The invention also encompasses scFv of antibodies of this invention. Single chain variable region fragments are made by linking light and/or heavy chain variable regions by using a short linking peptide (Bird et al., Science 242:423-426, 1988). An example of a linking peptide is $(GGGGS)_3$ (SEQ ID NO: 89), which bridges approximately 3.5 nm between the carboxy terminus of one variable region and amino terminus of the other variable region. Linkers of other sequences have been the designed and used (Bird et al., 1988, supra). Linkers should be short, flexible polypeptides and preferably comprised of less than about 20 amino acid residues. Linkers can in turn be modified for additional functions, such as attachment of drugs or attachment to solid supports. The single chain variants can be produced either recombinantly or synthetically. For synthetic production of scFv, an automated synthesizer can be used. For recombinant production of scFv, a suitable plasmid containing polynucleotide that encodes the scFv can be introduced into a suitable host cell, either eukaryotic, such as yeast, plant, insect or mammalian cells, or prokaryotic, amino terminus of the other variable region. Linkers of other sequences have been designed and used, Bird et al. (1988). Linkers can in turn be modified for additional functions, such as attachment of drugs or attachment to solid supports. The single chain variants can be produced either recombinantly or synthetically. For synthetic production of scFv, an automated synthesizer can be used. For recombinant production of scFv, a suitable plasmid containing polynucleotide that encodes the scFv can be introduced into a suitable host cell, either eukaryotic, such as yeast, plant, insect or mammalian cells, or prokaryotic, such as E. coli. Polynucleotides encoding the scFv of interest can be made by routine manipulations such as ligation of polynucleotides. The resultant scFv can be isolated using standard protein purification techniques known in the art.

Other forms of single chain antibodies, such as diabodies or minibodies are also encompassed. Diabodies are bivalent, bispecific antibodies in which heavy chain variable (VH) and light chain variable (VL) domains are expressed on a single polypeptide chain, but using a linker that is too short to allow for pairing between the two domains on the same chain, thereby forcing the domains to pair with complementary domains of another chain and creating two antigen binding sites (see e.g., Holliger, P., et al., Proc. Natl. Acad Sci. USA 90:6444-6448 (1993); Poljak, R. J., et al., Structure 2:1121-1123 (1994)). Minibody includes the VL and VH domains of a native antibody fused to the hinge region and CH3 domain of the immunoglobulin molecule. See, e.g., U.S. Patent No. 5,837,821.

A bispecific antibody is an antibody that can bind simultaneously to two different targets. Bispecific antibodies (bsAb) and bispecific antibody fragments (bsFab) may have at least one arm that binds to, for example, a tumor-associated antigen and at least one other arm that binds to a targetable conjugate that bears a therapeutic or diagnostic agent. A variety of bispecific fusion proteins can be produced using molecular engineering.

the VL region region shown in SEQ ID NOs: 3, 7, 11, 15, 19, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, and 169. In various aspects of the invention, a fusion polypeptide is provided that comprises at least about 10, at least about 15, at least about 20, at least about 25, or at least about 30 contiguous amino acids of the variable light chain region and/or at least about 10, at least about 15, at least about 20, at least about 25, or at least about 30 contiguous amino acids of the variable heavy chain region. In another aspect, the fusion polypeptide comprises a light chain variable region and/or a heavy chain variable region, as shown in any of the sequence pairs in Table 2. For example, SEQ ID NOs:3 and 5; 3 and 9; 7 and 5; 11 and 13; 15 and 13; 19 and 17; 69 and 31; 49 and 37; and, 33 and 73 . In some aspects, the fusion polypeptide comprises one or more CDR(s). In still other aspects, the fusion polypeptide comprises CDR H3 (VH CDR3) and/or CDR L3 (VL CDR3). For purposes of this invention, a fusion protein contains one or more antibodies and another amino acid sequence to which it is not attached in the native molecule, for example, a heterologous sequence or a homologous sequence from another region. Exemplary heterologous sequences include, but are not limited to a "tag" such as a FLAG tag or a 6His tag. Tags are well known in the art.

A fusion polypeptide can be created by methods known in the art, for example, synthetically or recombinantly. Typically, the fusion proteins of this invention are made by expressing a polynucleotide encoding them using recombinant methods described herein, although they may also be prepared by other means known in the art, including, for example, chemical synthesis.

This invention also provides compositions comprising antibodies conjugated (for example, linked) to an agent that facilitate coupling to a solid support (such as biotin or avidin). For simplicity, reference will be made generally to antibodies with the understanding that these methods apply to any of the anti-CXCR4 antibody, or antigen-binding fragments thereof, embodiments described herein. Conjugation generally refers to linking these components as described herein. The linking (which is generally fixing these components in proximate association at least for administration) can be achieved in any number of ways. For example, a direct reaction between an agent and an antibody is possible when each possesses a substituent capable of reacting with the other. For example, a nucleophilic group, such as an amino or sulfhydryl group, on one may be capable of reacting with a carbonyl-containing group, such as an anhydride or

CLAIMS

1. An isolated antibody, or an antigen binding fragment thereof, that binds to chemokine receptor 4 (CXCR4) and comprises:

a) a heavy chain variable (VH) region comprising (i) a VH CDR1 selected from the group consisting of SEQ ID NOs:107, 113, and 114; (ii) a VH CDR2 selected from the group consisting of SEQ ID NOs: 162, and 128, and, (iii) a VH CDR3 set forth as SEQ ID NO: 112; and

b) a light chain variable region (VL) region comprising (i) a VL CDR1 set forth as SEQ ID NO: 144; (ii) a VL CDR2 set forth as SEQ ID NO: 145; and (iii) a VL CDR3 set forth as SEQ ID NO: 139.

2. An isolated antibody, or an antigen binding fragment thereof, that binds to CXCR4 and comprises:

a) a heavy chain variable (VH) region comprising complementary determining regions selected from the group consisting of (i) a VH CDR1 comprising the sequence set forth as SEQ ID NOs: 107, 113, and 114; (ii) a VH CDR2 comprising the sequence set forth as SEQ ID NOs: 162 and 128, and; (iii) a VH CDR3 comprising the sequence set forth as SEQ ID NO: 112; and

b) a light chain variable region (VL) region comprising complementary determining regions selected from the group consisting of (i) a VL CDR1 comprising the sequence set forth as SEQ ID NO: 144; (ii) a VL CDR2 comprising the sequence set forth as SEQ ID NO 145; and (iii) a VL CDR3 comprising the sequence set forth as SEQ ID NOs: 139.

3. An isolated antibody, or an antigen binding fragment thereof, that binds to CXCR4 and comprises:

a) a light chain variable (VL) region comprising (i) VL CDR1 comprising the sequence X1SX2X3SLFNSX4X5RKNYLX6 wherein X1 is R or K; X2 is S or A; X3 is W, N or Q; X4 is H or R; X5 is T or F; and X6 is A, L, N, or M (SEQ ID NO: 151); (ii) a VL CDR2 comprising the sequence WASARX1S wherein X1 is G or E (SEQ ID NOs: 152), and (iii) VL CDR3 comprising the sequence KQSFX1LRT wherein X1 is N or R (SEQ ID NO: 153); and

b) a heavy chain variable (VH) region comprising (i) VH CDR1 comprising the sequence set forth as SEQ ID NOs: 107, 108, 109, 113, or 114; (ii) a VH CDR2 comprising the sequence set forth as SEQ ID NO: 157 and (iii) a VH CDR3 comprising the sequence set forth as SEQ ID NO: 112.

4. An isolated antibody, or an antigen binding fragment thereof, that binds to CXCR4 and comprises:

a heavy chain variable (VH) region sequence comprising: EVQLVESGGGLVQPGGSLRLSCAASGFTFSDYYMSWVRQAPGKGLEWVX1FIRHKX2N X3X4TX5EYSTX6X7 X8GRFTISRDX9SKNX10LYLQMNSLX11X12EDTAVYYCAX13DLPGFAYWGQGTLVTV SS (SEQ ID NO: 106), wherein X1 is G or S; X2 is V or A; X3 is G , F, K, V, T, L, or I; X4 is E or Y; X5 is T or R; X6 is W or S; X7 is D or V; X8 is K, T, or R; X9 is D or N; X10 is T or S; X11 is R or K; X12 is A or T; and/or X13 is K or R; and

a light chain variable region (VL) region comprising (i) a VL CDR1 set forth as SEQ ID NO: 144; (ii) a VL CDR2 set forth as SEQ ID NO: 145; and (iii) a VL CDR3 set forth as SEQ ID NO: 139

5. The isolated antibody or antigen binding fragment thereof, that binds to chemokine receptor 4 (CXCR4) selected from the group consisting of:

a) a heavy chain variable (VH) region having a VH CDR1 of SEQ ID NO:107, 113 or 114; a VH CDR2 of SEQ ID NO:162 or 128 and a VH CDR3 of SEQ ID NO:112 and a light chain variable (VL) region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:139;

b) a VH region having a VH CDR1 of SEQ ID NO:115, 116, 117, 121 or 122; a VH CDR2 of SEQ ID NO:118 or 119 and a VH CDR3 of SEQ ID NO:120 and a VL region having a VL CDR1 of SEQ ID NO:135; a VL CDR2 of SEQ ID NO:136 and a VL CDR3 of SEQ ID NO:137;

c) a VH region having a VH CDR1 of SEQ ID NO:107, 108, 109, 113 or 114; a VH CDR2 of SEQ ID NO:110 or 111 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:131; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:133;

d) a VH region having a VH CDR1 of SEQ ID NO:107, 108, 109, 113 or 114; a VH CDR2 of SEQ ID NO:154 or 123 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:139; and

e) a VH region having a VH CDR1 of SEQ ID NO:107, 108, 109, 113 or 114; a VH CDR2 of SEQ ID NO:157 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:151; a VL CDR2 of SEQ ID NO:152 and a VL CDR3 of SEQ ID NO:153.

6. The isolated antibody or antigen binding fragment thereof of claim 1 wherein the antibody comprises a heavy chain variable (VH) region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:162 and a VH CDR3 of SEQ ID NO:112 and a light chain variable (VL) region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:139.

7. An isolated antibody or antigen binding fragment thereof, that binds to chemokine receptor 4 (CXCR4) selected from the group consisting of:

a) a heavy chain variable (VH) region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a light chain variable (VL) region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:139;

b) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

c) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:150; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

d) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:141; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

e) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:140;

f) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:147; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

g) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:159 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

h) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:160 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

i) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:161 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

j) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:162 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

k) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:163 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

l) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:164 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

m) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:165 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

o) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:166 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

p) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:167 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

q) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:168 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

r) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:168 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

s) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:163 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:140;

t) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:139;

u) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:162 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:139;

v) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:163 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:139; and

w) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:162 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:140.

8. The antibody or antigen binding fragment thereof of claim 1, wherein the antibody comprises: a heavy chain variable (VH) region comprising VH CDR1, VH CDR2 and VH CDR3 from a VH region of SEQ ID NO: 33.

9. The antibody or antigen binding fragment thereof any one of claim 1, wherein the antibody comprises: a light chain variable (VL) region comprising VL CDR1, VL CDR2 and VL CDR3 from a VL region of SEQ ID NO: 73.

10. An isolated antibody, or an antigen binding fragment thereof of claim 1, wherein the antibody comprises:

a) a heavy chain variable (VH) region comprising VH CDR1, VH CDR2 and VH CDR3 from a VH region of SEQ ID NO: 33; and

b) a light chain variable (VL) region comprising VL CDR1, VL CDR2 and VL CDR3 from a VL region of SEQ ID NO: 73.

11. The isolated antibody or antigen binding fragment thereof of claim 6 that comprises an antibody or antigen-binding fragment thereof comprising a VH region of SEQ ID NO:33 and a VL region of SEQ ID NO:73.

12. The isolated antibody or antigen fragment thereof of claim 6, wherein the antibody or antigen fragment thereof comprises a heavy chain variable region having an amino acid sequence that is at least 95% identical to SEQ ID NO: 33 and a light chain variable having an amino acid sequence that is at least 95% identical to SEQ ID NO: 73.

13. The antibody or the antigen binding fragment of claim 1, wherein the antibody comprises a heavy chain variable (VH) region produced by the expression vector with ATCC Accession No. PTA-121353.

14. The antibody or the antigen binding fragment of claim 1, wherein the antibody comprises a light chain variable (VL) region produced by the expression vector with ATCC Accession No. PTA-121354.

15. An isolated antibody or antigen binding fragment thereof of, that binds to chemokine receptor 4 (CXCR4) selected from the group consisting of:

a) a heavy chain variable (VH) region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a light chain variable (VL) region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:139;

b) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

c) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:150; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

d) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:141; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

e) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:140;

f) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:147; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

g) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:159 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

h) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:160 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

i) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:161 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

j) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:162 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

k) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:163 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

l) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:164 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

m) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:165 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

n) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:166 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

o) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:167 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

p) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:168 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

q) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:168 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:138; a VL CDR2 of SEQ ID NO:132 and a VL CDR3 of SEQ ID NO:140;

r) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:163 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:140;

s) a VH region having a VH CDR1 of SEQ ID NO: 107; a VH CDR2 of SEQ ID NO:158 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:139;

t) a VH region having a VH CDR1 of SEQ ID NO: 107; a VH CDR2 of SEQ ID NO:162 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:139;

u) a VH region having a VH CDR1 of SEQ ID NO: 107; a VH CDR2 of SEQ ID NO:163 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:139; and

v) a VH region having a VH CDR1 of SEQ ID NO:107; a VH CDR2 of SEQ ID NO:162 and a VH CDR3 of SEQ ID NO:112 and a VL region having a VL CDR1 of SEQ ID NO:144; a VL CDR2 of SEQ ID NO:145 and a VL CDR3 of SEQ ID NO:140.

16. The antibody or antigen binding fragment thereof of claim 1, wherein the antibody is a humanized, chimeric, CDR grafted, or recombinant human antibody.

17. The antibody or antigen binding fragment thereof of claim 1 any one of the preceding claims, wherein the antibody is not caninized or felinized.

18. The antibody or antigen binding fragment thereof of claim 1, wherein the antibody comprises an acyl donor glutamine-containing tag engineered at a specific site.

19. A pharmaceutical composition comprising a therapeutically effective amount of the antibody or antigen binding fragment thereof of claim 1 and a pharmaceutically acceptable carrier.

20. An isolated polynucleotide comprising a nucleotide sequence encoding the antibody or antigen binding fragment thereof of claim 1.

21. A vector comprising the polynucleotide of claim 20.

22. An isolated host cell that recombinantly produces the antibody or antigen binding fragment thereof of claim 1.

23. A method of producing an antibody or antigen binding fragment thereof, comprising culturing the host cell of claim 22 under conditions that result in production of the antibody or antigen binding fragment thereof, and isolating the antibody or antigen binding fragment thereof from the host cell or culture medium.

24. Use of an effective amount of the pharmaceutical composition according to claim 19 in the manufacture of a medicament fortreating a disorder associated with CXCR4 function or expression in a subject.

25. Use of claim 24, wherein the disorder is a cancer.

26. Use of claim 25, wherein the cancer is a hematological cancer.

27. Use of claim 25, wherein the cancer is a B cell or a T cell malignancy.

28. Use of claim 24, wherein the cancer is selected from the group consisting of acute lymphocytic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), small lymphocytic lymphoma (SLL), multiple myeloma (MM), non-Hodgkin's lymphoma (NHL), Hodgkin's lymphoma, mantle cell lymphoma (MCL), follicular lymphoma, Waldenstrom's macroglobulinemia (WM), B-cell lymphoma and diffuse large B-cell lymphoma (DLBCL).

29. Use of claim 25, wherein the cancer is selected from the group consisting of bladder, breast, cervical, choriocarcinoma, colon, esophageal, gastric, glioblastoma, head and neck, kidney, lung, oral, ovarian, pancreatic, prostate, and skin cancer.

30. Use of an effective amount of the pharmaceutical composition of claim 19 in the manufacture of a medicament for decreasing tumor growth or progression in a subject who has a CXCR4 expressing tumor.

31. Use of an effective mount of the pharmaceutical composition of claim 19 in the manufacture of a medicament for decreasing metastasis of CXCR4 expressing cancer cells in a subject.

32. Use of an effective amount of the pharmaceutical composition of claim 19 in the manufacture of a medicament for inducing tumor regression in a subject who has a CXCR4 expressing tumor.

33. An isolated antibody or antigen binding fragment thereof of claim 1 for use in detecting, diagnosing and/or treating a disorder associated with expression of CXCR4.

34. Use of an isolated antibody of claim 1 in the manufacture of a medicament for treating a disorder associated with expression of CXCR4.

35. The use of claim 34, wherein the disorder is a cancer.

36. The use of claim 35 wherein the cancer is a hematological cancer.

37. The use of claim 35, wherein the cancer is a B cell or a T cell malignancy.

38. The use of claim 35, wherein the cancer is selected from the group consisting of acute lymphocytic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), small lymphocytic lymphoma (SLL), multiple myeloma (MM), non-Hodgkin's lymphoma (NHL), Hodgkin's lymphoma, mantle cell lymphoma (MCL), follicular lymphoma, Waldenstrom's macroglobulinemia (WM), B-cell lymphoma and diffuse large B-cell lymphoma (DLBCL).

39. The use of claim 35 wherein the cancer is selected from the group consisting of bladder, breast, cervical, choriocarcinoma, colon, esophageal, gastric, glioblastoma, head and neck, kidney, lung, oral, ovarian, pancreatic, prostate, and skin cancer.

40. An isolated antibody or antigen binding fragment thereof of any one of claims 1-18 for use in detecting, diagnosing and/or treating a disorder associated with expression of CXCR4.

41. Use of an isolated antibody of any one of claims 1-18 in the manufacture of a medicament for treating a disorder associated with expression of CXCR4.