

ANTIBODIES TO MAdCAM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of, and priority to U.S.S.N. 62/532,809 filed on July 14, 2017, the content of which is incorporated herein in its entirety.

INCORPORATION-BY-REFERENCE OF SEQUENCE LISTING

[0002] The content of the text file name “SHR-1258A_ST25.txt”, which was created on July 14, 2017 and is 197 KB in size, is hereby incorporated-by-reference in its entirety.

BACKGROUND OF THE INVENTION

[0003] Mucosal addressin cell adhesion molecule (MAdCAM) is a member of the immunoglobulin superfamily of cell adhesion receptors. The selectivity of lymphocyte homing to specialized lymphoid tissue and mucosal sites of the gastrointestinal tract is determined by the endothelial expression of MAdCAM (Berlin, C. et al., *Cell*, 80:413-422(1994); Berlin, C., et al., *Cell*, 74:185-195 (1993); and Erle, D.J., et al., *J. Immunol.*, 153: 517-528 (1994)). MAdCAM is uniquely expressed on the cell surface of high endothelial venules of organized intestinal lymphoid tissue, such as Peyer's patches and mesenteric lymph nodes (Streeter et al., *Nature*, 331:41-6 (1988); Nakache et al., *Nature*, 337:179-81 (1989); Briskin et al., *Am. J. Pathol.* 151:97-110 (1997)), but also in other lymphoid organs, such as pancreas, gall bladder and splenic venules and marginal sinus of the splenic white pulp (Briskin et al (1997), *supra*; Kraal et al., *Am. J. Path.*, 147: 763-771 (1995)).

[0004] While MAdCAM plays a physiological role in gut immune surveillance, it appears to facilitate excessive lymphocyte extravasation in inflammatory bowel disease under conditions of chronic gastrointestinal tract inflammation. TNF α and other pro-inflammatory cytokines increase endothelial MAdCAM expression and, in biopsy specimens taken from patients with Crohn's disease and ulcerative colitis, there is an approximate 2-3 fold focal

increase in MAdCAM expression at sites of inflammation (Briskin et al. (1997), Souza et al., *Gut*, 45:856-63 (1999); Arihiro et al., *Pathol Int.*, 52:367-74 (2002)). Similar patterns of elevated expression have been observed in experimental models of colitis (Hesterberg et al. , *Gastroenterology*, 111:1373-1380 (1997); Picarella et al., *J. Immunol.*, 158: 2099-2106 (1997); Connor et al., *J Leukoc Biol.*, 65:349-55 (1999); Kato et al. , *J Pharmacol Exp Ther.*, 295:183-9 (2000); Hokari et al. , *Clin Exp Immunol.*, 26:259-65 (2001); Shigematsu et al., *Am J Physiol Gastrointest Liver Physiol.*, 281:G1309-15 (2001)). In other pre-clinical models for inflammatory conditions, such as insulin-dependent diabetes (Yang et al. *Diabetes*, 46:1542-7 (1997); Hänninen et al., *J Immunol.*, 160:6018-25 (1998)), graft versus host disease (Fujisaki et al., *Scand J Gastroenterol.*, 38:437-42 (2003), Murai et al. , *Nat Immunol.*, 4:154-60 (2003)), chronic liver disease (Hillan et al., *Liver*, 19:509-18 (1999); Grant et al., *Hepatology*, 33:1065-72 (2001)), inflammatory encephalopathy (Stalder et al., *Am J Pathol.*, 153:767-83 (1998); Kanawar et al. , *Immunol Cell Biol.*, 78:641-5 (2000)), and gastritis (Barrett et al. , *J Leukoc Biol.*, 67:169-73 (2000); Hatanaka et al., *Clin Exp Immunol.*, 130:183-9 (2002)), there is also reawakening of fetal MAdCAM expression and participation of activated $\alpha_4\beta_7^+$ lymphocytes in disease pathogenesis. In these inflammatory models as well as hapten-mediated (e.g., TNBS, DSS, etc.) or adoptive transfer ($CD4^+CD45Rb^{high}$) mouse colitic models, the rat anti-mouse MAdCAM monoclonal antibody (mAb), MECA-367, which blocks the binding of $\alpha_4\beta_7^+$ lymphocytes to MAdCAM, reduces the lymphocyte recruitment, tissue extravasation, inflammation and disease severity. Mouse monoclonal antibodies (mAbs) against human MAdCAM also have been reported (see, e.g., WO 96/24673 and WO 99/58573).

[0005] Given the role of MAdCAM in inflammatory bowel disease (IBD) and other inflammatory diseases associated with the gastrointestinal tract or other tissues, a means for inhibiting $\alpha_4\beta_7$ binding and MAdCAM-mediated leukocyte recruitment is desirable. It

further would be desirable to have such therapeutic means with advantageous properties including but not limited to the absence of unwanted interactions with other medications in patients and favorable physico-chemical properties such as pK/pD values in humans, solubility, stability, shelf-life and *in vivo* half-life. A therapeutic protein, such as an antibody, would advantageously be free of unwanted post-translational modifications or aggregate formation. Accordingly, there is a critical need for therapeutic anti-MAdCAM antibodies.

SUMMARY OF THE INVENTION

[0006] Provided herein is an isolated antibody that specifically binds MAdCAM, wherein at least the CDR sequences of said antibody are human CDR sequences, or an antigen-binding portion of said antibody. In embodiments the antibody is a human antibody, preferably an antibody that acts as a MAdCAM antagonist. Also provided are compositions comprising said antibodies or portions.

[0007] The disclosure also provides a composition comprising the heavy and/or light chain of said anti-MAdCAM antagonist antibody or the variable region or other antigen-binding portion thereof or nucleic acid molecules encoding any of the foregoing and a pharmaceutically acceptable carrier. Compositions of the invention may further comprise another component, such as a therapeutic agent or a diagnostic agent. Diagnostic and therapeutic methods are also provided by the invention.

[0008] The disclosure further provides an isolated cell line, that produces said anti-MAdCAM antibody or antigen-binding portion thereof.

[0009] The disclosure also provides nucleic acid molecules encoding the heavy and/or light chain of said anti-MAdCAM antibody or the variable region thereof or antigen-binding portion thereof.

[0010] The disclosure provides vectors and host cells comprising said nucleic acid molecules, as well as methods of recombinantly producing the polypeptides encoded by the nucleic acid molecules.

[0011] Non-human transgenic animals or plants that express the heavy and/or light chain of said anti-MAdCAM antibody, or antigen-binding portion thereof, are also provided.

[0012] In embodiments, a human monoclonal antibody or an antigen-binding portion thereof is provided that specifically binds to Mucosal Addressin Cell Adhesion Molecule (MAdCAM).

[0013] In embodiments, the human monoclonal antibody or antigen-binding portion possesses at least one of the following properties: (a) binds to human cells; (b) has a selectivity for MAdCAM over VCAM or fibronectin of at least 100 fold; (c) binds to human MAdCAM with a K_d of 3×10^{-10} M or less; or (d) inhibits the binding of $\alpha_4\beta_7$ expressing cells to human MAdCAM. (e) inhibits the recruitment of lymphocytes to gastrointestinal lymphoid tissue.

[0014] In embodiments, the human monoclonal antibody or antigen-binding portion binds human MAdCAM with a K_d of 3×10^{-10} M or less and inhibits $\alpha_4\beta_7$ binding to human MAdCAM.

[0015] In embodiments, the heavy chain comprises an amino acid sequence at least 80%, 85%, or 90% identical to SEQ ID NO: 148.

[0016] In embodiments, the heavy chain comprises an amino acid sequence identical to SEQ ID NO: 148.

[0017] In embodiments, heavy chain comprises between 1 and 25 amino acid substitutions as compared to SEQ ID NO: 148.

[0018] In embodiments, the heavy chain comprises between 1 and 10 amino acid substitutions as compared to SEQ ID NO: 148.

[0019] In embodiments, the light chain comprises an amino acid sequence at least 80%, 85%, or 90% identical to SEQ ID NO: 150.

[0020] In embodiments, the light chain comprises an amino acid sequence identical to SEQ ID NO: 150.

[0021] In embodiments, the light chain comprises between 1 and 25 amino acid substitutions as compared to SEQ ID NO: 150.

[0022] In embodiments, the light chain comprises between 1 and 10 amino acid substitutions as compared to SEQ ID NO: 150.

[0023] In embodiments, the heavy chain comprises an amino acid sequence at least 80%, 85%, or 90% identical to SEQ ID NO: 148, and the light chain comprises an amino acid sequence at least 80%, 85%, or 90% identical to SEQ ID NO: 150.

[0024] In embodiments, the heavy chain comprises an amino acid sequence identical to SEQ ID NO: 148, and the light chain comprises an amino acid sequence identical to SEQ ID NO: 150.

[0025] In embodiments, a nucleic acid sequence encoding the amino acid sequence of a MAdCAM antibody is provided.

[0026] In embodiments, a cell producing a human monoclonal antibody that binds MAdCAM is provided.

[0027] In embodiments, a cell comprising a nucleic acid sequence encoding a MAdCAM antibody is provided.

[0028] In embodiments, a hybridoma cell line that produces a human monoclonal MAdCAM antibody is provided. In embodiments, the hybridoma is selected from the group consisting of 1.7.2 (ECACC Accession No. 03090901), 1.8.2 (ECACC Accession No. 03090902), 6.14.2 (ECACC Accession No. 03090903), 6.22.2 (ECACC Accession No. 03090904), 6.34.2 (ECACC Accession No. 03090905), 6.67.1 (ECACC Accession No.

03090906), 6.73.2 (ECACC Accession No. 03090907), 6.77.1 (ECACC Accession No. 03090908), 7.16.6 (ECACC Accession No. 03090909), 7.20.5 (ECACC Accession No. 03090910), 7.26.4 (ECACC Accession No. 03090911), and 9.8.2 (ECACC Accession No. 03090912).

[0029] In embodiments, the human monoclonal antibody produced by the hybridoma cell line or an antigen-binding portion of said monoclonal antibody is provided.

[0030] In embodiments, the heavy chain C-terminal lysine is cleaved.

[0031] In embodiments, said antibody or antigen-binding portion inhibits binding of human MAdCAM to $\alpha_4\beta_7$, and wherein the antibody or portion thereof has at least one of the following properties: (a) cross-competes with a reference antibody for binding to MAdCAM; (b) competes with a reference antibody for binding to MAdCAM; (c) binds to the same epitope of MAdCAM as a reference antibody; (d) binds to MAdCAM with substantially the same K_d as a reference antibody; (e) binds to MAdCAM with substantially the same off rate as a reference antibody; wherein the reference antibody is selected from the group consisting of: monoclonal antibody 1.7.2, monoclonal antibody 1.8.2, monoclonal antibody 6.14.2, monoclonal antibody 6.22.2, monoclonal antibody 6.34.2, monoclonal antibody 6.67.1, monoclonal antibody 6.73.2, monoclonal antibody 6.77.1, monoclonal antibody 7.16.6, monoclonal antibody 7.20.5, monoclonal antibody 7.26.4, monoclonal antibody 9.8.2, X481.2 monoclonal antibody, monoclonal antibody 6.22.2-mod, monoclonal antibody 6.34.2-mod, monoclonal antibody 6.67.1-mod, monoclonal antibody 6.77.1-mod and monoclonal antibody 7.26.4-mod.

[0032] In embodiments, the antibody is selected from the group consisting of: (a) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 2 and SEQ ID NO: 4, without the signal sequences; (b) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 6 and SEQ ID NO: 8, without the signal sequences; (c) an antibody

comprising the amino acid sequences set forth in SEQ ID NO: 10 and SEQ ID NO: 12, without the signal sequences; (d) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 14 and SEQ ID NO: 16, without the signal sequences; (e) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 18 and SEQ ID NO: 20, without the signal sequences; (f) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 22 and SEQ ID NO: 24, without the signal sequences; (g) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 26 and SEQ ID NO: 28, without the signal sequences; (h) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 30 and SEQ ID NO: 32, without the signal sequences; (i) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 34 and SEQ ID NO: 36, without the signal sequences; (j) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 38 and SEQ ID NO: 40, without the signal sequences; (k) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 42 and SEQ ID NO: 44, without the signal sequences; (l) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 46 and SEQ ID NO: 48, without the signal sequences; (m) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 52 and SEQ ID NO: 54, without the signal sequences; (n) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 56 and SEQ ID NO: 58, without the signal sequences; (o) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 60 and SEQ ID NO: 62, without the signal sequences; (p) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 64 and SEQ ID NO: 66, without the signal sequences; and (q) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 42 and SEQ ID NO: 68, without the signal sequences (r) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 148 and SEQ ID NO: 150, without the signal sequence.

[0033] In embodiments, the heavy chain of said antibody or portion thereof comprises the heavy chain CDR1, CDR2 and CDR3 or wherein the light chain comprises the light chain CDR1, CDR2 and CDR3 of a monoclonal antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod.

[0034] In embodiments, said antibody or portion comprises a heavy chain that utilizes a human VH 1-18 gene, a human VH 3-15 gene, a human VH 3-21 gene, a human VH 3-23 gene, a human VH 3-30 gene, a human VH 3-33 gene or a human VH 4-4 gene.

[0035] In embodiments, said antibody or portion comprises a light chain that utilizes a human V_K A2 gene, a human V_K A3 gene, a human V_K A26 gene, a human V_K B3 gene, a human V_K O12 gene or a human V_K O18 gene.

[0036] In embodiments, the heavy chain variable region, the light chain variable region or both are at least 90% identical in amino acid sequence to the corresponding region or regions of a monoclonal antibody selected from the group consisting of: monoclonal antibody 1.7.2, monoclonal antibody 1.8.2, monoclonal antibody 6.14.2, monoclonal antibody 6.22.2, monoclonal antibody 6.34.2, monoclonal antibody 6.67.1, monoclonal antibody 6.73.2, monoclonal antibody 6.77.1, monoclonal antibody 7.16.6, monoclonal antibody 7.20.5, monoclonal antibody 7.26.4, monoclonal antibody 9.8.2, monoclonal antibody X481.2, monoclonal antibody 6.22.2-mod, monoclonal antibody 6.34.2-mod, monoclonal antibody 6.67.1-mod, monoclonal antibody 6.77.1-mod and monoclonal antibody 7.26.4-mod.

[0037] In embodiments, a monoclonal antibody or an antigen-binding portion thereof is provided that specifically binds MAdCAM, wherein: (a) the heavy chain comprises the heavy chain CDR1, CDR2 and CDR3 amino acid sequences of a reference antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-

mod (b) the light chain comprises the light chain CDR1, CDR2 and CDR3 amino acid sequences of a reference antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod (c) the antibody comprises a heavy chain of (a) and a light chain of (b); and (d) the antibody of (c) wherein the heavy chain and light chain CDR amino acid sequences are selected from the same reference antibody.

[0038] In embodiments, the heavy chain, the light chain or both comprise the amino acid sequence from the beginning of the CDR1 through the end of the CDR3 of the heavy chain, the light chain or both, respectively, of the reference antibody.

[0039] In embodiments, said antibody comprises: (a) a heavy chain comprising the heavy chain variable region amino acid sequence of an antibody selected from the group consisting of: 1.7.2 (SEQ ID NO: 2); 1.8.2 (SEQ ID NO: 6); 6.14.2 (SEQ ID NO: 10); 6.22.2 (SEQ ID NO: 14); 6.34.2 (SEQ ID NO: 18); 6.67.1 (SEQ ID NO: 22); 6.73.2 (SEQ ID NO: 26); 6.77.1 (SEQ ID NO: 30); 7.16.6 (SEQ ID NO: 34); 7.20.5 (SEQ ID NO: 38); 7.26.4 (SEQ ID NO: 42); and 9.8.2 (SEQ ID NO: 46); X481.2 (SEQ ID NO: 148), 6.22.2-mod (SEQ ID NO: 52); 6.34.2-mod (SEQ ID NO: 56); 6.67.1-mod (SEQ ID NO: 60); 6.77.1-mod (SEQ ID NO: 64); and 7.26.4-mod (SEQ ID NO: 42); (b) a light chain comprising the light chain variable region amino acid sequence of an antibody selected from the group consisting of: 1.7.2 (SEQ ID NO: 4); 1.8.2 (SEQ ID NO: 8); 6.14.2 (SEQ ID NO: 12); 6.22.2 (SEQ ID NO: 16); 6.34.2 (SEQ ID NO: 20); 6.67.1 (SEQ ID NO: 24); 6.73.2 (SEQ ID NO: 28); 6.77.1 (SEQ ID NO: 32); 7.16.6 (SEQ ID NO: 36); 7.20.5 (SEQ ID NO: 40); 7.26.4 (SEQ ID NO: 44); and 9.8.2 (SEQ ID NO: 48); X481.2 (SEQ ID NO: 150), 6.22.2-mod (SEQ ID NO: 54); 6.34.2-mod (SEQ ID NO: 58); 6.67.1-mod (SEQ ID NO: 62); 6.77.1-mod (SEQ ID NO: 66); and 7.26.4-mod (SEQ ID NO: 68); or (c) the heavy chain of (a) and the light chain of (b).

[0040] In embodiments, the monoclonal antibody is an immunoglobulin G (IgG), an IgM, an IgE, and IgA or an IgD molecule, a humanized antibody, a chimeric antibody or a bispecific antibody.

[0041] In embodiments, the antigen-binding portion is an Fab fragment, an F(ab')₂ fragment, an F_V fragment or a single chain antibody.

[0042] In embodiments, a pharmaceutical composition is provided comprising an effective amount of the monoclonal antibody or antigen-binding portion thereof and a pharmaceutically acceptable carrier.

[0043] In embodiments, a method of treating inflammatory disease in a subject in need thereof is provided, comprising the step of administering to said subject the monoclonal antibody or antigen-binding portion thereof wherein said antibody or antigen-binding portion inhibits binding of MAdCAM to $\alpha_4\beta_7$.

[0044] In embodiments, the inflammatory disease is inflammatory disease of the gastrointestinal tract.

[0045] In embodiments, the inflammatory disease of the gastrointestinal tract is selected from the group consisting of inflammatory bowel disease, Crohn's disease, ulcerative colitis, diverticula disease, gastritis, liver disease, primary biliary sclerosis and sclerosing cholangitis.

[0046] In embodiments, the inflammatory bowel disease is Crohn's disease, ulcerative colitis or both.

[0047] In embodiments, the inflammatory diseases are insulin-dependent diabetes and graft versus host disease.

[0048] In embodiments, an isolated cell line is provided that produces the monoclonal antibody or antigen-binding portion or the heavy chain or light chain of said antibody or of said portion thereof. In embodiments, the cell line produces an antibody selected from the

group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, and X481.2 or an antibody comprising the amino acid sequences of one of said antibodies. In embodiments, the cell line produces a monoclonal antibody selected from the group consisting of: 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod, 7.26.4-mod, and X481.2 or an antibody comprising the amino acid sequences of one of said antibodies.

[0049] In embodiments, an isolated nucleic acid molecule is provided comprising a nucleotide sequence that encodes the heavy chain or an antigen-binding portion thereof or the light chain or an antigen-binding portion thereof of an antibody.

[0050] In embodiments, a vector is provided comprising a nucleic acid molecule, wherein the vector optionally comprises an expression control sequence operably linked to the nucleic acid molecule. In embodiments, a host cell is provided comprising the vector or the nucleic acid molecule.

[0051] In embodiments, a host cell is provided comprising a nucleic acid molecule encoding the heavy chain or an antigen-binding portion thereof and a nucleic acid molecule encoding the light chain or an antigen-binding portion thereof of an antibody or antigen-binding portion.

[0052] In embodiments, a method is provided for producing a human monoclonal antibody or antigen-binding portion thereof that specifically binds MAdCAM, comprising culturing the host cell or the cell line under suitable conditions and recovering said antibody or antigen-binding portion.

[0053] In embodiments, a non-human transgenic animal or transgenic plant is provided comprising (a) nucleic acid molecule encoding the heavy chain or an antigen-binding portion thereof; (b) a nucleic acid molecule encoding the light chain or an antigen-binding portion thereof; or (c) both (a) and (b) of an antibody, wherein the non-human transgenic animal or transgenic plant expresses said heavy chain or light chain or both.

[0054] In embodiments, a method is provided of isolating an antibody or antigen-binding portion thereof that specifically binds to MAdCAM, comprising the step of isolating the antibody from the non-human transgenic animal or transgenic plant.

[0055] In embodiments, a method is provided of treating a subject in need thereof with a human antibody or antigen-binding portion thereof that specifically binds to MAdCAM and inhibits binding to $\alpha_4 \beta_7$ comprising the steps of: (a) administering an effective amount of an isolated nucleic acid molecule encoding the heavy chain or an antigen-binding portion thereof, an isolated nucleic acid molecule encoding the light chain or an antigen-binding portion thereof, or nucleic acid molecules encoding the light chain and the heavy chain or antigen-binding portions thereof; and (b) expressing the nucleic acid molecule.

[0056] In embodiments, a method for producing a human monoclonal antibody that specifically binds MAdCAM is provided, comprising the steps of: (a) immunizing a non-human transgenic animal that is capable of producing human antibodies with MAdCAM, with an immunogenic portion of MAdCAM or a cell or tissue expressing MAdCAM; and (b) allowing the transgenic animal to mount an immune response to MAdCAM.

[0057] In embodiments, a human monoclonal antibody is produced as above.

[0058] In embodiments, a method is provided of inhibiting $\alpha_4 \beta_7$ binding to cells expressing human MAdCAM comprising contacting the cells with the monoclonal antibody or an antigen-binding portion thereof.

[0059] In embodiments, a method for inhibiting MAdCAM-mediated leukocyte-endothelial cell adhesion is provided comprising contacting the endothelial cells with the monoclonal antibody or an antigen-binding portion thereof.

[0060] In embodiments, a method is provided for inhibiting MAdCAM-mediated leukocyte adhesion, migration and infiltration into tissues comprising the step of contacting the endothelial cells with the monoclonal antibody or an antigen-binding portion thereof.

[0061] In embodiments, a method is provided for inhibiting $\alpha_4 \beta_7$ /MAdCAM-dependent cellular adhesion comprising the step of contacting cells expressing human MAdCAM with the monoclonal antibody or antigen-binding portion thereof.

[0062] In embodiments, a method is provided for inhibiting the MAdCAM-mediated recruitment of lymphocytes to gastrointestinal lymphoid tissue comprising the step of contacting cells expressing human MAdCAM with the monoclonal antibody or antigen-binding portion thereof.

[0063] In embodiments, a monoclonal antibody or an antigen-binding portion thereof is provided that specifically binds MAdCAM, wherein said antibody or portion thereof comprises one or more of an FR1, FR2, FR3 or FR4 amino acid sequence of a human monoclonal antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod.

[0064] In embodiments, the human monoclonal antibody or antigen-binding portion comprises: (a) a heavy chain amino acid sequence that is at least 90% identical to the heavy chain amino acid sequence of a monoclonal antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod; (b) a light chain amino acid sequence that is at least 90% identical to the light chain amino acid sequence of a monoclonal antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod; (c) both (a) and (b); or (d) either (a), (b) or (c), with or without the signal sequence.

[0065] In embodiments, a method is provided for diagnosing a disorder characterized by circulating soluble human MAdCAM comprising the steps of: (1) contacting a biological sample with the monoclonal antibody or antigen-binding portion and (2) detecting binding.

[0066] In embodiments, a method is provided for detecting inflammation in a subject comprising the steps of: (1) administering to said subject the monoclonal antibody or antigen-binding portion wherein said antibody or portion thereof is detectably labeled and (2) detecting binding.

[0067] In embodiments, a diagnostic kit is provided comprising the monoclonal antibody or antigen-binding portion.

[0068] In embodiments, the pharmaceutical composition is provided further comprising one or more additional anti-inflammatory or immunomodulatory agents. In embodiments, the one or more additional anti-inflammatory or immunomodulatory agents are selected from the group consisting of: corticosteroids, aminosalicylates, azathioprine, methotrexate, cyclosporin, FK506, IL-10, GM-CSF, rapamycin, anti-TNF α agents and adhesion molecule antagonists.

[0069] In embodiments, a vaccine is provided comprising an effective amount of the human antibody thereof or antigen-binding portion and a pharmaceutically acceptable carrier. In embodiments, the vaccine is mucosal.

[0070] In embodiments, a method is provided of detecting the effect of administration of an inhibitory anti-MAdCAM antibody or antigen-binding portion thereof to a subject comprising the steps of: (a) administering to a subject a human monoclonal antibody that specifically binds to MAdCAM; and (b) determining whether there is an increase in the levels of circulating $\alpha_4\beta_7$ -expressing leukocytes. In embodiments, said leukocytes are lymphocytes. In embodiments, said increase in the levels of circulating $\alpha_4\beta_7$ -expressing leukocytes is determined by FACS analysis.

[0071] In embodiments, a monoclonal antibody, or antigen-binding portion thereof, is provided that binds MAdCAM comprising the variable region of the light chain of SEQ ID NO: 150 and the variable region of the heavy chain of SEQ ID NO: 148.

[0072] In embodiments, a monoclonal antibody, or antigen-binding fragment thereof, is provided that binds MAdCAM comprising a heavy chain variable region encoded by nucleotide SEQ ID NO: 149, and a light chain variable region encoded by nucleotide SEQ ID NO: 35.

BRIEF DESCRIPTION OF THE DRAWINGS

[0073] Figure 1 (i.e. Figure 1A - Figure 1T) is an alignment of the predicted amino acid sequences of the heavy and kappa light chain variable regions of twelve human anti-MAdCAM monoclonal antibodies with the germline amino acid sequences of the corresponding human genes.

[0074] Figure 1A shows an alignment of the predicted amino acid sequence of the heavy chain for antibodies 1.7.2 and 1.8.2 with the germline human VH 3-15 gene product.

[0075] Figure 1B shows an alignment of the predicted amino acid sequence of the heavy chain for antibody 6.14.2 with the germline human VH 3-23 gene product.

[0076] Figure 1C shows an alignment of the predicted amino acid sequence of the heavy chain for antibody 6.22.2 with the germline human VH 3-33 gene product.

[0077] Figure 1D shows an alignment of the predicted amino acid sequence of the heavy chain for antibody 6.34.2 with the germline human VH 3-30 gene product.

[0078] Figure 1E shows an alignment of the predicted amino acid sequence of the heavy chain for antibody 6.67.1 with the germline human VH 4-4 gene product.

[0079] Figure 1F shows an alignment of the predicted amino acid sequence of the heavy chain for antibody 6.73.2 with the germline human VH 3-23 gene product.

[0080] Figure 1G shows an alignment of the predicted amino acid sequence of the heavy chain for antibody 6.77.1 with the germline human VH 3-21 gene product.

[0081] Figure 1H shows an alignment of the predicted amino acid sequence of the heavy chain for antibodies 7.16.6 and 7.26.4 with the germline human VH 1-18 gene product.

[0082] Figure 1I shows an alignment of the predicted amino acid sequence of the heavy chain for antibody 7.20.5 with the germline human VH 4-4 gene product.

[0083] Figure 1J shows an alignment of the predicted amino acid sequence of the heavy chain for antibody 9.8.2 with the germline human VH 3-33 gene product.

[0084] Figure 1K shows an alignment of the predicted amino acid sequence of the light kappa chain for antibodies 1.7.2 and 1.8.2 with the germline human A3 gene product.

[0085] Figure 1L shows an alignment of the predicted amino acid sequence of the kappa light chain for antibody 6.14.2 with the germline human O12 gene product.

[0086] Figure 1M shows an alignment of the predicted amino acid sequence of the kappa light chain for antibody 6.22.2 with the germline human A26 gene product.

[0087] Figure 1N shows an alignment of the predicted amino acid sequence of the kappa light chain for antibody 6.34.2 with the germline human O12 gene product.

[0088] Figure 1O shows an alignment of the predicted amino acid sequence of the kappa light chain for antibody 6.67.1 with the germline human B3 gene product.

[0089] Figure 1P shows an alignment of the predicted amino acid sequence of the kappa light chain for antibody 6.73.2 with the germline human O12 gene product.

[0090] Figure 1Q shows an alignment of the predicted amino acid sequence of the kappa light chain for antibody 6.77.1 with the germline human A2 gene product.

[0091] Figure 1R shows an alignment of the predicted amino acid sequence of the kappa light chain for antibodies 7.16.6 and 7.26.4 with the germline human A2 gene product.

[0092] Figure 1S shows an alignment of the predicted amino acid sequence of the kappa light chain for antibody 7.20.5 with the germline human A3 gene product.

[0093] Figure 1T shows an alignment of the predicted amino acid sequence of the kappa light chain for antibody 9.8.2 with the germline human O18 gene product.

[0094] Figure 2 (i.e. Figure 2A and Figure 2B) are CLUSTAL alignments of the predicted heavy and kappa light chain amino acid sequences of human anti-MAdCAM antibodies.

[0095] Figure 2A is a CLUSTAL alignment and radial tree of the predicted kappa light chain amino acid sequences, showing the degree of similarity between the anti-MAdCAM antibody kappa light chains.

[0096] Figure 2B is a CLUSTAL alignment and radial tree of the predicted heavy amino acid sequences, showing the degree of similarity between the anti-MAdCAM antibody heavy chains.

[0097] Figure 3 is an amino acid sequence CLUSTAL alignment of the 2 N-terminal domains of cynomolgus and human MAdCAM which form the $\alpha_4\beta_7$ binding domain. The β -strands are aligned according to Tan et al., Structure (1998) 6:793-801.

[0098] Figure 4 is a graph representing the dose effects of purified biotinylated 1.7.2 and 7.16.6 on the adhesion of human peripheral blood lymphocytes to sections of MAdCAM-expressing frozen human liver endothelium.

[0099] Figure 5 shows a two dimensional graphical representation based on the data captured in Table 7 of the diversity of MAdCAM epitopes to which the anti-MAdCAM antibodies, 1.7.2, 6.22.2, 6.34.2, 6.67.1, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2 bind. Anti-MAdCAM antibodies within the same circle show the same reactivity pattern, belong in the same epitope bin and are likely to recognize the same epitope on MAdCAM. Anti-MAdCAM antibody clones within overlapping circles are unable to bind simultaneously and

are, therefore, likely to recognize an overlapping epitope on MAdCAM. Non-integrating circles represent anti-MAdCAM antibody clones with distinct spatial epitope separation.

[0100] Figure 6 shows sandwich ELISA data with anti-MAdCAM antibodies 1.7.2 and an Alexa 488-labelled 7.16.6, showing that two antibodies that are able to detect different epitopes on MAdCAM could be used to detect soluble MAdCAM for diagnostic purposes.

[0101] Figure 7 shows the effect of an inhibitory anti-MAdCAM antibody (1 mg/kg) on the number of circulating peripheral $\alpha_4\beta_7^+$ lymphocytes, expressed as a fold increase over control IgG2a mAb or vehicle, using anti-MAdCAM mAb 7.16.6 in a cynomolgus monkey model.

DETAILED DESCRIPTION OF THE INVENTION

Definitions and General Techniques

[0102] Unless otherwise defined herein, scientific and technical terms used in connection with the present disclosure shall have the meanings that are commonly understood by those of ordinary skill in the art. Further, unless otherwise required by context, singular terms shall include pluralities and plural terms shall include the singular. Generally, nomenclatures used in connection with, and techniques of, cell and tissue culture, molecular biology, immunology, microbiology, genetics, protein and nucleic acid chemistry and hybridization described herein are those well known and commonly used in the art. The methods and techniques of the present disclosure are generally performed according to conventional methods well known in the art and as described in various general and more specific references that are cited and discussed throughout the present specification unless otherwise indicated. See, *e.g.*, Sambrook et al., *Molecular Cloning: A Laboratory Manual*, 2nd ed., Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y. (1989) and Ausubel et al., *Current Protocols in Molecular Biology*, Greene Publishing Associates (1992), and Harlow and Lane, *Antibodies: A Laboratory Manual*, Cold Spring Harbor Laboratory Press, Cold

Spring Harbor, N.Y. (1990), which are incorporated herein by reference. Enzymatic reactions and purification techniques are performed according to manufacturer's specifications, as commonly accomplished in the art or as described herein. Standard techniques are used for chemical syntheses, chemical analyses, pharmaceutical preparation, formulation, and delivery, and treatment of patients.

[0103] The following terms, unless otherwise indicated, shall be understood to have the following meanings:

[0104] The term "polypeptide" encompasses native or artificial proteins, protein fragments and polypeptide analogs of a protein sequence. A polypeptide may be monomeric or polymeric.

[0105] The term "isolated protein" or "isolated polypeptide" is a protein or polypeptide that by virtue of its origin or source of derivation (1) is not associated with naturally associated components that accompany it in its native state, (2) is free of other proteins from the same species (3) is expressed by a cell from a different species, or (4) does not occur in nature.

Thus, a polypeptide that is chemically synthesized or synthesized in a cellular system different from the cell from which it naturally originates will be "isolated" from its naturally associated components. A protein may also be rendered substantially free of naturally associated components by isolation, using protein purification techniques well known in the art.

[0106] A protein or polypeptide is "substantially pure," "substantially homogeneous" or "substantially purified" when at least about 60 to 75% of a sample exhibits a single species of polypeptide. The polypeptide or protein may be monomeric or multimeric. A substantially pure polypeptide or protein will typically comprise about 50%, 60%, 70%, 80% or 90% W/W of a protein sample, more usually about 95%, and preferably will be over 99% pure. Protein purity or homogeneity may be indicated by a number of means well known in the art, such as

polyacrylamide gel electrophoresis of a protein sample, followed by visualizing a single polypeptide band upon staining the gel with a stain well known in the art. For certain purposes, higher resolution may be provided by using HPLC or other means well known in the art for purification.

[0107] The term “polypeptide fragment” as used herein refers to a polypeptide that has an amino-terminal and/or carboxy-terminal deletion, but where the remaining amino acid sequence is identical to the corresponding positions in the naturally-occurring sequence. In some embodiments, fragments are at least 5, 6, 8 or 10 amino acids long. In other embodiments, the fragments are at least 14 amino acids long, more preferably at least 20 amino acids long, usually at least 50 amino acids long, even more preferably at least 70, 80, 90, 100, 150 or 200 amino acids long.

[0108] The term “polypeptide analog” as used herein refers to a polypeptide that comprises a segment of at least 25 amino acids that has substantial identity to a portion of an amino acid sequence and that has at least one of the following properties: (1) specific binding to MAdCAM under suitable binding conditions, (2) ability to inhibit $\alpha_4\beta_7$ integrin and/or L-selectin binding to MAdCAM, or (3) ability to reduce MAdCAM cell surface expression *in vitro* or *in vivo*. Typically, polypeptide analogs comprise a conservative amino acid substitution (or insertion or deletion) with respect to the naturally-occurring sequence. Analogs typically are at least 20 amino acids long, preferably at least 50, 60, 70, 80, 90, 100, 150 or 200 amino acids long or longer, and can often be as long as a full-length naturally-occurring polypeptide.

[0109] Preferred amino acid substitutions are those which: (1) reduce susceptibility to proteolysis, (2) reduce susceptibility to oxidation, (3) alter binding affinity for forming protein complexes, (4) alter binding affinities, or (5) confer or modify other physicochemical or functional properties of such analogs. Analogs can include various muteins of a sequence

other than the naturally-occurring peptide sequence. For example, single or multiple amino acid substitutions (preferably conservative amino acid substitutions) may be made in the naturally-occurring sequence (preferably in the portion of the polypeptide outside the domain(s) forming intermolecular contacts. A conservative amino acid substitution should not substantially change the structural characteristics of the parent sequence (*e.g.*, a replacement amino acid should not tend to break a helix that occurs in the parent sequence, or disrupt other types of secondary structure that characterizes the parent sequence). Examples of art-recognized polypeptide secondary and tertiary structures are described in *Proteins, Structures and Molecular Principles* (Creighton, Ed., W. H. Freeman and Company, New York (1984)); *Introduction to Protein Structure* (C. Branden and J. Tooze, eds., Garland Publishing, New York, N.Y. (1991)); and Thornton et al., *Nature*, 354:105 (1991), which are each incorporated herein by reference.

[0110] Non-peptide analogs are commonly used in the pharmaceutical industry as drugs with properties analogous to those of the template peptide. These types of non-peptide compound are termed “peptide mimetics” or “peptidomimetics”. Fauchere, *J. Adv. Drug Res.*, 15:29(1986); Veber and Freidinger, *TINS*, p.392(1985); and Evans et al., *J. Med. Chem.*, 30:1229(1987), which are incorporated herein by reference. Such compounds are often developed with the aid of computerized molecular modeling. Peptide mimetics that are structurally similar to therapeutically useful peptides may be used to produce an equivalent therapeutic or prophylactic effect. Generally, peptidomimetics are structurally similar to a paradigm polypeptide (*i.e.*, a polypeptide that has a desired biochemical property or pharmacological activity), such as a human antibody, but have one or more peptide linkages optionally replaced by a linkage such as: $-\text{CH}_2\text{NH}-$, $-\text{CH}_2\text{S}-$, $-\text{CH}_2-\text{CH}_2-$, $-\text{CH}=\text{CH}-$ (*cis* and *trans*), $-\text{COCH}_2-$, $-\text{CH}(\text{OH})\text{CH}_2-$, and $-\text{CH}_2\text{SO}-$, by methods well known in the art. Systematic substitution of one or more amino acids of a consensus sequence with a D-amino

acid of the same type (*e.g.*, D-lysine in place of L-lysine) may also be used to generate more stable peptides. In addition, constrained peptides comprising a consensus sequence or a substantially identical consensus sequence variation may be generated by methods known in the art (Rizo and Gierasch *Ann. Rev. Biochem.* 61:387 (1992), incorporated herein by reference); for example, by adding internal cysteine residues capable of forming intramolecular disulfide bridges which cyclize the peptide.

[0111] An “immunoglobulin” is a tetrameric molecule. In a naturally-occurring immunoglobulin, each tetramer is composed of two identical pairs of polypeptide chains, each pair having one “light” (about 25 kDa) and one “heavy” chain (about 50-70 kDa). The amino-terminal portion of each chain includes a variable region of about 100 to 110 or more amino acids primarily responsible for antigen recognition. The carboxy-terminal portion of each chain defines a constant region primarily responsible for effector function. Human light chains are classified as κ and λ light chains. Heavy chains are classified as μ , δ , γ , α , or ϵ , and define the antibody’s isotype as IgM, IgD, IgG, IgA, and IgE, respectively. Within light and heavy chains, the variable and constant regions are joined by a “J” region of about 12 or more amino acids, with the heavy chain also including a “D” region of about 10 or more amino acids. See generally, *Fundamental Immunology*, Ch. 7 (Paul, W., ed., 2nd ed. Raven Press, N.Y. (1989)) (incorporated by reference in its entirety for all purposes). The variable regions of each light/heavy chain pair form the antibody binding site such that an intact immunoglobulin has two binding sites.

[0112] Immunoglobulin chains exhibit the same general structure of relatively conserved framework regions (FR) joined by three hypervariable regions, also called complementarity determining regions or CDRs. The CDRs from the two chains of each pair are aligned by the framework regions to form an epitope-specific binding site. From N-terminus to C-terminus, both light and heavy chains comprise the domains FR1, CDR1, FR2, CDR2, FR3, CDR3 and

FR4. The assignment of amino acids to each domain is in accordance with the definitions of Kabat, *Sequences of Proteins of Immunological Interest* (National Institutes of Health, Bethesda, Md. (1987 and 1991)), or Chothia & Lesk, *J. Mol. Biol.*, 196:901-917(1987); Chothia et al., *Nature*, 342:878-883(1989), each of which is incorporated herein by reference in their entirety.

[0113] An “antibody” refers to an intact immunoglobulin or to an antigen-binding portion thereof that competes with the intact antibody for specific binding. In some embodiments, an antibody is an antigen-binding portion thereof. Antigen-binding portions may be produced by recombinant DNA techniques or by enzymatic or chemical cleavage of intact antibodies. Antigen-binding portions include, *inter alia*, Fab, Fab', F(ab')₂, Fv, dAb, and complementarity determining region (CDR) fragments, single-chain antibodies (scFv), chimeric antibodies, diabodies and polypeptides that contain at least a portion of an immunoglobulin that is sufficient to confer specific antigen binding to the polypeptide. A Fab fragment is a monovalent fragment consisting of the VL, VH, CL and CH1 domains; a F(ab)₂ fragment is a bivalent fragment comprising two Fab fragments linked by a disulfide bridge at the hinge region; a Fd fragment consists of the VH and CH1 domains; an Fv fragment consists of the VL and VH domains of a single arm of an antibody; and a dAb fragment (Ward et al., *Nature*, 341:544-546(1989)) consists of a VH domain.

[0114] As used herein, an antibody that is referred to as, *e.g.*, 1.7.2, 1.8.2, 6.14.2, 6.34.2, 6.67.1, 6.77.2, 7.16.6, 7.20.5, 7.26.4, 9.8.2 or X481.2 is a monoclonal antibody that is produced by the hybridoma of the same name. For example, antibody 1.7.2 is produced by hybridoma 1.7.2. An antibody that is referred to as 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod, 7.26.4-mod, or X481.2 is a monoclonal antibody whose sequence has been modified from its corresponding parent by site-directed mutagenesis.

[0115] A single-chain antibody (scFv) is an antibody in which VL and VH regions are paired to form a monovalent molecule via a synthetic linker that enables them to be made as a single protein chain (Bird et al., *Science*, 242:423-426 (1988) and Huston et al., *Proc. Natl. Acad. Sci. USA*, 85:5879-5883 (1988)). Diabodies are bivalent, bispecific antibodies in which VH and 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) and Poljak, R. J., et al., *Structure*, 2:1121-1123 (1994)). One or more CDRs from an antibody of the disclosure may be incorporated into a molecule either covalently or noncovalently to make it an immunoadhesin that specifically binds to MAdCAM. An immunoadhesin may incorporate the CDR(s) as part of a larger polypeptide chain, may covalently link the CDR(s) to another polypeptide chain, or may incorporate the CDR(s) noncovalently. The CDRs permit the immunoadhesin to specifically bind to a particular antigen of interest.

[0116] An antibody may have one or more binding sites. If there is more than one binding site, the binding sites may be identical to one another or may be different. For instance, a naturally-occurring immunoglobulin has two identical binding sites, a single-chain antibody or Fab fragment has one binding site, while a “bispecific” or “bifunctional” antibody (diabody) has two different binding sites.

[0117] An “isolated antibody” is an antibody that (1) is not associated with naturally-associated components, including other naturally-associated antibodies, that accompany it in its native state, (2) is free of other proteins from the same species, (3) is expressed by a cell from a different species, or (4) does not occur in nature. Examples of isolated antibodies include an anti-MAdCAM antibody that has been affinity purified using MAdCAM, an anti-

MAdCAM antibody that has been produced by a hybridoma or other cell line *in vitro*, and a human anti-MAdCAM antibody derived from a transgenic mammal or plant.

[0118] As used herein, the term “human antibody” means an antibody in which the variable and constant region sequences are human sequences. The term encompasses antibodies with sequences derived from human genes, but which have been changed, *e.g.*, to decrease possible immunogenicity, increase affinity, eliminate cysteines or glycosylation sites that might cause undesirable folding, etc. The term encompasses such antibodies produced recombinantly in non-human cells which might impart glycosylation not typical of human cells. The term also encompasses antibodies which have been raised in a transgenic mouse which comprises some or all of the human immunoglobulin heavy and light chain loci.

[0119] In one aspect, the disclosure provides a humanized antibody. In some embodiments, the humanized antibody is an antibody that is derived from a non-human species, in which certain amino acids in the framework and constant domains of the heavy and light chains have been mutated so as to avoid or abrogate an immune response in humans. In some embodiments, a humanized antibody may be produced by fusing the constant domains from a human antibody to the variable domains of a non-human species. Examples of how to make humanized antibodies may be found in United States Patent Nos. 6,054,297, 5,886,152 and 5,877,293. In some embodiments, a humanized anti-MAdCAM antibody of the disclosure comprises the amino acid sequence of one or more framework regions of one or more human anti-MAdCAM antibodies of the disclosure.

[0120] In another aspect, the disclosure provides a “chimeric antibody”. In some embodiments the chimeric antibody refers to an antibody that contains one or more regions from one antibody and one or more regions from one or more other antibodies. In a preferred embodiment, one or more of the CDRs are derived from a human anti-MAdCAM antibody of the disclosure. In a more preferred embodiment, all of the CDRs are derived from a human

anti-MAdCAM antibody of the disclosure. In another preferred embodiment, the CDRs from more than one human anti-MAdCAM antibody of the disclosure are mixed and matched in a chimeric antibody. For instance, a chimeric antibody may comprise a CDR1 from the light chain of a first human anti-MAdCAM antibody may be combined with CDR2 and CDR3 from the light chain of a second human anti-MAdCAM antibody, and the CDRs from the heavy chain may be derived from a third anti-MAdCAM antibody. Further, the framework regions may be derived from one of the same anti-MAdCAM antibodies, from one or more different antibodies, such as a human antibody, or from a humanized antibody.

[0121] A “neutralizing antibody,” “an inhibitory antibody” or antagonist antibody is an antibody that inhibits the binding of $\alpha_4\beta_7$ or $\alpha_4\beta_7$ -expressing cells, or any other cognate ligand or cognate ligand-expressing cells, to MAdCAM by at least about 20%. In a preferred embodiment, the antibody reduces and/or inhibits the binding of $\alpha_4\beta_7$ integrin or $\alpha_4\beta_7$ -expressing cells to MAdCAM by at least 40%, more preferably by 60%, even more preferably by 80%, 85%, 90%, 95% or 100%. The binding reduction may be measured by any means known to one of ordinary skill in the art, for example, as measured in an *in vitro* competitive binding assay. An example of measuring the reduction in binding of $\alpha_4\beta_7$ -expressing cells to MAdCAM is presented in Example I.

[0122] Fragments or analogs of antibodies can be readily prepared by those of ordinary skill in the art following the teachings of this specification. Preferred amino- and carboxy-termini of fragments or analogs occur near boundaries of functional domains. Structural and functional domains can be identified by comparison of the nucleotide and/or amino acid sequence data to public or proprietary sequence databases. Preferably, computerized comparison methods are used to identify sequence motifs or predicted protein conformation domains that occur in other proteins of known structure and/or function. Methods to identify

protein sequences that fold into a known three-dimensional structure are known (Bowie et al., *Science*, 253:164 (1991)).

[0123] The term “surface plasmon resonance”, as used herein, refers to an optical phenomenon that allows for the analysis of real-time biospecific interactions by detection of alterations in protein concentrations within a biosensor matrix, for example using the BIAcore system (Pharmacia Biosensor AB, Uppsala, Sweden and Piscataway, N.J.). For further descriptions, see Jonsson, U., et al., *Ann. Biol. Clin.*, 51:19-26 (1993); Jonsson, U., et al., *Biotechniques*, 11:620-627 (1991); Johnsson, B., et al., *J. Mol. Recognit.*, 8:125-131 (1995); and Johnsson, B., et al., *Anal. Biochem.*, 198:268-277 (1991).

[0124] The term “ k_{off} ” refers to the off rate constant for dissociation of an antibody from the antibody/antigen complex.

[0125] The term “ K_d ” refers to the dissociation constant of a particular antibody-antigen interaction. An antibody is said to bind an antigen when the dissociation constant is $\leq 1 \mu\text{M}$, preferably $\leq 100 \text{ nM}$ and most preferably $\leq 10 \text{ nM}$.

[0126] The term “epitope” includes any protein determinant capable of specific binding to an immunoglobulin or T-cell receptor or otherwise interacting with a molecule. Epitopic determinants usually consist of chemically active surface groupings of molecules such as amino acids or carbohydrate side chains and usually have specific three dimensional structural characteristics, as well as specific charge characteristics. An epitope may be “linear” or “conformational.” In a linear epitope, all of the points of interaction between the protein and the interacting molecule (such as an antibody) occur linearly along the primary amino acid sequence of the protein. In a conformational epitope, the points of interaction occur across amino acid residues on the protein that are separated from one another.

[0127] As used herein, the twenty conventional amino acids and their abbreviations follow conventional usage. See *Immunology - A Synthesis* (2nd Edition, E.S. Golub and D.R. Gren,

Eds., Sinauer Associates, Sunderland, Mass. (1991)), which is incorporated herein by reference. Stereoisomers (*e.g.*, D-amino acids) of the twenty conventional amino acids, unnatural amino acids such as α -, α -disubstituted amino acids, N-alkyl amino acids, lactic acid, and other unconventional amino acids may also be suitable components for polypeptides of the present disclosure. Examples of unconventional amino acids include: 4-hydroxyproline, γ -carboxyglutamate, ϵ -N,N,N-trimethyllysine, ϵ -N-acetyllysine, O-phosphoserine, N-acetylserine, N-formylmethionine, 3-methylhistidine, 5-hydroxylysine, s-N-methylarginine, and other similar amino acids and imino acids (*e.g.*, 4-hydroxyproline). In the polypeptide notation used herein, the lefthand direction is the amino terminal direction and the righthand direction is the carboxy-terminal direction, in accordance with standard usage and convention.

[0128] The term “polynucleotide” as referred to herein means a polymeric form of nucleotides of at least 10 bases in length, either ribonucleotides or deoxynucleotides or a modified form of either type of nucleotide. The term includes single and double stranded forms of DNA.

[0129] The term “isolated polynucleotide” as used herein shall mean a polynucleotide of genomic, cDNA, or synthetic origin or some combination thereof, which by virtue of its origin the “isolated polynucleotide” (1) is not associated with all or a portion of a polynucleotide in which the “isolated polynucleotide” is found in nature, (2) is operably linked to a polynucleotide which it is not linked to in nature, or (3) does not occur in nature as part of a larger sequence.

[0130] The term “oligonucleotide” referred to herein includes naturally occurring, and modified nucleotides linked together by naturally occurring, and non-naturally occurring oligonucleotide linkages. Oligonucleotides are a polynucleotide subset generally comprising a length of 200 bases or fewer. Preferably oligonucleotides are 10 to 60 bases in length and

most preferably 12, 13, 14, 15, 16, 17, 18, 19, or 20 to 40 bases in length. Oligonucleotides are usually single stranded, *e.g.*, for probes; although oligonucleotides may be double stranded, *e.g.*, for use in the construction of a gene mutant. Oligonucleotides of the disclosure can be either sense or antisense oligonucleotides.

[0131] The term “naturally occurring nucleotides” referred to herein includes deoxyribonucleotides and ribonucleotides. The term “modified nucleotides” referred to herein includes nucleotides with modified or substituted sugar groups and the like. The term “oligonucleotide linkages” referred to herein includes oligonucleotides linkages such as phosphorothioate, phosphorodithioate, phosphoroselenoate, phosphorodiselenoate, phosphoroanilothioate, phosphoraniladate, phosphoroamidate, and the like. See, *e.g.*, LaPlanche et al., *Nucl. Acids Res.* 14:9081 (1986); Stec et al., *J. Am. Chem. Soc.* 106:6077(1984); Stein et al., *Nucl. Acids Res.*, 16:3209(1988); Zon et al., *Anti-Cancer Drug Design* 6:539(1991); Zon et al., *Oligonucleotides and Analogues: A Practical Approach*, pp. 87-108 (F. Eckstein, Ed., Oxford University Press, Oxford England(1991)); Stec et al., U.S. Patent No. 5,151,510; Uhlmann and Peyman, *Chemical Reviews*, 90:543(1990), the disclosures of which are hereby incorporated by reference. An oligonucleotide can include a label for detection, if desired.

[0132] “Operably linked” sequences include both expression control sequences that are contiguous with the gene of interest and expression control sequences that act in *trans* or at a distance to control the gene of interest. The term “expression control sequence” as used herein refers to polynucleotide sequences which are necessary to effect the expression and processing of coding sequences to which they are ligated. Expression control sequences include appropriate transcription initiation, termination, promoter and enhancer sequences; efficient RNA processing signals such as splicing and polyadenylation signals; sequences that stabilize cytoplasmic mRNA; sequences that enhance translation efficiency (*i.e.*, Kozak

consensus sequence); sequences that enhance protein stability; and when desired, sequences that enhance protein secretion. The nature of such control sequences differs depending upon the host organism; in prokaryotes, such control sequences generally include promoter, ribosomal binding site, and transcription termination sequence; in eukaryotes, generally, such control sequences include promoters and transcription termination sequence. The term “control sequences” is intended to include, at a minimum, all components whose presence is essential for expression and processing, and can also include additional components whose presence is advantageous, for example, leader sequences and fusion partner sequences.

[0133] The term “vector”, as used herein, is intended to refer to a nucleic acid molecule capable of transporting another nucleic acid to which it has been linked. One type of vector is a “plasmid”, which refers to a circular double stranded DNA loop into which additional DNA segments may be ligated. Another type of vector is a viral vector, wherein additional DNA segments may be ligated into the viral genome. Certain vectors are capable of autonomous replication in a host cell into which they are introduced (*e.g.*, bacterial vectors having a bacterial origin of replication and episomal mammalian vectors). Other vectors (*e.g.*, non-episomal mammalian vectors) can be integrated into the genome of a host cell upon introduction into the host cell, and thereby are replicated along with the host genome. Moreover, certain vectors are capable of directing the expression of genes to which they are operatively linked. Such vectors are referred to herein as “recombinant expression vectors” (or simply, “expression vectors”). In general, expression vectors of utility in recombinant DNA techniques are often in the form of plasmids. In the present specification, “plasmid” and “vector” may be used interchangeably as the plasmid is the most commonly used form of vector. However, the disclosure is intended to include such other forms of expression vectors, such as viral vectors (*e.g.*, replication defective retroviruses, adenoviruses and adeno-associated viruses), which serve equivalent functions.

[0134] The term “recombinant host cell” (or simply “host cell”), as used herein, is intended to refer to a cell into which a recombinant expression vector has been introduced. It should be understood that such terms are intended to refer not only to the particular subject cell but to the progeny of such a cell. Because certain modifications may occur in succeeding generations due to either mutation or environmental influences, such progeny may not, in fact, be identical to the parent cell, but are still included within the scope of the term “host cell” as used herein.

[0135] The term “selectively hybridize” referred to herein means to detectably and specifically bind. Polynucleotides, oligonucleotides and fragments thereof in accordance with the disclosure selectively hybridize to nucleic acid strands under hybridization and wash conditions that minimize appreciable amounts of detectable binding to nonspecific nucleic acids. “High stringency” or “highly stringent” conditions can be used to achieve selective hybridization conditions as known in the art and discussed herein. An example of “high stringency” or “highly stringent” conditions is a method of incubating a polynucleotide with another polynucleotide, wherein one polynucleotide may be affixed to a solid surface such as a membrane, in a hybridization buffer of 6X SSPE or SSC, 50% formamide, 5X Denhardt’s reagent, 0.5% SDS, 100 µg/ml denatured, fragmented salmon sperm DNA at a hybridization temperature of 42°C for 12-16 hours, followed by twice washing at 55°C using a wash buffer of 1X SSC, 0.5% SDS. See also Sambrook et al., *supra*, pp. 9.50-9.55.

[0136] The term “percent sequence identity” in the context of nucleotide sequences refers to the residues in two sequences which are the same when aligned for maximum correspondence. The length of sequence identity comparison may be over a stretch of at least about nine nucleotides, usually at least about 18 nucleotides, more usually at least about 24 nucleotides, typically at least about 28 nucleotides, more typically at least about 32 nucleotides, and preferably at least about 36, 48 or more nucleotides. There are a number of

different algorithms known in the art which can be used to measure nucleotide sequence identity. For instance, polynucleotide sequences can be compared using FASTA, Gap or Bestfit, which are programs in Wisconsin Package Version 10.3, Accelrys, San Diego, CA. FASTA, which includes, *e.g.*, the programs FASTA2 and FASTA3, provides alignments and percent sequence identity of the regions of the best overlap between the query and search sequences (Pearson, *Methods Enzymol.*, 183: 63-98 (1990); Pearson, *Methods Mol. Biol.*, 132: 185-219 (2000); Pearson, *Methods Enzymol.*, 266: 227-258 (1996); Pearson, *J. Mol. Biol.*, 276: 71-84 (1998); herein incorporated by reference). Unless otherwise specified, default parameters for a particular program or algorithm are used. For instance, percent sequence identity between nucleotide sequences can be determined using FASTA with its default parameters (a word size of 6 and the NOPAM factor for the scoring matrix) or using Gap with its default parameters as provided in Wisconsin Package Version 10.3, herein incorporated by reference.

[0137] A reference to a nucleotide sequence encompasses its complement unless otherwise specified. Thus, a reference to a nucleic acid molecule having a particular sequence should be understood to encompass its complementary strand, with its complementary sequence.

[0138] In the molecular biology art, researchers use the terms “percent sequence identity”, “percent sequence similarity” and “percent sequence homology” interchangeably. In this application, these terms shall have the same meaning with respect to nucleotide sequences only.

[0139] The term “substantial similarity” or “substantial sequence similarity,” when referring to a nucleic acid or fragment thereof, indicates that, when optimally aligned with appropriate nucleotide insertions or deletions with another nucleic acid (or its complementary strand), there is nucleotide sequence identity in at least about 85%, preferably at least about 90%, and more preferably at least about 95%, 96%, 97%, 98% or 99% of the nucleotide

bases, as measured by any well-known algorithm of sequence identity, such as FASTA, BLAST or Gap, as discussed above.

[0140] As applied to polypeptides, the term “substantial identity” means that two peptide sequences, when optimally aligned, such as by the programs GAP or BESTFIT using default gap weights, share at least 75% or 80% sequence identity, preferably at least 90% or 95% sequence identity, even more preferably at least 98% or 99% sequence identity. Preferably, residue positions that are not identical differ by conservative amino acid substitutions. A “conservative amino acid substitution” is one in which an amino acid residue is substituted by another amino acid residue having a side chain (R group) with similar chemical properties (*e.g.*, charge or hydrophobicity). In general, a conservative amino acid substitution will not substantially change the functional properties of a protein. In cases where two or more amino acid sequences differ from each other by conservative substitutions, the percent sequence identity or degree of similarity may be adjusted upwards to correct for the conservative nature of the substitution. Means for making this adjustment are well-known to those of skill in the art. See, *e.g.*, Pearson, *Methods Mol. Biol.*, 24: 307-31 (1994), herein incorporated by reference. Examples of groups of amino acids that have side chains with similar chemical properties include 1) aliphatic side chains: glycine, alanine, valine, leucine and isoleucine; 2) aliphatic-hydroxyl side chains: serine and threonine; 3) amide-containing side chains: asparagine and glutamine; 4) aromatic side chains: phenylalanine, tyrosine, and tryptophan; 5) basic side chains: lysine, arginine, and histidine; and 6) sulfur-containing side chains are cysteine and methionine. Preferred conservative amino acids substitution groups are: valine-leucine-isoleucine, phenylalanine-tyrosine, lysine-arginine, alanine-valine, glutamate-aspartate, and asparagine-glutamine.

[0141] Alternatively, a conservative replacement is any change having a positive value in the PAM250 log-likelihood matrix disclosed in Gonnet et al., *Science*, 256: 1443-45 (1992),

herein incorporated by reference. A “moderately conservative” replacement is any change having a nonnegative value in the PAM250 log-likelihood matrix.

[0142] Sequence similarity for polypeptides is typically measured using sequence analysis software. Protein analysis software matches similar sequences using measures of similarity assigned to various substitutions, deletions and other modifications, including conservative amino acid substitutions. For instance, GCG contains programs such as “Gap” and “Bestfit” which can be used with default parameters to determine sequence homology or sequence identity between closely related polypeptides, such as homologous polypeptides from different species of organisms or between a wild type protein and a mutein thereof. See, *e.g.*, Wisconsin package Version 10.3. Polypeptide sequences also can be compared using FASTA using default or recommended parameters, a program in Wisconsin package Version 10.3. FASTA (*e.g.*, FASTA2 and FASTA3) provides alignments and percent sequence identity of the regions of the best overlap between the query and search sequences (Pearson (1990); Pearson (2000)). Another preferred algorithm when comparing a sequence of the disclosure to a database containing a large number of sequences from different organisms is the computer program BLAST, especially blastp or tblastn, using default parameters. See, *e.g.*, Altschul et al., *J. Mol. Biol.* 215: 403-410 (1990); Altschul et al., *Nucleic Acids Res.* 25:3389-402 (1997); herein incorporated by reference.

[0143] The length of polypeptide sequences compared for homology will generally be at least about 16 amino acid residues, usually at least about 20 residues, more usually at least about 24 residues, typically at least about 28 residues, and preferably more than about 35 residues. When searching a database containing sequences from a large number of different organisms, it is preferable to compare amino acid sequences.

[0144] As used herein, the terms “label” or “labeled” refers to incorporation of another molecule in the antibody. In one embodiment, the label is a detectable marker, *e.g.*,

incorporation of a radiolabeled amino acid or attachment to a polypeptide of biotinyl moieties that can be detected by marked avidin (*e.g.*, streptavidin containing a fluorescent marker or enzymatic activity that can be detected by optical or colorimetric methods). In another embodiment, the label or marker can be therapeutic, *e.g.*, a drug conjugate or toxin. Various methods of labeling polypeptides and glycoproteins are known in the art and may be used.

Examples of labels for polypeptides include, but are not limited to, the following:

radioisotopes or radionuclides (*e.g.*, ^3H , ^{14}C , ^{15}N , ^{35}S , ^{90}Y , ^{99}Tc , ^{111}In , ^{125}I , ^{131}I), fluorescent labels (*e.g.*, FITC, rhodamine, lanthanide phosphors), enzymatic labels (*e.g.*, horseradish peroxidase, β -galactosidase, luciferase, alkaline phosphatase), chemiluminescent markers, biotinyl groups, predetermined polypeptide epitopes recognized by a secondary reporter (*e.g.*, leucine zipper pair sequences, binding sites for secondary antibodies, metal binding domains, epitope tags), magnetic agents, such as gadolinium chelates, toxins such as pertussis toxin, taxol, cytochalasin B, gramicidin D, ethidium bromide, emetine, mitomycin, etoposide, tenoposide, vincristine, vinblastine, colchicin, doxorubicin, daunorubicin, dihydroxy anthracin dione, mitoxantrone, mithramycin, actinomycin D, 1-dehydrotestosterone, glucocorticoids, procaine, tetracaine, lidocaine, propranolol, and puromycin and analogs or homologs thereof. In some embodiments, labels are attached by spacer arms of various lengths to reduce potential steric hindrance.

[0145] The term “agent” is used herein to denote a chemical compound, a mixture of chemical compounds, a biological macromolecule, or an extract made from biological materials. The term “pharmaceutical agent or drug” as used herein refers to a chemical compound or composition capable of inducing a desired therapeutic effect when properly administered to a patient. Other chemistry terms herein are used according to conventional usage in the art, as exemplified by *The McGraw-Hill Dictionary of Chemical Terms* (Parker, S., Ed., McGraw-Hill, San Francisco (1985)), incorporated herein by reference).

[0146] The term “anti-inflammatory” or “immuno-modulatory” agent is used herein to refer to agents that have the functional property of inhibiting inflammation, including inflammatory disease in a subject, including in a human. In various embodiments of this disclosure, the inflammatory disease may be, but is not limited to inflammatory diseases of the gastrointestinal tract including Crohn’s disease, ulcerative colitis, diverticula disease, gastritis, liver disease, primary biliary sclerosis, sclerosing cholangitis. Inflammatory diseases also include but are not limited to abdominal disease (including peritonitis, appendicitis, biliary tract disease), acute transverse myelitis, allergic dermatitis (including allergic skin, allergic eczema, skin atopy, atopic eczema, atopic dermatitis, cutaneous inflammation, inflammatory eczema, inflammatory dermatitis, flea skin, miliary dermatitis, miliary eczema, house dust mite skin), ankylosing spondylitis (Reiters syndrome), asthma, airway inflammation, atherosclerosis, arteriosclerosis, biliary atresia, bladder inflammation, breast cancer, cardiovascular inflammation (including vasculitis, rheumatoid nail-fold infarcts, leg ulcers, polymyositis, chronic vascular inflammation, pericarditis, chronic obstructive pulmonary disease), chronic pancreatitis, perineural inflammation, colitis (including amoebic colitis, infective colitis, bacterial colitis, Crohn’s colitis, ischemic colitis, ulcerative colitis, idiopathic proctocolitis, inflammatory bowel disease, pseudomembranous colitis), collagen vascular disorders (rheumatoid arthritis, SLE, progressive systemic sclerosis, mixed connective tissue disease, diabetes mellitus), Crohn’s disease (regional enteritis, granulomatous ileitis, ileocolitis, digestive system inflammation), demyelinating disease (including myelitis, multiple sclerosis, disseminated sclerosis, acute disseminated encephalomyelitis, perivenous demyelination, vitamin B12 deficiency, Guillain-Barre syndrome, MS-associated retrovirus), dermatomyositis, diverticulitis, exudative diarrhea, gastritis, granulomatous hepatitis, granulomatous inflammation, cholecystitis, insulin-dependent diabetes mellitus, liver inflammatory diseases (liver fibrosis primary biliary

cirrhosis, hepatitis, sclerosing cholangitis), lung inflammation (idiopathic pulmonary fibrosis, eosinophilic granuloma of the lung, pulmonary histiocytosis X, peribronchiolar inflammation, acute bronchitis), lymphogranuloma venereum, malignant melanoma, mouth/tooth disease (including gingivitis, periodontal disease), mucositis, musculoskeletal system inflammation (myositis), nonalcoholic steatohepatitis (nonalcoholic fatty liver disease), ocular & orbital inflammation (including uveitis, optic neuritis, peripheral rheumatoid ulceration, peripheral corneal inflammation,), osteoarthritis, osteomyelitis, pharyngeal inflammation, polyarthritis, proctitis, psoriasis, radiation injury, sarcoidosis, sickle cell necropathy, superficial thrombophlebitis, systemic inflammatory response syndrome, thyroiditis, systemic lupus erythematosus, graft versus host disease, acute burn injury, Behçet's syndrome, Sjögren's syndrome.

[0147] The terms patient and subject include human and veterinary subjects.

Human Anti-MAdCAM Antibodies and Characterization Thereof

[0148] In one embodiment, the disclosure provides anti-MAdCAM antibodies comprising human CDR sequences. In a preferred embodiment, the disclosure provides human anti-MAdCAM antibodies. In some embodiments, human anti-MAdCAM antibodies are produced by immunizing a non-human transgenic animal, *e.g.*, a rodent, whose genome comprises human immunoglobulin genes so that the transgenic animal produces human antibodies. In some embodiments, the disclosure provides an anti-MAdCAM antibody that does not bind complement.

[0149] In a preferred embodiment, the anti-MAdCAM antibody is 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another preferred embodiment, the anti-MAdCAM antibody comprises a light chain comprising an amino acid sequence selected from SEQ ID NO: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 54, 58, 62, 66, , 68 or 150 (with

or without the signal sequence) or the variable region of any one of said amino acid sequences, or one or more CDRs from these amino acid sequences. In another preferred embodiment, the anti-MAdCAM antibody comprises a heavy chain comprising an amino acid sequence selected from SEQ ID NO: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 52, 56, 60, 64 or 148 (with or without the signal sequence) or the amino acid sequence of the variable region, or of one or more CDRs from said amino acid sequences. Also included in the disclosure are human anti-MAdCAM antibodies comprising the amino acid sequence from the beginning of the CDR1 to the end of the CDR3 of any one of the above-mentioned sequences. The disclosure further provides an anti-MAdCAM antibody comprising one or more FR regions of any of the above-mentioned sequences.

[0150] The disclosure further provides an anti-MAdCAM antibody comprising one of the afore-mentioned amino acid sequences in which one or more modifications have been made. In some embodiments, cysteines in the antibody, which may be chemically reactive, are substituted with another residue, such as, without limitation, alanine or serine. In one embodiment, the substitution is at a non-canonical cysteine. The substitution can be made in a CDR or framework region of a variable domain or in the constant domain of an antibody. In some embodiments, the cysteine is canonical.

[0151] In some embodiments, an amino acid substitution is made to eliminate potential proteolytic sites in the antibody. Such sites may occur in a CDR or framework region of a variable domain or in the constant domain of an antibody. Substitution of cysteine residues and removal of proteolytic sites may decrease the heterogeneity in the antibody product. In some embodiments, asparagine-glycine pairs, which form potential deamidation sites, are eliminated by altering one or both of the residues. In some embodiments, an amino acid substitution is made to add or to remove potential glycosylation sites in the variable region of an antibody of the disclosure.

[0152] In some embodiments, the C-terminal lysine of the heavy chain of the anti-MAdCAM antibody of the disclosure is cleaved. In various embodiments of the disclosure, the heavy and light chains of the anti-MAdCAM antibodies may optionally include a signal sequence.

[0153] In one aspect, the disclosure provides twelve inhibitory human anti-MAdCAM monoclonal antibodies and the hybridoma cell lines that produce them. Table 1 lists the sequence identifiers (SEQ ID NO:) of the nucleic acids encoding the full-length heavy and light chains (including signal sequence), and the corresponding full-length deduced amino acid sequences.

Table 1

HUMAN ANTI-MAdCAM ANTIBODIES				
Monoclonal Antibody	SEQUENCE IDENTIFIER (SEQ ID NO:)			
	Full Length			
	Heavy		Light	
	DNA	Protein	DNA	Protein
1.7.2	1	2	3	4
1.8.2	5	6	7	8
6.14.2	9	10	11	12
6.22.2	13	14	15	16
6.34.2	17	18	19	20
6.67.1	21	22	23	24
6.73.2	25	26	27	28
6.77.1	29	30	31	32
7.16.6	33	34	35	36
7.20.5	37	38	39	40
7.26.4	41	42	43	44
9.8.2	45	46	47	48
X481.2	149	148	35	150

[0154] In another aspect, the disclosure provides a modified version of certain of the above-identified human anti-MAdCAM monoclonal antibodies. Table 2 lists the sequence identifiers for the DNA and protein sequences of the modified antibodies.

Table 2

HUMAN ANTI-MAdCAM ANTIBODIES				
Modified Monoclonal Antibody	SEQUENCE IDENTIFIER (SEQ ID NO:)			
	Full Length			
	Heavy		Light	
	DNA	Protein	DNA	Protein
6.22.2-mod	51	52	53	54
6.34.2-mod	55	56	57	58
6.67.1-mod	59	60	61	62
6.77.1-mod	63	64	65	66
7.26.4-mod	41	42	67	68
X481.2	149	148	35	150

Class and Subclass of anti-MAdCAM Antibodies

[0155] The antibody may be an IgG, an IgM, an IgE, an IgA or an IgD molecule. In a preferred embodiment, the antibody is an IgG class and is an IgG₁, IgG₂, IgG₃ or IgG₄ subclass. In a more preferred embodiment, the anti-MAdCAM antibody is subclass IgG₂ or IgG₄. In another preferred embodiment, the anti-MAdCAM antibody is the same class and subclass as antibody 1.7.2, 1.8.2, 7.16.6, 7.20.5, 7.26.4, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod which is IgG₂, or 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1 or 9.8.2, which is IgG₄.

[0156] The class and subclass of anti-MAdCAM antibodies may be determined by any method known in the art. In general, the class and subclass of an antibody may be determined using antibodies that are specific for a particular class and subclass of antibody. Such antibodies are available commercially. ELISA, Western Blot as well as other techniques can determine the class and subclass. Alternatively, the class and subclass may be

determined by sequencing all or a portion of the constant domains of the heavy and/or light chains of the antibodies, comparing their amino acid sequences to the known amino acid sequences of various classes and subclasses of immunoglobulins, and determining the class and subclass of the antibodies as the class showing the highest sequence identity.

Species and Molecule Selectivity

[0157] In another aspect of the disclosure, the anti-MAdCAM antibody demonstrates both species and molecule selectivity. In one embodiment, the anti-MAdCAM antibody binds to human, cynomolgus or dog MAdCAM. In some embodiments, the anti-MAdCAM antibody does not bind to a New World monkey species such as a marmoset. Following the teachings of the specification, one may determine the species selectivity for the anti-MAdCAM antibody using methods well known in the art. For instance, one may determine species selectivity using Western blot, FACS, ELISA or immunohistochemistry. In a preferred embodiment, one may determine the species selectivity using immunohistochemistry.

[0158] In some embodiments, an anti-MAdCAM antibody that specifically binds MAdCAM has selectivity for MAdCAM over VCAM, fibronectin or any other antigen that is at least 10 fold, preferably at least 20, 30, 40, 50, 60, 70, 80 or 90 fold, most preferably at least 100 fold. In a preferred embodiment, the anti-MAdCAM antibody does not exhibit any appreciable binding to VCAM, fibronectin or any other antigen other than MAdCAM. One may determine the selectivity of the anti-MAdCAM antibody for MAdCAM using methods well known in the art following the teachings of the specification. For instance, one may determine the selectivity using Western blot, FACS, ELISA, or immunohistochemistry.

Binding Affinity of anti-MAdCAM antibodies to MAdCAM

[0159] In another aspect of the disclosure, the anti-MAdCAM antibodies specifically bind to MAdCAM with high affinity. In one embodiment, the anti-MAdCAM antibody specifically binds to MAdCAM with a K_d of 3×10^{-8} M or less, as measured by surface

plasmon resonance, such as BIAcore. In more preferred embodiments, the antibody specifically binds to MAdCAM with a K_d of 1×10^{-8} or less or 1×10^{-9} M or less. In an even more preferred embodiment, the antibody specifically binds to MAdCAM with a K_d of 1×10^{-10} M or less. In other preferred embodiments, an antibody of the disclosure specifically binds to MAdCAM with a K_d of 2.66×10^{-10} M or less, 2.35×10^{-11} M or less or 9×10^{-12} M or less. In another preferred embodiment, the antibody specifically binds to MAdCAM with a K_d of 1×10^{-11} M or less. In another preferred embodiment, the antibody specifically binds to MAdCAM with substantially the same K_d as an antibody selected from 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. An antibody with “substantially the same K_d ” as a reference antibody has a K_d that is ± 100 pM, preferably ± 50 pM, more preferably ± 20 pM, still more preferably ± 10 pM, ± 5 pM or ± 2 pM, compared to the K_d of the reference antibody in the same experiment. In another preferred embodiment, the antibody binds to MAdCAM with substantially the same K_d as an antibody that comprises one or more variable domains or one or more CDRs from an antibody selected from 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In still another preferred embodiment, the antibody binds to MAdCAM with substantially the same K_d as an antibody that comprises one of the amino acid sequences selected from SEQ ID NOS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 52, 54, 56, 58, 62, 64, 66, 68, 148 or 450 (with or without the signal sequence), or the variable domain thereof. In another preferred embodiment, the antibody binds to MAdCAM with substantially the same K_d as an antibody that comprises one or more CDRs from an antibody that comprises an amino acid sequence selected from SEQ ID NOS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 52, 54, 56, 58, 62, 64, 66, 68, 148 or 450.

[0160] The binding affinity of an anti-MAdCAM antibody to MAdCAM may be determined by any method known in the art. In one embodiment, the binding affinity can be measured by competitive ELISAs, RIAs or surface plasmon resonance, such as BIAcore. In a more preferred embodiment, the binding affinity is measured by surface plasmon resonance. In an even more preferred embodiment, the binding affinity and dissociation rate is measured using a BIAcore. An example of determining binding affinity is described below in Example II.

Half-Life of Anti-MAdCAM Antibodies

[0161] According to another object of the disclosure, the anti-MAdCAM antibody has a half-life of at least one day *in vitro* or *in vivo*. In a preferred embodiment, the antibody or portion thereof has a half-life of at least three days. In a more preferred embodiment, the antibody or portion thereof has a half-life of four days or longer. In another embodiment, the antibody or portion thereof has a half-life of eight days or longer. In another embodiment, the antibody or antigen-binding portion thereof is derivatized or modified such that it has a longer half-life, as discussed below. In another preferred embodiment, the antibody may contain point mutations to increase serum half life, such as described WO 00/09560, published February 24, 2000.

[0162] The antibody half-life may be measured by any means known to one having ordinary skill in the art. For instance, the antibody half life may be measured by Western blot, ELISA or RIA over an appropriate period of time. The antibody half-life may be measured in any appropriate animal, such as a primate, *e.g.*, cynomolgus monkey, or a human.

Identification of MAdCAM Epitopes Recognized by Anti-MAdCAM Antibody

[0163] The disclosure also provides a human anti-MAdCAM antibody that binds the same antigen or epitope as a human anti-MAdCAM antibody provided herein. Further, the

disclosure provides a human anti-MAdCAM antibody that competes or cross-competes with a human anti-MAdCAM antibody. In a preferred embodiment, the human anti-MAdCAM antibody is 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another preferred embodiment, the human anti-MAdCAM antibody comprises one or more variable domains or one or more CDRs from an antibody selected from 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In still another preferred embodiment, the human anti-MAdCAM antibody comprises one of the amino acid sequences selected from SEQ ID NOS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46 48, 52, 54, 56, 58, 62, 64, 66, 68, 148 or 150 (with or without the signal sequence), or a variable domain thereof. In another preferred embodiment, the human anti-MAdCAM antibody comprises one or more CDRs from an antibody that comprises one of the amino acid sequences selected from SEQ ID NOS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46 48, 52, 54, 56, 58, 62, 64, 66, 68, 148 or 150. In a highly preferred embodiment, the anti-MAdCAM antibody is another human antibody.

[0164] One may determine whether an anti-MAdCAM antibody binds to the same antigen as another anti-MAdCAM antibody using a variety of methods known in the art. For instance, one can use a known anti-MAdCAM antibody to capture the antigen, elute the antigen from the anti-MAdCAM antibody, and then determine whether the test antibody will bind to the eluted antigen. One may determine whether an antibody competes with an anti-MAdCAM antibody by binding the anti-MAdCAM antibody to MAdCAM under saturating conditions, and then measuring the ability of the test antibody to bind to MAdCAM. If the test antibody is able to bind to the MAdCAM at the same time as the anti-MAdCAM antibody, then the test antibody binds to a different epitope than the anti-MAdCAM

antibody. However, if the test antibody is not able to bind to the MAdCAM at the same time, then the test antibody competes with the human anti-MAdCAM antibody. This experiment may be performed using ELISA, or surface plasmon resonance or, preferably, BIAcore. To test whether an anti-MAdCAM antibody cross-competes with another anti-MAdCAM antibody, one may use the competition method described above in two directions, i.e. determining if the known antibody blocks the test antibody and vice versa.

Light and Heavy Chain Gene Usage

[0165] The disclosure also provides an anti-MAdCAM antibody that comprises a light chain variable region encoded by a human κ gene. In a preferred embodiment, the light chain variable region is encoded by a human V κ A2, A3, A26, B3, O12 or O18 gene family. In various embodiments, the light chain comprises no more than eleven, no more than six or no more than three amino acid substitutions from the germline human V κ A2, A3, A26, B3, O12 or O18 sequence. In a preferred embodiment, the amino acid substitutions are conservative substitutions.

[0166] SEQ ID NOS: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48 and 150 provide the amino acid sequences of the full-length kappa light chains of thirteen anti-MAdCAM antibodies, 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4 and 9.8.2 and X481.2. Figures 1K-1T are alignments of the amino acid sequences of the light chain variable domains of twelve anti-MAdCAM antibodies with the germline sequences from which they are derived. Figure 2A shows an alignment of the amino acid sequences of the light chain variable domains of the kappa light chains of twelve anti-MAdCAM antibodies to each other. Following the teachings of this specification, one of ordinary skill in the art could determine the differences between the germline sequences and the antibody sequences of additional anti-MAdCAM antibodies. SEQ ID NOS: 54, 58, 62, 66 or 68 provide the amino acid sequences of the full length kappa light chains of five additional anti-MAdCAM

antibodies, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod, modified by amino acid substitution from their parent anti-MAdCAM antibodies, 6.22.2, 6.34.2, 6.67.1, 6.77.1 or 7.26.4, respectively.

[0167] In a preferred embodiment, the VL of the anti-MAdCAM antibody contains the same mutations, relative to the germline amino acid sequence, as any one or more of the VL of antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. The disclosure includes an anti-MAdCAM antibody that utilizes the same human V_K and human J_K genes as an exemplified antibody. In some embodiments, the antibody comprises one or more of the same mutations from germline as one or more exemplified antibodies. In some embodiments, the antibody comprises different substitutions at one or more of the same positions as one or more of the exemplified antibodies. For example, the VL of the anti-MAdCAM antibody may contain one or more amino acid substitutions that are the same as those present in antibody 7.16.6, and another amino acid substitution that is the same as antibody 7.26.4. In this manner, one can mix and match different features of antibody binding in order to alter, *e.g.*, the affinity of the antibody for MAdCAM or its dissociation rate from the antigen. In another embodiment, the mutations are made in the same position as those found in any one or more of the VL of antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod, but conservative amino acid substitutions are made rather than using the same amino acid. For example, if the amino acid substitution compared to the germline in one of the antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod is glutamate, one may conservatively substitute aspartate. Similarly, if the amino acid substitution is serine, one may conservatively substitute threonine.

[0168] In another preferred embodiment, the light chain comprises an amino acid sequence that is the same as the amino acid sequence of the VL of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another highly preferred embodiment, the light chain comprises amino acid sequences that are the same as the CDR regions of the light chain of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another preferred embodiment, the light chain comprises an amino acid sequence with at least one CDR region of the light chain of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another preferred embodiment, the light chain comprises amino acid sequences with CDRs from different light chains that use the same V_K and J_K genes. In a more preferred embodiment, the CDRs from different light chains are obtained from 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another preferred embodiment, the light chain comprises an amino acid sequence selected from SEQ ID NOS: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 54, 58, 62, 64, 66, 68, or 150 with or without the signal sequence. In another embodiment, the light chain comprises an amino acid sequence encoded by a nucleotide sequence selected from SEQ ID NOS: 3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 53, 57, 61, 65 or 67 (with or without the signal sequence), or a nucleotide sequence that encodes an amino acid sequence having 1-11 amino acid insertions, deletions or substitutions therefrom. Preferably, the amino acid substitutions are conservative amino acid substitutions. In another embodiment, the antibody or portion thereof comprises a lambda light chain.

[0169] The present disclosure also provides an anti-MAdCAM antibody or portion thereof that comprises a human VH gene sequence or a sequence derived from a human VH gene. In one embodiment, the heavy chain amino acid sequence is derived from a human VH 1-18, 3-15, 3-21, 3-23, 3-30, 3-33 or 4-4 gene family. In various embodiments, the heavy chain comprises no more than fifteen, no more than six or no more than three amino acid changes from germline human VH 1-18, 3-15, 3-21, 3-23, 3-30, 3-33 or 4-4 gene sequence.

[0170] SEQ ID NOS: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, and 148 provide the amino acid sequences of the full-length heavy chains of thirteen anti-MAdCAM antibodies. Figures 1A-1J are alignments of the amino acid sequences of the heavy chain variable regions of twelve anti-MAdCAM antibodies with the germline sequences from which they are derived. Figure 2B shows the alignments of the amino acid sequences of the heavy chain variable regions of twelve anti-MAdCAM antibodies to each other. Following the teachings of this specification and the nucleotide sequences of the disclosure, one of ordinary skill in the art could determine the encoded amino acid sequence of the twelve anti-MAdCAM heavy chains and the germline heavy chains and determine the differences between the germline sequences and the antibody sequences. SEQ ID NOS: 52, 56, 60 and 64 provide the amino acid sequences of the full length heavy chains of anti-MAdCAM antibodies, 6.22.2-mod, 6.34.2-mod and 6.67.1-mod, modified by amino acid substitution from their parent anti-MAdCAM antibodies, 6.22.2, 6.34.2 and 6.67.1 respectively. One further modified anti-MAdCAM antibody, 7.26.4-mod, has a full length heavy chain amino acid sequence which is SEQ ID NO: 42.

[0171] In a preferred embodiment, the VH of the anti-MAdCAM antibody contains the same mutations, relative to the germline amino acid sequence, as any one or more of the VH of antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. Similar to

that discussed above, the antibody comprises one or more of the same mutations from germline as one or more exemplified antibodies. In some embodiments, the antibody comprises different substitutions at one or more of the same positions as one or more of the exemplified antibodies. For example, the VH of the anti-MAdCAM antibody may contain one or more amino acid substitutions that are the same as those present in antibody 7.16.6, and another amino acid substitution that is the same as antibody 7.26.4. In this manner, one can mix and match different features of antibody binding in order to alter, *e.g.*, the affinity of the antibody for MAdCAM or its dissociation rate from the antigen. In another embodiment, an amino acid substitution compared to germline is made at the same position as a substitution from germline as found in any one or more of the VH of reference antibody 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod, but the position is substituted with a different residue, which is a conservative substitution compared to the reference antibody.

[0172] In another preferred embodiment, the heavy chain comprises an amino acid sequence that is the same as the amino acid sequence of the VH of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another highly preferred embodiment, the heavy chain comprises amino acid sequences that are the same as the CDR regions of the heavy chain of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another preferred embodiment, the heavy chain comprises an amino acid sequence from at least one CDR region of the heavy chain of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.4, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another preferred embodiment, the heavy chain comprises amino acid

sequences with CDRs from different heavy chains. In a more preferred embodiment, the CDRs from different heavy chains are obtained from 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another preferred embodiment, the heavy chain comprises an amino acid sequence selected from SEQ ID NOS: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 52, 56, 60, 64 or 148 with or without the signal sequence. In another embodiment, the heavy chain comprises an amino acid sequence encoded by a nucleotide sequence selected from SEQ ID NOS: 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 51, 55, 59, 63 or 149 or a nucleotide sequence that encodes an amino acid sequence having 1-15 amino acid insertions, deletions or substitutions therefrom. In another embodiment, the substitutions are conservative amino acid substitutions.

Methods of Producing Antibodies and Antibody-Producing Cell Lines

Immunization

[0173] In one embodiment of the instant disclosure, human antibodies are produced by immunizing a non-human animal comprising some or all of the human immunoglobulin heavy and light chain loci with an MAdCAM antigen. In a preferred embodiment, the non-human animal is a XENOMOUSE™ animal, which is an engineered mouse strain that comprises large fragments of the human immunoglobulin loci and is deficient in mouse antibody production. See, *e.g.*, Green et al., *Nature Genetics* 7:13-21 (1994) and United States Patents 5,916,771, 5,939,598, 5,985,615, 5,998,209, 6,075,181, 6,091,001, 6,114,598 and 6,130,364. See also WO 91/10741, WO 94/02602, WO 96/34096 and WO 96/33735, WO 98/16654, WO 98/24893, WO 98/50433, WO 99/45031, WO 99/53049, WO 00 09560 and WO 00/037504. The XENOMOUSE™ animal produces an adult-like human repertoire of fully human antibodies and generates antigen-specific human mAbs. A second generation XENOMOUSE™ animal contains approximately 80% of the human antibody V gene

repertoire through introduction of megabase sized, germline configuration YAC fragments of the human heavy chain loci and κ light chain loci. In other embodiments, XENOMOUSE[™] mice contain approximately all of the human heavy chain and λ light chain locus. See Mendez et al., *Nature Genetics* 15:146-156 (1997), Green and Jakobovits, *J. Exp. Med.* 188:483-495 (1998), the disclosures of which are hereby incorporated by reference.

[0174] The disclosure also provides a method for making anti-MAdCAM antibodies from non-human, non-mouse animals by immunizing non-human transgenic animals that comprise human immunoglobulin loci. One may produce such animals using the methods described immediately above. The methods disclosed in these documents can be modified as described in U.S. Patent 5,994,619 (the “‘619 patent”), which is hereby incorporated by reference. The ‘619 patent describes methods for producing novel cultured inner cell mass (CICM) cells and cell lines, derived from pigs and cows, and transgenic CICM cells into which heterologous DNA has been inserted. CICM transgenic cells can be used to produce cloned transgenic embryos, fetuses, and offspring. The ‘619 patent also describes methods of producing transgenic animals that are capable of transmitting the heterologous DNA to their progeny. In a preferred embodiment, the non-human animals may be rats, sheep, pigs, goats, cattle or horses.

[0175] In another embodiment, the non-human animal comprising human immunoglobulin loci are animals that have a “minilocus” of human immunoglobulins. In the minilocus approach, an exogenous Ig locus is mimicked through the inclusion of individual genes from the Ig locus. Thus, one or more VH genes, one or more DH genes, one or more JH genes, a μ constant domain(s), and a second constant domain(s) (preferably a gamma constant domain(s)) are formed into a construct for insertion into an animal. This approach is described, *inter alia*, in U.S. Patent No. 5,545,807, 5,545,806, 5,625,126, 5,633,425,

5,661,016, 5,770,429, 5,789,650, 5,814,318, 5,591,669, 5,612,205, 5,721,367, 5,789,215, and 5,643,763, hereby incorporated by reference.

[0176] An advantage of the minilocus approach is the rapidity with which constructs including portions of the Ig locus can be generated and introduced into animals. However, a potential disadvantage of the minilocus approach is that there may not be sufficient immunoglobulin diversity to support full B-cell development, such that there may be lower antibody production.

[0177] To produce a human anti-MAdCAM antibody, a non-human animal comprising some or all of the human immunoglobulin loci is immunized with a MAdCAM antigen and an antibody or the antibody-producing cell is isolated from the animal. The MAdCAM antigen may be isolated and/or purified MAdCAM and is preferably a human MAdCAM. In another embodiment, the MAdCAM antigen is a fragment of MAdCAM, preferably the extracellular domain of MAdCAM. In another embodiment, the MAdCAM antigen is a fragment that comprises at least one epitope of MAdCAM. In another embodiment, the MAdCAM antigen is a cell that expresses MAdCAM on its cell surface, preferably a cell that overexpresses MAdCAM on its cell surface.

[0178] Immunization of animals may be done by any method known in the art. See, *e.g.*, Harlow and Lane, *Antibodies: A Laboratory Manual*, New York: Cold Spring Harbor Press (1990). Methods for immunizing non-human animals such as mice, rats, sheep, goats, pigs, cattle and horses are well known in the art. See, *e.g.*, Harlow and Lane and United States Patent 5,994,619. In a preferred embodiment, the MAdCAM antigen is administered with an adjuvant to stimulate the immune response. Such adjuvants include complete or incomplete Freund's adjuvant, RIBI (muramyl dipeptides) or ISCOM (immunostimulating complexes). Such adjuvants may protect the polypeptide from rapid dispersal by sequestering it in a local deposit, or they may contain substances that stimulate the host to secrete factors that are

chemotactic for macrophages and other components of the immune system. Preferably, if a polypeptide is being administered, the immunization schedule will involve two or more administrations of the polypeptide, spread out over several weeks.

[0179] Example I provides a protocol for immunizing a XENOMOUSE[™] animal with full-length human MAdCAM in phosphate-buffered saline.

Production of Antibodies and Antibody-Producing Cell Lines

[0180] After immunization of an animal with a MAdCAM antigen, antibodies and/or antibody-producing cells may be obtained from the animal. An anti-MAdCAM antibody-containing serum is obtained from the animal by bleeding or sacrificing the animal. The serum may be used as it is obtained from the animal, an immunoglobulin fraction may be obtained from the serum, or the anti-MAdCAM antibodies may be purified from the serum.

[0181] In another embodiment, antibody-producing immortalized cell lines may be prepared from the immunized animal. After immunization, the animal is sacrificed and B cells are immortalized using methods well-known in the art. Methods of immortalizing cells include, but are not limited to, transfecting them with oncogenes, infecting them with an oncogenic virus and cultivating them under conditions that select for immortalized cells, subjecting them to carcinogenic or mutating compounds, fusing them with an immortalized cell, *e.g.*, a myeloma cell, and inactivating a tumor suppressor gene. See, *e.g.*, Harlow and Lane, *supra*. In embodiments involving the myeloma cells, the myeloma cells do not secrete immunoglobulin polypeptides (a non-secretory cell line). After immortalization and antibiotic selection, the immortalized cells, or culture supernatants thereof, are screened using MAdCAM, a portion thereof, or a cell expressing MAdCAM. In a preferred embodiment, the initial screening is performed using an enzyme-linked immunoassay (ELISA) or a radioimmunoassay (RIA), preferably an ELISA. An example of ELISA screening is provided in PCT Publication No. WO 00/37504, herein incorporated by reference.

[0182] In another embodiment, antibody-producing cells may be prepared from a human who has an autoimmune disorder and who expresses anti-MAdCAM antibodies. Cells expressing the anti-MAdCAM antibodies may be isolated by isolating white blood cells and subjecting them to fluorescence-activated cell sorting (FACS) or by panning on plates coated with MAdCAM or a portion thereof. These cells may be fused with a human non-secretory myeloma to produce human hybridomas expressing human anti-MAdCAM antibodies. In general, this is a less preferred embodiment because it is likely that the anti-MAdCAM antibodies will have a low affinity for MAdCAM.

[0183] Anti-MAdCAM antibody-producing cells, *e.g.*, hybridomas are selected, cloned and further screened for desirable characteristics, including robust cell growth, high antibody production and desirable antibody characteristics, as discussed further below. Hybridomas may be cultured and expanded *in vivo* in syngeneic animals, in animals that lack an immune system, *e.g.*, nude mice, or in cell culture *in vitro*. Methods of selecting, cloning and expanding hybridomas are well known to those of ordinary skill in the art.

[0184] Preferably, the immunized animal is a non-human animal that expresses human immunoglobulin genes and the splenic B cells are fused to a myeloma derived from the same species as the non-human animal. More preferably, the immunized animal is a XENOMOUSE™ animal and the myeloma cell line is a non-secretory mouse myeloma, such as the myeloma cell line is P3-X63-AG8-653 (ATCC). See, *e.g.*, Example I.

[0185] Thus, in one embodiment, the disclosure provides methods for producing a cell line that produces a human monoclonal antibody or a fragment thereof directed to MAdCAM comprising (a) immunizing a non-human transgenic animal described herein with MAdCAM, a portion of MAdCAM or a cell or tissue expressing MAdCAM; (b) allowing the transgenic animal to mount an immune response to MAdCAM; (c) isolating antibody-producing cells from transgenic animal; (d) immortalizing the antibody-producing cells; (e)

creating individual monoclonal populations of the immortalized antibody-producing cells; and (f) screening the immortalized antibody-producing cells or culture supernatants thereof to identify an antibody directed to MAdCAM.

[0186] In one aspect, the disclosure provides hybridomas that produce human anti-MAdCAM antibodies. In a preferred embodiment, the hybridomas are mouse hybridomas, as described above. In another embodiment, the hybridomas are produced in a non-human, non-mouse species such as rats, sheep, pigs, goats, cattle or horses. In another embodiment, the hybridomas are human hybridomas, in which a human non-secretory myeloma is fused with a human cell expressing an anti-MAdCAM antibody.

Nucleic Acids, Vectors, Host Cells and Recombinant Methods of Making Antibodies

Nucleic Acids

[0187] Nucleic acid molecules encoding anti-MAdCAM antibodies of the disclosure are provided. In one embodiment, the nucleic acid molecule encodes a heavy and/or light chain of an anti-MAdCAM immunoglobulin. In a preferred embodiment, a single nucleic acid molecule encodes a heavy chain of an anti-MAdCAM immunoglobulin and another nucleic acid molecule encodes the light chain of an anti-MAdCAM immunoglobulin. In a more preferred embodiment, the encoded immunoglobulin is a human immunoglobulin, preferably a human IgG. The encoded light chain may be a λ chain or a κ chain, preferably a κ chain.

[0188] In a preferred embodiment the nucleic acid molecule encoding the variable region of the light chain comprises the germline sequence of a human V κ the A2, A3, A26, B3, O12 or O18 gene or a variant of said sequence. In a preferred embodiment, the nucleic acid molecule encoding the light chain comprises a sequence derived from a human J κ 1, J κ 2, J κ 3, J κ 4 or J κ 5 gene. In a preferred embodiment, the nucleic acid molecule encoding the light chain encodes no more than eleven amino acid changes from the germline A2, A3, A26, B3, O12 or O18 V κ gene, preferably no more than six amino acid changes, and even more

preferably no more than three amino acid changes. In a more preferred embodiment, the nucleic acid encoding the light chain is the germline sequence.

[0189] The disclosure provides a nucleic acid molecule that encodes a variable region of the light chain (VL) containing up to eleven amino acid changes compared to the germline sequence, wherein the amino acid changes are identical to amino acid changes from the germline sequence from the VL of one of the antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. The disclosure also provides a nucleic acid molecule comprising a nucleotide sequence that encodes the amino acid sequence of the variable region of the light chain of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. The disclosure also provides a nucleic acid molecule comprising a nucleotide sequence that encodes the amino acid sequence of one or more of the CDRs of any one of the light chains of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In a preferred embodiment, the nucleic acid molecule comprises a nucleotide sequence that encodes the amino acid sequence of all of the CDRs of any one of the light chains of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another embodiment, the nucleic acid molecule comprises a nucleotide sequence that encodes the amino acid sequence of one of SEQ ID NOS: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 54, 58, 62, 66, 68, 150 or comprises a nucleotide sequence of one of SEQ ID NOS: 3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 53, 57, 61, 65 or 67. In another preferred embodiment, the nucleic acid molecule comprises a nucleotide sequence that encodes the amino acid sequence of one or more of the CDRs of any one of SEQ ID NOS: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 54,

58, 62, 66, 68, 150 or comprises a nucleotide sequence of one or more of the CDRs of any one of SEQ ID NOS: 3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 53, 57, 61, 65, or 67. In a more preferred embodiment, the nucleic acid molecule comprises a nucleotide sequence that encodes the amino acid sequence of all of the CDRs of any one of SEQ ID NOS: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 54, 58, 62, 66, 68, 150 or comprises a the nucleotide sequence of all the CDRs of any one of SEQ ID NOS: 3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 53, 57, 61, 65, or 67.

[0190] The disclosure also provides a nucleic acid molecule that encodes an amino acid sequence of a VL that has an amino acid sequence that is at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98% or 99% identical to a VL described above, particularly to a VL that comprises an amino acid sequence of one of SEQ ID NOS: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 54, 58, 62, 66, , 68 or 150. The disclosure also provides a nucleotide sequence that is at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98% or 99% identical to a nucleotide sequence of one of SEQ ID NOS: 3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 53, 57, 61, 65 or 67.

[0191] In another embodiment, the disclosure provides a nucleic acid molecule that hybridizes under highly stringent conditions to a nucleic acid molecule encoding a VL as described above, particularly a nucleic acid molecule that comprises a nucleotide sequence encoding an amino acid sequence of SEQ ID NOS: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 54, 58, 62, 66, 68, 150. The disclosure also provides a nucleic acid molecule that hybridizes under highly stringent conditions to a nucleic acid molecule comprising a nucleotide sequence of one of SEQ ID NOS: 3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 53, 57, 61, 65 or 67.

[0192] The disclosure also provides a nucleic acid molecule encoding a heavy chain variable region (VH) that utilizes a human VH 1-18, 3-15, 3-21, 3-23, 3-30, 3-33 or 4-4 VH

gene. In some embodiments, the nucleic acid molecule encoding the VH gene further utilizes a human JH4 or JH6 family gene. In some embodiments, the nucleic acid molecule encoding the VH gene utilize the human JH4b or JH6b gene. In another embodiment, the nucleic acid molecule comprises a sequence derived from a human D 3-10, 4-23, 5-5, 6-6 or 6-19 gene. In an even more preferred embodiment, the nucleic acid molecule encoding the VH contains no more than fifteen amino acid changes from the germline VH 1-18, 3-15, 3-21, 3-23, 3-30, 3-33 or 4-4 genes, preferably no more than six amino acid changes, and even more preferably no more than three amino acid changes. In a highly preferred embodiment, the nucleic acid molecule encoding the VH contains at least one amino acid change compared to the germline sequence, wherein the amino acid change is identical to an amino acid change from the germline sequence from the heavy chain of one of the antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In an even more preferred embodiment, the VH contains no more than fifteen amino acid changes compared to the germline sequences, wherein the changes are identical to those changes from the germline sequence from the VH of one of the antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod.

[0193] In one embodiment, the nucleic acid molecule comprises a nucleotide sequence that encodes the amino acid sequence of the VH of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another embodiment, the nucleic acid molecule comprises a nucleotide sequence that encodes the amino acid sequence of one or more of the CDRs of the heavy chain of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In a

preferred embodiment, the nucleic acid molecule comprises nucleotide sequences that encode the amino acid sequences of all of the CDRs of the heavy chain of 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another preferred embodiment, the nucleic acid molecule comprises a nucleotide sequence that encodes the amino acid sequence of one of SEQ ID NOS: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 52, 56, 60, 64 or 148 or that comprises a nucleotide sequence of one of SEQ ID NOS: 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 51, 55, 59, 63, or 149. In another preferred embodiment, the nucleic acid molecule comprises a nucleotide sequence that encodes the amino acid sequence of one or more of the CDRs of any one of SEQ ID NOS: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 52, 56, 60, 64 or 148 or comprises a nucleotide sequence of one or more of the CDRs of any one of SEQ ID NOS: 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 51, 55, 59, 63 or 149. In a preferred embodiment, the nucleic acid molecule comprises a nucleotide sequence that encodes the amino acid sequences of all of the CDRs of any one of SEQ ID NOS: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 52, 56, 60, 64, 148 or comprises a nucleotide sequence of all of the CDRs of any one of SEQ ID NOS: 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 51, 55, 59, 63 or 149. In some embodiments the nucleic acid molecule comprises a nucleotide sequence encoding a contiguous region from the beginning of CDR1 to the end of CDR3 of a heavy or light chain of any of the above-mentioned anti-MAdCAM antibodies.

[0194] In another embodiment, the nucleic acid molecule encodes an amino acid sequence of a VH that is at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98% or 99% identical to one of the amino acid sequences encoding a VH as described immediately above, particularly to a VH that comprises an amino acid sequence of one of SEQ ID NOS: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 52, 56, 60 or 64. The disclosure also provides a nucleotide sequence that is at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98% or 99% identical to a

nucleotide sequence of one of SEQ ID NOS: 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 51, 55, 59, 63 or 149.

[0195] In another embodiment, the nucleic acid molecule encoding a VH is one that hybridizes under highly stringent conditions to a nucleotide sequence encoding a VH as described above, particularly to a VH that comprises an amino acid sequence of one of SEQ ID NOS: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 52, 56, 60, 64 or 148. The disclosure also provides a nucleotide sequence encoding a VH that hybridizes under highly stringent conditions to a nucleic acid molecule comprising a nucleotide sequence of one of SEQ ID NOS: 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 51, 55, 59, 63, 149.

[0196] The nucleotide sequence encoding either or both of the entire heavy and light chains of an anti-MAdCAM antibody or the variable regions thereof may be obtained from any source that produces an anti-MAdCAM antibody. Methods of isolating mRNA encoding an antibody are well-known in the art. See, *e.g.*, Sambrook et al., *Molecular Cloning: A Laboratory Manual*, 2d ed., Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y. (1989). The mRNA may be used to produce cDNA for use in the polymerase chain reaction (PCR) or cDNA cloning of antibody genes. In one embodiment of the disclosure, the nucleic acid molecules may be obtained from a hybridoma that expresses an anti-MAdCAM antibody, as described above, preferably a hybridoma that has as one of its fusion partners a transgenic animal cell that expresses human immunoglobulin genes, such as a XENOMOUSE[™] animal, a non-human mouse transgenic animal or a non-human, non-mouse transgenic animal. In another embodiment, the hybridoma is derived from a non-human, non-transgenic animal, which may be used, *e.g.*, for humanized antibodies.

[0197] A nucleic acid molecule encoding the entire heavy chain of an anti-MAdCAM antibody may be constructed by fusing a nucleic acid molecule encoding the entire variable domain of a heavy chain or an antigen-binding domain thereof with a constant domain of a

heavy chain. Similarly, a nucleic acid molecule encoding the light chain of an anti-MAdCAM antibody may be constructed by fusing a nucleic acid molecule encoding the variable domain of a light chain or an antigen-binding domain thereof with a constant domain of a light chain. Nucleic acid molecules encoding the VH and VL regions may be converted to full-length antibody genes by inserting them into expression vectors already encoding heavy chain constant and light chain constant regions, respectively, such that the VH segment is operatively linked to the heavy chain constant region (CH) segment(s) within the vector and the VL segment is operatively linked to the light chain constant region (CL) segment within the vector. Alternatively, the nucleic acid molecules encoding the VH or VL chains are converted into full-length antibody genes by linking, *e.g.*, ligating, the nucleic acid molecule encoding a VH chain to a nucleic acid molecule encoding a CH chain using standard molecular biological techniques. The same may be achieved using nucleic acid molecules encoding VL and CL chains. The sequences of human heavy and light chain constant region genes are known in the art. See, *e.g.*, Kabat et al., *Sequences of Proteins of Immunological Interest*, 5th Ed., NIH Publ. No. 91-3242 (1991). Nucleic acid molecules encoding the full-length heavy and/or light chains may then be expressed from a cell into which they have been introduced and the anti-MAdCAM antibody isolated.

[0198] In a preferred embodiment, the nucleic acid encoding the variable region of the heavy chain encodes the variable region of amino acid sequences of SEQ ID NOS: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 52, 56, 60, 64 or 148, and the nucleic acid molecule encoding the variable region of the light chains encodes the variable region of amino acid sequence of SEQ ID NOS: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 54, 58, 62, 66, 68 or 150.

[0199] In one embodiment, a nucleic acid molecule encoding either the heavy chain of an anti-MAdCAM antibody or an antigen-binding portion thereof, or the light chain of an anti-

MAdCAM antibody or an antigen-binding portion thereof may be isolated from a non-human, non-mouse animal that expresses human immunoglobulin genes and has been immunized with a MAdCAM antigen. In other embodiment, the nucleic acid molecule may be isolated from an anti-MAdCAM antibody-producing cell derived from a non-transgenic animal or from a human patient who produces anti-MAdCAM antibodies. mRNA from the anti-MAdCAM antibody-producing cells may be isolated by standard techniques, cloned and/or amplified using PCR and library construction techniques, and screened using standard protocols to obtain nucleic acid molecules encoding anti-MAdCAM heavy and light chains.

[0200] The nucleic acid molecules may be used to recombinantly express large quantities of anti-MAdCAM antibodies, as described below. The nucleic acid molecules may also be used to produce chimeric antibodies, single chain antibodies, immunoadhesins, diabodies, mutated antibodies and antibody derivatives, as described further below. If the nucleic acid molecules are derived from a non-human, non-transgenic animal, the nucleic acid molecules may be used for antibody humanization, also as described below.

[0201] In another embodiment, the nucleic acid molecules of the disclosure may be used as probes or PCR primers for specific antibody sequences. For instance, a nucleic acid molecule probe may be used in diagnostic methods or a nucleic acid molecule PCR primer may be used to amplify regions of DNA that could be used, *inter alia*, to isolate nucleotide sequences for use in producing variable domains of anti-MAdCAM antibodies. In a preferred embodiment, the nucleic acid molecules are oligonucleotides. In a more preferred embodiment, the oligonucleotides are from highly variable regions of the heavy and light chains of the antibody of interest. In an even more preferred embodiment, the oligonucleotides encode all or a part of one or more of the CDRs.

Vectors

[0202] The disclosure provides vectors comprising the nucleic acid molecules of the disclosure that encode the heavy chain or the antigen-binding portion thereof. The disclosure also provides vectors comprising the nucleic acid molecules of the disclosure that encode the light chain or antigen-binding portion thereof. The disclosure also provides vectors comprising nucleic acid molecules encoding fusion proteins, modified antibodies, antibody fragments, and probes thereof.

[0203] To express the antibodies, or antibody portions of the disclosure, DNAs encoding partial or full-length light and heavy chains, obtained as described above, are inserted into expression vectors such that the genes are operatively linked to transcriptional and translational control sequences. Expression vectors include plasmids, retroviruses, adenoviruses, adeno-associated viruses (AAV), plant viruses such as cauliflower mosaic virus, tobacco mosaic virus, cosmids, YACs, EBV derived episomes, and the like. The antibody gene is ligated into a vector such that transcriptional and translational control sequences within the vector serve their intended function of regulating the transcription and translation of the antibody gene. The expression vector and expression control sequences are chosen to be compatible with the expression host cell used. The antibody light chain gene and the antibody heavy chain gene can be inserted into separate vector. In a preferred embodiment, both genes are inserted into the same expression vector. The antibody genes are inserted into the expression vector by standard methods (*e.g.*, ligation of complementary restriction sites on the antibody gene fragment and vector, or blunt end ligation if no restriction sites are present).

[0204] A convenient vector is one that encodes a functionally complete human CH or CL immunoglobulin sequence, with appropriate restriction sites engineered so that any VH or VL sequence can be easily inserted and expressed, as described above. In such vectors, splicing

usually occurs between the splice donor site in the inserted J region and the splice acceptor site preceding the human C region, and also at the splice regions that occur within the human CH exons. Polyadenylation and transcription termination occur at native chromosomal sites downstream of the coding regions. The recombinant expression vector can also encode a signal peptide that facilitates secretion of the antibody chain from a host cell. The antibody chain gene may be cloned into the vector such that the signal peptide is linked in-frame to the amino terminus of the antibody chain gene. The signal peptide can be an immunoglobulin signal peptide or a heterologous signal peptide (i.e., a signal peptide from a non-immunoglobulin protein).

[0205] In addition to the antibody chain genes, the recombinant expression vectors of the disclosure carry regulatory sequences that control the expression of the antibody chain genes in a host cell. It will be appreciated by those skilled in the art that the design of the expression vector, including the selection of regulatory sequences may depend on such factors as the choice of the host cell to be transformed, the level of expression of protein desired, etc. Preferred regulatory sequences for mammalian host cell expression include viral elements that direct high levels of protein expression in mammalian cells, such as promoters and/or enhancers derived from retroviral LTRs, cytomegalovirus (CMV) (such as the CMV promoter/enhancer), Simian Virus 40 (SV40) (such as the SV40 promoter/enhancer), adenovirus, (*e.g.*, the adenovirus major late promoter (AdMLP)), polyoma and strong mammalian promoters such as native immunoglobulin and actin promoters. For further description of viral regulatory elements, and sequences thereof, see *e.g.*, U.S. Pat. Nos. 5,168,062, 4,510,245, and 4,968,615, each of which is hereby incorporated by reference. Methods for expressing antibodies in plants, including a description of promoters and vectors, as well as transformation of plants are known in the art. See, *e.g.*, United States Patent

6,517,529. Methods of expressing polypeptides in bacterial cells or fungal cells, *e.g.*, yeast cells, are also well known in the art.

[0206] In addition to the antibody chain genes and regulatory sequences, the recombinant expression vectors of the disclosure may carry additional sequences, such as sequences that regulate replication of the vector in host cells (*e.g.*, origins of replication) and selectable marker genes. The selectable marker gene facilitates selection of host cells into which the vector has been introduced (see, *e.g.*, U.S. Pat. Nos. 4,399,216, 4,634,665 and 5,179,017). For example, typically the selectable marker gene confers resistance to drugs, such as G418, hygromycin or methotrexate, on a host cell into which the vector has been introduced. Preferred selectable marker genes include the dihydrofolate reductase (DHFR) gene (for use in dhfr⁻ host cells with methotrexate selection/amplification) and the neo gene (for G418 selection), and the glutamate synthetase gene.

Non-Hybridoma Host Cells and Methods of Recombinantly Producing Protein

[0207] Nucleic acid molecules encoding the heavy chain or an antigen-binding portion thereof and/or the light chain or an antigen-binding portion thereof of an anti-MAdCAM antibody, and vectors comprising these nucleic acid molecules, can be used for transformation of a suitable mammalian plant, bacterial or yeast host cell. Transformation can be by any known method for introducing polynucleotides into a host cell. Methods for introduction of heterologous polynucleotides into mammalian cells are well known in the art and include dextran-mediated transfection, calcium phosphate precipitation, polybrene-mediated transfection, protoplast fusion, electroporation, encapsulation of the polynucleotide(s) in liposomes, biolistic injection and direct microinjection of the DNA into nuclei. In addition, nucleic acid molecules may be introduced into mammalian cells by viral vectors. Methods of transforming cells are well known in the art. See, *e.g.*, U.S. Patent Nos. 4,399,216, 4,912,040, 4,740,461, and 4,959,455 (which patents are hereby incorporated

herein by reference). Methods of transforming plant cells are well known in the art, including, *e.g.*, Agrobacterium-mediated transformation, biolistic transformation, direct injection, electroporation and viral transformation. Methods of transforming bacterial and yeast cells are also well known in the art.

[0208] Mammalian cell lines available as hosts for expression are well known in the art and include many immortalized cell lines available from the American Type Culture Collection (ATCC). These include, *inter alia*, Chinese hamster ovary (CHO) cells, NS0, SP2 cells, HEK-293T cells, NIH-3T3 cells, HeLa cells, baby hamster kidney (BHK) cells, monkey kidney cells (COS), human hepatocellular carcinoma cells (*e.g.*, Hep G2), A549 cells, 3T3 cells, and a number of other cell lines. Mammalian host cells include human, mouse, rat, dog, monkey, pig, goat, bovine, horse and hamster cells. Cell lines of particular preference are selected through determining which cell lines have high expression levels. Other cell lines that may be used are insect cell lines, such as Sf9 cells, amphibian cells, bacterial cells, plant cells and fungal cells. When recombinant expression vectors encoding the heavy chain or antigen-binding portion thereof, the light chain and/or antigen-binding portion thereof are introduced into mammalian host cells, the antibodies are produced by culturing the host cells for a period of time sufficient to allow for expression of the antibody in the host cells or, more preferably, secretion of the antibody into the culture medium in which the host cells are grown. Antibodies can be recovered from the culture medium using standard protein purification methods. Plant host cells include, *e.g.*, Nicotiana, Arabidopsis, duckweed, corn, wheat, potato, etc. Bacterial host cells include *E. coli* and *Streptomyces* species. Yeast host cells include *Schizosaccharomyces pombe*, *Saccharomyces cerevisiae* and *Pichia pastoris*.

[0209] Further, expression of antibodies of the disclosure (or other moieties therefrom) from production cell lines can be enhanced using a number of known techniques. For example, the glutamine synthetase gene expression system (the GS system) is a common

approach for enhancing expression under certain conditions. The GS system is discussed in whole or part in connection with European Patent Nos. 0 216 846, 0 256 055, 0 338 841 and 0 323 997.

[0210] It is likely that antibodies expressed by different cell lines or in transgenic animals will have different glycosylation from each other. However, all antibodies encoded by the nucleic acid molecules provided herein, or comprising the amino acid sequences provided herein are part of the instant disclosure, regardless of the glycosylation of the antibodies.

Transgenic Animals and Plants

[0211] The disclosure also provides transgenic non-human animals and transgenic plants comprising one or more nucleic acid molecules of the disclosure that may be used to produce antibodies of the disclosure. Antibodies can be produced in and recovered from tissue or bodily fluids, such as milk, blood or urine, of goats, cows, horses, pigs, rats, mice, rabbits, hamsters or other mammals. See, *e.g.*, U.S. Patent Nos. 5,827,690, 5,756,687, 5,750,172, and 5,741,957. As described above, non-human transgenic animals that comprise human immunoglobulin loci can be immunized with MAdCAM or a portion thereof. Methods for making antibodies in plants are described, *e.g.*, in U.S. Patents 6,046,037 and 5,959,177, incorporated herein by reference.

[0212] In another embodiment, non-human transgenic animals and transgenic plants are produced by introducing one or more nucleic acid molecules of the disclosure into the animal or plant by standard transgenic techniques. See Hogan, *supra*. The transgenic cells used for making the transgenic animal can be embryonic stem cells, somatic cells or fertilized egg cells. The transgenic non-human organisms can be chimeric, nonchimeric heterozygotes, and nonchimeric homozygotes. See, *e.g.*, Hogan et al., *Manipulating the Mouse Embryo: A Laboratory Manual 2ed.*, Cold Spring Harbor Press (1999); Jackson et al., *Mouse Genetics and Transgenics: A Practical Approach*, Oxford University Press (2000); and Pinkert,

Transgenic Animal Technology: A Laboratory Handbook, Academic Press (1999). In another embodiment, the transgenic non-human organisms may have a targeted disruption and replacement that encodes a heavy chain and/or a light chain of interest. In a preferred embodiment, the transgenic animals or plants comprise and express nucleic acid molecules encoding heavy and light chains that combine to bind specifically to MAdCAM, preferably human MAdCAM. In another embodiment, the transgenic animals or plants comprise nucleic acid molecules encoding a modified antibody such as a single-chain antibody, a chimeric antibody or a humanized antibody. The anti-MAdCAM antibodies may be made in any transgenic animal. In a preferred embodiment, the non-human animals are mice, rats, sheep, pigs, goats, cattle or horses. The non-human transgenic animal expresses said encoded polypeptides in blood, milk, urine, saliva, tears, mucus and other bodily fluids.

Phage Display Libraries

[0213] The disclosure provides a method for producing an anti-MAdCAM antibody or antigen-binding portion thereof comprising the steps of synthesizing a library of human antibodies on phage, screening the library with a MAdCAM or a portion thereof, isolating phage that bind MAdCAM, and obtaining the antibody from the phage. One method to prepare the library of antibodies comprises the steps of immunizing a non-human host animal comprising a human immunoglobulin locus with MAdCAM or an antigenic portion thereof to create an immune response, extracting cells from the host animal the cells that are responsible for production of antibodies; isolating RNA from the extracted cells, reverse transcribing the RNA to produce cDNA, amplifying the cDNA using a primer, and inserting the cDNA into phage display vector such that antibodies are expressed on the phage. Recombinant anti-MAdCAM antibodies of the disclosure may be obtained in this way.

[0214] Recombinant anti-MAdCAM human antibodies of the disclosure in addition to the anti-MAdCAM antibodies disclosed herein can be isolated by screening of a recombinant

combinatorial antibody library, preferably a scFv phage display library, prepared using human VL and VH cDNAs prepared from mRNA isolated from human lymphocytes. Methodologies for preparing and screening such libraries are known in the art. There are commercially available kits for generating phage display libraries (*e.g.*, the Pharmacia Recombinant Phage Antibody System, catalog no. 27-9400-01; and the Stratagene SurfZAP™ phage display kit, catalog no. 240612). There are also other methods and reagents that can be used in generating and screening antibody display libraries (see, *e.g.*, U.S. Pat. No. 5,223,409; PCT Publication No. WO 92/18619; PCT Publication No. WO 91/17271; PCT Publication No. WO 92/20791; PCT Publication No. WO 92/15679; PCT Publication No. WO 93/01288; PCT Publication No. WO 92/01047; PCT Publication No. WO 92/09690; Fuchs et al. (1991), *Biotechnology*, 9:1369-1372; Hay et al., *Hum. Antibod. Hybridomas*, 3:81-85 (1992); Huse et al., *Science*, 246:1275-1281 (1989); McCafferty et al., *Nature*, 348:552-554 (1990); Griffiths et al., *EMBO J*, 12:725-734 (1993); Hawkins et al., *J. Mol. Biol.*, 226:889-896 (1992); Clackson et al., *Nature*, 352:624-628 (1991); Gram et al., *Proc. Natl. Acad. Sci. USA*, 89:3576-3580 (1992); Garrad et al., *Biotechnology*, 9:1373-1377 (1991); Hoogenboom et al., *Nuc Acid Res*, 19:4133-4137 (1991); and Barbas et al., *Proc. Natl. Acad. Sci. USA*, 88:7978-7982 (1991).

[0215] In a preferred embodiment, to isolate human anti-MAdCAM antibodies with the desired characteristics, a human anti-MAdCAM antibody as described herein is first used to select human heavy and light chain sequences having similar binding activity toward MAdCAM, using the epitope imprinting methods described in Hoogenboom et al., PCT Publication No. WO 93/06213. The antibody libraries used in this method are preferably scFv libraries prepared and screened as described in McCafferty et al., PCT Publication No. WO 92/01047, McCafferty et al., *Nature*, 348:552-554 (1990); and Griffiths et al., *EMBO J*,

12:725-734 (1993). The scFv antibody libraries preferably are screened using human MAdCAM as the antigen.

[0216] Once initial human VL and VH segments are selected, “mix and match” experiments, in which different pairs of the initially selected VL and VH segments are screened for MAdCAM binding, are performed to select preferred VL/VH pair combinations. Additionally, to further improve the quality of the antibody, the VL and VH segments of the preferred VL/VH pair(s) can be randomly mutated, preferably within the CDR3 region of VH and/or VL, in a process analogous to the *in vivo* somatic mutation process responsible for affinity maturation of antibodies during a natural immune response. This *in vitro* affinity maturation can be accomplished by amplifying VH and VL regions using PCR primers complimentary to the VH CDR3 or VL CDR3, respectively, which primers have been “spiked” with a random mixture of the four nucleotide bases at certain positions such that the resultant PCR products encode VH and VL segments into which random mutations have been introduced into the VH and/or VL CDR3 regions. These randomly mutated VH and VL segments can be rescreened for binding to MAdCAM.

[0217] Following screening and isolation of an anti-MAdCAM antibody of the disclosure from a recombinant immunoglobulin display library, nucleic acid encoding the selected antibody can be recovered from the display package (*e.g.*, from the phage genome) and subcloned into other expression vectors by standard recombinant DNA techniques. If desired, the nucleic acid can be further manipulated to create other antibody forms of the disclosure, as described below. To express a recombinant human antibody isolated by screening of a combinatorial library, the DNA encoding the antibody is cloned into a recombinant expression vector and introduced into a mammalian host cells, as described above.

Class Switching

[0218] Another aspect of the instant disclosure is to provide a mechanism by which the class of an anti-MAdCAM antibody may be switched with another. In one aspect of the disclosure, a nucleic acid molecule encoding VL or VH is isolated using methods well-known in the art such that it does not include any nucleotide sequences encoding CL or CH. The nucleic acid molecule encoding VL or VH is then operatively linked to a nucleotide sequence encoding a CL or CH from a different class of immunoglobulin molecule. This may be achieved using a vector or nucleic acid molecule that comprises a CL or CH encoding sequence, as described above. For example, an anti-MAdCAM antibody that was originally IgM may be class switched to an IgG. Further, the class switching may be used to convert one IgG subclass to another, *e.g.*, from IgG₄ to IgG₂. A preferred method for producing an antibody of the disclosure comprising a desired isotype or antibody subclass comprises the steps of isolating a nucleic acid encoding the heavy chain of an anti-MAdCAM antibody and a nucleic acid encoding the light chain of an anti-MAdCAM antibody, obtaining the variable region of the heavy chain, ligating the variable region of the heavy chain with the constant domain of a heavy chain of the desired isotype, expressing the light chain and the ligated heavy chain in a cell, and collecting the anti-MAdCAM antibody with the desired isotype.

Antibody Derivatives

[0219] One may use the nucleic acid molecules described above to generate antibody derivatives using techniques and methods known to one of ordinary skill in the art.

Humanized Antibodies

[0220] The immunogenicity of non-human antibodies can be reduced to some extent using techniques of humanization, potentially employing display techniques using appropriate libraries. It will be appreciated that murine antibodies or antibodies from other species can be humanized or primatized using techniques well known in the art. See, *e.g.*, Winter and

Harris, *Immunol Today*, 14:43-46 (1993) and Wright et al., *Crit. Reviews in Immunol.*, 12:125-168 (1992). The antibody of interest may be engineered by recombinant DNA techniques to substitute the C_H1, C_H2, C_H3, hinge domains, and/or the framework domain with the corresponding human sequence (see WO 92/02190 and U.S. Patent Nos. 5,530,101, 5,585,089, 5,693,761, 5,693,792, 5,714,350, and 5,777,085). In another embodiment, a non-human anti-MAdCAM antibody can be humanized by substituting the C_H1, hinge domain, C_H2, C_H3, and/or the framework domains with the corresponding human sequence of a anti-MAdCAM antibody of the disclosure.

Mutated Antibodies

[0221] In another embodiment, the nucleic acid molecules, vectors and host cells may be used to make mutated anti-MAdCAM antibodies. The antibodies may be mutated in the variable domains of the heavy and/or light chains to alter a binding property of the antibody. For example, a mutation may be made in one or more of the CDR regions to increase or decrease the K_d of the antibody for MAdCAM. Techniques in site-directed mutagenesis are well-known in the art. See, *e.g.*, Sambrook et al., and Ausubel et al., *supra*. In a preferred embodiment, mutations are made at an amino acid residue that is known to be changed compared to germline in a variable region of an anti-MAdCAM antibody. In a more preferred embodiment, one or more mutations are made at an amino acid residue that is known to be changed compared to the germline in a variable region or CDR region of one of the anti-MAdCAM antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another embodiment, one or more mutations are made at an amino acid residue that is known to be changed compared to the germline in a variable region or CDR region whose amino acid sequence is presented in SEQ ID NOS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 52, 54, 56, 58, 62, 64, 66, 68 148 or

150 or whose nucleotide sequence is presented in SEQ ID NOS: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 51, 53, 55, 57, 61, 63, 65, 67 or 149.

In another embodiment, the nucleic acid molecules are mutated in one or more of the framework regions. A mutation may be made in a framework region or constant domain to increase the half-life of the anti-MAdCAM antibody. See, *e.g.*, WO 00/09560, published February 24, 2000, herein incorporated by reference. In one embodiment, there may be one, three or five or ten point mutations and no more than fifteen point mutations. A mutation in a framework region or constant domain may also be made to alter the immunogenicity of the antibody, to provide a site for covalent or non-covalent binding to another molecule, or to alter such properties as complement fixation. Mutations may be made in each of the framework regions, the constant domain and the variable regions in a single mutated antibody. Alternatively, mutations may be made in only one of the framework regions, the variable regions or the constant domain in a single mutated antibody.

[0222] In one embodiment, there are no greater than fifteen amino acid changes in either the VH or VL regions of the mutated anti-MAdCAM antibody compared to the anti-MAdCAM antibody prior to mutation. In a more preferred embodiment, there is no more than ten amino acid changes in either the VH or VL regions of the mutated anti-MAdCAM antibody, more preferably no more than five amino acid changes, or even more preferably no more than three amino acid changes. In another embodiment, there are no more than fifteen amino acid changes in the constant domains, more preferably, no more than ten amino acid changes, even more preferably, no more than five amino acid changes.

Modified Antibodies

[0223] In another embodiment, a fusion antibody or immunoadhesin may be made which comprises all or a portion of an anti-MAdCAM antibody linked to another polypeptide. In a preferred embodiment, only the variable regions of the anti-MAdCAM antibody are linked to

the polypeptide. In another preferred embodiment, the VH domain of an anti-MAdCAM antibody are linked to a first polypeptide, while the VL domain of an anti-MAdCAM antibody are linked to a second polypeptide that associates with the first polypeptide in a manner in which the VH and VL domains can interact with one another to form an antibody binding site. In another preferred embodiment, the VH domain is separated from the VL domain by a linker such that the VH and VL domains can interact with one another (see below under Single Chain Antibodies). The VH-linker-VL antibody is then linked to the polypeptide of interest. The fusion antibody is useful to directing a polypeptide to a MAdCAM-expressing cell or tissue. The polypeptide may be a therapeutic agent, such as a toxin, growth factor or other regulatory protein, or may be a diagnostic agent, such as an enzyme that may be easily visualized, such as horseradish peroxidase. In addition, fusion antibodies can be created in which two (or more) single-chain antibodies are linked to one another. This is useful if one wants to create a divalent or polyvalent antibody on a single polypeptide chain, or if one wants to create a bispecific antibody.

[0224] To create a single chain antibody, (scFv) the VH- and VL-encoding DNA fragments are operatively linked to another fragment encoding a flexible linker, *e.g.*, encoding the amino acid sequence (Gly₄-Ser)₃, such that the VH and VL sequences can be expressed as a contiguous single-chain protein, with the VL and VH regions joined by the flexible linker (see, *e.g.*, Bird et al., *Science*, 242:423-426 (1988); Huston et al., *Proc. Natl. Acad. Sci. USA*, 85:5879-5883 (1988); McCafferty et al., *Nature*, 348:552-554 (1990)). The single chain antibody may be monovalent, if only a single VH and VL are used, bivalent, if two VH and VL are used, or polyvalent, if more than two VH and VL are used.

[0225] In another embodiment, other modified antibodies may be prepared using anti-MAdCAM-encoding nucleic acid molecules. For instance, "Kappa bodies" (Ill et al., *Protein Eng*, 10: 949-57(1997)), "Minibodies" (Martin et al., *EMBO J*, 13: 5303-9(1994)),

“Diabodies” (Holliger et al., *PNAS USA*, 90: 6444-6448(1993)), or “Janusins” (Traunecker et al., *EMBO J*, 10:3655-3659 (1991) and Traunecker et al., “Janusin: new molecular design for bispecific reagents,” *Int J Cancer Suppl*, 7:51-52 (1992)) may be prepared using standard molecular biological techniques following the teachings of the specification.

[0226] In another aspect, chimeric and bispecific antibodies can be generated. A chimeric antibody may be made that comprises CDRs and framework regions from different antibodies. In a preferred embodiment, the CDRs of the chimeric antibody comprises all of the CDRs of the variable region of a light chain or heavy chain of a human anti-MAdCAM antibody, while the framework regions are derived from one or more different antibodies. In a more preferred embodiment, the CDRs of the chimeric antibody comprise all of the CDRs of the variable regions of the light chain and the heavy chain of a human anti-MAdCAM antibody. The framework regions may be from another species and may, in a preferred embodiment, be humanized. Alternatively, the framework regions may be from another human antibody.

[0227] A bispecific antibody can be generated that binds specifically to MAdCAM through one binding domain and to a second molecule through a second binding domain. The bispecific antibody can be produced through recombinant molecular biological techniques, or may be physically conjugated together. In addition, a single chain antibody containing more than one VH and VL may be generated that binds specifically to MAdCAM and to another molecule. Such bispecific antibodies can be generated using techniques that are well known for example, in connection with (i) and (ii) see, *e.g.*, Fanger et al., *Immunol Methods* 4: 72-81 (1994) and Wright and Harris, *supra.* and in connection with (iii) see, *e.g.*, Traunecker et al., *Int. J. Cancer (Suppl.)* 7: 51-52 (1992). In a preferred embodiment, the bispecific antibody binds to MAdCAM and to another molecule expressed at high level on endothelial cells. In a more preferred embodiment, the other molecule is VCAM, ICAM or L-selectin.

[0228] In various embodiments, the modified antibodies described above are prepared using one or more of the variable regions or one or more CDR regions from one of the antibodies selected from 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod or 7.26.4-mod. In another embodiment, the modified antibodies are prepared using one or more of the variable regions or one or more CDR regions whose amino acid sequence is presented in SEQ ID NOS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 52, 54, 56, 58, 62, 64, 66, 68, 148 or 150 or whose nucleotide sequence is presented in SEQ ID NOS: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 51, 53, 55, 57, 61, 63, 65, 67 or 149.

Derivatized and Labeled Antibodies

[0229] An antibody or antibody portion of the disclosure can be derivatized or linked to another molecule (*e.g.*, another peptide or protein). In general, the antibodies or portions thereof are derivatized such that the MAdCAM binding is not affected adversely by the derivatization or labeling. Accordingly, the antibodies and antibody portions of the disclosure are intended to include both intact and modified forms of the human anti-MAdCAM antibodies described herein. For example, an antibody or antibody portion of the disclosure can be functionally linked (by chemical coupling, genetic fusion, noncovalent association or otherwise) to one or more other molecular entities, such as another antibody (*e.g.*, a bispecific antibody or a diabody), a detection agent, a cytotoxic agent, a pharmaceutical agent, and/or a protein or peptide that can mediate association of the antibody or antibody portion with another molecule (such as a streptavidin core region or a polyhistidine tag).

[0230] One type of derivatized antibody is produced by crosslinking two or more antibodies (of the same type or of different types, *e.g.*, to create bispecific antibodies). Suitable

crosslinkers include those that are heterobifunctional, having two distinctly reactive groups separated by an appropriate spacer (*e.g.*, m-maleimidobenzoyl-N-hydroxysuccinimide ester) or homobifunctional (*e.g.*, disuccinimidyl suberate). Such linkers are available from Pierce Chemical Company, Rockford, Ill.

[0231] Another type of derivatized antibody is a labeled antibody. Useful detection agents with which an antibody or antibody portion of the disclosure may be derivatized include fluorescent compounds, including fluorescein, fluorescein isothiocyanate, rhodamine, 5-dimethylamine-1-naphthalenesulfonyl chloride, phycoerythrin, lanthanide phosphors and the like. An antibody may also be labeled with enzymes that are useful for detection, such as horseradish peroxidase, β -galactosidase, luciferase, alkaline phosphatase, glucose oxidase and the like. When an antibody is labeled with a detectable enzyme, it is detected by adding additional reagents that the enzyme uses to produce a reaction product that can be discerned. For example, when the agent horseradish peroxidase is present, the addition of hydrogen peroxide and diaminobenzidine leads to a colored reaction product, which is detectable. An antibody may also be labeled with biotin, and detected through indirect measurement of avidin or streptavidin binding. An antibody may be labeled with a magnetic agent, such as gadolinium. An antibody may also be labeled with a predetermined polypeptide epitope recognized by a secondary reporter (*e.g.*, leucine zipper pair sequences, binding sites for secondary antibodies, metal binding domains, epitope tags). In some embodiments, labels are attached by spacer arms of various lengths to reduce potential steric hindrance.

[0232] An anti-MAdCAM antibody may also be labeled with a radiolabeled amino acid. The radiolabel may be used for both diagnostic and therapeutic purposes. For instance, the radiolabel may be used to detect MAdCAM-expressing tissues by x-ray or other diagnostic techniques. Further, the radiolabel may be used therapeutically as a toxin for diseased tissue or MAdCAM expressing tumors. Examples of labels for polypeptides include, but are not

limited to, the following radioisotopes or radionuclides -- ^3H , ^{14}C , ^{15}N , ^{35}S , ^{90}Y , ^{99}Tc , ^{111}In , ^{125}I , ^{131}I .

[0233] An anti-MAdCAM antibody may also be derivatized with a chemical group such as polyethylene glycol (PEG), a methyl or ethyl group, or a carbohydrate group. These groups may be useful to improve the biological characteristics of the antibody, *e.g.*, to increase serum half-life or to increase tissue binding. This methodology would also apply to any antigen-binding fragments or versions of anti-MAdCAM antibodies.

Pharmaceutical Compositions and Kits

[0234] In a further aspect, the disclosure provides compositions comprising an inhibitory human anti-MAdCAM antibody and methods for treating subjects with such compositions. In some embodiments, the subject of treatment is human. In other embodiments, the subject is a veterinary subject. In some embodiments, the veterinary subject is a dog or a non-human primate.

[0235] Treatment may involve administration of one or more inhibitory anti-MAdCAM monoclonal antibodies of the disclosure, or antigen-binding fragments thereof, alone or with a pharmaceutically acceptable carrier. Inhibitory anti-MAdCAM antibodies of the disclosure and compositions comprising them, can be administered in combination with one or more other therapeutic, diagnostic or prophylactic agents. Additional therapeutic agents include anti-inflammatory or immunomodulatory agents. These agents include, but are not limited to, the topical and oral corticosteroids such as prednisolone, methylprednisolone, NCX-1015 or budesonide; the aminosaliclates such as mesalazine, olsalazine, balsalazide or NCX-456; the class of immunomodulators such as azathioprine, 6-mercaptopurine, methotrexate, cyclosporin, FK506, IL-10 (Ilodecakin), IL-11 (Oprelevkin), IL-12, MIF/CD74 antagonists, CD40 antagonists, such as TNX-100/5-D12, OX40L antagonists, GM-CSF, pimecrolimus or rapamycin; the class of anti-TNF α agents such as infliximab, adalimumab, CDP-870,

onerecept, etanercept; the class of anti-inflammatory agents, such as PDE-4 inhibitors (roflumilast, etc), TACE inhibitors (DPC-333, RDP-58, etc) and ICE inhibitors (VX-740, etc) as well as IL-2 receptor antagonists, such as daclizumab, the class of selective adhesion molecule antagonists, such as natalizumab, MLN-02, or alicaforsen, classes of analgesic agents such as, but not limited to, COX-2 inhibitors, such as rofecoxib, valdecoxib, celecoxib, P/Q-type voltage sensitive channel ($\alpha 2\delta$) modulators, such as gabapentin and pregabalin, NK-1 receptor antagonists, cannabinoid receptor modulators, and delta opioid receptor agonists, as well as anti-neoplastic, anti-tumor, anti-angiogenic or chemotherapeutic agents. Such additional agents may be included in the same composition or administered separately. In some embodiments, one or more inhibitory anti-MAdCAM antibodies of the disclosure can be used as a vaccine or as adjuvants to a vaccine. In particular, because MAdCAM is expressed in lymphoid tissue, vaccine antigens can be advantageously targeted to lymphoid tissue by conjugating the antigen to an anti-MAdCAM antibody of the disclosure.

[0236] As used herein, “pharmaceutically acceptable carrier” means any and all solvents, dispersion media, coatings, antibacterial and antifungal agents, isotonic and absorption enhancing or delaying agents, and the like that are physiologically compatible. Some examples of pharmaceutically acceptable carriers are water, saline, phosphate buffered saline, acetate buffer with sodium chloride, dextrose, glycerol, Polyethylene glycol, ethanol and the like, as well as combinations thereof. In many cases, it will be preferable to include isotonic agents, for example, sugars, polyalcohols such as mannitol, sorbitol, or sodium chloride in the composition. Additional examples of pharmaceutically acceptable substances are surfactants, wetting agents or minor amounts of auxiliary substances such as wetting or emulsifying agents, preservatives or buffers, which enhance the shelf life or effectiveness of the antibody.

[0237] The compositions of this disclosure may be in a variety of forms, for example, liquid, semi-solid and solid dosage forms, such as liquid solutions (*e.g.*, injectable and infusible solutions), dispersions or suspensions, tablets, pills, lyophilized cake, dry powders, liposomes and suppositories. The preferred form depends on the intended mode of administration and therapeutic application. Typical preferred compositions are in the form of injectable or infusible solutions, such as compositions similar to those used for passive immunization of humans. The preferred mode of administration is parenteral (*e.g.*, intravenous, subcutaneous, intraperitoneal, intramuscular, intradermal). In a preferred embodiment, the antibody is administered by intravenous infusion or injection. In another preferred embodiment, the antibody is administered by intramuscular, intradermal or subcutaneous injection.

[0238] Therapeutic compositions typically must be sterile and stable under the conditions of manufacture and storage. The composition can be formulated as a solution, lyophilized cake, dry powder, microemulsion, dispersion, liposome, or other ordered structure suitable to high drug concentration. Sterile injectable solutions can be prepared by incorporating the anti-MAdCAM antibody in the required amount in an appropriate solvent with one or a combination of ingredients enumerated above, as required, followed by sterilization. In the case of sterile powders for the preparation of sterile injectable solutions, the preferred methods of preparation are vacuum drying and freeze-drying that yields a powder of the active ingredient plus any any additional desired ingredient from a previously sterile solution thereof. Generally, dispersions are prepared by incorporating the active compound into a sterile vehicle that contains a basic dispersion medium and the required other ingredients from those enumerated above. The desired characteristics of a solution can be maintained, for example, by the use of surfactants and the required particle size in the case of dispersion by the use of surfactants, phospholipids and polymers. Prolonged absorption of injectable

compositions can be brought about by including in the composition an agent that delays absorption, for example, monostearate salts, polymeric materials, oils and gelatin.

[0239] The antibodies of the present disclosure can be administered by a variety of methods known in the art, although for many therapeutic applications, the preferred route/mode of administration is subcutaneous, intramuscular, intradermal or intravenous infusion. As will be appreciated by the skilled artisan, the route and/or mode of administration will vary depending upon the desired results.

[0240] In certain embodiments, the antibody compositions may be prepared with a carrier that will protect the antibody against rapid release, such as a controlled release formulation, including implants, transdermal patches, and microencapsulated delivery systems.

Biodegradable, biocompatible polymers can be used, such as ethylene vinyl acetate, polyanhydrides, polyglycolic acid, collagen, polyorthoesters, and polylactic acid. Many methods for the preparation of such formulations are patented or generally known to those skilled in the art. See, *e.g.*, *Sustained and Controlled Release Drug Delivery Systems* (J. R. Robinson, ed., Marcel Dekker, Inc., New York (1978)).

[0241] In certain embodiments, an anti-MAdCAM antibody of the disclosure can be orally administered, for example, with an inert diluent or an assimilable edible carrier. The compound (and other ingredients, if desired) can also be enclosed in a hard or soft shell gelatin capsule, compressed into tablets, or incorporated directly into the subject's diet. For oral therapeutic administration, the anti-MAdCAM antibodies can be incorporated with excipients and used in the form of ingestible tablets, buccal tablets, troches, capsules, elixirs, suspensions, syrups, wafers, and the like. To administer a compound of the disclosure by other than parenteral administration, it may be necessary to coat the compound with, or co-administer the compound with, a material to prevent its inactivation.

[0242] The compositions of the disclosure may include a “therapeutically effective amount” or a “prophylactically effective amount” of an antibody or antigen-binding portion of the disclosure. A “therapeutically effective amount” refers to an amount effective, at dosages and for periods of time necessary, to achieve the desired therapeutic result. A therapeutically effective amount of the antibody or antibody portion may vary according to factors such as the disease state, age, sex, and weight of the individual, and the ability of the antibody or antibody portion to elicit a desired response in the individual. A therapeutically effective amount is also one in which any toxic or detrimental effects of the antibody or antibody portion are outweighed by the therapeutically beneficial effects. A “prophylactically effective amount” refers to an amount effective, at dosages and for periods of time necessary, to achieve the desired prophylactic result. Typically, since a prophylactic dose is used in subjects prior to or at an earlier stage of disease, the prophylactically effective amount may be less than the therapeutically effective amount.

[0243] Dosage regimens can be adjusted to provide the optimum desired response (*e.g.*, a therapeutic or prophylactic response). For example, a single bolus can be administered, several divided doses can be administered over time or the dose can be proportionally reduced or increased as indicated by the exigencies of the therapeutic situation. It is especially advantageous to formulate parenteral compositions in dosage unit form for ease of administration and uniformity of dosage. Dosage unit form as used herein refers to physically discrete units suited as unitary dosages for the mammalian subjects to be treated; each unit containing a pre-determined quantity of active compound calculated to produce the desired therapeutic effect in association with the required pharmaceutical carrier. The specification for the dosage unit forms of the disclosure are dictated by and directly dependent on (a) the unique characteristics of the anti-MAdCAM antibody or portion thereof and the particular therapeutic or prophylactic effect to be achieved, and (b) the limitations

inherent in the art of compounding such an antibody for the treatment of sensitivity in individuals.

[0244] An exemplary, non-limiting range for a therapeutically or prophylactically effective amount of an antibody or antibody portion of the disclosure is 0.025 to 50 mg/kg, more preferably 0.1 to 50 mg/kg, more preferably 0.1-25, 0.1 to 10 or 0.1 to 3 mg/kg. In some embodiments, a formulation contains 5 mg/mL of antibody in a buffer of 20 mM sodium acetate, pH 5.5, 140 mM NaCl, and 0.2 mg/mL polysorbate 80. It is to be noted that dosage values may vary with the type and severity of the condition to be alleviated. It is to be further understood that for any particular subject, specific dosage regimens should be adjusted over time according to the individual need and the professional judgment of the person administering or supervising the administration of the compositions, and that dosage ranges set forth herein are exemplary only and are not intended to limit the scope or practice of the claimed composition.

[0245] Another aspect of the present disclosure provides kits comprising an anti-MAdCAM antibody or antibody portion of the disclosure or a composition comprising such an antibody. A kit may include, in addition to the antibody or composition, diagnostic or therapeutic agents. A kit can also include instructions for use in a diagnostic or therapeutic method. In a preferred embodiment, the kit includes the antibody or a composition comprising it and a diagnostic agent that can be used in a method described below. In another preferred embodiment, the kit includes the antibody or a composition comprising it and one or more therapeutic agents that can be used in a method described below.

Gene Therapy

[0246] The nucleic acid molecules of the instant disclosure can be administered to a patient in need thereof via gene therapy. The therapy may be either *in vivo* or *ex vivo*. In a preferred embodiment, nucleic acid molecules encoding both a heavy chain and a light chain

are administered to a patient. In a more preferred embodiment, the nucleic acid molecules are administered such that they are stably integrated into chromosomes of B cells because these cells are specialized for producing antibodies. In a preferred embodiment, precursor B cells are transfected or infected *ex vivo* and re-transplanted into a patient in need thereof. In another embodiment, precursor B cells or other cells are infected *in vivo* using a recombinant virus known to infect the cell type of interest. Typical vectors used for gene therapy include liposomes, plasmids and viral vectors. Exemplary viral vectors are retroviruses, adenoviruses and adeno-associated viruses. After infection either *in vivo* or *ex vivo*, levels of antibody expression can be monitored by taking a sample from the treated patient and using any immunoassay known in the art or discussed herein.

[0247] In a preferred embodiment, the gene therapy method comprises the steps of administering an isolated nucleic acid molecule encoding the heavy chain or an antigen-binding portion thereof of an anti-MAdCAM antibody and expressing the nucleic acid molecule. In another embodiment, the gene therapy method comprises the steps of administering an isolated nucleic acid molecule encoding the light chain or an antigen-binding portion thereof of an anti-MAdCAM antibody and expressing the nucleic acid molecule. In a more preferred method, the gene therapy method comprises the steps of administering of an isolated nucleic acid molecule encoding the heavy chain or an antigen-binding portion thereof and an isolated nucleic acid molecule encoding the light chain or the antigen-binding portion thereof of an anti-MAdCAM antibody of the disclosure and expressing the nucleic acid molecules. The gene therapy method may also comprise the step of administering another anti-inflammatory or immunomodulatory agent.

Diagnostic Methods of Use

[0248] The anti-MAdCAM antibodies may be used to detect MAdCAM in a biological sample *in vitro* or *in vivo*. The anti-MAdCAM antibodies may be used in a conventional

immunoassay, including, without limitation, an ELISA, an RIA, FACS, tissue immunohistochemistry, Western blot or immunoprecipitation. The anti-MAdCAM antibodies of the disclosure may be used to detect MAdCAM from humans. In another embodiment, the anti-MAdCAM antibodies may be used to detect MAdCAM from Old World primates such as cynomolgus and rhesus monkeys, chimpanzees and apes. The disclosure provides a method for detecting MAdCAM in a biological sample comprising contacting a biological sample with an anti-MAdCAM antibody of the disclosure and detecting the antibody bound to MAdCAM. In one embodiment, the anti-MAdCAM antibody is directly derivatized with a detectable label. In another embodiment, the anti-MAdCAM antibody (the first antibody) is unlabeled and a second antibody or other molecule that can bind the anti-MAdCAM antibody is labeled. As is well known to one of skill in the art, a second antibody is chosen that is able to specifically bind the specific species and class of the first antibody. For example, if the anti-MAdCAM antibody is a human IgG, then the secondary antibody may be an anti-human-IgG. Other molecules that can bind to antibodies include, without limitation, Protein A and Protein G, both of which are available commercially, *e.g.*, from Pierce Chemical Co.

[0249] Suitable labels for the antibody or secondary have been disclosed *supra*, and include various enzymes, prosthetic groups, fluorescent materials, luminescent materials, magnetic agents and radioactive materials. Examples of suitable enzymes include horseradish peroxidase, alkaline phosphatase, β -galactosidase, or acetylcholinesterase; examples of suitable prosthetic group complexes include streptavidin/biotin and avidin/biotin; examples of suitable fluorescent materials include umbelliferone, fluorescein, fluorescein isothiocyanate, rhodamine, dichlorotriazinylamine fluorescein, dansyl chloride or phycoerythrin; an example of a luminescent material includes luminol; an example of a

magnetic agent includes gadolinium; and examples of suitable radioactive material include ^{125}I , ^{131}I , ^{35}S or ^3H .

[0250] In an alternative embodiment, MAdCAM can be assayed in a biological sample by a competition immunoassay utilizing MAdCAM standards labeled with a detectable substance and an unlabeled anti-MAdCAM antibody. In this assay, the biological sample, the labeled MAdCAM standards and the anti-MAdCAM antibody are combined and the amount of labeled MAdCAM standard bound to the unlabeled antibody is determined. The amount of MAdCAM in the biological sample is inversely proportional to the amount of labeled MAdCAM standard bound to the anti-MAdCAM antibody.

[0251] One may use the immunoassays disclosed above for a number of purposes. In one embodiment, the anti-MAdCAM antibodies may be used to detect MAdCAM in cells in cell culture. In a preferred embodiment, the anti-MAdCAM antibodies may be used to determine the level of cell surface MAdCAM expression after treatment of the cells with various compounds. This method can be used to test compounds that may be used to activate or inhibit MAdCAM. In this method, one sample of cells is treated with a test compound for a period of time while another sample is left untreated, cell surface expression could then be determined by flow cytometry, immunohistochemistry, Western blot, ELISA or RIA. In addition, the immunoassays may be scaled up for high throughput screening in order to test a large number of compounds for either activation or inhibition of MAdCAM.

[0252] The anti-MAdCAM antibodies of the disclosure may also be used to determine the levels of MAdCAM on a tissue or in cells derived from the tissue. In a preferred embodiment, the tissue is a diseased tissue. In a more preferred embodiment, the tissue is inflamed gastrointestinal tract or a biopsy thereof. In a preferred embodiment of the method, a tissue or a biopsy thereof is excised from a patient. The tissue or biopsy is then used in an immunoassay to determine, *e.g.*, MAdCAM levels, cell surface levels of MAdCAM, or

localization of MAdCAM by the methods discussed above. The method can be used to determine if an inflamed tissue expresses MAdCAM at a high level.

[0253] The above-described diagnostic method can be used to determine whether a tissue expresses high levels of MAdCAM, which may be indicative that the tissue will respond well to treatment with anti-MAdCAM antibody. Further, the diagnostic method may also be used to determine whether treatment with anti-MAdCAM antibody (see below) is causing a tissue to express lower levels of MAdCAM and thus can be used to determine whether the treatment is successful.

[0254] The antibodies of the present disclosure may also be used *in vivo* to localize tissues and organs that express MAdCAM. In a preferred embodiment, the anti-MAdCAM antibodies can be used to localize inflamed tissue. The advantage of the anti-MAdCAM antibodies of the present disclosure is that they will not generate an immune response upon administration. The method comprises the steps of administering an anti-MAdCAM antibody or a pharmaceutical composition thereof to a patient in need of such a diagnostic test and subjecting the patient to imaging analysis determine the location of the MAdCAM-expressing tissues. Imaging analysis is well known in the medical art, and includes, without limitation, x-ray analysis, gamma scintigraphy, magnetic resonance imaging (MRI), positron emission tomography or computed tomography (CT). In another embodiment of the method, a biopsy is obtained from the patient to determine whether the tissue of interest expresses MAdCAM rather than subjecting the patient to imaging analysis. In a preferred embodiment, the anti-MAdCAM antibodies may be labeled with a detectable agent that can be imaged in a patient. For example, the antibody may be labeled with a contrast agent, such as barium, which can be used for x-ray analysis, or a magnetic contrast agent, such as a gadolinium chelate, which can be used for MRI or CT. Other labeling agents include, without limitation, radioisotopes, such as ⁹⁹Tc. In another embodiment, the anti-MAdCAM antibody will be unlabeled and will

be imaged by administering a second antibody or other molecule that is detectable and that can bind the anti-MAdCAM antibody.

[0255] The anti-MAdCAM antibodies of the disclosure may also be used to determine the levels of soluble MAdCAM present in donor blood, serum, plasma, or other biofluid, including, but not limited to, stool, urine, sputum or biopsy sample. In a preferred embodiment, the biofluid is plasma. The biofluid is then used in an immunoassay to determine levels of soluble MAdCAM. Soluble MAdCAM could be a surrogate marker for ongoing gastrointestinal inflammation and the method of detection could be used as a diagnostic marker to measure disease severity.

[0256] The above-described diagnostic method can be used to determine whether an individual expresses high levels of soluble MAdCAM, which may be indicative that the individual will respond well to treatment with an anti-MAdCAM antibody. Further, the diagnostic method may also be used to determine whether treatment with anti-MAdCAM antibody (see below) or other pharmaceutical agent of the disease is causing an individual to express lower levels of MAdCAM and thus can be used to determine whether the treatment is successful.

Inhibition of $\alpha_4\beta_7$ /MAdCAM-dependent adhesion by anti-MAdCAM antibody:

[0257] In another embodiment, the disclosure provides an anti-MAdCAM antibody that binds MAdCAM and inhibits the binding and adhesion of $\alpha_4\beta_7$ -integrin bearing cells to MAdCAM or other cognate ligands, such as L-selectin, to MAdCAM. In a preferred embodiment, the MAdCAM is human and is either a soluble form, or expressed on the surface of a cell. In another preferred embodiment, the anti-MAdCAM antibody is a human antibody. In another embodiment, the antibody or portion thereof inhibits binding between $\alpha_4\beta_7$ and MAdCAM with an IC_{50} value of no more than 50 nM. In a preferred embodiment, the IC_{50} value is no more than 5 nM. In a more preferred embodiment, the IC_{50} value is less

than 5 nM. In a more preferred embodiment, the IC₅₀ value is less than 0.05 µg/mL, 0.04 µg/mL or 0.03 µg/mL. In another preferred embodiment the IC₅₀ value is less than 0.5 µg/mL, 0.4 µg/mL or 0.3 µg/mL. The IC₅₀ value can be measured by any method known in the art. Typically, an IC₅₀ value can be measured by ELISA or adhesion assay. In a preferred embodiment, the IC₅₀ value is measured by adhesion assay using either cells or tissue which natively express MAdCAM or cells or tissue which have been engineered to express MAdCAM.

Inhibition of lymphocyte recruitment to gut-associated lymphoid tissue by anti-MAdCAM antibodies

[0258] In another embodiment, the disclosure provides an anti-MAdCAM antibody that binds natively expressed MAdCAM and inhibits the binding of lymphocytes to specialised gastrointestinal lymphoid tissue. In a preferred embodiment, the natively-expressed MAdCAM is human or primate MAdCAM and is either a soluble form, or expressed on the surface of a cell. In another preferred embodiment, the anti-MAdCAM antibody is a human antibody. In another embodiment, the antibody or portion thereof inhibits the recruitment of gut-trophic $\alpha_4\beta_7^+$ lymphocytes to tissues expressing MAdCAM with an IC₅₀ value of no more than 5 mg/kg. In a preferred embodiment, the IC₅₀ value is no more than 1 mg/kg. In a more preferred embodiment, the IC₅₀ value is less than 0.1 mg/kg. In one embodiment, the IC₅₀ value can be determined by measuring the dose effect relationship of recruitment of technetium-labeled peripheral blood lymphocytes to the gastrointestinal tract using gamma scintigraphy or single photon emission computed tomography. In another embodiment, the IC₅₀ value can be determined by measuring the increase in gut-trophic $\alpha_4\beta_7^+$ lymphocytes, such as, but not limited to, CD4⁺ $\alpha_4\beta_7^+$ memory T-cells, in the peripheral circulation using flow cytometry as a function of the dose of anti-MAdCAM antibody.

[0259] In order that this disclosure may be better understood, the following examples are set forth. These examples are for purposes of illustration only and are not to be construed as limiting the scope of the disclosure in any manner.

MDFGLALLLAGLLGLLLGQSLQVKPLQVEPPEPVVAVALGASRQLTCRLACADRGASVQWRG
LDTSLGAVQSDTGRSVLTVRNASLSAAGTRVCVCGSCGGRTFQHTVQLLVYAFPDQLTVSPA
LVPGDPEVACTAHKVTPVDPNALSFSLLVGGQELEGAQALGPEVQEEEEEPQGDDEVLFRVT
ERWRLPPLGTPVPALYCQATMRLPGLELSHRQAI PVLHSPTSPEPPDTSPESPDTSPE
PDTSQEPDTSQEPDTSQEPDTSQEPDTSPEPPDKTSPEPAPOOGSTHTPRSPGSTRTRRPE

I QPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVDVSHEDPEVKFN
 WYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISK
 AKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKATPPVLD
 DGSFFLYSKLTVDKSRWQQGNVFSQSVMEALHNHYTQKSLSLSPGK (SEQ ID NO:
 107)

Underlined: signal peptide

Bold: MAdCAM extracellular domain

Recombinant Protein Expression/Purification:

[0263] CHO-DHFR cells were transfected with pCDNA3.1+ vector containing MAdCAM-IgG₁ Fc fusion protein cDNA and stable clones expressing MAdCAM-IgG₁ Fc fusion protein selected in Iscove's media containing 600 µg/mL G418 and 100 ng/mL methotrexate. For protein expression, a hollow fibre bioreactor was seeded with stably expressing MAdCAM-IgG₁ Fc CHO cells in Iscove's media containing 10% low IgG fetal bovine serum (Gibco), non essential amino acids (Gibco), 2 mM glutamine (Gibco), sodium pyruvate (Gibco), 100 µg/mL G418 and 100 ng/mL methotrexate, and used to generate concentrated media supernatant. The MAdCAM-IgG₁ Fc fusion protein was purified from the harvested supernatant by affinity chromatography. Briefly, supernatant was applied to a HiTrap Protein G Sepharose (5 mL, Pharmacia) column (2 mL/min), washed with 25 mM Tris pH 8, 150 mM NaCl (5 column volumes) and eluted with 100 mM glycine pH 2.5 (1 mL/min), immediately neutralising fractions to pH 7.5 with 1M Tris pH 8. Fractions containing MAdCAM-IgG₁ Fc fusion protein were identified by SDS-PAGE, pooled together and applied to a Sephacryl S100 column (Pharmacia), pre-equilibrated with 35 mM BisTris pH 6.5, 150 mM NaCl. The gel filtration was performed at 0.35 mL/min, collecting a peak of MAdCAM-IgG₁ Fc fusion protein in *ca.* 3 x 5 mL fractions. These samples were pooled and applied to a Resource Q (6 mL, Pharmacia) column, pre-equilibrated in 35 mM BisTris pH6.5. The column was washed with 5 column volumes of 35 mM Bis Tris pH 6.5, 150 mM NaCl (6 mL/min) and MAdCAM-IgG₁ Fc fusion protein eluted into a 4-6 mL fraction with 35 mM Bis Tris pH 6.5, 400 mM NaCl. At this stage the protein was 90% pure and

migrating as a single band at approximately 68 kD by SDS-PAGE. For use as an immunogen and all subsequent assays, the material was buffer exchanged into 25 mM HEPES pH 7.5, 1 mM EDTA, 1 mM DTT, 100 mM NaCl, 50% glycerol and stored as aliquots at -80°C.

(ii) Cell membranes stably expressing MAdCAM

[0264] A SacI/NotI fragment comprising nucleotides 645-1222 of the published MAdCAM sequence (Shyjan AM, et al., *J Immunol.*, 156, 2851-7 (1996)) was PCR amplified from a colon cDNA library and cloned into SacI/NotI sites of pIND-Hygro vector (Invitrogen). A SacI fragment, comprising the additional 5' coding sequence was sub-cloned into this construct from pCDNA3.1 MAdCAM-IgG₁ Fc, to generate the full length MAdCAM cDNA. A KpnI/NotI fragment containing the MAdCAM cDNA was then cloned into corresponding sites in a pEF5FRTV5GWCAT vector (Invitrogen) and replacing the CAT coding sequence. The cDNA insert was sequence verified and used in transfections to generate single stably expressing clones in FlpIn NIH 3T3 cells (Invitrogen) by Flp recombinase technology, according to the manufacturer's instructions. Stably expressing clones were selected by their ability to support the binding of a $\alpha_4\beta_7^+$ JY human B lymphoblastoid cell line (Chan BM, et al, *J. Biol. Chem.*, 267:8366-70 (1992)), outlined below. Stable clones of CHO cells expressing MAdCAM were prepared in the same way, using FlpIn CHO cells (Invitrogen).

[0265] MAdCAM-expressing FlpIn NIH-3T3 cells were grown in Dulbecco's modified Eagles Medium (Gibco), containing 2 mM L-glutamine, 10% Donor calf serum (Gibco) and 200 μ g/mL Hygromycin B (Invitrogen) and expanded in roller bottles. MAdCAM-expressing FlpIn CHO cells were grown in Ham's F12/Dulbecco's modified Eagles Medium (Gibco), containing 2 mM L-glutamine, 10% Donor calf serum (Gibco) and 350 μ g/mL Hygromycin B (Invitrogen) and expanded in roller bottles. Cells were harvested by use of a non-enzymatic cell dissociation solution (Sigma) and scraping, washing in phosphate buffered

saline by centrifugation. Cell membranes were prepared from the cell pellet by two rounds of polytron homogenization in 25 mM Bis Tris pH 8, 10 mM MgCl₂, 0.015% (w/v) aprotinin, 100 U/mL bacitracin and centrifugation. The final pellet was resuspended in the same buffer, and 50x10⁶ cell equivalents aliquoted into thick-walled eppendorfs and spun at >100,000g to generate cell membrane pellets for XenoMouse mice immunisations. Supernatant was decanted and membranes were stored in eppendorfs at -80°C until required. Confirmation of protein expression in the cell membranes was determined by SDS-PAGE and Western blotting with a rabbit anti-peptide antibody raised against the N-terminal residues of MAdCAM ([C]-KPLQVEPPEP).

Immunization and hybridoma generation:

[0266] Eight to ten week old XENOMOUSE™ mice were immunized intraperitoneally or in their hind footpads with either the purified recombinant MAdCAM-IgG₁ Fc fusion protein (10 µg/dose/mouse), or cell membranes prepared from either stably expressing MAdCAM-CHO or NIH 3T3 cells (10x10⁶ cells/dose/mouse). This dose was repeated five to seven times over a three to eight week period. Four days before fusion, the mice received a final injection of the extracellular domain of human MAdCAM in PBS. Spleen and lymph node lymphocytes from immunized mice were fused with the non-secretory myeloma P3-X63-Ag8.653 cell line and were subjected to HAT selection as previously described (Galfre and Milstein, *Methods Enzymol.* 73:3-46 (1981)). A panel of hybridomas all secreting MAdCAM specific human IgG₂κ and IgG₄κ antibodies were recovered and sub-cloned. Twelve hybridoma sub-clones, 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4 and 9.8.2, producing monoclonal antibodies specific for MAdCAM were recovered and detected with assays described below. The parental lines 1.7, 1.8, 6.14, 6.22, 6.34, 6.67, 6.73, 6.77, 7.16, 7.20, 7.26 and 9.8, from which the sub-clone hybridoma lines,

1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4 and 9.8.2, were derived all had anti-MAdCAM activity.

X481.2

[0267] A selected clone was further engineered to remove an inadvertent splicing event in the final protein. The inadvertent splicing event resulted in the production of an extended protein. It was discovered that the extension was the result of a read-through that led to the inadvertent splicing event. Without wishing to be bound by theory, it is believed that the inadvertent splicing event brought together the end of the heavy chain with a region 4244bp downstream (in the SV40 Derived Sequence Region). A new vector was designed to eliminate this observed extension. The heavy chain region was engineered to replace a nucleotide at the 3' end of the heavy chain (a change from T to A) resulting in the removal of the splice donor sight. The resulting MAdCAM antibody from this reengineered clone is X481.2.

ELISA assays:

[0268] Detection of antigen-specific antibodies in mouse serum and hybridoma supernatant was determined by ELISA as described (Coligan et al., Unit 2.1 "Enzyme-linked immunosorbent assays," in *Current Protocols in Immunology* (1994)) using MAdCAM-IgG₁ Fc fusion protein to capture the antibodies. For animals that were immunised with MAdCAM-IgG₁ Fc fusion protein, antibodies were screened for non-specific reactivity against human IgG₁ and for the ability to bind to FlpIn CHO MAdCAM cells by flow cytometry.

[0269] In a preferred ELISA assay, the following techniques are used:

[0270] ELISA plates were coated overnight at 4°C with 100 µL/well of MAdCAM-IgG₁ Fc fusion (4.5 µg/mL) in plate containing buffer (100 mM sodium carbonate/bicarbonate buffer

pH 9.6). After incubation, coating buffer was removed and the plate blocked with 200 μ L/well blocking buffer (5% BSA, 0.1% Tween 20, in phosphate buffered saline) and incubated at room temperature for 1 hour. Blocking buffer was removed and 50 μ L/well of hybridoma supernatant or other serum or supernatant (*e.g.*, positive control) added for 2 hours at room temperature. After incubation the plate was washed with PBS (3 x 100 μ L/well) and the binding of the hybridoma mAb detected with HRP-conjugated secondary antibodies (*i.e.* 1:1000 mouse anti-human IgG₂-HRP (SB Cat. No. 9060-05) for IgG₂ antibodies or 1:1000 mouse anti-human IgG₄-HRP (Zymed Cat. No. 3840) for IgG₄ antibodies) diluted in PBS. The plates were incubated at room temperature for 1 hour, washed in PBS (3 x 100 μ L/well) and finally developed with 100 μ L OPD (o-phenylenediamine (DAKO S2405) + 5 μ L 30% H₂O₂/12 mL). The plates were allowed to develop 10-20 mins, stopping the reaction with 100 μ L 2M H₂SO₄. The plates were read at 490 nm.

Adhesion assays:

[0271] Antibodies that demonstrated binding to MAdCAM-IgG1 Fc fusion protein by ELISA, were assessed for antagonist activity in an adhesion assays with $\alpha_4\beta_7^+$ JY cells and either (i) MAdCAM-IgG1 Fc fusion protein or (ii) MAdCAM-CHO cells.

(i) MAdCAM-IgG1 Fc fusion assay

[0272] 100 μ L of a 4.5 μ g/mL solution of purified MAdCAM-IgG1 Fc fusion protein in Dulbecco's PBS was adsorbed to 96 well Black Microfluor "B" u-bottom (Dynex #7805) plates overnight at 4°C. The MAdCAM coated plates were then inverted and excess liquid blotted off, prior to blocking at 37°C for at least 1 hour in 10% BSA/ PBS. During this time cultured JY cells were counted using trypan blue exclusion (should be approximately 8×10^5 cells/mL) and 20×10^6 cells/assay plate pipetted into a 50 mL centrifuge tube. JY cells were cultured in RPMI1640 media (Gibco), containing 2 mM L-glutamine and 10% heat-

inactivated fetal bovine serum (Life Technologies #10108-165) and seeded at $1-2 \times 10^5/\text{mL}$ every 2-3 days to prevent the culture from differentiating. The cells were washed twice with RPMI 1640 media (Gibco) containing 2 mM L-glutamine (Gibco) by centrifugation (240g), resuspending the final cell pellet at 2×10^6 cells/mL in RPMI 1640 for Calcein AM loading. Calcein AM (Molecular Probes #C-3099) was added to the cells as a 1:200 dilution in DMSO (*ca.* final concentration 5 μM) and the cells protected from light during the course of the incubation (37°C for 30 min). During this cell incubation step the antibodies to be tested, were diluted as follows: for single dose testing, the antibodies were made up to 3 $\mu\text{g/mL}$ (1 $\mu\text{g/mL}$ final) in 0.1 mg/mL BSA (Sigma#A3059) in PBS; for full IC_{50} curves, the antibodies were diluted in 0.1 mg/mL BSA/ PBS, with 3 $\mu\text{g/mL}$ (1 $\mu\text{g/mL}$ final) being the top concentration, then doubling dilutions (1:2 ratio) across the plate. The final well of the row was used for determining total binding, so 0.1mg/ml BSA in PBS was used.

[0273] After blocking, the plate contents were flicked out and 50 μL of antibodies/controls were added to each well and the plate incubated at 37°C for 20 min. During this time, Calcein-loaded JY cells were washed once with RPMI 1640 media containing 10% fetal bovine serum and once with 1 mg/mL BSA/PBS by centrifugation, resuspending the final cell pellet to $1 \times 10^6/\text{mL}$ in 1 mg/mL BSA/PBS. 100 μL of cells were added to each well of the U bottomed plate, the plate sealed, briefly centrifuged (1000 rpm for 2 min) and the plate then incubated at 37°C for 45 min. At the end of this time, the plates were washed with a Skatron plate washer and fluorescence measured using a Wallac Victor² 1420 Multilabel Reader (excitation λ 485nm, emission λ 535nm count from top, 8 mm from bottom of plate, for 0.1 sec with normal emission aperture). For each antibody concentration, percent adhesion was expressed as a percentage of maximal fluorescence response in the absence of any antibody minus fluorescence associated with non-specific binding. The IC_{50} value is defined as the anti-MAdCAM antibody concentration at which the adhesion response is decreased to 50%

of the response in the absence of anti-MAdCAM antibody. Antibodies that were able to inhibit the binding of JY cells to MAdCAM-IgG₁ Fc fusion with an IC₅₀ value <0.1 µg/mL, were considered to have potent antagonist activity and were progressed to the MAdCAM-CHO adhesion assay. All twelve of the tested Abs showed potent antagonist activity (Table 3). Monoclonal antibodies 1.7.2, 1.8.2, 7.16.6, 7.20.5 and 7.26.4 were derived from IgG₂κ lineages, and monoclonal antibodies 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1 and 9.8.2 were derived from IgG₄κ lineages.

(ii) MAdCAM-CHO cell adhesion assay.

[0274] JY cells were cultured as above. MAdCAM-expressing CHO cells were generated with the pEF5FRT MAdCAM cDNA construct and using the Flp recombinase technology (Invitrogen) as described above. Single stable clones of MAdCAM-expressing CHO cells were selected based on their ability to support the adhesion of JY cells and the binding, by flow cytometry, of the rabbit anti-peptide antibody, raised against the N-terminus of MAdCAM and described above. MAdCAM-expressing CHO cells were cultured in a DMEM/F12 media (Gibco # 21331-020) containing 2 mM L-glutamine, 10% fetal bovine serum (Gibco) and 350 µg/mL Hygromycin B (Invitrogen), splitting 1:5 every 2/3 days. For the adhesion assay, MAdCAM-expressing CHO cells were seeded at 4x10⁴ cells/well in 96 well black plates—clear bottom (Costar # 3904) in 200 µL culture medium and cultured overnight at 37°C/5% CO₂.

[0275] The following day, hybridoma supernatant or purified monoclonal antibody was diluted from a starting concentration of 30 µg/mL (equivalent to a final concentration of 10 µg/mL) in 1 mg/mL BSA/PBS, as described above. For the MAdCAM CHO plates, the plate contents were flicked out and 50 µL of antibodies/controls were added to each well and the plate incubated at 37°C for 20 min. The final well of the row was used for determining total

binding, so 0.1 mg/mL BSA in PBS was used. Calcein AM-loaded JY cells, to a final concentration of 1×10^6 /mL in 1 mg/mL BSA/PBS, were prepared as above, then 100 μ L added to the plate after the 20 min incubation period with the antibody. The plate was then incubated at 37°C for 45 min, then washed on a Tecan plate washer (PW 384) and fluorescence measured using the Wallac plate reader as described above. For each antibody concentration, percent adhesion was expressed as a percentage of maximal fluorescence response in the absence of any antibody minus fluorescence associated with non-specific binding. Antibodies that were able to inhibit the binding of JY cells to MAdCAM CHO cells with an IC_{50} value $<1 \mu$ g/mL were considered to have potent antagonist activity. As before, the IC_{50} value is defined as the anti-MAdCAM antibody concentration at which the adhesion response had decreased to 50% of the response in the absence of anti-MAdCAM antibody. The IC_{50} potencies for 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4 and 9.8.2 in this assay are described below in Table 3.

Table 3. IC_{50} values of exemplified anti-MAdCAM antibodies

Clone	MAdCAM IgG ₁ Fc fusion		MAdCAM FlpIn CHO Assay	
	Mean IC_{50} (μ g/mL)	n	Mean IC_{50} (μ g/mL)	n
1.7.2	0.030 $\pm$ 0.011	6	0.502 $\pm$ 0.280	9
1.8.2	0.027 $\pm$ 0.011	4	0.424 $\pm$ 0.107	8
7.16.6	0.019 $\pm$ 0.009	7	0.389 $\pm$ 0.093	16
7.20.5	0.025 $\pm$ 0.027	7	0.387 $\pm$ 0.202	9
7.26.4	0.021 $\pm$ 0.040	4	0.574 $\pm$ 0.099	15
6.14.2	0.011 $\pm$ 0.005	4	0.291 $\pm$ 0.096	6
6.22.2	0.018 $\pm$ 0.011	4	0.573 $\pm$ 0.168	7
6.34.2	0.013 $\pm$ 0.008	4	0.285 $\pm$ 0.073	7
6.67.1	0.013 $\pm$ 0.070	4	0.298 $\pm$ 0.115	8
6.73.2	0.020 $\pm$ 0.010	4	0.369 $\pm$ 0.103	8
6.77.1	0.022 $\pm$ 0.004	4	0.520 $\pm$ 0.100	4
9.8.2	0.020 $\pm$ 0.050	4	0.440 $\pm$ 0.342	8

IgG2

IgG4

[0276] To measure the antagonist potency of anti-MAdCAM mAbs in flow-based assays, under sheer stress conditions that are designed to mimic the microvascular environment on the high endothelial venules which serve the gut associated lymphoid tissue, CHO cells expressing MAdCAM were plated in glass microslides (50 x 4 mm) and allowed to adhere to form a confluent monolayer (*ca.* 2.5×10^5 cells). The cells were then incubated with affinity-purified mAb over a range of concentrations (0.1-10 $\mu\text{g/mL}$) for 20 mins at 37°C, before being connected to the flow assay system. An isotype matched IgG₂ or IgG₄ mAb (10 $\mu\text{g/mL}$) was used as a negative control. Normal donor peripheral blood lymphocytes (PBLs) were perfused over the cell monolayer at a constant shear stress of 0.05 Pa. Experiments were videoed and total adhesion of lymphocytes (rolling + firm adhesion) was calculated. All of the tested monoclonal antibodies were shown to be potent antagonists under the conditions described.

(iii) Stamper-Woodruff assays

[0277] To visualise MAdCAM⁺ vessels, biotinylated anti-MAdCAM mAb was generated on 1-2 mg of affinity-purified protein, using a 20 molar excess of biotin-NHS (Pierce) in phosphate buffer saline, according to manufacturer's instructions. The reaction was allowed to sit at room temperature (30 min), and desalted with a PD-10 (Pharmacia) column and the protein concentration determined.

[0278] Normal liver lymph node was removed from a donor organ, snap-frozen in liquid nitrogen and stored at -70°C until use. 10 μm cryostat sections were cut, air-dried on poly-L lysine coated slides, and fixed in acetone prior to the assay. Sections were blocked using an avidin-biotin blocking system (DAKO), and then incubated with biotinylated anti-MAdCAM mAb over a range of concentrations (1-50 $\mu\text{g/mL}$) at room temperature (2 hrs). An isotype matched IgG₂ or IgG₄ mAb (50 $\mu\text{g/mL}$) was used as a negative control and a blocking anti- β_7 antibody (50 $\mu\text{g/mL}$) as a positive control.

[0279] Peripheral blood lymphocytes, taken from normal donors, were labeled with a mouse anti-human CD2 mAb (DAKO) to allow subsequent visualisation of adherent cells. 5×10^5 PBLs were added to each lymph node section and incubated for 30 mins before being gently rinsed off to avoid detachment of adherent cells. Sections were then re-fixed in acetone, and re-incubated with biotinylated anti-MAdCAM mAb (10 $\mu\text{g/mL}$), followed by biotinylated goat-anti-mouse mAb (to recognise CD2 labeled PBLs and unstained MAdCAM⁺ vessels) and then streptABcomplex/HRP (DAKO). Finally MAdCAM⁺ vessels & CD2 labeled PBLs were visualised by addition of DAB substrate (DAKO) to the sections, with a brown reaction product showing areas of positive staining. Lymphocyte adhesion was quantified by counting the number of lymphocytes adhering to 50 MAdCAM-1⁺ vessels of portal tracts, veins or sinusoids. Data, expressed as mean values, were then normalised to percent adhesion, using the adhesion of PBLs in the absence of any antibody taken as 100%. The data were compiled on the basis of n=3 different PBL donors and for different liver lymph node donors. Representative data for biotinylated purified monoclonal antibodies 1.7.2 and 7.16.6 are depicted in Figure 4 compared to a blocking anti- β_7 antibody control.

Selectivity assays:

[0280] VCAM and fibronectin are close structural and sequence homologues to MAdCAM. Affinity-purified anti-MAdCAM mAbs were assessed for MAdCAM-specificity by determining their ability to block the binding of $\alpha_4\beta_1^+/\alpha_5\beta_1^+$ Jurkat T-cells (ATCC) to their cognate cell adhesion molecule. 100 μL of a 4.5 $\mu\text{g/mL}$ solution of Fibronectin cell binding fragment (110 Kd, Europa Bioproducts Ltd, Cat. No. UBF4215-18) or VCAM (Panvera) in Dulbecco's PBS was adsorbed to 96 well Black Microfluor "B" u-bottom (Dynex #7805) plates overnight at 4°C. The coated plates were then inverted and excess liquid blotted off, prior to blocking at 37°C for at least 1 hour in 10% BSA/ PBS. During this time cultured Jurkat T cells were counted using trypan blue exclusion and loaded with Calcein AM dye as

previously described for JY cells above. The antibodies to be tested, were diluted from a top concentration of 10 $\mu\text{g/mL}$ in 0.1 mg/ml BSA in PBS. The final well of the row was used for determining total binding, so 0.1mg/ml BSA in PBS was used. Echistatin (Bachem, Cat. No. H-9010) prepared in PBS was used at a top concentration of 100 nM to block the $\alpha_5\beta_1$ /Fibronectin interaction. An anti-CD106 mAb (Clone 51-10C9, BD Pharmingen Cat. No. 555645) at a top concentration of 1 $\mu\text{g/mL}$ was used to block the $\alpha_4\beta_1$ /VCAM interaction.

[0281] After blocking, the plate contents were flicked out and 50 μL of antibodies/controls were added to each well and the plate incubated at 37°C for 20 min. Calcein-loaded Jurkat T cells were washed once as before, resuspending the final cell pellet to $1 \times 10^6/\text{mL}$ in 1 mg/mL BSA/PBS. 100 μL of cells were added to each well of the U bottomed plate, the plate sealed, briefly centrifuged (1000 rpm for 2 min) and the plate then incubated at 37°C for 45 min. At the end of this time, the plates were washed with a Skatron plate washer and fluorescence measured using a Wallac Victor² 1420 Multilabel Reader (excitation λ 485nm, emission λ 535nm count from top, 8 mm from bottom of plate, for 0.1 sec with normal emission aperture). For each antibody, the degree of inhibition is expressed below pictorially, in Table 4 (- negligible inhibition of adhesion, *** complete inhibition of adhesion). All mAbs exemplified are potent and selective anti-MAdCAM antagonists, demonstrating substantially greater than 100 fold selectivity for MAdCAM over VCAM and fibronectin.

Table 4. Comparative selectivity of anti-MAdCAM antibody for MAdCAM over other cell adhesion molecules, Fibronectin and VCAM

Clone	Inhibition in $\alpha 5\beta 1$ /Fibronectin assay (10 μ g/mL)	Inhibition in $\alpha 4\beta 1$ /VCAM assay (10 μ g/mL)	Inhibition in $\alpha 4\beta 7$ /MAdCAM assay (0.1 μ g/mL)
1.7.2	-	-	***
1.8.2	-	-	***
7.16.6	-	-	***
7.20.5	-	-	***
7.26.4	-	-	***
6.14.2	-	-	***
6.22.2	-	-	***
6.34.2	-	-	***
6.67.1	-	-	***
6.73.2	-	-	***
6.77.1	-	-	***
9.8.2	-	-	***

IgG2
IgG4

[0282] Hybridomas were deposited in the European Collection of Cell Cultures (ECACC), H.P.A at CAMR, Porton Down, Salisbury, Wiltshire SP4 0JG on 9th September 2003 with the following deposit numbers:

<u>Hybridoma</u>	<u>Deposit No.</u>
1.7.2	03090901
1.8.2	03090902
6.14.2	03090903
6.22.2	03090904
6.34.2	03090905

6.67.1	03090906
6.73.2	03090907
6.77.1	03090908
7.16.6	03090909
7.20.5	03090910
7.26.4	03090911
9.8.2	03090912

EXAMPLE II:

Determination of Affinity Constants (K_d) of Fully Human Anti-MAdCAM Monoclonal Antibodies by BIAcore

[0283] We performed affinity measures of purified antibodies by surface plasmon resonance using the BIAcore 3000 instrument, following the manufacturer's protocols.

Protocol 1

[0284] To perform kinetic analyses, a high density mouse anti-human (IgG₂ and IgG₄) antibody surface over a CM5 BIAcore sensor chip was prepared using routine amine coupling. Hybridoma supernatants were diluted 10, 5, 2-fold in HBS-P (10 mM HEPES pH 7.4, 150 mM NaCl, 0.005% Surfactant P20) running buffer containing 100 µg/mL BSA and 10 mg/mL carboxymethyl dextran or used neat. Each mAb was captured onto a separate surface using a 1 min contact time and a 5 min wash for stabilization of the mAb baseline. MAdCAM-IgG₁ Fc (141 nM) fusion protein was then injected at over all surfaces for one minute, followed by a 3 min dissociation. The data were normalized for the amount of antibody captured on each surface and evaluated with global fit Langmuir 1:1, using baseline drift models available on the BIAevaluation software provided by BIAcore.

Protocol 2

[0285] Affinity-purified mAb were immobilized onto the dextran layer of a CM5 biosensor chip using amine coupling. Chips were prepared using pH 4.5 acetate buffer as the immobilization buffer and protein densities of 2.5-5.5 kRU were achieved. Samples of MAdCAM-IgG₁ Fc fusion protein in running buffer were prepared at concentrations ranging

from 0.2-55 nM (a 0 nM solution comprising running buffer alone was included as a zero reference). Samples were randomized and injected in duplicate for 3 min each across 4 flow cells using HBS-EP (10 mM HEPES pH 7.4, 150 mM NaCl, 3 mM EDTA, 0.005% Surfactant P20) as running buffer. A flow rate of 100 μ L/min was used to minimize mass transport limitations. Dissociation of MAdCAM-IgG₁ Fc fusion protein was monitored for 180 mins, the surface regenerated by a 6 sec injection of 25 mM H₃PO₄ (50 μ L/min), or 10 mM (6.22.2), 20 mM (6.67.1, 6.73.2, 6.77.1) to 25 mM (6.34.2) and 45 mM NaOH (6.14.2) and the data analysed using the BIAevaluation (v3.1) software package.

[0286] Table 5 lists affinity measurements for representative anti-MAdCAM antibodies of the present disclosure:

Table 5. Determination of affinity constant, K_d , by surface plasmon resonance (BIAcore)

CLONE	Protocol 1			Protocol 2		
	k_{on} (1/Ms)	k_{off} (1/s)	K_D (pM)	k_{on} (1/Ms)	k_{off} (1/s)	K_D (pM)
1.7.2	2.4×10^5	1×10^{-5}	42	5.5×10^3	1.3×10^{-7}	23.6
1.8.2	2.9×10^5	1×10^{-5}	35	1.8×10^5	2.3×10^{-5}	128
7.16.6	1.5×10^6	2.2×10^{-6}	1.5	2.9×10^5	1.4×10^{-6}	4.8
7.20.5	4.5×10^5	1.9×10^{-5}	42.2	1.6×10^5	1.2×10^{-5}	75
7.26.4	9.6×10^5	2.6×10^{-4}	271	1.5×10^5	1.2×10^{-5}	80
6.14.2	1.3×10^5	1×10^{-5}	7.7	5×10^5	$< 5 \times 10^{-6}$	< 10
6.22.2	1.5×10^6	1.4×10^{-5}	9.3	2.3×10^5	8.7×10^{-7}	3.8
6.34.2	1.2×10^6	1.9×10^{-5}	15.8	3.3×10^5	$< 5 \times 10^{-6}$	< 15
6.67.1	5.9×10^5	1×10^{-5}	17	2.4×10^5	$< 5 \times 10^{-6}$	< 20
6.73.2	1.4×10^5	1.3×10^{-4}	93			
6.77.1	1.5×10^5	1×10^{-5}	6.7			
9.8.2	2.3×10^6	2.3×10^{-4}	100	4.4×10^5	1.4×10^{-5}	32.5

IgG2
IgG4

[0287] The kinetic analyses indicate that the antibodies prepared in accordance with the disclosure possess high affinities and strong binding constants for the extracellular domain of MAdCAM.

EXAMPLE III:

Identification of epitope selectivity and species cross-reactivity of anti-MAdCAM mAbs

[0288] Antibodies recognize surface-exposed epitopes on antigens as regions of linear (primary) sequence or structural (secondary) sequence. Luminex epitope binning, BIAcore binning and species immunohistochemical analysis were used in concert, in order to define the functional epitope landscape of the anti-MAdCAM antibodies.

Luminex-based Epitope Binning:

[0289] MxhlgG 2,3,4-conjugated beads (Calbiochem M1 1427) were coupled to the primary unknown anti-MAdCAM antibody. We added 150 μ L of primary unknown antibody dilution (0.1 μ g/mL diluted in hybridoma medium) to the well of a 96-well tissue culture plate. The bead stock was gently vortexed and diluted in supernatant to a concentration of 0.5×10^5 beads/mL. The beads were incubated in the supernatant on a shaker overnight in the dark at 4°C.

[0290] Each well of a 96-well microtiter filter plate (Millipore # MABVN1250) was pre-wetted by adding 200 μ L wash buffer (PBS containing 0.05% Tween20) and removed by aspiration. Next, 50 μ L/well of the 0.5×10^5 beads/mL stock was added to the filter plate, and the wells washed with wash buffer (2 x 100 μ L/well). 60 μ L/well of MAdCAM-IgG₁ Fc antigen diluted in hybridoma medium (0.1 μ g/mL) was added. The plates were covered and incubated at room temperature with gentle shaking for one hour. The wells were washed twice by addition of 100 μ L/well wash buffer followed by aspiration. Next, we added 60

μL/well of secondary unknown anti-MAdCAM antibody diluted in hybridoma medium (0.1 μg/mL). The plates were shaken at room temperature in the dark for two hours. Next, the wells were washed twice by addition of 100 μL/well wash buffer followed by aspiration. Next, 60 μL/well of biotinylated MxhIgG 2,3,4 (0.5 μg/mL) was added. The plates were shaken at room temperature in the dark for one hour. The wells were washed twice by addition of 100 μL/well wash buffer followed by aspiration. To each well, 60 μL of 1 μg/mL MxhIgG 2,3,4 Streptavidin-PE (Pharmacia #554061) diluted in hybridoma medium was added. The plates were shaken at room temperature in the dark for twenty minutes. The wells were washed twice by addition of 100 μL/well wash buffer followed by aspiration. Next, each well was resuspended in 80 μL blocking buffer (PBS with 0.5% bovine serum albumin, 0.1% TWEEN and 0.01% Thimerosal) carefully pipetted up and down to resuspend the beads.

[0291] Using Luminex 100 and its accompanying software (Luminex® Corporation) the plates were read to determine luminescence readings. Based on the luminescence data obtained for the various anti-MAdCAM antibodies tested, the anti-MAdCAM antibodies were grouped according to their binding specificities. The anti-MAdCAM antibodies that were tested fall into a series of epitope bins, represented in Table 8.

BIAcore binning:

[0292] In a similar method to that described above, BIAcore can also be used to determine the epitope exclusivity of the anti-MAdCAM antibodies exemplified by this disclosure. Nine anti-MAdCAM antibody clones, 6.22.2, 6.34.2, 6.67.1, 6.77.1, 7.20.5, 9.8.2, 1.7.2, 7.26.4 and 7.16.6, were immobilized onto the dextran layer of separate flow cells of a CM5 biosensor chip using amine coupling. The immobilization buffer was either 10 mM acetate buffer pH 4.5 (clones 6.22.2, 6.34.2, 7.20.5, 9.8.2, 1.7.2, 7.26.4 and 7.16.6) or 10 mM acetate buffer pH 5.5 (clones 6.67.1 and 6.77.1). A protein density of approximately 3750 RU was achieved in

all cases. Deactivation of unreacted N-hydroxysuccinimide esters was performed using 1 M ethanolamine hydrochloride, pH 8.5.

[0293] MAdCAM-IgG₁ Fc fusion protein was diluted to a concentration of 1.5 µg/mL (approximately 25 nM) in HBS-EP running buffer (0.01 M HEPES pH 7.4, 0.15 M NaCl, 3 mM EDTA, 0.005% Polysorbate 20). It was then injected across the first flow cell, in a volume of 50 µL at a rate of 5 µL/min. After the injection was complete, the first antibody probe was added to the same flow cell. All test antibodies were diluted to a concentration of approximately 20 µg/mL in HBS-EP, and also injected in a volume of 50 µL at a flow rate of 5 µL/min. When no binding of the test antibody was observed, the next test clone was injected immediately afterwards. When binding did occur, the sensor surface was regenerated to remove both the MAdCAM-IgG₁ Fc fusion protein and the test antibody. A variety of regeneration solutions were used depending upon the immobilized antibody and the test antibody present. A summary of the regeneration conditions used is depicted in Table 6.

Table 6. Summary of regeneration conditions used to perform BIAcore epiope mapping

Immobilised antibody	Antibody probe to be removed	Regeneration solution	Injection volume
7.16.6	6.22.2	40 mM Phosphoric Acid	20 µL
	6.34.2	40 mM Phosphoric Acid	40 µL
	7.20.5	40 mM Phosphoric Acid	20 µL
6.77.1	9.8.2	40 mM Phosphoric Acid	10 µL
	1.7.2	40 mM Phosphoric Acid	5 µL
	7.16.6	40 mM Phosphoric Acid	10 µL
1.7.2	6.77.1	25 mM Phosphoric Acid	5 µL
	9.8.2	25 mM Phosphoric Acid	5 µL
	7.20.5	25 mM Phosphoric Acid	5 µL
	6.22.2	25 mM Phosphoric Acid	5 µL
	6.34.2	25 mM Sodium Hydroxide	5 µL
	6.67.1	25 mM Sodium Hydroxide	5 µL
6.22.2	9.8.2	25 mM Sodium Hydroxide	20 µL
	7.26.4	25 mM Sodium Hydroxide	5 µL
6.34.2	9.8.2	25 mM Sodium Hydroxide	70 µL
	1.7.2	40 mM Sodium Hydroxide	5 µL
	7.26.4	40 mM Sodium Hydroxide	5 µL

6.67.1	9.8.2	40 mM Sodium Hydroxide	5 μ L
	1.7.2	40 mM Sodium Hydroxide	5 μ L
7.20.5	9.8.2	25 mM Phosphoric Acid	5 μ L
	1.7.2	25 mM Phosphoric Acid	5 μ L
	7.26.4	25 mM Phosphoric Acid	5 μ L
7.26.4	9.8.2	40 mM Sodium Hydroxide	20 μ L
	6.22.2	75 mM Phosphoric Acid	20 μ L
	7.20.5	75 mM Phosphoric Acid	20 μ L
	7.16.6	75 mM Phosphoric Acid	20 μ L
9.8.2	9.8.2	25 mM Phosphoric Acid	15 μ L
	6.22.2	25 mM Phosphoric Acid	10 μ L
	7.20.5	25 mM Phosphoric Acid	20 μ L
	7.16.6	25 mM Phosphoric Acid	10 μ L

(Flow rate was 50 μ L/min during all regeneration procedures)

[0294] After regeneration, MAdCAM-IgG₁ Fc fusion protein was bound again and further test antibodies were injected. These procedures were carried out until the entire panel of clones had been injected over the surface of the immobilised antibody, with bound MAdCAM-IgG₁ Fc fusion protein. A new flow cell with a different immobilised antibody and bound MAdCAM was then used for probing with the nine test clones. Anti-MAdCAM antibodies 1.7.2 and 1.8.2 were expected to recognise the same MAdCAM epitope, based on the close primary amino acid sequence homology of their heavy and kappa light chains, SEQ ID NOS: 2, 4, 6, 8 respectively. Accordingly, only 1.7.2 was assessed through the BIAcore response matrix. Antibodies 6.14.2 and 6.73.2 were omitted from this analysis, but all other combinations of anti-MAdCAM antibody pairs were tested in this way. An arbitrary level of 100 RU was chosen as the threshold between binding/non-binding and a response matrix, (Table 7), was created based on whether binding was observed.

Table 7. BIAcore epitope binning response matrix

Immobilised antibody	Secondary antibody								
	6.22.2	6.34.2	6.67.1	6.77.1	7.20.5	9.8.2	1.7.2	7.26.4	7.16.6
6.22.2	-	-	-	-	-	x	x	x	x
6.34.2	-	-	-	-	-	x	x	x	x
6.67.1	-	-	-	-	-	x	x	-	-
6.77.1	-	-	-	-	-	x	x	-	x

7.20.5	-	-	-	-	-	x	x	x	x
9.8.2	x	x	x	x	x	x	-	-	x
1.7.2	x	x	x	x	x	x	-	-	x
7.26.4	x	x	-	-	x	x	-	-	x
7.16.6	x	x	-	-	x	-	-	-	x

Response matrix for all combinations of antibody pairs. - indicates no binding of the antibody probe, x indicates binding was observed (above a chosen threshold level of 100 RU).

[0295] The matrix diagonal in Table 7 (shaded grey) holds the binding data for identical probe pairs. In all instances, except for the two clones 7.16.6 and 9.8.2, the antibodies were self-blocking. Antibodies 7.16.6 and 9.8.2 do not cross compete. The lack of self-blocking could be due to a mAb-induced conformational change in the fusion protein that permits additional binding of the mAb to a second site on MAdCAM-IgFc. Grouping the clones that show the same reactivity pattern gives rise to at least six different epitope bins, as shown in the graphical representation, Figure 5).

[0296] Further precise identification of the MAdCAM epitope sequences with which an anti-MAdCAM antibody interacts can be determined by any of a number of methods, including, but not limited to, Western analysis of spotted peptide library arrays (Reineke et al., *Curr. Topics in Microbiol. and Immunol* 243: 23-36 (1999), M. Famulok, E-L Winnacker, C-H Wong eds., Springer-Verlag, Berlin), phage or bacterial flagellin/*fliC* expression library display, or simple MALDI-TOF analysis of bound protein fragments following limited proteolysis.

Immunohistochemical assays:

[0297] OCT or sucrose-embedded frozen tissue specimens of ileum (Peyer's patches), mesenteric lymph node, spleen, stomach, duodenum, jejunum and colon were used as a positive staining controls for the anti-MAdCAM mAbs. For staining human sections with human IgG₂ mAbs, biotinylated derivatives of the anti-MAdCAM mAbs were generated. 10 µm frozen tissue sections were cut onto poly L-lysine coated slides, placed directly into

100% acetone 4°C (10 min), then 3% hydrogen peroxide in methanol (10 min), washing between steps with PBS. The slides were blocked with Biotin Blocking System (DAKO Cat. No. X0590), prior to incubation with the primary antibody (1:100 - 1:1000) in PBS (1 hr), washed with PBS-Tween 20 (0.05%) and then binding developed with HRP-Streptavidin (BD Bioscience Cat. No.550946, 30 min) and DAB substrate (Sigma Cat. No. D5905). For IgG₄ mAbs, an HRP-conjugated, mouse anti-human IgG₄ (Zymed Cat. No. 3840) secondary was used. The slides were counterstained with Mayer's Haemalum (1 min), washed and then mounted in DPX.

[0298] Binding affinity was compared for a number of species (mouse, rat, rabbit, dog, pig, cynomolgus and human tissue). There was no reactivity for rat, rabbit and pig tissue by immunohistochemistry and no cross-reactivity of the anti-MAdCAM antibodies for recombinant mouse MAdCAM, when analyzed by ELISA. The data for human, cynomolgus and dog tissue are presented in table form, Table 8 below:

Table 8. Pattern of cross reactivity of anti-MAdCAM antibodies to MAdCAM species orthologues

CLONE	Luminex BIN	IHC cross-reactivity			
		human ileum	cyno ileum	marmoset ileum	dog ileum
1.7.2	3a				
1.8.2	3a				
7.16.6	3b				
7.20.5	2b			n.d	
7.26.4	3b			n.d	
6.14.2	2			n.d	
6.22.2	2			n.d	
6.34.2	6			n.d	
6.67.1	5			n.d	
6.73.2	3		n.d	n.d	
6.77.1	1			n.d	
9.8.2	3a		n.d		

IgG2	No Binding
IgG4	Binding

n.d: not determined

[0299] Anti-MAdCAM binding to specialised endothelial structures and lymphoid tissue is indicated by the shading, according to the key. The epitope bin based on Luminex epitope analysis and the pattern of MAdCAM cross-reactivity are indicated for each antibody.

Luminex epitope binning data for anti-MAdCAM antibodies 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.3 and 6.77.1 (*italics*) were derived from separate experiments than that for 1.7.2, 1.8.2, 7.16.6, 7.20.5, 7.26.4 and 9.8.2 (**bold type**), as indicated by the difference in font character.

[0300] All anti-MAdCAM antibodies tested had the ability to recognize a human MAdCAM epitope expressed on vascular endothelial compartments of the gastrointestinal tract. Apart from 1.7.2 and 1.8.2, all other anti-MAdCAM antibodies tested were able to specifically bind the vascular endothelial compartments of the cynomolgus gastrointestinal tract. Certain other anti-MAdCAM antibodies, namely 6.14.2 and 6.67.1 also had the ability to specifically recognize the dog MAdCAM orthologue as well as cynomolgus MAdCAM.

Generation of a functionally active chimeric cynomolgus/human MAdCAM-expressing CHO cell line:

[0301] The differences in binding affinity of certain anti-MAdCAM antibodies for human and cynomolgus MAdCAM led us to determine whether a structural basis for this observation could be made.

[0302] Based on the published amino acid sequence for Macaque MAdCAM (Shyjan AM, et al., *J Immunol.*, 156, 2851-7 (1996)), primers were designed to PCR amplify the cynomolgus MAdCAM $\alpha_4\beta_7$ binding domain sequence. Total RNA was prepared from frozen excised cynomolgus mesenteric lymph node (*ca.* 200 mg) using the Trizol method (Invitrogen) according to the manufacturer's instructions. 1-2 μ g was oligo-dT primed and reverse transcribed with AMV reverse transcriptase (Promega). A proportion of the reverse transcribed product was subjected to PCR with forward 5'-AGC ATG GAT CGG GGC CTG GCC-3' (SEQ ID NO: 67) and reverse 5'-GTG CAG GAC CGG GAT GGC CTG-3' (SEQ

ID NO: 68) primers with GC-2 polymerase in 1M GC melt (Clontech) and at an annealing temperature of 62°C. An RT-PCR product of the appropriate size was excised and purified from a 1% agarose gel after electrophoresis, then TOPO-TA cloned (Invitrogen) between EcoRI sites of pCR2.1. The insert was sequence confirmed. The nucleotide and predicted translated amino acid sequences are shown in SEQ ID NOS 49 and 50, respectively.

[0303] The predicted human and cynomolgus MAdCAM amino acid sequences for the $\alpha 4\beta 7$ binding domain show a high degree of sequence identity (90.8%) when aligned (Figure 3 provides this sequence alignment). To generate a functionally active cynomolgus MAdCAM-expressing cell line, which mimicked the anti-MAdCAM binding pattern represented by Table 8, a SacI fragment corresponding to the cynomolgus $\alpha 4\beta 7$ binding domain sequence in pCR2.1, was subcloned directly into the C-terminal human MAdCAM pIND-Hygro construct containing carboxyl-terminal mucin stalk and transmembrane domain, described above. The sequence and orientation was verified, then a KpnI/NotI fragment was cloned into pEF5FRTV5GWCAT vector (Invitrogen), replacing the CAT coding sequence and used in transfections to generate single stably expressing clones in Flp In CHO cells (Invitrogen), according to the manufacturer's instructions.

[0304] The binding of anti-MAdCAM antibody clones to the CHO cells expressing cynomolgus/human MAdCAM chimera was assessed by flow cytometry and the functional activity of anti-MAdCAM antibodies was determined using a very similar JY cell adhesion assay as that described above. The binding and functional activity of anti-MAdCAM antibodies are expressed in Table 9.

[0305] Table 9. Correlation between the functional activity in the cynomolgus/human MAdCAM-CHO/JY adhesion assay and human and cynomolgus/human MAdCAM CHO cell binding, as measured by FACS, for a range of anti-MAdCAM antibodies.

CLONE	Functional IC ₅₀ (μg/mL)	FACS binding	
		human	cyno/human
1.7.2	inactive		
1.8.2	inactive		
7.16.6	0.72		
7.20.5	0.62		
7.26.4	0.96		
6.14.2	0.53		
6.22.2	0.83		
6.34.2	0.47		
6.67.1	0.75		
6.73.2	inactive		
6.77.1	0.64		
9.8.2	0.83		

IgG2	No Binding
IgG4	Binding

[0306] Taken together, there is a good correlation between the ability of a given anti-MAdCAM antibody to bind human or cynomolgus MAdCAM, as detected by immunohistochemistry (Table 8), with recombinant cell-based binding and functional activity (Table 9). Anti-MAdCAM antibodies 1.7.2, 1.8.2 and 6.73.2, for instance, demonstrated a consistent lack of binding to cynomolgus tissue and cells expressing a chimeric cynomolgus/human MAdCAM protein. Anti-MAdCAM antibodies 1.7.2, 1.8.2 and 6.73.2 also did not have the ability to detect functional blocking activity in the cynomolgus/human MAdCAM/JY adhesion assay.

[0307] Similar approaches could be used to define the epitope of the anti-MAdCAM antibodies 6.14.2 and 6.67.1 that recognise dog MAdCAM.

EXAMPLE IV:Use of anti-MAdCAM mAbs
in the detection of circulating soluble MAdCAM as a method of disease diagnosis

[0308] Anti-MAdCAM antibodies can be used for the detection of circulating soluble MAdCAM (sMAdCAM). Detection of sMAdCAM in clinical plasma, serum samples or other biofluid, such as, but not limited to, stool, urine, sputum. is likely to be a useful surrogate disease biomarker for underlying disease, including, but not limited to, inflammatory bowel disease.

[0309] Based on the epitope binning data (Tables 7 and 8), anti-MAdCAM antibodies 1.7.2 and 7.16.6 appear to recognise different epitopes on human MAdCAM. ELISA plates were coated overnight at 4°C with 100 µL/well of a 50 µg/mL solution of 1.7.2 in phosphate buffered saline (PBS). After incubation the plate was blocked for 1.5 hours with a PBS blocking buffer containing 10% milk (200 µL/well). After incubation the plate was washed with PBS (2 x 100 µL/well) and serial dilutions of MAdCAM-IgG1-Fc fusion protein, from a top concentration of 50 µg/mL down to approximately 5 ng/mL in PBS, to a final volume of 100 µL, were added to the plate for incubation of 2 hours at room temperature. In a similar approach the MAdCAM-IgG1-Fc protein can be diluted in plasma or serum, or some other such relevant biofluid and used to determine the expression of soluble MAdCAM in a clinical sample, as described below. As a negative control, only buffer was added to the wells containing the primary anti-MAdCAM antibody. After this time, the plate was washed with PBS (3 x 100 µL/well) and the plate then incubated in the dark with an Alexa488-labelled 7.16.6 (100 µL, 5 µg/mL). The Alexa488-labelled 7.16.6 was generated using a commercially available kit (Molecular Probes, A-20181), following Manufacturer's protocols.

[0310] The plate was washed with PBS containing 0.05% Tween-20, and binding of labeled 7.16.6 to captured soluble MAdCAM determined by measuring the fluorescence (Wallac Victor² 1420 Multilabel Reader, excitation λ 485nm, emission λ 535nm count from top, 3 mm from bottom of plate, for 0.1 sec with normal emission aperture). When fluorescence is plotted as a function of the concentration of MAdCAM-IgG1-Fc fusion protein, Figure 6, it indicates that 1.7.2 and a labeled 7.16.6 can be used for diagnostic purposes to determine the level of circulating soluble MAdCAM expressed in a biofluid or clinical sample. This sandwich ELISA approach is not restricted to the use of 1.7.2 and 7.16.6, but any combination of anti-MAdCAM antibodies that recognise different epitopes on MAdCAM, as outlined by the data and interpretation of table 7 and Figure 5. Similar strategies could be applied to the development of similar assays, such as immunohistochemistry and Western Blot, with the other anti-MAdCAM antibodies described, using different partners, variants, labels, etc.

EXAMPLE V:

Amino acid structure of anti-MAdCAM mAbs prepared in accordance to the disclosure

[0311] In the following discussion, structural information related to the anti-MAdCAM mAbs prepared in accordance with the disclosure is provided.

[0312] To analyze structures of mAbs produced in accordance with the disclosure, we cloned the genes encoding the heavy and light chain fragments out of the specific hybridoma clone. Gene cloning and sequencing was accomplished as follows:

[0313] Poly(A)⁺ mRNA was isolated from approximately 2×10^5 hybridoma cells derived from immunized XenoMouse mice using Fast-Track kit (Invitrogen). The generation of random primed cDNA was followed by PCR. Human VH or V κ family specific primers (Marks et al., 'Oligonucleotide primers for polymerase chain reaction amplification of human

immunoglobulin variable genes and design of family-specific oligonucleotide probes'; *Eur. J. Immunol.*, **21**, 985-991 (1991)) or a universal human VH primer, MG-30 (5'-CAG GTG CAG CTG GAG CAG TCI GG-3 (SEQ ID NO: 108) was used in conjunction with primers specific for the human C γ 2, MG40-d (5'-GCT GAG GGA GTA GAG TCC TGA GGA-3 (SEQ ID NO: 109) or C γ 4 constant region, MG-40d (5'-GCT GAG GGA GTA GAG TCC TGA GGA CTG T -3 (SEQ ID NO: 110), or C κ constant region (h κ P2; as previously described in Green et al., 1994). Sequences of the human mAb-derived heavy and kappa chain transcripts from hybridomas were obtained by direct sequencing of PCR products generated from poly (A⁺) RNA using the primers described above. PCR products were cloned into pCR2.1 using a TOPO-TA cloning kit (Invitrogen) and both strands were sequenced using Prism dye terminator sequencing kits and an ABI 377 sequencing machine. All sequences were analysed by alignments to the 'V BASE sequence directory' (Tomlinson, et al, *J. Mol. Biol.*, **227**, 776-798 (1992); *Hum. Mol. Genet.*, **3**, 853-860 (1994); *EMBO J.*, **14**, 4628-4638 (1995).)

[0314] Further each of the antibodies, 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod, were subjected to full length DNA sequencing. For such, total RNA was isolated from approximately 3-6x10⁶ hybridoma cells using an RNeasy kit (Qiagen). The mRNA was reverse transcribed using oligo-dT and an AMV-based reverse transcriptase system (Promega). V BASE was used to design 5' specific amplification primers, containing an optimal Kozak sequence and ATG start codon (underlined) and 3' reverse primers for the specific heavy and kappa chains as depicted in Table 10.

Table 10: PCR primer pairs for cDNA amplification from anti-MAdCAM mAb-expressing hybridomas and primers used in the construction of modified versions of anti-MAdCAM antibodies.

	Oligo sequence
VH1-18	5' TATCTAAGCTTCTAGACTCGAGCGCCACCATGGACTGGACCTGGAGCATCCTT 3' (SEQ ID NO: 70)
VH3-15	5' TATCTAAGCTTCTAGACTCGAGCGCCACCATGGAGTTTGGGCTGAGCTGGATT 3' (SEQ ID NO: 71)
VH3-21	5' TATCTAAGCTTCTAGACTCGAGCGCCACCATGGAACCTGGGGCTCCGCTGGGTT 3' (SEQ ID NO: 72)
VH3-23	5' TATCTAAGCTTCTAGACTCGAGCGCCACCATGGAGTTTGGGCTGAGCTGGCTT 3' (SEQ ID NO: 73)
VH3-30	5' TATCTAAGCTTCTAGACTCGAGCGCCACCATGGAGTTTGGGCTGAGCTGGGTT 3' (SEQ ID NO: 74)
VH3-33	5' TATCTAAGCTTCTAGACTCGAGCGCCACCATGGAGTTTGGGCTGAGCTGGGTT 3' (SEQ ID NO: 75)
VH4-4	5' TATCTAAGCTTCTAGACTCGAGCGCCACCATGAAACACCTGTGGTTCTTCCTC 3' (SEQ ID NO: 76)
A2/A3	5' TATCTAAGCTTCTAGACCCGGGCGCCACCATGAGGCTCCCTGCTCAGCTCCTG 3' (SEQ ID NO: 77)
A26	5' TATCTAAGCTTCTAGACCCGGGCGCCACCATGTTGCCATCACAACCTATTGGG 3' (SEQ ID NO: 78)
B3	5' TATCTAAGCTTCTAGACCCGGGCGCCACCATGGTGTTCAGACCCAGGTCCTC 3' (SEQ ID NO: 79)
O12	5' TATCTAAGCTTCTAGACCCGGGCGCCACCATGGACATGAGGGTCCCGCTCAG 3' (SEQ ID NO: 80)
O18	5' TATCTAAGCTTCTAGACCCGGGCGCCACCATGGACATGAGGGTCCCTGCTCAG 3' (SEQ ID NO: 81)
RevIgG2	5' TTCTCTGATCAGAATTCCTATCATTTACCCGGAGACAGGGAGAG 3' (SEQ ID NO: 82)
RevIgG4	5' TTCTTTGATCAGAATTCCTACTAACACTCTCCCTGTGTAAGC 3' (SEQ ID NO: 83)
RevKappa	5' TTCTCTGATCAGAATTCCTATCATTTACCCAGAGACAGGGAGAG 3' (SEQ ID NO: 84)
6.22.2VK_F1	5'-GGA TCT GGG ACA GAT TTC ACC CTC ACC ATC AAT AGC CTG GAA GC-3' (SEQ ID NO: 85)
6.22.2VK_R1	5'-GCT TCC AGG CTA TTG ATG GTG AGG GTG AAA TCT GTC CCA GAT CC-3' (SEQ ID NO: 86)
6.22.2VH_F1	5'-GCA GCG TCT GGA TTC ACC TTC AGT AGC-3' (SEQ ID NO: 87)
6.22.2VH_R1	5'-GCT ACT GAA GGT GAA TCC AGA CGC TGC-3' (SEQ ID NO: 88)
6.22.2VH_CS*	5'-CGG AGG TGC TTC TAG AGC AGG GCG-3' (SEQ ID NO: 89)
6.34.2VK_F1	5'-GCA AGT CAG AGT ATT AGT AGC TAT TTA AAT TGG TAT CAG CAG AAA CC-3' (SEQ ID NO: 90)
6.34.2VK_R1	5'-GGT TTC TGC TGA TAC CAA TTT AAA TAG CTA CTA ATA CTC TGA CTT GC-3' (SEQ ID NO: 91)
6.34.2VK_F2	5'-CCA TCA GTT CTC TGC AAC CTG AGG ATT TTG CAA CTT ACT ACT GTC ACC-3' (SEQ ID NO: 92)
6.34.2VK_R3	5'-GGT GAC AGT AGT AAG TTG CAA AAT CCT CAG GTT GCA GAG AAC TGA TGG-3' (SEQ ID NO: 93)
6.34.2VH_F16.34.2VH_R1	5'-GCA AAT GAA CAG CCT GCG CGC TGA GGA CAC G-3' (SEQ ID NO: 94)
	5'-CGT GTC CTC AGC GCG CAG GCT GTT CAT TTG C-3' (SEQ ID NO: 95)
6.67.1VK_F1	5'-CAA TAA GAA CTA CTT AGC TTG GTA CCA ACA GAA ACC AGG ACA GCC-3' (SEQ ID NO: 96)
6.67.1VK_R1	5'-GGC TGT CCT GGT TTC TGT TGG TAC CAA GCT AAG TAG TTC TTA TTG-3' (SEQ ID NO: 97)
6.67.1VH_F1	5'-CCC TCA GGG GTC GAG TCA CCA TGT CAG TAG ACA CGT CCA AGA ACC-3' (SEQ ID NO: 98)
6.67.1VH_R1	5'-GGT TCT TGG ACG TGT CTA CTG ACA TGG TGA CTC GAC CCC TGA GGG-3' (SEQ ID NO: 99)
6.67.1VH_CS*	5'-ATT CTA GAG CAG GGC GCC AGG-3' (SEQ ID NO: 100)
6.77.1VK_F1	5'-CCA TCT CCT GCA AGT CTA GTC AGA GCC TCC-3' (SEQ ID NO: 101)
6.77.1VK_R1	5'-GGA GGC TCT GAC TAG ACT TGC AGG AGA TGG-3' (SEQ ID NO: 102)
6.77.1VK_F2	5'-GGT TTA TTA CTG CAT GCA AAG TAT ACA GCT TAT GTC CAG TTT TGG CC -

	Oligo sequence
6.77.1VK_R2	3' (SEQ ID NO: 103) 5'-GGC CAA AAC TGG ACA TAA GCT GTA TAC TTT GCA TGC AGT AAT AAA CC - 3' (SEQ ID NO: 104)
7.26.4K_F1	5'-CCT GCA AGT CTA GTC AGA GCC TCC-3' (SEQ ID NO: 105)
7.26.4K_R1	5'-GGA GGC TCT GAC TAG ACT TGC AGG-3' (SEQ ID NO: 106)

[0315] The primers pairs were used to amplify the cDNAs using Expand High Fidelity Taq polymerase (Roche), and the PCR products cloned into pCR2.1 TOPO-TA (Invitrogen) for subsequent sequencing. Heavy and kappa light chain sequence verified clones were then cloned into pEE6.1 and pEE12.1 vectors (LONZA) using XbaI/EcoRI and HindIII/EcoRI sites respectively.

Gene Utilization Analysis

[0316] Table 11 displays the heavy and kappa light chain gene utilization for each hybridoma outlined in the disclosure.

CLONE	Heavy Chain			Kappa light Chain	
	VH	D	JH	Vκ	Jκ
1.7.2	VH3-15	D6-19	JH4b	A3	JK5
1.8.2	VH3-15	D6-19	JH4b	A3	JK5
7.16.6	VH1-18	D6-6	JH6b	A2	JK1
7.20.5	VH4-4	D3-10	JH6b	A3	JK4
7.26.4	VH1-18	D6-6	JH6b	A2	JK1
6.14.2	VH3-23	D5-5	JH4b	O12	JK5
6.22.2	VH3-33	D5-12	JH6b	A26	JK4
6.34.2	VH3-30	D4-23	JH6b	O12	JK3
6.67.1	VH4-4	D3-10	JH4b	B3	JK4
6.73.2	VH3-23	D6-19	JH6b	O12	JK2
6.77.1	VH3-21	D6-19	JH6b	A2	JK2
9.8.2	VH3-33	D3-10 or D3-16	JH4b	O18	JK5

IgG2

IgG4

Table 11: Heavy and Kappa light chain Gene Utilization

Sequence Analysis

[0317] To further examine antibody structure predicted amino acid sequences of the antibodies were obtained from the cDNAs obtained from the clones.

[0318] Sequence identifier numbers (SEQ ID NO:) 1-48 and 51-68 provide the nucleotide and amino acid sequences of the heavy and kappa light chains of the anti-MAdCAM antibodies 1.7.2 (SEQ ID NOS 1-4), 1.8.2 (SEQ ID NOS 5-8), 6.14.2 (SEQ ID NOS 9-12), 6.22.2 (SEQ ID NOS 13-16), 6.34.2 (SEQ ID NOS 17-20), 6.67.1 (SEQ ID NOS 21-24), 6.73.2 (SEQ ID NOS 25-28), 6.77.1 (SEQ ID NOS 29-32), 7.16.6 (SEQ ID NOS 33-36), 7.20.5 (SEQ ID NOS 37-40), 7.26.4 (SEQ ID NOS 41-44), 9.8.2 (SEQ ID NOS 45-48) and the modified anti-MAdCAM antibodies 6.22.2-mod (SEQ ID NOS 51-54), 6.34.2-mod (SEQ ID NOS 55-58), 6.67.1-mod (SEQ ID NOS 59-62) and 6.77.1-mod (SEQ ID NOS 63-66) and 7.26.4-mod (SEQ ID NOS 41-42, 67-68). For each anti-MAdCAM antibody sequence cloned, the sequences of the signal peptide sequence (or the bases encoding the same) are indicated in lower case and underlined.

[0319] Figures 1A-1J provide sequence alignments between the predicted heavy chain amino acid sequences of antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4 and 9.8.2 and the amino acid sequence of the respective germline gene products. The positions of the CDR1, CDR2 and CDR3 sequences of the antibodies are underlined, differences between the expressed sequence the corresponding germline sequence are indicated in bold and where there are additions in the expressed sequence compared to the germline these are indicated as a (-) in the germline sequence.

[0320] Figures 1K-1T provide sequence alignments between the predicted kappa light chain amino acid sequences of the antibodies 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4 and 9.8.2 and the amino acid sequence of the respective germline gene products. The positions of the CDR1, CDR2 and CDR3 sequences of the

antibodies are underlined, differences between the expressed sequence the corresponding germline they are indicated in bold and where there are additions in the expressed sequence compared to the germline these are indicated as a (-) in the germline sequence.

Presence of post-translational modification: glycosylation and deamidation:

[0321] The effect of some of the changes in the expressed anti-MAdCAM antibody sequence, compared with the derived germline sequence, is to introduce residues that potentially could be subject to N-linked glycosylation (Asn-X-Ser/Thr) and/or deamidation (Asn-Gly) (see Table 12). The nucleic acid sequences encoding the kappa light chain variable domain amino acid sequences of the anti-MAdCAM antibodies 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.26.4 and 9.8.2, (SEQ ID NOS: 16, 20, 24, 28, 32, 44 and 48) and the heavy chain variable domain of antibody 6.14.2, (SEQ ID NO: 10), predict the presence of N-linked glycosylation. The presence of this post-translational modification was investigated using a combination of SDS-PAGE and Pro-Q® Emerald 488 Glycoprotein (Molecular Probes) staining with mAbs 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.26.4 and 9.8.2.

[0322] Briefly, approximately 2 µg of reduced anti-MAdCAM antibody was loaded onto a 4-12% SDS-polyacrylamide gel using a MOPS buffer. Following electrophoresis, the gel was fixed in 50% MeOH, 5% acetic acid and washed in 3% acetic acid. Any carbohydrates on the gel were then oxidised with periodic acid and stained using Pro-Q® Emerald 488 Glycoprotein Stain Kit (Molecular Probes). After a final wash step, glycoprotein staining was visualised using a fluorescence scanner set at a wavelength of 473 nm.

[0323] After glycoprotein staining, the gel was stained for total protein using SYPRO Ruby protein gel stain and analysed using a fluorescence scanner set at a wavelength of 473 nm. The kappa light chains of anti-MAdCAM antibodies, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.26.4 and 9.8.2, all stained positively for the presence of glycosylation. As an additional confirmation, anti-MAdCAM antibody 7.26.4, was subjected to tryptic/chymotryptic

digestion, the LC-MS/MS analysis confirmed the presence of a modified tryptic peptide and provided additional confirmation of kappa light chain glycosylation.

[0324] Specific Asn-Gly sequences in the CDR1 regions of anti-MAdCAM antibodies, 1.7.2, 1.8.2, 6.22.2 and 7.20.5, render these regions sensitive to deamidation. Deamidation at neutral pH introduces a negative charge and can also lead to β -isomerisation, which could affect the properties of an antibody. For anti-MAdCAM antibodies 1.7.2, 1.8.2 and 7.20.5, the presence of deamidated Asn-isoaspartate residues was assessed by mass spectroscopy following trapping the isoaspartate side chain with MeOH.

[0325] In brief, for the anti-MAdCAM antibody 1.7.2, the status of the tryptic/Asp-N peptide SSQSLLQSNNGYNYL (SEQ ID NO: 69) (1573.7 Da) was selected for monitoring by LC-MS/MS. Anti-MAdCAM antibody 1.7.2 was reduced in 10 mM DTT, alkylated in 5 mM Na iodoacetate and subsequently buffer exchanged into trypsin digestion buffer (50mM Tris-HCl, 1mM CaCl₂, pH 7.6). The antibody was then mixed with sequencing grade modified trypsin (Promega) in a protease:protein ratio of 1:20. Protein was digested in trypsin for 15 hours at 30°C, and the resulting peptides separated by HPLC using a C-18 RPC on an Ettan LC system. The ³³Asn-containing peptide (4032 Da) was collected from the column and diluted in Asp-N digestion buffer (50 mM sodium phosphate buffer, pH 8.0). Endoproteinase Asp-N (Roche) was then added at an approximate peptide:enzyme ratio of 10:1.

[0326] Acetyl chloride (100 μ L) was added to a sample of methanol (1 mL, -20°C), the mixture warmed to room temperature. The tryptic+Asp-N digest was dried in a Speed-Vac and then 5 μ L of the methanol/acetyl chloride was added (45 min, room temp), then dried again in a Speed-Vac. The resulting residue was re-constituted in 0.1% TFA and peptides were analysed initially on the Voyager-DE STR MALDI-TOF mass spectrometer using either the nitrocellulose thin layer sample preparation method or reverse phase purification using C18 ZipTips (Millipore) followed by droplet mixing with α -cyano matrix. The methylated

peptide mixture was also analysed using LC-MS/MS on a Deca XP Plus Ion Trap Mass Spectrometer as above. The elution was plumbed straight into the Ion Trap MS and peptides were subsequently analysed by MS and MS/MS. The MS was set to analyse all ions between 300 and 2000 Da. The strongest ion in any particular scan was then subjected to MS/MS analysis.

Table 12. Post-translational modification of anti-MAdCAM antibodies

CLONE	Heavy Chain		Kappa light chain			
	Glycosylation (NXS/T)	Confirmed	Glycosylation (NXS/T)	Confirmed	Deamidation (NG)	Confirmed
1.7.2	TFNNSAMT	N.D	CKSNQSLLY	MS/PAGE	LQSN G YN	MS
1.8.2					LQSN G YN	MS
7.16.6					HGNG G YNY	MS
7.20.5						
7.26.4						
6.14.2			SGTNFTLTII ASQNISSYL SSNNKTYLA RASQNIITN SCNSSQSL HSDNLSIT	PAGE PAGE PAGE PAGE PAGE PAGE	LTING L EA	N.D
6.22.2						
6.34.2						
6.67.1						
6.73.2						
6.77.1						
9.8.2						

IgG2
IgG4

Mutagenesis studies:

[0327] The primary amino acid sequence of the anti-MAdCAM antibodies exemplified in this disclosure can be modified, by site-directed mutagenesis, to remove potential sites of post-translational modification (*e.g.*, glycosylation, de-amidation) or to alter the isotype background, or to engineer other changes which may improve the therapeutic utility. As an example, PCR was used to engineer changes to the anti-MAdCAM antibodies 6.22.2, 6.34.2, 6.67.1, 6.77.1 and 7.26.4, to revert certain framework sequences to germline, to remove potential glycosylation sites and/or to change the isotype background to a human IgG₂. pCR2.1 TOPO-TA cloned cDNAs (100 ng), corresponding to heavy chain nucleotide SEQ ID NOS: 13, 17, 21 and 29, and kappa light nucleotide SEQ ID NOS: 15, 19, 23, 31 and 43,

were used as a template in a series of PCRs using overlap-extension and a panel of primer sets described in Table 10.

[0328] 6.22.2 Heavy chain: PCR primer sets 6.22.2_VH_F1 and 6.22.2VH_CS* (1) and VH3-33 and 6.22.2_VH_R1 (2) were used to generate separate PCR products (1) and (2), using an Expand *Taq* polymerase and a pCR2.1 TOPO-TA cDNA template (100 ng) represented by nucleotide sequence SEQ ID NO: 13. Products (1) and (2) were purified and combined in a third PCR step (*ca.* 50 ng each) along with VH3-33 and VK6.22.2_CS* primers, to generate the modified 6.22.2 heavy chain V-domain. This modified version contains a His/Phe mutation in FR1 and introduces an XbaI restriction site to enable in frame cloning into a pEE6.1 derived vector, termed pEE6.1CH, which contains the corresponding human IgG₂ constant domain. The final PCR fragment was cloned into the XbaI site of pEE6.1CH, checked for orientation and the insert full sequence verified. The nucleotide sequence for the modified 6.22.2 heavy chain is found in SEQ ID NO: 51 and the corresponding amino acid sequence in SEQ ID NO: 52. The changes in the nucleotide and amino acid sequences compared with the parent are indicated.

[0329] 6.22.2 kappa light chain: PCR primer sets 6.22.2_VK_F1 and revKappa (1), and A26 and 6.22.2_VK_R1 (2) were used to generate separate PCR products (1) and (2), using an Expand *Taq* polymerase and a pCR2.1 TOPO-TA cDNA template (100 ng) represented by nucleotide sequence SEQ ID NO: 15. Products (1) and (2) were purified and combined in a third PCR step (*ca.* 50 ng each) along with A26 and revKappa primers, to generate the modified 6.22.2 kappa light chain V-domain. This modified version contains Asn/Asp and Gly/Ser changes to the FR3 sequence. The resultant PCR product was cloned into pEE12.1 using HindIII/EcoRI sites and fully sequence verified. The nucleotide sequence for the modified 6.22.2 kappa light chain is found in SEQ ID NO: 53 and the corresponding amino

acid sequence in SEQ ID NO: 54. The changes in the nucleotide and amino acid sequences compared with the parent are indicated.

[0330] 6.34.2 Heavy chain: PCR primer sets 6.34.2_VH_F1 and 6.22.2VH_CS* (1) and VH3-30 and 6.34.2_VH_R1 (2) were used to generate separate PCR products (1) and (2), using an Expand *Taq* polymerase and a pCR2.1 TOPO-TA cDNA template (100 ng) represented by nucleotide sequence SEQ ID NO: 17. Products (1) and (2) were purified and combined in a third PCR step (*ca.* 50 ng each) along with VH3-30 and VK6.22.2_CS* primers, to generate the modified 6.34.2 heavy chain V-domain. This modified version contains a Ser/Arg mutation in FR3 and introduces an XbaI restriction site to enable in frame cloning into a pEE6.1 derived vector, termed pEE6.1CH, which contains the corresponding human IgG2 constant domain. The final PCR fragment was cloned into the XbaI site of pEE6.1CH, checked for orientation and the insert full sequence verified. The nucleotide sequence for the modified 6.34.2 heavy chain is found in SEQ ID NO: 55 and the corresponding amino acid sequence in SEQ ID NO: 56. The changes in the nucleotide and amino acid sequences compared with the parent are indicated.

[0331] 6.34.2 kappa light chain: PCR primer sets O12 and 6.34.2_VK_R1 (1), 6.34.2_VK_F1 and 6.34.2_VK_R2 (2), as well as 6.34.2_VK_F2 and revKappa (3) were used to generate separate PCR products (1), (2) and (3), using an Expand *Taq* polymerase and a pCR2.1 TOPO-TA cDNA template (100 ng) represented by nucleotide sequence SEQ ID NO: 19. Products (1), (2) and (3) were purified and (1) and (2) were combined in a third PCR step (*ca.* 50 ng each), along with O12 and 6.34.2_VK_R2 primers, to generate the PCR product (4). PCR products (2) and (3) were combined in a fourth PCR step (*ca.* 50 ng each), along with 6.34.2_VK_F1 and revKappa, to generate the PCR product (5). PCR products (4) and (5) were purified and combined together (*ca.* 50 ng each) with primers O12 and revKappa to generate the modified 6.34.2 kappa light chain V-domain. This modified version contains

an Asn/Ser change in CDR1, a Phe/Tyr change in FR2 and Arg-Thr/Ser-Ser, Asp/Glu and Ser/Tyr changes to the FR3 sequence. The resultant PCR product was cloned into pEE12.1 using HindIII/EcoR1 sites and fully sequence verified. The nucleotide sequence for the modified 6.34.2 kappa light chain is found in SEQ ID NO: 57 and the corresponding amino acid sequence in SEQ ID NO: 58. The changes in the nucleotide and amino acid sequences compared with the parent are indicated.

[0332] 6.67.1 Heavy chain: PCR primer sets 6.67.1_VH_F1 and 6.67.1VH_CS* (1) and VH4-4 and 6.67.1_VH_R1 (2) were used to generate separate PCR products (1) and (2), using an Expand *Taq* polymerase and a pCR2.1 TOPO-TA cDNA template (100 ng) represented by nucleotide sequence SEQ ID NO: 21. Products (1) and (2) were purified and combined in a third PCR step (*ca.* 50 ng each) along with VH4-4 and VK6.67.1_CS* primers, to generate the modified 6.67.1 heavy chain V-domain. This modified version contains an Ile-Leu-Ala/Met-Ser-Val conversion in FR3 and introduces an XbaI restriction site to enable in frame cloning into a pEE6.1 derived vector, termed pEE6.1CH, which contains the corresponding human IgG2 constant domain. The final PCR fragment was cloned into the XbaI site of pEE6.1CH, checked for orientation and the insert full sequence verified. The nucleotide sequence for the modified 6.67.1 heavy chain is found in SEQ ID NO: 59 and the corresponding amino acid sequence in SEQ ID NO: 60. The changes in the nucleotide and amino acid sequences compared with the parent are indicated.

[0333] 6.67.1 kappa light chain: PCR primer sets 6.67.1_VK_F1 and revKappa (1), and B3 and 6.67.1_VK_R1 (2) were used to generate separate PCR products (1) and (2), using an Expand *Taq* polymerase and a pCR2.1 TOPO-TA cDNA template (100 ng) represented by nucleotide sequence SEQ ID NO: 23. Products (1) and (2) were purified and combined in a third PCR step (*ca.* 50 ng each) along with B3 and revKappa primers, to generate the modified 6.67.1 kappa light chain V-domain. This modified version contains a Thr/Asn

change in CDR1 and an Arg/Gly change in FR2. The resultant PCR product was cloned into pEE12.1 using HindIII/EcoR1 sites and fully sequence verified. The nucleotide sequence for the modified 6.67.1 kappa light chain is found in SEQ ID NO: 61 and the corresponding amino acid sequence in SEQ ID NO: 62. The changes in the nucleotide and amino acid sequences compared with the parent are indicated.

[0334] 6.77.1 Heavy chain: PCR primer sets VH 3-21 and 6.22.2VH_CS* were used to generate a single PCR product using an Expand *Taq* polymerase and a pCR2.1 TOPO-TA cDNA template (100 ng) represented by nucleotide sequence SEQ ID NO: 29. The PCR products were digested with XbaI, gel purified and cloned into the XbaI site of pEE6.1CH, checking for orientation. The insert was fully sequence verified. The nucleotide sequence for the modified 6.77.1 heavy chain is found in SEQ ID NO: 63 and the corresponding amino acid sequence in SEQ ID NO: 64. The changes in the nucleotide and amino acid sequences compared with the parent are indicated.

[0335] 6.77.1 kappa light chain: PCR primer sets A2 and 6.77.1_VK_R1 (1), 6.77.1_VK_VK_F1 and 6.77.1_R2 (2), as well as 6.77.1_VK_F2 and revKappa (3) were used to generate separate PCR products (1), (2) and (3), using an Expand *Taq* polymerase and a pCR2.1 TOPO-TA cDNA template (100 ng) represented by nucleotide sequence SEQ ID NO: 31. Products (1), (2) and (3) were purified and, (1) and (2) were combined in a third PCR step (*ca.* 50 ng each) along with A2 and 6.77.1_VK_R2 primers, to generate PCR product (4). PCR product (2) and (3) were combined in a fourth PCR step (*ca.* 50 ng each) along with 6.77.1_VK_F1 and revKappa primers, to generate PCR product (5). PCR products (4) and (5) were purified and combined together (*ca.* 50 ng each) with primers A2 and JK2 to generate the modified 6.77.1 kappa light chain V-domain. This modified version contains an Asn/Lys change in CDR1, a Ser/Tyr change in FR3 and a Cys/Ser residue change in CDR3 sequence. The resultant PCR product was cloned into pEE12.1 using

HindIII/EcoR1 sites and fully sequence verified. The nucleotide sequence for the modified 6.77.1 kappa light chain is found in SEQ ID NO: 65 and the corresponding amino acid sequence in SEQ ID NO: 66. The changes in the nucleotide and amino acid sequences compared with the parent are indicated.

[0336] 7.26.4 kappa light chain: PCR primer sets 7.26.4_VK_F1 and revKappa (1), and A2 and 7.26.4_VK_R1 (2) were used to generate separate PCR products (1) and (2), using an Expand *Taq* polymerase and a pCR2.1 TOPO-TA cDNA template (100 ng) represented by nucleotide sequence SEQ ID NO: 43. Products (1) and (2) were purified and combined in a third PCR step (*ca.* 50 ng each) along with A2 and revKappa primers, to generate the modified 7.26.4 kappa light chain V-domain. This modified version contains an Asn/Ser change in CDR1. The resultant PCR product was cloned into pEE12.1 using HindIII/EcoR1 sites and fully sequence verified. The nucleotide sequence for the modified 7.26.4 kappa light chain is found in SEQ ID NO: 67 and the corresponding amino acid sequence in SEQ ID NO: 68. The changes in the nucleotide and amino acid sequences compared with the parent are indicated.

[0337] A functional eukaryotic expression vector for each of the modified versions of 6.22.2, 6.34.2, 6.67.1, 6.77.1 and 7.26.4, referred to as 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod, and representing respectively the heavy chain nucleotide sequences SEQ ID NOS: 51, 55, 59, 63 and 41, and corresponding amino acid sequences SEQ ID NOS: 52, 56, 60, 64 and 42, as well as the kappa light chain nucleotide sequences SEQ ID NOS: 53, 57, 61, 65 and 67, and the corresponding amino acid sequences SEQ ID NOS: 54, 58, 62, 66 and 68 were assembled as follows: The heavy chain cDNA inserts corresponding to 6.22.2-mod, 6.34.2-mod, 6.67.1-mod and 6.77.1-mod were excised from the pEE6.1CH vector with NotI/SalI, the parental version of the heavy chains of 7.26.4 was excised from the pEE6.1 vector with NotI/SalI, and the purified fragments were cloned into

identical sites into the corresponding pEE12.1 vector containing the modified versions of the kappa light chain sequences 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod. The sequences of the vectors were confirmed, and purified amounts used in transient transfections with HEK 293T cells. Briefly, 9×10^6 HEK 293T cells, seeded in a T165 flask the day before transfection and washed into Optimem, were transiently transfected with vector cDNAs corresponding to 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod (40 μ g) using Lipofectamine PLUS (Invitrogen) according to manufacturer's instructions. The cells were incubated for 3 hrs, then the transfection media replaced with DMEM (Invitrogen 21969-035) media containing 10% ultra-low IgG fetal calf serum (Invitrogen 16250-078) and L-Glutamine (50 mL). The media supernatant was harvested 5 days later, filter sterilised and the anti-MAdCAM antibody purified using protein G sepharose affinity chromatography, in a similar manner as to that described above. The amount of antibody recovered (20-100 μ g) was quantified by a Bradford assay.

[0338] The anti-MAdCAM activity of affinity purified antibody corresponding to 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod was assessed in the MAdCAM-IgG1-Fc fusion assay as described previously. The IC₅₀ values of these anti-MAdCAM antibodies compared with the parental anti-MAdCAM antibodies from which they were derived are presented in Table 13. There was minimal effect of the amino acid substitutions described above on the activity of the modified anti-MAdCAM antibodies compared with their parents was minimal. The antibodies also maintained their binding to CHO cells expressing recombinant human MAdCAM or the cynomolgus/human MAdCAM chimera.

Table 13. Activity of modified versions of anti-MAdCAM antibodies, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod compared with their parents.

CLONE	MAdCAM IgG1 Fc fusion Assay Mean IC50 ($\mu\text{g/mL}$)	
	Parent	Modified
6.22.2	0.018	0.058
6.34.2	0.013	0.049
6.67.1	0.013	0.037
6.77.1	0.022	0.077
7.26.4	0.021	0.033

EXAMPLE VIIncrease in β_7^+ lymphocytes in the peripheral circulation by blocking anti-MAdCAM antibodies

[0339] An assay was developed to identify and correlate a mechanistic effect of an anti-MAdCAM antibody and its circulating level in blood. An inhibitory anti-MAdCAM antibody should have the effect of inhibiting the recruitment of leukocytes expressing the $\alpha_4\beta_7$ integrin to the gastrointestinal tract. Classes of $\alpha_4\beta_7$ integrin-bearing leukocytes should, therefore, be restricted to the peripheral circulation.

[0340] This was demonstrated with a fully human anti-human MAdCAM mAb 7.16.6, in cynomolgus.

[0341] Purified anti-human MAdCAM mAb 7.16.6 (1 mg/kg) or vehicle (20 mM NaAcetate, 0.2 mg/mL polysorbate 80, 45 mg/mL mannitol, and 0.02 mg/mL EDTA at pH 5.5) were assessed in a similar manner by intravenous administration via the saphenous vein to two groups of cynomolgus monkeys (n=4/group). At day 3 post-dosing blood samples were collected in EDTA tubes by femoral venipuncture. LPAM specific antibodies, which crossreact with the cynomolgus $\alpha_4\beta_7$ integrin, are not commercially available, so an anti- β_7 antibody (recognising $\alpha_4\beta_7$ and $\alpha_E\beta_7$ integrin) was used instead. Antibodies (30 μL), according to the following table, table 15, were added to tubes containing 100 μL of cynomolgus blood, mixed by gentle vortexing and incubated for 20-30 mins at 4°C.

Table 15. Antibodies (BD Pharmingen) used in immunophenotyping of cynomolgus blood

Catalogue Number	Antibody or Isotype
555748	mIgG1, k-FITC
555844	mIgG2a, k-PE
559425	mIgG1 - PerCP
555751	mIgG1, k-APC
555728	CD 28-FITC
555945	β 7-PE
558814	CD 95-APC
550631	CD 4-PerCP

[0342] To each tube, 1 mL of 1:10 FACSlyse solution (BD # 349202) was added, mixed by gentle vortex and incubated at room temperature for approximately 12 minutes in the dark until red blood cell lysis was complete. Then 2 mL of BD stain buffer (# 554656) was added to each tube, mixed and centrifuged at 250 x g for 6-7 mins at room temperature. The supernatant was decanted and the pellet resuspended in 3 mL of stain buffer, mixed again and centrifuged at 250 x g for 6-7 mins at room temperature. Cytofix buffer (BD # 554655), containing w/v paraformaldehyde (100 μ L) was added to the cell pellets from monkey peripheral blood and mixed thoroughly by low/moderate speed of vortexer. The samples were kept at 4°C in the dark until they acquired on the FACSCalibur. Just prior to acquisition, PBS (100 μ L) was added to all tubes immediately before acquisition. The absolute cell numbers of CD4⁺ β 7⁺CD95^{lo}CD28⁺ (naïve), CD4⁺ β 7⁺CD95^{hi}CD28⁺ (central memory), CD4⁺ β 7⁻CD95^{hi}CD28⁺ (central memory), CD4⁺ β 7⁺CD95^{hi}CD28⁻ (effector memory) were acquired by appropriate gating and quadrant analyses. Other T cell subsets for example, CD8⁺ T central memory cell (β 7⁺CD8⁺CD28⁺CD95⁺) and any other leukocytes bearing a MAdCAM ligand, may also be analyzed by this method with the appropriate antibodies. Compared with the vehicle control, anti-MAdCAM mAb 7.16.6 caused an approximate 3 fold increase in the levels of circulating CD4⁺ β 7⁺CD95^{hi}CD28⁺ central memory T cells, as shown in Figure 7. There were no effects on the population of circulating

CD4⁺β₇-CD95^{hi}CD28⁺ central memory T cells, indicating that the effect of anti-MAdCAM mAb 7.16.6 is specific for gut homing T cells. The effects of anti-MAdCAM mAb 7.16.6, in cynomolgus, on populations of circulating (α₄)β₇⁺ lymphocytes indicates that this is a robust surrogate proof of mechanism biomarker, particularly in the context of practical application in a clinical setting.

Sequences

[0343] SEQ ID NO: 1-48, 51-68 and 148-150 provide nucleotide and amino acid sequences of the heavy and kappa light chains for thirteen human anti-MAdCAM antibodies, nucleotide and amino acid sequences of cynomolgus MAdCAM $\alpha_4\beta_7$ binding domain sequences and nucleotide and amino acid sequences of five modified human anti-MAdCAM antibodies.

[0344] SEQ ID NO: 1-48 and 148-150 provide the heavy and kappa light chain nucleotide and amino acid sequences of thirteen human monoclonal anti-MAdCAM antibodies: 1.7.2 (SEQ ID NO: 1-4), 1.8.2 (SEQ ID NO: 5-8), 6.14.2 (SEQ ID NO: 9-12), 6.22.2 (SEQ ID NO: 13-16), 6.34.2 (SEQ ID NO: 17-20), 6.67.1 (SEQ ID NO: 21-24), 6.73.2 (SEQ ID NO: 25-28), 6.77.1 (SEQ ID NO: 29-32), 7.16.6 (SEQ ID NO: 33-36), 7.20.5 (SEQ ID NO: 37-40), 7.26.4 (SEQ ID NO: 41-44), 9.8.2 (SEQ ID NO: 45-48), X481.2 (SEQ ID NO: 35, 148-150).

[0345] SEQ ID NO: 49-50 provide the nucleotide and amino acid sequences of a cynomolgus MAdCAM $\alpha_4\beta_7$ binding domain.

[0346] SEQ ID NO: 51-68 provide the heavy and kappa light chain nucleotide and amino acid sequences for the modified monoclonal anti-MAdCAM antibodies: 6.22.2 (SEQ ID NO: 51-54), modified 6.34.2 (SEQ ID NO: 55-58), modified 6.67.1 (SEQ ID NO: 59-62), modified 6.77.1 (SEQ ID NO: 63-66) and the kappa light chain nucleotide and amino acid sequences of modified monoclonal anti-MAdCAM antibody: modified 7.26.4 (SEQ ID NO: 67-68).

SEQ ID NOS: 70-106 and 108-110 provide various primer sequences.

Key:

Signal sequence: underlined lower case

Amino acid changes in modified anti-MAdCAM antibodies sequence compared to parent:
underlined upper case

SEQ ID NO. 1

1.7.2 Heavy Chain Nucleotide Sequence

```
1   atggagtttg ggctgagctg gattttcctt gctgctat ttt taaaaggtgt
51  ccagtgtGAG GTGCAGCTGG TGGAGTCTGG GGGAGGCTTG GTGAAGCCTG
101 GGGGGTCCCT TAGACTCTCC TGTGTAGCCT CTGGATTCAC TTTCAC TAAC
151 GCCTGGATGA TCTGGGTCCG CCAGGCTCCA GGAAGGGGC TGGAGTGGGT
201 TGGCCGTATT AAAAGGAAAA CTGATGGTGG GACACAGAC TACGCTGCAC
251 CCGTGAAAGG CAGATTCACC ATCTCAAGAG ATGATTCAAA AAACACGCTG
301 TATCTGCAAA TGAACAGCCT GAAACCGAG GACACAGCCG TGTATTACTG
351 TACCACAGGG GGAGTGGCTG AGGACTACTG GGGCCAGGGA ACCCTGGTCA
401 CCGTCTCCTC AGCCTCCACC AAGGGCCCAT CGGTCTTCCC CCTGGCGCCC
451 TGCTCCAGGA GCACCTCCGA GAGCACAGCG GCCCTGGGCT GCCTGGTCAA
501 GGACTACTTC CCCGAACCGG TGACGGTGTC GTGGAAC TCA GCGCTCTGA
551 CCAGCGGCGT GCACACCTTC CCAGCTGTCC TACAGTCCTC AGGACTCTAC
601 TCCCTCAGCA GCGTGGTGAC CGTGCCCTCC AGCAACTTCG GCACCCAGAC
651 CTACACCTGC AACGTAGATC ACAAGCCAG CAACACCAAG GTGGACAAGA
701 CAGTTGAGCG CAAATGTTGT GTCGAGTGCC CACCGTGCCC AGCACCACCT
751 GTGGCAGGAC CGTCAGTCTT CCTCTTCCCC CAAAACCCA AGGACACCCT
801 CATGATCTCC CGGACCCCTG AGGTCACGTG CGTGGTGGTG GACGTGAGCC
851 ACGAAGACCC CGAGGTCCAG TTCAACTGGT ACGTGGACGG CGTGGAGGTG
901 CATAATGCCA AGACAAAGCC ACGGGAGGAG CAGTTCAACA GCACGTTCGG
951 TGTGGTCAGC GTCCTCACC GGTGTGCACCA GGAAGGCTG AACGGCAAGG
1001 AGTACAAGTG CAAGGTCTCC AACAAAGGCC TCCAGCCCC CATCGAGAAA
1051 ACCATCTCCA AAACCAAAGG GCAGCCCGA GAACCACAGG TGTACACCCT
1101 GCCCCATCC CGGGAGGAGA TGACCAAGAA CCAGGTCAGC CTGACCTGCC
1151 TGGTCAAAGG CTTCTACCCC AGCGACATCG CCGTGGAGTG GGAGAGCAAT
1201 GGGCAGCCGG AGAACAATA CAAGACCACA CCTCCCATGC TGGACTCCGA
1251 CGGCTCCTTC TTCCTCTACA GCAAGCTCAC CGTGGACAAG AGCAGGTGGC
1301 AGCAGGGGAA CGTCTTCTCA TGCTCCGTGA TGCATGAGGC TCTGCACAAC
1351 CACTACACGC AGAAGAGCCT CTCCCTGTCT CCGGTAAAT GA
```

SEQ ID NO. 2

1.7.2 Predicted Heavy Chain Protein Sequence

```

1   mefglswifl aailkgvqcE VQLVESGGGL VKPGGSLRLS CVASGFTFTN
51  AWMIWVRQAP GKGLEWVGRI KRKTDGGTTD YAAPVKGRFT ISRDDSKNTL
101 YLQMNSLKTE DTAVYYCTTG GVAEDYWGQG TLVTVSSAST KGPSVFPLAP
151 CSRSTSESTA ALGCLVKDYF PEPVTVSWNS GALTSGVHTF PAVLQSSGLY
201 SLSSVVTVPs SNFGTQTYTC NVDHKPSNTK VDKTVERKCC VECPPCPAPP
251 VAGPSVFLFP PKPKDTLMIS RTPEVTCVVV DVSHEDPEVQ FNWYVDGVEV
301 HNAKTKPREE QFNSTFRVVS VLTVVHQDWL NGKEYKCKVS NKGLPAPIEK
351 TISKTKGQPR EPQVYTLPPS REEMTKNQVS LTCLVKGFYP SDIAVEWESN
401 GQPENNYKTT PPM LDSGSF FLYSKLTVDK SRWQQGNVFS CSVMHEALHN
451 HYTQKSLSLs PGK

```

SEQ ID NO. 3

1.7.2 Kappa Light Chain Nucleotide Sequence

```

1   atgaggctcc ctgctcagct cctggggctg ctaatgctct gggctctctgg
51  atccagtgagg GATATTGTGA TGACTCAGTC TCCACTCTCC CTGCCCCTCA
101 CCCCTGGAGA GCCGGCCTCC ATCTCCTGCA GGTCTAGTCA GAGCCTCCTG
151 CAAAGTAATG GATACAACTA TTTGGATTGG TACCTGCAGA AGCCAGGGCA
201 GTCTCCACAG CTCCTGATCT ATTTGGGTTC TAATCGGGCC TCCGGGGTCC
251 CTGACAGGTT CAGTGGCAGT GGATCAGGCA CAGATTTTAC ACTGAAAATC
301 AGCAGAGTGG AGGCTGAGGA TGTGGGGTTC TATTACTGCA TGCAAGCTCT
351 ACAAACATATC ACCTTCGGCC AAGGGACACG ACTGGAGATT AAACGAAGTG
401 TGGCTGCACC ATCTGTCTTC ATCTTCCCGC CATCTGATGA GCAGTTGAAA
451 TCTGGAAGTG CCTCTGTTGT GTGCCTGCTG AATAACTTCT ATCCCAGAGA
501 GGCCAAAGTA CAGTGGAAGG TGGATAACGC CCTCCAATCG GGTAAGTCCC
551 AGGAGAGTGT CACAGAGCAG GACAGCAAGG ACAGCACCTA CAGCCTCAGC
601 AGCACCCCTGA CGCTGAGCAA AGCAGACTAC GAGAAACACA AAGTCTACGC
651 CTGCGAAGTC ACCCATCAGG GCCTGAGCTC GCCCGTCACA AAGAGCTTCA
701 ACAGGGGAGA GTGTTAGTGA

```

SEQ ID NO. 4

1.7.2 Predicted Kappa Light Chain Protein Sequence

```

1   mrlpaqlgl lmlwvsgssg DIVMTQSPLS LPVTPGEPAS ISCRSSQSLL
51  QSNGYNYLDW YLQKPGQSPQ LLIYLGSNRA SGVPDRFSGS GSGTDFTLKI
101 SRVEAEDVGV YYCMQALQTI TFGQGTRLEI KRTVAAPSVF IFPPSDEQLK
151 SGTASVVCLL NNFYPREAKV QWKVDNALQS GNSQESVTEQ DSKDSTYSLS
202 STLTLKADY EKHKVYACEV THQGLSSPVT KSFNRGEC

```

SEQ ID NO. 5

1.8.2 Heavy Chain Nucleotide Sequence

```

1   atggaggtttg ggctgagctg gatttttcctt gctgctattt taaaaggtgt
51  ccagtgtGAG GTGCAGCTGG TGGAGTCTGG GGGAGGCTTG GTGAAGCCTG
101 GGGGGTCCCT TAGACTCTCC TGTGTAGTCT CTGGATTAC TTTCACTAAC
151 GCCTGGATGA TCTGGGTCCG CCAGGCTCCA GGAAGGGGC TGGAGTGGGT
201 TGGCCGTATT AAAAGGAAAA CTGATGGTGG GACAACAGAC TACGCTGCAC
251 CCGTGAAAGG CAGATTACAC ATCTCAAGAG ATGATTCAAA AAACACGCTG
301 TATCTGCAAA TGAACAGCCT GAAAACCGAG GACACAGCCG TGTATTACTG
351 TACCACAGGG GGAGTGGCTG AGGACTACTG GGGCCAGGGA ACCCTGGTCA
401 CCGTCTCCTC AGCCTCCACC AAGGGCCCAT CGGTCTTCCC CCTGGCGCCC
451 TGCTCCAGGA GCACCTCCGA GAGCACAGCG GCCCTGGGCT GCCTGGTCAA
501 GGACTACTTC CCCGAACCGG TGACGGTGTC GTGGAAC TCA GCGCTCTGA
551 CCAGCGGCGT GCACACCTTC CCAGCTGTCC TACAGTCCTC AGGACTCTAC
601 TCCCTCAGCA GCGTGGTGAC CGTGCCCTCC AGCAACTTCG GCACCCAGAC
651 CTACACCTGC AACGTAGATC ACAAGCCAG CAACACCAAG GTGGACAAGA
701 CAGTTGAGCG CAAATGTTGT GTCGAGTGCC CACCGTGCCC AGCACCACCT
751 GTGGCAGGAC CGTCAGTCTT CCTCTTCCCC CAAAAACCA AGGACACCTT
801 CATGATCTCC CGGACCCCTG AGGTCACGTG CGTGGTGGT GACGTGAGCC
851 ACGAAGACCC CGAGGTCCAG TTCAACTGGT ACGTGGACGG CGTGGAGGTG
901 CATAATGCCA AGACAAAGCC ACGGGAGGAG CAGTTCAACA GCACGTTCCG
951 TGTGGTCAGC GTCCTCACCG TTGTGCACCA GGACTGGCTG AACGGCAAGG
1001 AGTACAAGTG CAAGGTCTCC ACAAAGGCC TCCCAGCCCC CATCGAGAAA
1051 ACCATCTCCA AAACCAAAGG GCAGCCCCGA GAACCACAGG TGTACACCTT
1101 GCCCCATCC CGGGAGGAGA TGACCAAGAA CCAGGTCAGC CTGACCTGCC
1151 TGGTCAAAGG CTTCTACCCC AGCGACATCG CCGTGGAGTG GGAGAGCAAT
1201 GGGCAGCCGG AGAACAATA CAAGACCACA CCTCCCATGC TGGACTCCGA
1251 CGGCTCCTTC TTCCTCTACA GCAAGCTCAC CGTGGACAAG AGCAGGTGGC
1301 AGCAGGGGAA CGTCTTCTCA TGCTCCGTGA TGCATGAGGC TCTGCACAAC
1351 CACTACACGC AGAAGAGCCT CTCCCTGTCT CCGGTAAT GA

```

SEQ ID NO. 6

1.8.2 Predicted Heavy Chain Protein Sequence

```

1   mefglswifl aailkgvgcE VQLVESGGGL VKPGGSLRLS CTVVSGFTFTN
51  AWMIWVRQAP GKGLEWVGRI KRKTDGGTTD YAAPVKGRFT ISRDDSKNTL
101 YLQMNLSLKE DAVYYCTTG GVAEDYWGQG TLTVVSSAST KGPSVFPLAP
151 CSRSTSESTA ALGCLVKDYF PEPVTVSWNS GALTSGVHTF PAVLQSSGLY
201 SLSSVVTVP S NFGTQTYTC NVDHKPSNTK VDKTVERKCC VECPPCPAPP
251 VAGPSVFLFP PKPKDTLMIS RTPEVTCVVV DVSHEDPEVQ FNWYVDGVEV
301 HNAKTKPREE QFNSTFRVVS VLTVVHQDWL NGKEYKCKVS NKGLPAPIEK
351 TISKTKGQPR EPQVYTLPPS REEMTKNQVS LTCLVKGFYP SDIAVEWESN
401 GQPENNYKTT PPM L DSDGSF FLYSKLTVDK SRWQQGNVFS CSVMHEALHN
451 HYTQKSLSL S PGK

```

SEQ ID NO. 7

1.8.2 Kappa Light Chain Nucleotide Sequence

1	<u>atgaggctcc</u>	<u>ctgctcagct</u>	<u>cctggggctg</u>	<u>ctaagtctct</u>	<u>gggtctctgg</u>
51	<u>atccagtggg</u>	GATATTGTGA	TGACTCAGTC	TCCACTCTCC	CTGCCCCTCA
101	CCCCTGGAGA	GCCGGCCTCC	ATCTCCTGCA	GGTCTAGTCA	GAGCCTCCTG
151	CAAAGTAATG	GATTCAACTA	TTTGGATTGG	TACCTGCAGA	AGCCAGGGCA
201	GTCTCCACAG	CTCCTGATCT	ATTTGGGTTC	TAATCGGGCC	TCCGGGGTCC
251	CTGACAGGTT	CAGTGGCAGT	GGGTCAGGCA	CAGATTTTAC	ACTGAAAATC
301	AGCAGAGTGG	AGGCTGAGGA	TGTTGGGGTT	TATTACTGCA	TGCAAGCTCT
351	ACAAACTATC	ACCTTCGGCC	AAGGGACACG	ACTGGAGATT	AAACGAACTG
401	TGGCTGCACC	ATCTGTCTTC	ATCTTCCCGC	CATCTGATGA	GCAGTTGAAA
451	TCTGGAAGT	CCTCTGTTGT	GTGCCTGCTG	AATAACTTCT	ATCCCAGAGA
501	GGCCAAAGTA	CAGTGGAAGG	TGGATAACGC	CCTCCAATCG	GGTAACTCCC
551	AGGAGAGTGT	CACAGAGCAG	GACAGCAAGG	ACAGCACCTA	CAGCCTCAGC
601	AGCACCTTGA	CGCTGAGCAA	AGCAGACTAC	GAGAAACACA	AAGTCTACGC
651	CTGCGAAGTC	ACCCATCAGG	GCCTGAGCTC	GCCCCTCACA	AAGAGCTTCA
701	ACAGGGGAGA	GTGTTAGTGA			

SEQ ID NO. 8

1.8.2 Predicted Kappa Light Chain Protein Sequence

1	<u>mrlpaqlgl</u>	<u>lmlwvsgssg</u>	DIVMTQSPLS	LPVTPGEPAS	ISCRSSQSLL
51	QSNGFNYLDW	YLQKPGQSPQ	LLIYLGSNRA	SGVPDRFSGS	GSQTDFTLKI
101	SRVEAEDVGV	YYCMQALQTI	TFGQGRLEI	KRTVAAPSVF	IFPPSDEQLK
151	SGTASVVCLL	NNFYPREAKV	QWKVDNALQS	GNSQESVTEQ	DSKDSTYSLS
202	STLTLSKADY	EKKHVYACEV	THQGLSSPVT	KSFNRGEC	

SEQ ID NO. 9

6.14.2 Heavy Chain Nucleotide Sequence

```
1   atggaggtttg ggctgagctg gcttttttctt gtggctatatt taaaagggtgt
51  ccagtgtGAG GTGCAGCTGT TGGAGTCTGG GGGAGGCTTG GTACAGCCTG
101 GGGGGTCCCT GAGACTCTCC TGTGCAGCCT CTGGACTCAC CTTTAAACAAT
151 TCTGCCATGA CCTGGGTCCG CCAGGCTCCA GGGAAGGGGC TGGAGTGGGT
201 CTCAACTACT AGTGGAAGTG GTGGTACCAC ATACTACGCA GACTCCGTGA
251 AGGGCCGGTT CACCATCTCC AGAGACTCTC CCAAGAACAC GCTCTATCTG
301 CAAATGAACA GCCTGAGAGC CGAGGACACG GCCGTATATT ACTGTGCGGC
351 CCGTGGATAC AGCTATGGTA CGACCCCTTA TGAGTACTGG GGCCAGGGAA
401 CCCTGGTCAC CGTCTCCTCA GCTTCCACCA AGGGCCCATC CGTCTTCCCC
451 CTGGCGCCCT GTTCCAGGAG CACCTCCGAG AGCACAGCCG CCCTGGGCTG
501 CCTGGTCAAG GACTACTTCC CCGAACCGET GACGGTGTCG TGGAATCAG
551 GCGCCCTGAC CAGCGGCGTG CACACCTTCC CGGCTGTCCT ACAGTCCTCA
601 GGACTCTACT CCCTCAGCAG CGTGGTGACC GTGCCCTCCA GCAGCTTGGG
651 CACGAAGACC TACACCTGCA ACGTAGATCA CAAGCCCAGC AACACCAAGG
701 TGGACAAGAG AGTTGAGTCC AAATATGGTC CCCCATGCCC ATCATGCCCA
751 GCACCTGAGT TCCTGGGGGG ACCATCAGTC TTCTGTTCC CCCCAAAC
801 CAAGGACACT CTCATGATCT CCCGGACCCC TGAGGTCACG TCGTGGTG
851 TGGACGTGAG CCAGGAAGAC CCCGAGGTCC AGTTCAACTG GTACGTGGAT
901 GGCGTGGAGG TGCATAATGC CAAGACAAAG CCGCGGGAGG AGCAGTTCAA
951 CAGCACGTAC CGTGTGGTCA GCGTCCTCAC CGTCCTGCAC CAGGACTGGC
1001 TGAACGGCAA GGAGTACAAG TGCAAGGTCT CCAACAAAGG CCTCCCGTCC
1051 TCCATCGAGA AAACCATCTC CAAAGCCAAA GGGCAGCCCC GAGAGCCACA
1101 GGTGTACACC CTGCCCCCAT CCCAGGAGGA GATGACCAAG AACCAGGTCA
1151 GCCTGACCTG CCTGGTCAAA GGCTTCTACC CCAGCGACAT CGCCGTGGAG
1201 TGGGAGAGCA ATGGGCAGCC GGAGAACAAAC TACAAGACCA CGCCTCCCGT
1251 GCTGGACTCC GACGGCTCCT TCTTCTCTA CAGCAGGCTA ACCGTGGACA
1301 AGAGCAGGTG GCAGGAGGGG AATGTCTTCT CATGCTCCGT GATGCATGAG
1351 GCTCTGCACA ACCACTACAC ACAGAAGAGC CTCTCCCTGT CTCTGGGTAA
1401 ATGA
```

SEQ ID NO. 10

6.14.2 Predicted Heavy Chain Protein Sequence

```
1   mefglswlfl vailkgvqcE VQLLESGGGL VQPGGSLRLS CAASGLTFNN
51  SAMTWVRQAP GKGLEWVSTT SGSGGTTYA DSVKGRFTIS RDSPKNTLYL
101 QMNSLRAEDT AVYYCAARGY SYGTPYEYW GQGLLTVTVSS ASTKGPSVFP
151 LAPCSRSTSE STAALGCLVK DYFPEPTVS WNSGALTSKV HTFPAVLQSS
201 GLYSLSSVVT VPSSSLGTKT YTCNVDPKPS NTKVDKRVES KYGPPCPSCP
251 APEFLGGPSV FLFPPKPKDT LMISRTPEVT CVVVDVSDQED PEVQFNWYVD
301 GVEVHNAKTK PREEQFNSTY RVVSVLTVLH QDWLNGKEYK CKVSNKGLPS
351 SIEKTISKAK QPREPQVYT LPQSQEEMTK NQVSLTCLVK GFYPSDIAVE
401 WESNGQPENN YKTTTPVLDS DGSFFLYSRL TVDKSRWQEG NVFSCSVMH
451 ALHNHYTQKS LSLSLGK
```

SEQ ID NO. 11

6.14.2 Kappa Light Chain Nucleotide Sequence

```
1   atggacatga ggggtcccccgc tcagctcctg gggctcctgc tactctggct
51  ccgagggggcc agatgtGACA TCCAGATGAC CCAGTCTCCA TCCTCCCTGT
101 CTGCATCTGT AGGAGACAGA GTCACCATCA CTTGCCGGGC AAGTCGGAGC
151 ATTAGCAGCT ATTTAAATG GTATCAGCAG AAACCAGGGA AAGCCCCTAA
201 AGTCCTGATC TTTTTTGTGT CCAGTTTGCA AAGTGGGGTC CCATCAAGGT
251 TCAGTGGCAG TGGCTCTGGG ACAGATTTC CTCTACCAT CAGCAGTCTG
301 CAACCTGAAG ATTTTGCAAC TTACTACTGT CAACAGAATT ACATTCCCCC
351 TATTACCTTC GGCCAGGGGA CACGACTGGA GATCAGACGA ACTGTGGCTG
401 CACCATCTGT CTTCATCTTC CCGCCATCTG ATGAGCAGTT GAAATCTGGA
451 ACTGCCTCTG TTGTGTGCCT GCTGAATAAC TTCTATCCCA GAGAGGCCAA
501 AGTACAGTGG AAGGTGGATA ACGCCCTCCA ATCGGGTAAC TCCCAGGAGA
551 GTGTCACAGA GCAGGACAGC AAGGACAGCA CCTACAGCCT CAGCAGCACC
601 CTGACGCTGA GCAAAGCAGA CTACGAGAAA CACAAAGTCT ACGCCTGCGA
651 AGTCACCCAT CAGGGCCTGA GCTCGCCCGT CACAAAGAGC TTCAACAGGG
701 GAGAGTGTTA G
```

SEQ ID NO. 12

6.14.2 Predicted Kappa Light Chain Protein Sequence

```
1   mdmrvpaql1 gl1111wlrge rcDIQMTQSP SSLASVGDV VTITCRASRS
51  ISSYLNWYQQ KPGKAPKVL1 FFVSSLQSGV PSRFSGSGSG TDFTLTISSL
101 QPEDFATYYC QQNYIPPITF GQGRLEIRR TVAAPSVFIF PPSDEQLKSG
151 TASVVCLLN FYPREAKVQW KVDNALQSGN SQESVTEQDS KDSTYSLSST
202 LTLSKADYEK HKVYACEVTH QGLSSPVTKS FNRGEC
```

SEQ ID NO. 13

6.22.2 Heavy Chain Nucleotide Sequence

```
1   atggaggtttg ggctgagctg ggttttcctc gttgctcttt taagaggtgt
51  ccagtgtCAG GTGCAGCTGG TGGAGTCTGG GGGAGGCGTG GTCCAGCCTG
101 GGAGGTCCCT GAGACTCTCC TGTGCAGCGT CTGGACACAC CTTCAGTAGC
151 GATGGCATGC ACTGGGTCCG CCAGGCTCCA GGCAAGGGGC TGGAGTGGGT
201 GGCAATTATA TGGTATGATG GAAGTAATAA ATATTATGCA GACTCCGTGA
251 AGGGCCGATT CACCATCTCC AGAGACAATT CCAAGAACAC GCTGTATCTG
301 CAAATGAACA GCCTGAGAGC CGAGGACACG GCTGTATATT ACTGTGCGAG
351 AGATCCCGGC TACTATTACG GTATGGACGT CTGGGGCCAA GGGACCACGG
401 TCACCGTCTC CTCAGCTTCC ACCAAGGGCC CATCCGTCTT CCCCCTGGCG
451 CCCTGCTCCA GGAGCACCTC CGAGAGCACA GCCGCCCTGG GCTGCCTGGT
501 CAAGGACTAC TTCCCCGAAC CGGTGACGGT GTCGTGGAAC TCAGGCGCCC
551 TGACCAGCGG CGTGCACACC TTCCCGGCTG TCCTACAGTC CTCAGGACTC
601 TACTCCCTCA GCAGCGTGGT GACCGTGCCC TCCAGCAGCT TGGGCACGAA
651 GACCTACACC TGCAACGTAG ATCACAAGCC CAGCAACACC AAGGTGGACA
701 AGAGAGTTGA GTCCAAATAT GGTCCCCCAT GCCCATCATG CCCAGCACCT
751 GAGTTCCTGG GGGGACCATC AGTCTTCCTG TTCCCCCAA AACCCAAGGA
801 CACTCTCATG ATCTCCCGGA CCCCTGAGGT CACGTGCGTG GTGGTGGACG
851 TGAGCCAGGA AGACCCCGAG GTCCAGTTCA ACTGGTACGT GGATGGCGTG
901 GAGGTGCATA ATGCCAAGAC AAAGCCGCGG GAGGAGCAGT TCAACAGCAC
951 GTACCGTGTG GTCAGCGTCC TCACCGTCCT GCACCAGGAC TGGCTGAACG
1001 GCAAGGAGTA CAAGTGCAAG GTCTCCAACA AAGGCTCCC GTCCTCCATC
1051 GAGAAAACCA TCTCCAAAGC CAAAGGGCAG CCCCAGAGC CACAGGTGTA
1101 CACCCTGCCC CCATCCCAGG AGGAGATGAC CAAGAACCAG GTCAGCCTGA
1151 CCTGCCTGGT CAAAGGCTTC TACCCAGCG ACATCGCCGT GGAGTGGGAG
1201 AGCAATGGGC AGCCGGAGAA CAACTACAAG ACCGCGCCTC CCGTGCTGGA
1251 CTCCGACGGC TCCTTCTTCC TCTACAGCAG GCTAACCGTG GACAAGAGCA
1301 GGTGGCAGGA GGGGAATGTC TTCTCATGCT CCGTGATGCA TGAGGCTCTG
1351 CACAACCACT ACACACAGAA GAGCCTCTCC CTGTCTCTGG GTAAATGA
```

SEQ ID NO. 14

6.22.2 Predicted Heavy Chain Protein Sequence

```
1   mefglswvfl vallrgvqcQ VQLVESGGGV VQPGRSLRLS CAASGHTFSS
51  DGMHWVRQAP GKGLEWVAII WYDGSNKYYA DSVKGRFTIS RDNSKNTLYL
101 QMNSLRAEDT AVYYCARDPG YYYGMDVWQ GTTTVTVSSAS TKGPSVFPLA
151 PCSRSTSEST AALGCLVKDY FPEPVTVSWN SGALTSGVHT FPAVLQSSGL
201 YSLSSVVTVP SSSLGKTYT CNVDHKPSNT KVDKRVESKY GPPCPSCPAP
251 EFLGGPSVFL FPPKPKDTLM ISRTPEVTCV VVDVSQEDPE VQFNWYVDGV
301 EVHNAKTKPR EEQFNSTYRV VSVLTVLHQD WLNKEYKCK VSNKGLPSSI
351 EKTISKAKGQ PREPQVYTL PPSQEEMTKNQ VSLTCLVKGF YPSDIAVEWE
401 SNGQPENNYK TAPPVLDSDG SFFLYSRLTV DKSRWQEGNV FSCSVMEAL
451 HNHYTQKSL LSLGK
```

SEQ ID NO. 15

6.22.2 Kappa Light Chain Nucleotide Sequence

```
1   atgttgccat cacaactcat tgggtttctg ctgctctggg ttccagcttc
51  caggggtGAA ATTGTGCTGA CTCAGTCTCC AGACTTTCAG TCTGTGACTC
101 CAAAAGAGAA AGTCACCATC ACCTGCCGGG CCAGTCAGAG AATTGGTAGT
151 AGCTTACACT GGTACCAGCA GAAACCAGAT CAGTCTCCAA AACTCCTCAT
201 CAAGTATGCT TCCAGTCCT TCTCAGGGGT CCCCTCGAGG TTCAGTGGCA
251 GTGGATCTGG GACAAATTC ACCCTACCA TCAATGGCCT GGAAGCTGAA
301 GATGCTGCAA CTTATTACTG TCATCAGAGT GGTCGTTTAC CGCTCACTTT
351 CGGCGGAGGG ACCAAGGTGG AGATCAAACG AACTGTGGCT GCACCATCTG
401 TCTTCATCTT CCCGCCATCT GATGAGCAGT TGAAATCTGG AACTGCCTCT
451 GTTGTGTGCC TGCTGAATAA CTTCTATCCC AGAGAGGCCA AAGTACAGTG
501 GAAGGTGGAT AACGCCCTCC AATCGGGTAA CTCCCAGGAG AGTGTACAG
551 AGCAGGACAG CAAGGACAGC ACCTACAGCC TCAGCAGCAC CCTGACGCTG
601 AGCAAAGCAG ACTACGAGAA ACACAAAGTC TACGCCTGCG AAGTCACCCA
651 TCAGGGCCTG AGCTCGCCCG TCACAAAGAG CTTCAACAGG GGAGAGTGTT
701 AGTGA
```

SEQ ID NO. 16

6.22.2 Predicted Kappa Light Chain Protein Sequence

```
1   mlpsqligfl llwvpasrgE IVLTQSPDFQ SVTPKEKVTI TCRASQRIGS
51  SLHWYQQKPD QSPKLLIKYA SQSFSGVPSR FSGSGSGTNF TLTINGLEAE
101 DAATYYCHQS GRLPLTFGGG TKVEIKRTVA APSVFIFPPS DEQLKSGTAS
151 VVCLLNHFYP REAKVQWKVD NALQSGNSQE SVTEQDSKDS TYSLSTLTLL
201 SKADYEKHKV YACEVTHQGL SSPVTKSENR GEC
```

SEQ ID NO. 17

6.34.2 Heavy Chain Nucleotide Sequence

```
1   atggaggtttg ggctgagctg ggttttcctc gttgctcttt taagaggtgt
51  ccagtgtCAG GTGCAGCTGG TGGAGTCTGG GGGAGGCGTG GTCCAGCCTG
101 GGAGGTCCCT GAGACTCTCC TGTGCAGCCT CTGGATTCAC CTTCAGTAGC
151 TATGGCATGC ACTGGGTCCG CCAGGCTCCA GGCAAGGGGC TGGAGTGGGT
201 GGCAGTTATA TCAAATGATG GAAATAATAA ATACTATGCA GACTCCGTGA
251 AGGGCCGATT CACCATCTCC AGAGACAATT CCAAAAACAC GCTGTATCTG
301 CAAATGAACA GCCTGAGCGC TGAGGACACG GCTGTGTATT ACTGTGCGAG
351 AGATAGTACG GCGATAACCT ACTACTACTA CGGAATGGAC GTCTGGGGCC
401 AAGGGACCAC GGTCACCGTC TCCTCAGCTT CCACCAAGGG CCCATCCGTC
451 TTCCCCCTGG CGCCCTGCTC CAGGAGCACC TCCGAGAGCA CAGCCGCCCT
501 GGGCTGCCTG GTCAAGGACT ACTTCCCCGA ACCGGTGACG GTGTCGTGGA
551 ACTCAGGCGC CCTGACCAGC GCGGTGCACA CCTTCCCGGC TGTCTACAG
601 TCCTCAGGAC TCTACTCCCT CAGCAGCGTG GTGACCGTGC CCTCCAGCAG
651 CTTGGGCACG AAGACCTACA CCTGCAACGT AGATCACAAAG CCCAGCAACA
701 CCAAGGTGGA CAAGAGAGTT GAGTCCAAAT ATGGTCCCCC ATGCCCATCA
751 TGCCAGCAC CTGAGTTCCT GGGGGGACCA TCAGTCTTCC TGTTCCTCC
801 AAAACCCAAG GACACTCTCA TGATCTCCCG GACCCCTGAG GTCACGTGCG
851 TGGTGGTGGA CGTGAGCCAG GAAGACCCCG AGGTCCAGTT CAACTGGTAC
901 GTGGATGGCG TGGAGGTGCA TAATGCCAAG ACAAAGCCGC GGGAGGAGCA
951 GTTCAACAGC ACGTACCGTG TGGTCAGCGT CCTCACCCTC CTGCACCAGG
1001 ACTGGCTGAA CGGCAAGGAG TACAAGTGCA AGGTCTCCAA CAAAGGCCTC
1051 CCGTCCTCCA TCGAGAAAAC CATCTCCAAA GCCAAAGGGC AGCCCCGAGA
1101 GCCACAGGTG TACACCCCTG CCCCATCCCA GGAGGAGATG ACCAAGAACC
1151 AGGTCAGCCT GACCTGCCTG GTCAAAGGCT TCTACCCAG CGACATCGCC
1201 GTGGAGTGGG AGAGCAATGG ACAGCCGAG ACAACTACA AGACCACGCC
1251 TCCCGTGCTG GACTCCGACG GCTCCTTCTT CCTCTACAGC AGGCTAACCG
1301 TGGACAAGAG CAGGTGGCAG GAGGGGAATG TCTTCTCATG CTCCGTGATG
1351 CATGAGGCTC TGCACAACCA CTACACACAG AAGAGCCTCT CCCTGTCTCT
1401 GGGTAAATGA
```

SEQ ID NO. 18

6.34.2 Predicted Heavy Chain Protein Sequence

```
1   mefglswvfl vallrgvgcQ VQLVESGGGV VQPGRSLRLS CAASGFTFSS
51  YGMHWVRQAP GKGLEWVAVI SNDGNNKYA DSVKGRFTIS RDNSKNTLYL
101 QMNSLSAEDT AVYYCARDST AITYYYGMD VWGQTTTVTV SSASTKGPSV
151 FPLAPCSRST SESTAALGCL VKDYFPEPVT VSWNSGALTS GVHTFPAVLQ
201 SSGLYSLSSV VTVPSSSLGT KTYTCNV DDK PSNTKVDKRV ESKYGPPCPS
251 CPAPEFLGGP SVFLFPPKPK DTLNISRTPE VTCVVVDVSQ EDPEVQFNWY
301 VDGVEVHNAK TKPREEQFNS TYRVVSVLTV LHQDWLNGKE YKCKVSNKGL
351 PSSIEKTISK AKGQPREPQV YTLPPSQEEM TKNQVSLTCL VKGFYPSDIA
401 VEWESNGQPE NNYKTTTPVL DSDGSFFLYS RLTVDKSRWQ EGNVFSQSV
451 HEALHNHYTQ KSLSLSLGK
```

SEQ ID NO. 19

6.34.2 Kappa Light Chain Nucleotide Sequence

```

1   atggacatga ggggtccccgc tcagctcctg gggctcctgc tactctggct
51  ccgaggtgcc agatgtGACA TCCAGATGAC CCAGTCTCCA TCCTCCCTGT
101 CTGCATCTGT CGGAGACAGA GTCACCATCA CTTGCCGGGC AAGTCAGAAT
151 ATTAGTAGCT ATTTAAATTG GTTTCAGCAG AAACCAGGGA AAGCCCCTAA
201 GTCCTGATC TATGCTGCAT CCGGTTTGAA GCGTGGGGTC CCATCACGGT
251 TCAGTGGTAG TGGATCTGGG ACAGATTTC CTCTACCAT CAGGACTCTG
301 CAACCTGATG ATTTTGCAAC TTA CTCTGT CACCAGAGTT ACAGTCTCCC
351 ATTCACTTTC GGCCCTGGGA CCAAAGTGGA TATCAAACGA ACTGTGGCTG
401 CACCATCTGT CTTCATCTTC CCGCCATCTG ATGAGCAGTT GAAATCTGGA
451 ACTGCCTCTG TTGTGTGCCT GCTGAATAAC TTCTATCCCA GAGAGGCCAA
501 AGTACAGTGG AAGGTGGATA ACGCCCTCCA ATCGGGTAAC TCCCAGGAGA
551 GTGTCACAGA GCAGGACAGC AAGGACAGCA CCTACAGCCT CAGCAGCACC
601 CTGACGCTGA GCAAAGCAGA CTACGAGAAA CACAAAGTCT ACGCCTGCGA
651 AGTCACCCAT CAGGGCCTGA GCTCGCCCGT CACAAAGAGC TTCAACAGGG
701 GAGAGTGTTA GTGA

```

SEQ ID NO. 20

6.34.2 Predicted Kappa Light Chain Protein Sequence

```

1   mdmrvpaql1 gl1111wlrge rcDIQMTQSP SSLASVSGDR VTITCRASQN
51  ISSYLNWFQQ KPGKAPKLLI YAASGLKRGV PSRFSGSGSG TDFTLTIRTL
101 QPDDFATYSC HQSYSLPFTF GPGTKVDIKR TVAAPSVFIF PPSDEQLKSG
151 TASVVCLLNN FYPREAKVQW KVDNALQSGN SQESVTEQDS KDSTYSLSST
201 LTLSKADYEK HKVYACEVTH QGLSSPVTKS FNRGEC

```

SEQ ID NO. 21

6.67.1 Heavy Chain Nucleotide Sequence

```

1   atgaaacacc tgtggttctt cctcctgctg gtggcagctc ccagatgggt
51  cctgtcccCAG GTGCAGCTGC AGGAGTCGGG CCCAGGACTG GTGAAGCCTT
101 CGGAGACCCCT GTCCCTCACC TGCACGTCTT CTGGTGACTC CATCAGTAGT
151 AACTATTGGA GCTGGATCCG GCAGCCCGCC GGAAGGGAC TGGAGTGGAT
201 TGGGCGTATC TATACCAAGT GGGGCACCAA CTCCAACCC TCCCTCAGGG
251 GTCGAGTCAC CATTCTAGCA GACACGTCCA AGAACCAAGT CTCTCTGAAA
301 CTGAGTTCTG TGACCGCCGC GGACACGGCC GTGTATTACT GTGCGAGAGA
351 TCGTATTACT ATAATTCGGG GACTTATTC ATCCTTCTTT GACTACTGGG
401 GCCAGGGAAC CCTGGTCACC GTCTCCTCAG CTCCACCAA GGGCCCATCC
451 GTCTTCCCCC TGGCGCCCTG CTCCAGGAGC ACCTCCGAGA GCACAGCCGC
501 CCTGGGCTGC CTGGTCAAGG ACTACTTCCC CGAACCGGTG ACGGTGTCGT
551 GGAACCTCAG CGCCCTGACC AGCGGCGTGC ACACCTTCCC GGCTGTCCTA
601 CAGTCCTCAG GACTCTACTC CCTCAGCAGC GTGGTGACCG TGCCCTCCAG
651 CAGCTTGGGC ACGAAGACCT ACACCTGCAA CGTAGATCAC AAGCCCAGCA
701 ACACCAAGGT GGACAAGAGA GTTGAGTCCA AATATGGTCC CCCATGCCCCA
751 TCATGCCCCA CACCTGAGTT CCTGGGGGGA CCATCAGTCT TCCTGTTCCC
801 CCCAAAACCC AAGGACACTC TCATGATCTC CCGGACCCCT GAGGTCACGT
851 GCGTGGTGGT GGACGTGAGC CAGGAAGACC CCGAGGTCCA GTTCAACTGG
901 TACGTGGATG GCGTGGAGGT GCATAATGCC AAGACAAAGC CGCGGGAGGA
951 GCAGTTCAAC AGCACGTACC GTGTGGTCAG CGTCCTCACC GTCTGCACC
1001 AGGACTGGCT GAACGGCAAG GAGTACAAGT GCAAGGTCTC CAACAAAGGC
1051 CTCCCGTCTC CCATCGAGAA AACCATCTCC AAAGCCAAAG GGCAGCCCCG
1101 AGAGCCACAG GTGTACACCC TGCCCCATC CCAGGAGGAG ATGACCAAGA
1151 ACCAGGTCAG CCTGACCTGC CTGGTCAAAG GCTTCTACCC CAGCGACATC
1201 GCCGTGGAGT GGGAGAGCAA TGGGCAGCCG GAGAACAAC AAGACCAC
1251 GCCTCCCGTG CTGGACTCCG ACGGCTCCTT CTTCCTCTAC AGCAGGCTAA
1301 CCGTGGACAA GAGCAGGTGG CAGGAGGGGA ATGTCTTCTC ATGCTCCGTG
1351 ATGCATGAGG CTCTGCACAA CCACTACACA CAGAAGAGCC TCTCCCTGTC
1401 TCTGGGTAAA TGA

```

SEQ ID NO. 22

6.67.1 Predicted Heavy Chain Protein Sequence

```

1   mkhlwfflll vaaprwlsQ VQLQESGPGL VKPSETLSLT CTVSGDSISS
51  NYWSWIRQPA GKGLEWIGRI YTSGGTNSNP SLRGRVTILA DTSKNQFSLK
101 LSSVTAADTA VYYCARDRIT IIRGLIPSFY DYWGQGTLLV VSSASTKGPS
151 VFPLAPCSRS TSESTAALGC LVKDYFPEPV TVSWNSGALT SGVHTFPAVL
201 QSSGLYSLSS VVTVPSSSLG TKTYTCNVDH KPSNTKVDKR VESKYGPPCP
251 SCPAPEFLGG PSVFLFPPKP KDTLMISRTPEVTCVVDVS QEDPEVQFNW
301 YVDGVEVHNA KTKPREEQFN STYRVVSVLT VLHQDWLNGK EYKCKVSNKG
351 LPSSIEKTIS KAKGQPREPQ VYTLPPSQEE MTKNQVSLTC LVKGFYPSDI
401 AVEWESNGQP ENNYKTTTPV LDSDGSFFLY SRLTVDKSRW QEGNVFSCSV
451 MHEALHNHYT QKSLSLSLGK

```

SEQ ID NO. 23

6.67.1 Kappa Light Chain Nucleotide Sequence

1	<u>atggtgttgc</u>	<u>agacccaggt</u>	<u>cttcatttct</u>	<u>ctgttgctct</u>	<u>ggatctctgg</u>
51	<u>tgcctacggg</u>	GACATCGTGA	TGACCCAGTC	TCCAGACTCC	CTGGCTGTGT
101	CTCTGGGCGA	GAGGGCCACC	ATCAACTGCA	AGTCCAGCCA	GAGTGTTTTA
151	TACAGCTCCA	ACAATAAGAC	CTACTTAGCT	TGGTACCAAC	AGAAACCAAG
201	ACAGCCTCCT	AAATTGCTCA	TTTACTGGGC	ATCTATACGG	GAATATGGGG
251	TCCCTGACCG	ATTCAGTGGC	AGCGGGTCTG	GGACAGATTT	CACTCTCACC
301	ATCAGCAGCC	TGCAGGCTGA	AGATGTGGCA	GTTTATTTCT	GTCAACAATA
351	TTATAGTATT	CCTCCCCTCA	CTTTCGGCGG	AGGGACCAAG	GTGGAGATCA
401	AACGAACTGT	GGCTGCACCA	TCTGTCTTCA	TCTTCCCGCC	ATCTGATGAG
451	CAGTTGAAAT	CTGGAAGTGC	CTCTGTTGTG	TGCCTGCTGA	ATAACTTCTA
501	TCCCAGAGAG	GCCAAAGTAC	AGTGGAAGGT	GGATAACGCC	CTCCAATCGG
551	GTAAC TCCCA	GGAGAGTGTC	ACAGAGCAGG	ACAGCAAGGA	CAGCACCTAC
601	AGCCTCAGCA	GCACCCTGAC	GCTGAGCAAA	GCAGACTACG	AGAAACACAA
651	AGTCTACGCC	TGCGAAGTCA	CCCATCAGGG	CCTGAGCTCG	CCCGTCACAA
701	AGAGCTTCAA	CAGGGGAGAG	TGTTAGTGA		

SEQ ID NO. 24

6.67.1 Predicted Kappa Light Chain Protein Sequence

1	<u>mvltqtqvfis</u>	<u>lllwisgayg</u>	DIVMTQSPDS	LAVSLGERAT	INCKSSQSVL
51	YSSNNKTYLA	WYQQKPRQPP	KLLIYWASIR	EYGVPRFSG	SGSGTDFTLT
101	ISSLQAEDVA	VYFCQQYYSI	PPLTFGGGK	VEIKRTVAAP	SVFIFPPSDE
151	QLKSGTASVV	CLLNFFYPRE	AKVQWKVDNA	LQSGNSQESV	TEQDSKDSTY
201	SLSSTLTLSK	ADYEKHKVYA	CEVTHQGLSS	PVTKSENRGE	C

SEQ ID NO. 25

6.73.2 Heavy Chain Nucleotide Sequence

```
1   atggaggtttg ggctgagctg gcttttttctt gtggctatatt taaaaggtgt
51  ccagtgtGAG GTGCAGCTGT TGGAGTCTGG GGGAGACTTG GTCCAGCCTG
101 GGGGGTCCCT GAGACTCTCC TGTGCAGCCT CTGGATTCAC CTTTAGAAGT
151 TATGCCATGA ACTGGGTCCG ACAGGCTCCA GGGAAGGGGC TGGAGTGGGT
201 CTAGTTTATT AGTGGTCGTG GTGGTACTAC ATACTACGCA GACTCCGTGA
251 AGGGCCGGTT CACCATCTCC AGAGACAATT CCAAGAACAC GCTGTATCTG
301 CAAATGAACA GCCTGAGAGC CGAGGACGCG GCCGTATATT ACTGTGCGAA
351 GATAGCAGTG GCTGGAGAGG GGCTCTACTA CTACTACGGT ATGGACGTCT
401 GGGGCCAAGG GACCACGGTC ACCGTCTCCT CAGCTTCCAC CAAGGGCCCA
451 TCCGTCTTCC CCCTGGCGCC CTGCTCCAGG AGCACCTCCG AGAACACAGC
501 CGCCTGGGC TGCCTGGTCA AGGACTACTT CCCCGAACCG GTGACGGTGT
551 CGTGGAACTC AGGCGCCCTG ACCAGCGGCG TGACACCTT CCCGGCTGTC
601 CTACAGTCCCT CAGGACTCTA CTCCCTCAGC AGCGTGGTGA CCGTGCCCTC
651 TAGCAGCTTG GGCACGAAGA CCTACACCTG CAACGTAGAT CACAAGCCCA
701 GCAACACCAA GGTGGACAAG AGAGTTGAGT CCAAATATGG TCCCCCATGC
751 CCATCATGCC CAGCACCTGA GTTCCTGGGG GGACCATCAG TCTTCTGT
801 CCCCCAAAAA CCAAGGACA CTCTCATGAT CTCCCGGACC CCTGAGGTCA
851 CGTGCGTGGT GGTGGACGTG AGCCAGGAAG ACCCCGAGGT CCAGTTCAAC
901 TGGTACGTGG ATGGCGTGGA GGTGCATAAT GCCAAGACAA AGCCGCGGGA
951 GGAGCAGTTC AACAGCACGT ACCGTGTGGT CAGCGTCCTC ACCGTCCTGC
1001 ACCAGGACTG GCTGAACGGC AAGGAGTACA AGTGCAAGGT CTCCAACAAA
1051 GGCCTCCCGT CCTCCATCGA GAAAACCATC TCCAAAGCCA AAGGGCAGCC
1101 CCGAGAGCCA CAGGTGTACA CCTGCCCCC ATCCCAGGAG GAGATGACCA
1151 AGAACCAGGT CAGCCTGACC TGCCTGGTCA AAGGCTTCTA CCCCAGCGAC
1201 ATCGCCGTGG AGTGGGAGAG CAATGGGCAG CCGGAGAACA ACTACAAGAC
1251 CACGCCTCCC GTGCTGGACT CCGACGGCTC CTTCTTCCTC TACAGCAGGC
1301 TAACCGTGGA CAAGAGCAGG TGGCAGGAGG GGAATGTCTT CTCATGCTCC
1351 GTGATGCATG AGGCTCTGCA CAACCACTAC ACACAGAAGA GCCTCTCCCT
1401 GTCTCTGGGT AAATGATAG
```

SEQ ID NO. 26

6.73.2 Predicted Heavy Chain Protein Sequence

```
1   mefglswlfl vailkgvqcE VQLLESGGDL VQPGGSLRLS CAASGFTFRS
51  YAMNWVRQAP GKGLEWVSVI SGRGGTTYA DSVKGRFTIS RDNSKNTLYL
101 QMNSLRAEDA AVYYCAKIAV AGEGLYYYYG MDVWQGQTTV TVSSASTKGP
151 SVFPLAPCSR STSENTAALG CLVKDYFPEP VTVSWNSGAL TSGVHTFPAV
201 LQSSGLYSLs SVVTVPSSSL GTKTYTCNVD HKPSNTKVDK RVESKYGPpC
251 PSCPAPEFLG GPSVFLFPPK PKDTLMISRT PEVTCVVVDV SQEDPEVQFN
301 WYVDGVEVHN AKTKPREEQF NSTYRVVSVL TVLHQDWLNG KEYKCKVSNK
351 GLPSSIEKTI SKAKGQPREP QVYTLPPSQE EMTKNQVSLT CLVKGFYPSD
401 IAVEWESNGQ PENNYKTTTP VLDSDGSFFL YSRLTVDKSR WQEGNVFSCS
451 VMHEALHNHY TQKSLSLSLG K
```

SEQ ID NO. 27

6.73.2 Kappa Light Chain Nucleotide Sequence

```
1   atggacatga ggggtccccgc tcagctcctg gggctcctgc tactctggct
51  ccgaggtgcc agatgtGACA TCCAGATGAC CCAGTCTCCA TCCTCCCTGT
101 CTGCATCTGT AGGTGACAGA GTCACCTTCA CTTGCCGGGC AAGTCAGAAC
151 ATTACCAACT ATTTAAATTG GTATCAGCAG AAACCAGGGA AGGCCCCTAA
201 GTCCTGATC TATGCTGCGT CCAGTTTGCC AAGAGGGGTC CCATCAAGGT
251 TCCGTGGCAG TGGATCTGGG ACAGATTTC CTCTACCAT CAGCAGTCTG
301 CAACCTGAAG ATTTTGCAAC TTACTACTGT CAACAGAGTT ACAGTAATCC
351 TCCGGAGTGC GGTTTTGGCC AGGGGACCAC GCTGGATATC AAACGAACTG
401 TGGCTGCACC ATCTGTCTTC ATCTTCCCGC CATCTGATGA GCAGTTGAAA
451 TCTGGAAGT CCTCTGTTGT GTGCCTGCTG AATAACTTCT ATCCCAGAGA
501 GGCCAAAGTA CAGTGGAAGG TGGATAACGC CCTCCAATCG GGTAACCTCC
551 AGGAGAGTGT CACAGAGCAG GACAGCAAG ACAGCACCTA CAGCCTCAGC
601 AGCACCTGA CGCTGAGCAA AGCAGACTAC GAGAAACACA AAGTCTACGC
651 CTGCGAAGTC ACCCATCAGG GCCTGAGCTC GCCCCTCACA AAGAGCTTCA
701 ACAGGGGAGA GTGTTAGTGA
```

SEQ ID NO. 28

6.73.2 Predicted Kappa Light Chain Protein Sequence

```
1   mdmrvpaql lllllwlrge rcDIQMTQSP SSLASVGDV VTFTCRASQN
51  ITNYLNWYQQ KPGKAPKLLI YAASSLPRGV PSRFRGSGSG TDFTLTISSL
101 QPEDFATYYC QSYSNPPEC GFGQGTTLDI KRTVAAPSVF IFPPSDEQLK
151 SGTASVVCLL NNFYPREAKV QWKVDNALQS GNSQESVTEQ DSKDSTYSL
201 STLTLSKADY EKHKVYACEV THQGLSSPVT KSFNRGEC
```

SEQ ID NO. 29

6.77.1 Heavy Chain Nucleotide Sequence

```
1   atggaactgg ggctccgctg ggttttcctt gttgctatatt tagaaggtgt
51  ccagtgtGAG GTGCAGCTGG TGGAGTCTGG GGGAGGCCTG GTCAAGCCTG
101 GGGGGTCCCT GAGACTCTCC TGTGCAGCCT CTGGATTCAC CTTCAGTAGC
151 TATAGCATGA ACTGGGTCCG CCAGGTCCA GGAAGGGGC TGGAGTGGGT
201 CTCATCCATT AGTAGTAGTA GTAGTTACAT ATACTACGCA GACTCAGTGA
251 AGGGCCGATT CACCATCTCC AGAGACAACG CCAAGAACTC ACTGTATCTG
301 CAAATGAACA GCCTGAGAGC CGAGGACACG GCTGTGTATT ACTGTGCGAG
351 AGATGGGTAT AGCAGTGGCT GGTCTACTA CTACTACTAC GGTATGGACG
401 TCTGGGGCCA AGGGACCACG GTCACCGTCT CCTCAGCTTC CACCAAGGGC
451 CCATCCGTCT TCCCCCTGGC GCCCTGCTCC AGGAGCACCT CCGAGAGCAC
501 AGCCGCCCTG GGCTGCCCTGG TCAAGGACTA CTTCCCCGAA CCGGTGACGG
551 TGTCGTGGAA CTCAGGCGCC CTGACCAGCG GCGTGACAC CTTCCCGGCT
601 GTCCTACAGT CCTCAGGACT CTACTCCCTC AGCAGCGTGG TGACCGTGCC
651 CTCACAGCAGC TTGGGCACGA AGACCTACAC CTGCAACGTA GATCACAAGC
701 CCAGCAACAC CAAGGTGGAC AAGAGAGTTG AGTCCAAATA TGGTCCCCCA
751 TGCCCATCAT GCCCAGCACC TGAGTTCCTG GGGGGACCAT CAGTCTTCCT
801 GTTCCCCCCA AAACCCAAGG ACACTCTCAT GATCTCCCGG ACCCCTGAGG
851 TCACGTGCGT GGTGGTGGAC GTGAGCCAGG AAGACCCCGA GGTCCAGTTC
901 AACTGGTACG TGGATGGCGT GGAGGTGCAT AATGCCAAGA CAAAGCCGCG
951 GGAGGAGCAG TTCAACAGCA CGTACCGTGT GGTGAGCGTC CTCACCGTCC
1001 TGCACCAGGA CTGGCTGAAC GGCAAGGAGT ACAAGTGCAA GGTCTCCAAC
1051 AAAGGCCTCC CGTCTCTCAT CGAGAAAACC ATCTCAAAG CCAAAGGGCA
1101 GCCCCGAGAG CCACAGGTGT ACACCTGCC CCCATCCAG GAGGAGATGA
1151 CCAAGAACCA GGTGAGCCTG ACCTGCCTGG TCAAAGGCTT CTACCCAGC
1201 GACATCGCCC TGGAGTGGGA GAGCAATGGG CAGCCGGAGA ACAACTACAA
1251 GACCACGCCT CCCGTGCTGG ACTCCGACGG CTCTTCTTTC CTCTACAGCA
1301 GGCTAACCCT GGACAAGAGC AGGTGGCAGG AGGGGAATGT CTTTTCACGC
1351 TCCGTGATGC ATGAGGCTCT GCACAACCAC TACACACAGA AGAGCCTCTC
1401 CCTGTCTCTG GGTAAATGAT AGGAATTCTG ATGA
```

SEQ ID NO. 30

6.77.1 Predicted Heavy Chain Protein Sequence

```
1   melglrwvfl vailegvqcE VQLVESGGGL VKPGGSLRLS CAASGFTFSS
51  YSMNWVRQAP GKGLEWVSSI SSSSSYIYYA DSVKGRFTIS RDNAKNSLYL
101 QMNSLRAEDT AVYYCARDGY SSGWSYYYYY GMDVWGQGT VTVSSASTKG
151 PSVFPLAPCS RSTSESTAAL GCLVKDYFPE PVTVSWNSGA LTSGVHTFPA
201 VLQSSGLYSL SSVVTVPSSS LGTKITYTCNV DHKPSNTKVD KRVESKYGPP
251 CPSCPAPPEFL GGPSVFLFPP KPKDTLMISR TPEVTCVVVD VSQEDPEVQF
301 NWYVDGVEVH NAKTKPREEQ FNSTYRVVSV LTVLHQDWLN GKEYKCKVSN
351 KGLPSSIEKT ISKAKQPRE PQVYTLPPSQ EEMTKNQVSL TCLVKGFYPS
401 DIAVEWESNG QPENNYKTP PVLDSDGSFF LYSRLTVDKS RWQEGNVFSR
451 SVMHEALHNH YTQKSLSLSL GK
```

SEQ ID NO. 31

6.77.1 Kappa Light Chain Nucleotide Sequence

1	<u>atgaggctcc</u>	<u>ctgctcagct</u>	<u>cctggggctg</u>	<u>ctaagtctct</u>	<u>ggatacctgg</u>
51	<u>atccagtgca</u>	GATATTGTGA	TGACCCAGAC	TCCACTCTCT	CTGTCCGTCA
101	CTCCTGGACA	GCCGGCCTCC	ATCTCCTGCA	ACTCTAGTCA	GAGCCTCCTG
151	CTTAGTGATG	GAAAGACCTA	TTTGAATTGG	TACCTGCAGA	AGCCCGGCCA
201	GCCTCCACAG	CTCCTGATCT	ATGAAGTTTC	CAACCGGTTC	TCTGGAGTGC
251	CAGACAGGTT	CAGTGGCAGC	GGGTCAGGGA	CAGATTTTCA	ACTGAAAATC
301	AGCCGGGTGG	AGGCTGAGGA	TGTTGGGGTT	TATTCCTGCA	TGCAAAGTAT
351	ACAGCTTATG	TGCAGTTTTG	GCCAGGGGAC	CAAGCTGGAG	ATCAAACGAA
401	CTGTGGCTGC	ACCATCTGTC	TTCATCTTCC	CGCCATCTGA	TGAGCAGTTG
451	AAATCTGGAA	CTGCCTCTGT	TGTGTGCCTG	CTGAATAACT	TCTATCCCAG
501	AGAGGCCAAA	GTACAGTGGA	AGGTGGATAA	CGCCCTCCAA	TCGGGTAAC
551	CCCAGGAGAG	TGTCACAGAG	CAGGACAGCA	AGGACAGCAC	CTACAGCCTC
601	AGCAGCACCC	TGACGCTGAG	CAAAGCAGAC	TACGAGAAAC	ACAAAGTCTA
651	CGCCTGCGAA	GTCACCCATC	AGGGCCTGAG	CTCGCCCGTC	ACAAAGAGCT
701	TCAACAGGGG	AGAGTGTTAG	TGA		

SEQ ID NO. 32

6.77.1 Predicted Kappa Light Chain Protein Sequence

1	<u>mrlpaqlgl</u>	<u>lmlwipgssa</u>	DIVMTQTPLS	LSVTPGQPAS	ISCNSSQSLL
51	LSDGKTYLW	YLQKPGQPPQ	LLIYEVSNRF	SGVPDRFSGS	GSSTDFTLKI
101	SRVEAEDVGV	YSCMQSIQLM	CSFGQGTKLE	IKRTVAAPSV	FIFPPSDEQL
151	KSGTASVVCL	LNNFYPREAK	VQWKVDNALQ	SGNSQESVTE	QDSKDSSTYS
201	SSTLTLSKAD	YEKHKVYACE	VTHQGLSSPV	TKSFNRGEC	

SEQ ID NO. 33

7.16.6 Heavy Chain Nucleotide Sequence

```
1   atggactgga cctggagcat ccttttcttg gtggcagcag caacaggtgc
51  ccactccCAG GTTCAGCTGG TGCAGTCTGG AGCTGAGGTG AAGAAGCCTG
101 GGGCCTCAGT GAAGGTCTCC TGCAAGGCTT CTGGTTACAC CTTTACCAGC
151 TATGGTATCA ACTGGGTGCG ACAGGCCCTT GGACAAGGGC TTGAGTGGAT
201 GGGATGGATC AGCGTTTACA GTGGTAACAC AAACATATGCA CAGAAGGTCC
251 AGGGCAGAGT CACCATGACC GCAGACACAT CCACGAGCAC AGCCTACATG
301 GACCTGAGGA GCCTGAGATC TGACGACACG GCCGTGTATT ACTGTGCGAG
351 AGAGGGTAGC AGCTCGTCCG GAGACTACTA TTACGGTATG GACGTCTGGG
401 GCCAAGGGAC CACGGTCACC GTCTCCTCAG CCTCCACCAA GGGCCCATCG
451 GTCTTCCCCC TGGCGCCCTG CTCCAGGAGC ACCTCCGAGA GCACAGCGGC
501 CCTGGGCTGC CTGGTCAAGG ACTACTTCCC CGAACC GGTTG TCGT
551 GGAACCTCAG CGCTCTGACC AGCGGCGTGC ACACCTTCCC AGCTGTCTTA
601 CAGTCCTCAG GACTCTACTC CCTCAGCAGC GTGGTGACCG TGCCCTCCAG
651 CAACTTCGGC ACCCAGACCT ACACCTGCAA CGTAGATCAC AAGCCCAGCA
701 ACACCAAGGT GGACAAGACA GTTGAGCGCA AATGTTGTGT CGAGTGCCCA
751 CCGTGCCCA GACACCTGTG GGCAGGACCG TCAGTCTTCC TCTTCCCCC
801 AAAACCCAAG GACACCCTCA TGATCTCCCG GACCCCTGAG GTCACGTGCG
851 TGGTGGTGGA CGTGAGCCAC GAAGACCCCG AGGTCCAGTT CAACTGGTAC
901 GTGGACGGCG TGGAGGTGCA TAATGCCAAG ACAAAGCCAC GGGAGGAGCA
951 GTTCAACAGC ACGTTCCGTG TGGTCAGCGT CCTACCGTT GTGCACCAGG
1001 ACTGGCTGAA CGGCAAGGAG TACAAGTGCA AGGTCTCCAA CAAAGGCCTC
1051 CCAGCCCCCA TCGAGAAAAC CATCTCCAAA ACCAAAGGGC AGCCCCGAGA
1101 ACCACAGGTG TACACCCTGC CCCCATCCCG GGAGGAGATG ACCAAGAACC
1151 AGGTCAGCCT GACCTGCCTG GTCAAAGGCT TCTACCCAG CGACATCGCC
1201 GTGGAGTGGG AGAGCAATGG GCAGCCGGAG ACAAAC TACA AGACCACACC
1251 TCCCATGCTG GACTCCGACG GCTCCTTCTT CCTCTACAGC AAGCTCACCG
1301 TGGACAAGAG CAGGTGGCAG CAGGGGAACG TCTTCTCATG CTCCGTGATG
1351 CATGAGGCTC TGCACAACCA CTACACGCAG AAGAGCCTCT CCCTGTCTCC
1401 GGGTAAATGA
```

SEQ ID NO. 34

7.16.6 Predicted Heavy Chain Protein Sequence

```
1   mdwtwsilfl vaaatgahsQ VQLVQSGAEV KKPGASVKVS CKASGYTFTS
51  YGINWVRQAP GQGLEWMGWI SVYSGNTNYA QKVQGRVTMT ADTSTSTAYM
101 DLRLSLRSDDT AVYYCAREGS SSSGDYYYGM DVWGQGTIVT VSSASTKGPS
151 VFPLAPCSRS TSESTAALGC LVKDYFPEPV TVSWNSGALT SGVHTFPAVL
201 QSSGLYSLSS VVTVPSSNFG TQTYTCNVDH KPSNTKVDKT VERKCCVECP
251 PCPAPPVAGP SVFLFPPKPK DTLMISRTPE VTCVVVDVSH EDPEVQFNWY
301 VDGVEVHNAK TKPREEQFNS TFRVSVLTV VHQDWLNGKE YKCKVSNKGL
351 PAPIEKTISK TKGQPREPQV YTLPPSREEM TKNQVSLTCL VKGFYPSDIA
401 VEWESNGQPE NNYKTTPLML DSDGSFFLYS KLTVDKSRWQ QGNVFSCSVM
451 HEALHNHYTQ KSLSLSPGK
```

SEQ ID NO. 35

7.16.6 Kappa Light Chain Nucleotide Sequence and X481.2 Kappa Light Chain Nucleotide Sequence

```
1   atgaggctcc ctgctcagct cctggggctg ctaatgctct ggatacctgg
51  atccagtgca GATATTGTGA TGACCCAGAC TCCACTCTCT CTGTCCGTCA
101 CCCCTGGACA GCCGGCCTCC ATCTCCTGCA AGTCTAGTCA GAGCCTCCTG
151 CATACTGATG GAACGACCTA TTTGTATTGG TACCTGCAGA AGCCAGGCCA
201 GCCTCCACAG CTCCTGATCT ATGAAGTTTC CAACCGGTTT TCTGGAGTGC
251 CAGATAGGTT CAGTGGCAGC GGGTCAGGGA CAGATTTTAC ACTGAAAATC
301 AGCCGGGTGG AGGCTGAGGA TGTGGGATT TATTACTGCA TGCAAAATAT
351 ACAGCTTCCG TGGACGTTTC GCCAAGGGAC CAAGGTGGAA ATCAAACGAA
401 CTGTGGCTGC ACCATCTGTC TTCATCTTCC CGCCATCTGA TGAGCAGTTG
451 AAATCTGGAA CTGCCTCTGT TGTGTGCCTG CTGAATAACT TCTATCCCAG
501 AGAGGCCAAA GTACAGTGGA AGGTGGATAA CGCCCTCCAA TCGGGTAACT
551 CCCAGGAGAG TGTACAGAG CAGGACAGCA AGGACAGCAC CTACAGCCTC
601 AGCAGCACCC TGACGCTGAG CAAAGCAGAC TACGAGAAAC ACAAAGTCTA
651 CGCTGCGAA GTCACCCATC AGGGCCTGAG CTCGCCCCTC ACAAAGAGCT
701 TCAACAGGGG AGAGTGTTAG TGA
```

SEQ ID NO. 36

7.16.6 Kappa Light Chain Protein Sequence

```
1   mrlpaqlql lmlwipgssa DIVMTQTPLS LSVTPGQPAS ISCKSSQSLL
51  HTDGTYYLYW YLQKPGQPPQ LLIYEVSNR FSGVPDRFSGS GSGTDFTLKI
101 SRVEAEDVGI YYCMQNIQLP WTFGQGTKVE IKRTVAAPSV FIFPPSDEQL
151 KSGTASVVCL LNNFYFPREK VQWKVDNALQ SGNSQESVTE QDSKDYSTYSL
201 SSTLTLSKAD YEKHKVYACE VTHQGLSSPV TKSFNREGC
```

SEQ ID NO. 37

7.20.5 Heavy Chain Nucleotide Sequence

```
1   atgaaacacc tgtggttett cctcctgctg gtggcagctc ccagatgggt
51  cctgtcccCAG GTGCAGCTGC AGGAGTCGGG CCCAGGACTG GTGAAGCCTT
101 CGGAGACCCT GTCCCTCACC TGCACGTCTC CTGGTAGCTC CATCAGTAGT
151 TACCACTGGA ACTGGATCCG GCAGCCCGCC GGAAGGGAC TGGAGTGGAT
201 TGGGCGTATC TATACCACTG GGAGCACCAA CTACAACCC TCCCTCAAGA
251 GTCGAGTCAC CATGTCACCTA GACACGTCCA AGAACCAGTT CTCCCTGAAG
301 CTGAGCTCTG TGACCGCCGC GGACACGGCC GTGTATTACT GTGCGAGAGA
351 GGGGTCAGG TATTACTATG CTTCTGGGAG TTATTACTAC GGTCTGGACG
401 TCTGGGGCCA AGGGACCACG GTCACCGTCT CCTCAGCCTC CACCAAGGGC
451 CCATCGGTCT TCCCCCTGGC GCCCTGCTCC AGGAGCACCT CCGAGAGCAC
501 AGCGGCCCTG GGCTGCCCTG TCAAGGACTA CTTCCCCGAA CCGGTGACGG
551 TGTCGTGGAA CTCAGGCGCT CTGACCAGCG GCGTGCACAC CTTCCCAGCT
601 GTCCTACAGT CCTCAGGACT CTACTCCCTC AGCAGCGTGG TGACCGTGCC
651 CTCAGCAAC TTCGGCACCC AGACCTACAC CTGCAACGTA GATCACAAGC
701 CCAGCAACAC CAAGGTGGAC AAGACAGTTG AGCGCAAATG TTGTGTCGAG
751 TGCCCACCGT GCCCAGCACC ACCTGTGGCA GGACCGTCAG TCTTCTCTT
801 CCCCCAAAA CCAAGGACA CCCTCATGAT CTCCCGGACC CCTGAGGTCA
851 CGTGCGTGGT GGTGGACGTG AGCCACGAAG ACCCCGAGGT CCAGTTCAAC
901 TGGTACGTGG ACGGCGTGGA GGTGCATAAT GCCAAGACAA AGCCACGGGA
951 GGAGCAGTTC AACAGCACGT TCCGTGTGGT CAGCGTCCTC ACCGTTGTGC
1001 ACCAGGACTG GCTGAACGGC AAGGAGTACA AGTGCAAGGT CTCCAACAAA
1051 GGCCTCCCAG CCCCATCGA GAAAACCATC TCCAAAACCA AAGGGCAGCC
1101 CCGAGAACCA CAGGTGTACA CCTGCCCCC ATCCCGGAG GAGATGACCA
1151 AGAACCAGGT CAGCCTGACC TGCCTGGTCA AAGGCTTCTA CCCCAGCGAC
1201 ATCGCCGTGG AGTGGGAGAG CAATGGGCAG CCGGAGAACA ACTACAAGAC
1251 CACACCTCCC ATGCTGGACT CCGACGGCTC CTTCTTCTC TACAGCAAGC
1301 TCACCGTGGA CAAGAGCAGG TGGCAGCAGG GGAACGTCTT CTCATGCTCC
1351 TGATGTCATG AGGCTCTGCA CAACCACTAC ACGCAGAAGA GCCTCTCCCT
1401 GTCTCCGGGT AAATGA
```

SEQ ID NO. 38

7.20.5 Predicted Heavy Chain Protein Sequence

```
1   mkhlwfflll vaaprwvlsQ VQLQESGPGL VKPSETLSLT CTVSGSSISS
51  YHWNWIRQPA GKGLEWIGRI YTSGSTNYP SLKSRVTMSL DTSKNQFSLK
101 LSSVTAADTA VYYCAREGVR YYYASGSYYY GLDVWGQGT VTVSSASTKG
151 PSVFPLAPCS RSTSESTAAL GCLVKDYFPE PVTVSWNSGA LTSGVHTFPA
201 VLQSSGLYSL SSVVTVPSSN FGTQTYTCNV DHKPSNTKVD KTVRKCCVE
251 CPPCPAPPVA GPSVFLFPPK PKDTLMISRT PEVTCVVVDV SHEDPEVQFN
301 WYVDGVEVHN AKTKPREEQF NSTFRVSVL TVVHQDWLNG KEYKCKVSNK
351 GLPAPIEKTI SKTKGQPREP QVYTLPPSRE EMTKNQVSLT CLVKGFYPSD
401 IAVEWESNGQ PENNYKTPP MLDSGSEFFL YSKLTVDKSR WQQGNVFSCS
451 VMHEALHNNH TQKSLSLSPG K
```

SEQ ID NO. 39

7.20.5 Kappa Light Chain Nucleotide Sequence

```

1   atgaggctcc ctgctcagct cctggggctg ctaatgctct gggctctctgg
51  atccagtggg GATATTGTGA TGA CTAGTC TCCACTCTCC CTGCCCCTCA
101 CCCCTGGAGA GCCGGCCTCC ATCTCCTGCA GGTCTAGTCA GAGCCTCCTG
151 CATGGTAATG GATACAAC TA TTTGGATTGG TACCTGCAGA AGCCAGGGCA
201 GTCTCCACAG CTCCTGATCT ATTTGGGTTC TAATCGGGCC TCCGGGGTCC
251 CTGACAGGTT CAGTGGCAGT GGATCAGGCA CAGATTTTAC ACTGAAAATC
301 AGCAGAGTGG AGGCTGAGGA TGTGGGGT TATTACTGCA TGCAAGCTCT
351 ACAAACCTCT ACTTTCGGCG GAGGGACCA GGTGGAGATC AAACGAAGTG
401 TGGCTGCACC ATCTGTCTTC ATCTTCCCGC CATCTGATGA GCAGTTGAAA
451 TCTGGAAGTG CCTCTGTTGT GTGCCTGCTG AATAACTTCT ATCCCAGAGA
501 GGCCAAAGTA CAGTGGAAGG TGGATAACGC CCTCCAATCG GGTAAGTCCC
551 AGGAGAGTGT CACAGAGCAG GACAGCAAGG ACAGCACCTA CAGCCTCAGC
601 AGCACCTCTG CGCTGAGCAA AGCAGACTAC GAGAAACACA AAGTCTACGC
651 CTGCGAAGTC ACCCATCAGG GCCTGAGCTC GCCCCTCACA AAGAGCTTCA
701 ACAGGGGAGA GTGTTAGTGA

```

SEQ ID NO. 40

7.20.5 Predicted Kappa Light Chain Protein Sequence

```

1   mrlpaql lgl lmlwvsgssg DIVMTQSPLS LPVTPGEPAS ISCRSSQSLL
51  HNGGNYLDW YLQKPGQSPQ LLIYLGSNRA SGVPDRFSGS GSGTDFTLKI
101 SRVEAEDVGV YYCMQALQTL TFGGGTKVEI KRTVAAPSVF IFPPSDEQLK
151 SGTASVVC LL NNFYPREAKV QWKVDNALQS GNSQESVTEQ DSKDSTYSLS
201 STLTLKADY EKHKVYACEV THQGLSSPVT KSFNRGEC

```

SEQ ID NO. 41

7.26.4 Heavy Chain Nucleotide Sequence

```
1   atggactgga cctggagcat ccttttcttg gtggcagcag caacaggtgc
51  ccactcccCAG GTTCAGCTGG TGCAGTCTGG AGCTGAGGTG AAGAAGCCTG
101 GGGCCTCAGT GAAGGTCTCC TGCAGGCTT CTGGTTACAC CTTTACCAGC
151 TATGGTATCG ACTGGGTGCG ACAGGCCCTT GGACAAGGGC TTGAGTGGAT
201 GGGATGGATC AGCGTTTACA GTGGTAACAC AAAGTATGCA CAGAAGCTCC
251 AGGGCAGAGT CACCATGTCC ACAGACACAT CCACGAGCAC AGCCTACATG
301 GAGCTGAGGA GCCTGAGATC TGACGACACG GCCGTGTATT ACTGTGCGAG
351 AGAGGGTAGC AGCTCGTCCG GAGACTACTA CTACGGTATG GACGTCTGGG
401 GCCAAGGGAC CACGGTCACC GTCTCCTCAG CCTCCACCAA GGGCCCATCG
451 GTCTTCCCCC TGGCGCCCTG CTCCAGGAGC ACCTCCGAGA GCACAGCGGC
501 CCTGGGCTGC CTGGTCAAGG ACTACTTCCC CGAACCAGGTG ACGGTGTCGT
551 GGAAGTCAGG CGCTCTGACC AGCGGCGTGC ACACCTTCCC AGCTGTCTTA
601 CAGTCCTCAG GACTCTACTC CCTCAGCAGC GTGGTGACCG TGCCCTCCAG
651 CAACTTCGGC ACCCAGACCT ACACCTGCAA CGTAGATCAC AAGCCCAGCA
701 ACACCAAGGT GGACAAGACA GTTGAGCGCA AATGTTGTGT CGAGTGCCCA
751 CCGTGCCCAAG CACCACCTGT GGCAGGACCG TCAGTCTTCC TCTTCCCCC
801 AAAACCCAAG GACACCCTCA TGATCTCCCG GACCCCTGAG GTCACGTGCG
851 TGGTGGTGGA CGTGAGCCAC GAAGACCCCG AGGTCCAGTT CAACTGGTAC
901 GTGGACGGCG TGGAGGTGCA TAATGCCAAG ACAAAGCCAC GGGAGGAGCA
951 GTTCAACAGC ACGTTCCGTG TGGTCAGCGT CCTACCCGTT GTGCACCAGG
1001 ACTGGCTGAA CGGCAAGGAG TACAAGTGCA AGGTCTCCAA CAAAGGCCTC
1051 CCAGCCCCCA TTGAGAAAAC CATCTCCAAA ACCAAAGGGC AGCCCCGAGA
1101 ACCACAGGTG TACACCCTGC CCCCATCCCG GGAGGAGATG ACCAAGAACC
1151 AGGTCAGCCT GACCTGCCTG GTCAAAGGCT TCTACCCAG CGACATCGCC
1201 GTGGAGTGGG AGAGCAATGG GCAGCCGAG AACAATAACA AGACCACACC
1251 TCCCATGCTG GACTCCGACG GCTCCTTCTT CCTCTACAGC AAGCTCACCG
1301 TGGACAAGAG CAGGTGGCAG CAGGGGAACG TCTTCTCATG CTCCGTGATG
1351 CATGAGGCTC TGCACAACCA CTACACGCAG AAGAGCCTCT CCCTGTCTCC
1402 GGTAAATGA
```

SEQ ID NO. 42

7.26.4 Predicted Heavy Chain Protein Sequence

```
1   mdwtwsilfl vaaatgahsQ VQLVQSGAEV KKPGASVKVS CEASGYTFTS
51  YGIDWVRQAP GQGLEWMGWI SVYSGNTNYA QKLQGRVTMS TDTSTSTAYM
101 ELRSLRSDDT AVYYCAREGS SSSGDYYYGM DVWGQGTIVT VSSASTKGPS
151 VFPLAPCSRS TSESTAALGC LVKDYFPEPV TVSWNSGALT SGVHTFPAVL
201 QSSGLYSLSS VVTVPSSNFG TQTYTCNVDH KPSNTKVDKT VERKCCVECP
251 PCPAPPVAGP SVFLFPPKPK DTLNISRTPE VTCVVVDVSH EDPEVQFNWY
301 VDGVEVHNAK TKPREEQFNS TFRVSVLTV VHQDWLNGKE YKCKVSNKGL
351 PAPIEKTISK TKGQPREPQV YTLPPSREEM TKNQVSLTCL VKGFYPSDIA
401 VEWESNGQPE NNYKTTPLML DSDGSFFLYS KLTVDKSRWQ QGNVFSCSVM
451 HEALHNHYTQ KSLSLSPGK
```

SEQ ID NO. 43

7.26.4 Kappa Light Chain Nucleotide Sequence

1	<u>atgaggctcc</u>	<u>ctgctcagct</u>	<u>cctggggctg</u>	<u>ctaattgctct</u>	<u>ggatacctgg</u>
51	<u>atccagtgcg</u>	GATATTGTGA	TGACCCAGAC	TCCACTCTCT	CTGTCCGTCA
101	CCCCTGGACA	GCCGGCCTCC	ATCTCCTGCA	AGTCTAATCA	GAGCCTCCTG
151	TATAGTGATG	GAAAGACCTA	TTTGTTTGG	TACCTGCAGA	AGCCAGGCCA
201	GCCTCCACAG	CTCCTGATCT	ATGAAGTTTC	CAACCGATTC	TCTGGAGTGC
251	CAGATAGGTT	CAGTGGCAGC	GGGTCAGGGA	CAGATTTTAC	ACTGAAAATC
301	AGCCGGGTGG	AGGCTGAGGA	TGTTGGGGTT	TATTACTGCA	TGCAAAGTAT
351	ACAGCTTCCG	TGGACGTTCC	GCCAAGGGAC	CAAGGTGGAA	ATCAAACGAA
401	CTGTGGCTGC	ACCATCTGTC	TTCATCTTCC	CGCCATCTGA	TGAGCAGTTG
451	AAATCTGGAA	CTGCCTCTGT	TGTGTGCCTG	CTGAATAACT	TCTATCCCAG
501	AGAGGCCAAA	GTACAGTGGA	AGGTGGATAA	CGCCCTCCAA	TCGGGTAAC
551	CCCAGGAGAG	TGTCACAGAG	CAGGACAGCA	AGGACAGCAC	CTACAGCCTC
601	AGCAGCACCC	TGACGCTGAG	CAAAGCAGAC	TACGAGAAAC	ACAAAGTCTA
651	CGCCTGCGAA	GTCACCCATC	AGGGCCTGAG	CTCGCCCGTC	ACAAAGAGCT
701	TCAACAGGGG	AGAGTGTTAG	TGA		

SEQ ID NO. 44

7.26.4 Predicted Kappa Light Chain Protein Sequence

1	<u>mrlpaqlgl</u>	<u>lmlwipgssa</u>	DIVMTQTPLS	LSVTPGQPAS	ISCKSNQSLI
51	YSDGKTYLFW	YLQKPGQPPQ	LLIYEVSNRF	SGVPDRFSGS	GSGETDFTLKI
101	SRVEAEDVGV	YYCMQSIQLP	WTFGQGTKVE	IKRTVAAPSV	FIFPPSDEQL
151	KSGTASVVCL	LNNFYPREAK	VQWKVDNALQ	SGNSQESVTE	QDSKDSSTYS
201	SSTLTLSKAD	YEKHKVYACE	VTHQGLSSPV	TKSFNRGEC	

SEQ ID NO. 45

9.8.2 Heavy Chain Nucleotide Sequence

```
1   atggaggtttg ggctgagctg ggttttcctc gttgctcttt taagaggtgt
51  ccagtgtCAG GTGCAGCTGG TGGAGTCTGG GGGAGGCGTG GTCCAGCCTG
101 GGAGGTCCCT GAGACTCTCC TGTGCAGCGT CTGGATTAC CTTCACTAGC
151 TATGGCATGC ACTGGGTCCG CCAGGCTCCA GGCAAGGGGC TGGAGTGGGT
201 GGCAGTTATA TGGTATGATG GAAGTAATGA ATACTATGCA GACTCCGTGA
251 AGGGCCGATT CACCATCTCC AGAGACAATT CCAAGAACAC GCTGTATCTG
301 CAAATGAACA GCCTGAGAGC CGAGGACACG GCTGTGTATT ACTGTGCGAG
351 GGGGGCGTAC CACTTTGCCT ACTGGGGCCA GGAACCCCTG GTCACCGTCT
401 CCTCAGCTTC CACCAAGGGC CCATCCGTCT TCCCCTGGC GCCCTGCTCC
451 AGGAGCACCT CCGAGAGCAC AGCCGCCCTG GGCTGCCTGG TCAAGGACTA
501 CTCCCCGAA CCGGTGACGG TGTCTGGGAA CTCAGGCGCC CTGACCAGCG
551 GCGTGACAC CTTCCCGGCT GTCCTACAGT CCTCAGGACT CTACTCCCTC
601 AGCAGCGTGG TGACCGTGCC CTCCAGCAGC TTGGGCACGA AGACCTACAC
651 CTGCAACGTA GATCACAAGC CCAGCAACAC CAAGGTGGAC AAGAGAGTTG
701 AGTCCAAATA TGGTCCCCCA TGCCCATCAT GCCCAGCACC TGAGTTCCTG
751 GGGGGACCAT CAGTCTTCCT GTTCCCCCA AAACCAAGG ACACTCTCAT
801 GATCTCCCGG ACCCTGAGG TCACGTGCGT GGTGGTGGAC GTGAGCCAGG
851 AAGACCCGA GGTCCAGTTC AACTGGTACG TGGATGGCGT GGAGGTGCAT
901 AATGCCAAGA CAAAGCCGCG GGAGGAGCAG TTCAACAGCA CGTACCGTGT
951 GGTGAGCGTC CTCACCGTCC TGCACCAGGA CTGGCTGAAC GGCAAGGAGT
1001 ACAAGTGCAA GGTCTCCAAC AAAGGCCTCC CGTCCTCCAT CGAGAAAACC
1051 ATCTCCAAAG CCAAAGGGCA GCCCCGAGAG CCACAGGTGT ACACCCTGCC
1101 CCCATCCCAG GAGGAGATGA CCAAGAACCA GGTGAGCCTG ACCTGCCTGG
1151 TCAAAGGCTT CTACCCACG GACATCGCCG TGGAGTGGGA GAGCAATGGG
1201 CAGCCGGAGA ACAACTACAA GACCACGCCT CCCGTGCTGG ACTCCGACGG
1251 CTCTTCTTTC CTCTACAGCA GGCTAACCGT GGACAAGAGC AGGTGGCAGG
1301 AGGGGAATGT CTTCTCATGC TCCGTGATGC ATGAGGCTCT GCACAACCAC
1351 TACACACAGA AGAGCCTCTC CCTGTCTCTG GGTAAATGA
```

SEQ ID NO. 46

9.8.2 Predicted Heavy Chain Chain Protein Sequence

```
1   mefglswvfl vallrgvgcQ VQLVESGGGV VQPGRSLRLS CAASGFTFSS
51  YGMHWVRQAP GKGLEWVAVI WYDGSNEYA DSVKGRFTIS RDNSKNTLYL
101 QMNSLRAEDT AVYYCARGAY HFAYWGQGTL VTVSSASTKG PSVFPLAPCS
151 RSTSESTAAL GCLVKDYFPE PVTVSWNSGA LTSGVHTFPA VLQSSGLYSL
201 SSVVTVPSST LGTKTYTCNV DHKPSNTKVD KRVESKYGPP CPSCPAPEFL
251 GGPSVFLFPP KPKDTLMISR TPEVTCVVVD VSQEDPEVQF NWYVDGVEVH
301 NAKTKPREEQ FNSTYRVVSV LTVLHQDWLN GKEYKCKVSN KGLPSSIEKT
351 ISKAKQPRE PQVYTLPPSQ EEMTKNQVSL TCLVKGFYPS DIAVEWESNG
401 QPENNYKTPP PVLDSGDSFF LYSRLTVDKS RWQEGNVFSC SVMHEALHNN
451 YTKSLSLSL GK
```

SEQ ID NO. 47

9.8.2 Kappa Light Chain Nucleotide Sequence

```
1   atggacatga gggtcacctg tcagctcctg gggctcctgc tgctctggct
51  ctcaagtcgca ggtgccagat gtGACATCCA GATGACCCAG TCTCCATCCT
101 CCCTGTCTGC ATCTGTAGGA GACAGAGTCA CCATCACTTG CCAGGCGAGT
151 CAGGACATTA GCAACTATTT AAATTGGTAT CAGCAGAAAC CAGGGAAAAGC
201 CCCTAAGCTC CTGATCTACG ATGCATCCAA TTTGGAAACA GGGGTCCCAT
251 CAAGGTTTCAG TGGAAGTGGG TCTGGGACAG ATTTTACTTT CACCATCAGC
301 AGCCTGCAGC CTGAAGATAT TGCAACATAT TCCTGTCAAC ACTCTGATAA
351 TCTCTCGATC ACCTTCGGCC AGGGGACACG ACTGGAGATT AAACGAACTG
401 TGGCTGCACC ATCTGTCTTC ATCTTCCCGC CATCTGATGA GCAGTTGAAA
451 TCTGGAAGTGG CCTCTGTTGT GTGCCTGCTG AATAACTTCT ACCCCAGAGA
501 GGCCAAAGTA CAGTGGAAGG TGGATAACGC CCTCCAATCG GGTAAGTCCC
551 AGGAGAGTGT CACAGAGCAG GACAGCAAGG ACAGCACCTA CAGCCTCAGC
601 AGCACCCCTGA CGCTGAGCAA AGCAGACTAC GAGAAACACA AAGTCTACGC
651 CTGCGAAGTC ACCCATCAGG GCCTGAGCTC GCCCCTCACA AAGAGCTTCA
701 ACAGGGGAGA GTGTTAGTGA
```

SEQ ID NO. 48

9.8.2 Predicted Kappa Light Chain Protein Sequence

```
1   mdmrvpaql1 gl1111wlsva garcDIQMTQ SPSSLSASVG DRVTITCQAS
51  QDISNYLNWY QQKPGKAPKL LIYDASNLET GVPSRFSGSG SGTDFTFITIS
101 SLQPEDIATY SCQHSNLSI TFGQGRLEI KRTVAAPSVF IFPPSDEQLK
151 SGTASVVCLL NNFYPREKV QWKVDNALQS GNSQESVTEQ DSKDSTYSLS
201 STLTLISKADY EKHKVYACEV THQGLSSPVT KSFNRGEC
```

SEQ ID NO. 49

Nucleotide Sequence of cynomolgus MAdCAM $\alpha_4\beta_7$ binding domain

```
1   ATGGATCGGG GCCTGGCCCT CCTGCTGGCG GGGCTTCTGG GGCTCCTCCA
51  GCCGGGCTGC GGCCAGTCCC TCCAGGTGAA GCCCTGCAG GTGGAGCCCC
101 CGGAGCCGGT GGTGGCCGTG GCCCTGGGCG CCTCTCGCCA GCTCACCTGC
151 CGCCTGGACT GCGCGGACGG CGGGGCCACG GTGCAGTGGC GGGGCCTGGA
201 CACCAGCCTG GCGCGGTGTC AGTCGGACGC GGGCCGCAGC GTCCTCACC
251 TCGGCAACGC CTCGCTGTCT GCGGCCGGGA CCCGTGTGTG CGTGGGCTCC
301 TCGGGGGGCC GCACCTTCCA GCACACCGTG CGGCTCCTTG TGTACGCCTT
351 CCCGGACCAG CTGACCATCT CCCCAGCAGC CCTGGTGCCT GGTGACCCGG
401 AGGTGGCCTG TACGGCTCAC AAAGTCACGC CTGTGGACCC CAATGCGCTC
451 TCCTTCTCCC TGCTCCTGGG GGACCAGGAA CTGGAGGGGG CCCAGGCTCT
501 GGGCCCGGAG GTGGAGGAGG AGGAGGAGCC CCAGGAGGAG GAGGACGTGC
551 TGTTCAGGGT GACAGAGCGC TGGCGGCTGC CGACCCTGGC AACCCCTGTC
601 CTGCCCAGCG TCTACTGCCA GGCCACGATG AGGCTGCCTG GCTTGGAGCT
651 CAGCCACCGC CAGGCCATCC CGGTCCTGCA C
```

SEQ ID NO. 50

Amino acid sequence of cynomolgus MAdCAM $\alpha_4\beta_7$ binding domain

```
1   MDRGLALLLA GLLGLLQPGC GQSLQVKPLQ VEPPEPVVAV ALGASRQLTC
51  RLDCA DGAT VQWRGLDTSL GAVQSDAGRS VLTVRNASLS AAGTRVCVGS
101 CGGRTFQHTV RLLVYAFPDQ LTISPAALVP GDPEVACTAH KVTVPDPNAL
151 SFSLLLGDQE LEGAQALGPE VEEEEEPQEE EDVLFRTVTER WRLPTLATPV
201 LPALYCQATM RLPGLELSHR QAIPVLH
```

SEQ ID NO. 51**Modified 6.22.2 Heavy Chain Nucleotide Sequence**

```

1   atggagtttg ggctgagctg ggttttcttc gttgctcttt taagaggtgt
51  ccagtgtCAG GTGCAGCTGG TGGAGTCTGG GGGAGGCGTG GTCCAGCCTG
101 GGAGGTCCCT GAGACTCTCC TGTGCAGCGT CTGGATTAC CTTCAGTAGC
151 GATGGCATGC ACTGGGTCCG CCAGGCTCCA GGCAAGGGGC TGGAGTGGGT
201 GGCAATTATA TGGTATGATG GAAGTAATAA ATATTATGCA GACTCCGTGA
251 AGGGCCGATT CACCATCTCC AGAGACAATT CCAAGAACAC GCTGTATCTG
301 CAAATGAACA GCCTGAGAGC CGAGGACACG GCTGTATATT ACTGTGCGAG
351 AGATCCCGGC TACTATTACG GTATGGACGT CTGGGGCCAA GGGACCACGG
401 TCACCGTCTC CTCAGCTTCC ACCAAGGGCC CATCCGTCTT CCCCTGGCG
451 CCTGCTCTA GAAGCACCTC CGAGAGCACA GCGGCCCTGG GCTGCCTGGT
501 CAAGGACTAC TTCCCCGAAC CGGTGACGGT GTCGTGGAAC TCAGGCGCTC
551 TGACCAGCGG CGTGCACACC TTCCCAGCTG TCCTACAGTC CTCAGGACTC
601 TACTCCCTCA GCAGCGTGGT GACCGTGCCC TCCAGCAACT TCGGCACCCA
651 GACCTACACC TGCAACGTAG ATCACAAGCC CAGCAACACC AAGGTGGACA
701 AGACAGTTGA GCGCAAATGT TGTGTCGAGT GCCCACCCTG CCCAGCACCA
751 CCTGTGGCAG GACCGTCAGT CTTCTCTTTC CCCCCAAAAC CCAAGGACAC
801 CCTCATGATC TCCCGGACCC CTGAGGTCAC GTGCGTGGTG GTGGACGTGA
851 GCCACGAAGA CCCCAGGTC CAGTTCAACT GGTACGTGGA CGGCGTGGAG
901 GTGCATAATG CCAAGACAAA GCCACGGGAG GAGCAGTTCA ACAGCACGTT
951 CCGTGTGGTC AGCGTCTCA CCGTTGTGCA CCAGGACTGG CTGAACGGCA
1001 AGGAGTACAA GTGCAAGGTC TCCAACAAAG GCCTCCCAGC CCCCATCGAG
1051 AAAACCATCT CCAAACCAA AGGGCAGCCC CGAGAACCAC AGGTGTACAC
1101 CCTGCCCCCA TCCCGGGAGG AGATGACCAA GAACCAGGTC AGCCTGACCT
1151 GCCTGGTCAA AGGCTTCTAC CCCAGCGACA TCGCCGTGGA GTGGGAGAGC
1201 AATGGGCAGC CGGAGAACAA CTACAAGACC ACACCTCCCA TGCTGGACTC
1251 CGACGGCTCC TTCTTCTCTT ACAGCAAGCT CACCGTGGAC AAGAGCAGGT
1301 GGCAGCAGGG GAACGCTTTC TCATGCTCCG TGATGCATGA GGCTCTGCAC
1351 AACCACTACA CGCAGAAGAG CCTCTCCCTG TCTCCGGGTA AATGATAG

```

SEQ ID NO. 52**Modified 6.22.2 Heavy Chain Amino Acid Sequence**

```

1   mefglswvfl vallrgvqcQ VQLVESGGGV VQPGRSLRLS CAASGFTFSS
51  DMHWRQAP GKGLEWVAII WYDGSNKYYA DSVKGRFTIS RDNSKNTLYL
101 QMNSLRAEDT AVYYCARDPG YYYGMDVWGQ GTTVTVSSAS TKGPSVFPLA
151 PCSRSTSEST AALGCLVKDY FPEPVTVSWN SGALTSKVHT FPAVLQSSGL
201 YSLSSVVTVP SSNFGTQTYT CNVDHKPSNT KVDKTVKRC CVECPCPAP
251 PVAGPSVFLF PKPKDTLMI SRTPEVTCVV VDVSHEDPEV QFNWYVDGVE
301 VHNAKTKPRE EQFNSTFRVV SVLTVVHQDW LNGKEYKCKV SNKGLPAPIE
351 KTISKTKGQP REPQVYTLPP SREEMTKNQV SLTCLVKGFY PSDIAVEWES
401 NGQPENNYKT TPPMLDSDGS FFLYSKLTVD KSRWQQGNVF SCSVMHEALH
451 NHYTQKSLSL SPGK

```

SEQ ID NO. 53

Modified 6.22.2 Kappa Light Chain Nucleotide Sequence

```
1   atgttgccat cacaactcat tgggtttctg ctgetctggg ttccagcttc
51  caggggtGAA ATTGTGCTGA CTCAGTCTCC AGACTTTCAG TCTGTGACTC
101 CAAAAGAGAA AGTCACCATC ACCTGCCGGG CCAGTCAGAG AATTGGTAGT
151 AGCTTACACT GGTACCAGCA GAAACCAGAT CAGTCTCCAA AACTCCTCAT
201 CAAGTATGCT TCCCAGTCCT TCTCAGGGGT CCCCTCGAGG TTCAGTGGCA
251 GTGGATCTGG GACAGATTTC ACCCTACCA TCAATAGCCT GGAAGCTGAA
301 GATGCTGCAA CTTATTACTG TCATCAGAGT GGTCGTTTAC CGCTCACTTT
351 CGCGGAGGG ACCAAGGTGG AGATCAAACG AACTGTGGCT GCACCATCTG
401 TCTTCATCTT CCCGCCATCT GATGAGCAGT TGAAATCTGG AACTGCCTCT
451 GTTGTGTGCC TGCTGAATAA CTTCTATCCC AGAGAGGCCA AAGTACAGTG
501 GAAGGTGGAT AACGCCCTCC AATCGGGTAA CTCCAGGAG AGTGTCACAG
551 AGCAGGACAG CAAGGACAGC ACCTACAGCC TCAGCAGCAC CCTGACGCTG
601 AGCAAAGCAG ACTACGAGAA ACACAAAGTC TACGCCTGCG AAGTCACCCA
651 TCAGGGCCTG AGCTCGCCCG TCACAAAGAG CTTCAACAGG GGAGAGTGTT
701 AGTGA
```

SEQ ID NO. 54

Modified 6.22.2 Kappa Light Chain Amino Acid Sequence

```
1   mlpsqligfl llwvpasrgE IVLTQSPDFQ SVTPKEKVTI TCRASQRIGS
51  SLHWYQQKPD QSPKLLIKYA SQSFSGVPSR FSGSGSGTDF TLTINSLEAE
101 DAATYYCHQS GRLPLTFGGG TKVEIKRTVA APSVFIFPPS DEQLKSGTAS
151 VVCLLNNFYP REAKVQWKVD NALQSGNSQE SVTEQDSKDS TYSLSSTLTLL
201 SKADYEKHKV YACEVTHQGL SSPVTKSFNR GEC
```

SEQ ID NO. 55

Modified 6.34.2 Heavy Chain Nucleotide Sequence

```

1   atggagtttg ggctgagctg ggttttcctc gttgctcttt taagaggtgt
51  ccagtgtcAG GTGCAGCTGG TGGAGTCTGG GGGAGGCGTG GTCCAGCCTG
101 GGAGGTCCCCT GAGACTCTCC TGTGCAGCCT CTGGATTACAC CTTCAGTAGC
151 TATGGCATGC ACTGGGTCCG CCAGGCTCCA GGCAAGGGGC TGGAGTGGGT
201 GGCAGTTATA TCAAATGATG GAAATAATAA ATACTATGCA GACTCCGTGA
251 AGGGCCGATT CACCATCTCC AGAGACAATT CAAAAACAC GCTGTATCTG
301 CAAATGAACA GCCTGCGCGC TGAGGACACG GCTGTGTATT ACTGTGCGAG
351 AGATAGTACG GCGATAACCT ACTACTACTA CGGAATGGAC GTCTGGGGCC
401 AAGGGACCAC GGTCACCGTC TCCTCAGCTT CCACCAAGGG CCCATCCGTC
451 TTCCCCCTGG CGCCCTGCTC TAGAAGCACC TCCGAGAGCA CAGCGGCCCT
501 GTCTGTCCTG GTCAAGGACT ACTTCCCCGA ACCGGTGACG GTGTCGTGGA
551 ACTCAGGCGC TCTGACCAGC GGCGTGCACA CCTTCCCAGC TGTCTACAG
601 TCCTCAGGAC TCTACTCCCT CAGCAGCGTG GTGACCGTGC CCTCCAGCAA
651 CTTCGGCACC CAGACCTACA CCTGCAACGT AGATCACAAG CCCAGCAACA
701 CCAAGGTGGA CAAGACAGTT GAGCGCAAAT GTTGTGTCTG GTGCCCACCG
751 TGCCGACGAC CACCTGTGGC AGGACCGTCA GTCTTCTCTT TCCCCCAA
801 ACCCAAGGAC ACCCTCATGA TCTCCCGGAC CCCTGAGGTC ACGTGCCTGG
851 TGGTGGACGT GAGCCACGAA GACCCCGAGG TCCAGTTCAA CTGGTACGTG
901 GACGGCGTGG AGGTGCATAA TGCCAAGACA AAGCCACGGG AGGAGCAGTT
951 CAACAGCACG TTCCGTGTGG TCAGCGTCCT CACCGTTGTG CACCAGGACT
1001 GGCTGAACGG CAAGGAGTAC AAGTGAAGG TCTCCAACAA AGGCCTCCCA
1051 GCCCCCATCG AGAAAACCAT CTCCAAAACC AAAGGGCAGC CCGAGAACC
1101 ACAGGTGTAC ACCCTGCCCC CATCCCGGGA GGAGATGACC AAGAACCAGG
1151 TCAGCCTGAC CTGCCTGGTC AAAGGCTTCT ACCCCAGCGA CATCGCCGTG
1201 GAGTGGGAGA GCAATGGGCA GCCGGAGAAC AACTACAAGA CCACACCTCC
1251 CATGCTGGAC TCCGACGGCT CTTTCTTCTT CTACAGCAAG CTCACCGTGG
1301 ACAAGAGCAG GTGGCAGCAG GGAACGTCT TCTCATGCTC CGTGATGCAT
1351 GAGGCTCTGC ACAACCACTA CACGCAGAAG AGCCTCTCCC TGTCTCCGGG
1401 TAAATGATAG

```

SEQ ID NO. 56

Modified 6.34.2 Heavy Chain Amino Acid Sequence

```

1   mefglswvfl vallrgvqcQ VQLVESGGGV VQPGRSLRLS CAASGFTFSS
51  YGMHWVRQAP GKGLEWVAVI SNDGNNKYA DSVKGRFTIS RDNSKNTLYL
101 QMNSLRAEDT AVYYCARDST AITYYYGMD VWGQGTTVTV SSASTKGPSV
151 FPLAPCSRST SESTAALGCL VKDYFPEPVT VSWNSGALTS GVHTFPAVLQ
201 SSGLYSLSSV VTPSSNFGT QTYTCNVDHK PSNTKVDKTV ERKCCVECPP
251 CPAPPVAGPS VFLFPPKPKD TLMISRTPEV TCVVVDVSHE DPEVQFNWYV
301 DGVEVHNAKT KPREEQFNST FRVVSVLTVV HQDWLNGKEY KCKVSNKGLP
351 APIEKTISKI KGQPREPQVY TLPPSREEMT KNQVSLTCLV KGFYPSDIAV
401 EWESNGQPEN NYKTTTPMLD SDGSFFLYSK LTVDKSRWQQ GNVFSCSVMH
451 EALHNHYTQK SLSLSPGK

```

SEQ ID NO. 57

Modified 6.34.2 Kappa Light Chain Nucleotide Sequence

```

1   atggacatga ggggtccccgc tcagctcctg gggctcctgc tactctggct
51  ccgaggtgcc agatgtGACA TCCAGATGAC CCAGTCTCCA TCCTCCCTGT
101 CTGCATCTGT CGGAGACAGA GTCACCATCA CTTGCCGGGC AAGTCAGAGT
151 ATTAGTAGCT ATTTAAATTG GTATCAGCAG AAACCAGGGA AAGCCCCTAA
201 GTCCTGATC TATGCTGCAT CCGGTTTGAA GCGTGGGGTC CCATCACGGT
251 TCAGTGGTAG TGGATCTGGG ACAGATTTC CTCTACCAT CAGTTCTCTG
301 CAACCTGAGG ATTTTGCAAC TTACTACTGT CACCAGAGTT ACAGTCTCCC
351 ATTCACTTTC GGCCCTGGGA CCAAAGTGGA TATCAAACGA ACTGTGGCTG
401 CACCATCTGT CTTCATCTTC CCGCCATCTG ATGAGCAGTT GAAATCTGGA
451 ACTGCCTCTG TTGTGTGCCT GCTGAATAAC TTCTATCCCA GAGAGGCCAA
501 AGTACAGTGG AAGGTGGATA ACGCCCTCCA ATCGGGTAAC TCCCAGGAGA
551 GTGTCACAGA GCAGGACAGC AAGGACAGCA CCTACAGCCT CAGCAGCACC
601 CTGACGCTGA GCAAAGCAGA CTACGAGAAA CACAAAGTCT ACGCCTGCGA
651 AGTCACCCAT CAGGGCCTGA GCTCGCCCGT CACAAAGAGC TTCAACAGGG
701 GAGAGTGTTA GTGA

```

SEQ ID NO. 58

Modified 6.34.2 Kappa Light Chain Amino Acid Sequence

```

1   mdmrvpaql1 gl1111wlrga rcDIQMTQSP SSLASVGDR VTITCRASQS
51  ISSYLNWYQQ KPGKAPKLLI YAASGLKRGV PSRFSGSGSG TDFTLTISSL
101 QPEDFATYYC HQSYSLPFTF GPGTKVDIKR TVAAPSVFIF PPSDEQLKSG
151 TASVVCLLNN FYPREAKVQW KVDNALQSGN SQESVTEQDS KDSTYSLSST
201 LTLSKADYEK HKVYACEVTH QGLSSPVTKS FNRGEC

```

SEQ ID NO. 59

Modified 6.67.1 Heavy Chain Nucleotide Sequence

```

1   atgaaacacc tgtgggttctt cctcctgctg gtggcagctc ccagatgggt
51  cctgtcccCAG GTGCAGCTGC AGGAGTCGGG CCCAGGACTG GTGAAGCCTT
101 CGGAGACCCT GTCCCTCACC TGCAGTGTCT CTGGTGACTC CATCAGTAGT
151 AACTATTGGA GCTGGATCCG GCAGCCCGCC GGAAGGGAC TGGAGTGGAT
201 TGGGCGTATC TATACCAAGT GGGGCACCAA CTCCAACCCC TCCCTCAGGG
251 GTCGAGTCAC CATGTCAGTA GACACGTCCA AGAACCAGTT CTCTCTGAAA
301 CTGAGTTCTG TGACCGCCGC GGACACGGCC GTGTATTACT GTGCGAGAGA
351 TCGTATTACT ATAATTCGGG GACTTATTC ATCCTTCTTT GACTACTGGG
401 GCCAGGGAAC CCTGGTCACC GTCTCCTCAG CTTCACCAA GGGCCCATCC
451 GTCTTCCCCC TGGCGCCCTG CTCTAGAAGC ACCTCCGAGA GCACAGCGGC
501 CTGGGCGTGC CTGGTCAAGG ACTACTTCCC CGAACCGGTG ACGGTGTCGT
551 GGAAGTCAGG CGCTCTGACC AGCGGCGTGC ACACCTTCCC AGCTGTCCTA
601 CAGTCCTCAG GACTCTACTC CCTCAGCAGC GTGGTGACCG TGCCCTCCAG
651 CAACTTCGGC ACCCAGACCT ACACCTGCAA CGTAGATCAC AAGCCCAGCA
701 ACACCAAGGT GGACAAGACA GTTGAGCGCA AATGTTGTGT CGAGTGCCCA
751 CCGTGCCCA CACCACCTGT GGCAGGACCG TCAGTCTTCC TCTTCCCCC
801 AAAACCCAAG GACACCCTCA TGATCTCCCG GACCCTGAG GTCACGTGCG
851 TGGTGGTGGA CGTGAGCCAC GAAGACCCG AGGTCCAGTT CAACTGGTAC
901 GTGACGCGC TGGAGGTGCA TAATGCCAAG ACAAGCCAC GGGAGGAGCA
951 GTTCAACAGC ACGTTCCGTG TGGTCAGCGT CCTCACCGTT GTGCACCAGG
1001 ACTGGCTGAA CGGCAAGGAG TACAAGTGCA AGGTCTCCAA CAAAGGCCTC
1051 CCAGCCCCCA TCGAGAAAAC CATCTCCAAA ACCAAAGGGC AGCCCCGAGA
1101 ACCACAGGTG TACACCCTGC CCCCATCCCG GGAGGAGATG ACCAAGAACC
1151 AGGTCAGCCT GACCTGCCTG GTCAAAGGCT TCTACCCAG CGACATCGCC
1201 GTGAGAGTGG AGAGCAATGG GCAGCCGAG AACAACTACA AGACCACACC
1251 TCCCATGCTG GACTCCGACG GCTCCTTCTT CCTCTACAGC AAGCTCACCG
1301 TGGACAAGAG CAGGTGGCAG CAGGGGAACG TCTTCTCATG CTCCGTGATG
1351 CATGAGGCTC TGCACAACCA CTACACGCAG AAGAGCCTCT CCCTGTCTCC
1401 GGGTAAATGA TAG

```

SEQ ID NO. 60

Modified 6.67.1 Heavy Chain Amino Acid Sequence

```

1   mkhlwfflll vaaprwvlsQ VQLQESGPGL VKPSETLSLT CTVSGDSISS
51  NYWSWIRQPA GKGLEWIGRI YTSGGTNSNP SLRGRVTMSV DTSKNQFSLK
101 LSSVTAADTA VYYCARDRIT IIRGLIPSFF DYWGQGTlVT VSSASTKGPS
151 VFPLAPCSRS TSESTAALGC LVKDYFPEPV TVSWNSGALT SGVHTFPAVL
201 QSSGLYSLSS VVTVPSSNFG TQTYTCNVDH KPSNTKVDKT VERKCCVECP
251 PCPAPPVAGP SVFLFPPKPK DTLMISRTPE VTCVVVDVSH EDPEVQFNWY
301 VDGVEVHNAK TKPREEQFNS TFRVSVLTV VHQDWLNGKE YKCKVSNKGL
351 PAPIEKTISK TKGQPREPQV YTLPPSREEM TKNQVSLTCL VKGFYPSDIA
401 VEWESNGQPE NNYKTTPLML DSDGSFFLYS KLTVDKSRWQ QGNVFSQSVN
451 HEALHNHYTQ KSLSLSPGK

```

SEQ ID NO. 61

Modified 6.67.1 Kappa Light Chain Nucleotide Sequence

```
1   atggtgttgc agaccaggt cttcatttct ctgttgctct ggatctctgg
51  tgcttacggg GACATCGTGA TGACCCAGTC TCCAGACTCC CTGGCTGTGT
101 CTCTGGGCGA GAGGGCCACC ATCAACTGCA AGTCCAGCCA GAGTGTTTTA
151 TACAGCTCCA ACAATAAGAA CTA1CTTAGCT TGGTACCAAC AGAAACCAGG
201 ACAGCCTCCT AAATTGCTCA TTTACTGGGC ATCTATACGG GAATATGGGG
251 TCCCTGACCG ATTCAGTGGC AGCGGGTCTG GGACAGATTT CACTCTCACC
301 ATCAGCAGCC TGCAGGCTGA AGATGTGGCA GTTTATTTCT GTCAACAATA
351 TTATAGTATT CCTCCCCTCA CTTTCGGCGG AGGGACCAAG GTGGAGATCA
401 AACGA2ACTGT GGCTGCACCA TCTGTCTTCA TCTTCCCGCC ATCTGATGAG
451 CAGTTGAAAT CTGGA3ACTGC CTCTGTTGTG TGCCTGCTGA ATAACTTCTA
501 TCCCAGAGAG GCCAAAGTAC AGTGGAAGGT GGATAACGCC CTCCAATCGG
551 GTA4ACTCCCA GGAGAGTGTC ACAGAGCAGG ACAGCAAGGA CAGCACCTAC
601 AGCCTCAGCA GCACCCTGAC GCTGAGCAAA GCAGACTACG AGAAACACAA
651 AGTCTACGCC TGC5GAAGTCA CCCATCAGGG CCTGAGCTCG CCCGTCACAA
701 AGAGCTTCAA CAGGGGAGAG TGTTAGTGA
```

SEQ ID NO. 62

Modified 6.67.1 Kappa Light Chain Amino Acid Sequence

```
1   mvlqtqv1fis lllwisgayg DIVMTQSPDS LAVSLGERAT INCKSSQSVL
51  YSSNNK2NYLA WYQQKPGQPP KLLIYWASIR EYGV3PDRFSG SGSGTDFTLT
101 ISSLQAEDVA VYFCQ4QYYSI PPLTFGGGTK VEIKRTVAAP SVFIFPPSDE
151 QLKSGTASVV CLLN5FYPRE AKVQWKVDNA LQSGNSQESV TEQDSKDSTY
201 SLSTLTLSK ADYE6KHKVYA CEVTHQGLSS PVT7KSFNRGE C
```

SEQ ID NO. 63

Modified 6.77.1 Heavy Chain Nucleotide Sequence

```

1   atggaactgg ggctccgctg ggttttcctt gttgctatatt tagaaggtgt
51  ccagtgtGAG GTGCAGCTGG TGGAGTCTGG GGGAGGCCTG GTCAAGCCTG
101 GGGGGTCCCT GAGACTCTCC TGTGCAGCCT CTGGATTAC CTCAGTAGC
151 TATAGCATGA ACTGGGTCCG CCAGGCTCCA GGAAGGGGC TGGAGTGGGT
201 CTCATCCATT AGTAGTAGTA GTAGTTACAT AACTACGCA GACTCAGTGA
251 AGGGCCGATT CACCATCTCC AGAGACAACG CCAAGAACTC ACTGTATCTG
301 CAAATGAACA GCCTGAGAGC CGAGGACACG GCTGTGTATT ACTGTGCGAG
351 AGATGGGTAT AGCAGTGGCT GGTCTACTA CTACTACTAC GGTATGGACG
401 TCTGGGGCCA AGGGACCACG GTCACCGTCT CCTCAGCTTC CACCAAGGGC
451 CCATCCGTCT TCCCCCTGGC GCCCTGCTCT AGAAGCACCT CCGAGAGCAC
501 AGCGGCCCTG GGCTGCCCTG TCAAGGACTA CTTCCCCGAA CCGGTGACGG
551 TGTCTGTGAA CTCAGGCGCT CTGACCAGCG GCGTGCACAC CTCCCAGCT
601 GTCTTACAGT CCTCAGGACT CTACTCCCTC AGCAGCGTGG TGACCGTGCC
651 CTCCAGCAAC TTCGGCACCC AGACCTACAC CTGCAACGTA GATCACAAGC
701 CCAGCAACAC CAAGGTGGAC AAGACAGTTG AGCGCAAATG TTGTGTCTGAG
751 TGCCCAACCGT GCCCAGCACC ACCTGTGGCA GGACCGTCAG TCTTCTCTT
801 CCCCCCAAAA CCCAAGGACA CCCTCATGAT CTCCCGGACC CCTGAGGTCA
851 CGTGCGTGGT GGTGGACGTG AGCCACGAAG ACCCGGAGGT CCAGTTCAAC
901 TGGTACGTGG ACGGCGTGGG GGTGCATAAT GCCAAGACAA AGCCACGGGA
951 GGAGCAGTTC AACAGCACGT TCCGTGTGGT CAGCGTCCTC ACCGTTGTGC
1001 ACCAGGACTG GCTGAACGGC AAGGAGTACA AGTGCAAGGT CTCCAACAAA
1051 GGCCTCCAG CCCCATCGA GAAAACCATC TCCAAAACCA AAGGGCAGCC
1101 CCGAGAACCA CAGGTGTACA CCCTGCCCCC ATCCCGGGAG GAGATGACCA
1151 AGAACCAGGT CAGCCTGACC TGCCTGGTCA AAGGCTTCTA CCCCAGCGAC
1201 ATCGCCGTGG AGTGGGAGAG CAATGGGCAG CCGGAGAACA ACTACAAGAC
1251 CACACCTCCC ATGCTGGACT CCGACGGCTC CTTCTTCCTC TACAGCAAGC
1301 TCACCGTGGA CAAGAGCAGG TGGCAGCAGG GGAACGTCTT CTCATGCTCC
1351 GTGATGCATG AGGCTCTGCA CAACCACTAC ACGCAGAAGA GCCTCTCCCT
1401 GTCTCCGGGT AAATGATAG

```

SEQ ID NO. 64

Modified 6.77.1 Heavy Chain Protein Sequence

```

1   melglrwvfl vailegvqcE VQLVESGGGL VKPGGSLRLS CAASGFTFSS
51  YSMNWVRQAP GKGLEWVSSI SSSSYIYYA DSVKGRFTIS RDNAKNSLYL
101 QMNSLRAEDT AVYYCARDGY SSGWSYYYYY GMDVWGQGT VTVSSASTKG
151 PSVFPLAPCS RSTSESTAAL GCLVKDYFPE PVTVSWNSGA LTVSGVHTFPA
201 VLQSSGLYSL SSVVTVPSN FGTQTYTCNV DHKPSNTKVD KTVRKCCVE
251 CPPCPAPPVA GPSVFLFPPK PKDTLMISRT PEVTCVVVDV SHEDPEVQFN
301 WYVDGVEVHN AKTKPREEQF NSTFRVSVL TVVHQDWLNG KEYKCKVSNK
351 GLPAPIEKTI SKTKGQPREP QVYTLPPSRE EMTKNQVSLT CLVKGFYPSD
401 IAVEWESNGQ PENNYKTPP MLDSGGSFFL YSKLTVDKSR WQGNVVFSCS
451 VMHEALHNY TQKSLSLSPG K

```

SEQ ID NO. 65

Modified 6.77.1 Kappa Light Chain Nucleotide Sequence

```
1   atgaggctcc ctgctcagct cctggggctg ctaatgctct ggatacctgg
51  atccagtgcg GATATTGTGA TGACCCAGAC TCCACTCTCT CTGTCCGTCA
101 CTCCTGGACA GCCGGCCTCC ATCTCCTGCA AGTCTAGTCA GAGCCTCCTG
151 CTTAGTGATG GAAAGACCTA TTTGAATTGG TACCTGCAGA AGCCCGGCCA
201 GCCTCCACAG CTCCTGATCT ATGAAGTTTC CAACCGGTTT TCTGGAGTGC
251 CAGACAGGTT CAGTGGCAGC GGGTCAGGGA CAGATTTTCA ACTGAAAATC
301 AGCCGGGTGG AGGCTGAGGA TGTGTTGGGT TATTACTGCA TGCAAAGTAT
351 ACAGCTTATG TGCAGTTTTG GCCAGGGGAC CAAGCTGGAG ATCAAACGAA
401 CTGTGGCTGC ACCATCTGTC TTCATCTTCC CGCCATCTGA TGAGCAGTTG
451 AAATCTGGAA CTGCCTCTGT TGTGTGCCTG CTGAATAACT TCTATCCCAG
501 AGAGGCCCAA GTACAGTGGG AGGTGGATAA CGCCCTCCAA TCGGGTAACT
551 CCCAGGAGAG TGTCACAGAG CAGGACAGCA AGGACAGCAC CTACAGCCTC
601 AGCAGCACCC TGACGCTGAG CAAAGCAGAC TACGAGAAAC ACAAAGTCTA
651 CGCCTGCGAA GTCACCCATC AGGGCCTGAG CTCGCCCCTC ACAAAGAGCT
701 TCAACAGGGG AGAGTGTTAG TGA
```

SEQ ID NO. 66

Modified 6.77.1 Kappa Light Chain Amino Acid Sequence

```
1   mrlpaqlql lmlwipgssa DIVMTQTPLS LSVTPGQPAS ISCKSSQSLL
51  LSDGKTYLNW YLQKPGQPPQ LLIYEVSNR FSGVPDRFSGS GSGTDFTLKI
101 SRVEAEDVG VYSCMQSIQLM SSFGQGTKLE IKRTVAAPSV FIFPPSDEQL
151 KSGTASVVCL LNNFYFPREK VQWKVDNALQ SGNSQESVTE QDSKDYSTYSL
201 SSTLTLSKAD YEKHKVYACE VTHQGLSSPV TKSFNRGEC
```

SEQ ID NO. 67

Modified 7.26.4 Kappa Light Chain Nucleotide Sequence

```
1   atgaggctcc ctgctcagct cctggggctg ctaatgctct ggatacctgg
51  atccagtgcg GATATTGTGA TGACCCAGAC TCCACTCTCT CTGTCCGTCA
101 CCCCTGGACA GCCGGCCTCC ATCTCCTGCA AGTCTAGTCA GAGCCTCCTG
151 TATAGTGATG GAAAGACCTA TTTGTTTGG TACCTGCAGA AGCCAGGCCA
201 GCCTCCACAG CTCCTGATCT ATGAAGTTTC CAACCGATTG TCTGGAGTGC
251 CAGATAGGTT CAGTGGCAGC GGGTCAGGGA CAGATTTTCA ACTGAAAATC
301 AGCCGGGTGG AGGCTGAGGA TGTTGGGGTT TATTACTGCA TGCAAAGTAT
351 ACAGCTTCCG TGGACGTTCC GCCAAGGGAC CAAGGTGGAA ATCAAACGAA
401 CTGTGGCTGC ACCATCTGTC TTCATCTTCC CGCCATCTGA TGAGCAGTTG
451 AAATCTGGAA CTGCCTCTGT TGTGTGCCTG CTGAATAACT TCTATCCCAG
501 AGAGGCCAAA GTACAGTGGA AGGTGGATAA CGCCTCCAA TCGGGTAACT
551 CCCAGGAGAG TGTCACAGAG CAGGACAGCA AGGACAGCAC CTACAGCCTC
601 AGCAGCACCC TGACGCTGAG CAAAGCAGAC TACGAGAAAC ACAAAGTCTA
651 CGCCTGCGAA GTCACCCATC AGGGCCTGAG CTCGCCCGTC ACAAAGAGCT
701 TCAACAGGGG AGAGTGTTAG TGA
```

SEQ ID NO. 68

Modified 7.26.4 Kappa Light Chain Amino Acid Sequence

```
1   mrlpaqlgl lmlwipgssa DIVMTQTPLS LSVTPGQPAS ISCKSSQSLL
51  YSDGKTYLFW YLQKPGQPPQ LLIYEVSNR FSGVPDRFSGS GSGTDFTLKI
101 SRVEAEDVG VYCMQSIQLP WTFGQGTKVE IKRTVAAPSV FIFPPSDEQL
151 KSGTASVVC LNNFYPREAK VQWKVDNALQ SGNSQESVTE QDSKDYSTSL
201 SSTLTLSKAD YEKHKVYACE VTHQGLSSPV TKSFNREGC
```

SEQ ID NO: 148

X481.2 Heavy Chain Amino Acid Sequence

```
1   QVQLVQSGAE VKKPGASVKV SCKASGYTFT SYGINWVRQA PGQGLEWMGW
51  ISVYSGNTNY AQKVQGRVTM TADTSTSTAY MDLRLRSDD TAVYYCAREG
101 SSSSGDYDYG MDVWGQGT TVSSASTKGP SVFPLAPCSR STSESTAALG
151 CLVKDYFPEP VTVSWNSGAL TSGVHTFPAV LQSSGLYSLS SVVTVFSSNF
201 GTQTYTCNVD HKPSNTKVDK TVERKCCVEC PPCPAPPVAG PSVFLFPPKP
251 KDTLMISRTP EVTCVVVDVS HEDPEVQFNW YVDGVEVHNA KTKPREEQFN
300 STFRVVSFLT VVHVDWLNGK EYKCKVSNKG LPAPIEKTIS KTKGQPREPQ
351 VYTLPPSREE MTKNQVSLTC LVKGFYPSDI AVEWESNGQP ENNYKTTTPM
401 LDSDSGSFFLY SKLTVDKSRW QQGNVFSCSV MHEALHNHYT QKSLSLSPGK
```

SEQ ID NO: 149

X481.2 Heavy Chain Nucleotide Sequence

```
1   ATGGACTGGA CCTGGAGCAT CCTTTTCTTG GTGGCAGCAG CAACAGGTGC
```

```
51   CCACTCCCAG GTTCAGCTGG TGCAGTCTGG AGCTGAGGTG AAGAAGCCTG
101  GGGCCTCAGT GAAGGTCTCC TGCAAGGCTT CTGGTTACAC CTTTACCAGC
151  TATGGTATCA ACTGGGTGCG ACAGGCCCTT GGACAAGGGC TTGAGTGGAT
201  GGGATGGATC AGCGTTTACA GTGGTAACAC AAATATGCA CAGAAGGTCC
251  AGGGCAGAGT CACCATGACC GCAGACACAT CCACGAGCAC AGCCTACATG
301  GACCTGAGGA GCCTGAGATC TGACGACACG GCCGTGTATT ACTGTGCGAG
351  AGAGGGTAGC AGCTCGTCCG GAGACTACTA TTACGGTATG GACGTCTGGG
401  GCCAAGGGAC CACGGTCACC GTCTCCTCAG CCTCCACCAA GGGCCCATCG
451  GTCTTCCCCC TGGCGCCCTG CTCCAGGAGC ACCTCCGAGA GCACAGCGGC
501  CCTGGGCTGC CTGGTCAAGG ACTACTTCCC CGAACCGGTG ACGGTGTCGT
551  GGAATCAGG CGCTCTGACC AGCGGCGTGC ACACCTTCCC AGCTGTCCTA
601  CAGTCCTCAG GACTCTACTC CCTCAGCAGC GTGGTGACCG TGCCCTCCAG
651  CAACTTCGGC ACCCAGACCT ACACCTGCAA CGTAGATCAC AAGCCCAGCA
701  ACACCAAGGT GGACAAGACA GTTGAGCGCA AATGTTGTGT CGAGTGCCCA
751  CCGTGCCCGC CACCACCTGT GGCAGGACCG TCAGTCTTCC TCTTCCCCCC
801  AAAACCCAAG GACACCCTCA TGATCTCCCG GACCCCTGAG GTCACGTGCG
851  TGGTGGTGGA CGTGAGCCAC GAAGACCCCG AGGTCCAGTT CAACTGGTAC
901  GTGGACGGCG TGGAGGTGCA TAATGCCAAG ACAAAGCCAC GGGAGGAGCA
951  GTTCAACAGC ACGTTCCTGT TGGTCAGCGT CCTCACCGTT GTGCACCAGG
1001 ACTGGCTGAA CGGCAAGGAG TACAAGTGCA AGGTCTCCAA CAAAGGCCTC
1051 CCAGCCCCCA TCGAGAAAAC CATCTCCAAA ACCAAAGGGC AGCCCCGAGA
1101 ACCACAGGTG TACACCCTGC CCCCATCCCG GGAGGAGATG ACCAAGAACC
1151 AGGTGAGCCT GACCTGCCTG GTCAAAGGCT TCTACCCCAG CGACATCGCC
1201 GTGGAGTGGG AGAGCAATGG GCAGCCGGAG AACAACTACA AGACCACACC
1251 TCCCATGCTG GACTCCGACG GCTCCTTCTT CCTCTACAGC AAGCTCACCG
1301 TGGACAAGAG CAGGTGGCAG CAGGGGAACG TCTTCTCATG CTCCGTGATG
1351 CATGAGGCTC TGCACAACCA CTACACGCAG AAGAGCCTCT CCCTGTCTCC
1401 GGGAAAATGA TAG
```

SEQ ID NO: 150

X481.2 Light Chain Amino Acid Sequence

```
1   DIVMTQTPLS LSVTPGQPAS ISCKSSQSLL HTDGTTYLYW YLQKPGQPPQ
51  LLIYEVSNRF SGVPDRFSGS GSGTDFTLKI SRVEAEDVGI YYCMQNIQLP
101 WTFGQGTKVE IKRTVAAPSV FIFPPSDEQL KSGTASVVCL LNNFYPREAK
151 VQWKVDNALQ SGNSQESVTE QDSKDSTYSL SSTLTLSKAD YEKHKVYACE
201 VTHQGLSSPV TKSFNRGEC
```

What is Claimed is:

1. A human monoclonal antibody or an antigen-binding portion thereof that specifically binds to Mucosal Addressin Cell Adhesion Molecule (MAdCAM).
2. The human monoclonal antibody or antigen-binding portion according to claim 1, wherein said antibody or portion possesses at least one of the following properties:
 - (a) binds to human cells;
 - (b) has a selectivity for MAdCAM over VCAM or fibronectin of at least 100 fold;
 - (c) binds to human MAdCAM with a K_d of 3×10^{-10} M or less; or
 - (d) inhibits the binding of $\alpha_4\beta_7$ expressing cells to human MAdCAM.
 - (e) inhibits the recruitment of lymphocytes to gastrointestinal lymphoid tissue.
3. The human monoclonal antibody or antigen-binding portion according to claim 2, wherein said antibody or portion binds human MAdCAM with a K_d of 3×10^{-10} M or less and inhibits $\alpha_4 \beta_7$ binding to human MAdCAM.
4. The human monoclonal antibody of any one of claims 1-3, wherein the heavy chain comprises an amino acid sequence at least 80%, 85%, or 90% identical to SEQ ID NO: 148.
5. The human monoclonal antibody of claim 4, wherein the heavy chain comprises an amino acid sequence identical to SEQ ID NO: 148.
6. The human monoclonal antibody of claim 4, wherein the heavy chain comprises between 1 and 25 amino acid substitutions as compared to SEQ ID NO: 148.
7. The human monoclonal antibody of claim 6, wherein the heavy chain comprises between 1 and 10 amino acid substitutions as compared to SEQ ID NO: 148.
8. The human monoclonal antibody of any one of claim 1-7, wherein the light chain comprises an amino acid sequence at least 80%, 85%, or 90% identical to SEQ ID NO: 150.

9. The human monoclonal antibody of claim 8, wherein the light chain comprises an amino acid sequence identical to SEQ ID NO: 150.

10. The human monoclonal antibody of claim 8, wherein the light chain comprises between 1 and 25 amino acid substitutions as compared to SEQ ID NO: 150.

11. The human monoclonal antibody of claim 10, wherein the light chain comprises between 1 and 10 amino acid substitutions as compared to SEQ ID NO: 150.

12. The human monoclonal antibody of any one of claims 1-3, wherein the heavy chain comprises an amino acid sequence at least 80%, 85%, or 90% identical to SEQ ID NO: 148, and the light chain comprises an amino acid sequence at least 80%, 85%, or 90% identical to SEQ ID NO: 150.

13. The human monoclonal antibody of claim 12, wherein the heavy chain comprises an amino acid sequence identical to SEQ ID NO: 148, and the light chain comprises an amino acid sequence identical to SEQ ID NO: 150.

14. A nucleic acid sequence encoding the amino acid sequence of any one of claims 4-13.

15. A cell producing the human monoclonal antibody of any one of claims 1-14.

16. A cell comprising the nucleic acid sequence of claim 14.

17. A hybridoma cell line that produces the human monoclonal antibody according to claim 1, wherein the hybridoma is selected from the group consisting of 1.7.2 (ECACC Accession No. 03090901), 1.8.2 (ECACC Accession No. 03090902), 6.14.2 (ECACC Accession No. 03090903), 6.22.2 (ECACC Accession No. 03090904), 6.34.2 (ECACC Accession No. 03090905), 6.67.1 (ECACC Accession No. 03090906), 6.73.2 (ECACC Accession No. 03090907), 6.77.1 (ECACC Accession No. 03090908), 7.16.6 (ECACC Accession No. 03090909), 7.20.5 (ECACC Accession No. 03090910), 7.26.4 (ECACC Accession No. 03090911), and 9.8.2 (ECACC Accession No. 03090912).

18. The human monoclonal antibody produced by the hybridoma cell line according to claim 17 or an antigen-binding portion of said monoclonal antibody.

19. The human monoclonal antibody according to claim 18, wherein the heavy chain C-terminal lysine is cleaved.

20. The human monoclonal antibody or antigen-binding portion thereof according to either of claims 1 or 18, wherein said antibody or antigen-binding portion inhibits binding of human MAdCAM to $\alpha_4\beta_7$, and wherein the antibody or portion thereof has at least one of the following properties:

- (a) cross-competes with a reference antibody for binding to MAdCAM;
- (b) competes with a reference antibody for binding to MAdCAM;
- (c) binds to the same epitope of MAdCAM as a reference antibody;
- (d) binds to MAdCAM with substantially the same K_d as a reference antibody;
- (e) binds to MAdCAM with substantially the same off rate as a reference antibody;

wherein the reference antibody is selected from the group consisting of: monoclonal antibody 1.7.2, monoclonal antibody 1.8.2, monoclonal antibody 6.14.2, monoclonal antibody 6.22.2, monoclonal antibody 6.34.2, monoclonal antibody 6.67.1, monoclonal antibody 6.73.2, monoclonal antibody 6.77.1, monoclonal antibody 7.16.6, monoclonal antibody 7.20.5, monoclonal antibody 7.26.4, monoclonal antibody 9.8.2, X481.2 monoclonal antibody, monoclonal antibody 6.22.2-mod, monoclonal antibody 6.34.2-mod, monoclonal antibody 6.67.1-mod, monoclonal antibody 6.77.1-mod and monoclonal antibody 7.26.4-mod.

21. A monoclonal antibody that specifically binds MAdCAM, wherein the antibody is selected from the group consisting of:

- (a) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 2 and SEQ ID NO: 4, without the signal sequences;
- (b) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 6 and SEQ ID NO: 8, without the signal sequences;
- (c) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 10 and SEQ ID NO: 12, without the signal sequences;
- (d) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 14 and SEQ ID NO: 16, without the signal sequences;

- (e) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 18 and SEQ ID NO: 20, without the signal sequences;
- (f) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 22 and SEQ ID NO: 24, without the signal sequences;
- (g) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 26 and SEQ ID NO: 28, without the signal sequences;
- (h) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 30 and SEQ ID NO: 32, without the signal sequences;
- (i) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 34 and SEQ ID NO: 36, without the signal sequences;
- (j) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 38 and SEQ ID NO: 40, without the signal sequences;
- (k) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 42 and SEQ ID NO: 44, without the signal sequences;
- (l) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 46 and SEQ ID NO: 48, without the signal sequences;
- (m) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 52 and SEQ ID NO: 54, without the signal sequences;
- (n) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 56 and SEQ ID NO: 58, without the signal sequences;
- (o) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 60 and SEQ ID NO: 62, without the signal sequences;
- (p) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 64 and SEQ ID NO: 66, without the signal sequences; and
- (q) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 42 and SEQ ID NO: 68, without the signal sequences.
- (r) an antibody comprising the amino acid sequences set forth in SEQ ID NO: 148 and SEQ ID NO: 150, without the signal sequence.

22. A monoclonal antibody or an antigen-binding portion thereof, wherein the heavy chain of said antibody or portion thereof comprises the heavy chain CDR1, CDR2 and CDR3 or wherein the light chain comprises the light chain CDR1, CDR2 and CDR3 of a monoclonal antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2,

6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod.

23. The monoclonal antibody or antigen-binding portion according to claim 22, wherein said antibody or portion comprises a heavy chain that utilizes a human VH 1-18 gene, a human VH 3-15 gene, a human VH 3-21 gene, a human VH 3-23 gene, a human VH 3-30 gene, a human VH 3-33 gene or a human VH 4-4 gene.

24. The monoclonal antibody or an antigen-binding portion thereof according to claim 23, wherein said antibody or portion comprises a light chain that utilizes a human V_K A2 gene, a human V_K A3 gene, a human V_K A26 gene, a human V_K B3 gene, a human V_K O12 gene or a human V_K O18 gene.

25. The human monoclonal antibody or antigen-binding portion according to claim 1, wherein the heavy chain variable region, the light chain variable region or both are at least 90% identical in amino acid sequence to the corresponding region or regions of a monoclonal antibody selected from the group consisting of: monoclonal antibody 1.7.2, monoclonal antibody 1.8.2, monoclonal antibody 6.14.2, monoclonal antibody 6.22.2, monoclonal antibody 6.34.2, monoclonal antibody 6.67.1, monoclonal antibody 6.73.2, monoclonal antibody 6.77.1, monoclonal antibody 7.16.6, monoclonal antibody 7.20.5, monoclonal antibody 7.26.4, monoclonal antibody 9.8.2, monoclonal antibody X481.2, monoclonal antibody 6.22.2-mod, monoclonal antibody 6.34.2-mod, monoclonal antibody 6.67.1-mod, monoclonal antibody 6.77.1-mod and monoclonal antibody 7.26.4-mod..

26. A monoclonal antibody or an antigen-binding portion thereof that specifically binds MAdCAM, wherein:

(a) the heavy chain comprises the heavy chain CDR1, CDR2 and CDR3 amino acid sequences of a reference antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod

(b) the light chain comprises the light chain CDR1, CDR2 and CDR3 amino acid sequences of a reference antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod

(c) the antibody comprises a heavy chain of (a) and a light chain of (b);
and

(d) the antibody of (c) wherein the heavy chain and light chain CDR amino acid sequences are selected from the same reference antibody.

27. The monoclonal antibody or antigen-binding portion according to claim 26, wherein the heavy chain, the light chain or both comprise the amino acid sequence from the beginning of the CDR1 through the end of the CDR3 of the heavy chain, the light chain or both, respectively, of the reference antibody.

28. The monoclonal antibody or antigen-binding portion according to claim 26, wherein said antibody comprises:

(a) a heavy chain comprising the heavy chain variable region amino acid sequence of an antibody selected from the group consisting of: 1.7.2 (SEQ ID NO: 2); 1.8.2 (SEQ ID NO: 6); 6.14.2 (SEQ ID NO: 10); 6.22.2 (SEQ ID NO: 14); 6.34.2 (SEQ ID NO: 18); 6.67.1 (SEQ ID NO: 22); 6.73.2 (SEQ ID NO: 26); 6.77.1 (SEQ ID NO: 30); 7.16.6 (SEQ ID NO: 34); 7.20.5 (SEQ ID NO: 38); 7.26.4 (SEQ ID NO: 42); and 9.8.2 (SEQ ID NO: 46); X481.2 (SEQ ID NO: 148), 6.22.2-mod (SEQ ID NO: 52); 6.34.2-mod (SEQ ID NO: 56); 6.67.1-mod (SEQ ID NO: 60); 6.77.1-mod (SEQ ID NO: 64); and 7.26.4-mod (SEQ ID NO: 42);

(b) a light chain comprising the light chain variable region amino acid sequence of an antibody selected from the group consisting of: 1.7.2 (SEQ ID NO: 4); 1.8.2 (SEQ ID NO: 8); 6.14.2 (SEQ ID NO: 12); 6.22.2 (SEQ ID NO: 16); 6.34.2 (SEQ ID NO: 20); 6.67.1 (SEQ ID NO: 24); 6.73.2 (SEQ ID NO: 28); 6.77.1 (SEQ ID NO: 32); 7.16.6 (SEQ ID NO: 36); 7.20.5 (SEQ ID NO: 40); 7.26.4 (SEQ ID NO: 44); and 9.8.2 (SEQ ID NO: 48); X481.2 (SEQ ID NO: 150), 6.22.2-mod (SEQ ID NO: 54); 6.34.2-mod (SEQ ID NO: 58); 6.67.1-mod (SEQ ID NO: 62); 6.77.1-mod (SEQ ID NO: 66); and 7.26.4-mod (SEQ ID NO: 68); or

(c) the heavy chain of (a) and the light chain of (b).

29. The monoclonal antibody according to any one of claims 1-13 and 18-28 that is an immunoglobulin G (IgG), an IgM, an IgE, and IgA or an IgD molecule, a humanized antibody, a chimeric antibody or a bispecific antibody.

30. The antigen-binding portion according to any one of claims 1-13, 18-20 and 22-29 which is an Fab fragment, an F(ab')₂ fragment, an F_v fragment or a single chain antibody.

31. A pharmaceutical composition comprising an effective amount of the monoclonal antibody or antigen-binding portion thereof according to any one of claims 1-13 and 18-30 and a pharmaceutically acceptable carrier.

32. A method of treating inflammatory disease in a subject in need thereof, comprising the step of administering to said subject the monoclonal antibody or antigen-binding portion thereof according to any one of claims 1-13 and 18-30 wherein said antibody or antigen-binding portion inhibits binding of MAdCAM to $\alpha_4\beta_7$.

33. The method of claim 32, wherein the inflammatory disease is inflammatory disease of the gastrointestinal tract.

34. The method of claim 33, wherein the inflammatory disease of the gastrointestinal tract is selected from the group consisting of inflammatory bowel disease, Crohn's disease, ulcerative colitis, diverticula disease, gastritis, liver disease, primary biliary sclerosis and sclerosing cholangitis.

35. The method of claim 33, wherein the inflammatory bowel disease is Crohn's disease, ulcerative colitis or both.

36. The method of claim 33, wherein the inflammatory diseases are insulin-dependent diabetes and graft versus host disease.

37. An isolated cell line that produces the monoclonal antibody or antigen-binding portion according to any one of claims 1-13 and 18-30 or the heavy chain or light chain of said antibody or of said portion thereof.

38. The cell line according to either of claims 17 or 37 that produces an antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, and X481.2 or an antibody comprising the amino acid sequences of one of said antibodies.

39. The cell line according to claim 38 that produces a monoclonal antibody selected from the group consisting of: 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod, 7.26.4-mod, and X481.2 or an antibody comprising the amino acid sequences of one of said antibodies.

40. An isolated nucleic acid molecule comprising a nucleotide sequence that encodes the heavy chain or an antigen-binding portion thereof or the light chain or an antigen-binding portion thereof of an antibody according to any one of claims 1-13 and 18-30.

41. A vector comprising the nucleic acid molecule according to claim 40, wherein the vector optionally comprises an expression control sequence operably linked to the nucleic acid molecule.

42. A host cell comprising the vector according to claim 41 or the nucleic acid molecule according to claim 40.

43. A host cell according to claim 42 comprising a nucleic acid molecule encoding the heavy chain or an antigen-binding portion thereof and a nucleic acid molecule encoding the light chain or an antigen-binding portion thereof of an antibody or antigen-binding portion according to any one of claims 1-3 and 5-17.

44. A method for producing a human monoclonal antibody or antigen-binding portion thereof that specifically binds MAdCAM, comprising culturing the host cell according to claim 42 or 43 or the cell line according to any one of claims 15-17, or 38 under suitable conditions and recovering said antibody or antigen-binding portion.

45. A non-human transgenic animal or transgenic plant comprising (a) nucleic acid molecule encoding the heavy chain or an antigen-binding portion thereof; (b) a nucleic acid molecule encoding the light chain or an antigen-binding portion thereof; or (c) both (a) and (b) of an antibody according to any one of claims 1-13 or 18-30, wherein the non-human transgenic animal or transgenic plant expresses said heavy chain or light chain or both.

46. A method of isolating an antibody or antigen-binding portion thereof that specifically binds to MAdCAM, comprising the step of isolating the antibody from the non-human transgenic animal or transgenic plant according to claim 45.

47. A method of treating a subject in need thereof with a human antibody or antigen-binding portion thereof that specifically binds to MAdCAM and inhibits binding to $\alpha_4 \beta_7$ comprising the steps of:

(a) administering an effective amount of an isolated nucleic acid molecule encoding the heavy chain or an antigen-binding portion thereof, an isolated nucleic acid molecule encoding the light chain or an antigen-binding portion thereof, or nucleic acid molecules encoding the light chain and the heavy chain or antigen-binding portions thereof; and

(b) expressing the nucleic acid molecule.

48. A method for producing a human monoclonal antibody that specifically binds MAdCAM, comprising the steps of:

(a) immunizing a non-human transgenic animal that is capable of producing human antibodies with MAdCAM, with an immunogenic portion of MAdCAM or a with cell or tissue expressing MAdCAM; and

(b) allowing the transgenic animal to mount an immune response to MAdCAM.

49. A human monoclonal antibody produced by the method according to claim 48.

50. A method of inhibiting $\alpha_4 \beta_7$ binding to cells expressing human MAdCAM comprising contacting the cells with the monoclonal antibody according to any one of claims 1-13 and 18-30 or an antigen-binding portion thereof.

51. A method for inhibiting MAdCAM-mediated leukocyte-endothelial cell adhesion comprising contacting the endothelial cells with the monoclonal antibody according to any one of claims 1-13 and 18-30 or an antigen-binding portion thereof.

52. A method for inhibiting MAdCAM-mediated leukocyte adhesion, migration and infiltration into tissues comprising the step of contacting the endothelial cells with the monoclonal antibody according to any one of claims 1-13 and 18-30 or an antigen-binding portion thereof.

53. A method for inhibiting $\alpha_4 \beta_7$ /MAdCAM-dependent cellular adhesion comprising the step of contacting cells expressing human MAdCAM with the monoclonal antibody according to any one of claims 1-13 and 18-30 or antigen-binding portion thereof.

54. A method for inhibiting the MAdCAM-mediated recruitment of lymphocytes to gastrointestinal lymphoid tissue comprising the step of contacting cells expressing human MAdCAM with the monoclonal antibody according to any one of claims 1-13 and pp or antigen-binding portion thereof.

55. A monoclonal antibody or an antigen-binding portion thereof that specifically binds MAdCAM, wherein said antibody or portion thereof comprises one or more of an FR1, FR2, FR3 or FR4 amino acid sequence of a human monoclonal antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod.

56. The human monoclonal antibody or antigen-binding portion according to claim 1, wherein the antibody comprises:

(a) a heavy chain amino acid sequence that is at least 90% identical to the heavy chain amino acid sequence of a monoclonal antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod;

(b) a light chain amino acid sequence that is at least 90% identical to the light chain amino acid sequence of a monoclonal antibody selected from the group consisting of: 1.7.2, 1.8.2, 6.14.2, 6.22.2, 6.34.2, 6.67.1, 6.73.2, 6.77.1, 7.16.6, 7.20.5, 7.26.4, 9.8.2, X481.2, 6.22.2-mod, 6.34.2-mod, 6.67.1-mod, 6.77.1-mod and 7.26.4-mod;

(c) both (a) and (b); or

(d) either (a), (b) or (c), with or without the signal sequence.

57. A method for diagnosing a disorder characterized by circulating soluble human MAdCAM comprising the steps of: (1) contacting a biological sample with the monoclonal antibody according to any one of claims 1-13 and 18-30 or antigen-binding portion and (2) detecting binding.

58. A method for detecting inflammation in a subject comprising the steps of: (1) administering to said subject the monoclonal antibody or antigen-binding portion according

to any one of claims 1-13 and 18-30 wherein said antibody or portion thereof is detectably labeled and (2) detecting binding.

59. A diagnostic kit comprising the monoclonal antibody according to any one of claims 1-13 and 18-30 or antigen-binding portion.

60. The pharmaceutical composition according to claim 18 further comprising one or more additional anti-inflammatory or immunomodulatory agents.

61. The pharmaceutical composition according to claim 60, wherein the one or more additional anti-inflammatory or immunomodulatory agents are selected from the group consisting of: corticosteroids, aminosalicylates, azathioprine, methotrexate, cyclosporin, FK506, IL-10, GM-CSF, rapamycin, anti-TNF α agents and adhesion molecule antagonists.

62. A vaccine comprising an effective amount of the human antibody thereof according to any one of claims 1-13 and 18-30 or antigen-binding portion and a pharmaceutically acceptable carrier.

63. The vaccine according to claim 62, wherein the vaccine is mucosal.

64. A method of detecting the effect of administration of an inhibitory anti-MAdCAM antibody or antigen-binding portion thereof to a subject comprising the steps of:

(a) administering to a subject a human monoclonal antibody that specifically binds to MAdCAM; and

(b) determining whether there is an increase in the levels of circulating $\alpha_4\beta_7$ -expressing leukocytes.

65. The method according to claim 64, wherein said leukocytes are lymphocytes.

66. The method according to claim 64, wherein said increase in the levels of circulating $\alpha_4\beta_7$ -expressing leukocytes is determined by FACS analysis.

67. A monoclonal antibody, or antigen-binding portion thereof, that binds MAdCAM comprising the variable region of the light chain of SEQ ID NO: 150 and the variable region of the heavy chain of SEQ ID NO: 148.

68. A monoclonal antibody, or antigen-binding fragment thereof, that binds MAdCAM comprising a heavy chain variable region encoded by nucleotide SEQ ID NO: 149, and a light chain variable region encoded by nucleotide SEQ ID NO: 35.