Claims

1. An isolated antibody, or antigen-binding portion thereof that specifically binds to canine or feline Oncostatin M receptor Beta (OSMR-β) or both, wherein the antibody antagonizes IL-31-mediated signaling or OSM-mediated signaling or both in a canine and/or feline cell.

2. The antibody, or antigen-binding portion thereof of claim 1, wherein the antibody antagonizes both IL-31-mediated signaling and OSM-mediated signaling in a canine and/or feline cell.

3. The antibody, or antigen-binding portion thereof of claim 1 or claim 2, comprising a combination of complementary determining region (CDR) sequences selected from the group consisting of:

   1) 02D09: variable heavy (VH)-CDR1 of SEQ ID NO: 1 (DYGMH), VH-CDR2 of SEQ ID NO: 2 (YISSGSRAVFFADTVKG), VH-CDR3 of SEQ ID NO: 3 (DRYDGRGFAY), variable light (VL)-CDR1 of SEQ ID NO: 4 (RASQSISNNLH), VL-CDR2 of SEQ NO: 5 (YASQSIS), and VL-CDR3 of SEQ ID NO: 6 (QQSNSWPLT);
   2) 09E09: VH-CDR1 of SEQ ID NO: 7 (SYAMS), VH-CDR2 of SEQ ID NO: 8 (YISSGGDYIYYADTVKG), VH-CDR3 of SEQ ID NO: 9 (DPITGTFAY), VL-CDR1 of SEQ ID NO: 10 (RASQDINNYLN), VL-CDR2 of SEQ ID NO: 11 (YTSTLHS), and VL-CDR3 of SEQ ID NO: 12 (QQGNTLPWT);
   3) 10F07: VH-CDR1 of SEQ ID NO: 13 (SYAMS), VH-CDR2 of SEQ ID NO: 14 (YISSGGDYFYYADTVKG), VH-CDR3 of SEQ ID NO: 15 (DPITGTFAY), VL-CDR1 of SEQ ID NO: 16 (RASQDITNYLN), VL-CDR2 of SEQ ID NO: 17 (YTSTLHS), and VL-CDR3 of SEQ ID NO: 18 (QQGHMLPWT);
   4) 14C04: VH-CDR1 of SEQ ID NO: 19 (NYWMN), VH-CDR2 of SEQ ID NO: 20 (QIYPGHVNTNYNGNFKD), VH-CDR3 of SEQ ID NO: 21 (SADNSGFVLFAY), VL-CDR1 of SEQ ID NO: 22 (RASKSVSTSGYSYLH), VL-CDR2 of SEQ ID NO: 23 (LASNLES), and VL-CDR3 of SEQ ID NO: 24 (QHSRELPLT);
   5) 19F07: VH-CDR1 of SEQ ID NO: 25 (DYYMA), VH-CDR2 of SEQ ID NO: 26 (NINYDGSSTYYLDSLKS), VH-CDR3 of SEQ ID NO: 27 (GLTWDFDV), VL-CDR1 of SEQ ID NO: 28 (KASQDVDTAVA), VL-CDR2 of SEQ ID NO: 29 (LASTRHT), and VL-CDR3 of SEQ ID NO: 30 (QQYSRFPLT); or
   6) CDR variants of 1, 2, 3, 4, or 5.

4. The antibody of any one of claims 1 to 3, comprising at least one of the group consisting of:

(a) a variable heavy chain comprising

SEQ ID NO: 31 (MU_02D09_VH)
EVQLVESGGGLVKPGGSLTLSCAASGFTFSDYGMHWLRQAPEKGLEWVAYISSGSRAVFFAD
TVKGRFTISRDNAKNTLFLQMTSLRSDDTAMYYCARDRYDGRGFAYWGQGTLVTVSA,

SEQ ID NO: 35 (MU_09E09_VH)
DVKLVESGEGLVKPGGSLKLSCAASGFTFSSYAMSWVRQTPEKRLEWVAYISSGGDYIYYADT
VKGRFTISRDNARNTLYLQMSSLKSEDTAMYYCTRDPITGTFAYWGQGTLVTVSA,

SEQ ID NO: 39 (MU_10F07_VH)
DVKLVESGEGLVKPGGSLKLSCAASGFTFSSYAMSWVRQTPEKRLEWVTYISSGGDYFYYAD
TVKGRFTISRDNARNTLYLQMSSLKSEDTAMYYCTRDPITGTFAYWGQGTLVTVSA,

SEQ ID NO: 43 (MU_14C04_VH)

EVQLQESGAELVKPGASVKISCKASGYAFSNYWMNWMKQRPGKGLEWIGQIYPGHVNTNYN
GNFKDKATLTADK
SSSTAYMQLSSLTSEDSAVYFCARSADNSGFVLFAYWGQGTLVTVS,

SEQ ID NO: 47 (MU_19F07_VH)

EVKLVESEGGLVQPGSSMKLSCTASGFTFSDYYMAWVRQVPEKGLEWVANINYDGSSTYYLD
SLKSRFIISRDNAKNILYLQMSSLKSEDTATYYCARGLTWDFDVWGTGTTVTVSS,

SEQ ID NO: 51 (FEL_02D09_VH1)
DVQLVESGGDLVKPGGSLRLTCVASGFTYSDYGMHWVRQAPGKGLQWVAYISSGSRAVFFA
DTVKGRFTISRDNAKNTLYLQMNSLKTEDTATYYCVRDRYDGRGFAYWGQGTLVTVSS,

SEQ ID NO: 53 (FEL_02D09_VH2)
DVQLVESGGDLVKPGGSLRLTCVASGFTFSDYGMHWVRQAPGKGLQWVAYISSGSRAVFFA
DTVKGRFTISRDNAKNTLYLQMNGLRTEDTATYYCARDRYDGRGFAYWGQGTLVTVSS,

SEQ ID NO: 59 (CAN_09E09_VH1)
EVQLVESGGDLVKPGGSLRLSCVASGFTFSSYAMSWVRQAPGKGLQWVAYISSGGDYIYYAD
TVKGRFTISRDNAKNTLYLQMNSLRAEDTAMYYCVRDPITGTFAYWGQGTLVTVSS,

SEQ ID NO: 61 (CAN_09E09_VH2)
EVQLVESGGDLVKPAGSLTLSCLASGFTFSSYAMSWVRQTPEKGLQWVAYISSGGDYIYYADT
VKGRFTISRDNAKNTLYLQMNSLRDEDTAVYYCARDPITGTFAYWGQGTLVTVSS,

SEQ ID NO: 67 (FEL_09E09_VH1)
DVQLVESGGDLVKPGGSLRLTCVASGFTYSSYAMSWVRQAPGKGLQWVAYISSGGDYIYYAD
TVKGRFTISRDNAKNTLYLQMNSLKTEDTATYYCVRDPITGTFAYWGQGTLVTVSS,

SEQ ID NO: 69 (FEL_09E09_VH2)
DVQLVESGGNLVKPGGSLRLTCVASGFTFSSYAMSWVRQAPGKGLQWVAYISSGGDYIYYAD
TVKGRFTISKDNAKNTLYLQMNSLKTEDTATYYCARDPITGTFAYWGQGTLVTVSS,

SEQ ID NO: 75 (CAN_10F07_VH1)
EVQLVESGGDLVKPGGSLRLSCVASGFTFSSYAMSWVRQAPGKGLQWVAYISSGGDYFYYA
DTVKGRFTISRDNAKNTLYLQMNSLRAEDTAMYYCVRDPITGTFAYWGQGTLVTVSS,

SEQ ID NO: 79 (CAN_10F07_VH2)
EVQLVESGGDLVKPAGSLTLSCLASGFTFSSYAMSWVRQTPEKGLQWVAYISSGGDYFYYAD
TVKGRFTISRDNAKNTLYLQMNSLRDEDTAVYYCARDPITGTFAYWGQGTLVTVSS,

SEQ ID NO: 83 (FEL_10F07_VH1)
DVQLVESGGDLVKPGGSLRLTCVASGFTYSSYAMSWVRQAPGKGLQWVAYISSGGDYFYYA
DTVKGRFTISRDNAKNTLYLQMNSLKTEDTATYYCVRDPITGTFAYWGQGTLVTVSS,

SEQ ID NO: 87 (FEL_10F07_VH2)
DVQLVESGGDLVKPGGSLRLTCVASGFTFSSYAMSWVRQAPGKGLQWVAYISSGGDYFYYA
DTVKGRFTISRDDAKNTLYLQMSSLKTEDTATYYCTGDPITGTFAYWGQGTLVTVSS,

SEQ ID NO: 91 (CAN_19F07_VH1)
EVQLVESGGDLVKPGGSLRLSCVASGFTFSDYYMAWVRQAPGKGLQWVANINYDGSSTYYLD
SLKSRFTISRDNAKNTLYLQMNSLRAEDTAMYYCVRGLTWDFDVWGQGTLVTVSS,

SEQ ID NO: 95 (CAN_19F07_VH2)
EVQLVESGGDLVKPAGSLTLSCLASGFTFSDYYMAWVRQTPEKGLQWVANINYDGSSTYYLD
SLKSRFTISRDNAKNTLYLQMNSLRDEDTAVYYCARGLTWDFDVWGQGTLVTVSS,

SEQ ID NO: 99 (FEL_19F07_VH1)
DVQLVESGGDLVKPGGSLRLTCVASGFTYSDYYMAWVRQAPGKGLQWVANINYDGSSTYYL
DSLKSRFTISRDNAKNTLYLQMNSLKTEDTATYYCVRGLTWDFDVWGQGTLVTVSS,

SEQ ID NO: 103 (FEL_19F07_VH2)
DVQLVESGGNLVKPGGSLRLTCVASGFTFSDYYMAWVRQAPGKGLQWVANINYDGSSTYYLD
SLKSRFTISRDNAKNTLYLQMNSLKTEDTATYYCARGLTWDFDVWGQGTLVTVSS,

SEQ ID NO: 127. (CAN_14C04_VH1)

EVQLVESGGDLVKPGGSLRLSCVASGFTFSNYWMNWVRQAPGKGLQWVAQIYPGHVNTNYN
GNFKDRFTISRDNARNTVYLQMNSLRAEDTAVYYCARSADNSGFVLFAYWGQGTLVTVSS, or

SEQ ID NO: 129. (CAN_14C04_VH2)

EVQLVESGGDLVKPGGSLRLSCVASGFTFSNYWMNWVRQSPGKGLQWVAQIYPGHVNTNYN
GNFKDRFTISRDNAKNTLYLQMNSLRAEDTAVYFCARSADNSGFVLFAYWGQGTLVTVSS;
and

(b) a variable light chain comprising

SEQ ID NO: 33 (MU_02D09_VL)
DIVLTQSPATLSVTPGDSVSLSCRASQSISNNLHWYQQTSHESPRLLITYASQSISGIPSRFSGS
GSGTDFTLSINSVETEDFGMYFCQQSNSWPLTFGAGTKLELK,

SEQ ID NO: 37 (MU_09E09_VL)
DLQMTQTTSSLSASLGDRVTISCRASQDINNYLNWYQQKPDGTVKLLIYYTSTLHSGVPSRFSG
SGSGTDYSLTISNLEQEDIATYFCQQGNTLPWTFGGGTKLEIK,

SEQ ID NO: 41 (MU_10F07_VL)
DIQMTQTTSSLSASLGDRVTISCRASQDITNYLNWYQQKPDGTVKLLIYYTSTLHSGVPSRFSG
SGSGTDFSLTISNLEQEDIATYFCQQGHMLPWTFGGGTKLEIK,

SEQ ID NO: 45 (MU_14C04_VL)
DIVLTQSPASLAVSLGQRATISCRASKSVSTSGYSYLHWYQQKPGQPPKLLIFLASNLESGVPA
RFSGSGSGTDFTLNIHPVEEEDAATYYCQHSRELPLTFGAGTKLELK,

SEQ ID NO: 49 (MU_19F07_VL)
DIVMTQSHKFMSPSVGDRVSITCKASQDVDTAVAWYQQKPGQSPKLLIYLASTRHTGVPDRFT
GSGSGTDFTLTISNVQSEDLADYFCQQYSRFPLTFGAGTKLELK,

SEQ ID NO: 55 (FEL_02D09_VL1)
EIQMTQSPSSLSASPGDRVTITCRASQSISNNLHWYQQKPGKVPKLLIYYASQSISGVPSRFSG
SGSGTDFTLTISSLEPEDAATYYCQQSNSWPLTFGQGT,

SEQ ID NO: 57 (FEL_02D09_VL2)
DIVMTQTPLSLSVTPGESASISCRASQSISNNLHWYLQKSGQSPRRLIYYASQSISGVPDRFSG
SGSGTDFTLRISRVEADDVGVYYCQQSNSWPLTFGQGT,

SEQ ID NO: 63 (CAN_09E09_VL1)
EIVMTQSPASLSLSQEEKVTITCRASQDINNYLNWYQQKPGQAPKLLIYYTSTLHSGVPSRFSG
SGSGTDFSFTISSLEPEDVAVYYCQQGNTLPWTFGQGT,

SEQ ID NO: 65 (CAN_09E09_VL2)
DIVLTQPTSVSGSLGQRVTISCRASQDINNYLNWYQQLPGKAPKLLVYYTSTLHSGVPDRFSGS
NSGSSATLTITGLQAEDEADYYCQQGNTLPWTFGQGT,

SEQ ID NO: 71 (FEL_09E09_VL1)
EIQMTQSPSSLSASPGDRVTITCRASQDINNYLNWYQQKPGKVPKLLIYYTSTLHSGVPSRFSG
SGSGTDFTLTISSLEPEDAATYYCQQGNTLPWTFGQGT,

SEQ ID NO: 73 (FEL_09E09_VL2)
DITMTQSPGSLAGSPGQQVTMNCRASQDINNYLNWYQQKPGQHPKLLIYYTSTLHSGVPDRF
SGSGSGTDFTLTISNLQAEDVASYYCQQGNTLPWTFGQGT,

SEQ ID NO: 77 (CAN_10F07_VL1)
EIVMTQSPASLSLSQEEKVTITCRASQDITNYLNWYQQKPGQAPKLLIYYTSTLHSGVPSRFSG
SGSGTDFSFTISSLEPEDVAVYYCQQGHMLPWTFGQGT,

SEQ ID NO: 81 (CAN_10F07_VL2)
DIVLTQPTSVSGSLGQRVTISCRASQDITNYLNWYQQLPGKAPKLLVYYTSTLHSGVPDRFSGS
NSGSSATLTITGLQAEDEADYYCQQGHMLPWTFGQGT,

SEQ ID NO: 85 (FEL_10F07_VL1)
EIQMTQSPSSLSASPGDRVTITCRASQDITNYLNWYQQKPGKVPKLLIYYTSTLHSGVPSRFSG
SGSGTDFTLTISSLEPEDAATYYCQQGHMLPWTFGQGT,

SEQ ID NO: 89 (FEL_10F07_VL2)
DITMTQSPGSLAGSPGQQVTMNCRASQDITNYLNWYQQKPGQHPKLLIYYTSTLHSGVPDRFS
GSGSGTDFTLTISNLQAEDVASYYCQQGHMLPWTFGQGT,

SEQ ID NO: 93 (CAN_19F07_VL1)
EIVMTQSPASLSLSQEEKVTITCKASQDVDTAVAWYQQKPGQAPKLLIYLASTRHTGVPSRFSG
SGSGTDFSFTISSLEPEDVAVYYCQQYSRFPLTFGQGT,

SEQ ID NO: 97 (CAN_19F07_VL2)
DIVMTQTPLSLSVSPGETASISCKASQDVDTAVAWFRQKPGQSPQRLIYLASTRHTGVPDRFS
GSGSGTDFTLRISRVEADDTGVYYCQQYSRFPLTFGQGT,

SEQ ID NO: 101 (FEL_19F07_VL1)
EIQMTQSPSSLSASPGDRVTITCKASQDVDTAVAWYQQKPGKVPKLLIYLASTRHTGVPSRFS
GSGSGTDFTLTISSLEPEDAATYYCQQYSRFPLTFGQGT,

SEQ ID NO: 105 (FEL_19F07_VL2)
DITMTQSPGSLAGSPGQQVTMNCKASQDVDTAVAWYQQKPGQHPKLLIYLASTRHTGVPDRF
SGSGSGTDFTLTISNLQAEDVASYYCQQYSRFPLTFGQGT,

SEQ ID NO: 131. (CAN_14C04_VL1)

EIVMTQSPASLSLSQEEKVTITCRASKSVSTSGYSYLHWYQQKPGQAPKLLIYLASNLESGVPS
RFSGSGSGTDFSFTISSLEPEDVAVYYCQHSRELPLTFGQGT, or

SEQ ID NO: 133. (CAN_14C04_VL2)

DIVMTQTPLSLSVSPGETASISCRASKSVSTSGYSYLHWYLQKPGQSPQLLIYLASNLESGVSK
RFSGSGSGTDFTLRISRVEADDTGIYYCQHSRELPLTFGQGT.

5. The antibody of any one of claims 1 to 4, wherein the antibody is chimeric.

6. The antibody of any one of claims 1 to 4, wherein the antibody is caninized or felinized.

7. The antibody of any one of claims 1 to 4, wherein the antibody inhibits or neutralizes an IL-31-mediated or OSM-mediated pruritic or allergic condition in a dog or cat.

8. The antibody of claim 7, wherein the IL-31-mediated or OSM-mediated pruritic condition is selected from the group consisting of atopic dermatitis, eczema, psoriasis, scleroderma, and pruritis.

9. The antibody of claim 8, wherein the IL-31-mediated or OSM-mediated allergic condition is selected from the group consisting of allergic dermatitis, summer eczema, urticaria, heaves, inflammatory airway disease, recurrent airway obstruction, airway hyper-responsiveness, chronic obstruction pulmonary disease, and inflammatory processes resulting from autoimmunity.

10. The antibody of any one of claims 1 to 4, wherein the antibody inhibits an IL-31-mediated or OSM-mediated fibrotic or inflammatory disorder.

11. The antibody of claim 10, wherein the IL-31-mediated or OSM-mediated fibrotic disorder is selected from the group consisting of renal fibrosis, pulmonary fibrosis, and dermal fibrosis.

12. The antibody of claim 10, wherein the IL-31-mediated or OSM-mediated inflammatory disorder is selected from the group consisting of inflammatory processes resulting from autoimmunity, inflammation in the skin or joint of animals affected by osteoarthritis, immune-mediated polyarthritis, chronic bronchitis, allergic asthma, atopic dermatitis, allergic dermatitis, pyotraumatic dermatitis, atherosclerosis, and cardiovascular disease.

13. The antibody of any one of claims 1 to 4, wherein the antibody reduces IL-31-mediated or OSM-mediated inflammatory pain.

14. The antibody of claim 13, wherein the IL-31-mediated or OSM-mediated inflammatory pain is osteoarthritis pain.

15. A veterinary composition comprising a therapeutically effective amount of the antibody of any one of claims 1 to 4.

16. Use of an antibody according to any one of claims 1 to 4 in the manufacture of a medicament for treating an IL-31-mediated or OSM-mediated disorder in a subject.

17. The use of claim 16, wherein the IL-31-mediated or OSM-mediated disorder is selected from the group consisting of a pruritic condition, an allergic condition, a fibrotic disorder, an inflammatory disorder, and inflammatory pain.

18. The use of claim 17, wherein the IL-31-mediated or OSM-mediated pruritic condition is selected from the group consisting of atopic dermatitis, eczema, psoriasis, scleroderma, and pruritis.

19. The use of claim 17, wherein the IL-31-mediated or OSM-mediated allergic condition is selected from the group consisting of allergic dermatitis, summer eczema, urticaria, heaves, inflammatory airway disease, recurrent airway obstruction, airway hyper-responsiveness, chronic obstruction pulmonary disease, and inflammatory processes resulting from autoimmunity.

20. The use of claim 17, wherein the IL-31-mediated or OSM-mediated fibrotic disorder is selected from the group consisting of renal fibrosis, pulmonary fibrosis, and dermal fibrosis.

21. The use of claim 17, wherein the IL-31-mediated or OSM-mediated inflammatory disorder is selected from the group consisting of inflammatory processes resulting from autoimmunity, inflammation in the skin or joint of animals affected by osteoarthritis, immune-mediated polyarthritis, chronic bronchitis, allergic asthma, atopic dermatitis, allergic dermatitis, pyotraumatic dermatitis, atherosclerosis, and cardiovascular disease.

22. The use of claim 17, wherein the IL-31-mediated or OSM-mediated inflammatory pain is osteoarthritis pain.

23. The use of any one of claims 16 to 22, wherein the subject is a dog or a cat.

24. Use of an antibody according to any one of claims 1 to 4 in the manufacture of a medicament for inhibiting IL-31 and/or OSM activity in a dog or cat.

25. A method of detecting OSMR Beta in a sample comprising:

a) incubating a sample comprising OSMR Beta in the presence of an antibody according to any one of claims 1 to 4; and
b) detecting the antibody which is bound to OSMR Beta in the sample.

26. The method of claim 25, wherein the antibody comprises a label.

27. The method of claim 25 or claim 26, further comprising quantitating the OSMR Beta in the sample.

28. A host cell that produces an isolated antibody or antigen-binding portion thereof comprising at least one of the following combinations of complementary determining region (CDR) sequences:

1) 02D09: variable heavy (VH)-CDR1 of SEQ ID NO: 1 (DYGMH), VH-CDR2 of SEQ ID NO: 2 (YISSGSRAVFFADTVKG), VH-CDR3 of SEQ ID NO: 3 (DRYDGRGFAY), variable light (VL)-CDR1 of SEQ ID NO: 4 (RASQSISNNLH), VL-CDR2 of SEQ NO: 5 (YASQSIS), and VL-CDR3 of SEQ ID NO: 6 (QQSNSWPLT);

2) 09E09: VH-CDR1 of SEQ ID NO: 7 (SYAMS), VH-CDR2 of SEQ ID NO: 8 (YISSGGDYIYYADTVKG), VH-CDR3 of SEQ ID NO: 9 (DPITGTFAY), VL-CDR1 of SEQ ID NO: 10 (RASQDINNYLN), VL-CDR2 of SEQ ID NO: 11 (YTSTLHS), and VL-CDR3 of SEQ ID NO: 12 (QQGNTLPWT);

3) 10F07: VH-CDR1 of SEQ ID NO: 13 (SYAMS), VH-CDR2 of SEQ ID NO: 14 (YISSGGDYFYYADTVKG), VH-CDR3 of SEQ ID NO: 15 (DPITGTFAY), VL-CDR1 of SEQ ID NO: 16 (RASQDITNYLN), VL-CDR2 of SEQ ID NO: 17 (YTSTLHS), and VL-CDR3 of SEQ ID NO: 18 (QQGHMLPWT);

4) 14C04: VH-CDR1 of SEQ ID NO: 19 (NYWMN), VH-CDR2 of SEQ ID NO: 20 (QIYPGHVNTNYNGNFKD), VH-CDR3 of SEQ ID NO: 21 (SADNSGFVLFAY), VL-CDR1 of SEQ ID NO: 22 (RASKSVSTSGYSYLH), VL-CDR2 of SEQ ID NO: 23 (LASNLES), and VL-CDR3 of SEQ ID NO: 24 (QHSRELPLT);

5) 19F07: VH-CDR1 of SEQ ID NO: 25 (DYYMA), VH-CDR2 of SEQ ID NO: 26 (NINYDGSSTYYLDSLKS), VH-CDR3 of SEQ ID NO: 27 (GLTWDFDV), VL-CDR1 of SEQ ID NO: 28 (KASQDVDTAVA), VL-CDR2 of SEQ ID NO: 29 (LASTRHT), and VL-CDR3 of SEQ ID NO: 30 (QQYSRFPLT); or

6) CDR variants of 1, 2, 3, 4, or 5.

29. An isolated nucleic acid comprising a nucleic acid sequence encoding at least one of the following combinations of complementary determining region (CDR) sequences:

1) 02D09: variable heavy (VH)-CDR1 of SEQ ID NO: 1 (DYGMH), VH-CDR2 of SEQ ID NO: 2 (YISSGSRAVFFADTVKG), and VH-CDR3 of SEQ ID NO: 3 (DRYDGRGFAY);

2) 09E09: VH-CDR1 of SEQ ID NO: 7 (SYAMS), VH-CDR2 of SEQ ID NO: 8 (YISSGGDYIYYADTVKG), and VH-CDR3 of SEQ ID NO: 9 (DPITGTFAY);

3) 10F07: VH-CDR1 of SEQ ID NO: 13 (SYAMS), VH-CDR2 of SEQ ID NO: 14 (YISSGGDYFYYADTVKG), and VH-CDR3 of SEQ ID NO: 15 (DPITGTFAY);

4) 14C04: VH-CDR1 of SEQ ID NO: 19 (NYWMN), VH-CDR2 of SEQ ID NO: 20 (QIYPGHVNTNYNGNFKD), and VH-CDR3 of SEQ ID NO: 21 (SADNSGFVLFAY);

5) 19F07: VH-CDR1 of SEQ ID NO: 25 (DYYMA), VH-CDR2 of SEQ ID NO: 26 (NINYDGSSTYYLDSLKS), and VH-CDR3 of SEQ ID NO: 27 (GLTWDFDV); or

6) CDR variants of 1, 2, 3, 4, or 5.

30. The nucleic acid of claim 29, further comprising a nucleic acid sequence encoding at least one of the following combinations of CDR sequences:

1) 02D09: variable light (VL)-CDR1 of SEQ ID NO: 4 (RASQSISNNLH), VL-CDR2 of SEQ NO: 5 (YASQSIS), and VL-CDR3 of SEQ ID NO: 6 (QQSNSWPLT);

2) 09E09: VL-CDR1 of VL-CDR1 of SEQ ID NO: 10 (RASQDINNYLN), VL-CDR2 of SEQ ID NO: 11 (YTSTLHS), and VL-CDR3 of SEQ ID NO: 12 (QQGNTLPWT);

3) 10F07: VL-CDR1 of SEQ ID NO: 16 (RASQDITNYLN), VL-CDR2 of SEQ ID NO: 17 (YTSTLHS), and VL-CDR3 of SEQ ID NO: 18 (QQGHMLPWT);

4) 14C04: VL-CDR1 of SEQ ID NO: 22 (RASKSVSTSGYSYLH), VL-CDR2 of SEQ ID NO: 23 (LASNLES), and VL-CDR3 of SEQ ID NO: 24 (QHSRELPLT);

5) 19F07: VL-CDR1 of SEQ ID NO: 28 (KASQDVDTAVA), VL-CDR2 of SEQ ID NO: 29 (LASTRHT), and VL-CDR3 of SEQ ID NO: 30 (QQYSRFPLT); or

6) CDR variants of 1, 2, 3, 4, or 5.

31. A nucleic acid sequence encoding at least one of the following combinations of CDR sequences:

1) 02D09: variable light (VL)-CDR1 of SEQ ID NO: 4 (RASQSISNNLH), VL-CDR2 of SEQ NO: 5 (YASQSIS), and VL-CDR3 of SEQ ID NO: 6 (QQSNSWPLT);

2) 09E09: VL-CDR1 of VL-CDR1 of SEQ ID NO: 10 (RASQDINNYLN), VL-CDR2 of SEQ ID NO: 11 (YTSTLHS), and VL-CDR3 of SEQ ID NO: 12 (QQGNTLPWT);

3) 10F07: VL-CDR1 of SEQ ID NO: 16 (RASQDITNYLN), VL-CDR2 of SEQ ID NO: 17 (YTSTLHS), and VL-CDR3 of SEQ ID NO: 18 (QQGHMLPWT);

4) 14C04: VL-CDR1 of SEQ ID NO: 22 (RASKSVSTSGYSYLH), VL-CDR2 of SEQ ID NO: 23 (LASNLES), and VL-CDR3 of SEQ ID NO: 24 (QHSRELPLT);

5) 19F07: VL-CDR1 of SEQ ID NO: 28 (KASQDVDTAVA), VL-CDR2 of SEQ ID NO: 29 (LASTRHT), and VL-CDR3 of SEQ ID NO: 30 (QQYSRFPLT); or

6) CDR variants of 1, 2, 3, 4, or 5.

32. A vector comprising the nucleic acid of any one of claims 29, 30, or 31.

33. A method of producing an antibody comprising culturing the host cell of claim 28 under conditions that result in production of the antibody and isolating the antibody from the host cell or culture medium of the host cell.