimmune or inflammatory disease, in a patient.

- [0099] “Instructional material,” as that term is used herein, includes a publication, a recording, a diagram, or any other medium of expression, which can be used to communicate the usefulness of the composition and/or compound of the invention in a kit. The instructional material of the kit may, for example, be affixed to a container that contains the compound and/or composition of the invention or be shipped together with a container, which contains the compound and/or composition. Alternatively, the instructional material may be shipped separately from the container with the intention that the recipient uses the instructional material and the compound cooperatively. Delivery of the instructional material may be, for example, by physical delivery of the publication or other medium of expression communicating the usefulness of the kit, or may alternatively be achieved by electronic transmission, for example by means of a computer, such as by electronic mail, or download from a website.

EXAMPLES

Example 1: Binding of mouse anti-human CD40 antibodies to human CD40

- [00100] Mouse anti-human-CD40 antibodies were generated and were tested for binding to human CD40 by surface plasmon resonance (SPR). The Vh and Vk sequences for each antibody are shown in Table 8.

TABLE 8

Mouse anti-human-CD40 variable heavy and light sequences

ID	VH Sequence	VL Sequence
	ADX_Y1060.ZZ0-1-Vh	ADX_Y1060.ZZ0-1-Vk
ADX_Y1060.ZZ0-1	QVQLVQSGAEVKKPGASVKVSCKASG YTFTGYMHWRQAPGQGLEWMGWIN PDSGGTNYAQKFQGRVTMTRDTSIST AYMELNRLRSDDTAVYYCARDQPLGY CTNGVCSYFDYWGGTLTVSS (SEQ ID NO: 53)	DIQMTQSPSSVSASVGDRVITITCRASQ GIYSWLAWYQQKPGKAPNLLIYTASTL QSGVPSRFSGSGSGTDFTLTISSLQPE DFATYYCQQANIFPLTFGGGTKVEIK (SEQ ID NO: 76)
	ADX_Y1072.ZZ0-1-Vh	ADX_Y1072.ZZ0-1-Vk

ID	VH Sequence	VL Sequence
ADX_Y1 072.ZZ0- 1	QVQFQQSGAELARPGASVKLSCKASG YTFTSYWMQWVKQRPQGQLEWIGTIY PGDGDSRYNQKFKGKALLTADKSSSI AYMQLNSLASEDSAVYFCARFSLYDG YPYYFDYWGGQTTTLTVSS (SEQ ID NO: 54)	DVVMQTPTLSLPVSLGDQASISCRSSQ SLVHRNGNTYLHWYQKPGQSPKLLIY RVSNRFGVDPDRFSGSGSGTDFTLKIS RVEAEDLGIYFCSQSTHFPYTFGGGTK LEIK (SEQ ID NO: 77)
	ADX_Y1234.ZZ0-1-Vh	ADX_Y1234.ZZ0-1-Vk
ADX_Y1 234.ZZ0- 1	EVQLVESGGGLVKPGGSLKLSKAASG FAFSSYDMSWVRQTPEKRLEWVAYIN SGVGNTYYPDTVKGRFTISRDNKNT LYLQMSSSLKSEDTAMYYCARHGNAY FAYWGQGTTLTVSA (SEQ ID NO: 55)	DILLTQSPAILSVPGERVVSFSCRASQ SIGTSIHWWYQQRTIGSPRLLIKYASES ISGIPSRFSGSGSGTDFTLSINSVESE DIADYYCQQINSWPLTFGAGTKLELK (SEQ ID NO: 78)
	ADX_Y1236.ZZ0-1-Vh	ADX_Y1236.ZZ0-1-Vk
ADX_Y1 236.ZZ0- 1	DVQLVESGGGLVQPGGSRKLSKAASG FTFSSFGMHWVRQAPKGLEWVAYIS SGSSTIYYADTVKGRFTISRDNPKNT LFLQMTSLRSEDTAMYYCARYGNAY DYWGQGTSTTVSS (SEQ ID NO: 56)	DIVMTQSQKFMSTSVGDRISITCKASQ NVRTAVAWYQQKPGQSPKALIYLASNR HTGVPARFSGSGSGTSYSLTISRMEAE DAATYYCQQRSSYPLTFGAGTKLELK (SEQ ID NO: 79)
	ADX_Y1238.ZZ0-1-Vh	ADX_Y1238.ZZ0-1-Vk
ADX_Y1 238.ZZ0- 1	QVQLQQSGAELVRPGTSVKVSKASG YAFTNYLIEWVKQRPQGQLEWIGVIN PGSGGTNYNEKFKGKATLTADKSSST AYMQLSSLTSDDSAVYFCARSQLGRR FDYWGGQTTTLTVSS (SEQ ID NO: 57)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVRTGVAWYQQKPGQSPKLLIYSASYR NTGVDPDRFTGSRSGTDFTFTISSVQAE DLAVYYCQQHYSPPYTFGGGTKLEIK (SEQ ID NO: 80)
	ADX_Y1241.ZZ0-1-Vh	ADX_Y1241.ZZ0-1-Vk
ADX_Y1 241.ZZ0- 1	EFQLQQSGPELVKPGASVKMSCKASG YTFTNYIIQWVKQPGQLEWIGYIN PYSSETNYNEKFKGKATLTSDKSSST AYMELSSLTSEDSAIYFCARDLIGNY WGQGTTLTVSS (SEQ ID NO: 58)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVGTAVAWYQQKPGQSPKLLIYWASTR HTGVDPDRFTGSGSGTDFTLTISNVQSE DLADYFCQQYSSYPLTFGAGTKLELK (SEQ ID NO: 81)
	ADX_Y1242.ZZ0-1-Vh	ADX_Y1242.ZZ0-1-Vk
ADX_Y1 242.ZZ0- 1	EFQLQQSGPELVKPGASVKMSCKASG YSFTSYVMHWVKQKPGQALEWIGYIN PSNDGSEYNERFKGKATLTSDKSST AYMELSSLTSEDSAVYYCARWAPYPF AYWGQGTTLTVSA (SEQ ID NO: 59)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFTISSVQAE DLAVYYCQQHYSTPYTFGGGTKLEIK (SEQ ID NO: 82)
	ADX_Y1249.ZZ0-1-Vh	ADX_Y1249.ZZ0-1-Vk
ADX_Y1 249.ZZ0- 1	QVQLQQSGAELARPGASVKMSCKASG YTFTSYTMHWVKQRPQGQLEWIGYID PSSHYTNYNQKFKGTATLTADKSSNT AYMQLSSLTSEDSAVYYCARDYRYAY WYFDVWGAGTTTLTVSS	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFTISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 83)

ID	VH Sequence	VL Sequence
	(SEQ ID NO: 60)	
	ADX_Y1256.ZZ0-1-Vh	ADX_Y1256.ZZ0-1-Vk
ADX_Y1 256.ZZ0- 1	QVQLQQSGAELAKPGSSVKMSCKASG YAFTSYWMHWVKQRPQGQLEWIGYIN PTTGYSAYNQKFKDKATLTADKSSST AYLQLTSLTSEDSAVYFCRWGLPPF AYWGQGTLLTVSA (SEQ ID NO: 61)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFTISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 84)
	ADX_Y1257.ZZ0-1-Vh	ADX_Y1257.ZZ0-1-Vk
ADX_Y1 257.ZZ0- 1	QVQLQQSGAELAKPGSSVKMSCKASG YAFTSYWMHWVKQRPQGQLEWIGYIN PTTGYSAYNQKFKAKTTLTADKSSST AYMQLTSLTFEDSAVYFCRWGLPPF AYWGQGTLLTVSA (SEQ ID NO: 62)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFTISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 85)
	ADX_Y1258.ZZ0-1-Vh	ADX_Y1258.ZZ0-1-Vk
ADX_Y1 258.ZZ0- 1	QVQLQQSGAELAKPGSSVKMSCKASG YAFTSYWMHWIKQRPQGQLEWIGFIN PTTGYSAYNQKFKDKATLTADKSSST AYMQLNSLTSEDSAVYFCARWGLPPF AYWGQGTLLTVSA (SEQ ID NO: 63)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFTISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 86)
	ADX_Y1259.ZZ0-1-Vh	ADX_Y1259.ZZ0-1-Vk
ADX_Y1 259.ZZ0- 1	QVQLQQSGAELAKPGASVKMSCKTSG YSFTSYWMHWIKQRPQGQLEWIGFIN PTTGYTEYNQKFKDKATLTADKSSST AYMQLSSLTSEDSAVYYCSRWGLPPF AYWGQGTLLTVSA (SEQ ID NO: 64)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFTISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 87)
	ADX_Y1260.ZZ0-1-Vh	ADX_Y1260.ZZ0-1-Vk
ADX_Y1 260.ZZ0- 1	QVQLQQSGAELTKPGASVKMSCKASG YSFTSYWMHWVKQRPQGQLEWIGSIN PSTGYTEDNQKFKDKATLTADKSSST AYMQLSSLTSEDSAVYYCARWGLPPF AYWGQGTLLTVSA (SEQ ID NO: 65)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFTISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 88)
	ADX_Y1261.ZZ0-1-Vh	ADX_Y1261.ZZ0-1-Vk
ADX_Y1 261.ZZ0- 1	QVQLQQSGAERAKPGASVKMSCKASG YSFTSYWMHWIKQRPQGQLEWIGFIN PNTGHTDYNQKFKDKATLTADKSSST AYMQLSSLTSEDSAVYFCRWGLPPF AYWGQGTLLTVSA (SEQ ID NO: 66)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFTISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 89)
	ADX_Y1262.ZZ0-1-Vh	ADX_Y1262.ZZ0-1-Vk
ADX_Y1 262.ZZ0- 1	QVQLQQSGAELAKPGSSVKMSCKASG YAFTSYWMHWVKQRPQGQLEWIGYIN PTTGYSAYNQKFKDKATLTADKSSST	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR

ID	VH Sequence	VL Sequence
	AYMQLNSLTSEDSAVYYCARWDPRPF AYWGQGTTLVTVSA (SEQ ID NO: 67)	YTGVPDRFTGSGYGTDFTFITISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 90)
	ADX_Y1263.ZZ0-1-Vh	ADX_Y1263.ZZ0-1-Vk
ADX_Y1 263.ZZ0- 1	QVQLQQSGAELAKPGTSVKMSCKASG YSFTSYVHWVKRPGQGLEWIGHTN PNTGYTEYNQKFKDKATLTVDSSST AYMQLNSLTSEDSAVYYCARWDPRPF AYWGQGTTLVTVSA (SEQ ID NO: 68)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFITISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 91)
	ADX_Y1264.ZZ0-1-Vh	ADX_Y1264.ZZ0-1-Vk
ADX_Y1 264.ZZ0- 1	EVQLQQSGTVLARPASVKMSCRASG YSFSSYWMHWVKRPGQGLEWIGSIN PGNSDAFYNNQKFKGAKLTAVTSAST AYMELSSLTNEDSAVYYCTRWGLPPF AYWGQGTTLVTVSA (SEQ ID NO: 69)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFITISSVQAE DLAVYYCHQHYSTPWTFGGGTKLEIK (SEQ ID NO: 92)
	ADX_Y1265.ZZ0-1-Vh	ADX_Y1265.ZZ0-1-Vk
ADX_Y1 265.ZZ0- 1	EVQLQQSGTVLAGPGASVKMSCKASG YSFTSYWMHWVKRPGQDLEWIGTIN PGKGSNNYNQKFKGAKLTAVTSAST AYMELSSLTNEDSAVYYCTRWGLPPF AYWGQGTTLVTVSA (SEQ ID NO: 70)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFITISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 93)
	ADX_Y1266.ZZ0-1-Vh	ADX_Y1266.ZZ0-1-Vk
ADX_Y1 266.ZZ0- 1	QVQLQQPGAELVKPGASVRLSCKASG YSFTSYWMHWVKRPGQGLEWIGQIN PSNGRTQYNEKFKSMATLTVDKSSST AYIQLSSLTSEDSAVYYCARWGLQPF AYWGQGTTLVTVSA (SEQ ID NO: 71)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFITISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 94)
	ADX_Y1267.ZZ0-1-Vh	ADX_Y1267.ZZ0-1-Vk
ADX_Y1 267.ZZ0- 1	QVQLQQPGAELVKPGASVRLSCEASG YSFTSYWMHWVKRPGQGLEWIGQIN PSNGRTQYNEKFKSMATLTVDKSSST AYIQLNSLTSEDSAVYYCARWGLQPF AYWGQGTTLVTVSA (SEQ ID NO: 72)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFITISSVQAE DLAVYYCLQHYTTPWTFGGGTKLEIK (SEQ ID NO: 95)
	ADX_Y1268.ZZ0-1-Vh	ADX_Y1268.ZZ0-1-Vk
ADX_Y1 268.ZZ0- 1	QVQLQQPGAELVKPGASVRLSCKASG YAFTSYWMHWVKRPGQGLEWIGQIN PSNGRSQYNEKFKTMATLTVDKSSST AYIQLSSLTSEDSAVYYCARWGLQPF AYWGQGTTLVTVSA (SEQ ID NO: 73)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSTAVAWYQQKPGQSPKLLIYSASYR YTGVPDRFTGSGSGTDFTFITISSVQAE DLAVYYCQQHYSTPWTFGGGTKLEIK (SEQ ID NO: 96)
	ADX_Y1269.ZZ0-1-Vh	ADX_Y1269.ZZ0-1-Vk

ID	VH Sequence	VL Sequence
ADX_Y1269.ZZ0-1	QVQLQQSGAELPRPGASVKMSCKASG YTFTDQYTVHWVKQRPQGQLEWIGYIN PSSSYTSYDQKFKDKATVTADKSSST AYMQLSSLTSEDSAVYYCARRTMYWY FDIWGAGTTTVTVSS (SEQ ID NO: 74)	DIVMTQSHKFMSTSVGDRVSITCKASQ DVSPNVAWYQQKPGQSPKLLIYSTSYR YTGVPDRFTGSRSGTDFTFITISSVQAE DLAIYYCQQHYSTPLTFGAGTKLELK (SEQ ID NO: 97)
	ADX_Y1297.ZZ0-1-Vh	ADX_Y1297.ZZ0-1-Vk
ADX_Y1297.ZZ0-1	QVQLQQSGAELVKPGASVKLSCKASG YTFTSYWMHWVKQRPQGQLEWIGEID PSDSYTNYNQNFKGKATLTVDKSSST AYMQLSSLTSEDSAVYYCARETYYYG SRFPYWGQGTLLTVSA (SEQ ID NO: 75)	DIVMTQSHKFMSTSVGDRVSVTCKASQ NVRINVAWYQQKPGQSPKALIYSASYR YSGVPDRFTGSGSGTDFTLTITNVQSE DLAEYFCQQYNTYPLTFGAGTKLELK (SEQ ID NO: 98)

- [00101] The CD40 kinetic and affinity data for human-CD40 monomer binding to mouse anti-human CD40 antibodies captured on a protein A sensor chip surface were assessed by SPR. The data are shown in Table 9. The data shown are for a single concentration of CD40 analyte (1 μ M) and are therefore reported as apparent (app) values.

TABLE 9
SPR kinetic/affinity data

Antibody	$k_{a,app}$ (1/Ms)	$k_{d,app}$ (1/s)	KD_{app} (M)
ADX_Y1072.ZZ0-1	7.7E+04	9.2E-03	1.2E-07
ADX_Y1238.ZZ0-1	5.5E+04	1.2E-04	2.2E-09
ADX_Y1258.ZZ0-1	1.7E+04	1.3E-04	7.9E-09
ADX_Y1260.ZZ0-1	5.2E+04	2.1E-04	4.0E-09
ADX_Y1262.ZZ0-1	3.7E+05	2.5E-03	6.6E-09
ADX_Y1264.ZZ0-1	1.4E+04	2.3E-04	1.7E-08
ADX_Y1267.ZZ0-1	3.7E+05	4.1E-04	1.1E-09
ADX_Y1268.ZZ0-1	3.2E+05	4.6E-04	1.4E-09

- [00102] Based on the SPR data and sequence data, three antibodies, ADX_Y1258.ZZ0-1, ADX_Y1262.ZZ0-1, and ADX_Y1268.ZZ0-1, were selected for humanization.

Example 2: Humanization and selection of humanized variants of Y12XX

[00103] Humanization background/procedure is as discussed in section “II. Engineered and Modified Antibodies” in WO2017004006, which is incorporated herein by reference in its entirety. Based on this analysis, nine (9) humanized Vh sequences (Vh-hz1, Vh-hz2, Vh-hz3, Vh-hz4, Vh-hz5, Vh-hz6, Vh-hz9, Vh-hz10, and Vh-hz11) and three (3) humanized Vκ sequences (Vκ-hz1, Vκ-hz2, and Vκ-hz3), were selected for testing. In addition, five (5) humanized Vh sequences (Vh-hz7, Vh-hz8, Vh-hz12, Vh-hz13, and Vh-hz14) were designed to contain mutations intended to reduce chemical liability risk designed. The mutations include D100Q (Y1262_IGHV1.6908-D100Q) and P101A (Y1262_IGHV1.6908-P101A) mutations to mitigate potential hydrolysis risk in Y1262_IGHV1.6908. The mutations also include N55Q (Y1268_IGHV1.6908-N55Q), G56A (Y1268_IGHV1.6908-G56A), and the S54T-N55T double mutation (Y1268_IGHV1.6908-S54T-N55T) to mitigate potential deamidation risk in Y1268_IGHV1.6908. The S54T-N55T double mutation was designed based on the corresponding amino acid residues found at these positions in ADX_Y1262.ZZ0-1-Vh. *See* Table 10.

[00104] The sequences for these variants are shown in Table 10.

TABLE 10

ID	Variable Hz #	SEQ ID NO:	Sequence
Y1258-Vh	Vh-C1	99	QVQLQQSGAELAKPGSSVKMSCKASGYAFTSYWMHW IKQRP GQGLEWIGFINPTTGyseynQKFkdKATLTA DKSSSTAYMQLNLSLTSEDSAVYFCARWGLPPFAYWG QGTLVTVSA
Y1258_IGHV1.6908-Vh	Vh-hz1	100	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQAPGQGLEWMGFINPTTGyseynQKFkdRVTITA DKSTSTAYME LS SLRSED TAV YFCARWGLPPFAYWG QGTLVTVSS
Y1258_IGHV1.6908_A40R-Vh	Vh-hz2	101	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQRP GQGLEWMGFINPTTGyseynQKFkdRVTITA DKSTSTAYME LS SLRSED TAV YFCARWGLPPFAYWG QGTLVTVSS
Y1258_IGHV1.6908_A40R-M48I-S84N-Vh	Vh-hz3	102	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQRP GQGLEWIGFINPTTGyseynQKFkdRVTITA DKSTSTAYME LS SLRSED TAV YFCARWGLPPFAYWG QGTLVTVSS
Y1262-Vh	Vh-C2	103	QVQLQQSGAELAKPGSSVKMSCKASGYAFTSYWMHW VKQRP GQGLEWIGYINPTTGysaynQKFkdKATLTA

ID	Variable Hz #	SEQ ID NO:	Sequence
			DKSSSTAYMQLNSLTSEDSAVYYCARWDPDPFAYWG QGTLVTVSA
Y1262_IGHV1.690 8-Vh	Vh-hz4	104	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQAPGQGLEWMGYINPTTGYSAYNQKFKDKATLTA DKSTSTAYMELSSLRSEDTAVYYCARWDPDPFAYWG QGTLVTVSS
Y1262_IGHV1.690 8_A40R-Vh	Vh-hz5	105	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQRP GQGLEWMGYINPTTGYSAYNQKFKDKATLTA DKSTSTAYMELSSLRSEDTAVYYCARWDPDPFAYWG QGTLVTVSS
Y1262_IGHV1.690 8_A40R-M48I- S84N-Vh	Vh-hz6	106	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQRP GQGLEWIGYINPTTGYSAYNQKFKDKATLTA DKSTSTAYMELNSLRSEDTAVYYCARWDPDPFAYWG QGTLVTVSS
Y1262_IGHV1.690 8-D100Q-Vh	Vh-hz7	107	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQAP GQGLEWMGYINPTTGYSAYNQKFKDKATLTA DKSTSTAYMELSSLRSEDTAVYYCARWQPRPFAYWG QGTLVTVSS
Y1262_IGHV1.690 8-P101A-Vh	Vh-hz8	108	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQAP GQGLEWMGYINPTTGYSAYNQKFKDKATLTA DKSTSTAYMELSSLRSEDTAVYYCARWDARPFAYWG QGTLVTVSS
Y1268-Vh	Vh-C3	109	QVQLQQPGAELVKPGASVRLSCKASGYAFTSYWMHW VKQRP GQGLEWIGQINPSNGRSQYNEKF K TMATLTV DKSSSTAYIQLSSLTSEDSAVYYCARWGLQPFAYWG QGTLVTVSA
Y1268_IGHV1.690 8-Vh	Vh-hz9	110	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQAP GQGLEWMGQINPSNGRSQYNEKF K TRVTITA DKSTSTAYMELSSLRSEDTAVYYCARWGLQPFAYWG QGTLVTVSS
Y1268_IGHV1.690 8_A40R-Vh	Vh-hz10	111	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQRP GQGLEWMGQINPSNGRSQYNEKF K TRVTITA DKSTSTAYMELSSLRSEDTAVYYCARWGLQPFAYWG QGTLVTVSS
Y1268_IGHV1.690 8_A40R-M48I-Vh	Vh-hz11	112	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQRP GQGLEWIGQINPSNGRSQYNEKF K TRVTITA DKSTSTAYMELSSLRSEDTAVYYCARWGLQPFAYWG QGTLVTVSS
Y1268_IGHV1.690 8-N55Q-Vh	Vh-hz12	113	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQAP GQGLEWMGQINPSQGRSQYNEKF K TRVTITA DKSTSTAYMELSSLRSEDTAVYYCARWGLQPFAYWG QGTLVTVSS
Y1268_IGHV1.690 8-G56A-Vh	Vh-hz13	113	QVQLVQSGAEVKKPGSSVKVSCASGYAFTSYWMHW VRQAP GQGLEWMGQINPSNARSQYNEKF K TRVTITA

ID	Variable Hz #	SEQ ID NO:	Sequence
			DKSTSTAYMELSSLRSED TAVYYCARWGLQPFAYWG QGTLVTVSS
Y1268_IGHV1.690 8-S54T-N55T-Vh	Vh-hz14	4	QVQLVQSGAEVKKPGSSVKV SCKASGYAFTSYWMHW VRQAPGGGLEWMGQINPTTGRSQYNEKFKTRVTITA DKSTSTAYMELSSLRSED TAVYYCARWGLQPFAYWG QGTLVTVSS
Y1258-Vk	Vk-C1	114	DIVMTQSHKFMSTSVGDRVSI TCKASQDVSTAVAWY QQKPGQSPKLLIYSASYRYTGVPDRFTGSGSGTDFT FTISSVQAEDLAVYYCQQHYSTPWTFGGGTKLEIK
Y1262-Vk	Vk-C2	115	DIVMTQSHKFMSTSVGDRVSI TCKASQDVSTAVAWY QQKPGQSPKLLIYSASYRYTGVPDRFTGSGYGTDF FTISSVQAEDLAVYYCQQHYSTPWTFGGGTKLEIK
Y1258_IGKV1.330 1-Vk	Vk-hz1	116	DIQMTQSPSSLSASVGDRVTITCKASQDVSTAVAWY QQKPGKAPKLLIYSASYRYTGVP SRFSGSGSGTDFT FTISLQPEDIA TYYCQQHYSTPWTFGGGTKVEIK
Y1258_IGKV1.390 2-Vk	Vk-hz2	10	DIQMTQSPSFLSASVGDRVTITCKASQDVSTAVAWY QQKPGKAPKLLIYSASYRYTGVP SRFSGSGSGTDFT LTISLQPEDFATYYCQQHYSTPWTFGGGTKVEIK
Y1258_IGKV3.150 1-Vk	Vk-hz3	16	EIVMTQSPATLSVSPGERATLSCKASQDVSTAVAWY QQKPGQAPRLIYSASYRYTGIPARFSGSGSGTEFT LTISLQSEDFAVYYCQQHYSTPWTFGGGTKVEIK

[00105] Table 10 provides the heavy and variable light domain sequences used for construction of humanized antibodies, as well as chimeric antibody controls, for CD40 binding analyses using BIAcore™ surface plasmon resonance (SPR), as well as Octet BLI titer analyses (discussed below).

- 5 **[00106]** Vh sequences were formatted with IgG1-P238K isotype (CH1-IgG1-P238K; SEQ ID NO:25). Vk sequences were formatted as a full light chain with a common CL sequence (amino acids 108-214 of SEQ ID No: 11). In Table 11, “Y1258” and “Y1262” refer to chimeric molecules containing mouse variable regions and human constant regions. The various different combinations of the humanized HC constructs and LC constructs, as
- 10 well as the chimeric Y1258 and Y1262 molecules were expressed as 3 milliliter (ml) supernatants for titer analysis and CD40 binding analysis. The family of molecules was collectively identified with an “Y12XX” prefix, followed by a “hz#” suffix to uniquely identify different heavy chain / light chain pairs.

- [00107]** Titer analysis was performed using Biolayer Interferometry (BLI) on an Octet
- 15 RED instrument (Fortebio) by capturing antibodies from supernatant using protein A sensor

tips and measuring capture response with respect to a standard curve obtained using a control antibody sample. SPR data were obtained by capturing antibodies on a protein A surface and testing the binding of 500 nM and 50 nM injections of human-CD40 analyte, using a BIAcore™ T200 instrument (GE Healthcare). The kinetic data for the two concentrations of hCD40-monomer were fit to a 1:1 Langmuir model, to yield estimates of the kinetic and affinity values for these interactions, and for comparison of the different molecules.

[00108] The Octet titer and BIAcore™ SPR CD40 binding data are provided in Table 11. In addition to testing supernatant (“sup”) samples, purified chimeric Y1258, Y1262 and Y1268 antibodies containing human wild-type IgG1f isotype

(ASTKGPSVFPLAPSSKSTSGGTAAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVKDKRVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK; SEQ ID NO:117) were tested by SPR as controls; these are named “Y1258-hIgG1f”, “Y1632-hIgG1f” and “Y1268-hIgG1f” in Table 11, and the Vh and Vk chains are denoted as “Chim-P.”

TABLE 11

Octet titer and BIAcore™ SPR CD40 binding data

Antibody ID	Vh	Vk	Sample	Titer (μg/ml)	ka (1/Ms)	kd (1/s)	KD (M)
Y1258-hIgG1f	Chim-P	Chim-P	purified	n/a	5.8E+04	5.9E-07	1.0E-11
Y1258	Vh-C1	Vk-C1	sup	54.2	5.6E+04	3.8E-06	6.7E-11
Y12XX-hz1	Vh-hz1	Vk-hz1	sup	3.8	1.5E+04	1.6E-05	1.1E-09
Y12XX-hz15	Vh-hz1	Vk-hz2	sup	34.6	1.6E+04	1.3E-04	8.0E-09
Y12XX-hz29	Vh-hz1	Vk-hz3	sup	56.7	3.7E+04	2.6E-06	6.9E-11
Y12XX-hz2	Vh-hz2	Vk-hz1	sup	4.5	1.7E+04	7.1E-05	4.1E-09
Y12XX-hz16	Vh-hz2	Vk-hz2	sup	58.6	2.0E+05	6.4E-04	3.2E-09
Y12XX-hz30	Vh-hz2	Vk-hz3	sup	82.6	4.1E+04	7.3E-07	1.8E-11
Y12XX-hz3	Vh-hz3	Vk-hz1	sup	6.4	1.5E+04	6.7E-05	4.5E-09
Y12XX-hz17	Vh-hz3	Vk-hz2	sup	50.7	3.7E+05	7.7E-02	2.1E-07
Y12XX-hz31	Vh-hz3	Vk-hz3	sup	93.9	4.1E+04	2.9E-07	7.0E-12
Y1262-hIgG1f	Chim-P	Chim-P	purified	n/a	4.8E+05	5.5E-03	1.2E-08
Y1262	Chim	Chim	sup	92.2	3.5E+05	2.8E-03	8.0E-09
Y12XX-hz4	Vh-hz4	Vk-hz1	sup	4.7	4.6E+05	2.2E-03	4.7E-09
Y12XX-hz18	Vh-hz4	Vk-hz2	sup	73.6	3.5E+05	2.4E-03	7.1E-09

Antibody ID	Vh	Vk	Sample	Titer ($\mu\text{g/ml}$)	k_a (1/Ms)	k_d (1/s)	KD (M)
Y12XX-hz32	Vh-hz4	Vk-hz3	sup	104.3	2.9E+05	3.0E-03	1.0E-08
Y12XX-hz5	Vh-hz5	Vk-hz1	sup	4.5	3.5E+05	2.5E-03	7.2E-09
Y12XX-hz19	Vh-hz5	Vk-hz2	sup	56.7	3.8E+05	2.3E-03	6.2E-09
Y12XX-hz33	Vh-hz5	Vk-hz3	sup	85.5	2.9E+05	3.3E-03	1.1E-08
Y12XX-hz6	Vh-hz6	Vk-hz1	sup	6.7	3.8E+05	2.4E-03	6.4E-09
Y12XX-hz20	Vh-hz6	Vk-hz2	sup	50.3	3.1E+05	2.5E-03	8.2E-09
Y12XX-hz34	Vh-hz6	Vk-hz3	sup	93.7	3.7E+05	2.8E-03	7.6E-09
Y12XX-hz8	Vh-hz8	Vk-hz1	sup	11.2	7.2E+05	1.5E-01	2.1E-07
Y12XX-hz22	Vh-hz8	Vk-hz2	sup	49.1	3.7E+05	7.9E-02	2.1E-07
Y12XX-hz36	Vh-hz8	Vk-hz3	sup	136.7	3.9E+05	1.0E-01	2.5E-07
Y1268-hIgG1f	Chim-P	Chim-P	purified	n/a	4.0E+05	1.3E-03	3.2E-09
Y12XX-hz9	Vh-hz9	Vk-hz1	sup	5.1	2.0E+05	8.9E-04	4.6E-09
Y12XX-hz23	Vh-hz9	Vk-hz2	sup	59.4	2.0E+05	6.4E-04	3.2E-09
Y12XX-hz37	Vh-hz9	Vk-hz3	sup	138.4	2.6E+05	8.4E-04	3.3E-09
Y12XX-hz10	Vh-hz10	Vk-hz1	sup	8.6	2.0E+05	7.3E-04	3.6E-09
Y12XX-hz24	Vh-hz10	Vk-hz2	sup	48.1	1.9E+05	8.2E-04	4.4E-09
Y12XX-hz38	Vh-hz10	Vk-hz3	sup	185.5	2.5E+05	8.8E-04	3.6E-09
Y12XX-hz11	Vh-hz11	Vk-hz1	sup	7.5	1.8E+05	8.8E-04	5.0E-09
Y12XX-hz25	Vh-hz11	Vk-hz2	sup	55.4	1.9E+05	6.4E-04	3.4E-09
Y12XX-hz39	Vh-hz11	Vk-hz3	sup	134.2	2.4E+05	8.4E-04	3.5E-09
Y12XX-hz12	Vh-hz12	Vk-hz1	sup	2.7	1.7E+05	1.4E-03	8.3E-09
Y12XX-hz26	Vh-hz12	Vk-hz2	sup	36.8	1.6E+05	1.2E-03	7.5E-09
Y12XX-hz40	Vh-hz12	Vk-hz3	sup	99.8	2.4E+05	1.1E-03	4.7E-09
Y12XX-hz13	Vh-hz13	Vk-hz1	sup	3.0	2.1E+05	8.3E-04	3.9E-09
Y12XX-hz27	Vh-hz13	Vk-hz2	sup	49.5	1.9E+05	8.8E-04	4.7E-09
Y12XX-hz41	Vh-hz13	Vk-hz3	sup	52.7	2.5E+05	9.4E-04	3.8E-09
Y12XX-hz14	Vh-hz14	Vk-hz1	sup	5.0	1.7E+05	8.3E-04	5.0E-09
Y12XX-hz28	Vh-hz14	Vk-hz2	sup	70.1	1.8E+05	6.2E-04	3.5E-09
Y12XX-hz42	Vh-hz14	Vk-hz3	sup	100.0	2.4E+05	8.3E-04	3.5E-09

[00109] For a given heavy chain construct, the titer is generally highest when paired with light chains containing Vk-hz3 (SEQ ID NO:18), lower for heavy chains paired with Vk-hz2 (SEQ ID NO:10), and the lowest for heavy chains paired with Vk-hz1 (SEQ ID NO:116) containing light chains.

[00110] The SPR analysis data show that the antibodies bound with variable affinity to CD40, with KD values ranging from greater than 1 E-07 to less than 1 E-09. For some antibodies, the affinity was too strong to accurately determine with confidence in this assay,

because the dissociation rate was too slow to measure. These values, which are italicized in the table, are beyond the limit of accurate quantitation in this assay.

[00111] Based on the sequences, titer, and SPR binding data, antibodies were selected for larger scale expression, purification, and further characterization. SPR analysis using purified antibodies was performed by capturing antibodies on a protein A surface, with binding of a 500 - 3.9 nM (2:1) dilution series of human-CD40 monomer, at either 25 °C or 37 °C in PBS-T pH 7.1 buffer; the titration data was fit to a 1:1 Langmuir model. The data is provided in Table 12.

TABLE 12

SPR kinetic/affinity data

Ligand	Sample	25 °C			37 °C		
		ka (1/Ms)	kd (1/s)	KD (nM)	ka (1/Ms)	kd (1/s)	KD (nM)
Y12XX-hz28	hCD40	2.2E+05	6.9E-04	3.1	4.4E+05	3.7E-03	8.5
Y12XX-hz40	hCD40	2.9E+05	1.3E-03	4.4	5.2E+05	5.7E-03	10.9
Y12XX-hz42	hCD40	3.1E+05	7.3E-04	2.3	6.3E+05	3.4E-03	5.5
Antibody B		6.1E+04	2.3E-03	37			

[00112] These data show that the selected Y12XX antibodies bind with high affinity and KD values in the range of KD = 1 E-9 M at 25 °C. The binding is compared to that of another anti-CD40 antibody, antibody BI-mAb-B (U.S. Pat. No. 9,090,696, heavy chain sequence SEQ ID NO: 32 and light chain sequence SEQ ID NO: 31; referred to herein as “Antibody B” and “BI-LALA”). As shown by the data in Table 12, Antibody B binds to CD40 with much lower affinity than the humanized Y12XX molecules.

[00113] All three humanized versions of the Y12XX antibody were potent antagonists of B cell proliferation stimulated with CD40L-IZ trimeric agonist. See Table 13.

Table 13**Inhibition of B cell proliferation induced by soluble CD40L trimer**

	Average (IC50 ng/ml)	Standard Deviation (STDEV)	n donors
Antibody B	9.4	3.9	6
Y12XX-hz28-P238K	6.7	3.6	8
Y12XX-hz40-P238K	6.0	4.7	2
Y12XX-hz42-P238K	12.1	2.3	2

- [00114] Y12XX-hz28-P238K was also a potent antagonist of B cell proliferation
 5 stimulated with cellular CD40L from CD40L-expressing CHO cells. *See* Table 14.

Table 14**Potency for inhibition of CD40L expressing CHO cells stimulation of B cell proliferation**

	Potency (IC50 ng/ml of % inhibition)	Standard deviation	n donors
Antibody B	62% *	25%	6
Y12XX-hz28-P238K	38.1	9.8	8

* % inhibition at highest dose tested (1-3 µg/ml)

- [00115] The data for the humanized Y12XX antibodies is compared to that of
 10 Antibody B, which showed potent inhibition of B cell proliferation driven by soluble CD40L
 signals, but was much less effective at inhibition of B cell proliferation driven by cellular
 CD40L (CHO cells overexpressing CD40L). In contrast, humanized Y12XX antibodies
 exhibited only a <10 fold shift in the potency for inhibition of cell surface CD40L
 stimulation, providing more robust blockade of B cell responses to CD40L.
- 15 [00116] Humanized Y12XX antibodies were formatted with IgG1-P238K isotype
 (CH1-IgG1-P238K; SEQ ID NO: 25) to reduce the binding affinity for FcγRs and reduce

Fc γ R-mediated signaling. Fc γ R binding for a representative humanized Y12XX antibody with this IgG1-P238K isotype (Y12XX-hz28-IgG1-P238K) was compared to the binding of a control antibody formatted with a wild type IgG1 isotype (control-IgG1) as well as Antibody B which has an IgG1 isotype containing the mutations L234A-L235A. These L234A-L235A mutations are also introduced to reduce Fc γ R binding.

[00117] Fc γ R binding SPR studies were performed by capturing antibodies on a protein A sensor chip surface and binding purified His-tagged human Fc γ Rs as analyte. hCD64 binding consisted of a titration of 10 μ M - 1.5 nM hCD64 (2:1 dilution series), while data for the low affinity Fc γ Rs hCD32a-H131, hCD32a-R131, hCD32b, hCD16a-V158, and hCD16a-F158 consisted of a titration of 10 μ M - 13.7 nM Fc γ R protein.

[00118] The control-IgG1 antibody demonstrated binding to all of the Fc γ Rs tested. See Figure 1A. Compared to wild type, the Y12XX-hz28-IgG1-P238K antibody demonstrated 125-fold weaker binding to hCD64, and demonstrated no detectable binding to any of the low affinity Fc γ Rs hCD32a-H131, hCD32a-R131, hCD32b, hCD16a-V158 and hCD16a-F158 tested. See Figure 1B. Antibody B also demonstrated weaker hCD64 binding than wild type IgG1, but also demonstrated appreciable binding to hCD16a-V158 (KD = 7 μ M) and some weak binding to hCD32a-H131 and hCD32a-R131. See Figure 1C. The KD values are provided in Figure 1D.

[00119] Humanized versions of the antibody Y12XX with P238K mutation in the Fc region were further tested for any agonist activity. Monocyte derived immature dendritic cells (iDC) are very sensitive to CD40 activation, increasing cytokine production (IL-6) and upregulating surface markers of activation (CD86 and CD54) upon CD40 stimulation. Therefore, the most promising humanized Y12XX antibodies were tested to assess their ability to stimulate iDC. The ability of CD40 antibodies to agonize CD40 can be enhanced by clustering or cross-linking binding of the Fc portions of the molecule to cell surface Fc γ R. Addition of CHO cells highly over-expressing CD32a, the low affinity Fc γ R, were used to evaluate the potential for Fc γ R mediated clustering/cross-link. The ratio of CHO cells to iDCs was 1:6 in these experiments, representing a potentially exaggerated level of clustering/cross-linking. BMS-986090 and 2141 were used as positive controls. BMS-986090 is an anti-CD40 antagonist domain antibody fused to IgG4 Fc (see SEQ ID NO: 1287 in WO 2012/145673). 2141 (mAb 134-2141) is a partial CD40 agonist (see Robert

Vonderheide et al., 2007, *J. Clin. Oncol.* 25(7): 876-883). L6-IgG4 is a fusion protein with no CD40 binding capability, and served as a negative control.

[00120] As illustrated by the data in Figure 2, the addition of either the partial agonist 2141 or BMS-986090 led to only weak activation of iDC in a subset of donors. However, addition of CD32a- expressing CHO cells to either 2141 or BMS-986090 led to robust increases in IL-6 production (Fig. 2B) and CD86 and CD54 upregulation (Fig. 2B and Fig. 2C, respectively) in nearly every donor tested, consistent with FcγR mediated clustering of these molecules through their Fc portions leading to CD40 activation. In contrast, Y12XX-hz28-P238K and Y12XX-hz40-P238K either alone or with CD32 dependent clustering did not show any signs of iDC activation above that observed with the negative control using iDC cells from 6-10 donors. Y12XX-hz42-P238K was tested in cells from 4 donors and exhibited signs of weak activation including IL-6 production and CD86 and CD54 upregulation in only one of the four donors, which, unlike the activity seen with 2141 or BMS-986090, was not dependent on the addition of CD32a-expressing CHO cells.

15 MATERIALS AND METHODS FOR EXAMPLES 1 and 2

[00121] **FcγR binding SPR:** FcγR binding can be measured in vitro using purified FcγRs using methods, such as BIAcore™ surface plasmon resonance (SPR). One method tests the binding of purified His-tagged FcγR proteins (FcγR-his) to antibodies that are captured on a sensor surface containing protein A which has been immobilized using standard ethyl(dimethylaminopropyl) carbodiimide (EDC)/N-hydroxysuccinimide (NHS) chemistry with ethanolamine blocking. These experiments are performed on a BIAcore™ T200 instrument (GE Healthcare, Marlborough, MA) at 25 °C. For example, samples of purified antibody at 3 μg/ml concentration are first captured on the immobilized protein A surface using a 15 second (s) contact time at 10 μl/min flow rate. This is followed by the binding of purified FcγR-His proteins at various concentrations, such as 10 μM - 1.5 nM (2:1 dilution series) or 10 μM - 13.7 nM (2:1 dilution series), using 120 s association and dissociation times at a flow rate of 30 μ/min. All steps are performed in a running buffer consisting of 10 mM NaPO₄, 130 mM NaCl, 0.05% p20 (PBS-T) pH 7.1. FcγR proteins tested in these studies include the “high affinity” FcγR CD64 (hFcγRI), as well as the “low affinity” FcγRs CD32a-H131 (FcγRIIa-H131), CD32a-R131 (FcγRIIa-R131), CD32b (FcγRIIb), CD16a-V158 (FcγRIIIa-V158), and CD16a-F158 (FcγRIIIa-F158), which were expressed and purified in house. SPR data are fit to either a 1:1 Langmuir model, or a 1:1

steady state model using BIAcore™ T200 evaluation software to obtain values for the association rate constant (ka), dissociation rate constant (kd) and dissociation constant (K_D).

- [00122] To compare binding responses for different FcγRs, SPR data can be analyzed by calculating the maximum binding response as a percentage of the theoretical maximum
5 binding response (%Rmax), using the equation:

EQUATION 1: $\%R_{max} = (\text{Binding Response Analyte}) / [((Mw \text{ Analyte}) / (Mw \text{ Ligand})) \times (\text{Response Ligand}) \times (\text{analyte:ligand stoichiometry})]$

- 10 where “Analyte” is the FcγR and “Ligand” is the captured antibody. This analysis does not take into account the mass of glycosylation of antibody or FcγR, and assumes 100% fractional activity for the captured ligand. Since the FcγRs are glycosylated, the %Rmax values are typically great than 100% under saturating conditions.

- [00123] **CD40 binding kinetics and affinity:** The monovalent CD40 binding affinity
15 of the antibody molecules is measured by surface plasmon resonance (SPR) on a BIAcore™ T200 instrument (GE Healthcare Life Sciences) at 25°C or 37°C by capturing antibody on an immobilized protein A sensor chip surface, and then binding human-CD40-monomer protein (generated in house) using, for example, an association time of 180 seconds, and dissociation time of 180 seconds or 360 seconds at 30 μl/min in PBS-T, pH 7.1. SPR data are fit to a 1:1
20 Langmuir model using BIAcore™ T200 evaluation software to obtain values for the association rate constant (ka), dissociation rate constant (kd) and dissociation constant (K_D).

- [00124] **Titer analysis:** Titer analysis was performed using Biolayer Interferometry (BLI) on an Octet® RED instrument (ForteBio, Freemont, CA) at 25°C. Antibodies are captured from supernatant using protein A sensor tips using association time of 120 seconds
25 and the binding response is measured and compared to a standard curve obtained using a control antibody sample to determine the concentration of antibody in the supernatant.

- [00125] **Primary Cell Isolation and Culture:** Peripheral blood mononuclear cells (PBMC) were isolated from heparinized human blood by Ficoll density gradient separation. Monocytes were isolated from PBMC following the Manual EasySep™ protocol
30 (STEMCELL, Vancouver, Canada). One million of isolated monocytes were plated in in each well of a 6-well plate in 6 mLs of complete media (RPMI-1640, 10% heat-inactivated fetal

bovine serum, 100 units/ml penicillin-streptomycin), containing IL-4 (100 ng/ml) and GM-CSF (100 ng/ml) and incubated for 6 days at 37 °C/5% CO₂, changing media every other day and replacing it with fresh media containing the same concentration of cytokines. iDCs (immature dendritic cells) were harvested on day 6, washed thoroughly, and re-suspended in complete media.

[00126] Treatment of iDCs with anti-CD40 Antibodies in the Presence or Absence of FcγR Clustering/Crosslinking:

Titration of the various biological agents were made in complete media, and added to duplicate 96-well plates. In the case of cross-linking, antibodies were added to the cells for 30 min prior to the addition of CD32a-expressing CHO cells at a ratio of 1:6. Cells were incubated at 37 °C/5% CO₂ for approximately 18-20 hours, 150 μL of supernatant was removed from each well, diluted 1:5 and evaluated for protein concentrations of IL-6, TNFα and IL-12 using a commercially available ELISA kits (R&D Systems, Minneapolis, MN), according to manufacturer's instructions. The cells remaining in the plates from the harvested supernatants were combined into 1 sample per duplicate treatment, and transferred to new 96-well round bottom (RB) plate, and placed at 4° C. Cells were washed with D-PBS, Ca⁺⁺ and Mg⁺⁺ free, and stained for 30 min on ice for cell viability using the LIVE/DEAD® Fixable Near-IR Dead Cell Stain Kit (Invitrogen, Carlsbad, CA). Cells were washed and re-suspended in D-PBS, Ca⁺⁺ and Mg⁺⁺ free, 2% FBS, 0.1 % NaN₃ (staining buffer) and blocked with 5μl/well of Human TruStain FcX™ (Fc Receptor Blocking Solution, Biolegend, San Diego, CA) in staining buffer.

DCs were immuno-stained with: PerCpCy5.5-conjugated αCD3, αCD19, αCD14 (Lin⁻), BUV395-conjugated αCD11c (BD Biosciences, San Diego, CA), APC-conjugated αCD86 (Biolegend, San Diego, CA), PE-conjugated αCD83 (eBioscience, San Diego, CA), FITC-conjugated αCD54 (Biolegend, San Diego, CA), and incubated at 4 °C. for 45 minutes. Cells were washed twice in staining buffer and fixed (15 at RT, protected from light), by adding 100 μl of BD Cytfix Fixation Buffer (BD Bioscience, San Diego, CA). DCs were evaluated for CD86, ICAM-1 and CD83 expression using a LSRII-Fortessa Flow Cytometer (BD Biosciences, San Diego, CA), and FlowJo analysis software (Treestar, Ashland, OR).

[00128] Inhibition of CD40L induced human B cell proliferation: Human tonsillar B cells were obtained from pediatric patients during routine tonsillectomy and isolated by

mincing and gently mashing the tissue, passing the cells through a screen and isolating mononuclear cells with density gradient separation using human Lympholyte®-H separation media (Cedarlane Labs, Burlington, ON). Mononuclear cells were collected from the interface, washed, and rosetted with sheep red blood cells (SRBC, Colorado Serum

- 5 Company; Denver, CO) for one hour at 4 ° C, followed by density gradient separation to remove T cells. Cells were again washed and re-suspended in RPMI containing 10% FBS (complete media). Titrations of antibodies were made in complete media, and added in triplicate to 96-well round bottom (RB) plates. 1 X 10⁵ tonsillar human B cells were added and stimulated with either soluble IZ-hCD40L (2 µg/mL), or with Chinese hamster ovary
- 10 cells stably transfected with human CD40L (CHO-hCD40L) irradiated with 10,000 rads, and plated at 2 X 10³ cells/well, in a final volume of 200 µL in each well. Plates were incubated at 37 °C./5% CO₂ for 72 hours, labeled for the last 6 hours with 0.5 µCi of ³[H]-thymidine per well, harvested, and counted by liquid scintillation. B cell proliferation was quantitated based on thymidine incorporation.

15 **Example 3: *In Vitro* Fc Receptor Assays**

[00129] Antibodies can exert effector functions, such as complement dependent cytotoxicity (CDC), and antibody dependent cellular cytotoxicity (ADCC), by binding of the Fc region to Fc gamma receptors (FcγRs) on the surface of immune cells or complement factors. Antibody dependent cellular phagocytosis is another potential Fc effector function. To

20 further characterize the properties of the humanized Y12XX antibodies, the antibodies were assayed for complement dependent cytotoxicity (CDC), antibody dependent cellular phagocytosis (ADCP), and antibody dependent cellular cytotoxicity (ADCC). Table 15 lists the antibodies assayed in this example.

Table 15

	Name	Reference
1	BMS-986291 (Y1238-hz1-P238K)	See WO 2018/217976
2	15B5-hz61-P238K	anti-CD40 antibody (produced in house)
3	5F11-45-P238K	See WO 2018/217976
4	Y12XX-hz28-P238K	
5	Y12XX-hz40-P238K	
6	Y12XX-hz42-P238K	

	Name	Reference
7	Antibody C	anti-CD40 antibody (<i>See</i> Ristov et al. (2018) Am J Transplant. 18(12):2895-2904. Epub 2018 May 24.)
8	BI-LALA	<i>See</i> U.S. Pat. No. 9,090,696, heavy chain sequence SEQ ID NO: 32 and light chain sequence SEQ ID NO: 31; IgG1 isotype containing the mutations L234A-L235A
9	BMS-986090	CD40 domain antibody (BMS3h-56-269-IgG ₄ Fc fusion polypeptide); <i>see</i> , e.g., WO 2012/145673)
10	TT hIgG1	Human anti-tetanus toxin antibody, IgG1 isotype (produced in house) (isotype control)
11	CD20 hIgG1	Human anti-CD20, IgG2 isotype (produced in house) (positive control)

[00130] The CDC assay was performed as follows. “CDC Assay Medium” refers to Roswell Park Memorial Institute medium (RPMI)-1640 (HyClone) with L-glutamine, phenol red-free (HyClone) supplemented with 0.1% BSA (Sigma), and 1% Penicillin-Streptomycin (Life Technologies). Fifty (50) microliters of target cells (5×10^5 cells/mL in CDC assay medium) were added to wells of a 96-well assay plate. The target cells were Raji cells which endogenously express CD40 (obtained from ATCC). Serial dilutions (from 133 to 0.002 nM) were prepared for each antibody tested, and 25 microliters of each antibody concentration were added to each well. Twenty-five microliters of human complement (obtained from Quidel; diluted 1:3 with CDC assay medium) was added to each well. The assay plates were incubated at 37 °C. for 4 hours in a humidified incubator. After the incubation, 100 microliters of CellTiter-Glo® (Promega, Madison, WI) was added to each well. Luminescence data was then acquired with a PerkinElmer EnVision® Plate Reader (PerkinElmer, Waltham, MA). Percent viability was calculated relative to isotype control (100 % viable). The resulting values are plotted against antibody concentration. Percentage of cell viability is plotted for each antibody using Prism v5.01 software from GraphPad Inc.

[00131] The CDC assay was performed twice. In the second assay, freshly thawed human complement serum was used. The results are depicted in Figure 3. Figure 3A depicts the first iteration of the assay, and Figure 3B depicts the second iteration of the assay. CD20 hIgG1 is a positive control and showed cytotoxicity. No detectable CDC activity was present

for the anti-CD40 antibodies assayed, and specifically, none of the humanized Y12XX antibodies assayed induced complement-dependent cytotoxicity.

[00132] The ADCP assay was performed as follows. “ADCP assay media” refers to RPMI-1640 media with L-glutamine, phenol red-free (HyClone) supplemented with 10% ultra-low IgG FBS (Gibco). The effector cells were primary human CD14⁺ monocytes purified from fresh PBMCs from 2 different healthy human donors. The target cells were again Raji cells. The Raji cells were labeled with 2.0 μ M PKH26 (red fluorescent dye; Sigma), and the concentration was adjusted to 4×10^6 cells/mL in ADCP assay media. The labeled target cells were pre-coated with antibodies by adding labeled target cells (50 μ L/well) to a V-bottom 96-well plate containing 50 μ L/well of test or control antibody, and incubating for 30 minutes over ice. The cells were washed, then effector cells (CD14⁺ monocytes) were added (100 μ L/well) to result in a final effector cell-to-target cell ratio (E:T) of 1:4 and a final antibody concentration ranging from 30 nM to 0.1 nM. The plate was then placed in a humidified 37°C incubator for 1 hour. Cells were stained with APC-anti-CD89 (BioLegend) for 30 min on ice and analyzed by flow cytometer (BD Canto™, BD Biosciences, San Jose, CA). Cells were gated for CD89⁺ cells and subsequently for stained phagocytosed effectors (CD89⁺, PKH26⁺). The percentage of phagocytosis was calculated as the population of CD89⁺, PKH26⁺ cells among the total CD89⁺ cells. Background value from the isotype control was subtracted to achieve the final percentage of phagocytosis. Data was analyzed using FlowJo software and Prism v5.01 software from GraphPad Inc.

[00133] Exemplary data using CD14⁺ monocytes from two different donors are depicted in Figure 4. CD20 hIgG1 is a positive control and induced phagocytosis of Raji cells, as expected. BMS-986090 also induced phagocytosis. In contrast, none of the other antibodies tested, including the humanized Y12XX anti-CD40 antibodies of this disclosure, induced detectable phagocytosis in this assay.

[00134] The ADCC assay was performed as follows. “ADCC assay media” refers to RPMI-1640 with L-glutamine, phenol red-free (HyClone) supplemented with 10% ultra-low IgG FBS (Gibco), and 1 mM sodium pyruvate (Life Technologies). Primary human NK (natural kill) cells were purified from fresh PBMCs from 2 different in-house donors, and used as effector cells. PBMC were purified from heparinized whole blood samples by density gradient centrifugation and washed with PBS supplemented with 2% FBS (HyClone). NK

cells were isolated from PBMC by negative selection using a magnetic bead-based separation kit (Miltenyi Biotec). To activate the NK cells, purified NK cells were resuspended at 1×10^6 cells/mL in MyeloCult H5100 media (StemCell Technologies) supplemented with $1 \mu\text{M}$ hydrocortisone (StemCell Technologies) and 500 IU/mL recombinant human IL-2 (Peprotech) and incubated overnight at 37°C . The following day, activated NK effector cells were washed twice in ADCC assay media and the concentration was adjusted to 5×10^5 cells/mL in ADCC assay media. Raji cells (the target cells) were labeled with calcein, as follows. Calcein AM (Life Technologies) reagent was prepared by adding $20 \mu\text{L}$ of ultrapure DMSO to the reagent tube containing $50 \mu\text{g}$ of lyophilized reagent. A volume of $2 \mu\text{L}$ of reconstituted Calcein AM was added to the suspended Raji cells for every 1 mL of volume; the cells were vortexed and placed in a humidified 37°C incubator for 30 minutes. After the incubation period, the labeled target cells were washed 3 times with ADCC assay media, and the concentration was adjusted to 10^5 cells/mL in ADCC assay media. Labeled target cells ($50 \mu\text{L/well}$) were added to a V-bottom 96-well plate containing $50 \mu\text{L/well}$ of test or control antibody. Activated NK effector cells were then added ($100 \mu\text{L/well}$) to result in a final effector cell-to-target cell ratio (E:T) of 10:1, and a final antibody concentration ranging from 0.0002 to $1 \mu\text{g/mL}$. The plate was then placed in a humidified 37°C incubator for 2 hours. Supernatant ($50 \mu\text{L/well}$) was transferred into an optical 96-well black plate, and calcein release was measured by reading fluorescence intensity using an EnVision® Plate Reader (PerkinElmer, Waltham, MA) set to 485 excitation and 535 nm emission filters.

[00135] Target cells incubated with effector cells in the absence of antibody provided the control for background of antibody-independent lysis (spontaneous lysis), while target cells lysed with $20 \mu\text{L/well}$ 10% Tween-20 lysis buffer represented maximal release in the assay.

[00136] The percentage of antibody-dependent cell lysis was calculated based on mean fluorescence intensity (MFI) with the following formula:

$$\text{Equation 2: } \left(\frac{\text{test MFI} - \text{mean background}}{\text{mean maximum} - \text{mean background}} \right) \times 100$$

Percentage of target cell lysis was plotted for each antibody using Prism v5.01 software from GraphPad Inc.

[00137] Exemplary data using NK cells from two different donors are depicted in Figure 5. Target cells were killed by positive control anti-CD20 antibody. In contrast, ADCC is low-to-negative for all of the anti-CD40 antibodies, indicating that these antibodies do not induce antibody-dependent cytotoxicity of Raji cells and evidencing the CD40 antagonism of these antibodies.

[00138] In summary, in this example, the potential of the humanized Y12XX anti-CD40 antibodies of this disclosure, and specifically, Y12XX-hz28-P238K, Y12XX-hz40-P238K, and Y12XX-hz42-P238K, to mediate ADCC (antibody-dependent cellular cytotoxicity), ADCP (antibody-dependent cellular phagocytosis), or CDC (complement-dependent cytotoxicity) was tested using endogenous-CD40-expressing Raji cells as targets. Anti-CD20 antibody was used as a positive control. For ADCC, NK cells were used as effector cells, and two experiments were run with effector cells from different donors. In each case, none of Y12XX-hz28-P238K, Y12XX-hz40-P238K, and Y12XX-hz42-P238K induced lysis of Raji cells. None of Y12XX-hz28-P238K, Y12XX-hz40-P238K, and Y12XX-hz42-P238K induced CDC of Raji cells beyond the effect of human IgG1 isotype control. For ADCP, CD14+ monocytes were utilized as effector cells, and in this system none of Y12XX-hz28-P238K, Y12XX-hz40-P238K, and Y12XX-hz42-P238K promoted cellular phagocytosis. In contrast, BMS-986090 exhibited cellular phagocytosis.

Example 4: Assay of NF- κ B/AP-1 Signaling

[00139] The objective of this example was to assess the NF- κ B/AP-1 inducible SEAP (secreted embryonic alkaline phosphate) activity on Ramos-Blue™ Cells (InvivoGen) resulting from stimulation with anti-CD40 antibodies.

[00140] Ramos-Blue™ Cells are a human B lymphocyte reporter cell line that express an NF- κ B/AP-1 inducible secreted embryonic alkaline phosphate (SEAP) reporter gene. The Ramos-Blue™ cell line has been used for NF- κ B/AP1 signaling as well as in Toll-like Receptors' (TLR's) signaling pathways, Ramos-Blue™ Cells endogenously express CD40 and are responsive to CD40 and TLR. When Ramos-Blue™ Cells lines are stimulated, they produce SEAP in the cell culture supernatant. SEAP can be detected by using the QUANTI-Blue™ detection medium (InvivoGen, San Diego, CA). Levels of SEAP can be observed visually or by using a spectrophotometer at 620 nm. Ramos-Blue™ Cells do not express CD32 (Fc γ RII).

[00141] Table 6 lists the test materials (antibodies and other polypeptide) assayed in this example. All of the test materials were prepared in house by BMS.

Table 16

Test Materials	Description
BMS-986325	Y12XX-hz28-P238K (fully human anti-CD40 isotype hIgG (P238K) mAb
BMS-986090	fully human anti-CD40 domain antibody IgG4 Fc fusion protein
mAb 134-2142 (CD40-2142 (hIgG2-Fc))	fully human anti-CD40 monoclonal antibody (agonist)
Anti-DT1D12-B16F7-hIgG1.3f mAb	Negative Control
CD40L-IZ	a human CD40L-Trimer (h-IZ-hCD40L-Trimer)

- 5 **[00142]** Ramos-Blue™ Cells were purchased from InvivoGen. For this assay, a transduced cell line designated herein as Ramos Blue Cells # 4, was prepared by transducing Ramos-Blue™ Cells with human CD32 (FcγRII). Both types of Ramos-Blue™ cells were cultures in Ramos Cell Culture Medium (Iscove's Modified Dulbecco's Medium (IMDM) supplemented with 10% Fetal Bovine Serum (FBS), 2mM L-Glutamine, penicillin and streptomycin (100 U/mL,-100 ug/mL), 100 ug/mL of Normomicin, and Zeocin as drug selection (100 ug/mL)). Cells were cultured at 37°C in 5% CO₂. Both types of cells were passed every 3 days and maintained at a cell density of 0.5 x 10⁶ cell/ml. Cells were used until cell passage # 21 (P21). After P21, the cells were discarded.

- [00143]** The assay was performed as follows. "AIM V™ medium" refers to serum free medium supplemented with L-glutamine, 50 µg/mL streptomycin sulfate, 10 µg/mL gentamicin sulfate (Thermo Fisher Scientific). To assess CD40 agonist activity by CD40 antagonist antibodies on the NF-kB/AP-1 activity in Ramos Blue Cells #4, cells were washed twice (2x) with AIM V™ medium without antibiotics Normocin/Zeoicin. The cells were then centrifuged at room temperature for 10 minutes at 2,000 rpm. Medium was aspirated carefully to not disrupt the cell pellet. One (1) mL of AIM V™ was added to the cell pellet to re-suspend the cell pellet, and an additional 9 ml of AIM V™ was added after resuspension. Cells were counted using the cell counter by adding 20 microliters (µl) ViaStain™ AOPI (acridine orange / propidium iodide) staining solution (Nexcelom Bioscience, LLC, Lawrence, MA) and 20 µl of Ramos-Blue™ Cells suspension.

- [00144] Ramos-Blue™ Cells were adjusted to 4×10^6 cell/mL in AIM V™ serum free medium. One hundred (100) μ l of 400K Ramos-Blue™ Cells were added per well in a flat bottom tissue culture plate. Then, 100 μ l of BMS-986325, BMS-986090, mAb134-2141 (CD40-2142), or control was added to each corresponding well. CD40L-IZ was used as positive control. Ramos-Blue™ cells (0.4×10^6 cells/well) in AIM V™ were included as negative control for the assay. The final volume was 200 μ l /well.
- [00145] Plates were incubated at 37°C. in a 5% CO₂ incubator for 20 hours. After 20 hours of cell culture, plates were centrifuged for 10 minutes at 2000 rpm.
- [00146] Forty (40) μ l of cell culture supernatant from stimulated Ramos cells were added to wells of a flat bottom plate. Then, 160 μ l of QUANTI-Blue™ Solution was added per well. The final volume was 200 μ l /well.
- [00147] Plates were incubated at 37°C. in a 5% CO₂ incubator for 1 to 6 hours. SEAP levels were measured every 60 minutes at 620 nm using the EnVision® Reader Optical (OD: 620 nm).
- [00148] Exemplary data are depicted in Figure 6. In this example, anti-CD40 monoclonal antibodies were tested against Ramos-Blue™ Cells lacking CD32 or Ramos-Blue™ Cells transduced with CD32 (Ramos Blue # 4) by assessing the NF κ -B/AP-1 inducible SEAP activity on Ramos-Blue™ Cells upon stimulation with anti-CD40 antibodies.
- [00149] Addition of CD40-2142 induced a significant signaling response in this assay (Figures 6A and 6b). These results indicate that CD40-2142 is a full agonist in this assay system. Addition of BMS-986090 showed no response by using the Ramos-Blue™ Cells (-CD32) (Figure 6A), but displayed a partial agonism in the assay using the Ramos Blue Cells # 4 (Ramos-Blue™ Cells transduced with CD32) (Figure 6B). This result indicates Fc γ R dependency mediates the agonistic response induced by addition of BMS-986090. The control polypeptide, trimer CD40L-IZ, induced a response in both assays as reflected in Figures 6C and 6D.
- [00150] In contrast, addition of BMS-986325 did not induce a significant NF κ -B/AP-1 response using either Ramos-Blue™ Cells (CD32⁻) (Figure 6A) or Ramos # 4 (CD32⁺) (Figure 6B). These data indicate that BMS-986325 did not agonize CD40 and did not engage CD32 (Fc γ RII). These data support that reduced engagement of low affinity Fc γ Rs, such as

CD32 (Fc γ RII), reduces the likelihood of undesirable agonist signaling and undesirable potential for toxicity.

EXAMPLE 7: Summary of Non-Clinical Pharmacokinetics Evaluation of BMS-986325

[00151] The pharmacokinetics (PK) of BMS-986325 (Y12XX-hz28-P238K) were
5 evaluated in mice and cynomolgus monkeys. Since BMS-986325 does not cross react to murine CD40 receptors, the PK evaluated in mice is intrinsic or non-specific PK. BMS-986325 cross reacts with monkey CD40 receptors, therefore the total PK (specific and non-specific PK) was evaluated in monkeys. After intravenous (IV) administration of BMS-986325 (single 1- and 10-mg/kg doses) to mice, BMS-986325 exhibited low total serum
10 clearance “CLT” of 0.5 to 1.02 mL/d/kg, limited volume of distribution at steady state “Vss” of 0.12 to 0.19 L/kg, and long apparent elimination half-life “T-HALF” of 118 to 183 hours (~ 5 to 8 days).

[00152] In monkeys, a single subcutaneous (SC) dose of BMS-986325 was administered. The dose administered is a dose at which specific clearance (target-mediated
15 drug disposition “TMDD”) is not saturated. After the single SC dose, BMS-986325 was well absorbed, with an absolute bioavailability of 70.4% (relative to exposures at the same IV dose). After IV administration of BMS-986325 (10 mg/kg single dose) to monkeys, BMS-986325 exhibited a CLT of 0.41 mL/d/kg, a limited Vss of 0.05 L/kg, and a T-HALF of 100 hours (~ 4 days). The time to maximum plasma concentration “Tmax” following a single SC
20 dose of BMS-986325 (doses of 1, 10, and 100 mg/kg administered) to monkeys was 24 to 54 hours. There were more-than-dose-proportional increases in exposure (maximum concentration “Cmax” and area under the concentration vs time curve extrapolated from time zero to infinity “AUC[INF]”) and an increase in T-HALF with dose (~ 31, ~ 119, and ~197 hours at 1, 10, and 100 mg/kg, respectively). These data suggest nonlinear PK and a
25 saturable clearance mechanism; this likely results from target (CD40)-mediated clearance, reflecting TMDD. In this single-dose PK study, anti-drug antibody (ADA) formation was detected in ~ 50% of monkeys, but had no apparent impact on the overall PK parameters.

[00153] Pharmacokinetic/pharmacodynamic modeling (TMDD model with quasi steady-state assumption [TMDD-Qss]) was used to describe the nonlinear PK observed in
30 monkeys, establish a relationship between serum drug exposure and CD40 receptor occupancy (RO) and subsequent human dose projection.

[00154] Although the present embodiments have been described in detail with reference to examples above, it is understood that various modifications can be made without departing from the spirit of these embodiments, and would readily be known to the skilled artisan.

- 5 **[00155]** These and other aspects disclosed herein, including the exemplary specific treatment methods, medicaments, and uses listed herein, will be apparent from the teachings contained herein.

CLAIMS

1. An isolated antibody, or antigen binding portion thereof, that specifically binds to human CD40, wherein said antibody comprises a first polypeptide portion comprising a heavy chain variable region, and a second polypeptide portion comprising a light chain variable region, wherein:
- 5 said heavy chain variable region comprises one of (i) a CDR1 comprising SEQ ID NO: 1, a CDR2 comprising SEQ ID NO: 2, a CDR3 comprising SEQ ID NO: 3 or (ii) a CDR1 comprising SEQ ID NO: 1, a CDR2 comprising SEQ ID NO: 12, a CDR3 comprising SEQ ID NO: 3; and
- 10 said light chain variable region comprises a CDR1 comprising SEQ ID NO: 7, a CDR2 comprising SEQ ID NO: 8, and a CDR3 comprising SEQ ID NO: 9.
2. The isolated antibody or antigen binding portion thereof of claim 1, wherein said antibody or antigen binding portion thereof antagonizes a CD40 activity.
- 15 3. The isolated antibody or antigen binding portion thereof of claim 1, wherein: said heavy chain variable region comprises one of:
- (i) a CDR1 consisting of SEQ ID NO: 1, a CDR2 consisting of SEQ ID NO: 2, a CDR3 consisting of SEQ ID NO: 3 or
- 20 (ii) a CDR1 consisting of SEQ ID NO: 1, a CDR2 consisting of SEQ ID NO: 12, a CDR3 consisting of SEQ ID NO: 3; and
- said light chain variable region comprises a CDR1 consisting of SEQ ID NO: 7, a CDR2 consisting of SEQ ID NO: 8, and a CDR3 consisting of SEQ ID NO: 9.
- 25 4. The isolated antibody or antigen binding portion thereof of claim 1, wherein: said heavy chain variable region comprises a CDR1 consisting of SEQ ID NO: 1, a CDR2 consisting of SEQ ID NO: 2, a CDR3 consisting of SEQ ID NO: 3; and
- said light chain variable region comprises a CDR1 consisting of SEQ ID NO: 7, a CDR2 consisting of SEQ ID NO: 8, and a CDR3 consisting of SEQ ID NO: 9.
- 30 5. The isolated antibody or antigen binding portion thereof of claim 1, wherein said heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 4, and said light chain variable region comprises the amino acid sequence of SEQ ID NO: 10.

6. The isolated antibody or antigen binding portion thereof of claim 1, wherein said heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 13, and said light chain variable region comprises the amino acid sequence of SEQ ID NO: 16.

5

7. The isolated antibody or antigen binding portion thereof of claim 1, wherein said heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 4, and said light chain variable region comprises the amino acid sequence of SEQ ID NO: 16.

10

8. The isolated antibody or antigen binding portion thereof of any one of claims 1-7, wherein said first polypeptide portion comprises a human heavy chain constant region; and said second polypeptide portion comprises a human light chain constant region.

15

9. The isolated antibody or antigen binding portion thereof of claim 8, wherein said human heavy chain constant region is a human IgG1 Fc domain comprising either (1) a mutation at Kabat position 238 that reduces binding to Fc-gamma-receptors (FcγRs), wherein proline 238 (P238) is mutated to one of the residues selected from the group consisting of: lysine, serine, alanine, arginine, and tryptophan, and wherein the antibody or antigen binding portion thereof has reduced FcγR binding; or

20

(2) an alanine substituted at Kabat position 297.

25

10. The isolated antibody or antigen binding portion thereof of any of claims 8 to 9, comprising a human IgG1 Fc domain comprising a mutation at Kabat position 238 that reduces binding to Fc-gamma-receptors (FcγRs), wherein proline 238 (P238) is mutated to one of the residues selected from the group consisting of: lysine, serine, alanine, arginine, and tryptophan, and wherein the antibody or antigen binding portion has reduced FcγR binding.

30

11. The isolated antibody or antigen binding portion thereof of claim 10, wherein P238 is mutated to lysine.

30

12. The isolated antibody or antigen binding portion thereof of claim 10 or 11, wherein the Fc domain comprises an amino acid sequence selected from: SEQ ID NO: 22,

SEQ ID NO: 23, SEQ ID NO: 24, SEQ ID NO: 25, SEQ ID NO: 26, SEQ ID NO: 27, SEQ ID NO: 28, or SEQ ID NO: 29.

13. The isolated antibody or antigen binding portion thereof of claim 9, wherein:
5 said heavy chain variable region comprises a CDR1 comprising SEQ ID NO: 1, a CDR2 comprising SEQ ID NO: 2, a CDR3 comprising SEQ ID NO: 3; and
said light chain variable region comprises a CDR1 comprising SEQ ID NO: 7, a CDR2 comprising SEQ ID NO: 8, and a CDR3 comprising SEQ ID NO: 9.

10 14. The isolated antibody or antigen binding portion thereof of claim 13, wherein the human IgG1 Fc domain comprises the amino acid sequence of SEQ ID NO: 22 or SEQ ID NO: 23.

15 15. The isolated antibody or antigen binding portion thereof of claim 1, wherein the first polypeptide portion comprises or consists of an amino acid sequence selected from the group consisting of: SEQ ID NO: 5, SEQ ID NO: 6, SEQ ID NO: 30, and SEQ ID NO: 31;
and
the second polypeptide portion comprises or consists of the amino acid sequence of
20 SEQ ID NO: 11.

16. The isolated antibody or antigen binding portion thereof of claim 1, wherein the first polypeptide portion comprises or consists of an amino acid sequence of SEQ ID NO: 5;
25 and
the second polypeptide portion comprises or consists of the amino acid sequence of SEQ ID NO: 11.

17. The isolated antibody or antigen binding portion thereof of claim 8, wherein
30 said human heavy chain constant region comprises a human IgG1 Fc domain comprising an alanine substituted at Kabat position 297.

18. The isolated antibody or antigen binding portion thereof of any of claims 1 to 17, wherein the isolated antibody or antigen binding portion thereof is humanized.

19. The antibody or antigen binding portion thereof of any of claims 1-7, wherein
5 the antigen binding portion is an scFv-Fc.

20. The antibody or antigen binding portion thereof of any one of claims 1-19, wherein the antibody or antigen-binding portion thereof is linked to a therapeutic agent.

10 21. The antibody or antigen binding portion thereof of any one of claims 1-20, wherein the antibody or antigen-binding portion thereof is linked to a second functional moiety having a different binding specificity than said antibody or antigen binding portion thereof.

15 22. The antibody or antigen binding portion thereof of any one of claims 1-21, further comprising an additional moiety.

23. A nucleic acid molecule encoding an isolated antibody or antigen binding
portion thereof of any one of claims 1 to 22.
20

24. An expression vector comprising the nucleic acid molecule of claim 23.

25. A cell transformed with the expression vector of claim 24 or the nucleic acid
of claim 23.
25

26. A method of preparing an anti-human CD40 antibody, or antigen binding
portion thereof, comprising:

- a) expressing the antibody, or antigen binding portion thereof, in the cell of claim 25;
and
- 30 b) isolating the antibody, or antigen binding portion thereof, from the cell.

27. A pharmaceutical composition comprising: a) the antibody, or antigen binding
portion thereof, of any one of claims 1 to 22; and b) a pharmaceutically acceptable carrier.

28. A method of treating or preventing an immune response in a subject comprising administering to the subject the antibody, or the antigen binding portion thereof, of any one of claims 1 to 22.

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29. A method of treating or preventing an autoimmune or inflammatory disease in a subject, comprising administering to the subject the antibody, or the antigen binding portion thereof, of any one of claims 1 to 22.

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30. The method of claim 28 or 29, wherein the antibody, or the antigen binding portion thereof is administered with an immunosuppressive/immunomodulatory and/or anti-inflammatory agent.

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31. The method of claim 30, wherein said immunosuppressive/ immunomodulatory and/or anti-inflammatory agent is a CTLA4 mutant molecule.

32. The method of claim 31, wherein said a CTLA4 mutant molecule L104EA29Y-Ig (belatacept).

20

33. The method of claim 28 or 29, wherein the subject has a disease selected from the group consisting of: Addison's disease, allergies, anaphylaxis, ankylosing spondylitis, asthma, atherosclerosis, atopic allergy, autoimmune diseases of the ear, autoimmune diseases of the eye, autoimmune hepatitis, autoimmune parotitis, bronchial asthma, coronary heart disease, Crohn's disease, diabetes, epididymitis, glomerulonephritis, Graves' disease, Guillain-Barre syndrome, Hashimoto's disease, hemolytic anemia, idiopathic thrombocytopenic purpura, inflammatory bowel disease, an immune response to recombinant drug products (e.g., Factor VII in hemophiliacs), lupus nephritis, systemic lupus erythematosus, multiple sclerosis, myasthenia gravis, pemphigus, psoriasis, rheumatic fever, rheumatoid arthritis, sarcoidosis, scleroderma, Sjogren's syndrome, spondyloarthropathies, thyroiditis, transplant rejection, vasculitis, and ulcerative colitis.

25

30

34. An antibody, or antigen binding portion thereof, of any one of claims 1 to 22 for use as a medicament.

35. An antibody, or antigen binding portion thereof, of any one of claims 1 to 22 for use in the treatment of a subject in need thereof.