ANTI-GCC ANTIBODY MOLECULES AND RELATED COMPOSITIONS AND METHODS

RELATED APPLICATIONS

[001] The present application claims the benefit of U.S. Provisional Application Serial No. 61/254,474, filed October 23, 2009. The entire content of U.S. Provisional Application Serial No. 61/254,474 is incorporated herein by this reference.

FIELD OF INVENTION

[002] The invention relates to antibody molecules which bind GCC, as well as to related molecules, e.g., nucleic acids which encode such antibody molecules, compositions, and related methods, e.g., therapeutic and diagnostic methods.

BACKGROUND

[003] Guanylyl cyclase C (GCC) is a transmembrane cell surface receptor that functions in the maintenance of intestinal fluid, electrolyte homeostasis and cell proliferation, see, e.g., Carrithers et al., *Proc. Natl. Acad. Sci. USA* 100:3018-3020 (2003). GCC is expressed at the mucosal cells lining the small intestine, large intestine and rectum (Carrithers et al., *Dis Colon Rectum* 39: 171-181 (1996)). GCC expression is maintained upon neoplastic transformation of intestinal epithelial cells, with expression in all primary and metastatic colorectal tumors (Carrithers et al., *Dis Colon Rectum* 39: 171-181 (1996); Buc et al. *Eur J Cancer* 41: 1618-1627 (2005); Carrithers et al., *Gastroenterology* 107: 1653-1661(1994)).

SUMMARY

[004] The inventors have discovered numerous anti-GCC antibodies, including both human and murine antibodies. Accordingly, in one aspect, the invention features an anti-GCC antibody molecule, as disclosed herein. The anti-GCC antibody molecules are useful as naked antibody molecules and as components of immunoconjugates. Accordingly, in another aspect, the invention features immunoconjugates comprising an anti-GCC antibody molecule and a therapeutic agent or label. The invention also features pharmaceutical compositions comprising the anti-GCC antibody molecules and immunoconjugates described herein. The invention also features methods of using the anti-GCC antibody molecules and immunoconjugates described herein for detection of GCC and of cells or tissues that express GCC; for diagnosis, prognosis, imaging, or staging of a GCC-mediated disease; for modulating an activity or function of a GCC protein; and for treatment of a GCC-mediated disease, as described herein. In another aspect, the invention also features isolated and/or recombinant nucleic acids encoding anti-GCC antibody molecule amino acid sequences, as well as vectors and host cells comprising such nucleic acids, and methods for producing anti-GCC antibody molecules.

[005] All publications, patent applications, patents and other references mentioned herein are incorporated by references in their entirety.

[006] Other features, objects, and advantages of the invention(s) disclosed herein will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF THE FIGURES

[007] Figure 1 depicts tumor growth in 293-GCC#2 bearing SCID mice treated with 5F9vc-MMAF, -DM1, and -DM4 on a q14d schedule.

[008] Figure 2 depicts lung weight of mice treated with 0.9%NaCl; 209 antibody at 40mg/kg; or 5F9 antibody at 10 or 40mg/kg on day 41 p.i.

[009] Figure 3 depicts the survival curve of CT26-hGCC tumor-bearing mice treated with 5F9 antibody.

[010] Figure 4 depicts ELISA binding assays to test antibody cross-reactivity of GCC orthologs.

DETAILED DESCRIPTION

Guanylyl Cyclase C

[011] Guanylyl cyclase C (GCC) (also known as STAR, ST Receptor, GUC2C, and GUCY2C) is a transmembrane cell surface receptor that functions in the maintenance of intestinal fluid, electrolyte homeostasis and cell proliferation (Carrithers et al., *Proc Natl Acad Sci U S A* 100: 3018-3020 (2003); Mann et al., *Biochem Biophys Res Commun* 239: 463-466 (1997); Pitari et al., *Proc Natl Acad Sci U S A* 100: 2695-2699 (2003)); GenBank Accession No. NM_004963, each of which is incorporated herein by reference). This function is mediated through binding of guanylin (Wiegand et al. FEBS Lett. 311:150-154 (1992)). GCC also is a receptor for heat-stable enterotoxin (ST, e.g., having an amino acid sequence of NTFYCCELCCNPACAGCY, SEQ ID NO:316) which is a peptide produced by *E. coli*, as well as other infectious organisms (Rao, M.C. *Ciba Found. Symp.* 112:74-93 (1985); Knoop F.C. and Owens, M. *J. Pharmacol. Toxicol. Methods* 28:67-72 (1992)). Binding of ST to GCC activates a signal cascade that results in enteric disease, e.g., diarrhea.

[012] Nucleotide sequence for human GCC (GenBank Accession No. NM_004963):

1 atgaagacgt tgctgttgga cttggctttg tggtcactgc tcttccagcc cgggtggctg

61 tcctttagtt cccaggtgag tcagaactgc cacaatggca gctatgaaat cagcgtcctg

121 atgatgggca actcagcctt tgcagagccc ctgaaaaact tggaagatgc ggtgaatgag

181 gggctggaaa tagtgagagg acgtctgcaa aatgctggcc taaatgtgac tgtgaacgct

241 actttcatgt attcggatgg tctgattcat aactcaggcg actgccggag tagcacctgt

301 gaaggcctcg acctactcag gaaaatttca aatgcacaac ggatgggctg tgtcctcata

361 gggccctcat gtacatactc caccttccag atgtaccttg acacagaatt gagctacccc

421 atgatctcag ctggaagttt tggattgtca tgtgactata aagaaacctt aaccaggctg

481 atgtctccag ctagaaagtt gatgtacttc ttggttaact tttggaaaac caacgatctg

541 cccttcaaaa cttattcctg gagcacttcg tatgtttaca agaatggtac agaaactgag

601 gactgtttct ggtaccttaa tgctctggag gctagcgttt cctatttctc ccacgaactc

661 ggctttaagg tggtgttaag acaagataag gagtttcagg atatcttaat ggaccacaac

721 aggaaaagca atgtgattat tatgtgtggt ggtccagagt tcctctacaa gctgaagggt

781 gaccgagcag tggctgaaga cattgtcatt attctagtgg atcttttcaa tgaccagtac

841 tttgaggaca atgtcacagc ccctgactat atgaaaaatg tccttgttct gacgctgtct

901 cctgggaatt cccttctaaa tagctctttc tccaggaatc tatcaccaac aaaacgagac

961 tttgctcttg cctatttgaa tggaatcctg ctctttggac atatgctgaa gatatttctt

1021 gaaaatggag aaaatattac cacccccaaa tttgctcatg ctttcaggaa tctcactttt

1081 gaagggtatg acggtccagt gaccttggat gactgggggg atgttgacag taccatggtg

1141 cttctgtata cctctgtgga caccaagaaa tacaaggttc ttttgaccta tgatacccac

1201 gtaaataaga cctatcctgt ggatatgagc cccacattca cttggaagaa ctctaaactt

1261 cctaatgata ttacaggccg gggccctcag atcctgatga ttgcagtctt caccctcact

1321 ggagctgtgg tgctgctcct gctcgtcgct ctcctgatgc tcagaaaata tagaaaagat

1381 tatgaacttc gtcagaaaaa atggtcccac attcctcctg aaaatatctt tcctctggag

1441 accaatgaga ccaatcatgt tagcctcaag atcgatgatg acaaaagacg agatacaatc

1501 cagagactac gacagtgcaa atacgacaaa aagcgagtga ttctcaaaga tctcaagcac

1561 aatgatggta atttcactga aaaacagaag atagaattga acaagttgct tcagattgac

1621 tattacaacc tgaccaagtt ctacggcaca gtgaaacttg ataccatgat cttcggggtg

1681 atagaatact gtgagagagg atccctccgg gaagttttaa atgacacaat ttcctaccct

1741 gatggcacat tcatggattg ggagtttaag atctctgtct tgtatgacat tgctaaggga

1801 atgtcatatc tgcactccag taagacagaa gtccatggtc gtctgaaatc taccaactgc

1861 gtagtggaca gtagaatggt ggtgaagatc actgattttg gctgcaattc cattttacct

1921 ccaaaaaagg acctgtggac agctccagag cacctccgcc aagccaacat ctctcagaaa

1981 ggagatgtgt acagctatgg gatcatcgca caggagatca tcctgcggaa agaaaccttc

2041 tacactttga gctgtcggga ccggaatgag aagattttca gagtggaaaa ttccaatgga

2101 atgaaaccct tccgcccaga tttattcttg gaaacagcag aggaaaaaga gctagaagtg

2161 tacctacttg taaaaaactg ttgggaggaa gatccagaaa agagaccaga tttcaaaaaa

2221 attgagacta cacttgccaa gatatttgga ctttttcatg accaaaaaaa tgaaagctat

2281 atggatacct tgatccgacg tctacagcta tattctcgaa acctggaaca tctggtagag

2341 gaaaggacac agctgtacaa ggcagagagg gacagggctg acagacttaa ctttatgttg

2401 cttccaaggc tagtggtaaa gtctctgaag gagaaaggct ttgtggagcc ggaactatat

2461 gaggaagtta caatctactt cagtgacatt gtaggtttca ctactatctg caaatacagc

2521 acccccatgg aagtggtgga catgcttaat gacatctata agagttttga ccacattgtt

2581 gatcatcatg atgtctacaa ggtggaaacc atcggtgatg cgtacatggt ggctagtggt

2641 ttgcctaaga gaaatggcaa tcggcatgca atagacattg ccaagatggc cttggaaatc

2701 ctcagcttca tggggacctt tgagctggag catcttcctg gcctcccaat atggattcgc

2761 attggagttc actctggtcc ctgtgctgct ggagttgtgg gaatcaagat gcctcgttat

2821 tgtctatttg gagatacggt caacacagcc tctaggatgg aatccactgg cctccctttg

2881 agaattcacg tgagtggctc caccatagcc atcctgaaga gaactgagtg ccagttcctt

2941 tatgaagtga gaggagaaac atacttaaag ggaagaggaa atgagactac ctactggctg

3001 actgggatga aggaccagaa attcaacctg ccaacccctc ctactgtgga gaatcaacag

3061 cgtttgcaag cagaattttc agacatgatt gccaactctt tacagaaaag acaggcagca

3121 gggataagaa gccaaaaacc cagacgggta gccagctata aaaaaggcac tctggaatac

3181 ttgcagctga ataccacaga caaggagagc acctattttt aa

(SEQ ID NO:227)

[013] Amino acid sequence for human GCC (GenPept Accession No. NP_004954):

1 mktllldlal wsllfqpgwl sfssqvsqnc hngsyeisvl mmgnsafaep lknledavne

61 gleivrgrlq naglnvtvna tfmysdglih nsgdcrsstc egldllrkis naqrmgcvli

121 gpsctystfq myldtelsyp misagsfgls cdyketltrl msparklmyf lvnfwktndl

181 pfktyswsts yvykngtete dcfwylnale asvsyfshel gfkvvlrqdk efqdilmdhn

241 rksnviimcg gpeflyklkg dravaedivi ilvdlfndqy fednvtapdy mknvlvltls

301 pgnsllnssf srnlsptkrd falaylngil lfghmlkifl engenittpk fahafrnltf

361 egydgpvtld dwgdvdstmv llytsvdtkk ykvlltydth vnktypvdms ptftwknskl

421 pnditgrgpq ilmiavftlt gavvllllva llmlrkyrkd yelrqkkwsh ippenifple

481 tnetnhvslk idddkrrdti qrlrqckydk krvilkdlkh ndgnftekqk ielnkllqid

541 yynltkfygt vkldtmifgv ieycergslr evlndtisyp dgtfmdwefk isvlydiakg

601 msylhsskte vhgrlkstnc vvdsrmvvki tdfgcnsilp pkkdlwtape hlrqanisqk

661 gdvysygiia qeiilrketf ytlscrdrne kifrvensng mkpfrpdlfl etaeekelev

721 yllvkncwee dpekrpdfkk iettlakifg lfhdqknesy mdtlirrlql ysrnlehlve

781 ertqlykaer dradrlnfml lprlvvkslk ekgfvepely eevtiyfsdi vgfttickys

841 tpmevvdmln diyksfdhiv dhhdvykvet igdaymvasg lpkrngnrha idiakmalei

901 lsfmgtfele hlpglpiwir igvhsgpcaa gvvgikmpry clfgdtvnta srmestglpl

961 rihvsgstia ilkrtecqfl yevrgetylk grgnettywl tgmkdqkfnl ptpptvenqq

1021 rlqaefsdmi anslqkrqaa girsqkprrv asykkgtley lqlnttdkes tyf

(SEQ ID NO:228)

[014] The GCC protein has some generally accepted domains each of which contributes a separable function to the GCC molecule. The portions of GCC include a signal sequence (for directing the protein to the cell surface) from amino acid residue 1 to about residue 23, or residue 1 to about residue 21 of SEQ ID NO:228 (excised for maturation to yield functional mature protein from about amino acid residues 22 or 24 to 1073 of SEQ ID NO:228), an extracellular domain for ligand, e.g., guanylin or ST, binding from about amino acid residue 24 to about residue 420, or about residue 54 to about residue 384 of SEQ ID NO:228, a transmembrane domain from about amino acid residue 431 to about residue 454, or about residue 436 to about residue 452 of SEQ ID NO:228, a kinase homology domain, predicted to have tyrosine kinase activity from about amino acid residue 489 to about residue 749, or about residue 508 to about residue 745 of SEQ ID NO:228 and a guanylyl cyclase catalytic domain from about residue 750 to about residue 1007, or about residue 816 to about residue 1002 of SEQ ID NO:228.

[015] In normal human tissues, GCC is expressed at the mucosal cells, e.g., at the apical brush border membranes, lining the small intestine, large intestine and rectum

(Carrithers et al., *Dis Colon Rectum* 39: 171-181 (1996)). GCC expression is maintained upon neoplastic transformation of intestinal epithelial cells, with expression in all primary and metastatic colorectal tumors (Carrithers et al., *Dis Colon Rectum* 39: 171-181 (1996); Buc et al. *Eur J Cancer* 41: 1618-1627 (2005); Carrithers et al., *Gastroenterology* 107: 1653-1661(1994)). Neoplastic cells from the stomach, esophagus and the gastroesophageal junction also express GCC (see, e.g., U.S. Patent No. 6,767,704; Debruyne et al. *Gastroenterology* 130:1191-1206 (2006)). The tissue-specific expression and association with cancer, e.g., of gastrointestinal origin, (e.g., colon cancer, stomach cancer, or esophageal cancer), can be exploited for the use of GCC as a diagnostic marker for this disease (Carrithers et al., *Dis Colon Rectum* 39: 171-181 (1996); Buc et al. *Eur J Cancer* 41: 1618-1627 (2005)).

[016] As a cell surface protein, GCC can also serve as a therapeutic target for receptor binding proteins such as antibodies or ligands. In normal intestinal tissue, GCC is expressed on the apical side of epithelial cell tight junctions that form an impermeable barrier between the luminal environment and vascular compartment (Almenoff et al., *Mol Microbiol* 8: 865-873); Guarino et al., *Dig Dis Sci* 32: 1017-1026 (1987)). As such, systemic intravenous administration of a GCC-binding protein therapeutic will have minimal effect on intestinal GCC receptors, while having access to neoplastic cells of the gastrointestinal system, including invasive or metastatic colon cancer cells, extraintestinal or metastatic colon tumors, esophageal tumors or stomach tumors, adenocarcinoma at the gastroesophageal junction. Additionally, GCC internalizes through receptor mediated endocytosis upon ligand binding (Buc et al. *Eur J Cancer* 41: 1618-1627 (2005); Urbanski et al., *Biochem Biophys Acta* 1245: 29-36 (1995)).

[017] Polyclonal antibodies raised against the extracellular domain of GCC (Nandi et al. *Protein Expr. Purif.* 8:151-159 (1996)) were able to inhibit the ST peptide binding to human and rat GCC and inhibit ST-mediated cGMP production by human GCC.

[018] GCC has been characterized as a protein involved in cancers, including colon cancers. See also, Carrithers et al., *Dis Colon Rectum* 39: 171-181 (1996); Buc et al. *Eur J Cancer* 41: 1618-1627 (2005); Carrithers et al., *Gastroenterology* 107: 1653-1661(1994); Urbanski et al., *Biochem Biophys Acta* 1245: 29-36 (1995). Antibody molecule therapeutics directed to GCC can be used alone in unconjugated form to thereby

inhibit the GCC-expressing cancerous cells. Anti-GCC antibody molecules of the invention can bind human GCC. In some embodiments, an anti-GCC antibody molecule of the invention can inhibit the binding of a ligand, e.g., guanylin or heat-stable enterotoxin to GCC. In other embodiments, an anti-GCC antibody molecule of the invention does not inhibit the binding of a ligand, e.g., guanylin or heat-stable enterotoxin to GCC.

[019] Monoclonal antibodies specific for GCC include GCC:B10 (Nandi et al., *J. Cell. Biochem.* 66:500-511 (1997)), GCC:4D7 (Vijayachandra et al. *Biochemistry* 39:16075-16083 (2000)) and GCC:C8 (Bakre et al. *Eur. J. Biochem.* 267:179-187 (2000)). GCC:B10 has a kappa light chain and an IgG2a isotype and cross-reacts to rat, pig and monkey GCC. GCC:B10 binds to the first 63 amino acids of the intracellular domain of GCC, specifically to residues 470-480 of SEQ ID NO:228 (Nandi et al. *Protein Sci.* 7:2175-2183 (1998)). GCC:4D7 binds to the kinase homology domain, within residues 491-568 of GCC (Bhandari et al. *Biochemistry* 40:9196-9206 (2001)). GCC:C8 binds to the protein kinase-like domain in the cytoplasmic portion of GCC.

Definitions and Methods

[020] Unless otherwise defined herein, scientific and technical terms used in connection with the present invention have the meanings that are commonly understood by those of ordinary skill in the art. Generally, nomenclature utilized in connection with, and techniques of, cell and tissue culture, molecular biology, and protein and oligo- or polynucleotide chemistry and hybridization described herein are those known in the art. GenBank or GenPept accession numbers and useful nucleic acid and peptide sequences can be found at the website maintained by the National Center for Biotechnological Information, Bethesda MD. Standard techniques are used for recombinant DNA, oligonucleotide synthesis, and tissue culture and transformation and transfection (e.g., electroporation, lipofection). Enzymatic reactions and purification techniques are performed according to manufacturer's specifications or as commonly accomplished in the art or as described herein. The foregoing techniques and procedures are generally performed according to methods known in the art, e.g., as described in various general and more specific references that are cited and discussed throughout the present specification. See e.g., Sambrook et al. *Molecular Cloning: A Laboratory Manual* (3rd ed., Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y. (2000)) or see generally, Harlow, E.

and Lane, D. (1988) *Antibodies: A Laboratory Manual*, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY. The nomenclatures utilized in connection with, and the laboratory procedures and techniques of, analytical chemistry, synthetic organic chemistry, and medicinal and pharmaceutical chemistry described herein are known in the art. Standard techniques are used for chemical syntheses, chemical analyses, pharmaceutical preparation, formulation, and delivery, and treatment of patients. Furthermore, unless otherwise required by context, singular terms shall include pluralities and plural terms shall include the singular.

[021] As used herein, the term "antibody molecule" refers to an antibody, antibody peptide(s) or immunoglobulin, or an antigen binding fragment of any of the foregoing, e.g., of an antibody. Antibody molecules include single chain antibody molecules, e.g., scFv, see. e.g., Bird et al. (1988) *Science* 242:423-426; and Huston et al. (1988) *Proc. Natl. Acad. Sci. USA* 85:5879-5883), and single domain antibody molecules, see, e.g., WO9404678. Although not within the term "antibody molecules," the invention also includes "antibody analog(s)," other non-antibody molecule protein-based scaffolds, e.g., fusion proteins and/or immunoconjugates that use CDRs to provide specific antigen binding.

[022] An "anti-GCC antibody molecule" refers to an antibody molecule (i.e., an antibody, antigen-binding fragment of an antibody or antibody analog) which interacts with or recognizes, e.g., binds (e.g., binds specifically) to GCC, e.g., human GCC. Exemplary anti-GCC antibody molecules are such as those summarized in Tables 1 and 2.

[023] As used herein, the term "antibody," "antibody peptide(s)" or "immunoglobulin" refers to single chain, two-chain, and multi-chain proteins and glycoproteins. The term antibody includes polyclonal, monoclonal, chimeric, CDR-grafted and human or humanized antibodies, all of which are discussed in more detail elsewhere herein. Also included within the term are camelid antibodies, see, e.g., US2005/0037421, and nanobodies, e.g., IgNARs (shark antibodies), see, e.g., WO03/014161. The term "antibody" also includes synthetic and genetically engineered variants.

[024] As used herein, the term "antibody fragment" or "antigen binding fragment" of an antibody refers, e.g., to Fab, Fab', $F(ab')_2$, and Fv fragments, single chain antibodies, functional heavy chain antibodies (nanobodies), as well as any portion of an

antibody having specificity toward at least one desired epitope, that competes with the intact antibody for specific binding (e.g., a fragment having sufficient CDR sequences and having sufficient framework sequences so as to bind specifically to an epitope). E.g., an antigen binding fragment can compete for binding to an epitope which binds the antibody from which the fragment was derived. Derived, as used in this and similar contexts, does not imply any particular method or process of derivation, but can refer merely to sequence similarity. Antigen binding fragments can be produced by recombinant techniques, or by enzymatic or chemical cleavage of an intact antibody. The term, antigen binding fragment, when used with a single chain, e.g., a heavy chain, of an antibody having a light and heavy chain means that the fragment of the chain is sufficient such that when paired with a complete variable region of the other chain, e.g., the light chain, it will allow binding of at least 25, 50, 75, 85 or 90% of that seen with the whole heavy and light variable region.)

[025] The term, "antigen binding constellation of CDRs" or "a number of CDRs sufficient to allow binding" (and similar language), as used herein, refers to sufficient CDRs of a chain, e.g., the heavy chain, such that when placed in a framework and paired with a complete variable region of the other chain, or with a portion of the other chain's variable region of similar length and having the same number of CDRs, e.g., the light chain, will allow binding, e.g., of at least 25, 50, 75, 85 or 90% of that seen with the whole heavy and light variable region.

[026] As used herein, the term "human antibody" includes an antibody that possesses a sequence that is derived from a human germ-line immunoglobulin sequence, such as an antibody derived from transgenic mice having human immunoglobulin genes (e.g., XENOMOUSE™ genetically engineered mice (Abgenix, Fremont, CA)), human phage display libraries, human myeloma cells, or human B cells.

[027] As used herein, the term "humanized antibody" refers to an antibody that is derived from a non-human antibody e.g., rodent (e.g., murine) that retains or substantially retains the antigen-binding properties of the parent antibody but is less immunogenic in humans. Humanized as used herein is intended to include deimmunized antibodies. Typically humanized antibodies include non –human CDRs and human or human derived framework and constant regions.

[028] The term "modified" antibody, as used herein, refers to antibodies that are prepared, expressed, created or isolated by recombinant means, such as antibodies

expressed using a recombinant expression vector transfected into a host cell, antibodies isolated from a recombinant, combinatorial antibody library, antibodies isolated from an animal (*e.g.*, a mouse, sheep or goat) that is transgenic for human immunoglobulin genes or antibodies prepared, expressed, created or isolated by any other means that involves splicing of human immunoglobulin gene sequences to other DNA sequences. Such modified antibodies include humanized, CDR grafted (e.g., an antibody having CDRs from a first antibody and a framework region from a different source, e.g., a second antibody or a consensus framework), chimeric, *in vitro* generated (e.g., by phage display) antibodies, and may optionally include variable or constant regions derived from human germline immunoglobulin sequences or human immunoglobulin genes or antibodies which have been prepared, expressed, created or isolated by any means that involves splicing of human immunoglobulin gene sequences to alternative immunoglobulin sequences. In embodiments a modified antibody molecule includes an antibody molecule having a sequence change from a reference antibody.

[029] The term "monospecific antibody" refers to an antibody or antibody preparation that displays a single binding specificity and affinity for a particular epitope. This term includes a "monoclonal antibody" or "monoclonal antibody composition."

[030] The term "bispecific antibody" or "bifunctional antibody" refers to an antibody that displays dual binding specificity for two epitopes, where each binding site differs and recognizes a different epitope.

[031] The terms "non-conjugated antibody" and "naked antibody" are used interchangeably to refer to an antibody molecule that is not conjugated to a non-antibody moiety, e.g., a therapeutic agent or a label.

[032] The terms "immunoconjugate", "antibody conjugate", "antibody drug conjugate", and "ADC" are used interchangeably and refer to an antibody that is conjugated to a non-antibody moiety, e.g., a therapeutic agent or a label.

[033] 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 "therapeutic agent" refers to an agent that has biological activity.

[034] The term "anti-cancer agent" or "chemotherapeutic agent" is used herein to refer to agents that have the functional property of inhibiting a development or progression

of a neoplasm in a human, particularly a malignant (cancerous) lesion, such as a carcinoma, sarcoma, lymphoma, or leukemia. Inhibition of metastasis or angiogenesis is frequently a property of anti-cancer or chemotherapeutic agents. A chemotherapeutic agent may be a cytotoxic or cytostatic agent. The term "cytostatic agent" refers to an agent which inhibits or suppresses cell growth and/or multiplication of cells.

[035] "Cytotoxic agents" refer to compounds which cause cell death primarily by interfering directly with the cell's functioning, including, but not limited to, alkylating agents, tumor necrosis factor inhibitors, intercalators, microtubule inhibitors, kinase inhibitors, proteasome inhibitors and topoisomerase inhibitors. A "toxic payload" as used herein refers to a sufficient amount of cytotoxic agent which, when delivered to a cell results in cell death. Delivery of a toxic payload may be accomplished by administration of a sufficient amount of immunoconjugate comprising an antibody or antigen binding fragment of the invention and a cytotoxic agent. Delivery of a toxic payload may also be accomplished by administration of a sufficient amount of an immunoconjugate comprising a cytotoxic agent, wherein the immunoconjugate comprises a secondary antibody or antigen binding fragment thereof which recognizes and binds an antibody or antigen binding fragment of the invention.

[036] As used herein the phrase, a sequence "derived from" or "specific for a designated sequence" refers to a sequence that comprises a contiguous sequence of approximately at least 6 nucleotides or at least 2 amino acids, at least about 9 nucleotides or at least 3 amino acids, at least about 10-12 nucleotides or 4 amino acids, or at least about 15-21 nucleotides or 5-7 amino acids corresponding, i.e., identical or complementary to, e.g., a contiguous region of the designated sequence. In certain embodiments, the sequence comprises all of a designated nucleotide or amino acid sequence. The sequence may be complementary (in the case of a polynucleotide sequence) or identical to a sequence region that is unique to a particular sequence as determined by techniques known in the art. Regions from which sequences may be derived, include but are not limited to, regions encoding specific epitopes, regions encoding CDRs, regions encoding framework sequences, regions encoding constant domain regions, regions encoding variable domain regions, as well as non-translated and/or non-transcribed regions. The derived sequence will not necessarily be derived physically from the sequence of interest under study, but may be generated in any manner, including, but not limited to, chemical synthesis, replication, reverse transcription or transcription, that is based on the information provided

by the sequence of bases in the region(s) from which the polynucleotide is derived. As such, it may represent either a sense or an antisense orientation of the original polynucleotide. In addition, combinations of regions corresponding to that of the designated sequence may be modified or combined in ways known in the art to be consistent with the intended use. For example, a sequence may comprise two or more contiguous sequences which each comprise part of a designated sequence, and are interrupted with a region which is not identical to the designated sequence but is intended to represent a sequence derived from the designated sequence. With regard to antibody molecules, "derived therefrom" includes an antibody molecule which is functionally or structurally related to a comparison antibody, e.g., "derived therefrom" includes an antibody molecule having similar or substantially the same sequence or structure, e.g., having the same or similar CDRs, framework or variable regions. "Derived therefrom" for an antibody also includes residues, e.g., one or more, e.g., 2, 3, 4, 5, 6 or more residues, which may or may not be contiguous, but are defined or identified according to a numbering scheme or homology to general antibody structure or three-dimensional proximity, i.e., within a CDR or a framework region, of a comparison sequence. The term "derived therefrom" is not limited to physically derived therefrom but includes generation by any manner, e.g., by use of sequence information from a comparison antibody to design another antibody.

[037] As used herein, the phrase "encoded by" refers to a nucleic acid sequence that codes for a polypeptide sequence, wherein the polypeptide sequence or a portion thereof contains an amino acid sequence of at least 3 to 5 amino acids, at least 8 to 10 amino acids, or at least 15 to 20 amino acids from a polypeptide encoded by the nucleic acid sequence.

[038] Calculations of "homology" between two sequences can be performed as follows. The sequences are aligned for optimal comparison purposes (e.g., gaps can be introduced in one or both of a first and a second amino acid or nucleic acid sequence for optimal alignment and non-homologous sequences can be disregarded for comparison purposes). The length of a reference sequence aligned for comparison purposes is at least 30%, 40%, or 50%, at least 60%, or at least 70%, 80%, 90%, 95%, 100% of the length of the reference sequence. The amino acid residues or nucleotides at corresponding amino acid positions or nucleotide positions are then compared. When a position in the first sequence is occupied by the same amino acid residue or nucleotide as the corresponding

position in the second sequence, then the molecules are identical at that position (as used herein amino acid or nucleic acid "identity" is equivalent to amino acid or nucleic acid "homology"). The percent identity between the two sequences is a function of the number of identical positions shared by the sequences, taking into account the number of gaps, and the length of each gap, which need to be introduced for optimal alignment of the two sequences.

[039] The comparison of sequences and determination of percent homology between two sequences can be accomplished using a mathematical algorithm. The percent homology between two amino acid sequences can be determined using any method known in the art. For example, the Needleman and Wunsch, *J. Mol. Biol.* 48:444-453 (1970), algorithm which has been incorporated into the GAP program in the GCG software package , using either a Blossum 62 matrix or a PAM250 matrix, and a gap weight of 16, 14, 12, 10, 8, 6, or 4 and a length weight of 1, 2, 3, 4, 5, or 6. The percent homology between two nucleotide sequences can also be determined using the GAP program in the GCG software package (Accelerys, Inc. San Diego, CA), using an NWSgapdna.CMP matrix and a gap weight of 40, 50, 60, 70, or 80 and a length weight of 1, 2, 3, 4, 5, or 6. An exemplary set of parameters for determination of homology are a Blossum 62 scoring matrix with a gap penalty of 12, a gap extend penalty of 4, and a frameshift gap penalty of 5.

[040] As used herein, the term "hybridizes under stringent conditions" describes conditions for hybridization and washing. Guidance for performing hybridization reactions can be found in *Current Protocols in Molecular Biology*, John Wiley & Sons, N.Y. (1989), 6.3.1-6.3.6. Aqueous and nonaqueous methods are described in that reference and either can be used. Specific hybridization conditions referred to herein are as follows: 1) low stringency hybridization conditions in 6X sodium chloride/sodium citrate (SSC) at about 45°C, followed by two washes in 0.2X SSC, 0.1% SDS at least at 50°C (the temperature of the washes can be increased to 55°C for low stringency conditions); 2) medium stringency hybridization conditions in 6X SSC at about 45°C, followed by one or more washes in 0.2X SSC, 0.1% SDS at 60°C; 3) high stringency hybridization conditions in 6X SSC at about 45°C, followed by one or more washes in 0.2X SSC, 0.1% SDS at 65°C; and 4) very high stringency hybridization conditions are 0.5M sodium phosphate, 7% SDS at 65°C, followed by one or more washes at 0.2X SSC,

1% SDS at 65°C. Very high stringency conditions (4) are often the preferred conditions and the ones that should be used unless otherwise specified.

[041] It is understood that the antibodies and antigen binding fragment thereof of the invention may have additional conservative or non-essential amino acid substitutions, which do not have a substantial effect on the polypeptide functions. Whether or not a particular substitution will be tolerated, i.e., will not adversely affect desired biological properties, such as binding activity, can be determined as described in Bowie, JU et al. *Science* 247:1306-1310 (1990) or Padlan et al. *FASEB J.* 9:133-139 (1995). A "conservative amino acid substitution" is one in which the amino acid residue is replaced with an amino acid residue having a similar side chain. Families of amino acid residues having similar side chains have been defined in the art. These families include amino acids with basic side chains (e.g., lysine, arginine, histidine), acidic side chains (e.g., aspartic acid, glutamic acid), uncharged polar side chains (e.g., asparagine, glutamine, serine, threonine, tyrosine, cysteine), nonpolar side chains (e.g., glycine, alanine, valine, leucine, isoleucine, proline, phenylalanine, methionine, tryptophan), beta-branched side chains (e.g., threonine, valine, isoleucine) and aromatic side chains (e.g., tyrosine, phenylalanine, tryptophan, histidine).

[042] A "non-essential" amino acid residue is a residue that can be altered from the wild-type sequence of the binding agent, e.g., the antibody, without abolishing or, without substantially altering a biological activity, whereas an "essential" amino acid residue results in such a change. In an antibody, an essential amino acid residue can be a specificity determining residue (SDR).

[043] As used herein, the term "isolated" refers to material that is removed from its original environment (e.g., the natural environment if it is naturally occurring). For example, a naturally occurring polynucleotide or polypeptide present in a living animal is not isolated, but the same polynucleotide or DNA or polypeptide, separated from some or all of the coexisting materials in the natural system, is isolated. Such polynucleotide could be part of a vector and/or such polynucleotide or polypeptide could be part of a composition, e.g., a mixture, solution or suspension or comprising an isolated cell or a cultured cell which comprises the polynucleotide or polypeptide, and still be isolated in that the vector or composition is not part of its natural environment.

[044] As used herein, the term "replicon" refers to any genetic element, such as a plasmid, a chromosome or a virus, that behaves as an autonomous unit of polynucleotide replication within a cell.

[045] As used herein, the term "operably linked" refers to a situation wherein the components described are in a relationship permitting them to function in their intended manner. Thus, for example, a control sequence "operably linked" to a coding sequence is ligated in such a manner that expression of the coding sequence is achieved under conditions compatible with the control sequence.

[046] As used herein, the term "vector" refers to a replicon in which another polynucleotide segment is attached, such as to bring about the replication and/or expression of the attached segment.

[047] As used herein, the term "control sequence" refers to a polynucleotide sequence that is necessary to effect the expression of a coding sequence to which it is ligated. The nature of such control sequences differs depending upon the host organism. In prokaryotes, such control sequences generally include a promoter, a ribosomal binding site and terminators and, in some instances, enhancers. The term "control sequence" thus is intended to include at a minimum all components whose presence is necessary for expression, and also may include additional components whose presence is advantageous, for example, leader sequences.

[048] As used herein, the term "purified product" refers to a preparation of the product which has been isolated from the cellular constituents with which the product is normally associated and/ or from other types of cells that may be present in the sample of interest.

[049] As used herein, the term "epitope" refers to a protein determinate capable of binding specifically to an antibody. Epitopic determinants usually consist of chemically active surface groupings of molecules such as amino acids or sugar side chains and usually have specific three dimensional structural characteristics, as well as specific charge characteristics. Some epitopes are linear epitopes while others are conformational epitopes. A linear epitope is an epitope wherein a contiguous amino acid primary sequence comprises the epitope recognized. A linear epitope typically includes at least 3, and more usually, at least 5, for example, about 8 to about 10 contiguous amino acids. A conformational epitope can result from at least two situations, such as: a) a linear sequence

which is only exposed to antibody binding in certain protein conformations, e.g., dependent on ligand binding, or dependent on modification (e.g., phosphorylation) by signaling molecules; or b) a combination of structural features from more than one part of the protein, or in multisubunit proteins, from more than one subunit, wherein the features are in sufficiently close proximity in 3-dimensional space to participate in binding.

[050] As used herein, "isotype" refers to the antibody class (e.g., IgM or IgGl) that is encoded by heavy chain constant region genes.

[051] As used herein, the terms "detectable agent," "label" or "labeled" are used to refer to incorporation of a detectable marker on a polypeptide or glycoprotein. 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., indium (^{111}In), iodine (^{131}I or ^{125}I), yttrium (^{90}Y), lutetium (^{177}Lu), actinium (^{225}Ac), bismuth (^{212}Bi or ^{213}Bi), sulfur (^{35}S), carbon (^{14}C), tritium (^{3}H), rhodium (^{188}Rh), technetium (^{99}mTc), praseodymium, or phosphorous (^{32}P) or a positron-emitting radionuclide, e.g., carbon-11 (^{11}C), potassium-40 (^{40}K), nitrogen-13 (^{13}N), oxygen-15 (^{15}O), fluorine-18 (^{18}F), and iodine-121 (^{121}I)), fluorescent labels (e.g., FITC, rhodamine, lanthanide phosphors), enzymatic labels (e.g., horseradish peroxidase, beta-galactosidase, luciferase, alkaline phosphatase), chemiluminescent, biotinyl groups (which can be detected by a marked avidin, e.g., a molecule containing a streptavidin moiety and a fluorescent marker or an enzymatic activity that can be detected by optical or calorimetric methods), and predetermined polypeptide epitopes 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.

[052] As used herein, "specific binding," "bind(s) specifically" or "binding specificity" means, for an anti-GCC antibody molecule, that the antibody molecule binds to GCC, e.g., human GCC protein, with greater affinity than it does to a non-GCC protein, e.g., BSA. Typically an anti-GCC molecule will have a K_d for the non-GCC protein, e.g., BSA, which is greater than 2, greater than 10, greater than 100, greater than 1,000 times, greater than 10^4 , greater than 10^5 , or greater than 10^6 times its K_d for GCC, e.g., human GCC protein. In determination of K_d, the K_d for GCC and the non-GCC protein, e.g., BSA, should be done under the same conditions.

[053] As used herein, the term "treat" or "treatment" is defined as the administration of an anti-GCC antibody molecule to a subject, e.g., a patient, or administration, e.g., by application, to an isolated tissue or cell from a subject which is returned to the subject. The anti-GCC antibody molecule can be administered alone or in combination with a second agent. The treatment can be to cure, heal, alleviate, relieve, alter, remedy, ameliorate, palliate, improve or affect the disorder, the symptoms of the disorder or the predisposition toward the disorder, e.g., a cancer. While not wishing to be bound by theory, treating is believed to cause the inhibition, ablation, or killing of a cell *in vitro* or *in vivo*, or otherwise reducing capacity of a cell, e.g., an aberrant cell, to mediate a disorder, e.g., a disorder as described herein (e.g., a cancer).

[054] As used herein, the term "subject" is intended to include mammals, primates, humans and non-human animals. For example, a subject can be a patient (e.g., a human patient or a veterinary patient), having a cancer, e.g., of gastrointestinal origin (e.g., colon cancer), a symptom of a cancer, e.g., of gastrointestinal origin (e.g., colon cancer), in which at least some of the cells express GCC, or a predisposition toward a cancer, e.g., of gastrointestinal origin (e.g., colon cancer), in which at least some of the cells express GCC. The term "non-human animals" of the invention includes all non-human vertebrates, e.g., non-human mammals and non-mammals, such as non-human primates, sheep, dog, cow, chickens, amphibians, reptiles, etc, unless otherwise noted. In an embodiment subject excludes one or more or all of a mouse, rat, rabbit or goat.

[055] As used herein, an amount of an anti-GCC antibody molecule "effective" or "sufficient" to treat a disorder, or a "therapeutically effective amount" or "therapeutically sufficient amount" refers to an amount of the antibody molecule which is effective, upon single or multiple dose administration to a subject, in treating a cell, e.g., cancer cell (e.g., a GCC-expressing tumor cell), or in prolonging curing, alleviating, relieving or improving a subject with a disorder as described herein beyond that expected in the absence of such treatment. As used herein, "inhibiting the growth" of the tumor or cancer refers to slowing, interrupting, arresting or stopping its growth and/or metastases and does not necessarily indicate a total elimination of the tumor growth.

[056] As used herein, "GCC," also known as "STAR", "GUC2C", "GUCY2C" or "ST receptor" protein refers to mammalian GCC, preferably human GCC protein. Human GCC refers to the protein shown in SEQ ID NO:228 and naturally occurring allelic protein

variants thereof. The allele in SEQ ID NO: 228 can be encoded by the nucleic acid sequence of GCC shown in SEQ ID NO:227. Other variants are known in the art. See, e.g., accession number Ensp0000261170, Ensembl Database, European Bioinformatics Institute and Wellcome Trust Sanger Institute, which has a leucine at residue 281; SEQ ID NO: 14 of published US patent application number US 20060035852; or GenBank accession number AAB19934. Typically, a naturally occurring allelic variant has an amino acid sequence at least 95%, 97% or 99% identical to the GCC sequence of SEQ ID NO:228. The transcript encodes a protein product of 1073 amino acids, and is described in GenBank accession no.: NM_004963. GCC protein is characterized as a transmembrane cell surface receptor protein, and is believed to play a critical role in the maintenance of intestinal fluid, electrolyte homeostasis and cell proliferation.

[057] Unless otherwise noted, the term "alkyl" refers to a saturated straight or branched hydrocarbon having from about 1 to about 20 carbon atoms (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein), with from about 1 to about 8 carbon atoms being preferred. Examples of alkyl groups are methyl, ethyl, *n*-propyl, *iso*-propyl, *n*-butyl, *iso*-butyl, *sec*-butyl, *tert*-butyl, *n*-pentyl, 2-pentyl, 3-pentyl, 2-methyl-2-butyl, *n*-hexyl, *n*-heptyl, *n*-octyl, *n*-nonyl, *n*-decyl, 3-methyl-2-butyl, 3-methyl-1-butyl, 2-methyl-1-butyl, 1-hexyl, 2-hexyl, 3-hexyl, 2-methyl-2-pentyl, 3-methyl-2-pentyl, 4-methyl-2-pentyl, 3-methyl-3-pentyl, 2-methyl-3-pentyl, 2,3-dimethyl-2-butyl, and 3,3-dimethyl-2-butyl.

[058] Alkyl groups, whether alone or as part of another group, may be referred to as "substituted." A substituted alkyl group is an alkyl group that is substituted with one or more groups, preferably 1 to 3 groups (and any additional substituents selected from halogen), including, but not limited to, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R', -OC(O)R', -C(O)OR', -C(O)NH_2 , -C(O)NHR', -C(O)N(R')$_2$, -NHC(O)R', -SR', -SO_3R', -S(O)$_2$R', -S(O)R', -OH, =O, -N_3 , -NH_2, -NH(R'), -N(R')$_2$ and -CN, where each R' is independently selected from -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, or -aryl, and wherein said -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, and -C_2-C_8 alkynyl groups can be optionally further substituted with one or more groups including, but not limited to, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R'', -OC(O)R'', -C(O)OR'', -C(O)NH_2 , -C(O)NHR'', -C(O)N(R'')$_2$, -NHC(O)R'', -SR'', -SO_3R'', -S(O)$_2$R'', -S(O)R'', -OH, -N_3

, $-NH_2$, $-NH(R'')$, $-N(R'')_2$ and -CN, where each R'' is independently selected from -H, $-C_1$-C_8 alkyl, $-C_2$-C_8 alkenyl, $-C_2$-C_8 alkynyl, or -aryl.

[059] Unless otherwise noted, the terms "alkenyl" and "alkynyl" refer to straight and branched carbon chains having from about 2 to about 20 carbon atoms (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein), with from about 2 to about 8 carbon atoms being preferred. An alkenyl chain has at least one double bond in the chain and an alkynyl chain has at least one triple bond in the chain. Examples of alkenyl groups include, but are not limited to, ethylene or vinyl, allyl, -1-butenyl, -2-butenyl, -isobutylenyl, -1-pentenyl, -2-pentenyl, -3-methyl-1-butenyl, -2-methyl-2-butenyl, and -2,3-dimethyl-2-butenyl. Examples of alkynyl groups include, but are not limited to, acetylenic, propargyl, acetylenyl, propynyl, -1-butynyl, -2-butynyl, -1-pentynyl, -2-pentynyl, and -3-methyl-1 butynyl.

[060] As with alkyl groups, alkenyl and alkynyl groups, can be substituted. A "substituted" alkenyl or alkynyl group is one that is substituted with one or more groups, preferably 1 to 3 groups (and any additional substituents selected from halogen), including but not limited to, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R', -OC(O)R', -C(O)OR', $-C(O)NH_2$, -C(O)NHR', $-C(O)N(R')_2$, -NHC(O)R', -SR', $-SO_3R'$, $-S(O)_2R'$, -S(O)R', -OH, =O, $-N_3$, $-NH_2$, -NH(R'), $-N(R')_2$ and -CN, where each R' is independently selected from -H, $-C_1$-C_8 alkyl, $-C_2$-C_8 alkyenl, $-C_2$-C_8 alkynyl, or -aryl and wherein said -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, $-C_1$-C_8 alkyl, $-C_2$-C_8 alkenyl, and $-C_2$-C_8 alkynyl groups can be optionally further substituted with one or more substituents including, but not limited to, $-C_1$-C_8 alkyl, $-C_2$-C_8 alkenyl, $-C_2$-C_8 alkynyl, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2C_8 alkynyl), -aryl, -C(O)R'', -OC(O)R'', -C(O)OR'', $-C(O)NH_2$, -C(O)NHR'', $-C(O)N(R'')_2$, -NHC(O)R'', -SR'', $-SO_3R''$, $-S(O)_2R''$, -S(O)R'', -OH, $-N_3$, $-NH_2$, -NH(R''), $-N(R'')_2$ and -CN, where each R'' is independently selected from -H, $-C_1$-C_8 alkyl, $-C_2$-C_8 alkenyl, $-C_2$-C_8 alkynyl, or -aryl.

[061] Unless otherwise noted, the term "alkylene" refers to a saturated branched or straight chain hydrocarbon radical having from about 1 to about 20 carbon atoms (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein), with from about 1 to about 8 carbon atoms being preferred and having two monovalent radical centers derived by the removal of two hydrogen atoms from the same

or two different carbon atoms of a parent alkane. Typical alkylenes include, but are not limited to, methylene, ethylene, propylene, butylene, pentylene, hexylene, heptylene, ocytylene, nonylene, decalene, 1,4-cyclohexylene, and the like. Alkylene groups, whether alone or as part of another group, can be optionally substituted with one or more groups, preferably 1 to 3 groups (and any additional substituents selected from halogen), including, but not limited to, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R', -OC(O)R', -C(O)OR', -C(O)NH_2 , -C(O)NHR', -C(O)N(R')$_2$, -NHC(O)R', -SR', -SO_3R', -S(O)$_2$R', -S(O)R', -OH, =O, -N_3 , -NH_2, -NH(R'), -N(R')$_2$ and -CN, where each R' is independently selected from -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, or -aryl and wherein said -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, and -C_2-C_8 alkynyl groups can be further optionally substituted with one or more substituents including, but not limited to, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R'', -OC(O)R'', -C(O)OR'', -C(O)NH_2, -C(O)NHR'', -C(O)N(R'')$_2$, -NHC(O)R'', -SR'', -SO_3R'', -S(O)$_2$R'', -S(O)R'', -OH, -N_3 , -NH_2, -NH(R''), -N(R'')$_2$ and -CN, where each R'' is independently selected from -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, or -aryl.

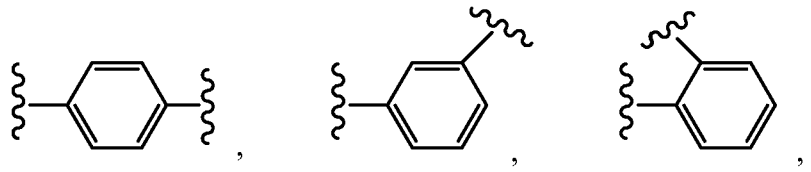
[062] Unless otherwise noted, the term "alkenylene" refers to an optionally substituted alkylene group containing at least one carbon-carbon double bond. Exemplary alkenylene groups include, for example, ethenylene (-CH=CH-) and propenylene (-CH=CHCH_2-).

[063] Unless otherwise noted, the term "alkynylene" refers to an optionally substituted alkylene group containing at least one carbon-carbon triple bond. Exemplary alkynylene groups include, for example, acetylene (-C≡C-), propargyl (-CH_2C≡C-), and 4-pentynyl (-CH_2CH_2CH_2C≡CH-).

[064] Unless otherwise noted, the term "aryl" refers to a monovalent aromatic hydrocarbon radical of 6-20 carbon atoms (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein) derived by the removal of one hydrogen atom from a single carbon atom of a parent aromatic ring system. Some aryl groups are represented in the exemplary structures as "Ar". Typical aryl groups include, but are not limited to, radicals derived from benzene, substituted benzene, phenyl, naphthalene, anthracene, biphenyl, and the like.

[065] An aryl group, whether alone or as part of another group, can be optionally substituted with one or more, preferably 1 to 5, or even 1 to 2 groups including, but not limited to, -halogen, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R', -OC(O)R', -C(O)OR', -C(O)NH_2, -C(O)NHR', -C(O)N(R')$_2$, -NHC(O)R', -SR', -SO_3R', -S(O)$_2$R', -S(O)R', -OH, -NO_2, -N_3, -NH_2, -NH(R'), -N(R')$_2$ and -CN, where each R' is independently selected from -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, or -aryl and wherein said -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), and -aryl groups can be further optionally substituted with one or more substituents including, but not limited to, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R'', -OC(O)R'', -C(O)OR'', -C(O)NH_2, -C(O)NHR'', -C(O)N(R'')$_2$, -NHC(O)R'', -SR'', -SO_3R'', -S(O)$_2$R'', -S(O)R'', -OH, -N_3, -NH_2, -NH(R''), -N(R'')$_2$ and -CN, where each R'' is independently selected from -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, or -aryl.

[066] Unless otherwise noted, the term "arylene" refers to an optionally substituted aryl group which is divalent (*i.e.,* derived by the removal of two hydrogen atoms from the same or two different carbon atoms of a parent aromatic ring system) and can be in the ortho, meta, or para configurations as shown in the following structures with phenyl as the exemplary aryl group:



Typical "-(C_1-C_8 alkylene)aryl," "-(C_2-C_8 alkenylene)aryl", "and -(C_2-C_8 alkynylene)aryl" groups include, but are not limited to, benzyl, 2-phenylethan-1-yl, 2-phenylethen-1-yl, naphthylmethyl, 2-naphthylethan-1-yl, 2-naphthylethen-1-yl, naphthobenzyl, 2-naphthophenylethan-1-yl and the like.

[067] Unless otherwise noted, the term "heterocycle," refers to a monocyclic, bicyclic, or polycyclic ring system having from 3 to 14 ring atoms (also referred to as ring members) wherein at least one ring atom in at least one ring is a heteroatom selected from N, O, P, or S (and all combinations and subcombinations of ranges and specific numbers of carbon atoms and heteroatoms therein). The heterocycle can have from 1 to 4 ring heteroatoms independently selected from N, O, P, or S. One or more N, C, or S atoms in a

heterocycle can be oxidized. A monocylic heterocycle preferably has 3 to 7 ring members (e.g., 2 to 6 carbon atoms and 1 to 3 heteroatoms independently selected from N, O, P, or S), and a bicyclic heterocycle preferably has 5 to 10 ring members (*e.g.,* 4 to 9 carbon atoms and 1 to 3 heteroatoms independently selected from N, O, P, or S). The ring that includes the heteroatom can be aromatic or non-aromatic. Unless otherwise noted, the heterocycle is attached to its pendant group at any heteroatom or carbon atom that results in a stable structure.

[068] Heterocycles are described in Paquette, "Principles of Modern Heterocyclic Chemistry" (W.A. Benjamin, New York, 1968), particularly Chapters 1, 3, 4, 6, 7, and 9; "The Chemistry of Heterocyclic Compounds, A series of Monographs" (John Wiley & Sons, New York, 1950 to present), in particular Volumes 13, 14, 16, 19, and 28; and *J. Am. Chem. Soc.* 82:5566 (1960).

[069] Unless otherwise noted, the term "heterocyclo" refers to an optionally substituted heterocycle group as defined above that is divalent (*i.e.,* derived by the removal of two hydrogen atoms from the same or two different carbon atoms of a parent heterocyclic ring system).

[070] Examples of "heterocycle" groups include by way of example and not limitation pyridyl, dihydropyridyl, tetrahydropyridyl (piperidyl), thiazolyl, pyrimidinyl, furanyl, thienyl, pyrrolyl, pyrazolyl, imidazolyl, tetrazolyl, benzofuranyl, thianaphthalenyl, indolyl, indolenyl, quinolinyl, isoquinolinyl, benzimidazolyl, piperidinyl, 4-piperidonyl, pyrrolidinyl, 2-pyrrolidonyl, pyrrolinyl, tetrahydrofuranyl, bis-tetrahydrofuranyl, tetrahydropyranyl, bis-tetrahydropyranyl, tetrahydroquinolinyl, tetrahydroisoquinolinyl, decahydroquinolinyl, octahydroisoquinolinyl, azocinyl, triazinyl, 6H-1,2,5-thiadiazinyl, 2H,6H-1,5,2-dithiazinyl, thienyl, thianthrenyl, pyranyl, isobenzofuranyl, chromenyl, xanthenyl, phenoxathinyl, 2H-pyrrolyl, isothiazolyl, isoxazolyl, pyrazinyl, pyridazinyl, indolizinyl, isoindolyl, 3H-indolyl, 1H-indazolyl, purinyl, 4H-quinolizinyl, phthalazinyl, naphthyridinyl, quinoxalinyl, quinazolinyl, cinnolinyl, pteridinyl, 4H-carbazolyl, carbazolyl, β-carbolinyl, phenanthridinyl, acridinyl, pyrimidinyl, phenanthrolinyl, phenazinyl, phenothiazinyl, furazanyl, phenoxazinyl, isochromanyl, chromanyl, imidazolidinyl, imidazolinyl, pyrazolidinyl, pyrazolinyl, piperazinyl, indolinyl, isoindolinyl, quinuclidinyl, morpholinyl, oxazolidinyl, benzotriazolyl, benzisoxazolyl, oxindolyl, benzoxazolinyl, and isatinoyl. Preferred "heterocycle" groups include, but are

not limited to, benzofuranyl, benzothiophenyl, indolyl, benzopyrazolyl, coumarinyl, isoquinolinyl, pyrrolyl, thiophenyl, furanyl, thiazolyl, imidazolyl, pyrazolyl, triazolyl, quinolinyl, pyrimidinyl, pyridinyl, pyridonyl, pyrazinyl, pyridazinyl, isothiazolyl, isoxazolyl and tetrazolyl.

[071] A heterocycle group, whether alone or as part of another group, can be optionally substituted with one or more groups, preferably 1 to 2 groups, including but not limited to, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R', -OC(O)R', -C(O)OR', -C(O)NH_2, -C(O)NHR', -C(O)N(R')$_2$, -NHC(O)R', -SR', -SO_3R', -S(O)$_2$R', -S(O)R', -OH, -N_3, -NH_2, -NH(R'), -N(R')$_2$ and -CN, where each R' is independently selected from -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, or -aryl and wherein said -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, and -aryl groups can be further optionally substituted with one or more substituents including, but not limited to, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R'', -OC(O)R'', -C(O)OR'', -C(O)NH_2, -C(O)NHR'', -C(O)N(R'')$_2$, -NHC(O)R'', -SR'', -SO_3R'', -S(O)$_2$R'', -S(O)R'', -OH, -N_3, -NH_2, -NH(R''), -N(R'')$_2$ and -CN, where each R'' is independently selected from -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, or aryl.

[072] By way of example and not limitation, carbon-bonded heterocycles can be bonded at the following positions: position 2, 3, 4, 5, or 6 of a pyridine; position 3, 4, 5, or 6 of a pyridazine; position 2, 4, 5, or 6 of a pyrimidine; position 2, 3, 5, or 6 of a pyrazine; position 2, 3, 4, or 5 of a furan, tetrahydrofuran, thiofuran, thiophene, pyrrole or tetrahydropyrrole; position 2, 4, or 5 of an oxazole, imidazole or thiazole; position 3, 4, or 5 of an isoxazole, pyrazole, or isothiazole; position 2 or 3 of an aziridine; position 2, 3, or 4 of an azetidine; position 2, 3, 4, 5, 6, 7, or 8 of a quinoline; or position 1, 3, 4, 5, 6, 7, or 8 of an isoquinoline. Still more typically, carbon bonded heterocycles include 2-pyridyl, 3-pyridyl, 4-pyridyl, 5-pyridyl, 6-pyridyl, 3-pyridazinyl, 4-pyridazinyl, 5-pyridazinyl, 6-pyridazinyl, 2-pyrimidinyl, 4-pyrimidinyl, 5-pyrimidinyl, 6-pyrimidinyl, 2-pyrazinyl, 3-pyrazinyl, 5-pyrazinyl, 6-pyrazinyl, 2-thiazolyl, 4-thiazolyl, or 5-thiazolyl.

[073] By way of example and not limitation, nitrogen bonded heterocycles can be bonded at position 1 of an aziridine, azetidine, pyrrole, pyrrolidine, 2-pyrroline, 3-pyrroline, imidazole, imidazolidine, 2-imidazoline, 3-imidazoline, pyrazole, pyrazoline, 2-

pyrazoline, 3-pyrazoline, piperidine, piperazine, indole, indoline, or 1H-indazole; position 2 of a isoindole, or isoindoline; position 4 of a morpholine; and position 9 of a carbazole, or β-carboline. Still more typically, nitrogen bonded heterocycles include 1-aziridyl, 1-azetedyl, 1-pyrrolyl, 1-imidazolyl, 1-pyrazolyl, and 1-piperidinyl.

[074] Unless otherwise noted, the term "carbocycle," refers to a saturated or unsaturated non-aromatic monocyclic, bicyclic, or polycyclic ring system having from 3 to 14 ring atoms (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein) wherein all of the ring atoms are carbon atoms. Monocyclic carbocycles preferably have 3 to 6 ring atoms, still more preferably 5 or 6 ring atoms. Bicyclic carbocycles preferably have 7 to 12 ring atoms, *e.g.*, arranged as a bicyclo [4,5], [5,5], [5,6] or [6,6] system, or 9 or 10 ring atoms arranged as a bicyclo [5,6] or [6,6] system. The term "carbocycle" includes, for example, a monocyclic carbocycle ring fused to an aryl ring (*e.g.,* a monocyclic carbocycle ring fused to a benzene ring). Carbocyles preferably have 3 to 8 carbon ring atoms.

[075] Carbocycle groups, whether alone or as part of another group, can be optionally substituted with, for example, one or more groups, preferably 1 or 2 groups (and any additional substituents selected from halogen), including, but not limited to, -halogen, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R', -OC(O)R', -C(O)OR', -C(O)NH_2 , -C(O)NHR', -C(O)N(R')$_2$, -NHC(O)R', -SR', -SO_3R', -S(O)$_2$R', -S(O)R', -OH, =O, -N_3, -NH_2, -NH(R'), -N(R')$_2$ and -CN, where each R' is independently selected from -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, or -aryl and wherein said -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), and -aryl groups can be further optionally substituted with one or more substituents including, but not limited to, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -halogen, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -aryl, -C(O)R'', -OC(O)R'', -C(O)OR'', -C(O)NH_2 , -C(O)NHR'', -C(O)N(R'')$_2$, -NHC(O)R'', -SR'', -SO_3R'', -S(O)$_2$R'', -S(O)R'', -OH, -N_3 , -NH_2, -NH(R''), -N(R'')$_2$ and -CN, where each R'' is independently selected from -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, or -aryl.

[076] Examples of monocyclic carbocylic substituents include -cyclopropyl, -cyclobutyl, -cyclopentyl, -1-cyclopent-1-enyl, -1-cyclopent-2-enyl, -1-cyclopent-3-enyl, cyclohexyl, -1-cyclohex-1-enyl, -1-cyclohex-2-enyl, -1-cyclohex-3-enyl, -cycloheptyl,

-cyclooctyl. -1,3-cyclohexadienyl, -1,4-cyclohexadienyl, -1,3-cycloheptadienyl, -1,3,5-cycloheptatrienyl, and –cyclooctadienyl.

[077] A "carbocyclo," whether used alone or as part of another group, refers to an optionally substituted carbocycle group as defined above that is divalent (i.e., derived by the removal of two hydrogen atoms from the same or two different carbon atoms of a parent carbocyclic ring system).

[078] Unless otherwise indicated by context, a hyphen (-) designates the point of attachment to the pendant molecule. Accordingly, the term "-(C_1-C_8 alkylene)aryl" or "-C_1-C_8 alkylene(aryl)" refers to a C_1-C_8 alkylene radical as defined herein wherein the alkylene radical is attached to the pendant molecule at any of the carbon atoms of the alkylene radical and one of the hydrogen atoms bonded to a carbon atom of the alkylene radical is replaced with an aryl radical as defined herein.

[079] When a particular group is "substituted", that group may have one or more substituents, preferably from one to five substituents, more preferably from one to three substituents, most preferably from one to two substituents, independently selected from the list of substituents. The group can, however, generally have any number of substituents selected from halogen. Groups that are substituted are so indicated.

[080] It is intended that the definition of any substituent or variable at a particular location in a molecule be independent of its definitions elsewhere in that molecule. It is understood that substituents and substitution patterns on the compounds of this invention can be selected by one of ordinary skill in the art to provide compounds that are chemically stable and that can be readily synthesized by techniques known in the art as well as those methods set forth herein.

[081] Protective groups as used herein refer to groups which selectively block, either temporarily or permanently, one reactive site in a multifunctional compound. Suitable hydroxy-protecting groups for use in the present invention are pharmaceutically acceptable and may or may not need to be cleaved from the parent compound after administration to a subject in order for the compound to be active. Cleavage is through normal metabolic processes within the body. Hydroxy protecting groups are well known in the art, see, PROTECTIVE GROUPS IN ORGANIC SYNTHESIS by T. W. *Greene* and P. G. M. Wuts (John Wiley & sons, 3rd Edition) incorporated herein by reference in its entirety and

for all purposes and include, for example, ether (e.g., alkyl ethers and silyl ethers including, for example, dialkylsilylether, trialkylsilylether, dialkylalkoxysilylether), ester, carbonate, carbamates, sulfonate, and phosphate protecting groups. Examples of hydroxy protecting groups include, but are not limited to, methyl ether; methoxymethyl ether, methylthiomethyl ether, (phenyldimethylsilyl)methoxymethyl ether, benzyloxymethyl ether, p-methoxybenzyloxymethyl ether, p-nitrobenzyloxymethyl ether, o-nitrobenzyloxymethyl ether, (4-methoxyphenoxy)methyl ether, guaiacolmethyl ether, t-butoxymethyl ether, 4-pentenyloxymethyl ether, siloxymethyl ether, 2-methoxyethoxymethyl ether, 2,2,2-trichloroethoxymethyl ether, bis(2-chloroethoxy)methyl ether, 2-(trimethylsilyl)ethoxymethyl ether, menthoxymethyl ether, tetrahydropyranyl ether, 1-methoxycylcohexyl ether, 4-methoxytetrahydrothiopyranyl ether, 4-methoxytetrahydrothiopyranyl ether S,S-Dioxide, 1-[(2-choro-4-methyl)phenyl]-4-methoxypiperidin-4-yl ether, 1-(2-fluorophneyl)-4-methoxypiperidin-4-yl ether, 1,4-dioxan-2-yl ether, tetrahydrofuranyl ether, tetrahydrothiofuranyl ether; substituted ethyl ethers such as 1-ethoxyethyl ether, 1-(2-chloroethoxy)ethyl ether, 1-[2-(trimethylsilyl)ethoxy]ethyl ether, 1-methyl-1-methoxyethyl ether, 1-methyl-1-benzyloxyethyl ether, 1-methyl-1-benzyloxy-2-fluoroethyl ether, 1-methyl-1phenoxyethyl ether, 2-trimethylsilyl ether, t-butyl ether, allyl ether, propargyl ethers, p-chlorophenyl ether, p-methoxyphenyl ether, benzyl ether, p-methoxybenzyl ether 3,4-dimethoxybenzyl ether, trimethylsilyl ether, triethylsilyl ether, tripropylsilylether, dimethylisopropylsilyl ether, diethylisopropylsilyl ether, dimethylhexylsilyl ether, t-butyldimethylsilyl ether, diphenylmethylsilyl ether, benzoylformate ester, acetate ester, chloroacetate ester, dichloroacetate ester, trichloroacetate ester, trifluoroacetate ester, methoxyacetate ester, triphneylmethoxyacetate ester, phenylacetate ester, benzoate ester, alkyl methyl carbonate, alkyl 9-fluorenylmethyl carbonate, alkyl ethyl carbonate, alkyl 2,2,2,-trichloroethyl carbonate, 1,1,-dimethyl-2,2,2-trichloroethyl carbonate, alkylsulfonate, methanesulfonate, benzylsulfonate, tosylate, methylene acetal, ethylidene acetal, and t-butylmethylidene ketal. Preferred protecting groups are represented by the formulas -R, -Si(R)(R)(R), -C(O)R, -C(O)OR, -C(O)NH(R), -$S(O)_2$R, -$S(O)_2$OH, $P(O)(OH)_2$, and -P(O)(OH)OR, wherein R is C_1-C_{20} alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, -C_1-C_{20} alkylene(carbocycle), -C_2-C_{20} alkenylene(carbocycle), -C_2-C_{20} alkynylene(carbocycle), -C_6-C_{10} aryl, -C_1-C_{20} alkylene(aryl), -C_2-C_{20} alkenylene(aryl), -C_2-C_{20} alkynylene(aryl), -C_1-C_{20} alkylene(heterocycle), -C_2-C_{20} alkenylene(heterocycle), or -C_2-C_{20} alkynylene(heterocycle)

wherein said alkyl, alkenyl, alkynyl, alkylene, alkenylene, alkynylene, aryl, carbocycle, and heterocycle radicals whether alone or as part of another group are optionally substituted.

[082] The abbreviation "AFP" refers to dimethylvaline-valine-dolaisoleuine-dolaproine-phenylalanine-p-phenylenediamine (*see* Formula (*XVIII*) *infra*).

[083] The abbreviation "MMAE" refers to monomethyl auristatin E (*see* Formula (*XIII*) *infra*).

[084] The abbreviation "AEB" refers to an ester produced by reacting auristatin E with paraacetyl benzoic acid (*see* Formula (*XXII*) *infra*).

[085] The abbreviation "AEVB" refers to an ester produced by reacting auristatin E with benzoylvaleric acid (*see* Formula (*XXIII*) *infra*).

[086] The abbreviation "MMAF" refers to monomethyl auristatin F (*see* Formula (*XXI*) *infra*).

Antibodies

[087] In certain aspects, the invention relates to anti-GCC antibody molecules with features such as those summarized in Tables 1 and 2. In other aspects, the invention relates to anti-GCC antibody molecules with features such as those summarized in Tables 3, 4, 5 and/or 6.

[088] In an embodiment, the anti-GCC antibody molecule is a human hybridoma antibody and is one of antibody 5F9, 5H3, 6H8, 8C2, 10C10, 10D3 and 1D3. In an embodiment, the anti-GCC antibody molecule is derived from antibody 5F9, 5H3, 6H8, 8C2, 10C10, 10D3, or 1D3. In an embodiment, the anti-GCC antibody molecule is produced by hybridoma 5F9 (PTA-8132).

[089] In an embodiment the anti-GCC antibody molecule is a selected lymphocyte antibody and is one of antibody Abx-12, Abx-020, Abx-106, Abx-198, Abx-221, Abx-229, Abx-338, and Abx-393. In an embodiment, the anti-GCC antibody molecule is derived from antibody Abx-12, Abx-020, Abx-106, Abx-198, Abx-221, Abx-229, Abx-338, and Abx-393.

[090] In an embodiment the anti-GCC antibody molecule is a murine antibody and is one of antibody mAb 3G1, mAb 8E12, mAb10B8, and mAb 8F1. In an

embodiment, the anti-GCC antibody molecule is derived from antibody mAb 3G1, mAb 8E12, and mAb 8F1.

[091] In an embodiment an anti-GCC antibody molecule will have an affinity for GCC, e.g., as measured by direct binding or competition binding assays, in a range described herein. In an embodiment the anti-GCC antibody molecule has a K_d of less than $1x10^{-6}$M, less than $1x10^{-7}$ M, less than $1x10^{-8}$ M, less than $1x10^{-9}$ M, less than $1x10^{-10}$ M, less than $1x10^{-11}$ M, less than $1x10^{-12}$ M, or less than $1x10^{-13}$ M. In an embodiment the antibody molecule is an IgG, or antigen-binding fragment thereof, and has a K_d of less than $1x10^{-6}$M, less than $1x10^{-7}$ M, less than $1x10^{-8}$ M, or less than $1x10^{-9}$ M. In an embodiment, an anti-GCC antibody molecule, e.g., a 5F9 antibody or antibody derived therefrom has a K_d of about 80 to about 200 pM, preferably about 100 to about 150 pM or about 120 pM. In an embodiment, an anti-GCC antibody molecule, e.g., a 5F9 antibody or antibody derived therefrom has a k_a of about 0.9 to about 1.25 $x10^5$ $M^{-1}s^{-1}$, preferably about 1.1 $x10^5$ $M^{-1}s^{-1}$. In an embodiment the antibody molecule is an ScFv and has a K_d of less than $1x10^{-6}$M, less than $1x10^{-7}$ M, less than $1x10^{-8}$ M, less than $1x10^{-9}$ M, less than $1x10^{-10}$ M, less than $1x10^{-11}$ M, less than $1x10^{-12}$ M, or less than $1x10^{-13}$ M.

[092] In embodiments, the antibody molecules are not immunoconjugates, i.e., are "naked" and in embodiments cause a cellular reaction upon binding to GCC. In related embodiments, the cellular reaction is performed by the GCC-expressing cell to which the antibody binds. Such a cellular reaction can be signal transduction mediated by GCC, e.g., if the antibody molecule is an agonist of GCC (see, e.g., US Patent Application publication no. US20040258687. In other embodiments, the cellular reaction is performed by a second cell, e.g., an immune effector cell (e.g., a natural killer cell) which recognizes the antibody molecule bound to GCC on the first cell. In some embodiments, surveillance molecules, e.g., complement molecules, contact the GCC-bound antibody molecule prior to the cellular reaction. The cellular reactions in these embodiments can cause death of the GCC-expressing cell.

[093] In further embodiments, antibody molecules which are immunoconjugates can both cause a cellular reaction upon binding to GCC and internalize to deliver an agent to the GCC-expressing cell to which it binds.

[094] In some embodiments, an anti-GCC antibody molecule of the invention can block ligand binding to GCC.

[095] In an embodiment, the anti-GCC antibody molecule fails to show substantial cross reaction with one or both of rat GCC and mouse GCC.

[096] In an embodiment, the antibody molecule is not GCC:B10, GCC:4D7 or GCC:C8. In another embodiment, an anti-GCC antibody molecule does not bind an intracellular domain of GCC, about amino acid residue 455 to 1073 of SEQ ID NO:228. For example, in this embodiment, an anti-GCC antibody molecule does not bind the kinase homology domain or the guanylyl cyclase domain of GCC.

[097] The naturally occurring mammalian antibody structural unit is typified by a tetramer. Each tetramer is composed of two 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 can be classified as kappa and lambda light chains. Heavy chains can be classified as mu, delta, gamma, alpha, or epsilon, 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 more amino acids. See generally, *Fundamental Immunology* Ch. 7 (Paul, W., ed., 2nd ed. Raven Press, N.Y. (1989)). The variable regions of each light/heavy chain pair form the antibody binding site. Preferred isotypes for the anti-GCC antibody molecules are IgG immunoglobulins, which can be classified into four subclasses, IgG1, IgG2, IgG3 and IgG4, having different gamma heavy chains. Most therapeutic antibodies are human, chimeric, or humanized antibodies of the IgG1 type. In a particular embodiment, the anti-GCC antibody molecule has the IgG1 isotype.

[098] The variable regions of each heavy and light chain pair form the antigen binding site. Thus, an intact IgG antibody has two binding sites which are the same. However, bifunctional or bispecific antibodies are artificial hybrid constructs which have two different heavy/light chain pairs, resulting in two different binding sites.

[099] The chains all 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, enabling binding to a specific epitope. From N-

terminal to C-terminal, 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). As used herein, CDRs are referred to for each of the heavy (HCDR1, HCDR2, HCDR3) and light (LCDR1, LCDR2, LCDR3) chains.

[0100] An anti-GCC antibody molecule can comprise all, or an antigen binding subset of the CDRs, of one or both, the heavy and light chain, of one of the above-referenced human hybridoma, selected lymphocyte, or murine antibodies. Amino acid sequences of human hybridoma, selected lymphocyte, and murine antibody portions, including variable regions and CDRs, can be found in Table 3 and Table 5.

[0101] Thus, in an embodiment the antibody molecule includes one or both of:

(a) one, two, three, or an antigen binding number of, light chain CDRs (LCDR1, LCDR2 and/or LCDR3) of one of the above-referenced human hybridoma, selected lymphocyte, or murine antibodies. In embodiments the CDR(s) may comprise an amino acid sequence of one or more or all of LCDR1-3 as follows: LCDR1, or modified LCDR1 wherein one to seven amino acids are conservatively substituted) LCDR2, or modified LCDR2 wherein one or two amino acids are conservatively substituted); or LCDR3, or modified LCDR3 wherein one or two amino acids are conservatively substituted; and

(b) one, two, three, or an antigen binding number of, heavy chain CDRs (HCDR1, HCDR2 and/or HCDR3) of one of the above-referenced human hybridoma, selected lymphocyte, or murine antibodies. In embodiments the CDR(s) may comprise an amino acid sequence of one or more or all of HCDR1-3 as follows: HCDR1, or modified HCDR1 wherein one or two amino acids are conservatively substituted; HCDR2, or modified HCDR2 wherein one to four amino acids are conservatively substituted; or HCDR3, or modified HCDR3 wherein one or two amino acids are conservatively substituted.

[0102] Useful immunogens for production of anti-GCC antibodies include GCC e.g., human GCC-expressing cells (e.g., a tumor cell line, e.g., T84 cells, or fresh or frozen colon tumor cells, recombinant cells expressing GCC); membrane fractions of GCC-

expressing cells (e.g., a colon tumor cell line, e.g., T84 cells, or fresh or frozen colonic tumor cells, recombinant cells expressing GCC, e.g., HT-29-GCC#2 cells, which express full-length GCC, or a portion thereof, e.g., CHO GCC #27 cells which express a portion comprising the GCC extracellular domain, e.g., SEQ ID NO:318); isolated or purified GCC, e.g., human GCC protein (e.g., biochemically isolated GCC, e.g., isolated from gastrointestinal tumor cells or recombinant cells expressing GCC or a variant thereof), or a portion thereof (e.g., the extracellular domain of GCC, the kinase homology domain of GCC or the guanylyl cyclase catalytic domain of GCC or peptide corresponding to a portion thereof, e.g., comprising at least about 8, 10, 12, 14, 16, 20, 24, 28 or 32 amino acid residues of SEQ ID NO:228); or an immunogen comprising SEQ ID NO:229 or comprising a mature portion thereof without the signal sequence (i.e., without amino acid residues 1 to about 21 or 23 of SEQ ID NO:229), e.g., the mature TOK107-hIgG protein, SEQ ID NO:317.

[0103] Immunogens can be fused to heterologous sequences to aid in biochemical manipulation, purification, immunization or antibody titer measurement. Such immunogens can comprise a portion of GCC, e.g., the extracellular domain, and a portion comprising a non-GCC polypeptide. Many options exist for constructing a fusion protein for ease of purification or immobilization onto a solid support, e.g., an affinity column or a microtiter plate or other suitable assay substrate/chip. For example, a fusion moiety can add a domain, *e.g.*, glutathione-S-transferase/kinase (GST), which can bind glutathione; an Fc region of an immunoglobulin, which can bind to protein A or protein G; amino acid residues, *e.g.*, two, three, four, five, preferably six histidine residues which can bind nickel or cobalt on an affinity column; an epitope tag, e.g., a portion of c-myc oncogene (myc-tag), a FLAG tag (U.S. Patent No. 4,703,004), a hemagglutinin (HA) tag, a T7 gene 10 tag, a V5 tag, an HSV tag, or a VSV-G tag which can bind a tag-specific antibody; or a cofactor, *e.g.*, biotin, which can bind streptavidin.

[0104] Immunogens which comprise the Fc portion of an immunoglobulin can hold the GCC, either in solution or attached to a cell, in a configuration which allows structural access to GCC epitopes by the host immune surveillance components for efficient antibody generation. Because immunoglobulin heavy chains comprising the Fc regions associate into dimers through interchain disulfide bonds, immunogens resulting from fusion with Fc regions are dimers. Valency of fusion proteins can reflect the type of immunoglobulin contributing an Fc region. For example, fusions with IgG proteins can be

dimers, IgA fusions can make tetrameric immunogens, and IgM fusions can make decameric immunogens, the latter two is facilitated with co-transfection of the J chain. An exemplary immunoglobulin for an Fc fusion protein is IgG1. The portion used typically has the IgG1 hinge, CH2 and CH3 domains encoded by a single exon. Because this exon also has a portion of the CH1 region, which has a cysteine oriented to disulfide bond with a cysteine from the light chain, a useful modification is to mutate the CH1 cysteine, e.g., to a serine, to ensure there is no unpaired cysteine in the fusion protein. Such a mutation also increases flexibility of the hinge.

[0105] An Fc portion derived from a non-host species, e.g., human Ig Fc region, for fusing to an immunogen for immunization in a host species, e.g., mouse, rat, rabbit, goat, acts as an adjuvant. This adjuvant function can trigger specific antibodies against both Fc and GCC epitopes. Fc-reactive antibodies can be identified and discarded during screening. The Fc portion can have a wild type sequence or a sequence which is mutated to modify effector function. For example, a mutated constant region (variant) can be incorporated into a fusion protein to minimize binding to Fc receptors and/or ability to fix complement. (see e.g. Winter et al., GB 2,209,757 B; Morrison et al., WO 89/07142; Morgan et al., WO 94/29351). In a preferred example, lysine 235 and glycine 237, numbered according to Fc region standards, are mutated, e.g., to alanine. An immunogen/fusion protein with Fc-mutated IgG can have reduced interaction with Fc receptors in the host. A preferred soluble immunogen fusion protein (after maturation to cleave the signal peptide and secretion) is TOK-107-hIgG (alt. name hGCC-ECD/hIgG1 Fc), which consists of amino acid residues 24 to 430 of SEQ ID NO:228 fused to mutated human IgG1 immunoglobulin Fc (SEQ ID NO:317).

[0106] To prepare a cell-expressed immunogen, the immunoglobulin portion can be structured to mimic an immunoglobulin portion of the B cell receptor. For example, the immunoglobulin Fc region can be further fused to a polypeptide comprising a transmembrane region from an immune receptor, such as Fcγ receptors, Fcα receptors, Fcα/μ receptor or Fcε receptors. Proper orientation of such an Fc receptor cell-bound immunogen with adequate exposure on the cell surface may be improved if the cell expressing the immunogen fusion protein further comprises additional components of the antigen receptor complex, e.g., B cell IgM receptor or IgD receptor. Suitable components of the complex include immunoglobulin (Ig) sheath proteins, such as MB-1 and B29

(CD79A and CD79B; Hombach et al. *Eur. J. Immunol.* 20:2795-2799 (1990) for IgM receptor), which form a heterodimer. The Ig sheath proteins can be provided endogenously by the transfected cell, e.g., if transfecting a B cell lymphoma cell line; or by co-transfection of the immunogen with sheath proteins, e.g., in a separate vector or in the same vector. Preferred IgG sheath proteins for immunization in mouse are mouse CD79a and CD79b (GenBank Accession Nos. NM_007655 and NM_008339, respectively). A preferred cell-bound immunogen fusion protein (after maturation to cleave the signal peptide and translocation to the cell surface) is the TOK111 product, consisting of the TOK-107hIgG (hGCC-ECD/hIgG1 Fc) fused to the mouse IgG2a (e.g., GenPept Accession No. AAB59661) transmembrane and intracellular domains (SEQ ID NO:318).

[0107] Useful epitopes, e.g., reference epitopes, from the GCC molecule, to which the anti-GCC antibody molecules, e.g., monoclonal antibodies, human antibodies or humanized antibodies, as described herein, can bind, can be found on the extracellular portion of GCC. Such GCC epitopes can bind antibody molecules on the surface of cells, e.g., on the cell exterior.

[0108] For example, an epitope for an anti-GCC antibody molecule can reside within, or include a residue(s) from, residues 1-50 of SEQ ID NO:228, or a fragment thereof that binds an anti-GCC antibody molecule of the invention, e.g., a 5F9-binding fragment thereof. Such fragments can comprise residues 1-25, 5-30, 10-35, 15-40, 20-45, 25-50, 5-45, 10-40, 15-35, 20-30 or 33-50 of SEQ ID NO:228. In some embodiments, an epitope for an anti-GCC antibody molecule, e.g., a 5F9 antibody, is a conformational epitope further comprising one or more additional amino acid residues in the GCC amino acid sequence beyond residue 50, i.e., selected from about residue 50 to 1073 of SEQ ID NO:228.

[0109] In another example, an epitope for an anti-GCC antibody molecule can reside within, or include a residue(s) from, SEQ ID NO:225, or residues 271-300 of SEQ ID NO:228, or a fragment thereof that binds an anti-GCC antibody molecule of the invention, e.g., an ABX-198-, a 3G1-, an 8F1-, or a 10B8-binding fragment thereof. Such fragments can comprise residues 281-290 of SEQ ID NO:228, or residues 281-290 of SEQ ID NO:228 wherein residue 281 is leucine, or residues 281-300 or residues 271-290 of SEQ ID NO:228. In some embodiments, an epitope for an anti-GCC antibody molecule, e.g., an ABX-198-, a 3G1-, an 8F1-, or a 10B8 antibody, is a conformational epitope

further comprising one or more additional amino acid residues, i.e., non-SEQ ID NO:225 residues in the GCC amino acid sequence e.g., selected from about residue 1 to 270 and/or about 301 to 1073 of SEQ ID NO:228.

[0110] In another example, an epitope for the anti-GCC antibody molecule can reside within, or include a residue(s) from SEQ ID NO:226, or residues 351-375 of SEQ ID NO:228, or a fragment thereof that binds an anti-GCC antibody molecule of the invention, e.g., an ABX-012-, ABX-338-, or ABX-106-binding fragment thereof. Such fragments can comprise 356-370 of SEQ ID NO:228, or residues 351-370 of SEQ ID NO:228, or residues 356-375 of SEQ ID NO:228. In some embodiments, an epitope for an anti-GCC antibody molecule, e.g., an ABX-012-, an ABX-338-, or an ABX-106 antibody, is a conformational epitope further comprising one or more additional amino acid residues, i.e., non-SEQ ID NO:226 residues in the GCC amino acid sequence e.g., selected from about residue 1 to 350 and/or about 376 to 1073 of SEQ ID NO:228.

[0111] Antibodies raised against such epitopes or the extracellular domain, e.g., epitopes that reside within, or include a residue(s) from amino acid residues 24 to 420 of SEQ ID NO:228, or a reference portion thereof, e.g., residues 24 to 75, 75 to 150, 150 to 225, 225 to 300, 300 to 375 or 375 to 420 of GCC, or antibody molecules derived therefrom, can be useful as therapeutic or diagnostic antibodies, as described herein.

[0112] In an embodiment, the anti-GCC antibody molecule has one or more of the following properties:

a) it competes for binding, e.g., binding to cell surface GCC or purified GCC, with one of the above-referenced anti-GCC antibody molecules summarized in Tables 1 and 2 e.g., human hybridoma antibodies (e.g., 5F9), selected lymphocyte antibodies (e.g., Abx-229), or murine antibodies (e.g., 3G1);

b) it binds to the same, or substantially the same, epitope on GCC as one of the above-referenced anti-GCC antibody molecules summarized in Tables 1 and 2, e.g., human hybridoma antibodies (e.g., 5F9), selected lymphocyte antibodies (e.g., Abx-229), or murine antibodies (e.g., 3G1). In an embodiment, the antibody binds the same epitope, as determined by one or more of a peptide array assay or by binding to truncation mutants, chimeras or point mutants expressed on the cell surface or membrane preparations, e.g., as those assays are described herein;

c) it binds to an epitope which has at least 1, 2, 3, 4, 5, 8, 10, 15 or 20 contiguous amino acid residues in common with the epitope of one of the above-referenced anti-GCC antibody molecules summarized in Tables 1 and 2, e.g., human hybridoma antibodies (e.g., 5F9), selected lymphocyte antibodies (e.g., Abx-229) or murine antibodies (e.g., 3G1);

d) it binds a region of human GCC that is bound by an anti-GCC antibody of the invention, wherein the region e.g., an extracellular or cytoplasmic region, is 10-15, 10-20, 20-30, or 20-40 residues in length, and binding is determined, e.g., by binding to truncation mutants; In an embodiment the anti-GCC antibody molecule binds the extracellular region of human GCC. In an embodiment an anti-GCC antibody molecule can bind the human GCC portion of the extracellular domain defined by amino acid residues 24 to 420 of SEQ ID NO:228. In an embodiment an anti-GCC antibody molecule can bind the guanylate cyclase signature site at amino acid residues 931 to 954 of SEQ ID NO:228; or

e) it binds to a reference epitope described herein.

[0113] In an embodiment the anti-GCC antibody molecule binds the GCC sequence ILVDLFNDQYFEDNVTAPDYMKNVLVLTLS (SEQ ID NO:225).

[0114] In an embodiment the anti-GCC antibody molecule binds the GCC sequence FAHAFRNLTFEGYDGPVTLDDWGDV (SEQ ID NO:226).

[0115] In an embodiment the antibody molecule binds a conformational epitope. In other embodiments an antibody molecule binds a linear epitope.

[0116] The anti-GCC antibody molecules can be polyclonal antibodies, monoclonal antibodies, monospecific antibodies, chimeric antibodies (See U.S. Pat. No. 6,020,153) or human or humanized antibodies or antibody fragments or derivatives thereof. Synthetic and genetically engineered variants (See U.S. Pat. No. 6,331,415) of any of the foregoing are also contemplated by the present invention. Monoclonal antibodies can be produced by a variety of techniques, including conventional murine monoclonal antibody methodology e.g., the standard somatic cell hybridization technique of Kohler and Milstein, *Nature* 256: 495 (1975). See generally, Harlow, E. and Lane, D. (1988) *Antibodies: A Laboratory Manual*, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY.

[0117] Immunization with protein, e.g., GCC or a soluble portion, or fusion protein comprising a portion of GCC (e.g., TOK107-hIg), or cells or membrane fractions therefrom, e.g., cells expressing surface-exposed GCC or a portion thereof (e.g., the pLKTOK4 product or the pLKTOK111 product), can be performed with the immunogen prepared for injection in a manner to induce a response, e.g., with adjuvant, e.g., complete Freund's adjuvant. Other suitable adjuvants include, TITERMAX GOLD® adjuvant (CYTRX Corporation, Los Angeles, CA) and alum. Small peptide immunogens can be linked to a larger molecule, such as keyhole limpet hemocyanin. Mice can be injected in a number of manners, e.g., subcutaneous, intravenous or intramuscular at a number of sites, e.g., in the peritoneum (i.p.), base of the tail, or foot pad, or a combination of sites, e.g., iP and base of tail (BIP). Booster injections can include the same or a different immunogen and can additionally include adjuvant, e.g., incomplete Freund's adjuvant. Immunization with DNA, e.g., DNA encoding GCC or a portion thereof or fusion protein comprising GCC or a portion thereof (e.g., encoding TOK107-hIg) can be injected using gene gun technology. For example, DNA is loaded onto microscopic gold particles and injected into mice at frequent intervals over a brief period.

[0118] Generally, where a monoclonal antibody is desired, a hybridoma is produced by fusing a suitable cell from an immortal cell line (*e.g.*, a myeloma cell line such as SP2/0, P3X63Ag8.653 or a heteromyeloma) with antibody-producing cells. Antibody-producing cells can be obtained from the peripheral blood or, preferably the spleen or lymph nodes, of humans, human-antibody transgenic animals or other suitable animals immunized with the antigen of interest. Cells that produce antibodies of human origin (*e.g.*, a human antibody) can be produced using suitable methods, for example, fusion of a human antibody-producing cell and a heteromyeloma or trioma, or immortalization of an activated human B cell via infection with Epstein Barr virus. (See, *e.g.*, U.S. Patent No. 6,197,582 (Trakht); Niedbala *et al.*, *Hybridoma,* 17:299-304 (1998); Zanella *et al.*, *J Immunol Methods*, 156:205-215 (1992); Gustafsson *et al.*, *Hum Antibodies Hybridomas*, 2:26-32 (1991).) The fused or immortalized antibody-producing cells (hybridomas) can be isolated using selective culture conditions, and cloned by limiting dilution. Cells which produce antibodies with the desired specificity can be identified using a suitable assay (*e.g.*, ELISA (e.g., with immunogen, e.g., TOK107-hIgG, immobilized on the microtiter well) or by FACS on a cell expressing GCC or a portion thereof, e.g., a cell expressing the pLKTOK111 product). For example, if the GCC-

immunogen comprises a fusion moiety that is an affinity reagent, this moiety can allow the fusion protein comprising GCC or a portion thereof to be bound to a matrix, e.g., protein G-coated, streptavidin-coated, glutathione-derivatized or antibody-coated microtitre plates or assay chips, which are then combined with the immune serum or conditioned medium from a hybridoma or antibody-expressing recombinant cell, and the mixture incubated under conditions conducive to complex formation (*e.g.*, at physiological conditions for salt and pH). Following incubation, the microtitre plate wells or chip cells are washed to remove any unbound components and binding by anti-GCC antibody is measured.

[0119] In embodiments, for therapeutic applications, the antibodies of the present invention are human or humanized antibodies. The advantage of human or humanized antibodies is that they potentially decrease or eliminate the immunogenicity of the antibody in a host recipient, thereby permitting an increase in the bioavailability and a reduction in the possibility of adverse immune reaction, thus potentially enabling multiple antibody administrations.

[0120] Modified antibodies include humanized, chimeric or CDR-grafted antibodies. Human anti-mouse antibody (HAMA) responses have led to development of chimeric or otherwise humanized antibodies. While chimeric antibodies have a human constant region and a murine variable region, it is expected that certain human anti-chimeric antibody (HACA) responses will be observed, particularly in chronic or multi-dose utilizations of the antibody. The presence of such murine or rat derived proteins can lead to the rapid clearance of the antibodies or can lead to the generation of an immune response against the antibody by a patient. In order to avoid the utilization of murine or rat derived antibodies, humanized antibodies where sequences are introduced to an antibody sequence to make it closer to human antibody sequence, or fully human antibodies generated by the introduction of human antibody function into a rodent have been developed so that the rodent would produce antibodies having fully human sequences. Human antibodies avoid certain of the problems associated with antibodies that possess murine, rabbit, or rat variable and/or constant regions.

Human Antibodies

[0121] Fully human antibody molecules can minimize the immunogenic and allergic responses intrinsic to mouse or mouse-derivatized mAbs and thus to increase the

efficacy and safety of the administered antibodies. The use of fully human antibody molecules can provide a substantial advantage in the treatment of chronic and recurring human diseases, such as inflammation, autoimmunity, and cancer, which require repeated antibody administrations. Also, human antibody molecules can be produced using genetically engineered strains of animals in which the antibody gene expression of the animal is suppressed and functionally replaced with human antibody molecule gene expression.

[0122] Methods for making human antibodies are known in the art. One method for making human antibodies employs the use of transgenic animals, such as a transgenic mouse. These transgenic animals contain a substantial portion of the human antibody producing genome, e.g., a human immunoglobulin locus that can undergo functional rearrangement, inserted into their own genome and the animal's own endogenous antibody production is rendered deficient in the production of antibodies. Methods for making such transgenic animals are known in the art. Such transgenic animals can be made using XENOMOUSE ™ technology or by using a "minilocus" approach. Methods for making XENOMICE™ are described in U.S. Pat. Nos. 6,162,963, 6,150,584, 6,114,598 and 6,075,181, which are incorporated herein by reference. Methods for making transgenic animals using the "minilocus" approach are described in U.S. Pat. Nos. 5,545,807, 5,545,806 and 5,625,825; also see International Publication No. WO93/12227, which are each incorporated herein by reference. Other transgenic human antibody- producing mice include HUMAB-MOUSE ®, KIRIN TC MOUSE™ transchromosome mice, KM-MOUSE® (MEDAREX, Princeton, NJ).

[0123] Using the human antibody transgenic animal technology, e.g., XENOMOUSE ™ technology, human antibodies can be obtained by immunizing a XENOMOUSE ™ mouse (Abgenix, Fremont, Calif.) with an antigen of interest. The lymphatic cells (such as B-cells) are recovered (e.g., isolated from spleen tissue) from the mice that express antibodies. These recovered cells can be fused with a myeloid-type cell line to prepare immortal hybridoma cell lines, using standard methodology. These hybridoma cell lines can be screened and selected to identify hybridoma cell lines that produce antibodies specific to the antigen of interest.

[0124] Human-antibody transgenic animals provide a source of nucleic acids that can be enriched in nucleic acids that encode antibodies having desired properties, such as

specificity and affinity. For example, nucleic acids encoding antibodies or antibody variable regions can be isolated from human-antibody transgenic mice that have been immunized with a GCC protein or variant or portion thereof. The isolated nucleic acids or portions thereof (e.g., portions encoding variable regions, CDRs, framework regions) can be expressed using any suitable method (e.g., phage display) to produce a library of antibodies or antigen-binding fragments of antibodies (e.g., single chain antigen-binding fragments, double chain antigen-binding fragments) that is enriched for antibodies or antigen-binding fragments that bind a GCC protein. Such a library can exhibit enhanced diversity (e.g., combinatorial diversity through pairing of heavy chain variable regions and light chain variable regions) relative to the repertoire of antibodies produced in the immunized human-antibody transgenic animal. The library can be screened using any suitable assay (e.g., a GCC protein binding assay) to identify antibodies or antigen-binding fragments having desired properties (e.g., specificity, affinity). The nucleic acids encoding antibody or antigen-binding fragments having desired properties can be recovered using any suitable method. (See, *e.g.*, U.S. Patent No. 5,871,907 (Winter et al.) and U.S. Patent No. 6,057,098 (Buechler et al.).)

[0125] Alternatively, the antibodies can be expressed in cell lines other than hybridoma cell lines. More specifically, sequences encoding particular antibodies can be cloned from cells producing the antibodies and used for transformation of a suitable mammalian host cell. In a preferred method, spleen and/or lymph node lymphocytes from immunized mice are isolated from the mice and plated in plaque assays as described previously in Babcook et al., *Proc Natl Acad Sci U S A.* 93: 7843-8 (1996), which is incorporated herein by reference. Briefly, cells are plated in agar with sheep red blood cells, coated with GCC antigen and cells secreting mAb against the GCC antigen would fix complement and lyse the red blood cells immediately surrounding the mAb producing cells. Cells within the cleared plaques are lifted for sequencing of the immunoglobulin sequences and subcloning into expression vectors. Supernatants from transiently transfected cells containing GCC specific mAb are subsequently screened by ELISA and for binding to cells by flow cytometry. The variable sequences, or a portion thereof of the produced human antibodies comprising CDRs which bind particular epitopes may be utilized for production of modified antibodies. For example, the variable regions of the produced antibodies may be spliced into an expression cassette for ease of transfer of constructs, increased expression of constructs, and/or incorporation of constructs into

vectors capable of expression of full length antibodies, see, e.g., US20060147445. In a particular embodiment, the expression cassette comprises the heavy chain constant region of the IgG1 isotype.

[0126] The Selected Lymphocyte Antibody Method (SLAM, see U.S. Pat. No. 5,627,052, Babcook et al. *Proc. Natl. Acad. Sci. U.S.A.* 93:7843-7848 (1996)) can also be used to identify cells which can provide the antibody of interest. In SLAM, B-cells are cultured directly, thus bypassing hybridoma technology, which typically captures only small percentage of the antibodies originally generated by a mouse. Using microplate-based assays, the B-cells are rapidly assayed over a period of several days. Typically, thousands of antigen-reactive cell-clones are identified, representing thousands of individual antigen-specific, e.g., GCC-specific, monoclonal antibodies. The number of different antigen-reactive monoclonal antibodies identified in a single experiment is typically increased many-fold. After applying additional rapid microplate-based assays to measure and rank antibodies by affinity and function, individual B-cell clones producing extremely high quality antibodies can be selected. In addition, by bypassing the hybridoma generation step, production can move rapidly into a recombinant manufacturing cell line. Individual B cells selected using the technology are isolated and the antibody genes can be directly introduced into a manufacturing cell line. The resulting cell line then can be developed for clinical trial testing over essentially the same timeline as that required for hybridoma cell line development.

[0127] Human mAb 5F9 (IgG2, kappa) can be produced by hybridoma 5F9, also referred to as hybridoma 46.5F9.8.2, which was deposited on January 10, 2007, on behalf of Millennium Pharmaceuticals Inc., 40 Landsdowne Street, Cambridge, MA, 02139, USA, at the American Type Culture Collection, 10801 University Boulevard, Manassas, Virginia 20110, U.S.A., under Accession No. PTA-8132. (The deposit was made pursuant to, and in satisfaction of, the requirements of the Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure.) The invention relates to hybridoma 5F9, to the antibody it produces, antigen-binding fragments thereof, and to nucleic acids encoding the antibody and portions thereof (*e.g.*, heavy chain, heavy chain variable region, light chain, light chain variable region, CDRs). As described herein, hybridoma 5F9 produces an IgG2, kappa antibody.

Humanization and Display Technologies and Modifications to Antibodies

[0128] As discussed above, there are advantages to producing antibodies with reduced immunogenicity. This can be accomplished in connection with techniques of humanization and display techniques using appropriate libraries. It will be appreciated that murine antibodies or antibodies from other species can be humanized or primatized using techniques known in the art. See e.g., Winter and Harris *Immunol Today* 14:43-46 (1993) and Wright et al. *Crit. Reviews in Immunol.* 12125-168 (1992). The antibody of interest may be engineered by recombinant DNA techniques to substitute the CH1, CH2, CH3, hinge domains, and/or the framework domain with the corresponding human sequence (see WO 92/02190 and U.S. Pat. Nos. 5,530,101, 5,585,089, 5,693,761, 5,693,792, 5,714,350, and 5,777,085). Also, the use of Ig cDNA for construction of chimeric immunoglobulin genes is known in the art (Liu et al. *Proc Natl Acad Sci USA.* 84:3439 (1987) and *J. Immunol.* 139:3521 (1987)). mRNA is isolated from a hybridoma or other cell producing the antibody and used to produce cDNA: The cDNA of interest may be amplified by the polymerase chain reaction using specific primers (U.S. Pat. Nos. 4,683,195 and 4,683,202).

[0129] Alternatively, phage display technology (see, e.g., McCafferty et al, *Nature*, 348:552- 553 (1990)) can be used to produce human antibodies and antibody fragments in vitro, from immunoglobulin variable (V) domain genes, e.g., from repertoires from unimmunized donors. According to this technique, antibody V domain genes are cloned in-frame into either a major or minor coat protein gene of a filamentous bacteriophage, such as M13 or fd, and displayed as functional antibody fragments on the surface of the phage particle. Because the filamentous particle contains a single-stranded DNA copy of the phage genome, selections based on the functional properties of the antibody also result in selection of the gene encoding the antibody exhibiting those properties. Thus, the phage mimics some of the properties of the B cell. Phage display can be performed in a variety of formats; for their review see, e.g., Johnson and Chiswell, *Current Opinion in Structural Biology*, 3:564-571 (1993). Several sources of V-gene segments can be used for phage display. Clackson et al., *Nature*, 352:624-628 (1991) isolated a diverse array of anti-oxazolone antibodies from a small random combinatorial library of V genes derived from the spleens of immunized mice. A repertoire of V genes from unimmunized human donors can be constructed and antibodies to a diverse array of antigens (including self-antigens)

can be isolated essentially following the techniques described by Marks et al., *J. Mol. Biol.*, 222:581- 597 (1991), or Griffith et al, *EMBO J.*, 12:725-734 (1993). See, also, U.S. Patent Nos. 5,565,332 and 5,573,905. Display libraries can contain antibodies or antigen-binding fragments of antibodies that contain artificial amino acid sequences. For example, the library can contain Fab fragments which contain artificial CDRs (e.g., random amino acid sequences) and human framework regions. (See, for example, U.S. Patent No. 6,300,064 (Knappik, et al.).)

[0130] Human antibodies may also be generated by in vitro activated B cells (see U.S. Patent Nos. 5,567,610 and 5,229,275).

[0131] The sequences of human constant region genes may be found in Kabat et al. (1991) *Sequences of Proteins of Immunological Interest*, N.I.H. publication no. 91-3242. Human C region genes are readily available from known clones. The choice of isotype will be guided by the desired effector functions, such as complement fixation, or activity in antibody-dependent cellular cytotoxicity. Isotypes can be IgG1, IgG2, IgG3 or IgG4. In particular embodiments, antibody molecules of the invention are IgG1 and IgG2. Either of the human light chain constant regions, kappa or lambda, may be used. The chimeric, humanized antibody is then expressed by conventional methods.

[0132] In some embodiments, an anti-GCC antibody molecule of the invention can draw antibody-dependent cellular cytotoxicity (ADCC) to a cell expressing GCC, e.g., a tumor cell. Antibodies with the IgG1 and IgG3 isotypes are useful for eliciting effector function in an antibody-dependent cytotoxic capacity, due to their ability to bind the Fc receptor. Antibodies with the IgG2 and IgG4 isotypes are useful to minimize an ADCC response because of their low ability to bind the Fc receptor. In related embodiments substitutions in the Fc region or changes in the glycosylation composition of an antibody, e.g., by growth in a modified eukaryotic cell line, can be made to enhance the ability of Fc receptors to recognize, bind, and/or mediate cytotoxicity of cells to which anti-GCC antibodies bind (see, e.g., U.S. Pat No. 7,317,091, 5,624,821 and publications including WO 00/42072, Shields, et al. *J. Biol. Chem.* 276:6591-6604 (2001), Lazar et al. *Proc. Natl. Acad. Sci. U.S.A.* 103:4005-4010 (2006), Satoh et al. *Expert Opin Biol. Ther.* 6:1161-1173 (2006)). In certain embodiments, the antibody or antigen-binding fragment (e.g., antibody of human origin, human antibody) can include amino acid substitutions or replacements that alter or tailor function (*e.g.*, effector function). For example, a constant region of

human origin (*e.g.*, γ1 constant region, γ2 constant region) can be designed to reduce complement activation and/or Fc receptor binding. (See, for example, U.S. Patent Nos. 5,648,260 (Winter et al.), 5,624,821 (Winter et al.) and 5,834,597 (Tso et al.), the entire teachings of which are incorporated herein by reference.) Preferably, the amino acid sequence of a constant region of human origin that contains such amino acid substitutions or replacements is at least about 95% identical over the full length to the amino acid sequence of the unaltered constant region of human origin, more preferably at least about 99% identical over the full length to the amino acid sequence of the unaltered constant region of human origin.

[0133] In still another embodiment, effector functions can also be altered by modulating the glycosylation pattern of the antibody. By altering is meant deleting one or more carbohydrate moieties found in the antibody, and/or adding one or more glycosylation sites that are not present in the antibody. For example, antibodies with enhanced ADCC activities with a mature carbohydrate structure that lacks fucose attached to an Fc region of the antibody are described in U.S. Patent Application Publication No. 2003/0157108 (Presta). See also U.S. Patent Application Publication No. 2004/0093621 (Kyowa Hakko Kogyo Co., Ltd). Glycofi has also developed yeast cell lines capable of producing specific glycoforms of antibodies.

[0134] Additionally or alternatively, an antibody can be made that has an altered type of glycosylation, such as a hypofucosylated antibody having reduced amounts of fucosyl residues or an antibody having increased bisecting GlcNac structures. Such altered glycosylation patterns have been demonstrated to increase the ADCC ability of antibodies. Such carbohydrate modifications can be accomplished by, for example, expressing the antibody in a host cell with altered glycosylation machinery. Cells with altered glycosylation machinery have been described in the art and can be used as host cells in which are engineered to express recombinant antibodies of the invention to thereby produce an antibody with altered glycosylation. For example, EP 1,176,195 by Hang et al. describes a cell line with a functionally disrupted FUT8 gene, which encodes a fucosyl transferase, such that antibodies expressed in such a cell line exhibit hypofucosylation. PCT Publication WO 03/035835 by Presta describes a variant CHO cell line, Lec13 cells, with reduced ability to attach fucose to Asn(297)-linked carbohydrates, also resulting in hypofucosylation of antibodies expressed in that host cell (see also Shields, R. L. et al., 2002 *J. Biol. Chem.* 277:26733-26740). PCT Publication WO 99/54342 by Umana et al.

describes cell lines engineered to express glycoprotein-modifying glycosyl transferases (e.g., beta(1,4)-N acetylglucosaminyltransferase III (GnTIII)) such that antibodies expressed in the engineered cell lines exhibit increased bisecting GlcNac structures which results in increased ADCC activity of the antibodies (see also Umana et al., 1999 *Nat. Biotech.* 17:176-180).

[0135] Humanized antibodies can also be made using a CDR-grafted approach. Techniques of generation of such humanized antibodies are known in the art. Generally, humanized antibodies are produced by obtaining nucleic acid sequences that encode the variable heavy and variable light sequences of an antibody that binds to GCC, identifying the complementary determining region or "CDR" in the variable heavy and variable light sequences and grafting the CDR nucleic acid sequences on to human framework nucleic acid sequences. (See, for example, U.S. Pat. Nos. 4,816,567 and 5,225,539). The location of the CDRs and framework residues can be determined (see, Kabat, E.A., *et al.* (1991) *Sequences of Proteins of Immunological Interest, Fifth Edition*, U.S. Department of Health and Human Services, NIH Publication No. 91-3242, and Chothia, C. et al. *J. Mol. Biol.* 196:901-917 (1987)). Anti-GCC antibody molecules described herein have the CDR amino acid sequences and nucleic acid sequences encoding CDRs listed in Tables 5 and 6. In some embodiments sequences from Tables 5 and 6 can be incorporated into molecules which recognize GCC for use in the therapeutic or diagnostic methods described herein. The human framework that is selected is one that is suitable for in vivo administration, meaning that it does not exhibit immunogenicity. For example, such a determination can be made by prior experience with in vivo usage of such antibodies and studies of amino acid similarities. A suitable framework region can be selected from an antibody of human origin having at least about 65% amino acid sequence identity, and preferably at least about 70%, 80%, 90% or 95% amino acid sequence identity over the length of the framework region within the amino acid sequence of the equivalent portion (e.g., framework region) of the donor antibody, e.g., an anti-GCC antibody molecule (e.g., 3G1). Amino acid sequence identity can be determined using a suitable amino acid sequence alignment algorithm, such as CLUSTAL W, using the default parameters. (Thompson J.D. et al., *Nucleic Acids Res.* 22:4673-4680 (1994).)

[0136] Once the CDRs and FRs of the cloned antibody that are to be humanized are identified, the amino acid sequences encoding the CDRs are identified and the corresponding nucleic acid sequences grafted on to selected human FRs. This can be done

using known primers and linkers, the selection of which are known in the art. All of the CDRs of a particular human antibody may be replaced with at least a portion of a non-human CDR or only some of the CDRs may be replaced with non-human CDRs. It is only necessary to replace the number of CDRs required for binding of the humanized antibody to a predetermined antigen. After the CDRs are grafted onto selected human FRs, the resulting "humanized" variable heavy and variable light sequences are expressed to produce a humanized Fv or humanized antibody that binds to GCC. Preferably, the CDR-grafted (e.g., humanized) antibody binds a GCC protein with an affinity similar to, substantially the same as, or better than that of the donor antibody. Typically, the humanized variable heavy and light sequences are expressed as a fusion protein with human constant domain sequences so an intact antibody that binds to GCC is obtained. However, a humanized Fv antibody can be produced that does not contain the constant sequences.

[0137] Also within the scope of the invention are humanized antibodies in which specific amino acids have been substituted, deleted or added. In particular, humanized antibodies can have amino acid substitutions in the framework region, such as to improve binding to the antigen. For example, a selected, small number of acceptor framework residues of the humanized immunoglobulin chain can be replaced by the corresponding donor amino acids. Locations of the substitutions include amino acid residues adjacent to the CDR, or which are capable of interacting with a CDR (see e.g., U.S. Patent Nos. 5,585,089 or 5,859,205). The acceptor framework can be a mature human antibody framework sequence or a consensus sequence. As used herein, the term "consensus sequence" refers to the sequence found most frequently, or devised from the most common residues at each position in a sequence in a region among related family members. A number of human antibody consensus sequences are available, including consensus sequences for the different subgroups of human variable regions (see, Kabat, E.A., et al., *Sequences of Proteins of Immunological Interest,* Fifth Edition, U.S. Department of Health and Human Services, U.S. Government Printing Office (1991)). The Kabat database and its applications are freely available on line, e.g. via IgBLAST at the National Center for Biotechnology Information, Bethesda, MD (also see, Johnson, G. and Wu, T.T., *Nucleic Acids Research* 29:205-206 (2001)).

[0138] Other techniques for humanizing antibodies are described in Padlan et al. EP 519596 A1, published on December 23, 1992.

[0139] The anti-GCC antibody molecule includes other humanized antibodies which may also be modified by specific deletion of human T cell epitopes or "deimmunization" by the methods disclosed in PCT Publication Nos. WO 98/52976 and WO 00/34317, the contents of which are incorporated herein by reference. Briefly, the murine heavy and light chain variable regions of an anti-GCC antibody can be analyzed for peptides that bind to MHC Class II; these peptides represent potential T-cell epitopes. For detection of potential T-cell epitopes, a computer modeling approach termed "peptide threading" can be applied, and in addition a database of human MHC class II binding peptides can be searched for motifs present in the murine VH and VL sequences, as described in PCT Publication Nos. WO 98/52976 and WO 00/34317. These motifs bind to any of the 18 major MHC class II DR allotypes, and thus constitute potential T cell epitopes. Potential T-cell epitopes detected can be eliminated by substituting small numbers of amino acid residues in the variable regions, or preferably, by single amino acid substitutions. As far as possible, conservative substitutions are made, often but not exclusively, an amino acid common at this position in human germline antibody sequences may be used. Human germline sequences are disclosed in Tomlinson, I.A. et al., *J. Mol. Biol.* 227:776-798(1992); Cook, G. P. et al., *Immunol. Today* Vol. 16 (5): 237-242(1995); Chothia, D. et al., *J. Mol. Bio.* 227:799-817(1992). The V BASE directory provides a comprehensive directory of human immunoglobulin variable region sequences (compiled by Tomlinson, I.A. et al. MRC Centre for Protein Engineering, Cambridge, UK). After the deimmunized VH and VL of an anti-GCC antibody are constructed by mutagenesis of the murine VH and VL genes, the mutagenized variable sequence can, optionally, be fused to a human constant region, e.g., human IgG1 or κ constant regions.

[0140] In other embodiments, reduction of an immunogenic response by a CDR-grafted antibody can be achieved by changes, e.g., deletions, substitutions, of amino acid residues in CDRs (Kashmiri et al. *Methods* 36:25-34 (2005), U.S. Pat. No. 6,818,749, Tan et al. *J. Immunol.* 169:1119-1125 (2006)). For example, residues at positions involved in contact with the antigen preferably would not be changed. Typically, such residues, the SDRs, are in positions which display high levels of variability among antibodies. Consensus sequences (e.g., SEQ ID NOs:302-307, Table 5) derived, e.g., by the Clustal method (Higgins D. G. et al., *Meth. Enzymol.* 266:383-402 (1996)), from anti-GCC antibody molecules, e.g., from antibodies described herein, aid in identifying SDRs. In the human anti-GCC antibody molecules described herein, the SDRs are the following, at least

the first residue or in some embodiments, the first four residues of heavy chain CDR1; at least the N-terminal portion, e.g., the first seven, ten or 13 residues of heavy chain CDR2; nearly all of heavy chain CDR3; the C-terminal portion, e.g., after residue six, eight, or nine of light chain CDR1; about the first, middle and/or last residue of light chain CDR2; and most of light chain CDR3, or at least after residue two or three. Accordingly, to maintain binding to GCC protein after humanization or modification of an anti-GCC antibody molecule, such SDR residues in CDRs of the anti-GCC antibody molecules are less amenable to changes, e.g., from murine residues to human consensus residues than are residues in other residues of the CDRs or the framework regions. Conversely, it can be beneficial to change residues in non-human, e.g., murine CDRs to residues identified as consensus in human CDRs, e.g., CDRs of anti-GCC antibody molecules described herein (e.g., the sequences listed in Table 5). For example, a serine can represent a human residue for the C-terminus of heavy chain CDR1, and/or a tyrosine can represent a human residue for the second and/or third residues of heavy chain CDR1; heavy chain CDR2 can end in S-(L/V)-K-(S/G) (SEQ ID NO:312) to represent a human CDR; to represent a human CDR3, there can be a glycine after four to six residues and/or an aspartate six to nine residues in heavy chain CDR3; light chain CDR1 can begin with (K/R)-(A/S)-SQS-(V/L)-(S/L) (SEQ ID NO:313) to represent a human CDR; light chain CDR2 can have a serine in the third residue and/or an arginine in the fifth residue represent a human CDR; and/or light chain CDR3 can have a glutamine in the second residue and/or a tyrosine or serine in the third residue represent a human CDR.

[0141] Anti-GCC antibodies that are not intact antibodies are also useful in this invention. Such antibodies may be derived from any of the antibodies described above. Useful antibody molecules of this type include (i) a Fab fragment, a monovalent fragment consisting of the VL, VH, CL and CH1 domains; (ii) a $F(ab')_2$ fragment, a bivalent fragment comprising two Fab fragments linked by a disulfide bridge at the hinge region; (iii) a Fd fragment consisting of the VH and CH1 domains; (iv) a Fv fragment consisting of the VL and VH domains of a single arm of an antibody, (v) a dAb fragment (Ward et al., *Nature* 341:544-546 (1989)), which consists of a VH domain; (vii) a single domain functional heavy chain antibody, which consists of a VHH domain (known as a nanobody) see e.g., Cortez-Retamozo, et al., *Cancer Res.* 64: 2853-2857(2004), and references cited therein; and (vii) an isolated CDR, e.g., one or more isolated CDRs together with sufficient framework to provide an antigen binding fragment. Furthermore, although the two

domains of the Fv fragment, VL and VH, are coded for by separate genes, they can be joined, using recombinant methods, by a synthetic linker that enables them to be made as a single protein chain in which the VL and VH regions pair to form monovalent molecules (known as single chain Fv (scFv); see e.g., Bird et al. *Science* 242:423-426 (1988); and Huston et al. *Proc. Natl. Acad. Sci. USA* 85:5879-5883 (1988). Such single chain antibodies are also intended to be encompassed within the term "antigen-binding fragment" of an antibody. These antibody fragments are obtained using conventional techniques known to those with skill in the art, and the fragments are screened for utility in the same manner as are intact antibodies. Antibody fragments, such as Fv, $F(ab')_2$ and Fab may be prepared by cleavage of the intact protein, e.g. by protease or chemical cleavage.

[0142] In embodiments, some or all of the CDRs sequences, of one or both the heavy and light chain, can be used in another antibody molecule, e.g., in a CDR-grafted, humanized, or chimeric antibody molecule.

[0143] Embodiments include an antibody molecule that comprises sufficient CDRs, e.g., all six CDRs from one of the above-referenced human hybridoma, selected lymphocyte, or murine antibodies to allow binding to cell surface GCC.

[0144] In an embodiment the CDRs, e.g., all of the HCDRs, or all of the LCDRs, or all six, are embedded in human or human derived framework region(s). Examples of human framework regions include human germline framework sequences, human germline sequences that have been affinity matured (either *in vivo* or *in vitro*), or synthetic human sequences, e.g., consensus sequences. In an embodiment the heavy chain framework is an IgG1 or IgG2 framework. In an embodiment the light chain framework is a kappa framework.

[0145] In an embodiment the anti-GCC antibody molecule, e.g., a CDR-grafted or humanized antibody molecule, comprises sufficient CDRs, e.g., all six CDRs from one of the antibodies described herein, e.g., sequences listed in Table 5, to allow binding to GCC. (Exemplary nucleic acid sequences which can encode the CDR amino acid sequences listed in Table 5, are provided, in Table 6 herein). In particular embodiments, an anti-GCC antibody molecule can comprise CDRs from 5F9 or Abx-229.

[0146] Antibody fragments for *in vivo* therapeutic or diagnostic use can benefit from modifications which improve their serum half lives. Suitable organic moieties intended to increase the *in vivo* serum half-life of the antibody can include one, two or

more linear or branched moiety selected from a hydrophilic polymeric group (*e.g.*, a linear or a branched polymer (*e.g.*, a polyalkane glycol such as polyethylene glycol, monomethoxy-polyethylene glycol and the like), a carbohydrate (*e.g.*, a dextran, a cellulose, a polysaccharide and the like), a polymer of a hydrophilic amino acid (*e.g.*, polylysine, polyaspartate and the like), a polyalkane oxide and polyvinyl pyrrolidone), a fatty acid group (*e.g.*, a mono-carboxylic acid or a di-carboxylic acid), a fatty acid ester group, a lipid group (*e.g.*, diacylglycerol group, sphingolipid group (*e.g.*, ceramidyl)) or a phospholipid group (*e.g.*, phosphatidyl ethanolamine group). Preferably, the organic moiety is bound to a predetermined site where the organic moiety does not impair the function (*e.g.*, decrease the antigen binding affinity) of the resulting immunoconjugate compared to the non-conjugated antibody moiety. The organic moiety can have a molecular weight of about 500 Da to about 50,000 Da, preferably about 2000, 5000, 10,000 or 20,000 Da. Examples and methods for modifying polypeptides, *e.g.*, antibodies, with organic moieties can be found, for example, in U.S. Patent Nos. 4,179,337 and 5,612,460, PCT Publication Nos. WO 95/06058 and WO 00/26256, and U.S. Patent Application Publication No. 20030026805.

[0147] An anti-GCC antibody molecule can comprise all, or an antigen binding fragment of the variable region, of one or both, the heavy and light chain, of one of the above-referenced human hybridoma, selected lymphocyte, or murine antibodies.

[0148] In an embodiment the light chain amino acid sequence of (a) can differ from one of the reference amino acid sequence(s) referred to in (a)(i-ii) by as many as 1, 2, 3, 4, 5, 10, or 15 residues. In embodiments the differences are conservative substitutions. In embodiments, the differences are in the framework regions. In an embodiment the heavy chain amino acid sequence of (b) can differ from one of the reference amino acid sequence(s) referred to in (b)(i-ii) by as many as 1, 2, 3, 4, 5, 10, or 15 residues. In embodiments the differences are conservative substitutions. In embodiments the differences are in the framework regions.

[0149] In an embodiment the anti-GCC antibody molecule comprises one or both of:

(a) a light chain amino acid sequence of all, or an antigen binding fragment of, either, (i) a light chain variable region amino acid sequence from Table 3, e.g., SEQ ID

NO:20, or (ii) a light chain variable region amino acid encoded by a nucleotide sequence from Table 4, e.g., SEQ ID NO:19; and

(b) a heavy chain amino acid sequence of all, or an antigen binding fragment of, either (i) a heavy chain variable region amino acid sequence from Table 3, e.g., SEQ ID NO:18, or (ii) a heavy chain amino acid sequence encoded by a nucleotide sequence from Table 4, e.g., SEQ ID NO:17.

[0150] In an embodiment the anti-GCC antibody molecule comprises one or both of:

a) a light chain variable region, or an antigen binding fragment thereof, having at least 85, 90, 95, 97 or 99 % homology with the light chain variable region of an anti-GCC antibody molecule of the invention, e.g., one of the above-referenced human hybridoma, selected lymphocyte, or murine antibodies; and

(b) a heavy chain variable region, or an antigen binding fragment thereof, having at least 85, 90, 95, 97 or 99 % homology with the heavy chain variable region of an anti-GCC antibody molecule of the invention, e.g., one of the above-referenced human hybridoma, selected lymphocyte, or murine antibodies.

[0151] Amino acid sequences of the variable regions of human hybridoma, selected lymphocyte, and murine antibodies can be found in Table 3.

[0152] In an embodiment, the anti-GCC antibody molecule is a 5F9 antibody molecule and includes one or both of: a) all or a fragment of the heavy chain constant region from SEQ ID NO: 231; and b) all or a fragment of the light chain constant region from SEQ ID NO: 233.

[0153] In another embodiment, the anti-GCC antibody molecule is an Abx-229 antibody molecule and includes one or both of: a) all or a GCC-binding fragment of the heavy chain variable region from SEQ ID NO: 46; and b) all or a GCC-binding fragment of the light chain variable region from SEQ ID NO: 48.

[0154] In one approach, consensus sequences encoding the heavy and light chain J regions may be used to design oligonucleotides for use as primers to introduce useful restriction sites into the J region for subsequent linkage of V region segments to human C region segments. C region cDNA can be modified by site directed mutagenesis to place a restriction site at the analogous position in the human sequence.

[0155] Expression vectors include plasmids, retroviruses, cosmids, YACs, EBV derived episomes, and the like. 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. 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. Suitable expression vectors can contain a number of components, for example, an origin of replication, a selectable marker gene, one or more expression control elements, such as a transcription control element (*e.g.*, promoter, enhancer, terminator) and/or one or more translation signals, a signal sequence or leader sequence, and the like. Polyadenylation and transcription termination occur at native chromosomal sites downstream of the coding regions. The resulting chimeric antibody may be joined to any strong promoter. Examples of suitable vectors that can be used include those that are suitable for mammalian hosts and based on viral replication systems, such as simian virus 40 (SV40), Rous sarcoma virus (RSV), adenovirus 2, bovine papilloma virus (BPV), papovavirus BK mutant (BKV), or mouse and human cytomegalovirus (CMV), and moloney murine leukemia virus (MMLV), native Ig promoters, etc. A variety of suitable vectors are known in the art, including vectors which are maintained in single copy or multiple copies, or which become integrated into the host cell chromosome, e.g., via LTRs, or via artificial chromosomes engineered with multiple integration sites (Lindenbaum et al. *Nucleic Acids Res.* 32:e172 (2004), Kennard et al. *Biotechnol. Bioeng.* Online May 20, 2009). Additional examples of suitable vectors are listed in a later section.

[0156] Thus, the invention provides an expression vector comprising a nucleic acid encoding an antibody, antigen-binding fragment of an antibody (e.g., a human, humanized, chimeric antibody or antigen-binding fragment of any of the foregoing), antibody chain (e.g., heavy chain, light chain) or antigen-binding portion of an antibody chain that binds a GCC protein.

[0157] Expression in eukaryotic host cells is useful because such cells are more likely than prokaryotic cells to assemble and secrete a properly folded and immunologically active antibody. However, any antibody produced that is inactive due to improper folding may be renaturable according to known methods (Kim and Baldwin, "Specific Intermediates in the Folding Reactions of Small Proteins and the Mechanism of

Protein Folding", *Ann. Rev. Biochem.* 51, pp. 459-89 (1982)). It is possible that the host cells will produce portions of intact antibodies, such as light chain dimers or heavy chain dimers, which also are antibody homologs according to the present invention.

[0158] Further, as described elsewhere herein, human antibodies or antibodies from other species can be generated through display-type technologies, including, without limitation, phage display, retroviral display, ribosomal display, and other techniques, using techniques well known in the art and the resulting molecules can be subjected to additional maturation, such as affinity maturation, as such techniques are known in the art. Winter and Harris *Immunol Today* 14:43-46 (1993) and Wright et al. *Crit. Reviews in Immunol.* 12125-168 (1992), Hanes and Plucthau PNAS USA 94:4937-4942 (1997) (ribosomal display), Parmley and Smith Gene 73:305-318 (1988) (phage display), Scott TIBS 17:241-245 (1992), Cwirla et al. *Proc Natl Acad Sci USA* 87:6378-6382 (1990), Russel et al. *Nucl. Acids Research* 21:1081-1085 (1993), Hoganboom et al. *Immunol. Reviews* 130:43-68 (1992), Chiswell and McCafferty *TIBTECH* 10:80-84 (1992), and U.S. Pat. No. 5,733,743. If display technologies are utilized to produce antibodies that are not human, such antibodies can be humanized as described above.

[0159] It will be appreciated that antibodies that are generated need not initially possess a particular desired isotype but, rather, the antibody as generated can possess any isotype. For example, the antibody produced by the 5F9 hybridoma (ATCC deposit no. PTA-8132) has the IgG2 isotype. The isotype of the antibody can be switched thereafter, e.g., to IgG1 or IgG3 to elicit an ADCC response when the antibody binds GCC on a cell, using conventional techniques that are known in the art. Such techniques include the use of direct recombinant techniques (see e.g., U.S. Pat. No. 4,816,397), cell-cell fusion techniques (see e.g., U.S. Pat No 5,916,771), among others. In the cell-cell fusion technique, a myeloma or other cell line is prepared that possesses a heavy chain with any desired isotype and another myeloma or other cell line is prepared that possesses the light chain. Such cells can, thereafter, be fused and a cell line expressing an intact antibody can be isolated.

[0160] In certain embodiments, the GCC antibody molecule is a human anti-GCC IgG1 antibody. Since such antibodies possess desired binding to the GCC molecule, any one of such antibodies can be readily isotype-switched to generate a human IgG4 isotype, for example, while still possessing the same variable region (which defines the antibody's

specificity and affinity, to a certain extent). Accordingly, as antibody candidates are generated that meet desired "structural" attributes as discussed above, they can generally be provided with at least certain additional "functional" attributes that are desired through isotype switching.

[0161] In an embodiment the variable region or antigen binding fragment thereof can be coupled to a constant region (or fragment thereof) other than the constant region it was generated with, e.g., a constant region (or fragment thereof) from another antibody or to a synthetic constant region (or fragment thereof). In embodiments the constant region is an IgG1 or IgG2 constant region (or fragment thereof). Sequence changes can be made in the variable or constant regions to modify effector activity of the antibody molecule.

Design and Generation of Other Therapeutics

[0162] The antibodies that are produced and characterized herein with respect to GCC provide for the design of other therapeutic modalities including other antibodies, other antagonists, or chemical moieties other than antibodies is facilitated. Such modalities include, without limitation, antibodies having similar binding activity or functionality, advanced antibody therapeutics, such as bispecific antibodies, immunoconjugates, and radiolabeled therapeutics, generation of peptide therapeutics, particularly intrabodies, and small molecules. Furthermore, as discussed above, the effector function of the antibodies of the invention may be changed by isotype switching to an IgG1, IgG2, IgG3, IgG4, IgD, IgA1, IgA2, IgE, or IgM for various therapeutic uses.

[0163] In connection with bispecific antibodies, bispecific antibodies can be generated that comprise (i) two antibodies, one with a specificity to GCC and another to a second molecule that are conjugated together, (ii) a single antibody that has one chain specific to GCC and a second chain specific to a second molecule, or (iii) a single chain antibody that has specificity to GCC and the other molecule. Such bispecific antibodies can be generated using techniques that are known. For example, bispecific antibodies may be produced by crosslinking two or more antibodies (of the same type or of different types). 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, IL. See also, e.g., Fanger et al. *Immunomethods* 4:72-81 (1994) and Winter and Harris *Immunol Today* 14:43-46

(1993) and Wright et al. *Crit. Reviews in Immunol.* 12125-168 (1992) and in connection with (iii) see e.g., Traunecker et al. *Int. J. Cancer* (Suppl.) 7:51-52 (1992). Songsivilai & Lachmann Clin. *Exp. Immunol.* 79: 315-321 (1990), Kostelny et al. *J. Immunol.* 148:1547-1553 (1992).

[0164] In addition, "Kappabodies" (Ill. et al. "Design and construction of a hybrid immunoglobulin domain with properties of both heavy and light chain variable regions" Protein Eng 10:949-57 (1997)), "Minibodies" (Martin et al. *EMBO J* 13:5303-9 (1994), US Patent No. 5,837,821), "Diabodies" (Holliger et al. *Proc Natl Acad Sci USA* 90:6444-6448 (1993)), or "Janusins" (Traunecker et al. *EMBO J* 10:3655-3659 (1991) and Traunecker et al. *Int J Cancer Suppl* 7:51-52 (1992)) may also be prepared.

Nucleic acid and Polypeptides

[0165] In another embodiment, the present invention relates to polynucleotide and polypeptide sequences that encode for or represent the antibody molecules described herein. Such polynucleotides encode for both the variable and constant regions of each of the heavy and light chains, although other combinations are also contemplated by the present invention in accordance with the compositions described herein. The present invention also contemplates oligonucleotide fragments derived from the disclosed polynucleotides and nucleic acid sequences complementary to these polynucleotides.

[0166] The polynucleotides can be in the form of RNA or DNA. Polynucleotides in the form of DNA, cDNA, genomic DNA, nucleic acid analogs and synthetic DNA are within the scope of the present invention. The DNA may be double-stranded or single-stranded, and if single stranded, may be the coding (sense) strand or non-coding (anti-sense) strand. The coding sequence that encodes the polypeptide may be identical to the coding sequence provided herein or may be a different coding sequence which coding sequence, as a result of the redundancy or degeneracy of the genetic code, encodes the same polypeptide as the DNA provided herein.

[0167] In embodiments provided, polynucleotides encode at least one heavy chain variable region and at least one light chain variable region of the present invention, e.g., as summarized in Table 4.

[0168] The present invention also includes variant polynucleotides containing modifications such as polynucleotide deletions, substitutions or additions, and any

polypeptide modification resulting from the variant polynucleotide sequence. A polynucleotide of the present invention may also have a coding sequence that is a variant of the coding sequence provided herein. For example, a variant polynucleotide can have at least 50%, 60%, 70%, 75%, 80%, 85%, 90%, 95% or 97% identity with a polynucleotide listed in Table 4. In embodiments, the variant polynucleotide encodes for an anti-GCC antibody molecule.

[0169] The present invention further relates to polypeptides that represent the antibodies of the present invention as well as fragments, analogs and derivatives of such polypeptides. The polypeptides of the present invention may be recombinant polypeptides, naturally produced polypeptides or synthetic polypeptides. The fragment, derivative or analogs of the polypeptides of the present invention may be one in which one or more of the amino acid residues is substituted with a conserved or non-conserved amino acid residue (preferably a conserved amino acid residue) and such substituted amino acid residue may or may not be one encoded by the genetic code; or it may be one in which one or more of the amino acid residues includes a substituent group; or it may be one in which the polypeptide is fused with another compound, such as a compound to increase the half-life of the polypeptide (for example, polyethylene glycol); or it may be one in which the additional amino acids are fused to the polypeptide, such as a leader or secretory sequence or a sequence that is employed for purification of the polypeptide or a proprotein sequence. Such fragments, derivatives and analogs are within the scope of the present invention. In various aspects, the polypeptides of the invention may be partially purified, or purified product.

[0170] A polypeptide of the present invention can have an amino acid sequence that is identical to that of the antibodies described herein, e.g., summarized in Tables 2 or 3, or that is different by minor variations due to one or more amino acid substitutions. The variation may be a "conservative change" typically in the range of about 1 to 5 amino acids, wherein the substituted amino acid has similar structural or chemical properties, e.g., replacement of leucine with isoleucine or threonine with serine; replacement of lysine with arginine or histidine. In contrast, variations may include nonconservative changes, e.g., replacement of a glycine with a tryptophan. Similar minor variations may also include amino acid deletions or insertions or both. Guidance in determining which and how many amino acid residues may be substituted, inserted, or deleted without changing biological or immunological activity may be found using computer programs known in the art, for example DNASTAR software (DNASTAR, Inc., Madison, Wis.).

[0171] In another aspect, the invention features, isolated and/or recombinant nucleic acids encoding anti-GCC antibody molecules. In embodiments, the nucleic acids encode one or more of an antibody molecule, a heavy chain, a light chain, a light chain variable region, a heavy chain variable region, portions of the heavy chains and light chains of the antibody molecules described herein (e.g., a light chain variable region fragment which when paired with a full length heavy chain variable region is antigen binding, or a heavy chain variable region fragment which when paired with a full length light chain variable region is antigen binding), and CDRs. Embodiments include such nucleic acids disposed in vectors, e.g., expression vectors. In specific embodiments the invention includes plasmids pTOK58D-5F9LC and pTOK58D-5F9HC. Still further, the invention encompasses antibody molecules produced by host cells, e.g., expressing the antibody molecules encoded by plasmids pTOK58D-5F9LC and pTOK58D-5F9HC.

[0172] In an embodiment, is provided a vector, e.g., an expression vector, comprising one or both of:

[0173] sequences encoding a light chain variable region, e.g., sequences listed in Table 4, an antigen binding fragment thereof, or one, two or three CDRs from a light chain (and optionally a framework region), described herein, e.g., in Table 6; and

[0174] sequences encoding a heavy chain variable region, e.g., sequences listed in Table 4, an antigen binding fragment thereof, or one, two or three CDRs from a heavy chain (and optionally a framework region), described herein, e.g., in Table 6.

[0175] In embodiments provided, polynucleotides encode at least one heavy chain variable region or at least one light chain variable region of the antibodies of the present invention. In embodiments provided, polypeptides can encode at least one heavy chain variable region and one light chain variable region of the antibodies of the present invention.

[0176] In an embodiment the anti-GCC antibody molecule comprises one or both of:

(a) a light chain variable region, or an antigen binding fragment thereof, encoded by a nucleic acid that hybridizes under selected stringency conditions with, (i) the complement of an anti-GCC antibody molecule-encoding-nucleic acid sequence described herein, e.g., in Table 4, or (ii) any nucleic acid sequence that encodes a light chain of an

anti-GCC antibody molecule of the invention, e.g., one of the above-referenced human hybridoma, selected lymphocyte, or murine antibodies summarized in Tables 1 and 2; and

(b) a heavy chain variable region, or an antigen binding fragment thereof, encoded by a nucleic acid that hybridizes under selected stringency conditions with, (i) the complement of an anti-GCC antibody molecule-encoding-nucleic acid sequence described herein, e.g., in Table 4, or (ii) any nucleic acid sequence that encodes a heavy chain of an anti-GCC antibody molecule of the invention, e.g., one of the above-referenced human hybridoma, selected lymphocyte, or murine antibodies summarized in Tables 1 and 2.

[0177] In an embodiment selected stringency conditions are high stringency or very high stringency conditions, e.g., as those conditions are described herein.

[0178] In additional aspects, the antibody or the antigen binding fragment comprises an amino acid sequence of the light chain variable region amino acid sequence of the antibody encoded by the DNA having ATCC Accession Number PTA-8132. In other additional aspects, the antibody or the antigen binding fragment comprises an amino acid sequence of the heavy chain variable region sequence of the antibody encoded by the DNA having ATCC Accession Number PTA-8132.

[0179] The present invention also provides vectors that include the polynucleotides of the present invention, host cells which are genetically engineered with vectors of the present invention and the production of the antibodies of the present invention by recombinant techniques.

[0180] The appropriate DNA sequence may be inserted into the vector by a variety of procedures. In general, the DNA sequence is inserted into appropriate restriction endonuclease sites by procedures known in the art. The polynucleotide sequence in the expression vector is operatively linked to an appropriate expression control sequence (i.e. promoter) to direct mRNA synthesis. Examples of such promoters include, but are not limited to, the Rous sarcoma virus LTR or the early or late SV40 promoter, the E. coli lac or trp, the phage lambda P_L promoter and other promoters known to control expression of genes in prokaryotic (*e.g.*, tac, T3, T7 promoters for *E. coli*) or eukaryotic (*e.g.*, cytomegalovirus promoter, adenovirus late promoter, EF-1a promoter) cells or their viruses. The expression vector also contains a ribosome binding site for translation

initiation and a transcription terminator. The vector may also include appropriate sequences for amplifying expression. For example, the vector can contain enhancers, which are transcription-stimulating DNA sequences of viral origin, such as those derived form simian virus such as SV40, polyoma virus, cytomegalovirus, bovine papilloma virus or Moloney sarcoma virus, or genomic, origin. The vector preferably also contains an origin of replication. The vector can be constructed to contain an exogenous origin of replication or, such an origin of replication can be derived from SV40 or another viral source, or by the host cell chromosomal replication mechanism.

[0181] In addition, the vectors optionally contain a marker gene for selection of transfected host cells such as dihydrofolate reductase marker genes to permit selection with methotrexate in a variety of hosts, or antibiotics, such as β-lactamase gene (ampicillin resistance), *Tet* gene (for tetracycline resistance) used in prokaryotic cells or neomycin, GA418 (geneticin, a neomycin-derivative) gpt (mycophenolic acid), ampicillin, or hygromycin resistance genes, or genes which complement a genetic lesion of the host cells such as the absence of thymidine kinase, hypoxanthine phosphoribosyl transferase, dihydrofolate reductase, etc. Genes encoding the gene product of auxotrophic markers of the host (*e.g.*, *LEU2, URA3, HIS3*) are often used as selectable markers in yeast.

[0182] In order to obtain the antibodies of the present invention, one or more polynucleotide sequences that encode for the light and heavy chain variable regions and light and heavy chain constant regions of the antibodies of the present invention should be incorporated into a vector. Polynucleotide sequences encoding the light and heavy chains of the antibodies of the present invention can be incorporated into one or multiple vectors and then incorporated into the host cells.

[0183] Suitable expression vectors for expression in mammalian cells include, for example, pCDM8, pCDNA1.1/amp, pcDNA3.1, pRc/RSV, pEF-1 (Invitrogen Life Technologies, Carlsbad, CA), pCMV-SCRIPT, pFB, pSG5, pXT1 (Stratagene, La Jolla, CA), pCDEF3 (Goldman, L.A., *et al.*, *Biotechniques*, 21:1013-1015 (1996)), pSVSPORT (GIBCO division of Invitrogen Life Technologies, Carlsbad, CA), pEF-Bos (Mizushima, S., *et al.*, *Nucleic Acids Res.*, 18:5322 (1990)), Bicistronic GPEX® Retrovector (Gala Biotech, Middleton, WI) and the like. Expression vectors which are suitable for use in various expression hosts, such as prokaryotic cells (*E. coli*), insect cells (*Drosophila* Schnieder S2 cells, Sf9) and yeast (*P. methanolica*, *P. pastoris*, *S. cerevisiae*) are also

available. Exemplary vectors are pLKTOK58 (wild type IgG1 Fc sequence) and pLKTOK59 (mutated IgG1 Fc sequence) (see U.S. Patent Application publication no. 20060147445).

[0184] As will be appreciated, antibodies in accordance with the present invention can be expressed in cell lines other than hybridoma cell lines. Sequences encoding the cDNAs or genomic clones for the particular antibodies can be used for a suitable mammalian or nonmammalian host cells. Transformation can be by any known method for introducing polynucleotides into a host cell, including, for example packaging the polynucleotide in a virus (or into a viral vector) and transducing a host cell with the virus (or vector) or by transfection procedures known in the art, for introducing heterologous polynucleotides into mammalian cells, e.g., dextran-mediated transfection, calcium phosphate precipitation, polybrene mediated transfection, protoplast fusion, electroporation, encapsulation of the polynucleotide(s) into liposomes and direct microinjection of the DNA molecule. The transformation procedure used depends upon the host to be transformed. Methods for introduction of heterologous polynucleotides into mammalian cells are known in the art and include, but are not limited to, dextran-mediated transfection, calcium phosphate precipitation, polybrene mediated transfection, protoplast fusion, electroporation, particle bombardment, encapsulation of the polynucleotide(s) in liposomes, peptide conjugates, dendrimers, and direct microinjection of the DNA into nuclei.

[0185] In another aspect, the invention features, a host cell comprising a nucleic acid described herein. In embodiments the cell expresses an antibody molecule, or component thereof, described herein. Still further embodiment provides a method of producing an antibody molecule, e.g., an anti-GCC antibody molecule described herein, e.g. a human or humanized antibody molecule comprising maintaining the host cell under conditions appropriate for expression, whereby immunoglobulin chain(s) are expressed and an antibody molecule is produced. An additional embodiment provides a host cell comprising any of the foregoing expression vectors encoding heavy and light chain antibody sequences. The host cell can be a eukaryotic cell, e.g., a mammalian cell, an insect cell, a yeast cell, or a prokaryotic cell, e.g., *E. coli*. For example, the mammalian cell can be a cultured cell or a cell line. Exemplary mammalian cells include lymphocytic cell lines (e.g., NS0), Chinese hamster ovary cells (CHO), COS cells. In a particular embodiment, the cultured host cell is a COS cell comprising nucleic acid sequences

encoding a 5F9 antibody molecule. In another embodiment, the host cell is Hybridoma 5F9 (PTA-8132). Additionally cells include oocyte cells, and cells from a transgenic animal, e.g., mammary epithelial cell. For example, nucleic acids encoding an antibody molecule described herein can be expressed in a transgenic nonhuman animal.

[0186] Mammalian cell lines available as hosts for expression are known in the art and include many immortalized cell lines available from the American Type Culture Collection (ATCC), including but not limited to Chinese hamster ovary (CHO) cells, NSO cells, HeLa cells, baby hamster kidney (BHK) cells, monkey kidney cells (COS), human hepatocellular carcinoma cells (e.g., Hep G2), and a number of other cell lines. Non-mammalian cells including but not limited to bacterial, yeast, insect, and plants can also be used to express recombinant antibodies. Site directed mutagenesis of the antibody CH2 domain to eliminate glycosylation may be preferred in order to prevent changes in either the immunogenicity, pharmacokinetic, and/or effector functions resulting from non-human glycosylation. The expression methods are selected by determining which system generates the highest expression levels and produce antibodies with constitutive GCC binding properties.

[0187] A still further embodiment provides a method of producing an anti-GCC antibody molecule, e.g., a human or humanized antibody molecule, comprising maintaining the host cell comprising nucleic acids described herein, e.g., one or more nucleic acid sequence listed in Table 4 or 6, under conditions appropriate for expression of an immunoglobulin, whereby immunoglobulin chains, are expressed and an antibody molecule, e.g., a human or humanized antibody molecule that binds GCC, or a fragment or variant thereof, is produced. For example, methods of expression of antibody molecules include the use of host cells wherein a first recombinant nucleic acid molecule encoding an antibody molecule, e.g., a human or humanized antibody light chain, and a second recombinant nucleic acid molecule encoding an antibody molecule, e.g., a human or humanized antibody heavy chain, are comprised in a single expression vector. In other embodiments, they are in separate vectors. The method can further comprise the step of isolating or recovering the antibody, antigen-binding fragment of an antibody, antibody chain or antigen-binding fragment of an antibody chain, if desired.

[0188] For example, a nucleic acid molecule (*i.e.*, one or more nucleic acid molecules) encoding the heavy and light chains of a human antibody that binds a GCC

protein, or an expression construct (*i.e.*, one or more constructs) comprising such nucleic acid molecule(s), can be introduced into a suitable host cell to create a recombinant host cell using any method appropriate to the host cell selected (*e.g.*, transformation, transfection, electroporation, infection), such that the nucleic acid molecule(s) are operably linked to one or more expression control elements (*e.g.*, in a vector, in a construct created by processes in the cell, integrated into the host cell genome). The resulting recombinant host cell can be maintained under conditions suitable for expression (*e.g.*, in the presence of an inducer, in a suitable non-human animal, in suitable culture media supplemented with appropriate salts, growth factors, antibiotics, nutritional supplements, *etc.*), whereby the encoded polypeptide(s) are produced. If desired, the encoded protein can be isolated or recovered (*e.g.*, from the animal, the host cell, medium, milk). This process encompasses expression in a host cell of a transgenic non-human animal (see, *e.g.*, WO 92/03918, GenPharm International) or plant.

[0189] Further, expression of antibodies of the invention (or other moieties therefrom) from production cell lines can be enhanced using a number of known techniques. For example, the glutamine synthetase and DHFR gene expression systems are common approaches for enhancing expression under certain conditions. High expressing cell clones can be identified using conventional techniques, such as limited dilution cloning, Microdrop technology, or any other methods known in the art. The GS system is discussed in whole or part in connection with European Patent Nos. 0 216 846, 0 256 055, and 0 323 997 and European Patent Application No. 89303964.4.

[0190] In an exemplary system for recombinant expression of a modified antibody, or antigen-binding portion thereof, of the invention, a recombinant expression vector encoding both the antibody heavy chain and the antibody light chain is introduced into dhfr- CHO cells by calcium phosphate-mediated transfection. Within the recombinant expression vector, the antibody heavy and light chain genes are each operatively linked to enhancer/promoter regulatory elements (e.g., derived from SV40, CMV, adenovirus and the like, such as a CMV enhancer/AdMLP promoter regulatory element or an SV40 enhancer/AdMLP promoter regulatory element) to drive high levels of transcription of the genes. The recombinant expression vector also carries a DHFR gene, which allows for selection of CHO cells that have been transfected with the vector using methotrexate selection/amplification. The selected transformant host cells are cultured to allow for expression of the antibody heavy and light chains and intact antibody is recovered from the

culture medium. Standard molecular biology techniques are used to prepare the recombinant expression vector, transfect the host cells, select for transformants, culture the host cells and recover the antibody from the culture medium.

[0191] Antibodies of the invention can also be produced transgenically through the generation of a mammal or plant that is transgenic for the immunoglobulin heavy and light chain sequences of interest and production of the antibody in a recoverable form therefrom. In connection with the transgenic production in mammals, antibodies can be produced in, and recovered from, the milk of goats, cows, or other mammals. See, e.g., U.S. Pat. Nos. 5,827,690, 5,756,687, 5,750,172, and 5,741,957.

[0192] The antibodies, antigen-binding fragments, antibody chains and antigen-binding portions thereof described herein also can be produced in a suitable *in vitro* expression system, by chemical synthesis or by any other suitable method.

Fusion Proteins and Immunoconjugates

[0193] The anti-GCC antibodies described herein can be functionally linked by any suitable method (e.g., chemical coupling, genetic fusion, noncovalent association or otherwise) to one or more non-antibody molecular entities.

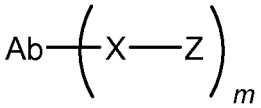
[0194] Fusion proteins can be produced in which an anti-GCC antibody molecule as described herein and a non-antibody moiety are components of a single continuous polypeptide chain. The non-antibody moiety can be located N-terminally, C-terminally, or internally, with respect to the antibody moiety. For example, some embodiments can be produced by the insertion of a nucleic acid encoding immunoglobulin sequences into a suitable expression vector, such as a pET vector (e.g., pET-15b, Novagen), a phage vector (e.g., pCNATAB 5 E, Pharmacia), or other vector, e.g., pRIT2T Protein A fusion vector, Pharmacia). The resulting construct can be expressed to produce antibody chains that comprise a non-antibody moiety (e.g., Histidine tag, E tag, or Protein A IgG binding domain). Fusion proteins can be isolated or recovered using any suitable technique, such as chromatography using a suitable affinity matrix (see, e.g., *Current Protocols in Molecular Biology* (Ausubel, F.M *et al.*, eds., Vol. 2, Suppl. 26, pp. 16.4.1-16.7.8 (1991)).

[0195] The invention provides anti-GCC antibody molecules which are directed to and, in embodiments, are internalized into cells. They are capable of delivering therapeutic agents or detectable agents to or into cells expressing GCC, but not to or into

cells where the target is not expressed. Thus, the invention also provides anti-GCC immunoconjugates comprising an anti-GCC antibody molecule as described herein, which is conjugated to a therapeutic agent or a detectable agent. In embodiments, the affinity for GCC of an anti-GCC immunoconjugate is at least 10, 25, 50, 75, 80, 90, or 95% of that for the unconjugated antibody. This can be determined using cell surface GCC or isolated GCC. In an embodiment the anti-GCC antibody molecule, e.g., an immunoconjugate, has an LD50, as determined by an assay described herein, of less than 1,000, 500, 250, 100, or 50 pM.

[0196] The anti-GCC antibody molecule can be modified to act as an immunoconjugate utilizing techniques that are known in the art. See e.g., Vitetta *Immunol Today* 14:252 (1993). See also U.S. Pat. No. 5,194,594. The preparation of radiolabeled antibodies can also be readily prepared utilizing techniques that are known in the art. See e.g., Junghans et al. in *Cancer Chemotherapy and Biotherapy* 655-686 (2d edition, Chafner and Longo, eds., Lippincott Raven (1996)). See also U.S. Pat. Nos. 4,681,581, 4,735,210, 5,101,827, 5,102,990 (U.S. Re. Pat. No. 35,500), 5,648,471, and 5,697,902.

[0197] In some embodiments, the antibody molecule and non-antibody moiety are connected by means of a linker. In such embodiments, the immunoconjugate is represented by formula (***I***):



(***I***)

wherein,

Ab is an anti-GCC antibody molecule described herein;

X is a moiety which connects Ab and Z, e.g., the residue of a linker described herein after covalent linkage to one or both of Ab and Z;

Z is a therapeutic agent or label; and

m ranges from about 1 to about 15.

[0198] The variable *m* represents the number of –X-Z moieties per antibody molecule in an immunoconjugate of formula (***I***). In various embodiments, *m* ranges from 1 to 15, 1 to 10, 1 to 9, 1 to 8, 1 to 7, 1 to 6, 1 to 5, 1 to 4, 1 to 3, or 1 to 2. In some embodiments, *m* ranges from 2 to 10, 2 to 9, 2 to 8, 2 to 7, 2 to 6, 2 to 5, 2 to 4 or 2 to 3. In other embodiments, *m* is 1, 2, 3, 4, 5 or 6. In compositions comprising a plurality of immunoconjugates of formula (***I***), *m* is the average number of –X-Z moieties per Ab, also referred to as the average drug loading. Average drug loading may range from 1 to about 15 –X-Z moieties per Ab. In some embodiments, when *m* represents the average drug loading, *m* is about 1, about 2, about 3, about 4, about 5, about 6, about 7, or about 8. In exemplary embodiments, *m* is from about 2 to about 8. In one embodiment, *m* is about 8. In another embodiment, *m* is about 4. In another embodiment, *m* is about 2.

[0199] The average number of –X-Z moieties per Ab may be characterized by conventional means such as mass spectroscopy, ELISA assay, and HPLC. The quantitative distribution of immunoconjugates in terms of *m* may also be determined. In some instances, separation, purification, and characterization of homogeneous immunoconjugates where *m* is a certain value, as distinguished from immunoconjugates with other drug loadings, may be achieved by means such as reverse phase HPLC or electrophoresis.

[0200] The immunoconjugates of formula (***I***) may exist as mixtures, wherein each component of the mixture has a different *m* value. For example, an immunoconjugate of formula (***I***) may exist as a mixture of two separate immunoconjugate components: one immunoconjugate component wherein *m* is 7, and the other immunoconjugate component wherein *m* is 8.

[0201] In one embodiment, the immunoconjugate of formula (***I***) exists as a mixture of three separate immunoconjugates wherein *m* for the three separate immunoconjugates is 1, 2, and 3, respectively.

[0202] In one embodiment, the immunoconjugate of formula (***I***) exists as a mixture of three separate immunoconjugates wherein *m* for the three separate immunoconjugates is 3, 4, and 5, respectively.

[0203] In one embodiment, the immunoconjugate of formula (***I***) exists as a mixture of three separate immunoconjugates wherein *m* for the three separate immunoconjugates is 5, 6, and 7, respectively.

[0204] In one embodiment, the immunoconjugate of formula (*I*) exists as a mixture of three separate immunoconjugates wherein *m* for the three separate immunoconjugates is 7, 8, and 9, respectively.

[0205] In one embodiment, the immunoconjugate of formula (*I*) exists as a mixture of three separate immunoconjugates wherein *m* for the three separate immunoconjugates is 9, 10, and 11, respectively.

[0206] In one embodiment, the immunoconjugate of formula (*I*) exists as a mixture of three separate immunoconjugates wherein *m* for the three separate immunoconjugates is 11, 12, and 13, respectively.

[0207] In one embodiment, the immunoconjugate of formula (*I*) exists as a mixture of three separate immunoconjugates wherein *m* for the three separate immunoconjugates is 13, 14, and 15, respectively.

[0208] A variety of suitable linkers (e.g., heterobifunctional reagents for connecting an antibody molecule to a therapeutic agent or label) and methods for preparing immunoconjugates are known in the art. (See, for example, Chari et al., Cancer Research 52:127-131 (1992).) The linker can be cleavable, e.g., under physiological conditions., e.g., under intracellular conditions, such that cleavage of the linker releases the drug (therapeutic agent or label) in the intracellular environment. In other embodiments, the linker is not cleavable, and the drug is released, for example, by antibody degradation.

[0209] The linker can be bonded to a chemically reactive group on the antibody moiety, e.g., to a free amino, imino, hydroxyl, thiol or carboxyl group (e.g., to the N- or C-terminus, to the epsilon amino group of one or more lysine residues, the free carboxylic acid group of one or more glutamic acid or aspartic acid residues, or to the sulfhydryl group of one or more cysteinyl residues). The site to which the linker is bound can be a natural residue in the amino acid sequence of the antibody moiety or it can be introduced into the antibody moiety, e.g., by DNA recombinant technology (e.g., by introducing a cysteine or protease cleavage site in the amino acid sequence) or by protein biochemistry (e.g., reduction, pH adjustment or proteolysis).

[0210] One of the most commonly used non-specific methods of covalent attachment is the carbodiimide reaction to link a carboxy (or amino) group of a compound to amino (or carboxy) groups of the antibody molecule. Additionally, bifunctional agents

such as dialdehydes or imidoesters have been used to link the amino group of a compound to amino groups of an antibody molecule. Also available for attachment of drugs to antibody molecules is the Schiff base reaction. This method involves the periodate oxidation of a drug that contains glycol or hydroxy groups, thus forming an aldehyde which is then reacted with the antibody molecule. Attachment occurs via formation of a Schiff base with amino groups of the antibody molecule. Isothiocyanates can also be used as coupling agents for covalently attaching drugs to antibody molecule. Other techniques are known to the skilled artisan and within the scope of the present invention.

[0211] In certain embodiments, an intermediate, which is the precursor of the linker (X), is reacted with the drug (Z) under appropriate conditions. In certain embodiments, reactive groups are used on the drug and/or the intermediate. The product of the reaction between the drug and the intermediate, or the derivatized drug, is subsequently reacted with the antibody molecule under appropriate conditions.

[0212] The immunoconjugate can be purified from reactants by employing methodologies well known to those of skill in the art, e.g., column chromatography (e.g., affinity chromatography, ion exchange chromatography, gel filtration, hydrophobic interaction chromatography), dialysis, diafiltration or precipitation. The immunoconjugate can be evaluated by employing methodologies well known to those skilled in the art, e.g., SDS-PAGE, mass spectroscopy, or capillary electrophoresis.

[0213] In some embodiments, the linker is cleavable by a cleaving agent that is present in the intracellular environment (*e.g.*, within a lysosome or endosome or caveolea). The linker can be, *e.g.*, a peptidyl linker that is cleaved by an intracellular peptidase or protease enzyme, including, but not limited to, a lysosomal or endosomal protease. In some embodiments, the peptidyl linker is at least two amino acids long or at least three amino acids long. Cleaving agents can include cathepsins B and D and plasmin, all of which are known to hydrolyze dipeptide drug derivatives resulting in the release of active drug inside target cells (*see*, *e.g.*, Dubowchik and Walker, 1999, *Pharm. Therapeutics* 83:67-123). Most typical are peptidyl linkers that are cleavable by enzymes that are present in GCC-expressing cells. For example, a peptidyl linker that is cleavable by the thiol-dependent protease cathepsin-B, which is highly expressed in cancerous tissue, can be used (*e.g.*, a Phe-Leu or a Gly-Phe-Leu-Gly linker (SEQ ID NO:319)). Other examples of such linkers are described, *e.g.*, in U.S. Patent No. 6,214,345, incorporated herein by

reference in its entirety and for all purposes. In a specific embodiment, the peptidyl linker cleavable by an intracellular protease is a Val-Cit linker or a Phe-Lys linker (*see, e.g.*, U.S. patent 6,214,345, which describes the synthesis of doxorubicin with the val-cit linker). One advantage of using intracellular proteolytic release of the therapeutic agent is that the agent is typically attenuated when conjugated and the serum stabilities of the conjugates are typically high.

[0214] In other embodiments, the cleavable linker is pH-sensitive, *i.e.*, sensitive to hydrolysis at certain pH values. Typically, the pH-sensitive linker is hydrolyzable under acidic conditions. For example, an acid-labile linker that is hydrolyzable in the lysosome (*e.g.*, a hydrazone, semicarbazone, thiosemicarbazone, cis-aconitic amide, orthoester, acetal, ketal, or the like) can be used. (*See, e.g.*, U.S. Patent Nos. 5,122,368; 5,824,805; 5,622,929; Dubowchik and Walker, 1999, *Pharm. Therapeutics* 83:67-123; Neville *et al.*, 1989, *Biol. Chem.* 264:14653-14661.) Such linkers are relatively stable under neutral pH conditions, such as those in the blood, but are unstable at below pH 5.5 or 5.0, the approximate pH of the lysosome. In certain embodiments, the hydrolyzable linker is a thioether linker (such as, *e.g.*, a thioether attached to the therapeutic agent via an acylhydrazone bond (*see, e.g.*, U.S. Patent No. 5,622,929).

[0215] In yet other embodiments, the linker is cleavable under reducing conditions (*e.g.*, a disulfide linker). A variety of disulfide linkers are known in the art, including, for example, those that can be formed using SATA (N-succinimidyl-S-acetylthioacetate), SPDP (N-succinimidyl-3-(2-pyridyldithio)propionate), SPDB (N-succinimidyl-3-(2-pyridyldithio)butyrate) and SMPT (N-succinimidyl-oxycarbonyl-alpha-methyl-alpha-(2-pyridyl-dithio)toluene), SPDB and SMPT (*See, e.g.*, Thorpe *et al.*, 1987, *Cancer Res.* 47:5924-5931; Wawrzynczak *et al.*, In *Immunoconjugates: Antibody Conjugates in Radioimagery and Therapy of Cancer* (C. W. Vogel ed., Oxford U. Press, 1987. *See also* U.S. Patent No. 4,880,935.)

[0216] In yet other specific embodiments, the linker is a malonate linker (Johnson *et al.*, 1995, *Anticancer Res.* 15:1387-93), a maleimidobenzoyl linker (Lau *et al.*, 1995, *Bioorg Med Chem.* 3(10):1299-1304), or a 3'-N-amide analog (Lau *et al.*, 1995, *Bioorg-Med-Chem.* 3(10):1305-12).

[0217] In yet other embodiments, the linker unit is not cleavable and the drug is released by antibody degradation. (See for example U.S. Publication No. 20050238649 incorporated by reference herein in its entirety and for all purposes).

[0218] Typically, the linker is not substantially sensitive to the extracellular environment. As used herein, "not substantially sensitive to the extracellular environment," in the context of a linker, means that no more than about 20%, typically no more than about 15%, more typically no more than about 10%, and even more typically no more than about 5%, no more than about 3%, or no more than about 1% of the linkers, in a sample of immunoconjugate, are cleaved when the immunoconjugate presents in an extracellular environment (*e.g.*, in plasma). Whether a linker is not substantially sensitive to the extracellular environment can be determined, for example, by incubating with plasma the immunoconjugate for a predetermined time period (*e.g.*, 2, 4, 8, 16, or 24 hours) and then quantitating the amount of free drug present in the plasma.

[0219] In other, non-mutually exclusive embodiments, the linker promotes cellular internalization. In certain embodiments, the linker promotes cellular internalization when conjugated to the therapeutic agent or label (Z). In yet other embodiments, the linker promotes cellular internalization when conjugated to both the Z moiety and the anti-GCC antibody molecule.

[0220] A variety of exemplary linkers that can be used with the present compositions and methods are described in WO 2004-010957, U.S. Publication No. 20060074008, U.S. Publication No. 20050238649, and U.S. Publication No. 20060024317 (each of which is incorporated by reference herein in its entirety and for all purposes).

[0221] Examples of linkers capable of being used to couple an antibody molecule to a therapeutic agent or label include, for example, maleimidocaproyl (mc); maleimidocaproyl-*p*-aminobenzylcarbamate; maleimidocaproyl-peptide-aminobenzylcarbamate linkers, e.g., maleimidocaproyl-L-phenylalanine-L-lysine-*p*-aminobenzylcarbamate and maleimidocaproyl-L-valine-L-citrulline-*p*-aminobenzylcarbamate (vc); N-succinimidyl 3-(2-pyridyldithio)proprionate (also known as N-succinimidyl 4-(2-pyridyldithio)pentanoate or SPP); 4-succinimidyl-oxycarbonyl-2-methyl-2-(2-pyridyldithio)-toluene (SMPT); N-succinimidyl 3-(2-pyridyldithio)propionate (SPDP); N-succinimidyl 4-(2-pyridyldithio)butyrate (SPDB); 2-iminothiolane; S-acetylsuccinic anhydride; disulfide benzyl carbamate; carbonate; hydrazone linkers; N-(α-

Maleimidoacetoxy) succinimide ester; *N*-[4-(*p*-Azidosalicylamido) butyl]-3′-(2′-pyridyldithio)propionamide (AMAS); *N*-[β-Maleimidopropyloxy]succinimide ester (BMPS); [N-ε-Maleimidocaproyloxy]succinimide ester (EMCS); N-[γ-Maleimidobutyryloxy]succinimide ester (GMBS); Succinimidyl-4-[N-Maleimidomethyl]cyclohexane-1-carboxy-[6-amidocaproate] (LC-SMCC); Succinimidyl 6-(3-[2-pyridyldithio]-propionamido)hexanoate (LC-SPDP); *m*-Maleimidobenzoyl-N-hydroxysuccinimide ester (MBS); *N*-Succinimidyl[4-iodoacetyl]aminobenzoate (SIAB); Succinimidyl 4-[*N*-maleimidomethyl]cyclohexane-1-carboxylate (SMCC); *N*-Succinimidyl 3-[2-pyridyldithio]-propionamido (SPDP); [N-ε-Maleimidocaproyloxy]sulfosuccinimide ester (Sulfo-EMCS); N-[γ-Maleimidobutyryloxy]sulfosuccinimide ester (Sulfo-GMBS); 4-Sulfosuccinimidyl-6-methyl-α-(2-pyridyldithio)toluamido]hexanoate) (Sulfo-LC-SMPT); Sulfosuccinimidyl 6-(3'-[2-pyridyldithio]-propionamido)hexanoate (Sulfo-LC-SPDP); *m*-Maleimidobenzoyl-N-hydroxysulfosuccinimide ester (Sulfo-MBS); *N*-Sulfosuccinimidyl[4-iodoacetyl]aminobenzoate (Sulfo-SIAB); Sulfosuccinimidyl 4-[*N*-maleimidomethyl]cyclohexane-1-carboxylate (Sulfo-SMCC); Sulfosuccinimidyl 4-[*p*-maleimidophenyl]butyrate (Sulfo-SMPB); ethylene glycol-bis(succinic acid N-hydroxysuccinimide ester) (EGS); disuccinimidyl tartrate (DST); 1,4,7,10-tetraazacyclododecane-1,4,7,10-tetraacetic acid (DOTA); diethylenetriamine-pentaacetic acid (DTPA); and thiourea linkers.

[0222] In some embodiments, the linker -X- has the formula $-A_a-W_w-Y_y-$, and the immunoconjugate of formula (***I***) is characterized by formula (***II***):

$$Ab-\left(A_a-W_w-Y_y-Z\right)_m \qquad (\textit{II})$$

wherein,

Ab is an anti-GCC antibody molecule described herein;

-A- is a Stretcher unit;

a is 0 or 1;

each –W- independently is an Amino Acid unit;

w is an integer ranging from 0 to 12;

-Y- is a self-immolative spacer unit;

y is 0, 1, or 2;

Z is a therapeutic agent or label; and

m ranges from about 1 to about 15.

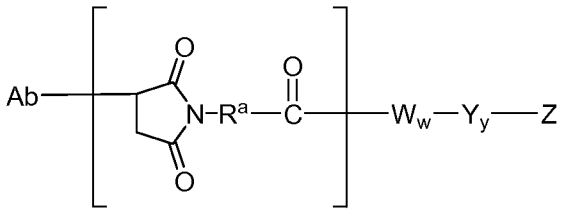
[0223] The Stretcher unit (A), when present, is capable of linking an Ab unit to an Amino Acid unit (-W-), if present, to a Spacer unit (-Y-), if present; or to a therapeutic agent or label (Z). Useful functional groups that can be present on an anti-GCC antibody molecule, either naturally or via chemical manipulation include, but are not limited to, sulfhydryl, amino, hydroxyl, the anomeric hydroxyl group of a carbohydrate, and carboxyl. Suitable functional groups are sulfhydryl and amino. In one example, sulfhydryl groups can be generated by reduction of the intramolecular disulfide bonds of an anti-GCC antibody molecule. In another embodiment, sulfhydryl groups can be generated by reaction of an amino group of a lysine moiety of an anti-GCC antibody molecule with 2-iminothiolane (Traut's reagent) or other sulfhydryl generating reagents. In certain embodiments, the anti-GCC antibody molecule is a recombinant antibody and is engineered to carry one or more lysines. In certain other embodiments, the recombinant anti-GCC antibody molecule is engineered to carry additional sulfhydryl groups, *e.g.*, additional cysteines.

[0224] In one embodiment, the Stretcher unit forms a bond with a sulfur atom of the Ab unit. The sulfur atom can be derived from a sulfhydryl group of an Ab. Representative Stretcher units of this embodiment are depicted within the square brackets of Formulas (***IIIa***) and (***IIIb***), wherein Ab-, -W-, -Y-, -Z, w and y are as defined above, and R^a is selected from -C_1-C_{10} alkylene-, -C_2-C_{10} alkenylene-, -C_2-C_{10} alkynylene-, -carbocyclo-, -O-(C_1-C_8 alkylene)-, O-(C_2-C_8 alkenylene)-, -O-(C_2-C_8 alkynylene)-, -arylene-, -C_1-C_{10} alkylene-arylene-, -C_2-C_{10} alkenylene-arylene, -C_2-C_{10} alkynylene-arylene, -arylene-C_1-C_{10} alkylene-, -arylene-C_2-C_{10} alkenylene-, -arylene-C_2-C_{10} alkynylene-, -C_1-C_{10} alkylene-(carbocyclo)-, -C_2-C_{10} alkenylene-(carbocyclo)-, -C_2-C_{10} alkynylene-(carbocyclo)-, -(carbocyclo)-C_1-C_{10} alkylene-, -(carbocyclo)-C_2-C_{10} alkenylene-, -(carbocyclo)-C_2-C_{10} alkynylene, heterocyclo-, -C_1-C_{10} alkylene-(heterocyclo)-, -C_2-C_{10} alkenylene-(heterocyclo)-, -C_2-C_{10} alkynylene-(heterocyclo)-, -(heterocyclo)-C_1-C_{10} alkylene-, -(heterocyclo)-C_2-C_{10} alkenylene-, -(heterocyclo)-C_2-C_{10} alkynylene-, -$(CH_2CH_2O)_r$-, or -$(CH_2CH_2O)_r$-CH_2-, and r is an integer ranging from 1-10,

wherein said alkyl, alkenyl, alkynyl, alkylene, alkenylene, alkynylene, aryl, carbocyle, carbocyclo, heterocyclo, and arylene radicals, whether alone or as part of another group, are optionally substituted. In some embodiments, said alkyl, alkenyl, alkynyl, alkylene, alkenylene, alkynylene, aryl, carbocyle, carbocyclo, heterocyclo, and arylene radicals, whether alone or as part of another group, are unsubstituted. In some embodiments, R^a is selected from -C_1-C_{10} alkylene-, - carbocyclo-, -O-(C_1-C_8 alkylene)-, -arylene-, -C_1-C_{10} alkylene-arylene-, -arylene-C_1-C_{10} alkylene-, -C_1-C_{10} alkylene-(carbocyclo)-, -(carbocyclo)-C_1-C_{10} alkylene-, -C_3-C_8 heterocyclo-, -C_1-C_{10} alkylene-(heterocyclo)-, -(heterocyclo)-C_1-C_{10} alkylene-, -$(CH_2CH_2O)_r$-, and -$(CH_2CH_2O)_r$-CH_2-; and r is an integer ranging from 1-10, wherein said alkylene groups are unsubstituted and the remainder of the groups are optionally substituted.

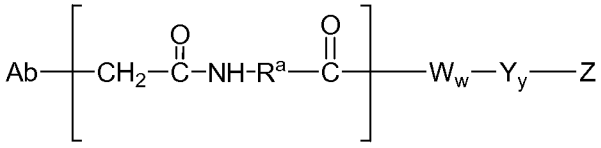
[0225] It is to be understood from all the exemplary embodiments that even where not denoted expressly, from 1 to 15 drug moieties can be linked to an Ab (m = 1-15).

[0226]



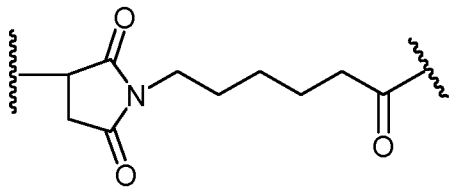
(***IIIa***)

[0227]

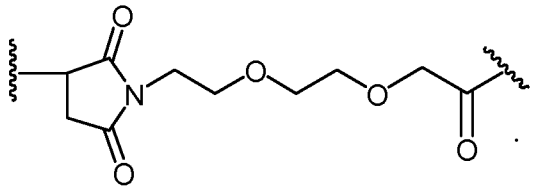


(***IIIb***)

[0228] An illustrative Stretcher unit is that of Formula (***IIIa***) wherein R^a is -$(CH_2)_5$-:

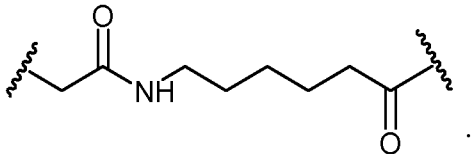


[0229] Another illustrative Stretcher unit is that of Formula (***IIIa***) wherein R^a is -$(CH_2CH_2O)_r$-CH_2-; and r is 2:

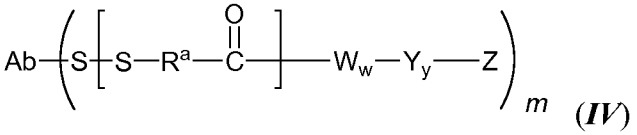


[0230] Another illustrative Stretcher unit is that of Formula (***IIIa***) wherein R^a is -arylene- or arylene-C_1-C_{10} alkylene-. In some embodiments, the aryl group is an unsubstituted phenyl group.

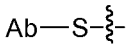
[0231] Still another illustrative Stretcher unit is that of Formula (***IIIb***) wherein R^a is $-(CH_2)_5-$:



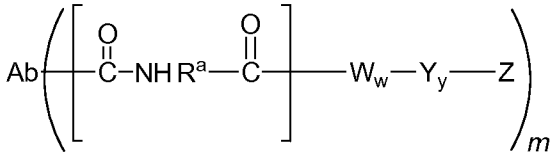
[0232] In certain embodiments, the Stretcher unit is linked to the Ab unit via a disulfide bond between a sulfur atom of the Ab unit and a sulfur atom of the Stretcher unit. A representative Stretcher unit of this embodiment is depicted within the square brackets of Formula (***IV***), wherein R^a, Ab-, -W-, -Y-, -Z, w and y are as defined above.

[0233]  (***IV***)

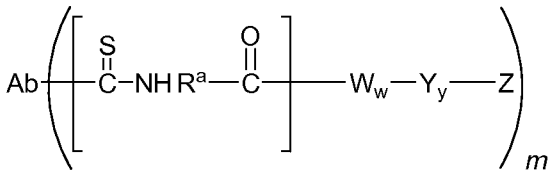
[0234] It should be noted that throughout this application, the S moiety in the formula below refers to a sulfur atom of the Ab unit, unless otherwise indicated by context.



[0235] In yet other embodiments, the Stretcher, prior to attachment to Ab, contains a reactive site that can form a bond with a primary or secondary amino group of the Ab. Examples of these reactive sites include, but are not limited to, activated esters such as succinimide esters, 4 nitrophenyl esters, pentafluorophenyl esters, tetrafluorophenyl esters, anhydrides, acid chlorides, sulfonyl chlorides, isocyanates and isothiocyanates. Representative Stretcher units of this embodiment are depicted within the square brackets of Formulas (***Va***) and (***Vb***), wherein $-R^a-$, Ab-, -W-, -Y-, -Z, w and y are as defined above;

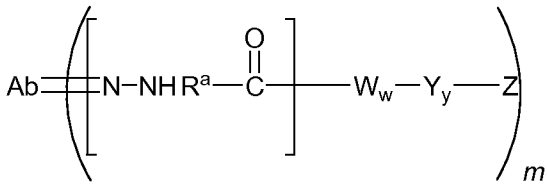
[0236] 

(*Va*)

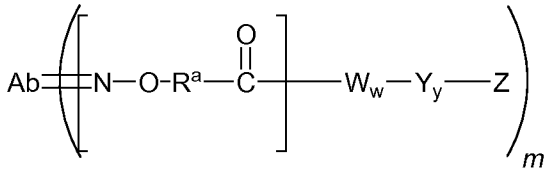
[0237] 

(*Vb*)

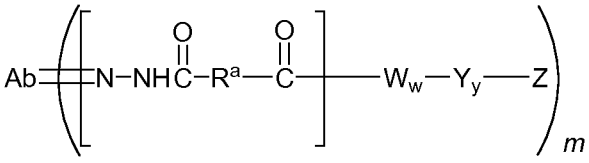
[0238] In some embodiments, the Stretcher contains a reactive site that is reactive to a modified carbohydrate's (-CHO) group that can be present on an Ab. For example, a carbohydrate can be mildly oxidized using a reagent such as sodium periodate and the resulting (-CHO) unit of the oxidized carbohydrate can be condensed with a Stretcher that contains a functionality such as a hydrazide, an oxime, a primary or secondary amine, a hydrazine, a thiosemicarbazone, a hydrazine carboxylate, and an arylhydrazide such as those described by Kaneko *et al.*, 1991, *Bioconjugate Chem.* 2:133-41. Representative Stretcher units of this embodiment are depicted within the square brackets of Formulas (***VIa***), (***VIb***), and (***VIc***), wherein –R^a-, Ab-, -W-, -Y-, -Z, w and y are as defined as above.



(*VIa*)



(*VIb*)

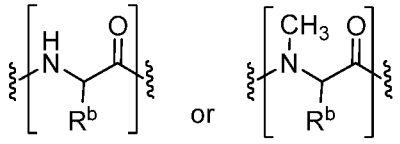


(*VIc*)

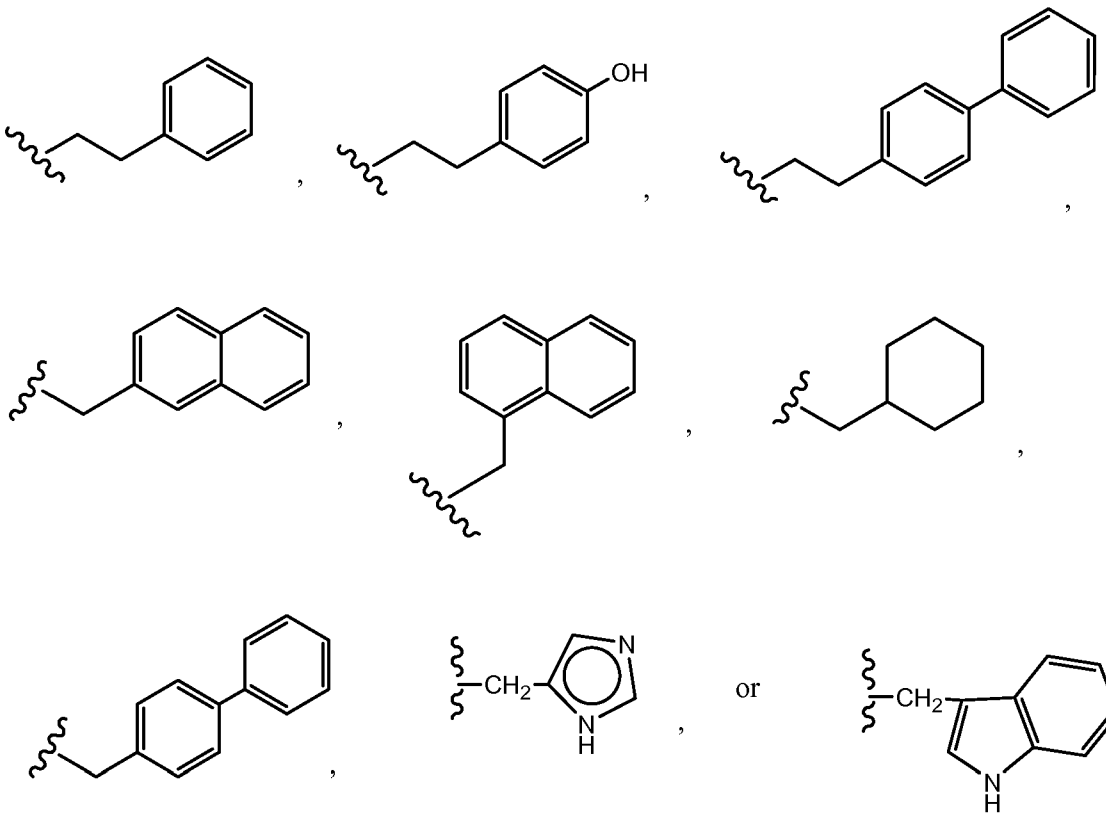
[0239] The Amino Acid unit (-W-), when present, links the Stretcher unit to the Spacer unit if the Spacer unit is present, links the Stretcher unit to the Drug moiety if the

Spacer unit is absent, and links the Ab unit to the therapeutic agent or label moiety if the Stretcher unit and Spacer unit are absent.

W_w- can be, for example, a monopeptide, dipeptide, tripeptide, tetrapeptide, pentapeptide, hexapeptide, heptapeptide, octapeptide, nonapeptide, decapeptide, undecapeptide or dodecapeptide unit. Each -W- unit independently has the formula denoted below in the square brackets, and w is an integer ranging from 0 to 12:

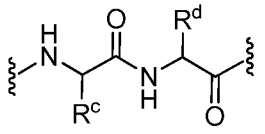


wherein R^b is hydrogen, methyl, isopropyl, isobutyl, *sec*-butyl, benzyl, *p*-hydroxybenzyl, -CH_2OH, -$CH(OH)CH_3$, -$CH_2CH_2SCH_3$, -CH_2CONH_2, -CH_2COOH, -$CH_2CH_2CONH_2$, -CH_2CH_2COOH, -$(CH_2)_3NHC(=NH)NH_2$, -$(CH_2)_3NH_2$, -$(CH_2)_3NHCOCH_3$, -$(CH_2)_3NHCHO$, -$(CH_2)_4NHC(=NH)NH_2$, -$(CH_2)_4NH_2$, -$(CH_2)_4NHCOCH_3$, -$(CH_2)_4NHCHO$, -$(CH_2)_3NHCONH_2$, -$(CH_2)_4NHCONH_2$, -$CH_2CH_2CH(OH)CH_2NH_2$, 2-pyridylmethyl-, 3-pyridylmethyl-, 4-pyridylmethyl-, phenyl, cyclohexyl,

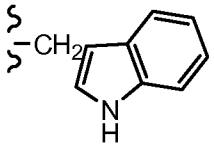


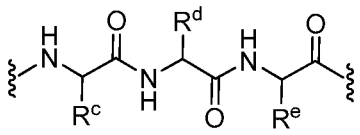
[0240] In some embodiments, the Amino Acid unit can be enzymatically cleaved by one or more enzymes, including a cancer or tumor-associated protease, to liberate the therapeutic agent or label moiety (-Z), which in one embodiment is protonated *in vivo* upon release to provide a therapeutic agent or label (Z).

[0241] In certain embodiments, the Amino Acid unit can comprise natural amino acids. In other embodiments, the Amino Acid unit can comprise non-natural amino acids. Illustrative W_w units are represented by formulas (***VII***)-(***IX***):

[0242]  (***VII***)

wherein R^c and R^d are as follows:

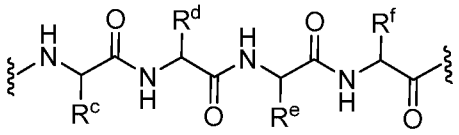
R^c	**R^d**
Benzyl	$(CH_2)_4NH_2$;
methyl	$(CH_2)_4NH_2$;
isopropyl	$(CH_2)_4NH_2$;
isopropyl	$(CH_2)_3NHCONH_2$;
benzyl	$(CH_2)_3NHCONH_2$;
isobutyl	$(CH_2)_3NHCONH_2$;
sec-butyl	$(CH_2)_3NHCONH_2$;
	$(CH_2)_3NHCONH_2$;
benzyl	methyl;
benzyl	$(CH_2)_3NHC(=NH)NH_2$;

 (***VIII***)

wherein R^c, R^d and R^e are as follows:

R^c	**R^d**	**R^e**

benzyl	Benzyl	$(CH_2)_4NH_2$;
isopropyl	Benzyl	$(CH_2)_4NH_2$; and
H	Benzyl	$(CH_2)_4NH_2$;



(*IX*)

wherein R^c, R^d, R^e and R^f are as follows:

R^c	R^d	R^e	R^f
H	benzyl	isobutyl	H; and
methyl	isobutyl	methyl	isobutyl.

[0243] Exemplary Amino Acid units include, but are not limited to, units of formula (*VII*) where: R^c is benzyl and R^d is $-(CH_2)_4NH_2$; R^c is isopropyl and R^d is $-(CH_2)_4NH_2$; or R^c is isopropyl and R^d is $-(CH_2)_3NHCONH_2$. Another exemplary Amino Acid unit is a unit of formula (*VIII*) wherein R^c is benzyl, R^d is benzyl, and R^e is $-(CH_2)_4NH_2$.

[0244] Useful $-W_w-$ units can be designed and optimized in their selectivity for enzymatic cleavage by a particular enzyme, for example, a tumor-associated protease. In one embodiment, a $-W_w-$ unit is that whose cleavage is catalyzed by cathepsin B, C and D, or a plasmin protease.

[0245] In one embodiment, $-W_w-$ is a dipeptide, tripeptide, tetrapeptide or pentapeptide. When R^b, R^c, R^d, R^e or R^f is other than hydrogen, the carbon atom to which R^b, R^c, R^d, R^e or R^f is attached is chiral.

[0246] Each carbon atom to which R^b, R^c, R^d, R^e or R^f is attached is independently in the (S) or (R) configuration.

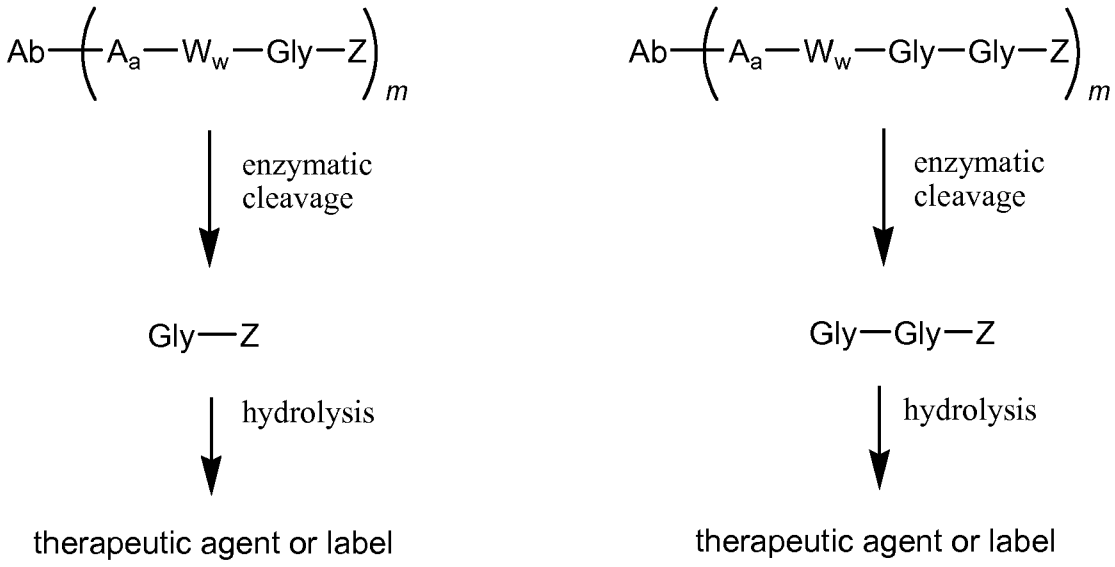
[0247] In one aspect of the Amino Acid unit, the Amino Acid unit is valine-citrulline (vc or val-cit). In another aspect, the Amino Acid unit is phenylalanine-lysine (i.e., fk). In yet another aspect of the Amino Acid unit, the Amino Acid unit is N-

methylvaline-citrulline. In yet another aspect, the Amino Acid unit is 5-aminovaleric acid, homo phenylalanine lysine, tetraisoquinolinecarboxylate lysine, cyclohexylalanine lysine, isonepecotic acid lysine, beta-alanine lysine, glycine serine valine glutamine and isonepecotic acid.

[0248] The Spacer unit (-Y-), when present, links an Amino Acid unit to the therapeutic agent or label moiety (-Z-) when an Amino Acid unit is present. Alternatively, the Spacer unit links the Stretcher unit to the therapeutic agent or label moiety when the Amino Acid unit is absent. The Spacer unit also links the therapeutic agent or label moiety to the Ab unit when both the Amino Acid unit and Stretcher unit are absent.

[0249] Spacer units are of two general types: non self-immolative or self-immolative. A non self-immolative Spacer unit is one in which part or all of the Spacer unit remains bound to the therapeutic agent or label moiety after cleavage, particularly enzymatic, of an Amino Acid unit from the antibody- drug conjugate. Examples of a non self-immolative Spacer unit include, but are not limited to a (glycine-glycine) Spacer unit and a glycine Spacer unit (both depicted in **Scheme 1**) (infra). When a conjugate containing a glycine-glycine Spacer unit or a glycine Spacer unit undergoes enzymatic cleavage via an enzyme (*e.g.*, a tumor-cell associated-protease, a cancer-cell-associated protease or a lymphocyte-associated protease), a glycine-glycine-Z moiety or a glycine-Z moiety is cleaved from Ab-Aa-Ww-. In one embodiment, an independent hydrolysis reaction takes place within the target cell, cleaving the glycine-Z moiety bond and liberating the therapeutic agent or label.

Scheme 1



[0250] In some embodiments, a non self-immolative Spacer unit (-Y-) is -Gly-. In some embodiments, a non self-immolative Spacer unit (-Y-) is -Gly-Gly-.

[0251] In one embodiment, the invention provides an immunoconjugate of formula (***II***) wherein the Spacer unit is absent (y = 0), or a pharmaceutically acceptable salt thereof.

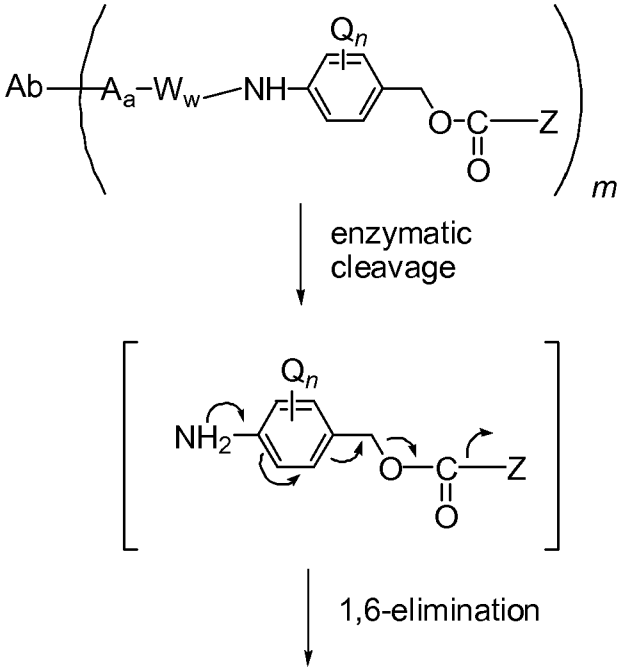
[0252] Alternatively, a conjugate containing a self-immolative Spacer unit can release -Z. As used herein, the term "self-immolative Spacer" refers to a bifunctional chemical moiety that is capable of covalently linking together two spaced chemical moieties into a stable tripartite molecule. It will spontaneously separate from the second chemical moiety if its bond to the first moiety is cleaved.

[0253] In some embodiments, $-Y_y-$ is a p-aminobenzyl alcohol (PAB) unit (see **Schemes 2** and **3**) whose phenylene portion is substituted with Q_n wherein Q is $-C_1-C_8$ alkyl, $-C_2-C_8$ alkenyl, $-C_2-C_8$ alkynyl, $-O-(C_1-C_8$ alkyl), $-O-(C_2-C_8$ alkenyl), $-O-(C_2-C_8$ alkynyl), -halogen,-nitro or -cyano; and *n* is an integer ranging from 0-4. The alkyl, alkenyl and alkynyl groups, whether alone or as part of another group, can be optionally substituted.

[0254] In some embodiments, -Y- is a PAB group that is linked to $-W_w-$ via the amino nitrogen atom of the PAB group, and connected directly to -Z via a carbonate, carbamate or ether group. Without being bound by any particular theory or mechanism,

Scheme 2 depicts a possible mechanism of release of a therapeutic agent or label (-Z) from a PAB group that is attached directly to -Z via a carbamate or carbonate group as described by Toki *et al.*, 2002, *J. Org. Chem.* 67:1866-1872.

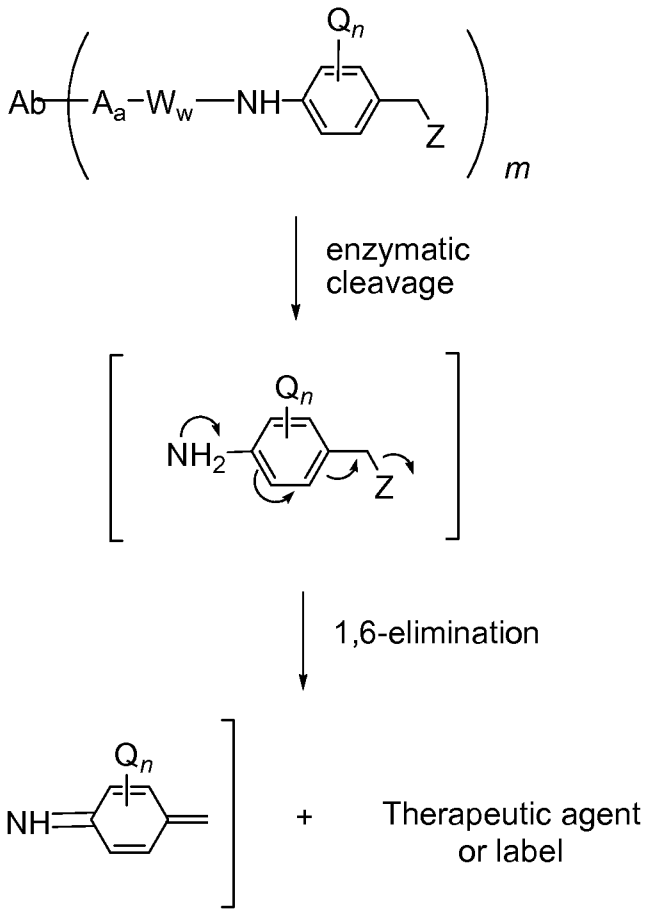
Scheme 2



[0255] In **Scheme 2**, Q is -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -halogen, -nitro or -cyano; m is an integer ranging from 0-4; and *m* ranges from 1 to about 20. The alkyl, alkenyl and alkynyl groups, whether alone or as part of another group, can be optionally substituted.

[0256] Without being bound by any particular theory or mechanism, **Scheme 3** depicts a possible mechanism of release of a therapeutic agent or label moiety (-Z) from a PAB group which is attached directly to -Z via an ether or amine linkage, wherein -Z includes the oxygen or nitrogen group that is part of the therapeutic agent or label moiety.

Scheme 3



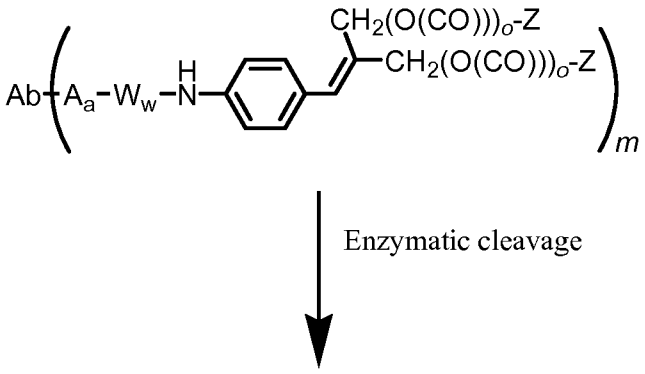
[0257] In **Scheme 3**, Q is -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -halogen, -nitro or -cyano; *n* is an integer ranging from 0-4; and *m* ranges from 1 to about 20. The alkyl, alkenyl and alkynyl groups, whether alone or as part of another group, can be optionally substituted.

[0258] Other examples of self-immolative spacers include, but are not limited to, aromatic compounds that are electronically similar to the PAB group such as 2-aminoimidazol-5-methanol derivatives (Hay *et al.*, 1999, *Bioorg. Med. Chem. Lett.* 9:2237) and ortho or para-aminobenzylacetals. Spacers can be used that undergo cyclization upon amide bond hydrolysis, such as substituted and unsubstituted 4-aminobutyric acid amides (Rodrigues *et al.*, 1995, *Chemistry Biology* 2:223), appropriately substituted bicyclo[2.2.1] and bicyclo[2.2.2] ring systems (Storm *et al.*, 1972, *J. Amer. Chem. Soc.* 94:5815) and 2-aminophenylpropionic acid amides (Amsberry *et al.*, 1990, *J. Org. Chem.* 55:5867). Elimination of amine-containing drugs that are substituted at the α-

position of glycine (Kingsbury *et al.*, 1984, *J. Med. Chem.* 27:1447) are also examples of self-immolative spacers.

[0259] In one embodiment, the Spacer unit is a branched bis(hydroxymethyl)-styrene (BHMS) unit as depicted in **Scheme 4**, which can be used to incorporate and release multiple drugs.

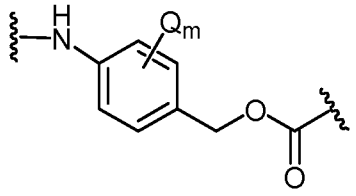
Scheme 4



[0260] In **Scheme 4**, Q is -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -halogen, -nitro or -cyano; *n* is an integer ranging from 0-4; *o* is 0 or 1; and *m* is an integer of from 1 to about 20. The alkyl, alkenyl and alkynyl groups, whether alone or as part of another group, can be optionally substituted.

[0261] In some embodiments, the -Z moieties are the same. In yet another embodiment, the -Z moieties are different.

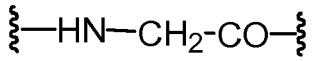
[0262] In one aspect, Spacer units (-Y_y-) are represented by Formulae (**X**)-(**XII**):



(***X***)

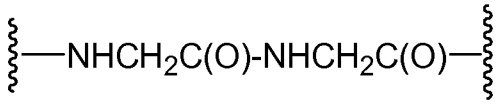
wherein Q is -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, -O-(C_1-C_8 alkyl), -O-(C_2-C_8 alkenyl), -O-(C_2-C_8 alkynyl), -halogen, -nitro or -cyano; and m is an integer ranging from

0-4. The alkyl, alkenyl and alkynyl groups, whether alone or as part of another group, can be optionally substituted.



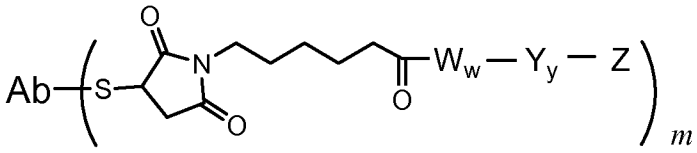
(*XI*)

and

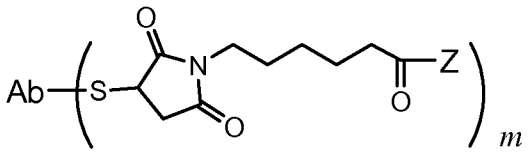


(*XII*)

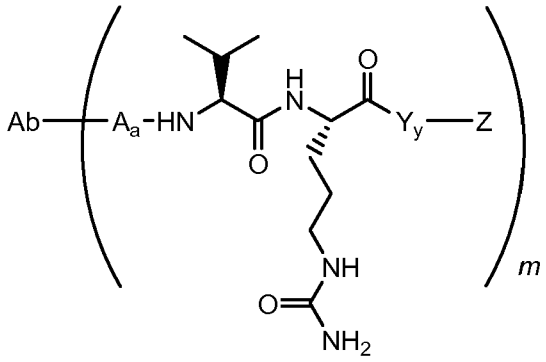
[0263] In a group of selected embodiments, the conjugates of Formula (*I*) and (*II*) are:

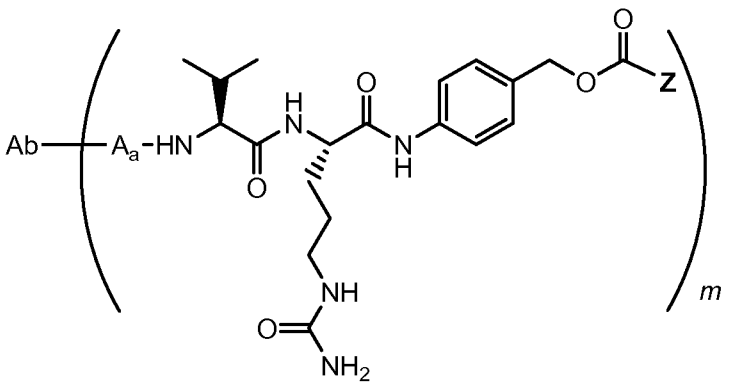


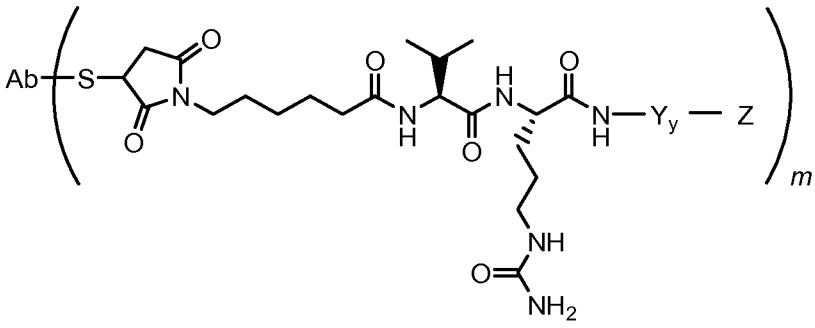
wherein w and y are each 0, 1 or 2:



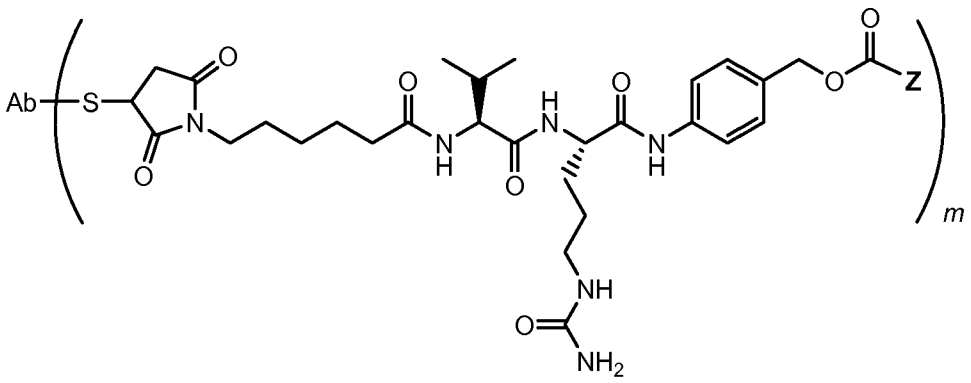
wherein w and y are each 0;







, and



.

wherein A_a, W_w, Y_y, Z and Ab have the meanings provided above.

[0264] The variable Z in formula (***I***) is a therapeutic agent or label. The therapeutic agent can be any agent capable of exerting a desired biological effect. In some embodiments, the therapeutic agent sensitizes the cell to a second therapeutic modality, e.g., a chemotherapeutic agent, radiation therapy, immunotherapy.

[0265] In some embodiments, the therapeutic agent is a cytostatic or cytotoxic agent. Examples include, without limitation, antimetabolites (e.g., azathioprine, 6-mercaptopurine, 6-thioguanine, fludarabine, pentostatin, cladribine, 5-fluorouracil (5FU),

floxuridine (FUDR), cytosine arabinoside (cytarabine), methotrexate, trimethoprim, pyrimethamine, pemetrexed); alkylating agents (e.g., cyclophosphamide, mechlorethamine, uramustine, melphalan, chlorambucil, thiotepa/chlorambucil, ifosfamide, carmustine, lomustine, streptozocin, busulfan, dibromomannitol, cisplatin, carboplatin, nedaplatin, oxaliplatin, satraplatin, triplatin tetranitrate, procarbazine, altretamine, dacarbazine, mitozolomide, temozolomide); anthracyclines (e.g., daunorubicin, doxorubicin, epirubicin, idarubicin, valrubicin); antibiotics (e.g., dactinomycin, bleomycin, mithramycin, anthramycin, streptozotocin, gramicidin D, mitomycins (e.g., mitomycin C), duocarmycins (e.g., CC-1065), calicheamicins); antimitotic agents (including, e.g., maytansinoids, auristatins, dolastatins, cryptophycins, vinca alkaloids (e.g., vincristine, vinblastine, vindesine, vinorelbine), taxanes (e.g., paclitaxel, docetaxel, or a novel taxane (see, e.g., International Patent Publication No. WO 01/38318, published May 31, 2001)), and colchicines; topoisomerase inhibitors (e.g., irinotecan, topotecan, amsacrine, etoposide, teniposide, mitoxantrone); and proteasome inhibitors (e.g., peptidyl boronic acids).

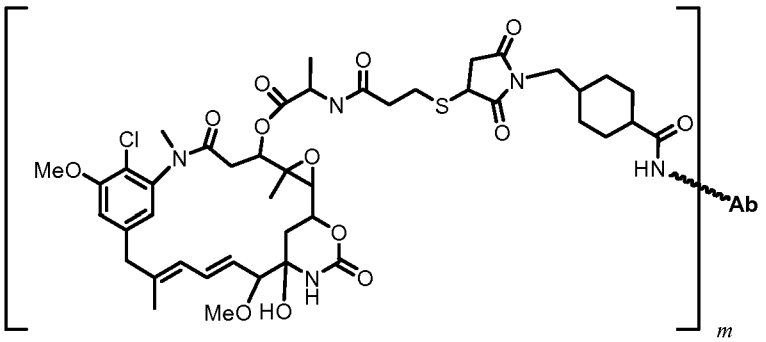
Maytansinoid immunoconjugates

[0266] In some embodiments, the therapeutic agent is a maytansinoid. Maytansinoid compounds and methods for their conjugation to antibodies are described, for example, in Chari et al., *Cancer Res.*, 52: 127-131 (1992); Widdison et al., *J. Med. Chem.* 49: 4392-4408 (2006); and U.S. Patent Nos. 5,208,020 and 6,333,410. Examples of maytansinoids include maytansine analogues having a modified aromatic ring (e.g., C-19-dechloro, C-20-demethoxy, C-20-acyloxy) and those having modifications at other positions (e.g., C-9-CH, C-14-alkoxymethyl, C-14-hydroxymethyl or acyloxymethyl, C-15-hydroxy/acyloxy, C-15-methoxy, C-18-N-demethyl, 4,5-deoxy). In certain embodiments, the maytansinoid is $N^{2'}$-deacetyl-$N^{2'}$-(4-mercapto-1-oxopentyl)maytansine (DM3), $N^{2'}$-deacetyl-$N^{2'}$-(3-mercapto-1-oxopropyl)-maytansine (DM1), or $N^{2'}$-deacetyl-$N^{2'}$-(4-mercapto-4-methyl-1-oxopentyl)maytansine (DM4).

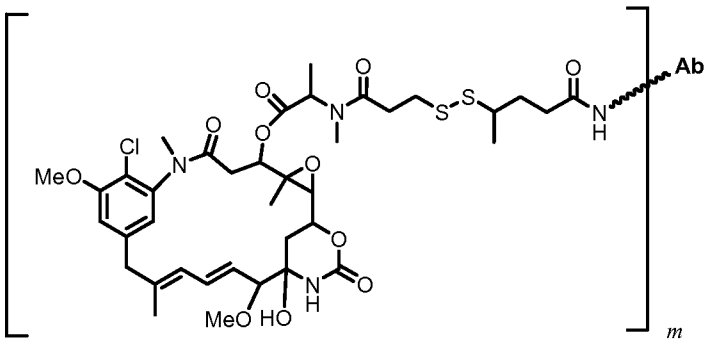
[0267] Maytansinoid compounds that comprise a sulfhydryl group can be coupled to antibodies using a heterobifunctional linker that is connected to the maytansinoid compound by way of a thioether or disulfide linkage. In some such embodiments, the linker is coupled to an amino group on the antibody (e.g., a terminal amino group or the epsilon amino group of a lysine residue. In some embodiments, the heterobifunctional

linker that is used to couple a maytansinoid compounds to an antibody is N-succinimidyl 3-(2-pyridyldithio)proprionate (also known as N-succinimidyl 4-(2-pyridyldithio)pentanoate, or SPP), 4-succinimidyl-oxycarbonyl-2-methyl-2-(2-pyridyldithio)-toluene (SMPT), N-succinimidyl 4-[*N*-maleimidomethyl]cyclohexane-1-carboxylate (SMCC), N-succinimidyl 3-(2-pyridyldithio)propionate (SPDP); N-succinimidyl 4-(2-pyridyldithio)butyrate (SPDB), 2-iminothiolane, or S-acetylsuccinic anhydride.

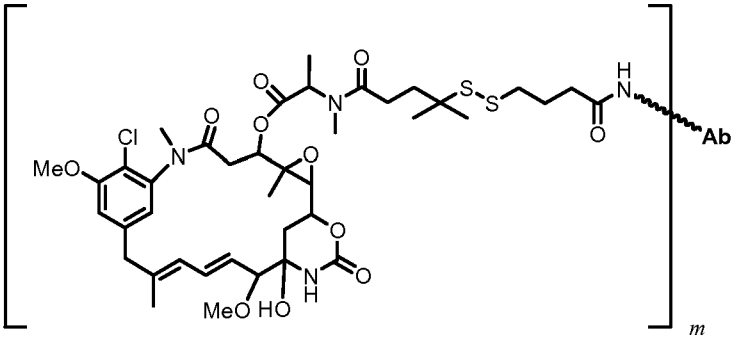
[0268] In certain embodiments, the immunoconjugate of formula (***I***) is characterized by the formula Ab-(SMCC-DM1)$_m$ (formula (***I-1***); Ab-(SPP-DM1)$_m$ (formula (***I-2***); or Ab-(SPDB-DM4)$_m$ (formula (***I-3***), wherein Ab is an anti-GCC antibody molecule as described herein, and *m* has the values and preferred values described above for formula (***I***).



(***I-1***)



(***I-2***)



(*I-3*)

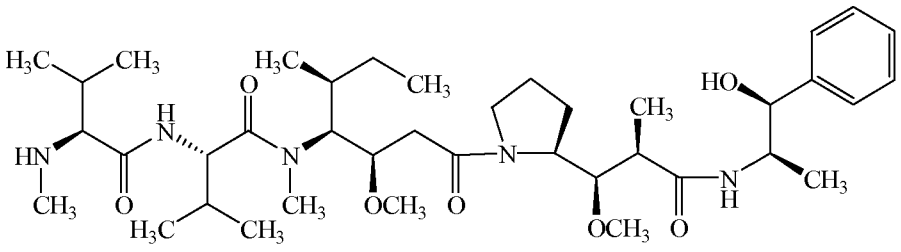
[0269] In some embodiments, the variable Ab in formula (*I-1*), (*I-2*), or (*I-3*) is an antibody molecule with features summarized in Tables 1 to 6. In certain embodiments, the variable Ab is a 5F9 antibody molecule or an Abx-229 antibody molecule.

[0270] In some embodiments, the variable *m* in formula (*I-1*), (*I-2*), or (*I-3*) ranges from about 1 to about 10, from about 3 to about 7, or from about 3 to about 5.

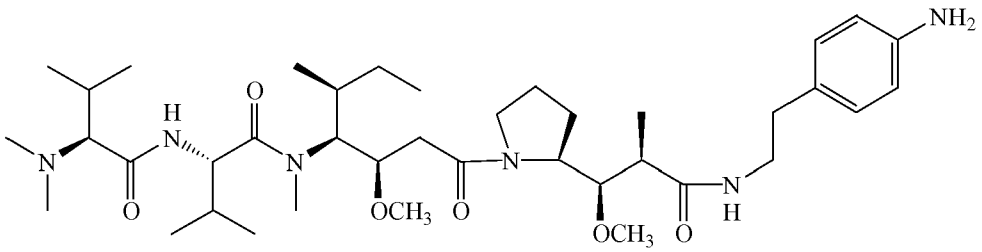
[0271] In certain particular embodiments, the invention relates to an immunoconjugate of formula (*I-1*), (*I-2*), or (*I-3*), wherein Ab is a 5F9 antibody molecule and *m* is about 4.

Dolastatin and auristatin immunoconjugates

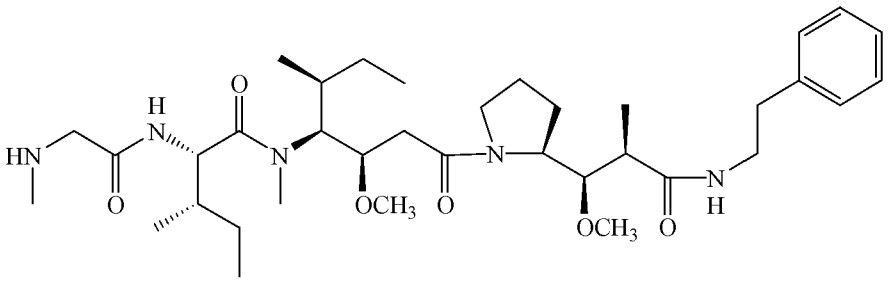
[0272] In some other embodiments the therapeutic agent is a dolastatin. In some embodiments, the therapeutic agent is an auristatin, such as auristatin E (also known in the art as a derivative of dolastatin-10) or a derivative thereof. In some embodiments, the therapeutic agent is a compound selected from compounds of formulae (*XIII*)-(*XXIII*), or a pharmaceutically acceptable salt form thereof:



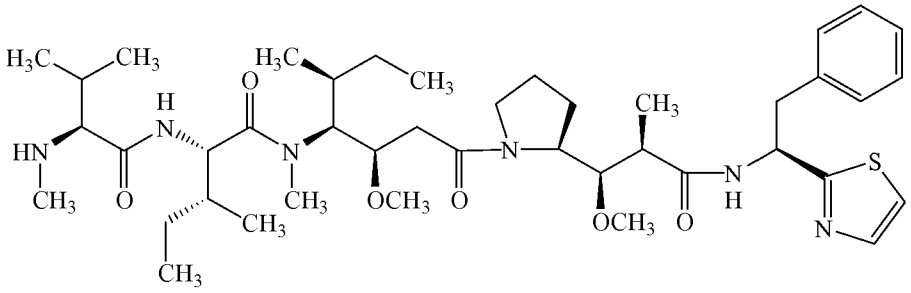
(*XIII*)



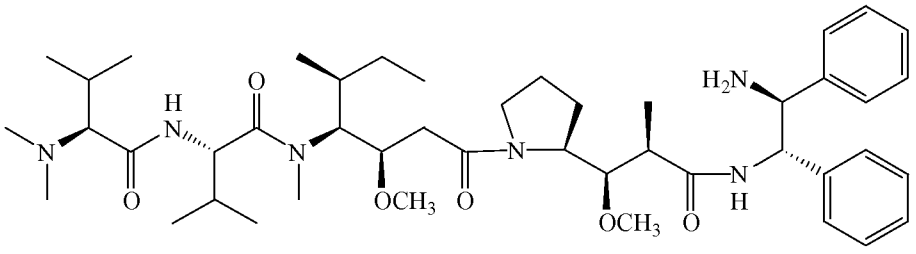
(*XIV*)



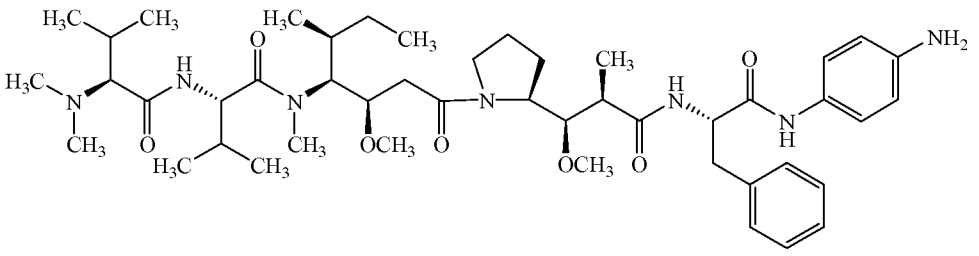
(*XV*)



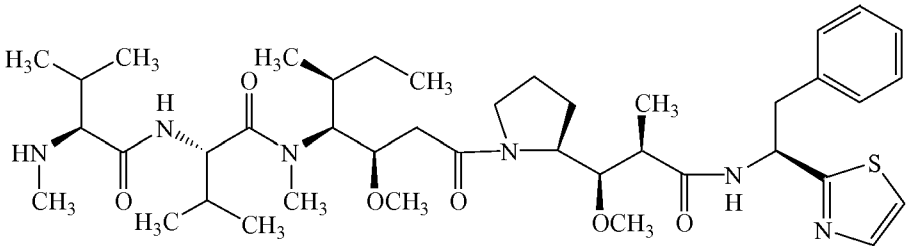
(*XVI*)



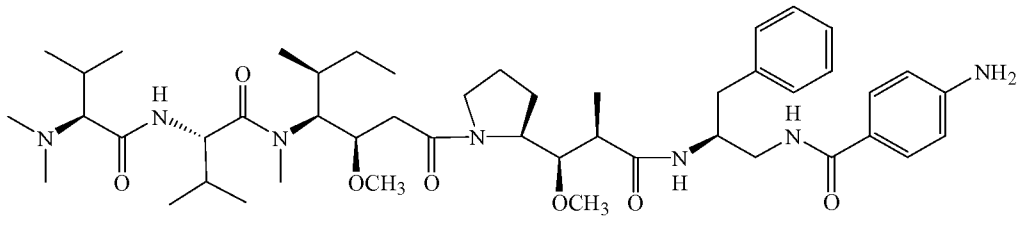
(*XVII*)



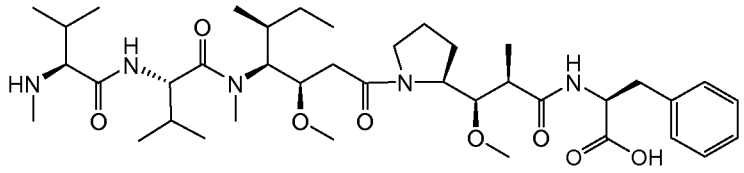
(*XVIII*)



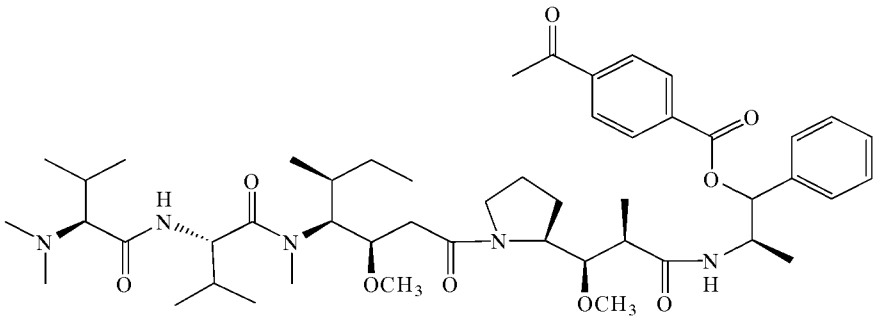
(*XIX*)



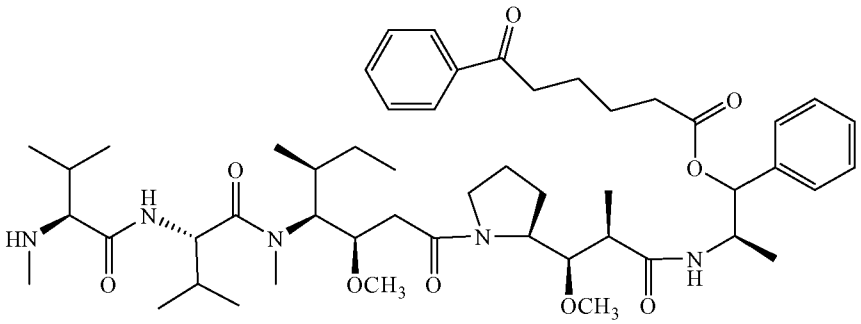
(*XX*)



(*XXI*)



(*XXII*)



(*XXIII*)

[0273] Auristatin compounds and methods for their conjugation to antibodies are described, for example, in Doronina et al., *Nature Biotech.*, 21: 778-784 (2003); Hamblett et al, *Clin. Cancer Res.*, 10: 7063-7070 (2004); Carter and Senter, *Cancer J.*, 14 154-169 (2008); U.S. Patent Nos. 7,498,298, 7,091,186, 6,884,869; 6,323,315; 6,239,104; 6,034,065; 5,780,588; 5,665,860; 5,663,149; 5,635,483; 5,599,902; 5,554,725; 5,530,097; 5,521,284; 5,504,191; 5,410,024; 5,138,036; 5,076,973; 4,986,988; 4,978,744; 4,879,278; 4,816,444; and 4,486,414; U.S. Patent Publication Nos. 20090010945, 20060074008, 20080300192, 20050009751, 20050238649, and 20030083236; and International Patent

Publication Nos. WO 04/010957 and WO 02/088172, each of which is incorporated by reference herein in its entirety and for all purposes.

[0274] The auristatin can be, for example, an ester formed between auristatin E and a keto acid. For example, auristatin E can be reacted with paraacetyl benzoic acid or benzoylvaleric acid to produce AEB and AEVB, respectively. Other typical auristatins include auristatin phenylalanine phenylenediamine (AFP; (***XVIII***)), monomethyl auristatin E (MMAE; (***XIII***)), and monomethyl auristatin F (MMAF; (***XXI***)).

[0275] Auristatins have been shown to interfere with microtubule dynamics and nuclear and cellular division and have anticancer activity. Auristatins for use in the present invention bind tubulin and can exert a cytotoxic or cytostatic effect on a GCC-expressing cell line. Methods for determining whether a compound binds tubulin are known in the art. See, for example, Muller et al., *Anal. Chem* 2006, 78, 4390-4397; Hamel et al., *Molecular Pharmacology,* 1995 47: 965-976; and Hamel et al., *The Journal of Biological Chemistry*, 1990 265:28, 17141-17149. For purposes of the present invention, the relative affinity of a compound to tubulin can be determined. Some preferred auristatins of the present invention bind tubulin with an affinity ranging from 10-fold lower (weaker affinity) than the binding affinity of MMAE to tubulin to 10-fold, 20-fold or even 100-fold higher (higher affinity) than the binding affinity of MMAE to tubulin.

[0276] There are a number of different assays, known in the art, that can be used for determining whether an auristatin or resultant immunoconjugate exerts a cytostatic or cytotoxic effect on a desired cell line. For example, the cytotoxic or cytostatic activity of an immunoconjugate can be measured by: exposing mammalian cells expressing a target protein of the immunoconjugate in a cell culture medium; culturing the cells for a period from about 6 hours to about 5 days; and measuring cell viability. Cell-based *in vitro* assays can be used to measure viability (proliferation), cytotoxicity, and induction of apoptosis (caspase activation) of the immunoconjugate.

[0277] For determining whether an immunoconjugate exerts a cytostatic effect, a thymidine incorporation assay may be used. For example, cancer cells expressing a target antigen at a density of 5,000 cells/well of a 96-well plated can be cultured for a 72-hour period and exposed to 0.5 μCi of ^{3}H-thymidine during the final 8 hours of the 72-hour period. The incorporation of ^{3}H-thymidine into cells of the culture is measured in the presence and absence of the immunoconjugate.

[0278] For determining cytotoxicity, necrosis or apoptosis (programmed cell death) can be measured. Necrosis is typically accompanied by increased permeability of the plasma membrane; swelling of the cell, and rupture of the plasma membrane. Apoptosis is typically characterized by membrane blebbing, condensation of cytoplasm, and the activation of endogenous endonucleases. Determination of any of these effects on cancer cells indicates that an immunoconjugate is useful in the treatment of cancers.

[0279] Cell viability can be measured by determining in a cell the uptake of a dye such as neutral red, trypan blue, or ALAMAR™ blue (*see, e.g.*, Page *et al.*, 1993, *Intl. J. Oncology* 3:473-476). In such an assay, the cells are incubated in media containing the dye, the cells are washed, and the remaining dye, reflecting cellular uptake of the dye, is measured spectrophotometrically. The protein-binding dye sulforhodamine B (SRB) can also be used to measure cytotoxicity (Skehan *et al.*, 1990, *J. Natl. Cancer Inst.* 82:1107-12).

[0280] Alternatively, a tetrazolium salt, such as MTT or WST, is used in a quantitative colorimetric assay for mammalian cell survival and proliferation by detecting living, but not dead, cells (*see, e.g.*, Mosmann, 1983, *J. Immunol. Methods* 65:55-63).

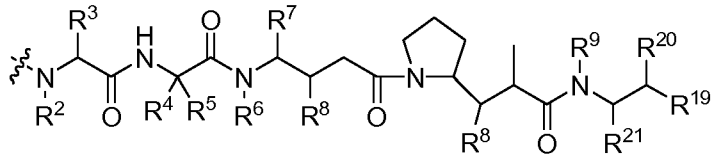
[0281] Apoptosis can be quantitated by measuring, for example, DNA fragmentation. Commercial photometric methods for the quantitative *in vitro* determination of DNA fragmentation are available. Examples of such assays, including TUNEL (which detects incorporation of labeled nucleotides in fragmented DNA) and ELISA-based assays, are described in *Biochemica*, 1999, no. 2, pp. 34-37 (Roche Molecular Biochemicals).

[0282] Apoptosis can also be determined by measuring morphological changes in a cell. For example, as with necrosis, loss of plasma membrane integrity can be determined by measuring uptake of certain dyes (*e.g.*, a fluorescent dye such as, for example, acridine orange or ethidium bromide). A method for measuring apoptotic cell number has been described by Duke and Cohen, Current Protocols in Immunology (Coligan *et al.* eds., 1992, pp. 3.17.1-3.17.16). Cells also can be labeled with a DNA dye (*e.g.*, acridine orange, ethidium bromide, or propidium iodide) and the cells observed for chromatin condensation and margination along the inner nuclear membrane. Other morphological changes that can be measured to determine apoptosis include, *e.g.*, cytoplasmic condensation, increased membrane blebbing, and cellular shrinkage.

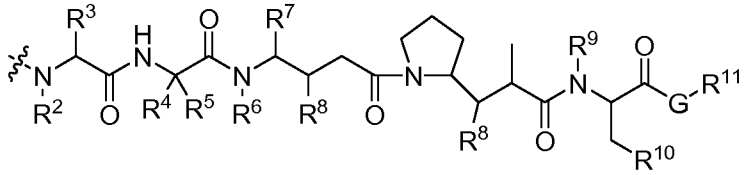
[0283] The presence of apoptotic cells can be measured in both the attached and "floating" compartments of the cultures. For example, both compartments can be collected by removing the supernatant, trypsinizing the attached cells, combining the preparations following a centrifugation wash step (*e.g.*, 10 minutes at 2000 rpm), and detecting apoptosis (*e.g.*, by measuring DNA fragmentation). (*See, e.g.*, Piazza *et al.*, 1995, *Cancer Research* 55:3110-16).

[0284] The effects of immunoconjugates can be tested or validated in animal models. A number of established animal models of cancers are known to the skilled artisan, any of which can be used to assay the efficacy of an immunoconjugate. Non-limiting examples of such models are described *infra*. Moreover, small animal models to examine the *in vivo* efficacies of immunoconjugates can be created by implanting human tumor cell lines into appropriate immunodeficient rodent strains, *e.g.*, athymic nude mice or SCID mice.

[0285] In some embodiments, the variable -Z in formula (***I***) is an auristatin moiety of the formula (***X-A***) or formula (***X-B***):



(***X-A***)



(***X-B***)

wherein, independently at each location:

the wavy line indicates a bond;

$\mathbf{R^2}$ is -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, or -C_2-C_{20} alkynyl;

$\mathbf{R^3}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, carbocycle, -C_1-C_{20} alkylene (carbocycle), -C_2-C_{20} alkenylene(carbocycle), -C_2-C_{20} alkynylene(carbocycle), -aryl, -C_1-C_{20} alkylene(aryl), -C_2-C_{20} alkenylene(aryl), -C_2-C_{20} alkynylene(aryl), -heterocycle, -C_1-C_{20} alkylene(heterocycle), -C_2-C_{20} alkenylene(heterocycle), or -C_2-C_{20} alkynylene(heterocycle);

$\mathbf{R^4}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, carbocycle, -C_1-C_{20} alkylene (carbocycle), -C_2-C_{20} alkenylene(carbocycle), -C_2-C_{20} alkynylene(carbocycle), -aryl, -C_1-C_{20} alkylene(aryl), -C_2-C_{20} alkenylene(aryl), -C_2-C_{20} alkynylene(aryl), -heterocycle, -C_1-C_{20} alkylene(heterocycle), -C_2-C_{20} alkenylene(heterocycle), or -C_2-C_{20} alkynylene(heterocycle);

$\mathbf{R^5}$ is -H or -C_1-C_8 alkyl;

or $\mathbf{R^4}$ and $\mathbf{R^5}$ jointly form a carbocyclic ring and have the formula -$(CR^aR^b)_s$- wherein R^a and R^b are independently -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, or -carbocycle and s is 2, 3, 4, 5 or 6,

$\mathbf{R^6}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, or -C_2-C_{20} alkynyl;

$\mathbf{R^7}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, -carbocycle, -C_1-C_{20} alkylene (carbocycle), -C_2-C_{20} alkenylene(carbocycle), -C_2-C_{20} alkynylene(carbocycle), -aryl, -C_1-C_{20} alkylene(aryl), -C_2-C_{20} alkenylene(aryl), -C_2-C_{20} alkynylene(aryl), heterocycle, -C_1-C_{20} alkylene(heterocycle), -C_2-C_{20} alkenylene(heterocycle), or -C_2-C_{20} alkynylene(heterocycle);

each $\mathbf{R^8}$ is independently -H, -OH, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, -O-(C_1-C_{20} alkyl), -O-(C_2-C_{20} alkenyl), -O-(C_1-C_{20} alkynyl), or -carbocycle;

$\mathbf{R^9}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, or -C_2-C_{20} alkynyl;

$\mathbf{R^{19}}$ is -aryl, -heterocycle, or -carbocycle;

$\mathbf{R^{20}}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, -carbocycle, -O-(C_1-C_{20} alkyl), -O-(C_2-C_{20} alkenyl), -O-(C_2-C_{20} alkynyl), or O$\mathbf{R^{18}}$ wherein $\mathbf{R^{18}}$ is -H, a hydroxyl protecting group, or a direct bond where O$\mathbf{R^{18}}$ represents =O;

$\mathbf{R^{21}}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, or -C_2-C_{20} alkynyl, -aryl, -heterocycle, or -carbocycle;

$\mathbf{R^{10}}$ is -aryl or -heterocycle;

G is –O-, -S-, -NH-, or -NR^{12}-, wherein $\mathbf{R^{12}}$ is -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl;

$\mathbf{R^{11}}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, -aryl, -heterocycle, -$(R^{13}O)_s$-R^{14}, or -$(R^{13}O)_s$-$CH(R^{15})_2$;

s is an integer ranging from 0-1000;

$\mathbf{R^{13}}$ is -C_2-C_{20} alkylene, -C_2-C_{20} alkenylene, or -C_2-C_{20} alkynylene;

$\mathbf{R^{14}}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, or -C_2-C_{20} alkynyl;

each occurrence of $\mathbf{R^{15}}$ is independently -H, -COOH, $-(CH_2)_t$-$N(R^{16})_2$, $-(CH_2)_t$-SO_3H, $-(CH_2)_t$-SO_3-C_1-C_{20} alkyl, $-(CH_2)_t$-SO_3-C_2-C_{20} alkenyl, or $-(CH_2)_t$-SO_3-C_2-C_{20} alkynyl;

each occurrence of $\mathbf{R^{16}}$ is independently -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl or $-(CH_2)_t$-COOH; and

t is an integer ranging from 0 to 6; wherein said alkyl, alkenyl, alkynyl, alkylene, alkenylene, alkynyklene, aryl, carbocyle, and heterocycle radicals, whether alone or as part of another group, are optionally substituted.

[0286] Auristatins of the formula (*X-A*) include those wherein said alkyl, alkenyl, alkynyl, alkylene, alkenylene, alkynyklene, aryl, carbocyle, and heterocycle radicals are unsubstituted.

[0287] Auristatins of the formula (*X-A*) include those wherein the groups of R^2, R^3, R^4, R^5, R^6, R^7, R^8, and R^9 are unsubstituted and the groups of R^{19}, R^{20} and R^{21} are optionally substituted as described herein.

[0288] Auristatins of the formula (*X-A*) include those wherein

$\mathbf{R^2}$ is -C_1-C_8 alkyl;

$\mathbf{R^3}$, $\mathbf{R^4}$ and $\mathbf{R^7}$ are independently selected from -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, monocyclic C_3-C_6 carbocycle, -C_1-C_{20} alkylene(monocyclic C_3-C_6 carbocycle), -C_2-C_{20} alkenylene(monocyclic C_3-C_6 carbocycle), -C_2-C_{20} alkynylene(monocyclic C_3-C_6 carbocycle), -C_6-C_{10} aryl, -C_1-C_{20} alkylene(C_6-C_{10} aryl), -C_2-C_{20} alkenylene(C_6-C_{10} aryl), -C_2-C_{20} alkynylene(C_6-C_{10} aryl), -heterocycle, -C_1-C_{20} alkylene(heterocycle), -C_2-C_{20} alkenylene(heterocycle), or -C_2-C_{20} alkynylene(heterocycle); wherein said alkyl, alkenyl, alkynyl, alkylene, alkenylene, alkynylene, carbocycle, aryl, and heterocycle radicals are optionally substituted;

$\mathbf{R^5}$ is -hydrogen;

$\mathbf{R^6}$ is -C_1-C_8 alkyl;

each $\mathbf{R^8}$ is independently selected from -OH, -O-(-C_1-C_{20} alkyl), -O-(-C_2-C_{20} alkenyl), or -O-(-C_2-C_{20} alkynyl) wherein said alkyl, alkenyl, and alkynyl radicals are optionally substituted;

$\mathbf{R^9}$ is -hydrogen or -C_1-C_8 alkyl;

$\mathbf{R^{19}}$ is optionally substituted phenyl;

$\mathbf{R^{20}}$ is $O\mathbf{R^{18}}$; wherein $\mathbf{R^{18}}$ is H, a hydroxyl protecting group, or a direct bond where $O\mathbf{R^{18}}$ represents =O;

$\mathbf{R^{21}}$ is selected from -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, or -carbocycle; wherein said alkyl, alkenyl, alkynyl, and carbocycle radicals are optionally substituted; or a pharmaceutically acceptable salt form thereof.

[0289] Auristatins of the formula (*X-A*) include those wherein

$\mathbf{R^2}$ is methyl;

$\mathbf{R^3}$ is -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, or -C_2-C_8 alkynyl, wherein said alkyl, alkenyl and alkynyl radicals are optionally substituted;

$\mathbf{R^4}$ is -H, -C_1-C_8 alkyl, -C_2-C_8 alkenyl, -C_2-C_8 alkynyl, monocyclic C_3-C_6 carbocycle, -C_6-C_{10} aryl, -C_1-C_8 alkylene(C_6-C_{10} aryl), -C_2-C_8 alkenylene(C_6-C_{10} aryl), -C_2-C_8 alkynylene(C_6-C_{10} aryl), -C_1-C_8 alkylene (monocyclic C_3-C_6 carbocycle), -C_2-C_8 alkenylene (monocyclic C_3-C_6 carbocycle), -C_2-C_8 alkynylene(monocyclic C_3-C_6 carbocycle); wherein said alkyl, alkenyl, alkynyl, alkylene, alkenylene, alkynylene, aryl, and carbocycle radicals whether alone or as part of another group are optionally substituted;

$\mathbf{R^5}$ is H; $\mathbf{R^6}$ is methyl;

$\mathbf{R^7}$ is -C_1-C_8 alkyl, -C_2-C_8 alkenyl or -C_2-C_8 alkynyl;

each $\mathbf{R^8}$ is methoxy;

$\mathbf{R^9}$ is -hydrogen or -C_1-C_8 alkyl;

$\mathbf{R^{19}}$ is phenyl;

$\mathbf{R^{20}}$ is $O\mathbf{R^{18}}$; wherein $\mathbf{R^{18}}$ is -H, a hydroxyl protecting group, or a direct bond where $O\mathbf{R^{18}}$ represents =O;

$\mathbf{R^{21}}$ is methyl; or a pharmaceutically acceptable salt form thereof.

[0290] Auristatins of the formula (*X-A*) include those wherein

$\mathbf{R^2}$ is methyl; $\mathbf{R^3}$ is H or C_1-C_3 alkyl; $\mathbf{R^4}$ is C_1-C_5 alkyl; $\mathbf{R^5}$ is H; $\mathbf{R^6}$ is methyl; $\mathbf{R^7}$ is isopropyl or sec-butyl; $\mathbf{R^8}$ is methoxy; $\mathbf{R^9}$ is hydrogen or C_1-C_8 alkyl; $\mathbf{R^{19}}$ is phenyl; $\mathbf{R^{20}}$ is $O\mathbf{R^{18}}$; wherein $\mathbf{R^{18}}$ is H, a hydroxyl protecting group, or a direct bond where OR^{18} represents =O; and $\mathbf{R^{21}}$ is methyl; or a pharmaceutically acceptable salt form thereof.

[0291] Auristatins of the formula (*X-A*) include those wherein

$\mathbf{R^2}$ is methyl or C_1-C_3 alkyl; $\mathbf{R^3}$ is H or C_1-C_3 alkyl; $\mathbf{R^4}$ is C_1-C_5 alkyl; $\mathbf{R^5}$ is H; $\mathbf{R^6}$ is C_1-C_3 alkyl; $\mathbf{R^7}$ is C_1-C_5 alkyl; $\mathbf{R^8}$ is C_1-C_3 alkoxy; $\mathbf{R^9}$ is hydrogen or C_1-C_8 alkyl; $\mathbf{R^{19}}$ is phenyl;

$\mathbf{R^{20}}$ is $\mathbf{OR^{18}}$; wherein $\mathbf{R^{18}}$ is H, a hydroxyl protecting group, or a direct bond where $\mathbf{OR^{18}}$ represents =O; and $\mathbf{R^{21}}$ is C_1-C_3 alkyl; or a pharmaceutically acceptable salt form thereof.

[0292] Auristatins of the formula (***X-B***) include those wherein

$\mathbf{R^2}$ is methyl;

$\mathbf{R^3}$, $\mathbf{R^4}$, and $\mathbf{R^7}$ are independently selected from -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, monocyclic C_3-C_6 carbocycle, -C_1-C_{20} alkylene(monocyclic C_3-C_6 carbocycle), -C_2-C_{20} alkenylene(monocyclic C_3-C_6 carbocycle), -C_2-C_{20} alkynylene(monocyclic C_3-C_6 carbocycle), -C_6-C_{10} aryl, -C_1-C_{20} alkylene(C_6-C_{10} aryl), -C_2-C_{20} alkenylene(C_6-C_{10} aryl), -C_2-C_{20} alkynylene(C_6-C_{10} aryl), -heterocycle, -C_1-C_{20} alkylene(heterocycle), -C_2-C_{20} alkenylene(heterocycle), or -C_2-C_{20} alkynylene(heterocycle); wherein said alkyl, alkenyl, alkynyl, alkylene, alkenylene, alkynylene, carbocyle, aryl, and heterocyclic radicals whether alone or as part of another group are optionally substituted;

$\mathbf{R^5}$ is -H;

$\mathbf{R^6}$ is methyl;

each $\mathbf{R^8}$ is methoxy;

$\mathbf{R^9}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, or -C_2-C_{20} alkynyl; wherein said alkyl, alkenyl and alkynyl radical are optionally substituted;

$\mathbf{R^{10}}$ is optionally substituted aryl or optionally substituted heterocycle;

G is –O-, -S-, -NH-, or -NR^{12}-, wherein $\mathbf{R^{12}}$ is -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, or -C_2-C_{20} alkynyl, each of which is optionally substituted;

$\mathbf{R^{11}}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl, -aryl, -heterocycle, -$(R^{13}O)_s$-R^{14}, or -$(R^{13}O)_s$-$CH(R^{15})_2$, wherein said alkyl, alkenyl, alkynyl, aryl, and heterocycle radicals are optionally substituted;

s is an integer ranging from 0-1000;

$\mathbf{R^{13}}$ is -C_2-C_{20} alkylene, -C_2-C_{20} alkenylene, or -C_2-C_{20} alkynylene, each of which is optionally substituted;

$\mathbf{R^{14}}$ is -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, or -C_2-C_{20} alkynyl wherein said alkyl, alkenyl and alkynyl radicals are optionally substituted;

each occurrence of $\mathbf{R^{15}}$ is independently -H, -COOH, –$(CH_2)_t$-$N(R^{16})_2$, –$(CH_2)_t$-SO_3H, –$(CH_2)_t$-SO_3-C_1-C_{20} alkyl, –$(CH_2)_t$-SO_3-C_2-C_{20} alkenyl, or –$(CH_2)_t$-SO_3-C_2-C_{20} alkynyl wherein said alkyl, alkenyl and alkynyl radicals are optionally substituted;

each occurrence of $\mathbf{R^{16}}$ is independently -H, -C_1-C_{20} alkyl, -C_2-C_{20} alkenyl, -C_2-C_{20} alkynyl or $-(CH_2)_t$-COOH wherein said alkyl, alkenyl and alkynyl radicals are optionally substituted;

t is an integer ranging from 0 to 6; or a pharmaceutically acceptable salt form thereof.

[0293] In certain of these embodiments, R^{10} is optionally substituted phenyl;

[0294] Auristatins of the formula (***X-B***) include those wherein the groups of R^2, R^3, R^4, R^5, R^6, R^7, R^8, and R^9 are unsubstituted and the groups of R^{10} and R^{11} are as described herein.

[0295] Auristatins of the formula (***X-B***) include those wherein said alkyl, alkenyl, alkynyl, alkylene, alkenylene, alkynyklene, aryl, carbocyle, and heterocycle radicals are unsubstituted.

[0296] Auristatins of the formula (***X-B***) include those wherein

$\mathbf{R^2}$ is C_1-C_3 alkyl; $\mathbf{R^3}$ is H or C_1-C_3 alkyl; $\mathbf{R^4}$ is C_1-C_5 alkyl; $\mathbf{R^5}$ is H; $\mathbf{R^6}$ is C_1-C_3 alkyl; $\mathbf{R^7}$ is C_1-C_5 alkyl; $\mathbf{R^8}$ is C_1-C_3 alkoxy; $\mathbf{R^9}$ is hydrogen or C_1-C_8 alkyl;
$\mathbf{R^{10}}$ is optionally substituted phenyl; **G** is O, S, or NH; and R^{11} is as defined herein; or a pharmaceutically acceptable salt form thereof.

[0297] Auristatins of the formula (***X-B***) include those wherein

$\mathbf{R^2}$ is methyl; $\mathbf{R^3}$ is H or C_1-C_3 alkyl; $\mathbf{R^4}$ is C_1-C_5 alkyl; $\mathbf{R^5}$ is H; $\mathbf{R^6}$ is methyl; $\mathbf{R^7}$ is isopropyl or sec-butyl; $\mathbf{R^8}$ is methoxy; $\mathbf{R^9}$ is hydrogen or C_1-C_8 alkyl;
$\mathbf{R^{10}}$ is optionally substituted phenyl; **G** is O, S, or NH; and R^{11} is as defined herein; or a pharmaceutically acceptable salt form thereof.

[0298] Auristatins of the formula (***X-B***) include those wherein

$\mathbf{R^2}$ is methyl; $\mathbf{R^3}$ is H or C_1-C_3 alkyl; $\mathbf{R^4}$ is C_1-C_5 alkyl; $\mathbf{R^5}$ is H; $\mathbf{R^6}$ is methyl; $\mathbf{R^7}$ is isopropyl or sec-butyl; $\mathbf{R^8}$ is methoxy; $\mathbf{R^9}$ is hydrogen or C_1-C_8 alkyl; $\mathbf{R^{10}}$ is phenyl; and **G** is O or NH and R^{11} is as defined herein, preferably hydrogen; or a pharmaceutically acceptable salt form thereof.

[0299] Auristatins of the formula (***X-B***) include those wherein

$\mathbf{R^2}$ is C_1-C_3 alkyl; $\mathbf{R^3}$ is H or C_1-C_3 alkyl; $\mathbf{R^4}$ is C_1-C_5 alkyl; $\mathbf{R^5}$ is H; $\mathbf{R^6}$ is C_1-C_3 alkyl; $\mathbf{R^7}$ is C_1-C_5 alkyl; $\mathbf{R^8}$ is C_1-C_3 alkoxy; $\mathbf{R^9}$ is hydrogen or C_1-C_8 alkyl;

$\mathbf{R^{10}}$ is phenyl; and **G** is O or NH and R^{11} is as defined herein, preferably hydrogen; or a pharmaceutically acceptable salt form thereof.

[0300] Auristatins of the formula (***X-A***) or (***X-B***) include those wherein R^3, R^4 and R^7 are independently isopropyl or sec-butyl and R^5 is -H. In an exemplary embodiment, R^3 and R^4 are each isopropyl, R^5 is H, and R^7 is sec-butyl. The remainder of the substituents are as defined herein.

[0301] Auristatins of the formula (***X-A***) or (***X-B***) include those wherein R^2 and R^6 are each methyl, and R^9 is H. The remainder of the substituents are as defined herein.

[0302] Auristatins of the formula (***X-A***) or (***X-B***) include those wherein each occurrence of R^8 is $-OCH_3$. The remainder of the substituents are as defined herein.

[0303] Auristatins of the formula (***X-A***) or (***X-B***) include those wherein R^3 and R^4 are each isopropyl, R^2 and R^6 are each methyl, R^5 is H, R^7 is sec-butyl, each occurrence of R^8 is $-OCH_3$, and R^9 is H. The remainder of the substituents are as defined herein.

[0304] Auristatins of the formula (***X-B***) include those wherein **G** is -O- or -NH-. The remainder of the substituents are as defined herein.

[0305] Auristatins of the formula (***X-B***) include those wherein R^{10} is aryl. The remainder of the substituents are as defined herein.

[0306] Auristatins of the formula (***X-B***) include those where R^{10} is -phenyl. The remainder of the substituents are as defined herein.

[0307] Auristatins of the formula (***X-B***)include those wherein **G** is -O-, and R^{11} is H, methyl or t-butyl. The remainder of the substituents are as defined herein.

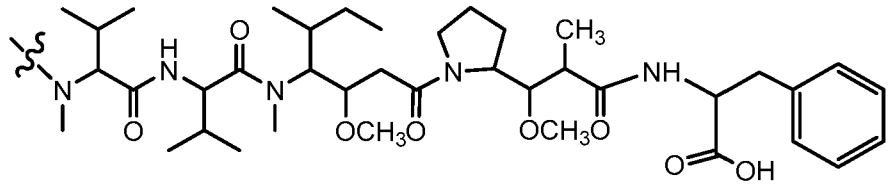
[0308] Auristatins of the formula (***X-B***) include those wherein, when **G** is -NH, R^{11} is $-(R^{13}O)_s-CH(R^{15})_2$, wherein R^{15} is $-(CH_2)_t-N(R^{16})_2$, and R^{16} is $-C_1-C_8$ alkyl or $-(CH_2)_t-COOH$. The remainder of the substituents are as defined herein.

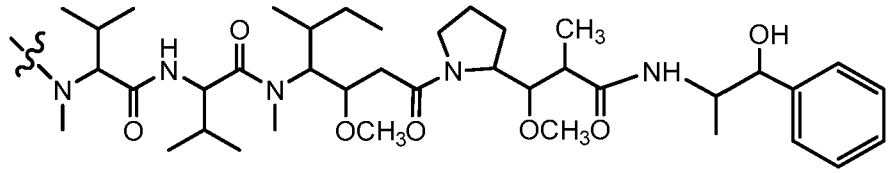
[0309] Auristatins of the formula (***X-B***) include those wherein when **G** is -NH, R^{11} is $-(R^{13}O)_s-CH(R^{15})_2$, wherein R^{15} is H or $-(CH_2)_t-SO_3H$. The remainder of the substituents are as defined herein.

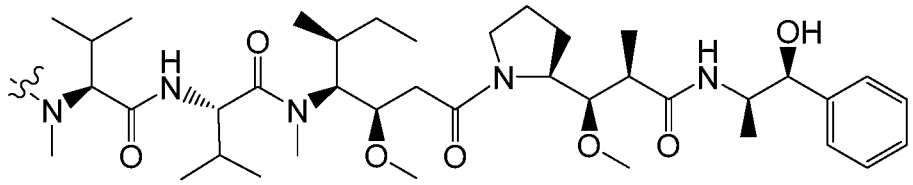
[0310] In preferred embodiments of the immunoconjugates of formula (***II***), when **Z** is an auristatin molecule of formula (***X-A***), w is an integer ranging from 1 to 12, preferably 2 to 12, y is 1 or 2, and a is preferably 1.

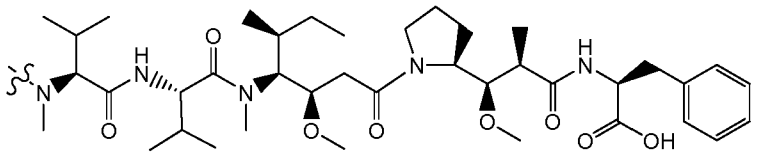
[0311] In some embodiments of the immunoconjugates of formula (***II***), when **Z** is an auristatin molecule of formula (***X-B***), a is 1 and w and y are 0.

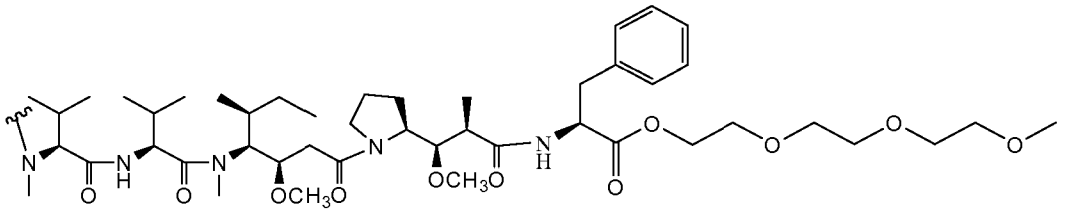
[0312] Illustrative therapeutic agents (-**Z**) include those having the following structures:



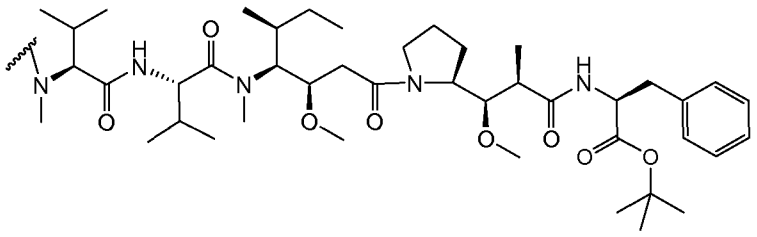




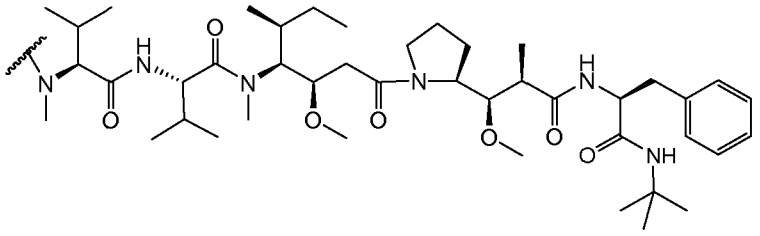




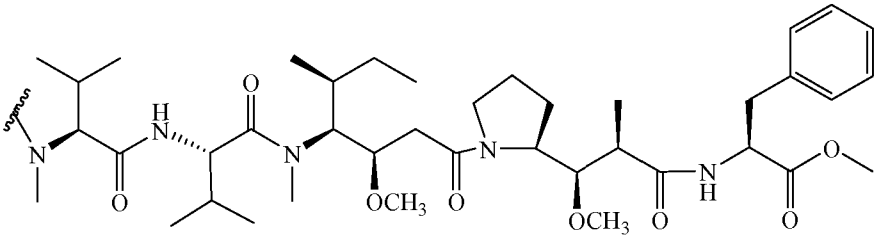
,



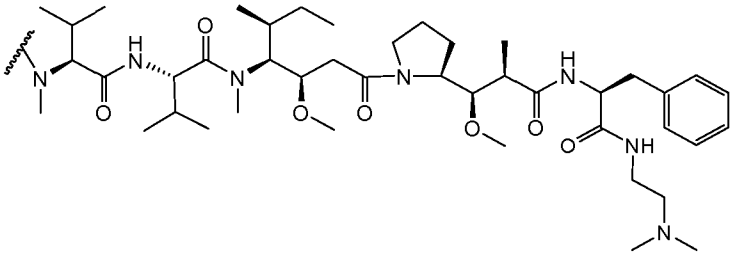
,



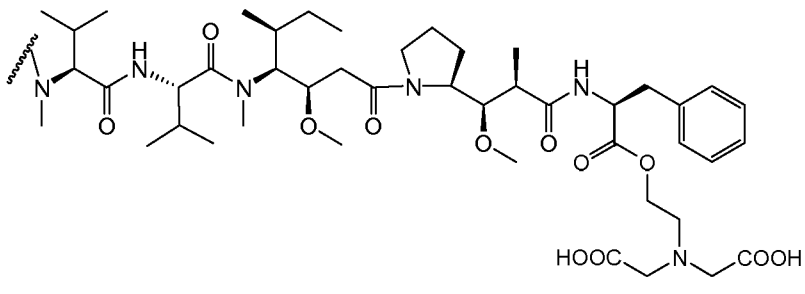
,



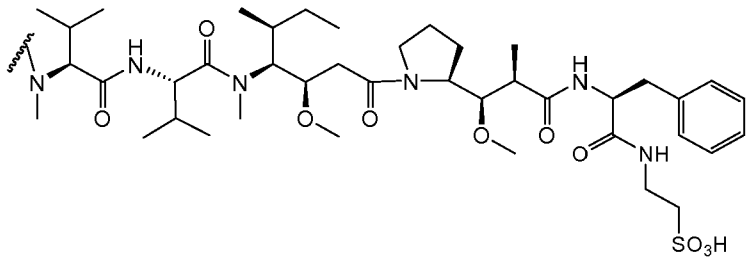
,



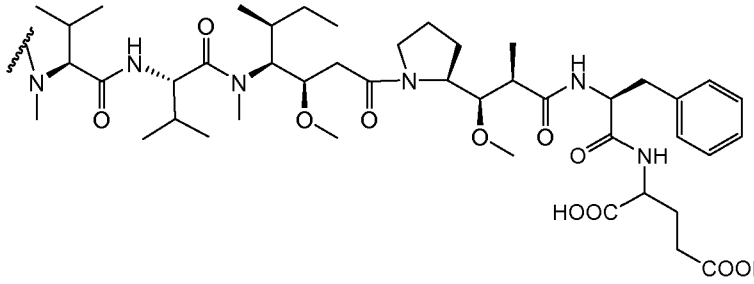
,



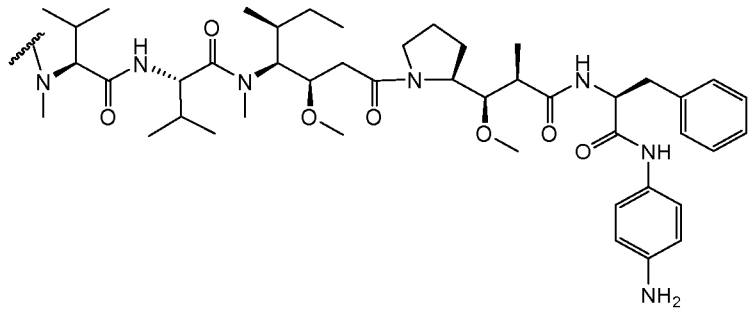
,



,



, and



[0313] In one aspect, hydrophilic groups, such as but not limited to triethylene glycol esters (TEG) can be attached to the auristatin molecule of formula (***X-B***) at R^{11}. Without being bound by theory, the hydrophilic groups assist in the internalization and non-agglomeration of the therapeutic agent.

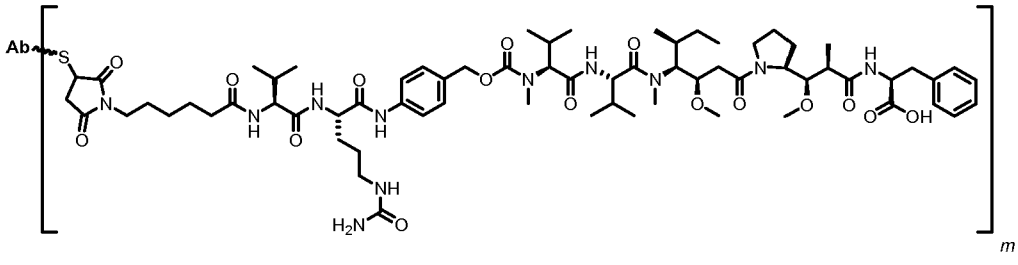
[0314] In some embodiments, the therapeutic agent is not TZT-1027. In some embodiments, the therapeutic agent is not auristatin E, dolastatin 10, or auristatin PE.

[0315] In some embodiments, the auristatin molecule is linked to a cysteine moiety on the antibody molecule by way of a linker containing a maleimide moiety, e.g., a maleimidocaproyl moiety.

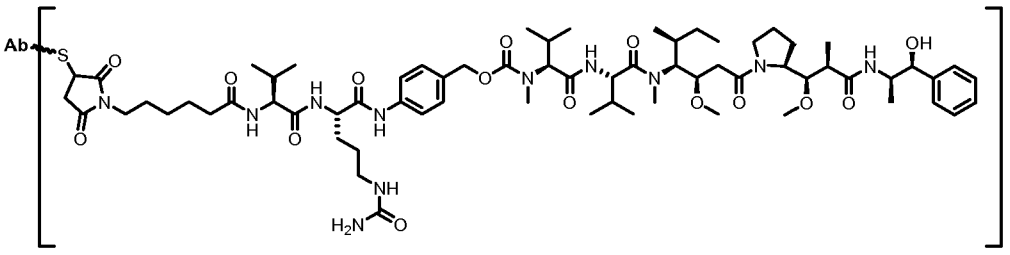
[0316] In some embodiments, the auristatin molecule is coupled to the antibody molecule using a heterobifunctional linker that is connected to a hydroxyl group on the auristatin molecule. In some such embodiments, the linker comprises a hydrazone. In some embodiments, the linker is a hydrazone compound formed by reaction of maleimidocaproylhydrazide and a ketocarboxylic acid, e.g., 5-benzoylvaleric acid. In particular embodiments, the linker is (Z)-6-(2-(6-(2,5-dioxo-2,5-dihydro-1H-pyrrol-1-yl)-hexanoyl)hydrazono)-6-phenylhexanoic acid.

[0317] In some other embodiments the auristatin molecule is coupled to the antibody using a heterobifunctional linker that is connected to a monomethyl amino group on the auristatin molecule. In some embodiments, the linker comprises a cleavable moiety, e.g., a peptide moiety, and a self-immolative *p*-aminobenzylcarbamate spacer. Exemplary linkers include maleimidocaproyl (mc), maleimidocaproyl-L-phenylalanine-L-lysine-*p*-aminobenzylcarbamate, and maleimidocaproyl-L-valine-L-citrulline-*p*-aminobenzylcarbamate (vc).

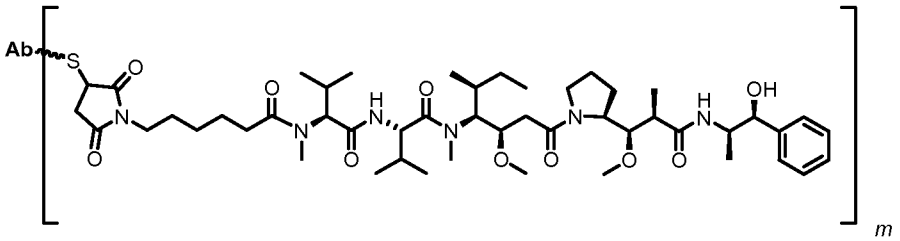
[0318] In certain embodiments, the immunoconjugate of formula (***I***) is characterized by the formula Ab-(vc-MMAF)$_m$ (formula (***I-4***)); Ab-(vc-MMAE)$_m$ (formula (***I-5***)); Ab-(mc-MMAE)$_m$ (formula (***I-6***)); or Ab-(mc-MMAF)$_m$, (formula (***I-7***)), wherein Ab is an anti-GCC antibody molecule as described herein, S is a sulfur atom of the antibody, and *m* has the values and preferred values described above for formula (***I***). In certain embodiments, *m* is an integer from 1 to about 5.



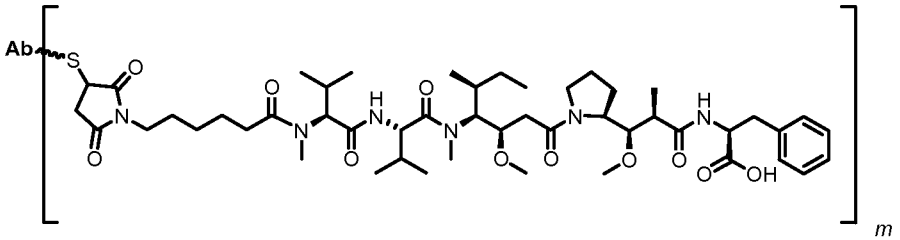
(***I-4***)



(*I-5*)



(*I-6*)



(*I-7*)

[0319] In some embodiments, the variable Ab in formula (*I-4*), (*I-5*), (*I-6*), or (*I-7*) is an antibody molecule with features summarized in Tables 1 to 6. In certain embodiments, the variable Ab is a 5F9 antibody molecule or an Abx-229 antibody molecule.

[0320] In some embodiments, the variable *m* in formula (*I-4*), (*I-5*), (*I-6*), or (*I-7*) ranges from about 2 to about 10, from about 6 to about 8, or from about 4 to about 6.

[0321] In certain particular embodiments, the invention relates to an immunoconjugate of formula (*I-4*), (*I-5*), (*I-6*), or (*I-7*), wherein Ab is a 5F9 antibody molecule and *m* is about 4.

[0322] The immunoconjugates disclosed herein can be used for modifying a given biological response. The therapeutic agent is not to be construed as limited to classical chemical therapeutic agents. For example, the therapeutic agent may be a nucleic acid, protein, or polypeptide possessing a desired biological activity. For example, the antibody

molecule can be conjugated to an antisense molecule, an siRNA molecule, shRNA molecule or miRNA molecule that can interfere with expression of a gene, thereby producing a desired biological effect.

[0323] Proteins and polypeptides that can be conjugated to the antibody molecules of the invention include, for example, toxins and components thereof, such as abrin, abrin A chain, ricin, ricin A chain, modeccin, modeccin A chain, alpha-sarcin, exotoxin A (from *Pseudomonas aeruginosa*), PE38 (truncated pseudomonas exotoxin), gelonin, diphtheria toxin, diphtheria toxin A fragment, certain *Aleurites fordii* proteins, certain *Dianthus caryophyllus* proteins (e.g., dianthin 30 and dianthin 32), certain *Phytolacca Americana* proteins (e.g., PAP, PAPII, and PAP-S), certain *Saponaria officinlis* proteins (e.g., saporin 6), *Momordica charantia* inhibitor, curcin, crotin, mitogillin, restrictocin, phenomycin, and enomycin; proteins to engage the immune system at the tumor or induce an effector function at the tumor, such as tumor necrosis factor, interferon, nerve growth factor, platelet derived growth factor, and tissue plasminogen activator; and biological response modifiers such as, for example, cytokines and lymphokines (e.g., interleukin-1 ("IL-1"), interleukin-2 ("IL-2"), interleukin-6 ("IL-6"), granulocyte macrophase colony stimulating factor ("GM-CSF"), and granulocyte colony stimulating factor ("G-CSF")), and other growth factors.

[0324] The antibodies of the invention can also be conjugated or fused to viral surface proteins present on viral particles. For example, a single-chain anti-GCC antibody of the present invention could be fused (e.g., to form a fusion protein) to a viral surface protein. Alternatively, a whole anti-GCC antibody of the present invention, or a fragment thereof, could be chemically conjugated (e.g., via a chemical linker) to a viral surface protein. Preferably, the virus is one that fuses with endocytic membranes, e.g., an influenza virus, such that the virus is internalized along with the anti-GCC antibody and thereby infects GCC-expressing cells. The virus can be genetically engineered as a cellular toxin. For example, the virus could express or induce the expression of genes that are toxic to cells, e.g., cell death promoting genes. Preferably, such viruses would be incapable of viral replication.

[0325] An anti-GCC antibody molecule described herein can also be conjugated to a prodrug or prodrug activator. In a method to kill or suppress tumor cells, a first anti-GCC antibody molecule of the invention is conjugated with a prodrug that is activated

only when in close proximity with a prodrug activator. The prodrug activator is conjugated with a second antibody molecule, preferably one that binds to a non-competing site on the GCC molecule. Whether two antibodies bind to competing or non-competing binding sites can be determined by conventional competitive binding assays. Drug-prodrug pairs suitable for use in the practice of the present invention are described in Blakely et al., "ZD2767, an Improved System for Antibody-directed Enzyme Prodrug Therapy That Results in Tumor Regressions in Colorectal Tumor Xenografts," (1996) *Cancer Research*, 56:3287-3292.

[0326] Therapeutically active radioisotopes can also be coupled to anti-GCC antibodies, or antigen binding fragments, or derivatives thereof. Radioactive isotopes can be used in diagnostic or therapeutic applications. Radioactive isotopes that can be coupled to the anti-GCC antibodies include, but are not limited to α-, β-, or γ-emitters, or β- and γ-emitters. See, e.g., S.E. Order, "Analysis, Results, and Future Prospective of the Therapeutic Use of Radiolabeled Antibody in Cancer Therapy," *Monoclonal Antibodies for Cancer Detection and Therapy*, R.W. Baldwin et al. (eds.), pp 303-316 (Academic Press 1985. Such radioactive isotopes include, but are not limited to copper (^{64}Cu), iodine (^{131}I or ^{125}I), yttrium (^{90}Y), lutetium (^{177}Lu), actinium (^{225}Ac), praseodymium, astatine (^{211}At), rhenium (^{186}Re), bismuth (^{212}Bi or ^{213}Bi), indium (^{111}In), technetium (^{99}mTc), phosphorus (^{32}P), rhodium (^{188}Rh), sulfur (^{35}S), carbon (^{14}C), tritium (^{3}H), chromium (^{51}Cr), chlorine (^{36}Cl), cobalt (^{57}Co or ^{58}Co), iron (^{59}Fe), selenium (^{75}Se), or gallium (^{67}Ga). Radioisotopes useful as therapeutic agents include yttrium (^{90}Y), lutetium (^{177}Lu), actinium (^{225}Ac), praseodymium, astatine (^{211}At), rhenium (^{186}Re), bismuth (^{212}Bi or ^{213}Bi), and rhodium (^{188}Rh). Radioisotopes useful as labels, e.g., for use in diagnostics, include iodine (^{131}I or ^{125}I), indium (^{111}In), technetium (^{99}mTc), phosphorus (^{32}P), carbon (^{14}C), and tritium (^{3}H), or one or more of the therapeutic isotopes listed above.

[0327] Radioimmunotherapy (RIT) using antibodies labeled with ^{131}I, ^{90}Y, and ^{177}Lu is under intense clinical investigation. There are significant differences in the physical characteristics of these three nuclides and as a result, the choice of radionuclide can be important in order to deliver maximum radiation dose to the tumor. The higher beta energy particles of ^{90}Y may be good for bulky tumors, but it may not be necessary for small tumors and especially bone metastases. The relatively low energy beta particles of ^{131}I are ideal, but *in vivo* dehalogenation of radioiodinated molecules is a major disadvantage for internalizing antibody. In contrast, ^{177}Lu has low energy beta particle

with only 0.2-0.3 mm range and delivers much lower radiation dose to bone marrow compared to ^{90}Y. In addition, due to longer physical half-life (compared to ^{90}Y), the tumor residence times are higher. As a result, higher activities (more mCi amounts) of ^{177}Lu labeled agents can be administered with comparatively less radiation dose to marrow. There have been several clinical studies investigating the use of ^{177}Lu labeled antibodies in the treatment of various cancers. (Mulligan T et al. *Clin Cancer Res*. 1: 1447-1454(1995); Meredith RF, et al. *J Nucl Med* 37:1491-1496(1996); Alvarez RD, et al. *Gynecologic Oncology* 65: 94-101(1997)).

[0328] Useful detectable agents with which an antibody or an antibody portion of the invention may be derivatized (or labeled) include fluorescent compounds, various enzymes, prosthetic groups, luminescent materials, bioluminescent materials, fluorescent emitting metal atoms, e.g., europium (Eu), and other anthanides, and radioactive materials (described above). Exemplary fluorescent detectable agents include fluorescein, fluorescein isothiocyanate, rhodamine, 5-dimethylamine-1-napthalenesulfonyl chloride, phycoerythrin and the like. An antibody may also be derivatized with detectable enzymes, such as alkaline phosphatase, horseradish peroxidase, β-galactosidase, acetylcholinesterase, glucose oxidase and the like. When an antibody is derivatized with a detectable enzyme, it is detected by adding additional reagents that the enzyme uses to produce a detectable reaction product. For example, when the detectable 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 derivatized with a prosthetic group (e.g., streptavidin/biotin and avidin/biotin). For example, an antibody may be derivatized with biotin, and detected through indirect measurement of avidin or streptavidin binding. 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; and examples of bioluminescent materials include luciferase, luciferin, and aequorin.

Pharmaceutical Compositions

[0329] In another aspect, the invention features compositions, e.g., pharmaceutically acceptable compositions, which include an anti-GCC antibody molecule or immunoconjugate thereof, as described herein, formulated together with a

pharmaceutically acceptable carrier. In embodiments, the anti-GCC antibody molecule is one with exemplary features summarized in Tables 1 and 2.

[0330] As used herein, "pharmaceutically acceptable carrier" includes any and all solvents, dispersion media, isotonic and absorption delaying agents, and the like that are physiologically compatible. The carrier can be suitable for intravenous, intramuscular, subcutaneous, parenteral, rectal, spinal or epidermal administration (*e.g.*, by injection or infusion). The pharmaceutical composition can include one or more additional excipients, e.g., salts, buffers, tonicity modifiers, lyoprotectants, nonionic detergents, surfactants, and preservatives.

[0331] The compositions may be in a variety of forms. These include, for example, liquid, semi-solid and solid dosage forms, such as liquid solutions (e.g., injectable and infusible solutions), dispersions or suspensions, liposomes and suppositories. The preferred form depends on the intended mode of administration and therapeutic application. Some typical compositions are in the form of injectable or infusible solutions, intended for parenteral administration (*e.g.*, intravenous, subcutaneous, intraperitoneal, intramuscular). In some embodiments, the antibody is administered by intravenous infusion or injection. In other embodiments, the antibody is administered by intramuscular or subcutaneous injection.

[0332] The phrases "parenteral administration" and "administered parenterally" as used herein means modes of administration other than enteral and topical administration, usually by injection, and includes, without limitation, intravenous, intramuscular, intraarterial, intrathecal, intracapsular, intraorbital, intracardiac, intradermal, intraperitoneal, transtracheal, subcutaneous, subcuticular, intraarticular, subcapsular, subarachnoid, intraspinal, epidural and intrasternal injection and infusion.

[0333] In some embodiments, the pharmaceutical composition is sterile and stable under the conditions of manufacture and storage. The composition can be formulated as a solution, microemulsion, dispersion, liposome, microsphere, or other ordered structure suitable to high antibody concentration. Sterile injectable solutions can be prepared by incorporating the active compound (*i.e.*, antibody or antibody portion) in the required amount in an appropriate solvent with one or a combination of ingredients enumerated above, as required, followed by sterilization, e.g., by filtration. 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. In the case of sterile powders for the preparation of sterile injectable solutions, the provided methods of preparation are vacuum drying and freeze-drying that yields a powder of the active ingredient plus any additional desired ingredient from a previously sterile-filtered solution thereof. The proper fluidity of a solution can be maintained, for example, by the use of a coating such as lecithin, by the maintenance of the required particle size in the case of dispersion and by the use of surfactants. Prolonged absorption of injectable compositions can be brought about by including in the composition an agent that delays absorption, for example, monostearate salts and gelatin.

[0334] The antibodies and antigen binding fragments of the present invention can be administered by a variety of methods known in the art, although for many therapeutic applications, the route/mode of administration is intravenous injection or infusion. As will be appreciated by the skilled artisan, the route and/or mode of administration will vary depending upon the desired results. In certain embodiments, the active compound may be prepared with a carrier that will protect the compound 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.

[0335] In certain embodiments, an anti-GCC antibody molecule or immunoconjugate described herein may be orally administered, for example, with an inert diluent or an assimilable edible carrier. The compound (and other ingredients if desired) may also be enclosed in a hard or soft shell gelatin capsule, compressed into tablets, buccal tablets, troches, capsules, elixirs, suspensions, syrups, wafers, and the like. To administer an antibody or an antibody fragment of the invention 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.

[0336] Therapeutic compositions can be administered with medical devices known in the art. For example, pharmaceutical preparations can be disposed within a device, e.g.,

an air- or liquid-tight container, which contains one or more dosages. Examples of delivery devices include, without limitation, vials, cannulas, needles, drip bags, and lines. The invention also provides methods of placing an antibody molecule or immunoconjugate described herein into such a device.

[0337] In some embodiments, the invention provides an anti-GCC antibody molecule or immunoconjugate described herein, which is formulated in a liposome composition. In some embodiments, the liposome is coated with antibody molecule. In some such embodiments, the liposome is filled with a therapeutic agent. Liposomic delivery can allow for the delivery of an agent, e.g., a therapeutic agent, that is not linked to the antibody. This approach can be used to deliver an agent, e.g., a therapeutic agent, that is not amenable to cross-linking to the antibody molecule or an agent, e.g., a therapeutic agent, which is to be sequestered, or which contact with non-target cells should be minimized. In particular embodiments, the liposome is filled with a cytostatic or cytotoxic agent. In certain particular embodiments, the therapeutic agent is selected from the group consisting of maytansinoids, an auristatins, dolastatins, duocarmycins, cryptophycins, taxanes, DNA alkylating agents calicheamicins, and derivatives of the foregoing. In other embodiments, the liposome is filled with nucleic acid sequence comprising RNA interference molecules, e.g., antisense molecules, siRNA, hsRNA or miRNA molecules, which are capable of diminishing GCC expression or the expression of another gene, e.g., an oncogene, in cells expressing GCC. In some other embodiments, the liposome is coated or filled with an immunoconjugate comprising an anti-GCC antibody molecule and a therapeutic agent or label.

[0338] Dosage regimens are adjusted to provide the optimum desired response (*e.g.*, a therapeutic response). For example, a single bolus may be administered, several divided doses may be administered over time or the dose may 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. The term "dosage unit form," as used herein, refers to physically discrete units suited as unitary dosages for the subjects to be treated; each unit contains a predetermined 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 invention are dictated by and directly dependent on (a) the unique characteristics of the active compound and the particular

therapeutic effect to be achieved, and (b) the limitations inherent in the art of compounding such an active compound for the treatment of sensitivity in individuals.

[0339] An exemplary, non-limiting range for a therapeutically or prophylactically effective amount of an antibody or an antigen binding fragment of the invention is 0.1-20 mg/kg, or 1-10 mg/kg. 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.

[0340] The pharmaceutical compositions of the invention may include a "therapeutically effective" amount of an antibody or an antigen binding fragment of the invention. 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 modified antibody or antibody fragment 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 modified antibody or antibody fragment is outweighed by the therapeutically beneficial effects. A "therapeutically effective dosage" preferably inhibits a measurable parameter (e.g., tumor growth rate) in treated subjects by at least about 20%, at least about 40%, at least about 60%, and in some embodiments at least about 80%, relative to untreated subjects. The ability of a compound to inhibit a measurable parameter, e.g., cancer, can be evaluated in an animal model system predictive of efficacy in human tumors. Alternatively, this property of a composition can be evaluated by examining the ability of the compound to inhibit, such inhibition *in vitro* by assays known to the skilled practitioner.

[0341] Also within the scope of the invention are kits comprising an anti-GCC antibody molecule or immunoconjugate as described herein. Further included are kits comprising liposome compositions comprising an anti-GCC antibody molecule or immunoconjugate. The kit can include one or more other elements including: instructions

for use; other reagents, e.g., a label, a therapeutic agent, or an agent useful for chelating, or otherwise coupling, an antibody to a label or therapeutic agent, or a radioprotective composition; devices or other materials for preparing the antibody for administration; pharmaceutically acceptable carriers; and devices or other materials for administration to a subject. Instructions for use can include instructions for diagnostic applications of the anti-GCC antibody molecule or immunoconjugate to detect GCC, *in vitro*, e.g., in a sample, e.g., a biopsy or cells from a patient having a cancer, or *in vivo*. The instructions can include guidance for therapeutic application including suggested dosages and/or modes of administration, e.g., in a patient with a cancer (e.g., a cancer of gastrointestinal origin, such as, for example, colon cancer, stomach cancer, esophageal cancer). Other instructions can include instructions on coupling of the antibody to a chelator, a label or a therapeutic agent, or for purification of a conjugated antibody, e.g., from unreacted conjugation components. As discussed above, the kit can include a label, e.g., any of the labels described herein. As discussed above, the kit can include a therapeutic agent, e.g., a therapeutic agent described herein. In some applications the antibody will be reacted with other components, e.g., a chelator or a label or therapeutic agent, e.g., a radioisotope, e.g., yttrium or lutetium. In such cases the kit can include one or more of a reaction vessel to carry out the reaction or a separation device, e.g., a chromatographic column, for use in separating the finished product from starting materials or reaction intermediates.

[0342] The kit can further contain at least one additional reagent, such as a diagnostic or therapeutic agent, e.g., a diagnostic or therapeutic agent as described herein, and/or one or more additional anti-GCC antibody molecules or immunoconjugates, formulated as appropriate, in one or more separate pharmaceutical preparations.

[0343] The kit can further contain a radioprotectant. The radiolytic nature of isotopes, e.g., ^{90}Yttrium (^{90}Y) is known. In order to overcome this radiolysis, radioprotectants may be included, e.g., in the reaction buffer, as long as such radioprotectants are benign, meaning that they do not inhibit or otherwise adversely affect the labeling reaction, e.g., of an isotope, such as of ^{90}Y, to the antibody. The formulation buffer of the present invention may include a radioprotectant such as human serum albumin (HSA) or ascorbate, which minimize radiolysis due to yttrium or other strong radionuclides. Other radioprotectants are known in the art and can also be used in the formulation buffer of the present invention, i.e., free radical scavengers (phenol, sulfites,

glutathione, cysteine, gentisic acid, nicotinic acid, ascorbyl palmitate, $HOP(:O)H_2I$ glycerol, sodium formaldehyde sulfoxylate, $Na_2S_2O.$, $Na_2S_2O_3$, and SO_2, etc.).

[0344] A provided kit is one useful for radiolabeling a chelator- conjugated protein or peptide with a therapeutic radioisotope for administration to a patient. The kit includes (i) a vial containing chelator-conjugated antibody, (ii) a vial containing formulation buffer for stabilizing and administering the radiolabeled antibody to a patient, and (iii) instructions for performing the radiolabeling procedure. The kit provides for exposing a chelator-conjugated antibody to the radioisotope or a salt thereof for a sufficient amount of time under amiable conditions, e.g., as recommended in the instructions. A radiolabeled antibody having sufficient purity, specific activity and binding specificity is produced. The radiolabeled antibody may be diluted to an appropriate concentration, e.g., in formulation buffer, and administered directly to the patient with or without further purification. The chelator- conjugated antibody may be supplied in lyophilized form.

Uses

[0345] The anti-GCC antibody molecules described herein have *in vitro* and *in vivo* diagnostic, prognostic, imaging, therapeutic and prophylactic utilities. For example, these antibody molecules can be administered to cells in culture, e.g. *in vitro* or *ex vivo*, or administered in a subject, e.g., *in vivo*, to treat, prevent, and/or diagnose a variety of disorders.

[0346] The antibody molecules, immunoconjugates, and fusion proteins described herein can be used can modulate an activity or function of a GCC protein, such as ligand binding (e.g., binding of ST or guanylin), GCC-mediated signal transduction, maintenance of intestinal fluid, electrolyte homeostasis, intracellular calcium release (calcium flux), cell differentiation, cell proliferation, or cell activation.

[0347] In one aspect, the invention features a method of killing, inhibiting or modulating the growth of, or interfering with the metabolism of, a GCC-expressing cell. In one embodiment, the invention provides a method of inhibiting GCC-mediated cell signaling or a method of killing a cell. The method may be used with any cell or tissue which expresses GCC, such as a cancerous cell (e.g., a cell from a cancer of the gastrointestinal system, such as, for example, a cancer of the colon, stomach, or esophagus, or a pancreatic cell), or a metastatic lesion. Nonlimiting examples of GCC-expressing

cells include T84 human colonic adenocarcinoma cells, fresh or frozen colonic tumor cells, and cells comprising a recombinant nucleic acid encoding GCC or a portion thereof.

[0348] Methods of the invention include the steps of contacting the cell with an anti-GCC antibody molecule or immunoconjugate thereof, as described herein, in an effective amount, i.e., amount sufficient to inhibit GCC-mediated cell signaling or an amount sufficient to kill the cell. The method can be used on cells in culture, e.g. *in vitro, in vivo, ex vivo*, or *in situ*. For example, cells that express GCC (e.g., cells collected by biopsy of a tumor or metastatic lesion; cells from an established cancer cell line; or recombinant cells), can be cultured *in vitro* in culture medium and the contacting step can be effected by adding the anti-GCC antibody molecule or immunoconjugate to the culture medium. In methods of killing a cell, the method comprises using a naked anti-GCC antibody molecule, or an immunoconjugate comprising an anti-GCC antibody molecule and a cytotoxic agent. The method will result in killing of cells expressing GCC, including in particular tumor cells expressing GCC (e.g., colonic tumor cells).

[0349] Reference to Table 7 can serve as a guide to select an antibody(ies) to use for various methods. For example, Table 7 indicates which antibodies were confirmed to internalize after binding GCC. Such antibodies would be useful when linked to a cytotoxic moiety or a moiety for cell imaging. Antibodies which do not internalize can be used for diagnostic purposes or therapeutic methods using naked antibody designed to elicit an antibody-dependent cell-mediated cytotoxic response, or perhaps for liposome delivery methods.

[0350] Anti-GCC antibody molecules of the present invention bind to extracellular domains of GCC or portions thereof in cells expressing the antigen. As a result, when practicing the methods of the present invention to kill, suppress, or detect cancerous cells, the antibodies or antigen binding fragments, bind to all such cells, not only to cells which are fixed or cells whose intracellular antigenic domains are otherwise exposed to the extracellular environment. Consequently, binding of the antibodies or antigen binding fragments, is concentrated in areas where there are cells expressing GCC, irrespective of whether these cells are fixed or unfixed, viable or necrotic. Additionally or alternatively, the anti-GCC antibody molecules, bind to and are internalized with GCC upon binding cells expressing the antigen.

[0351] The method also can be performed on cells present in a subject, as part of an *in vivo* protocol. In one embodiment, the subject is a human subject. Alternatively, the subject can be a mammal expressing a GCC antigen with which an anti-GCC antibody molecule disclosed herein cross-reacts. An anti-GCC antibody molecule or immunoconjugate thereof can be administered to a human subject for therapeutic purposes. An anti-GCC antibody molecule or immunoconjugate also can be administered to a non-human mammal expressing the GCC-like antigen with which the antibody cross-reacts (e.g., a primate, pig or mouse) for veterinary purposes or as an animal model of human disease. Animal models may be useful for evaluating the therapeutic efficacy of antibodies of the invention (e.g., testing of dosages and time courses of administration). For *in vivo* embodiments, the contacting step is effected in a subject and includes administering an anti-GCC antibody molecule or immunoconjugate thereof to the subject under conditions effective to permit both binding of the antibody molecule to the extracellular domain of GCC expressed on the cell, and the treating of the cell.

[0352] In one embodiment, the invention provides a method of treating cancer by administering an anti-GCC antibody molecule or an immunoconjugate comprising an anti-GCC antibody molecule and a cytotoxic agent to a patient in need of such treatment. The method can be used for the treatment of any cancerous disorder which includes at least some cells that express the GCC antigen. As used herein, the term "cancer" is meant to include all types of cancerous growths or oncogenic processes, metastatic tissues or malignantly transformed cells, tissues, or organs, irrespective of histopathologic type or stage of invasiveness. The terms "cancer" and "tumor" may be used interchangeably (e.g., when used in the context of treatment methods, "treatment of a cancer" and "treatment of a tumor" have the same meaning).

[0353] In embodiments, the treatment is sufficient to reduce or inhibit the growth of the subject's tumor, reduce the number or size of metastatic lesions, reduce tumor load, reduce primary tumor load, reduce invasiveness, prolong survival time, or maintain or improve the quality of life.

[0354] Examples of cancerous disorders include, but are not limited to, solid tumors, soft tissue tumors, and metastatic lesions. Examples of solid tumors include malignancies, e.g., sarcomas, adenocarcinomas, and carcinomas, of the various organ systems, such as those affecting colon and pancreas. Adenocarcinomas include

malignancies such as non-small cell carcinoma of the lung. Metastatic lesions of the aforementioned cancers can also be treated or prevented using the methods and compositions of the invention. In some embodiments, the cancer to be treated is a cancer of the gastrointestinal system (e.g., colorectal cancer, esophageal cancer, or stomach cancer). In some embodiments, the pancreatic cancer.

[0355] In one embodiment, the cancer is a colorectal cancer, e.g., colorectal adenocarcinoma, colorectal leiomyosarcoma, colorectal lymphoma, colorectal melanoma, or a colorectal neuroendocrine tumor. In a particular embodiment, the cancer is metastatic colon cancer. In another embodiment, the cancer is a stomach cancer (e.g., gastric adenocarcinoma, lymphoma, or sarcoma), or metastasis thereof. In another embodiment, the cancer is an esophageal cancer (e.g., a squamous cell carcinoma or adenocarcinoma of the esophagus).

[0356] The method can be useful in treating a relevant disorder at any stage or subclassification. For example, method can be used to treat early or late stage colon cancer, or colon cancer of any of stages 0, I, IIA, IIB, IIIA, IIIB, IIIC, and IV.

[0357] In some embodiments, the method for treating cancer (e.g., colorectal, esophageal, or stomach cancer) comprises administering to a patient in need of such treatment a naked anti-GCC antibody molecule described herein. In other embodiments, the method comprises administering an immunoconjugate comprising an anti-GCC antibody molecule described herein and a cytotoxic agent. In some such embodiments, the immunoconjugate is characterized by formula (***I***), as described herein. In certain embodiments, the immunoconjugate is characterized by formula (***I-1***), (***I-2***), (***I-3***), (***I-4***), (***I-5***), (***I-6***), or (***I-7***) as described herein. In particular embodiments, the immunoconjugate is characterized by formula (***I***), (***I-1***), (***I-2***), (***I-3***), (***I-4***), (***I-5***), (***I-6***), or (***I-7***), wherein the variable Ab is an antibody molecule with features summarized in Tables 1 to 6. In certain embodiments, the variable Ab is a 5F9 antibody molecule or an Abx-229 antibody molecule. In certain particular embodiments, the immunoconjugate is characterized by formula (***I-5***) or (***I-7***), wherein the variable Ab is a 5F9 antibody molecule.

[0358] Methods of administering antibody molecules and immunoconjugates are described above. Suitable dosages of the molecules used will depend on the age and weight of the subject and the particular compound used.

[0359] In some embodiments, the anti-GCC antibody molecule or immunoconjugate is administered in treatment cycles. A "treatment cycle" consists of a treatment period, during which the anti-GCC antibody molecule or immunoconjugate is administered as described above, followed by a rest period, during which no anti-GCC antibody molecule or immunoconjugate is administered. The treatment cycle can be repeated as necessary to achieve the desired effect.

[0360] The anti-GCC antibodies described herein (e.g., naked anti-GCC antibody molecules or immunoconjugates comprising an anti-GCC antibody molecule and a therapeutic agent) may be used in combination with other therapies. For example, the combination therapy can include a composition of the present invention co-formulated with, and/or co-administered with, one or more additional therapeutic agents, e.g., one or more anti-cancer agents, e.g., cytotoxic or cytostatic agents, hormone treatment, vaccines, and/or other immunotherapies. In other embodiments, the anti-GCC antibodies are administered in combination with other therapeutic treatment modalities, including surgery, radiation, cryosurgery, and/or thermotherapy. Such combination therapies may advantageously utilize lower dosages of the administered therapeutic agents, thus avoiding possible toxicities or complications associated with the various monotherapies.

[0361] Administered "in combination," as used herein, means that two (or more) different treatments are delivered to the subject during the course of the subject's affliction with the disorder, e.g., the two or more treatments are delivered after the subject has been diagnosed with the disorder and before the disorder has been cured or eliminated. In some embodiments, the delivery of one treatment is still occurring when the delivery of the second begins, so that there is overlap. This is sometimes referred to herein as "simultaneous" or "concurrent delivery." In other embodiments, the delivery of one treatment ends before the delivery of the other treatment begins. In some embodiments of either case, the treatment is more effective because of combined administration. For example, the second treatment is more effective, e.g., an equivalent effect is seen with less of the second treatment, or the second treatment reduces symptoms to a greater extent, than would be seen if the second treatment were administered in the absence of the first treatment, or the analogous situation is seen with the first treatment. In some embodiments, delivery is such that the reduction in a symptom, or other parameter related to the disorder is greater than what would be observed with one treatment delivered in the absence of the other. The effect of the two treatments can be partially additive, wholly

additive, or greater than additive. The delivery can be such that an effect of the first treatment delivered is still detectable when the second is delivered.

[0362] In some embodiments, the anti-GCC antibody molecule or immunoconjugate thereof is used in combination with a chemotherapeutic agent. Non-limiting examples of DNA damaging chemotherapeutic agents include topoisomerase I inhibitors (e.g., irinotecan, topotecan, camptothecin and analogs or metabolites thereof, and doxorubicin); topoisomerase II inhibitors (e.g., etoposide, teniposide, and daunorubicin); alkylating agents (e.g., melphalan, chlorambucil, busulfan, thiotepa, ifosfamide, carmustine, lomustine, semustine, streptozocin, decarbazine, methotrexate, mitomycin C, and cyclophosphamide); DNA intercalators (e.g., cisplatin, oxaliplatin, and carboplatin); DNA intercalators and free radical generators such as bleomycin; and nucleoside mimetics (e.g., 5-fluorouracil, capecitibine, gemcitabine, fludarabine, cytarabine, mercaptopurine, thioguanine, pentostatin, and hydroxyurea).

[0363] Chemotherapeutic agents that disrupt cell replication include: paclitaxel, docetaxel, and related analogs; vincristine, vinblastin, and related analogs; thalidomide, lenalidomide, and related analogs (e.g., CC-5013 and CC-4047); protein tyrosine kinase inhibitors (e.g., imatinib mesylate and gefitinib); proteasome inhibitors (e.g., bortezomib); NF-κB inhibitors, including inhibitors of IκB kinase; antibodies which bind to proteins overexpressed in cancers and thereby downregulate cell replication (e.g., trastuzumab, rituximab, cetuximab, and bevacizumab); and other inhibitors of proteins or enzymes known to be upregulated, over-expressed or activated in cancers, the inhibition of which downregulates cell replication.

[0364] The selection of therapeutic agent(s) or treatment modality to be combined with an anti-GCC antibody molecule or immunoconjugate of the invention will depend on the disorder to be treated. The additional agent(s) or treatment modality may include, for example, standard approved therapies for the indication being treated. For example, when the anti-GCC antibody molecule or immunoconjugate thereof is used to treat colon cancer, it may be used in combination with, e.g., surgery; radiation therapy; 5-fluorouricil (5-FU), capecitibine, leucovorin, irinotecan, oxaliplatin, bevacizumab, cetuximab, panitumum, or combinations thereof (e.g., oxaliplatin/capecitibine (XELOX), 5-fluorouricil/leucovorin/-oxaliplatin (FOLFOX), 5-fluorouricil/leucovorin/irinotecan (FOLFIRI), FOLFOX plus bevacizumab, or FOLFIRI plus bevacizumab).

[0365] In another aspect, the invention features the use of an anti-GCC antibody molecule or immunoconjugate as described herein in the manufacture of a medicament. In an embodiment, the medicament is for treating cancer, e.g., a gastrointestinal cancer. In some embodiments, the medicament comprises an anti-GCC antibody molecule having features summarized in Tables 1-6. In some embodiments, the medicament comprises a 5F9 antibody molecule or Abx-229 antibody molecule.

[0366] Anti-GCC antibodies and immunoconjugates described herein can be used to detect the presence of GCC, e.g., to detect the presence of GCC in a biological sample, or to detect the presence or distribution of GCC in a subject. The term "detecting" as used herein encompasses quantitative or qualitative detection. Detecting GCC or GCC protein, as used herein, means detecting intact GCC protein or detecting a portion of the GCC protein that comprises the epitope to which the anti-GCC antibody molecule binds.

[0367] Accordingly, in another aspect, the invention features, a method of detecting GCC protein, e.g., detecting a GCC expressing cell or tissue, e.g., a tumor cell, or a tumor having cells, that express GCC. The method comprises: contacting a material, e.g., a cell or tissue, e.g., a sample of a tumor which expresses GCC, with an anti-GCC antibody molecule, e.g., an anti-GCC antibody molecule described herein, under conditions which allow formation of a complex between the anti-GCC antibody molecule and GCC protein; and detecting formation of a complex between antibody molecule and GCC protein, to thereby detect the presence of GCC protein, e.g., to detect a GCC expressing cell or tumor.

[0368] In an embodiment the anti-GCC antibody molecule is an immunoconjugate comprising a detectable label.

[0369] In certain embodiments, the tissues include normal and/or cancerous tissues that express GCC at higher levels relative to other tissues, for example other tissue such as B cells and/or B cell associated tissues.

[0370] Methods of detection described herein, whether *in vitro* or *in vivo*, can be used to evaluate a subject. In an embodiment the method is performed *in vivo*, and can be used, e.g., for imaging, staging, evaluation or diagnosis of a patient. In certain embodiments, the disorder is a cell proliferative disorder, such as a cancer or a tumor, e.g., colon cancer.

[0371] Thus, in another aspect, the invention provides, a method for detecting the presence of GCC protein *in vitro* (e.g., in a biological sample, such as a tissue biopsy, e.g., from a tumor tissue, from a subject) or *in vivo* (e.g., by *in vivo* imaging in a subject). The method comprises: (i) contacting a sample with an anti-GCC antibody molecule or immunoconjugate thereof, or administering to a subject, an anti-GCC antibody molecule or immunoconjugate thereof; and (ii) detecting formation of a complex between the anti-GCC antibody molecule and GCC protein. Complex formation is indicative of the presence or level of GCC.

[0372] In embodiments the level of complex detected in the sample or subject is compared with a reference value, e.g., a value for complex formation or level of GCC. In an embodiment a level of GCC which exceeds a reference value is indicative of a GCC-mediated disorder.

[0373] In an embodiment the method comprises contacting a reference sample, e.g., a control sample (e.g., a control biological sample, such as plasma, tissue, biopsy) or a control subject) with an anti-GCC antibody molecule or immunoconjugate thereof and comparing the level of complex detected therein with the level detected in the sample or subject.

[0374] In certain embodiments, a test cell or tissue is obtained from an individual suspected of having a disorder associated with increased expression of GCC.

[0375] In an embodiment the level of GCC, in a sample from the subject, or in the subject, is compared with a reference level, e.g., the level of GCC in a control material, e.g., a normal cell of the same tissue origin as the subject's cell or a cell having GCC at levels comparable to such a normal cell. The method can comprise, e.g., responsive to the detected level of GCC, providing a diagnosis, a prognosis, an evaluation of the efficacy of treatment, or the staging of a disorder. A higher level of GCC in the sample or subject, as compared to the control material, indicates the presence of a disorder associated with increased expression of GCC. A higher level of GCC in the sample or subject, as compared to the control material, can also indicate, the relative lack of efficacy of a treatment, a relatively poorer prognosis, or a later stage of disease. The level of GCC can also be used to evaluate or select future treatment, e.g., the need for more or less aggressive treatment, or the need to switch from one treatment regimen to another.

[0376] The level of GCC can also be used to select or evaluate patients. E.g., in embodiments patients whose tumor cells express high amounts of GCC on their surfaces would be considered good candidates for treatment with toxin-conjugated anti-GCC antibody molecules. In embodiments patients whose tumor cells express low amounts of GCC on their surfaces would not be as good candidates for this or might be candidates for combining the anti-GCC antibody molecule with an additional treatment method, or be candidates for naked antibody therapy. In another example, the dose of the toxin-conjugated anti-GCC antibody molecule could be adjusted to reflect the number of GCC molecules expressed on the surfaces of tumor cells. Patients with high numbers of GCC molecules on their tumor cell surfaces might be treated with lower doses than patients with low numbers of GCC molecules. Detecting the presence of GCC-expressing tumor cells in vivo can allow identification of tissues into the primary GCC-expressing tumor has metastasized. Knowledge of which tissues have metastases can lead to targeted application of tumor therapy.

[0377] As discussed above, the antibody molecules described herein permit assessment of the presence of a GCC protein in normal versus neoplastic tissues, through which the presence or severity of disease, disease progress and/or the efficacy of therapy can be assessed. For example, therapy can be monitored and efficacy assessed. In one example, a GCC protein can be detected and/or measured in a first sample obtained from a subject having an inflammatory disease and therapy can be initiated. Later, a second sample can be obtained from the subject and GCC protein in the sample can be detected and/or measured. A decrease in the quantity of GCC protein detected or measured in the second sample can be indicative of therapeutic efficacy.

[0378] Exemplary cell proliferative disorders that may be evaluated, e.g., diagnosed, using an antibody disclosed herein include a proliferative disorder including, but not limited to, colon cancer, stomach cancer, esophageal cancer.

[0379] In certain embodiments, a method, such as those described above, comprises detecting binding of an anti-GCC antibody to GCC expressed on the surface of a cell or in a membrane preparation obtained from a cell expressing GCC on its surface. In certain embodiments, the method comprises contacting a cell with an anti-GCC antibody under conditions permissive for binding of the anti-GCC antibody to GCC, and detecting whether a complex is formed between the anti-GCC antibody and GCC on the cell surface.

An exemplary assay for detecting binding of an anti-GCC antibody to GCC expressed on the surface of a cell is a "FACS" assay.

[0380] Exemplary samples for methods described herein comprise tissue or body fluid, such as an inflammatory exudate, blood, serum, bowel fluid, stool sample, or biopsy. In one example, a sample (*e.g.*, tissue and/or body fluid) can be obtained from an individual and a suitable immunological method can be used to detect and/or measure GCC protein expression. Suitable immunological methods for detecting or measuring GCC protein expression include enzyme-linked immunosorbent assays (ELISA), radioimmunoassay, immunohistology, flow cytometry, and the like.

[0381] Anti-GCC antibody molecules used in methods described herein, e.g., in the *in vivo* and *in vitro* detection, e.g., diagnostic, staging, or imaging methods, can be directly or indirectly labeled with a detectable substance to facilitate detection of the bound or unbound binding agent. Suitable detectable substances include various biologically active enzymes, ligands, prosthetic groups, fluorescent materials, luminescent materials, chemiluminescent materials, bioluminescent materials, chromophoric materials, electron dense materials, paramagnetic (e.g., nuclear magnetic resonance active) materials, and radioactive materials. In some embodiments, the anti-GCC antibody molecule is coupled to a radioactive ion, e.g., indium (^{111}In), iodine (^{131}I or ^{125}I), yttrium (^{90}Y), lutetium (^{177}Lu), actinium (^{225}Ac), bismuth (^{212}Bi or ^{213}Bi), sulfur (^{35}S), carbon (^{14}C), tritium (^{3}H), rhodium (^{188}Rh), technetium (^{99}mTc), praseodymium, or phosphorous (^{32}P); or a positron-emitting radionuclide, e.g., carbon-11 (^{11}C), potassium-40 (^{40}K), nitrogen-13 (^{13}N), oxygen-15 (^{15}O), fluorine-18 (^{18}F), and iodine-121 (^{121}I).

[0382] Exemplary labels include fluorophores such as rare earth chelates or fluorescein and its derivatives, rhodamine and its derivatives, dansyl, umbelliferone, luceriferases, e.g., firefly luciferase and bacterial luciferase (U.S. Pat. No. 4,737,456), luciferin, and 2,3-dihydrophthalazinediones Other exemplary labels include horseradish peroxidase (HRP), alkaline phosphatase, galactosidase, glucoamylase, lysozyme, saccharide oxidases, e.g., glucose oxidase, galactose oxidase, and glucose 6-phosphate dehydrogenase, heterocyclic oxidases such as uricase and xanthine oxidase, coupled with an enzyme that employs hydrogen peroxide to oxidize a dye precursor such as HRP, lactoperoxidase, or microperoxidase, biotin/avidin, spin labels, bacteriophage labels, stable free radicals, and the like.

[0383] Fluorophore and chromophore labeled antibody molecules can be prepared from standard moieties known in the art. Since antibodies and other proteins absorb light having wavelengths up to about 310 nm, the fluorescent moieties should be selected to have substantial absorption at wavelengths above 310 nm and preferably above 400 nm. A variety of suitable fluorescent compounds and chromophores are described by Stryer *Science*, 162:526 (1968) and Brand, L. et al. *Annual Review of Biochemistry*, 41:843-868 (1972). The antibodies can be labeled with fluorescent chromophore groups by conventional procedures such as those disclosed in U.S. Patent Nos. 3,940,475, 4,289,747, and 4,376,110.

[0384] One group of fluorescers having a number of the desirable properties described above is the xanthene dyes, which include the fluoresceins derived from 3,6-dihydroxy-9-henylxanthhydrol and resamines and rhodamines derived from 3,6-diamino-9-phenylxanthydrol and lissanime rhodamine B. The rhodamine and fluorescein derivatives of 9-o-carboxyphenylxanthhydrol have a 9-o-carboxyphenyl group. Fluorescein compounds having reactive coupling groups such as amino and isothiocyanate groups such as fluorescein isothiocyanate and fluorescamine are readily available. Another group of fluorescent compounds are the naphthylamines, having an amino group in the α or β position.

[0385] Labeled antibody molecules can be used, for example, diagnostically and/or experimentally in a number of contexts, including (i) to isolate a predetermined antigen by standard techniques, such as affinity chromatography or immunoprecipitation; (ii) to detect a predetermined antigen (e.g., in a cellular lysate or cell supernatant) in order to evaluate the abundance and pattern of expression of the protein; (iii) to monitor protein levels in tissue as part of a clinical testing procedure, e.g., to determine the efficacy of a given treatment regimen

[0386] Certain other methods can be used to detect binding of anti-GCC antibodies to GCC. Such methods include, but are not limited to, antigen-binding assays that are known in the art, such as western blots, radioimmunoassays, ELISA (enzyme linked immunosorbent assay), "sandwich" Immunoassays, immunoprecipitation assays, fluorescent immunoassays, protein A immunoassays, and immunohistochemistry (IHC).

[0387] Complex formation between the anti-GCC antibody molecule and GCC can be detected by measuring or visualizing either the antibody (or antibody fragment) bound to the GCC antigen or unbound antibody molecule. Conventional detection assays can be used, e.g., western blots, radioimmunoassays, ELISA (enzyme linked immunosorbent assay), "sandwich" immunoassays, immunoprecipitation assays, fluorescent immunoassays, protein A immunoassays, and immunohistochemistry (IHC) or radioimmunoassay (RIA).

[0388] Alternative to labeling the anti-GCC antibody molecule, the presence of GCC can be assayed in a sample by a competition immunoassay utilizing standards labeled with a detectable substance and an unlabeled anti-GCC antibody molecule. In this assay, the biological sample, the labeled standards and the GCC binding agent are combined and the amount of labeled standard bound to the unlabeled antibody is determined. The amount of GCC in the sample is inversely proportional to the amount of labeled standard bound to the GCC binding agent.

[0389] It is also possible to directly detect GCC to anti-GCC antibody molecule complex formation without further manipulation or labeling of either component (GCC or antibody molecule), for example by utilizing the technique of fluorescence energy transfer (FET, see, for example, Lakowicz *et al.*, U.S. Patent No. 5,631,169; Stavrianopoulos, *et al.*, U.S. Patent No. 4,868,103). A fluorophore label on the first, 'donor' molecule is selected such that, upon excitation with incident light of appropriate wavelength, its emitted fluorescent energy will be absorbed by a fluorescent label on a second 'acceptor' molecule, which in turn is able to fluoresce due to the absorbed energy. Alternately, the 'donor' protein molecule may simply utilize the natural fluorescent energy of tryptophan residues. Labels are chosen that emit different wavelengths of light, such that the 'acceptor' molecule label may be differentiated from that of the 'donor'. Since the efficiency of energy transfer between the labels is related to the distance separating the molecules, spatial relationships between the molecules can be assessed. In a situation in which binding occurs between the molecules, the fluorescent emission of the 'acceptor' molecule label in the assay should be maximal. An FET binding event can be conveniently measured through standard fluorometric detection means well known in the art (*e.g.*, using a fluorimeter).

[0390] In another example, determination of the ability of an antibody molecule to recognize GCC can be accomplished without labeling either assay component (GCC or antibody molecule) by utilizing a technology such as real-time Biomolecular Interaction Analysis (BIA) (see, *e.g.*, Sjolander, S. and Urbaniczky, C., 1991, *Anal. Chem.* 63:2338-2345 and Szabo *et al.,* 1995, *Curr. Opin. Struct. Biol.* 5:699-705). As used herein, "BIA" or "surface plasmon resonance" is a technology for studying biospecific interactions in real time, without labeling any of the interactants (*e.g.*, BIACORE™). Changes in the mass at the binding surface (indicative of a binding event) result in alterations of the refractive index of light near the surface (the optical phenomenon of surface plasmon resonance (SPR)), resulting in a detectable signal which can be used as an indication of real-time reactions between biological molecules.

[0391] In still another embodiment, the invention provides a method for detecting the presence of GCC-expressing tumor tissues *in vivo*. The method includes (i) administering to a subject (e.g., a patient having a cancer) an anti-GCC antibody or antigen binding fragment thereof, preferably a antibody or antigen binding fragment thereof conjugated to a detectable label or marker; (ii) exposing the subject to a means for detecting said detectable label or marker to the GCC-expressing tissues or cells.

[0392] Examples of labels useful for diagnostic imaging in accordance with the present invention are radiolabels such as ^{131}I, ^{111}In, ^{68}Ga, ^{123}I, ^{99m}Tc, ^{32}P, ^{125}I, ^{3}H, ^{14}C, and ^{188}Rh, fluorescent labels such as fluorescein and rhodamine, nuclear magnetic resonance active labels, positron emitting isotopes detectable by a single photon emission computed tomography ("SPECT") detector or positron emission tomography ("PET") scanner, chemiluminescers such as luciferin, and enzymatic markers such as peroxidase or phosphatase. Short-range radiation emitters, such as isotopes detectable by short-range detector probes, such as a transrectal probe, can also be employed. The antibody can be labeled with such reagents using techniques known in the art. For example, see Wensel and Meares (1983) *Radioimmunoimaging and Radioimmunotherapy*, Elsevier, New York, for techniques relating to the radiolabeling of antibodies. See also, D. Colcher et al. *Meth. Enzymol.* 121: 802-816 (1986.

[0393] In the case of a radiolabeled antibody, the antibody is administered to the patient, is localized to the tumor bearing the antigen with which the antibody reacts, and is detected or "imaged" *in vivo* using known techniques such as radionuclear scanning using

e.g., a gamma camera or emission tomography or computed tomography. See e.g., A.R. Bradwell et al., "Developments in Antibody Imaging", *Monoclonal Antibodies for Cancer Detection and Therapy*, R.W. Baldwin et al., (eds.), pp 65-85 (Academic Press 1985). Alternatively, a positron emission transaxial tomography scanner, such as designated Pet VI located at Brookhaven National Laboratory, can be used where the radiolabel emits positrons (e.g., ^{11}C, ^{18}F, ^{15}O, and ^{13}N).

[0394] In other embodiments, the invention provides methods for determining the dose, e.g., radiation dose, that different tissues are exposed to when a subject, e.g., a human subject, is administered an anti-GCC antibody molecule that is conjugated to a radioactive isotope. The method includes: (i) administering an anti-GCC antibody molecule as described herein, e.g., a anti-GCC antibody molecule, that is labeled with a radioactive isotope to a subject; (ii) measuring the amount of radioactive isotope located in different tissues, e.g., tumor, or blood, at various time points until some or all of the radioactive isotope has been eliminated from the body of the subject; and (iii) calculating the total dose of radiation received by each tissue analyzed. The measurements can be taken at scheduled time points, e.g., day 1, 2, 3, 5, 7, and 12, following administration (at day 0) of the radioactively labeled anti-GCC antibody molecule to the subject. The concentration of radioisotope present in a given tissue, integrated over time, and multiplied by the specific activity of the radioisotope can be used to calculate the dose that a given tissue receives. Pharmacological information generated using anti-GCC antibody molecules labeled with one radioactive isotope, e.g., a gamma-emitter, e.g., ^{111}In, can be used to calculate the expected dose that the same tissue would receive from a different radioactive isotope which cannot be easily measured, e.g., a beta-emitter, e.g., ^{90}Y.

Anti-GCC Antibody Sequences

[0395] Anti-GCC antibodies were generated by several methods, as is discussed in more detail in the Examples. Briefly, mouse monoclonal antibodies 3G1 8F1 and 10B8 were generated by traditional immunization technology in conventional mice. Human monoclonal antibodies 1D2, 5F9, 5H3, 6H8, 8C2, and 10C10 were generated using transgenic mice that generate fully human IgG2 antibodies, utilizing Abgenix XENOMOUSE transgenic technology, and isolated using hybridoma technology. Human mAb Abx-012, mAb Abx-020, mAb Abx-106, mAb Abx-198, mAb Abx-221, mAb Abx-229, mAb Abx-338 and mAb Abx-393 were generated using transgenic mice that generate

fully human IgG2 antibodies. Single antibodies were isolated using Abgenix SLAM technology. These were used to make fully human IgG1 antibodies. Specificity of the antibodies against GCC was tested by ELISA and flow cytometry (FCM). A subset of the generated antibodies was selected for further characterization.

[0396] Table 1 below summarizes for several anti-GCC antibodies the antibody designation, the immunogen used to generate the antibody, the animal used, the source, the species and the isotype isolates.

Table 1

Ab	Immunogen	Animal	Source	Species	Isotype
3G1	TOK107-hIg	C57 conventional mouse	Hybridoma	Mouse	IgG1,k
8F1	TOK107-hIg	C57 conventional mouse	Hybridoma	Mouse	IgG1,k
10B8	TOK107-hIg	C57 conventional mouse	Hybridoma	Mouse	IgG1,k
1D3	TOK107-hIg	C57 conventional mouse	Hybridoma	Mouse	IgG1,k
8E12	TOK107-hIg	C57 conventional mouse	Hybridoma	Mouse	IgG1,k
5F9	TOK107-hIg	XenoMouse	Hybridoma	Human	IgG2,k
1D2	TOK107-hIg	XenoMouse	Hybridoma	Human	IgG2,k
5H3	CHO-GC-C#27 cells	XenoMouse	Hybridoma	Human	IgG2,k
6H8	CHO-GC-C#27 cells	XenoMouse	Hybridoma	Human	IgG2,k
8C2	CHO-GC-C#27 cells	XenoMouse	Hybridoma	Human	IgG2,k
10C10	CHO-GC-C#27 cells	XenoMouse	Hybridoma	Human	IgG2,k
10D3	CHO-GC-C#27 cells	XenoMouse	Hybridoma	Human	IgG2,k
1C9	CHO-GC-C#27 cells	XenoMouse	Hybridoma	Human	IgG2,k
229	TOK107-hIg	XenoMouse	SLAM	Human	IgG1,k
012	TOK107-hIg	XenoMouse	SLAM	Human	IgG1,k
221	TOK107-hIg	XenoMouse	SLAM	Human	IgG1,k
020	TOK107-hIg	XenoMouse	SLAM	Human	IgG1,k
338	TOK107-hIg	XenoMouse	SLAM	Human	IgG1,k

106	TOK107-hIg	XenoMouse	SLAM	Human	IgG1,k
198	TOK107-hIg	XenoMouse	SLAM	Human	IgG1,k
393	TOK107-hIg	XenoMouse	SLAM	Human	IgG1,k

[0397] The sequences of the light and heavy chain variable regions were determined. Table 2 below is a summary of the SEQ ID NOs for the variable regions of several antibodies. The amino acid and nucleic acid sequences for the variable regions of each of the heavy and light chains for murine and human anti-GCC antibodies are shown in Tables 3 and 4, respectively.

[0398] The amino acid and nucleic acid sequences for each of the CDRs of the heavy and light chains for anti-GCC antibodies are shown in Tables 5 and 6, respectively.

[0399] For example, Table 3, row 9 is an illustration of the encoded amino acid sequence of the mature heavy chain variable region of mAb 5F9 (SEQ ID NO:18); and the nucleic acid sequence encoding the mature heavy chain variable region of mAb 5F9 (SEQ ID NO:17) is depicted in Table 4, row 9. The encoded amino acid sequences of mAb 5F9 heavy chain CDR (CDR) 1 (SEQ ID NO:106), CDR2 (SEQ ID NO:108) and CDR3 (SEQ ID NO:110) are depicted in Table 5, rows 25-27, respectively; and the nucleic acid sequences of mAb 5F9 heavy chain CDR1 (SEQ ID NO:105), CDR2 (SEQ ID NO:107) and CDR3 (SEQ ID NO:109) are shown in Table 6, rows 25-27, respectively.

[0400] Table 3, row 10 is an illustration of the encoded amino acid sequence of the mature light chain variable region of mAb 5F9 (SEQ ID NO:20); and the nucleic acid sequence encoding the mature kappa light chain variable region of mAb 5F9 (SEQ ID NO:19) is depicted in Table 4, row 10. The encoded amino acid sequences of mAb 5F9 light chain CDR (CDR) 1 (SEQ ID NO:112), CDR2 (SEQ ID NO:114) and CDR3 (SEQ ID NO:116) are depicted in Table 5, rows 28-30, respectively; and the nucleic acid sequences of mAb 5F9 light chain CDR1 (SEQ ID NO:111), CDR2 (SEQ ID NO:113) and CDR3 (SEQ ID NO:115) are shown in Table 6, rows 28-30, respectively.

[0401] Sequencing of the CDRs allowed determination of the abundance of residues that might serve as toxin conjugation sites. An unpaired free cysteine in the antigen binding region could be a site for auristatin conjugation and a lysine could be a site for maytansine conjugation. Toxin conjugation to an amino acid of the CDR would raise

the concern of altering the binding affinity of the antibody to GCC. Thus, in embodiments the CDRs lack an amino acid which can be conjugated to a therapeutic agent.

Table 2. Summary of SEQ ID NOs for the variable regions of monoclonal antibodies.

mAb	IgG chain	NA SEQ ID	AA SEQ ID
3G1	**Heavy chain**	1	2
	Light chain	3	4
8E12	**Heavy chain**	5	6
	Light chain	7	8
8F1	**Heavy chain**	9	10
	Light chain	11	12
1D3	**Heavy chain**	13	14
	Light chain	15	16
5F9	**Heavy chain**	17	18
	Light chain	19	20
5H3	**Heavy chain**	21	22
	Light chain	23	24
6H8	**Heavy chain**	25	26
	Light chain	27	28
8C2	**Heavy chain**	29	30
	Light chain	31	32
10C10	**Heavy chain**	33	34
	Light chain	35	36
10D3	**Heavy chain**	286	287
	Light chain	288	289
Abx-012	**Heavy chain**	238	239

	Light chain	240	241
Abx-020	**Heavy chain**	37	38
	Light chain	39	40
Abx-106	**Heavy chain**	242	243
	Light chain	244	245
Abx-198	**Heavy chain**	41	42
	Light chain	43	44
Abx-221	**Heavy chain**	246	247
	Light chain	248	249
Abx-229	**Heavy chain**	45	46
	Light chain	47	48
Abx-338	**Heavy chain**	49	50
	Light chain	51	52
Abx-393	**Heavy chain**	53	54
	Light chain	55	56

Table 3. Amino acid sequence of mAb variable region

	mAb	IgG chain	SEQ ID NO:	Amino Acid Sequence
1	3G1	Heavy chain	2	QVQLKESGPGLVAPSQSLSITCTVSGFSLSRNAISWVRQP PGKGLEWLGVIWTGGGTNYNSALKSRLSIRKENSKSQVF LKMNSLQTEDTARYFCARSGYDGFDYWGQGTLVTVSA
2	3G1	Light chain	4	QIVLTQSPAIMSASPGEKVTMTCSASSSVNYMHWYQQK SGTSPKRWIYDTSKLASGVPARFSGSGSGTSYSLTITSME AEDAATYYCQQWSGNPYTFGGGTKLEIK
3	8E12	Heavy chain	6	QVQLKQSGAELVKPGASVKISCKASGYTFTDYYINWVK QRPGQGLEWIGKIGPRSGNTYYNEKFKGKATLTADKSSS TAYMQLSSLTSEDSAVYFCARWDAYWGQGTLVTVS
4	8E12	Light chain	8	DVVMTQTPLSLSVTIGQPASISCKSSQSLLYSNGKTYLN WLQQRPGQAPKHLMYQVSKLDPGIPDRFSGSGSETDFTL KISRVEAEDLGVYYCLQGTYYPYTFGGGTKLEIK
5	8F1	Heavy chain	10	QVQLQQPGAELVKPGASVQMSCKASGYIFTGYWMYWV KQRPGQGLEWIGRIHPSDSNTNYNQKFKGKATLTVDKSS STAYMQLSSLTSEDSAVYYCTHALAYWGQGTLVTVS
6	8F1	Light chain	12	DVVLTQTPLTLSITIGQPASISCKSSQSLLYSNGKTYLSWL LQRPGQSPKRLIYLVSQLDSGVPDRFTGSGSGTDFTLKIS RVEAEDLGVYYCVQGTHLFTFGSGTKLEIK
7	1D3	Heavy chain	14	QVQLKQSGAELVKPGASVKMSCKASGYTFTDYYINWV KQRPGQGLEWIGKIGPRSGSTYYNEKFKGKATLTADKSS STAYMQLSSLTSEDSAVYFCARWDAYWGQGTLVTVSA

8	**1D3**	**Light chain**	16	DVVMTQTPLSLSVTIGQPASISCKSSQSLLYSNGKTYLN WLQQRPGQAPKHLMYQVSKLDPGIPDRFSGSGSETDFTL KISRVEAEDLGVYYCLQGTYYPYTFGGGTKLEIK
9	**5F9**	**Heavy chain**	18	QVQLQQWGAGLLKPSETLSLTCAVFGGSFSGYYWSWIR QPPGKGLEWIGEINHRGNTNDNPSLKSRVTISVDTSKNQF ALKLSSVTAADTAVYYCARERGYTYGNFDHWGQGTLV TVSS
10	**5F9**	**Light chain**	20	EIVMTQSPATLSVSPGERATLSCRASQSVSRNLAWYQQK PGQAPRLLIYGASTRATGIPARFSGSGSGTEFTLTIGSLQS EDFAVYYCQQYKTWPRTFGQGTNVEIK
11	**5H3**	**Heavy chain**	22	QVQLVESGGGLVKPGGSLRLSCAASGFTFSDCYMSWIR QSPGKGLEWVSYITTSGNTIYYADSVKGRFTISRDNAKN SLYLQMNSLRAEDTAVYYCARDWGWFYGMDVWGQGT TVTVSS
12	**5H3**	**Light chain**	24	DIVMTQTPLSLSVTPGQPASISCKSSQSLLHNDGKTYLY WYLQKPGQPPQLLIYEVSNRFSGVPDRFSSSGSXTDFTLK ISRVEAEDVGVYYCMQSIQLPRTFGQGTKVEIK
13	**6H8**	**Heavy chain**	26	QVQLVESGGGVVQPGRSLRLSCAASGFTFSSYGMHWVR QAPGKGLEWVAAIWYDGSNKYYADSVKGRFTISRDNSK NTLYLQMNSLRAEDTAVYYCARGRSSSYFDYWGQGTL VTVSS
14	**6H8**	**Light chain**	28	DIVMTQTPLSSPVTLGQPASISCRSSQSLVHSDGNTYLSW LQQRPGQPPRLLIYKTSNRFSGVPDRFSGSGAGTDFTLKI SRVGAEDVGVYYCMQATQFPTFGQGTRLEIK
15	**8C2**	**Heavy chain**	30	QVQLVESGGGVVQPGRSLRLSCVASGFTFSSYGMHWVR QAPGKGLEWVGAIWYDGSNKYYAASVKGRFTISRDNSK NTLYLQMNSLRAEDTAVFYCARGRSSSYFDYWGQGTLV TVSS

16	**8C2**	**Light chain**	32	DIVMTQTPLSSPVTLGQPASISCRSSQSLVHSDGNTYLSW LQQRPGQPPRLLIYKTSNRFSGVPDRFSGSGAGTDFTLKI SRVGAEDVGVYYCMQATQFPTFGQGTRLEIK
17	**10C10**	**Heavy chain**	34	QVQLVESGGGVVQPGRSLRLSCAASGFTFSSYGMHWVR QAPGKGLEWVAAIWYDGSNKYYADSVKGRFTISRDNSK NTLYLQMNSLRAEDTAVYYCARGRSSSYFDYWGQGTL VTVSS
18	**10C10**	**Light chain**	36	DIVMTQTPLSSPVTLGQPASFSCRSSQSLVHSDGNTYLS WLQQRPGQPPRLLIYKISNRFSGVPDRFSGSGAGTDFTLK ISRVEAEDVGVYYCMQATQFPTFGQGTRLEIK
35	**10D3**	**Heavy chain**	287	QVQLQQWGAGLLKPSETLSLTCAVFGGSFSGYYWSWIR QPPGKGLEWIGEINHRGNTNDNPSLKSR VTISVDTSKNQFALKLSSVTAADTAVYYCARERGYTYG NFDHWGQGTLVTVSS
36	**10D3**	**Light chain**	289	EIVLTQSPGTLSLSPGERATLSCRASQSVSSRYLAWYQQ KPGQAPRLLIYGASSRATGTPDRFSGSGSGTDFTLTISRLE PEDFAVYFCQQYERSFTFGPGTKVD
19	**Abx-012**	**Heavy chain**	239	QVQLQESGPGLVKPSETLSLTCTVSGASISHYYWSWIRQ PAGKGLEWIGRIYISGRTSYNPSLKSRVTVSVDTSKNQFS LKLSSVTAADTAVYYCARDRLTGYFDYWGQGTLVTVSS
20	**Abx-012**	**Light chain**	241	EIVLTQSPGTLSLSPGERATLSCRASQSVSSSYLAWYQQK PGQAPRLLIYGASSRAAGIPDRFSGSGSGTDFTLTISRLEP EDFAVYYCQQYGSSLTFGGGTKVEIK
21	**Abx-020**	**Heavy chain**	38	QVQLVESGGGLVKPGGSLRLSCAASGFTFSDYYMSWIR QAPGKGLEWISYITSSGSTIYYSASVKGRFTISRDNAKNS LYLQMNSLRAEDTAVYYCARDFSGWFGVHFDYWGQGT LVTVSS

22	**Abx-020**	**Light chain**	40	DIVMTQTPLSLSVTPGQPASISCKSSQSLLHSDGKTYLYW YLQKPGQPPQLLIYEVSNRFSGVPNRFSGSGSGTDFTLKI SRVEAEDVGVYYCMQSIQLTWTFGQGTKVEIK
23	**Abx-106**	**Heavy chain**	243	QVQLQESGPGLVKPSETLSLTCTVSGASISHYYWSWIRQ PAGKGLEWIGRIYISGRTSYNPSLKSRVTVSVDTSKNQFS LKLSSVTAADTAVYYCARDRLTGYFDYWGQGTLVTVSS
24	**Abx-106**	**Light chain**	245	EIVLTQSPGTLSLSPGERATLSCRASQSVSSSYLAWYQQK PGQAPRLLIYGTSSRATGIPDRFSGSGSGTDFTLTISRLEP EDFAVYYCQQYGSSPMCSFGQGTKLEIK
25	**Abx-198**	**Heavy chain**	42	EVQLLESGGGLVQPGGSLRLSCAASGFTFSSYAMSWVR QAPGKGLDWVSDISGSGGSTYYADSVKGRFTISRDNSKN TLYLQMHSLSAEDTAIYYCAKRRWQGYFDLWGRGTLV TVSS
26	**Abx-198**	**Light chain**	44	EIVLTQSPGTLSLSPGERATLSCRARQRVDSRYLAWYQQ KPGQAPRLLIYGASSRATGIPDRFSGSGSGTDFTLTISRLE PEDFAVYYCQQYGSSPLTFGGGTKVEIK
27	**Abx-221**	**Heavy chain**	247	EVQLLESGGGLVQPGGSLRLSCAASGFTFSRYAMNWVR QAPGKGLEWVSGISGSGGSTYYADSVKGRFTISRDNSKN TLYLQMNSLRAEDTAVYYCAKDRDFWSGPFDYWGQGT LVTVSS
28	**Abx-221**	**Light chain**	249	EIVMTPSSATLSVSPGERATLSCRASQSVSRSLAWYQQK PGQAPRLLIYGASTRATGIPARFSGSGSGTEFTLTISSLQS EDVAVYYCQQYNNWMCSFGQGTKLEIK
29	**Abx-229**	**Heavy chain**	46	EVQLLESGGGLVQPGGSLRLSCAASGFTFSRYAMNWVR QAPGKGLEWVSGISGSGGRTYYADSVKGRFTISRDNSKN TLYLQMNSLRAEDTAVYYCAKDRDFWSGPFDYWGQGT LVTVSS
30	**Abx-229**	**Light chain**	48	EIVMTPSSATLSVSPGERATLSCRASQSVSRNLAWYQQK PGQAPRLLIYGASTRATGIPARFSGSGSGTEFTLTISSLQS EDFAVYYCHQYSNWMCSFGQGTKLEIK

31	**Abx-338**	**Heavy chain**	50	QVQLQESGPGLVKPSETLSLTCTVSGGSIRSYYWSWIRQP AGKGLEWIGRIYISGRTTFNPSLKSRVTISVDTSKNQFSLK LSSVTAADTAVYFCARDRYYGYLDYWGQGTLVTVSS
32	**Abx-338**	**Light chain**	52	EIVLTQSPGTLSLSPGERATLSCRASQSVSRSYLAWYQQ KPGQAPRLLIYDASSRATGIPDRFSGSGSGTDFTLTISRLE PEDFAVYYCQQYGSSPSTFGQGTRLEIK
33	**Abx-393**	**Heavy chain**	54	QVQLQESGPGLVKPSETLSLTCTVSGGSIRHYYWSWIRQ PPGKGLEWIGYIYYSGSTNYNLSLKSRVTISRDTSKNQVS LKLSSVTAADTAVYYCAAGMGFDYWGQGTLVTVSS
34	**Abx-393**	**Light chain**	56	DIQMTQSPSSLSASIGDRVTITCRASQAIRNDLGWYQLKP GKAPKRLIYSASSLQSGVPSRFSGSGSGTEFTLTISSLQPE DSATYYCLQHNSFPPTFGQGTKVEIK

Table 4. Nucleic acid sequence of mAb variable region

	mAb	IgG chain	SEQ ID NO:	Nucleic Acid Sequence
1	3G1	Heavy chain	1	CAGGTGCAGCTGAAGGAGTCAGGACCTGGCCTGGTG GCGCCCTCACAGAGCCTGTCCATCACATGCACTGTC TCTGGGTTCTCATTAAGCAGAAATGCTATAAGCTGG GTTCGCCAGCCACCAGGAAAGGGTCTGGAGTGGCTT GGAGTAATATGGACTGGTGGAGGCACAAATTATAAT TCAGCTCTCAAATCCAGACTGAGCATCCGCAAAGAG AACTCCAAGAGTCAAGTTTTCTTAAAAATGAACAGT CTACAAACTGAAGACACAGCCAGGTACTTCTGTGCC AGAAGTGGTTACGACGGGTTTGATTACTGGGGCCAA GGGACTCTGGTCACTGTCTCTGCA
2	3G1	Light chain	3	CAGATTGTTCTCACCCAGTCTCCAGCAATCATGTCTG CATCTCCAGGGGAGAAGGTCACCATGACCTGCAGTG CCAGCTCAAGTGTAAATTACATGCACTGGTACCAGC AGAAGTCAGGCACCTCCCCCAAAAGATGGATTTATG ACACATCCAAACTGGCTTCTGGAGTCCCTGCTCGCTT CAGTGGCAGTGGGTCTGGGACCTCTTACTCTCTCAC AATCACCAGCATGGAGGCTGAAGATGCTGCCACTTA TTACTGCCAGCAGTGGAGTGGTAACCCGTACACGTT CGGAGGGGGGACCAAACTGGAAATAAAA

3	**8E12**	**Heavy chain**	5	CAGGTCCAGTTGAAGCAGTCTGGAGCTGAACTGGTG AAGCCTGGGGCTTCAGTGAAGATATCCTGCAAGGCT TCTGGCTACACCTTCACTGACTACTATATAAACTGGG TGAAGCAGAGGCCTGGACAGGGCCTTGAGTGGATTG GAAAGATTGGTCCTCGAAGTGGTAATACTTACTACA ATGAGAAGTTCAAGGGCAAGGCCACACTGACTGCA GACAAATCGTCCAGCACAGCCTACATGCAGCTCAGC AGCCTGACATCTGAGGACTCTGCAGTCTATTTCTGTG CAAGATGGGATGCTTACTGGGGCCAAGGGACTCTGG TCACTGTCTCT
4	**8E12**	**Light chain**	7	GATGTTGTGATGACCCAGACTCCACTGTCTTTGTCGG TTACCATTGGACAACCAGCCTCTATCTCTTGCAAGTC AAGTCAGAGCCTCTTATATAGTAATGGAAAGACATA TTTGAATTGGTTACAACAGAGGCCTGGCCAGGCTCC AAAGCACCTAATGTATCAGGTGTCCAAACTGGACCC TGGCATCCCTGACAGGTTCAGTGGCAGTGGATCAGA AACAGATTTTACACTTAAAATCAGCAGAGTGGAGGC TGAAGATTTGGGAGTTTATTACTGCTTGCAAGGTAC ATATTATCCGTACACGTTCGGAGGGGGGACCAAGCT GGAAATAAAG
5	**8F1**	**Heavy chain**	9	CAGGTCCAACTGCAGCAGCCTGGGGCTGAACTGGTG AAGCCTGGGGCTTCAGTGCAGATGTCCTGTAAGGCT TCTGGCTATATTTTCACCGGCTACTGGATGTACTGGG TGAAGCAGAGGCCTGGCCAAGGCCTTGAGTGGATTG GAAGGATTCATCCTTCTGATAGTAATACTAACTACA ATCAAAAGTTCAAGGGCAAGGCCACATTGACTGTAG ACAAATCCTCCAGCACAGCCTACATGCAACTCAGCA GCCTGACATCTGAGGACTCTGCGGTCTATTACTGTAC CCATGCCCTTGCTTACTGGGGCCAAGGGACTCTGGT CACTGTCTCT

6	**8F1**	**Light chain**	11	GATGTTGTGTTGACCCAGACTCCACTCACTTTGTCGA TTACCATTGGACAACCAGCCTCTATCTCTTGCAAGTC AAGTCAGAGCCTCTTATATAGTAATGGAAAAACCTA TTTGAGTTGGTTATTACAGAGGCCAGGCCAGTCTCC AAAGCGCCTAATCTATCTGGTGTCTCAACTGGACTCT GGAGTCCCTGACAGGTTCACTGGCAGTGGATCAGGA ACAGATTTTACACTGAAGATCAGCAGAGTGGAGGCT GAGGATTTGGGAGTGTATTACTGCGTGCAAGGTACA CATTTATTCACGTTCGGCTCGGGGACAAAGTTGGAA ATAAAA
7	**1D3**	**Heavy chain**	13	CAGGTCCAGCTGAAGCAGTCTGGAGCTGAGCTGGTG AAGCCTGGGGCTTCAGTGAAGATGTCCTGCAAGGCT TCTGGCTACACCTTCACAGACTACTATATAAACTGG GTGAAGCAGAGGCCTGGACAGGGCCTTGAGTGGATT GGAAAGATTGGTCCTAGAAGTGGTAGTACTTACTAC AATGAGAAGTTCAAGGGCAAGGCCACACTGACTGC AGACAAATCCTCCAGCACAGCCTACATGCAGCTCAG CAGCCTGACATCTGAGGACTCTGCAGTCTATTTCTGT GCAAGATGGGATGCTTACTGGGGCCAAGGGACTCTG GTCACTGTCTCTGCA
8	**1D3**	**Light chain**	15	GATGTTGTGATGACCCAGACTCCACTGTCTTTGTCGG TTACCATTGGACAACCAGCCTCTATCTCTTGCAAGTC AAGTCAGAGCCTCTTATATAGTAATGGAAAGACATA TTTGAATTGGTTACAACAGAGGCCTGGCCAGGCTCC AAAGCACCTAATGTATCAGGTGTCCAAACTGGACCC TGGCATCCCTGACAGGTTCAGTGGCAGTGGATCAGA AACAGATTTTACACTTAAAATCAGCAGAGTGGAGGC TGAAGATTTGGGAGTTTATTACTGCTTGCAAGGTAC ATATTATCCGTACACGTTCGGAGGGGGGACCAAGCT GGAAATAAAA

9	**5F9**	**Heavy chain**	17	CAGGTGCAGCTACAGCAGTGGGGCGCAGGACTGTTG AAGCCTTCGGAGACCCTGTCCCTCACCTGCGCTGTCT TTGGTGGGTCCTTCAGTGGTTACTACTGGAGCTGGAT CCGCCAGCCCCCAGGGAAGGGGCTGGAGTGGATTG GGGAAATCAATCATCGTGGAAACACCAACGACAAC CCGTCCCTCAAGAGTCGAGTCACCATATCAGTAGAC ACGTCCAAGAACCAGTTCGCCCTGAAGCTGAGTTCT GTGACCGCCGCGGACACGGCTGTTTATTACTGTGCG AGAGAACGTGGATACACCTATGGTAACTTTGACCAC TGGGGCCAGGGAACCCTGGTCACCGTCTCCTCA
10	**5F9**	**Light chain**	19	GAAATAGTGATGACGCAGTCTCCAGCCACCCTGTCT GTGTCTCCAGGGGAAAGAGCCACCCTCTCCTGCAGG GCCAGTCAGAGTGTTAGCAGAAACTTAGCCTGGTAT CAGCAGAAACCTGGCCAGGCTCCCAGGCTCCTCATC TATGGTGCATCCACCAGGGCCACTGGAATCCCAGCC AGGTTCAGTGGCAGTGGGTCTGGGACAGAGTTCACT CTCACCATCGGCAGCCTGCAGTCTGAAGATTTTGCA GTTTATTACTGTCAGCAGTATAAAACCTGGCCTCGG ACGTTCGGCCAAGGGACCAACGTGGAAATCAAA
11	**5H3**	**Heavy chain**	21	CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCTTGGTC AAGCCTGGAGGGTCCCTGAGACTCTCCTGTGCAGCC TCTGGATTCACCTTCAGTGACTGCTACATGAGCTGG ATCCGCCAGTCTCCAGGGAAGGGGCTGGAGTGGGTT TCATACATTACTACTAGTGGTAATACCATTTACTACG CAGACTCTGTGAAGGGCCGATTCACCATCTCCAGGG ACAACGCCAAGAACTCACTGTATCTGCAAATGAACA GCCTGAGAGCCGAGGACACGGCCGTGTATTACTGTG CGAGAGACTGGGGATGGTTCTACGGTATGGACGTCT GGGGCCAAGGGACCACGGTCACCGTCTCCTCA

12	**5H3**	**Light chain**	23	GATATTGTGATGACCCAGACTCCACTCTCTCTGTCCG TCACCCCTGGACAGCCGGCCTCCATCTCCTGCAAGT CTAGTCAGAGCCTCCTGCATAATGATGGAAAGACCT ATTTGTATTGGTACCTGCAGAAGCCAGGCCAGCCTC CACAACTCCTGATCTATGAAGTTTCCAACCGGTTCTC TGGAGTGCCAGATAGGTTCAGTAGCAGCGGGTCNNG GACAGATTTCACACTGAAAATCAGCCGGGTGGAGGC TGAGGATGTTGGGGTTTATTACTGCATGCAAAGTAT ACAGCTTCCTCGGACGTTCGGCCAAGGGACCAAGGT GGAAATCAAA
13	**6H8**	**Heavy chain**	25	CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGTC CAGCCTGGGAGGTCCCTGAGACTCTCCTGTGCAGCG TCTGGATTCACCTTCAGTAGCTATGGCATGCACTGG GTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGGTG GCAGCTATATGGTATGATGGAAGTAATAAATACTAT GCAGACTCCGTGAAGGGCCGATTCACCATCTCCAGA GACAATTCCAAGAACACGCTGTATCTGCAAATGAAC AGCCTGAGAGCCGAGGACACGGCTGTGTATTACTGT GCGAGAGGGAGGAGCAGCTCGTACTTTGACTATTGG GGCCAGGGAACCCTGGTCACCGTCTCCTCA
14	**6H8**	**Light chain**	27	GATATTGTGATGACCCAGACTCCACTCTCCTCACCTG TCACCCTTGGACAGCCGGCCTCCATCTCCTGCAGGTC TAGTCAAAGCCTCGTACACAGTGATGGAAACACCTA CTTGAGTTGGCTTCAGCAGAGGCCAGGCCAGCCTCC AAGACTCCTAATTTATAAGACTTCTAACCGCTTCTCT GGGGTCCCAGACAGATTCAGTGGCAGTGGGGCAGG GACAGATTTCACACTGAAAATCAGCAGGGTGGGAGC TGAGGATGTCGGGGTTTATTACTGCATGCAAGCTAC GCAATTTCCAACCTTCGGCCAAGGGACACGACTGGA GATTAAA

15	**8C2**	**Heavy chain**	29	caggtgcagctggtggagtctgggggaggcgtggtccagcctgggaggTCCCT GAGACTCTCCTGTGTAGCGTCTGGATTCACCTTCAGT AGCTATGGCATGCACTGGGTCCGCCAGGCTCCAGGC AAGGGGCTGGAGTGGGTGGGAGCTATATGGTATGAT GGAAGTAATAAATACTATGCAGCCTCCGTGAAGGGC CGATTCACCATCTCCAGAGACAATTCCAAGAACACG CTGTATCTGCAAATGAACAGCCTGAGAGCCGAGGAC ACGGCTGTATTTTACTGTGCGAGAGGGAGGAGCAGC TCGTATTTTGACTACTGGGGCCAGGGAACCCTGGTC ACCGTCTCCTCA
16	**8C2**	**Light chain**	31	GATATTGTGATGACCCAGACTCCACTCTCCTCACCTG TCACCCTTGGACAGCCGGCCTCCATCTCCTGCAGGTC TAGTCAAAGCCTCGTACACAGTGATGGAAACACCTA CTTGAGTTGGCTTCAGCAGAGGCCAGGCCAGCCTCC AAGACTCCTAATTTATAAGACTTCTAACCGCTTCTCT GGGGTCCCAGACAGATTCAGTGGCAGTGGGGCAGG GACAGATTTCACACTGAAAATCAGCAGGGTGGGAGC TGAGGATGTCGGGGTTTATTACTGCATGCAAGCTAC GCAATTTCCAACCTTCGGCCAAGGGACACGACTGGA GATTAAA
17	**10C10**	**Heavy chain**	33	CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCGTGGTC CAGCCTGGGAGGTCCCTGAGACTCTCCTGTGCAGCG TCTGGATTCACCTTCAGTAGCTATGGCATGCACTGG GTCCGCCAGGCTCCAGGCAAGGGGCTGGAGTGGGTG GCAGCTATATGGTATGATGGAAGTAATAAATACTAT GCAGACTCCGTGAAGGGCCGATTCACCATCTCCAGA GACAATTCCAAGAACACGCTGTATCTGCAAATGAAC AGCCTGAGAGCCGAGGACACGGCTGTGTATTACTGT GCGAGAGGGAGGAGCAGCTCGTACTTTGACTATTGG GGCCAGGGAACCCTGGTCACCGTCTCCTCA

18	**10C10**	**Light chain**	35	GATATTGTGATGACCCAGACTCCACTCTCCTCACCTG TCACCCTTGGACAGCCGGCCTCCTTCTCCTGCAGGTC TAGTCAAAGCCTCGTACACAGTGATGGAAACACGTA CTTGAGTTGGCTTCAGCAGAGGCCAGGCCAGCCTCC AAGACTCCTAATTTATAAGATTTCTAACCGGTTCTCT GGGGTCCCAGACAGATTCAGTGGCAGTGGGGCAGG GACAGATTTCACACTGAAAATCAGCAGGGTGGAAGC TGAGGATGTCGGGGTTTATTACTGCATGCAAGCTAC ACAATTTCCAACCTTCGGCCAAGGGACACGACTGGA GATTAAA
35	**10D3**	**Heavy Chain**	286	CAGGTGCA GCTACAGCAGTGGGGCGCAGGACTGTTGAAGCCTTC GGAGACCCTGTCCC TCACCTGCGCTGTCTTTGGTGGGTCCTTCAGTGGTTA CTACTGGAGCTGG ATCCGCCAGCCCCCAGGGAAGGGGCTGGAGTGGATT GGGGAAATCAATCA TCGTGGAAACACCAACGACAACCCGTCCCTCAAGAG TCGAGTCACCATAT CAGTAGACACGTCCAAGAACCAGTTCGCCCTGAAGC TGAGTTCTGTGACC GCCGCGGACACGGCTGTTTATTACTGTGCGAGAGAA CGTGGATACACCTA TGGTAACTTTGACCACTGGGGCCAGGGAACCCTGGT CACCGTCTCCTCA

36	**10D3**	**Light chain**	288	GAAATTGTGTTGACGCAGTCTCCAGGCACCCTGTCTTTGTCTCCAGGGGA AAGAGCCACCCTCTCCTGCAGGGCCAGTCAGAGTGTTAGCAGCAGGTACT TAGCCTGGTACCAGCAGAAACCTGGCCAGGCTCCCAGGCTCCTCATCTAT GGTGCATCCAGCAGGGCCACTGGCACCCCAGACAGGTTCAGTGGCAGTGG GTCTGGGACAGACTTCACTCTCACCATCAGCAGACTGGAGCCTGAAGATT TTGCAGTGTATTTCTGTCAGCAGTATGAAAGGTCATTCACTTTCGGCCCT GGGACCAAAGTGGAT
19	**Abx-012**	**Heavy chain**	238	CAGGTGCAGTTGCAGGAGTCGGGCCCAGGACTGGTGAAGCCTTCGGAGACCCTGTCCCTCACCTGCACTGTCTCTGGTGC CTCCATCAGTCATTACTACTGGAGCTGGATCCGGCAGCCCGCCGGGAAGGGACTGGAATGGATTGGGCGTATCTATATCA GTGGGAGGACCAGCTACAACCCCTCCCTCAAGAGTCGAGTCACCGTGTCAGTAGACACGTCCAAGAACCAGTTCTCCCTG AAGCTGAGCTCTGTGACCGCCGCGGACACGGCCGTGTATTACTGTGCGAGAGATCGGCTAACTGGGTACTTTGACTACTG GGGCCAGGGAACCCTGGTCACCGTCTCCTCAG

20	**Abx-012**	**Light chain**	240	GAAATTGTGTTGACGCAGTCTCCAGGCACCCTGTCTTTGTCTCCAGGGGAAAGAGCCACCCTCTCCTGCAGGGCCAGTCA GAGTGTTAGCAGCAGCTACTTAGCCTGGTACCAGCAGAAACCTGGCCAGGCTCCCAGGCTCCTCATCTATGGTGCATCCA GCAGGGCCGCTGGCATCCCAGACAGGTTCAGTGGCAGTGGGTCTGGGACAGACTTCACTCTCACCATCAGCAGACTGGAG CCTGAAGATTTTGCAGTGTATTACTGTCAGCAGTATGGTAGCTCCCTCACTTTCGGCGGAGGGACCAAGGTGGAGATCAA AC
21	**Abx-020**	**Heavy chain**	37	CAGGTGCAGCTGGTGGAGTCTGGGGGAGGCTTGGTCAAGCCTGGAGGGTCCCTGAGACTCTCCTGTGCAGCCTCTGGATTCACCTTCAGTGACTACTACATGAGCTGGATCCGCCAGGCTCCAGGGAAGGGGCTGGAGTGGATTTCATACATTACTAGTAGTGGTAGTACCATATACTACTCAGCCTCTGTGAAGGGCCGATTCACCATCTCCAGGGACAACGCCAAGAACTCACTGTATCTGCAAATGAACAGCCTGAGAGCCGAGGACACGGCCGTGTATTACTGTGCGAGAGATTTCAGTGGCTGGTTCGGAGTCCACTTTGACTACTGGGGCCAGGGAACCCTGGTCACCGTCTCCTCG

22	**Abx-020**	**Light chain**	39	GATATTGTGATGACCCAGACTCCACTCTCTCTGTCCG TCACCCCTGGACAGCCGGCCTCCATCTCCTGTAAGTC TAGTCAGAGCCTCCTGCATAGTGATGGAAAGACCTA TTTGTATTGGTACCTGCAGAAGCCAGGCCAGCCTCC ACAGCTCCTGATCTATGAAGTTTCCAACCGGTTCTCT GGAGTGCCAAATAGGTTCAGTGGCAGCGGGTCAGG GACAGATTTCACACTGAAAATCAGCCGGGTGGAGGC TGAGGATGTTGGGGTTTATTACTGCATGCAAAGTAT ACAACTTACGTGGACGTTCGGCCAAGGGACCAAGGT GGAAATCAAA
23	**Abx-106**	**Heavy chain**	242	CAGGTGCAGTTGCAGGAGTCGGGCCCAGGACTGGTG AAGCCTTCGGAGACCCTGTCCCTCACCTGCACTGTCT CTGGTGC CTCCATCAGTCATTACTACTGGAGCTGGATCCGGCA GCCCGCCGGGAAGGGACTGGAATGGATTGGGCGTAT CTATATCA GTGGGAGGACCAGCTACAACCCCTCCCTCAAGAGTC GAGTCACCGTGTCAGTAGACACGTCCAAGAACCAGT TCTCCCTG AAGCTGAGCTCTGTGACCGCCGCGGACACGGCCGTG TATTACTGTGCGAGAGATCGGCTAACTGGGTACTTT GACTACTG GGGCCAGGGAACCCTGGTCACCGTCTCCTCAGC

24	**Abx-106**	**Light chain**	244	GAAATTGTGTTGACGCAGTCTCCAGGCACCCTGTCTTTGTCTCCAGGGGAAAGAGCCACCCTCTCCTGCAGGGCCAGTCA GAGTGTTAGCAGCAGCTACTTAGCCTGGTACCAGCAGAAACCTGGCCAGGCTCCCAGGCTCCTCATCTATGGTACATCCA GCAGGGCCACTGGCATCCCAGACAGGTTCAGTGGCAGTGGGTCTGGGACAGACTTCACTCTCACCATCAGCAGACTGGAG CCTGAAGACTTTGCAGTGTATTACTGTCAGCAGTATGGTAGCTCACCCATGTGCAGTTTTGGCCAGGGGACCAAGCTGGA GATCAAACG
25	**Abx-198**	**Heavy chain**	41	GAGGTGCAGCTGTTGGAGTCTGGGGGAGGCTTGGTACAGCCTGGGGGGTCCCTGAGACTCTCCTGTGCAGCCTCTGGATTCACCTTTAGCAGCTATGCCATGAGCTGGGTCCGCCAGGCTCCAGGGAAGGGGCTGGACTGGGTCTCAGATATTAGTGGTAGTGGTGGTAGCACATACTACGCAGACTCCGTGAAGGGCCGGTTCACCATCTCCAGAGACAATTCCAAGAACACGCTGTATCTGCAAATGCACAGCCTGAGCGCCGAGGACACGGCCATATATTACTGTGCGAAACGGCGGTGGCAGGGGTACTTCGATCTCTGGGGCCGTGGCACCCTGGTCACTGTCTCCTCA

26	**Abx-198**	**Light chain**	43	GAAATTGTGTTGACGCAGTCTCCAGGCACCCTGTCTT TGTCTCCAGGGGAAAGAGCCACCCTCTCCTGCAGGG CCAGGCAGCGTGTTGACAGCAGGTACTTAGCCTGGT ACCAGCAGAAACCTGGCCAGGCTCCCAGGCTCCTCA TCTATGGTGCATCCAGCAGGGCCACTGGCATCCCAG ACAGGTTCAGTGGCAGTGGGTCTGGGACAGACTTCA CTCTCACCATCAGCAGACTGGAGCCTGAAGATTTTG CAGTGTATTACTGTCAGCAGTATGGTAGCTCACCGC TCACTTTCGGCGGAGGGACCAAGGTGGAGATCAAA
27	**Abx-221**	**Heavy chain**	246	GAGGTGCAGCTGTTGGAGTCTGGGGGAGGCTTGGTA CAGCCTGGGGGGTCCCTGAGACTCTCCTGTGCAGCC TCTGGATT CACCTTTAGCCGCTATGCCATGAACTGGGTCCGCCA GGCTCCAGGGAAGGGGCTGGAGTGGGTCTCAGGTAT TAGTGGTA GTGGTGGTAGCACATACTACGCAGACTCCGTGAAGG GCCGGTTCACCATCTCCAGAGACAATTCCAAGAACA CGCTGTAT CTGCAAATGAACAGCCTGAGAGCCGAGGACACGGC CGTATATTACTGTGCGAAAGATCGCGATTTTTGGAG TGGTCCATT TGACTACTGGGGCCAGGGAACCCTGGTCACCGTCTC CTCAGC

28	**Abx-221**	**Light chain**	248	GAAATAGTGATGACGCCGTCTTCAGCCACCCTGTCT GTGTCTCCAGGGGAAAGAGCCACCCTCTCCTGTAGG GCCAGTCA GAGTGTTAGTAGAAGCTTAGCCTGGTACCAGCAGAA ACCTGGCCAGGCTCCCAGGCTCCTCATCTACGGTGC ATCCACCA GGGCCACTGGGATCCCAGCCAGGTTCAGTGGCAGTG GGTCTGGGACAGAATTCACTCTCACCATCAGCAGCC TGCAGTCT GAAGATGTTGCAGTTTATTACTGTCAGCAGTATAAT AACTGGATGTGCAGTTTTGGCCAGGGGACCAAGCTG GAGATCAA ACG
29	**Abx-229**	**Heavy chain**	45	GAGGTGCAGCTGTTGGAGTCTGGGGGAGGCTTGGTA CAGCCTGGGGGGTCCCTGAGACTCTCCTGTGCAGCC TCTGGATTCACCTTTAGCCGCTATGCCATGAACTGGG TCCGCCAGGCTCCAGGGAAGGGGCTGGAGTGGGTCT CAGGTATTAGTGGGAGTGGTGGTAGGACATACTACG CAGACTCCGTGAAGGGCCGGTTCACCATCTCCAGAG ACAATTCCAAGAACACACTATATCTGCAAATGAACA GCCTGAGAGCCGAGGACACGGCCGTATATTACTGTG CGAAAGATCGCGATTTTTGGAGTGGTCCATTTGACT ACTGGGGCCAGGGAACCCTGGTCACCGTCTCCTCA

30	**Abx-229**	**Light chain**	47	GAAATAGTGATGACGCCGTCTTCAGCCACCCTGTCT GTGTCTCCAGGGGAGAGAGCCACCCTCTCCTGCAGG GCCAGTCAGAGTGTTAGTAGAAACTTAGCCTGGTAC CAGCAGAAACCTGGCCAGGCTCCCAGGCTCCTCATC TATGGTGCATCCACCAGGGCCACTGGTATCCCAGCC AGGTTCAGTGGCAGTGGGTCTGGGACAGAATTCACT CTCACCATCAGCAGCCTGCAGTCTGAAGATTTTGCA GTTTATTACTGTCACCAGTATAGTAACTGGATGTGCA GTTTTGGCCAGGGGACCAAGCTGGAGATCAAA
31	**Abx-338**	**Heavy chain**	49	CAGGTGCAGCTGCAGGAGTCGGGCCCAGGACTGGTG AAGCCTTCGGAGACCCTGTCCCTCACCTGCACTGTCT CTGGTGGCTCCATCAGAAGTTACTACTGGAGCTGGA TCCGGCAGCCCGCCGGGAAGGGACTGGAGTGGATTG GACGTATTTATATCAGTGGGAGGACCACCTTCAACC CCTCCCTCAAGAGTCGAGTCACCATATCAGTGGACA CGTCCAAGAACCAGTTCTCCCTGAAGCTGAGCTCTG TGACCGCCGCGGACACGGCCGTGTATTTCTGTGCGA GAGATAGATATTATGGCTACCTTGACTACTGGGGCC AGGGAACCCTGGTCACCGTCTCCTCA
32	**Abx-338**	**Light chain**	51	GAAATTGTGTTGACGCAGTCTCCAGGCACCCTGTCTT TGTCTCCAGGGGAAAGAGCCACCCTCTCCTGCAGGG CCAGTCAGAGTGTTAGCCGCAGTTACTTAGCCTGGT ACCAACAGAAACCTGGCCAGGCTCCCAGGCTCCTCA TCTATGATGCATCCAGCAGGGCCACTGGCATCCCAG ACAGGTTCAGTGGCAGTGGGTCTGGGACAGACTTCA CTCTCACCATCAGCAGACTGGAGCCTGAAGATTTTG CAGTGTATTACTGTCAGCAGTATGGTAGTTCACCGA GCACCTTCGGCCAAGGGACACGACTGGAGATTAAA

33	**Abx-393**	**Heavy chain**	53	CAGGTGCAGCTGCAGGAGTCGGGCCCAGGACTGGTG AAGCCTTCGGAGACCCTGTCCCTCACCTGCACTGTCT CTGGCGGCTCCATCCGTCATTACTACTGGAGCTGGA TCCGGCAGCCCCCAGGGAAGGGACTGGAGTGGATTG GGTATATCTATTACAGTGGGAGCACCAACTACAACC TCTCCCTCAAGAGTCGAGTCACCATATCAAGAGACA CGTCCAAGAATCAGGTCTCCCTG AAGCTGAGTTCTGTGACCGCTGCGGACACGGCCGTG TATTATTGTGCGGCGGGTATGGGCTTTGACTACTGG GGCCAGGGAACCCTGGTCACCGTCTCCTCA
34	**Abx-393**	**Light chain**	55	GACATCCAGATGACCCAGTCTCCTTCCTCCCTGTCTG CATCTATAGGAGACAGAGTCACCATCACTTGCCGGG CAAGTCAGGCCATTAGAAATGATTTAGGCTGGTATC AGCTGAAACCGGGGAAAGCCCCTAAGCGCCTGATCT ATTCTGCATCCAGTTTGCAAAGTGGGGTCCCATCAA GGTTCAGCGGCAGTGGATCTGGGACAGAATTCACTC TCACAATCAGCAGCCTGCAGCCTGAGGATTCTGCAA CTTATTACTGTCTACAGCATAATAGTTTCCCTCCGAC GTTCGGCCAAGGGACCAAGGTGGAAATCAAA

Table 5: Amino acid sequence of CDRs

	mAb	IgG chain	SEQ ID NO:	Amino Acid Sequence
1	**3G1**	**VH CDR1**	58	RNAIS
2	**3G1**	**VH CDR2**	60	VIWTGGGTNYNSALKS
3	**3G1**	**VH CDR3**	62	SGYDGFDY
4	**3G1**	**VL CDR1**	64	SASSSVNYMH
5	**3G1**	**VL CDR2**	66	DTSKLAS
6	**3G1**	**VL CDR3**	68	QQWSGNPYT
7	**8E12**	**VH CDR1**	70	DYYIN
8	**8E12**	**VH CDR2**	72	KIGPRSGNTYYNEKFKG
9	**8E12**	**VH CDR3**	74	WDAY
10	**8E12**	**VL CDR1**	76	KSSQSLLYSNGKTYLN

11	**8E12**	**VL CDR2**	78	QVSKLDP
12	**8E12**	**VL CDR3**	80	LQGTYYPYT
13	**8F1**	**VH CDR1**	82	GYWMY
14	**8F1**	**VH CDR2**	84	RIHPSDSNTNYNQKFKG
15	**8F1**	**VH CDR3**	86	ALAY
16	**8F1**	**VL CDR1**	88	KSSQSLLYSNGKTYLS
17	**8F1**	**VL CDR2**	90	LVSQLDS
18	**8F1**	**VL CDR3**	92	VQGTHLFT
19	**1D3**	**VH CDR1**	94	DYYIN
20	**1D3**	**VH CDR2**	96	KIGPRSGSTYYNEKFKG
21	**1D3**	**VH CDR3**	98	WDAY
22	**1D3**	**VL CDR1**	100	KSSQSLLYSNGKTYL

23	**1D3**	**VL CDR2**	102	QVSKLDP
24	**1D3**	**VL CDR3**	104	LQGTYYPYT
25	**5F9**	**VH CDR1**	106	GYYWS
26	**5F9**	**VH CDR2**	108	EINHRGNTNDNPSLKS
27	**5F9**	**VH CDR3**	110	ERGYTYGNFDH
28	**5F9**	**VL CDR1**	112	RASQSVSRNLA
29	**5F9**	**VL CDR2**	114	GASTRAT
30	**5F9**	**VL CDR3**	116	QQYKTWPRT
31	**5H3**	**VH CDR1**	118	DCYMS
32	**5H3**	**VH CDR2**	120	YITTSGNTIYYADSVKG
33	**5H3**	**VH CDR3**	122	DWGWFYGMDV
34	**5H3**	**VL CDR1**	124	KSSQSLLHNDGKTYLY

35	**5H3**	**VL CDR2**	126	EVSNRFS
36	**5H3**	**VL CDR3**	128	MQSIQLPRT
37	**6H8**	**VH CDR1**	130	SYGMH
38	**6H8**	**VH CDR2**	132	AIWYDGSNKYYADSVKG
39	**6H8**	**VH CDR3**	134	GRSSSYFDY
40	**6H8**	**VL CDR1**	136	RSSQSLVHSDGNTYLS
41	**6H8**	**VL CDR2**	138	KTSNRFS
42	**6H8**	**VL CDR3**	140	MQATQFPT
43	**8C2**	**VH CDR1**	142	SYGMH
44	**8C2**	**VH CDR2**	144	AIWYDGSNKYYAASVKG
45	**8C2**	**VH CDR3**	146	GRSSSYFDY
46	**8C2**	**VL CDR1**	148	RSSQSLVHSDGNTYLS

47	**8C2**	**VL CDR2**	150	KTSNRFS
48	**8C2**	**VL CDR3**	152	MQATQFPT
49	**10C10**	**VH CDR1**	154	SYGMH
50	**10C10**	**VH CDR2**	156	AIWYDGSNKYYADSVKG
51	**10C10**	**VH CDR3**	158	GRSSSYFDY
52	**10C10**	**VL CDR1**	160	RSSQSLVHSDGNTYLS
53	**10C10**	**VL CDR2**	162	KISNRFS
54	**10C10**	**VL CDR3**	164	MQATQFPT
103	**10D3**	**VH CDR1**	291	GYYWS
104	**10D3**	**VH CDR2**	293	EINHRGNTNDNPSLKS
105	**10D3**	**VH CDR3**	295	ERGYTYGNFDH
106	**10D3**	**VL CDR1**	297	RASQSVSSRYLA

107	**10D3**	**VL CDR2**	299	GASSRAT
108	**10D3**	**VL CDR3**	301	QQYERSFT
55	**Abx-012**	**VH CDR1**	251	HYYWS
56	**Abx-012**	**VH CDR2**	253	RIYISGRTSYNPSLKS
57	**Abx-012**	**VH CDR3**	255	DRLTGYFDY
58	**Abx-012**	**VL CDR1**	257	RASQSVSSSYLA
59	**Abx-012**	**VL CDR2**	259	GASSRAA
60	**Abx-012**	**VL CDR3**	261	QQYGSSLT
61	**Abx-020**	**VH CDR1**	166	DYYMS
62	**Abx-020**	**VH CDR2**	168	YITSSGSTIYYSASVKG
63	**Abx-020**	**VH CDR3**	170	DFSGWFGVHFDY
64	**Abx-020**	**VL CDR1**	172	KSSQSLLHSDGKTYLY

65	**Abx-020**	**VL CDR2**	174	EVSNRFS
66	**Abx-020**	**VL CDR3**	176	MQSIQLTWT
67	**Abx-0106**	**VH CDR1**	263	HYYWS
68	**Abx-106**	**VH CDR2**	265	RIYISGRTSYNPSLKS
69	**Abx-106**	**VH CDR3**	267	DRLTGYFDY
70	**Abx-106**	**VL CDR1**	269	RASQSVSSSYLA
71	**Abx-106**	**VL CDR2**	271	GTSSRAT
72	**Abx-106**	**VL CDR3**	273	QQYGSSPMCS
73	**Abx-198**	**VH CDR1**	178	SYAMS
74	**Abx-198**	**VH CDR2**	180	DISGSGGSTYYADSVKG
75	**Abx-198**	**VH CDR3**	182	RRWQGYFDL
76	**Abx-198**	**VL CDR1**	184	RARQRVDSRYLA

77	**Abx-198**	**VL CDR2**	186	GASSRAT
78	**Abx-198**	**VL CDR3**	188	QQYGSSPLT
79	**Abx-221**	**VH CDR1**	275	RYAMN
80	**Abx-221**	**VH CDR2**	277	GISGSGGSTYYADSVKG
81	**Abx-221**	**VH CDR3**	279	DRDFWSGPFDY
82	**Abx-221**	**VL CDR1**	281	RASQSVSRSLA
83	**Abx-221**	**VL CDR2**	283	GASTRAT
84	**Abx-221**	**VL CDR3**	285	QQYNNWMCS
85	**Abx-229**	**VH CDR1**	190	RYAMN
86	**Abx-229**	**VH CDR2**	192	GISGSGGRTYYADSVKG
87	**Abx-229**	**VH CDR3**	194	DRDFWSGPFDY
88	**Abx-229**	**VL CDR1**	196	RASQSVSRNLA

89	**Abx-229**	**VL CDR2**	198	GASTRAT
90	**Abx-229**	**VL CDR3**	200	HQYSNWMCS
91	**Abx-338**	**VH CDR1**	202	SYYWS
92	**Abx-338**	**VH CDR2**	204	RIYISGRTTFNPSLKS
93	**Abx-338**	**VH CDR3**	206	DRYYGYLDY
94	**Abx-338**	**VL CDR1**	208	RASQSVSRSYLA
95	**Abx-338**	**VL CDR2**	210	DASSRAT
96	**Abx-338**	**VL CDR3**	212	QQYGSSPST
97	**Abx-393**	**VH CDR1**	214	HYYWS
98	**Abx-393**	**VH CDR2**	216	YIYYSGSTNYNLSLKS
99	**Abx-393**	**VH CDR3**	218	GMGFDY
100	**Abx-393**	**VL CDR1**	220	RASQAIRNDLG

101	**Abx-393**	**VL CDR2**	222	SASSLQS
102	**Abx-393**	**VL CDR3**	224	LQHNSFPPT
109	**consensus**	**VH CDR1**	302	x-x/Y-x/Y-M/W-S/N
110	**consensus**	**VH CDR2**	303	x-I-x-x-SG-[x or none]-x-T/I-[y/T/S]-x-x-L/V-K-s/G
111	**consensus**	**VH CDR3**	304	[4-6x]-G-[2-3x]-D-Y
112	**consensus**	**VL CDR1**	305	R/K-A/S-SQS-V/L-S/L-[5-9x]
113	**consensus**	**VL CDR2**	306	x-x-S-x-R-x-x
114	**consensus**	**VL CDR3**	307	Q/H/M-Q-Y/S-[5-7x]

Table 6. Nucleic acid sequence of CDRs

	mAb	**IgG chain**	**SEQ ID NO:**	**Nucleic Acid Sequence**
1	**3G1**	**VH CDR1**	57	AGAAATGCTATAAGC

2	**3G1**	**VH CDR2**	59	GTAATATGGACTGGTGGAGGCACAAATTAT AATTCAGCTCTCAAATCC
3	**3G1**	**VH CDR3**	61	AGTGGTTACGACGGGTTTGATTAC
4	**3G1**	**VL CDR1**	63	AGTGCCAGCTCAAGTGTAAATTACATGCAC
5	**3G1**	**VL CDR2**	65	GACACATCCAAACTGGCTTCT
6	**3G1**	**VL CDR3**	67	CAGCAGTGGAGTGGTAACCCGTACACG
7	**8E12**	**VH CDR1**	69	GACTACTATATAAAC
8	**8E12**	**VH CDR2**	71	AAGATTGGTCCTCGAAGTGGTAATACTTACT ACAATGAGAAGTTCAAGGGC
9	**8E12**	**VH CDR3**	73	TGGGATGCTTAC
10	**8E12**	**VL CDR1**	75	AAGTCAAGTCAGAGCCTCTTATATAGTAATG GAAAGACATATTTGAAT
11	**8E12**	**VL CDR2**	77	CAGGTGTCCAAACTGGACCCT
12	**8E12**	**VL CDR3**	79	TTGCAAGGTACATATTATCCGTACACG
13	**8F1**	**VH CDR1**	81	GGCTACTGGATGTAC

14	**8F1**	**VH CDR2**	83	AGGATTCATCCTTCTGATAGTAATACTAACT ACAATCAAAAGTTCAAGGGC
15	**8F1**	**VH CDR3**	85	GCCCTTGCTTAC
16	**8F1**	**VL CDR1**	87	AAGTCAAGTCAGAGCCTCTTATATAGTAATG GAAAAACCTATTTGAGT
17	**8F1**	**VL CDR2**	89	CTGGTGTCTCAACTGGACTCT
18	**8F1**	**VL CDR3**	91	GTGCAAGGTACACATTTATTCACG
19	**1D3**	**VH CDR1**	93	GACTACTATATAAAC
20	**1D3**	**VH CDR2**	95	AAGATTGGTCCTAGAAGTGGTAGTACTTACT ACAATGAGAAGTTCAAGGGC
21	**1D3**	**VH CDR3**	97	TGGGATGCTTAC
22	**1D3**	**VL CDR1**	99	AAGTCAAGTCAGAGCCTCTTATATAGTAATG GAAAGACATATTTGAAT
23	**1D3**	**VL CDR2**	101	CAGGTGTCCAAACTGGACCCT
24	**1D3**	**VL CDR3**	103	TTGCAAGGTACATATTATCCGTACACG
25	**5F9**	**VH CDR1**	105	GGTTACTACTGGAGC

26	**5F9**	**VH CDR2**	107	GAAATCAATCATCGTGGAAACACCAACGAC AACCCGTCCCTCAAG
27	**5F9**	**VH CDR3**	109	GAACGTGGATACACCTATGGTAACTTTGACC AC
28	**5F9**	**VL CDR1**	111	AGGGCCAGTCAGAGTGTTAGCAGAAACTTA GCC
29	**5F9**	**VL CDR2**	113	GGTGCATCCACCAGGGCCACT
30	**5F9**	**VL CDR3**	115	CAGCAGTATAAAACCTGGCCTCGGACG
31	**5H3**	**VH CDR1**	117	GACTGCTACATGAGC
32	**5H3**	**VH CDR2**	119	TACATTACTACTAGTGGTAATACCATTTACT ACGCAGACTCTGTGAAGGGC
33	**5H3**	**VH CDR3**	121	GACTGGGGATGGTTCTACGGTATGGACGTC
34	**5H3**	**VL CDR1**	123	AAGTCTAGTCAGAGCCTCCTGCATAATGATG GAAAGACCTATTTG
35	**5H3**	**VL CDR2**	125	GAAGTTTCCAACCGGTTCTCT
36	**5H3**	**VL CDR3**	127	ATGCAAAGTATACAGCTTCCTCGGACG
37	**6H8**	**VH CDR1**	129	AGCTATGGCATGCAC

38	**6H8**	**VH CDR2**	131	GCTATATGGTATGATGGAAGTAATAAATACT ATGCAGACTCCGTGAAGGGC
39	**6H8**	**VH CDR3**	133	GGGAGGAGCAGCTCGTACTTTGACTAT
40	**6H8**	**VL CDR1**	135	AGGTCTAGTCAAAGCCTCGTACACAGTGATG GAAACACCTACTTGAGT
41	**6H8**	**VL CDR2**	137	AAGACTTCTAACCGCTTCTCT
42	**6H8**	**VL CDR3**	139	ATGCAAGCTACGCAATTTCCAACC
43	**8C2**	**VH CDR1**	141	AGCTATGGCATGCAC
44	**8C2**	**VH CDR2**	143	GCTATATGGTATGATGGAAGTAATAAATACT ATGCAGCCTCCGTGAAGGGC
45	**8C2**	**VH CDR3**	145	GGGAGGAGCAGCTCGTATTTTGACTAC
46	**8C2**	**VL CDR1**	147	AGGTCTAGTCAAAGCCTCGTACACAGTGATG GAAACACCTACTTGAGT
47	**8C2**	**VL CDR2**	149	AAGACTTCTAACCGCTTCTCT
48	**8C2**	**VL CDR3**	151	ATGCAAGCTACGCAATTTCCA
49	**10C10**	**VH CDR1**	153	AGCTATGGCATGCAC

50	**10C10**	**VH CDR2**	155	GCTATATGGTATGATGGAAGTAATAAATACT ATGCAGACTCCGTGAAGGGC
51	**10C10**	**VH CDR3**	157	GGGAGGAGCAGCTCGTACTTTGACTAT
52	**10C10**	**VL CDR1**	159	AGGTCTAGTCAAAGCCTCGTACACAGTGATG GAAACACGTACTTGAGT
53	**10C10**	**VL CDR2**	161	AAGATTTCTAACCGGTTCTCT
54	**10C10**	**VL CDR3**	163	ATGCAAGCTACACAATTTCCAACC
103	**10D3**	**VH CDR1**	290	GGTTACTACTGGAGC
104	**10D3**	**VH CDR2**	292	GAAATCAATCATCGTGGAAACACCAACGAC AACCCGTCCCTCAAG
105	**10D3**	**VH CDR3**	294	GAACGTGGATACACCTATGGTAACTTTGACC AC
106	**10D3**	**VL CDR1**	296	AGGGCCAGTCAGAGTGTTAGCAGCAGGTAC TTAGCCT
107	**10D3**	**VL CDR2**	298	GGTGCATCCAGCAGGGCCACTG
108	**10D3**	**VL CDR3**	300	CAGCAGTATGAAAGGTCATTCACTT
55	**Abx-012**	**VH CDR1**	250	CATTACTACTGGAGC
56	**Abx-012**	**VH CDR2**	252	CGTATCTATATCAGTGGGAGGACCAGCTACA ACCCCTCCCTCAAGAGT

57	**Abx-012**	**VH CDR3**	254	GATCGGCTAACTGGGTACTTTGACTAC
58	**Abx-012**	**VL CDR1**	256	AGGGCCAGTCAGAGTGTTAGCAGCAGCTACTTAGCC
59	**Abx-012**	**VL CDR2**	258	GGTGCATCCAGCAGGGCCGCT
60	**Abx-012**	**VL CDR3**	260	CAGCAGTATGGTAGCTCCCTCACT
61	**Abx-020**	**VH CDR1**	165	GACTACTACATGAGC
62	**Abx-020**	**VH CDR2**	167	TACATTACTAGTAGTGGTAGTACCATATACTACTCAGCCTCTGTGAAGGGC
63	**Abx-020**	**VH CDR3**	169	GATTTCAGTGGCTGGTTCGGAGTCCACTTTGACTAC
64	**Abx-020**	**VL CDR1**	171	AAGTCTAGTCAGAGCCTCCTGCATAGTGATGGAAAGACCTATTTGTAT
65	**Abx-020**	**VL CDR2**	173	GAAGTTTCCAACCGGTTCTCT
66	**Abx-020**	**VL CDR3**	175	ATGCAAAGTATACAACTTACGTGGACG
67	**Abx-106**	**VH CDR1**	262	CATTACTACTGGAGC
68	**Abx-106**	**VH CDR2**	264	CGTATCTATATCAGTGGGAGGACCAGCTACAACCCCTCCCTCAAGAGT

69	**Abx-106**	**VH CDR3**	266	GATCGGCTAACTGGGTACTTTGACTAC
70	**Abx-106**	**VL CDR1**	268	AGGGCCAGTCAGAGTGTTAGCAGCAGCTAC TTAGCC
71	**Abx-106**	**VL CDR2**	270	GGTACATCCAGCAGGGCCACT
72	**Abx-106**	**VL CDR3**	272	CAGCAGTATGGTAGCTCACCCATGTGCAGT
73	**Abx-198**	**VH CDR1**	177	AGCTATGCCATGAGC
74	**Abx-198**	**VH CDR2**	179	GATATTAGTGGTAGTGGTGGTAGCACATACT ACGCAGACTCCGTGAAGGGC
75	**Abx-198**	**VH CDR3**	181	CGGCGGTGGCAGGGGTACTTCGATCTC
76	**Abx-198**	**VL CDR1**	183	AGGGCCAGGCAGCGTGTTGACAGCAGGTAC TTAGCC
77	**Abx-198**	**VL CDR2**	185	GGTGCATCCAGCAGGGCCACT
78	**Abx-198**	**VL CDR3**	187	CAGCAGTATGGTAGCTCACCGCTCACT
79	**Abx-221**	**VH CDR1**	274	CGCTATGCCATGAAC
80	**Abx-221**	**VH CDR2**	276	GGTATTAGTGGTAGTGGTGGTAGCACATACT ACGCAGACTCCGTGAAGGGC

81	**Abx-221**	**VH CDR3**	278	GATCGCGATTTTTGGAGTGGTCCATTTGACT AC
82	**Abx-221**	**VL CDR1**	280	AGGGCCAGTCAGAGTGTTAGTAGAAGCTTA GCC
83	**Abx-221**	**VL CDR2**	282	GGTGCATCCACCAGGGCCACT
84	**Abx-221**	**VL CDR3**	284	CAGCAGTATAATAACTGGATGTGCAGT
85	**Abx-229**	**VH CDR1**	189	CGCTATGCCATGAAC
86	**Abx-229**	**VH CDR2**	191	GGTATTAGTGGGAGTGGTGGTAGGACATAC TACGCAGACTCCGTGAAGGGC
87	**Abx-229**	**VH CDR3**	193	GATCGCGATTTTTGGAGTGGTCCATTTGACT AC
88	**Abx-229**	**VL CDR1**	195	AGGGCCAGTCAGAGTGTTAGTAGAAACTTA GCC
89	**Abx-229**	**VL CDR2**	197	GGTGCATCCACCAGGGCCACT
90	**Abx-229**	**VL CDR3**	199	CACCAGTATAGTAACTGGATGTGCAGT
91	**Abx-338**	**VH CDR1**	201	AGTTACTACTGGAGC
92	**Abx-338**	**VH CDR2**	203	CGTATTTATATCAGTGGGAGGACCACCTTCA ACCCCTCCCTCAAGAGT

93	**Abx-338**	**VH CDR3**	205	GATAGATATTATGGCTACCTTGACTAC
94	**Abx-338**	**VL CDR1**	207	AGGGCCAGTCAGAGTGTTAGCCGCAGTTACTTAGCC
95	**Abx-338**	**VL CDR2**	209	GATGCATCCAGCAGGGCCACT
96	**Abx-338**	**VL CDR3**	211	CAGCAGTATGGTAGTTCACCGAGCACC
97	**Abx-393**	**VH CDR1**	213	CATTACTACTGGAGC
98	**Abx-393**	**VH CDR2**	215	TATATCTATTACAGTGGGAGCACCAACTACAACCTCTCCCTCAAGAGT
99	**Abx-393**	**VH CDR3**	217	GGTATGGGCTTTGACTAC
100	**Abx-393**	**VL CDR1**	219	CGGGCAAGTCAGGCCATTAGAAATGATTTAGGC
101	**Abx-393**	**VL CDR2**	221	TCTGCATCCAGTTTGCAAAGT
102	**Abx-393**	**VL CDR3**	223	CTACAGCATAATAGTTTCCCTCCGACG

[0402] Expression vectors were created as described above which contain coding sequence for both the heavy and light chain of each of mAb 5F9 and Abx-229.

[0403] The invention is illustrated by the following examples, which should not be construed as further limiting.

EXAMPLES

EXAMPLE 1: Generation of anti-GCC antibodies and characterization

[0404] The generation of GCC protein for immunization and screening was performed as follows. GCC antigen was prepared by subcloning a portion of the GCC gene encoding a sequence comprising the following GCC sequence (signal sequence and extracellular domain) into an expression vector.

MKTLLLDLALWSLLFQPGWLSFSSQVSQNCHNGSYEISVLMMGNSAFAEPLKNLEDAVNEGLEIVR
GRLQNAGLNVTVNATFMYSDGLIHNSGDCRSSTCEGLDLLRKISNAQRMGCVLIGPSCTYSTFQMY
LDTELSYPMISAGSFGLSCDYKETLTRLMSPARKLMYFLVNFWKTNDLPFKTYSWSTSYVYKNGTE
TEDCFWYLNALEASVSYFSHELGFKVVLRQDKEFQDILMDHNRKSNVIIMCGGPEFLYKLKGDRAV
AEDIVIILVDLFNDQYFEDNVTAPDYMKNVLVLTLSPGNSLLNSSFSRNLSPTKRDFALAYLNGILLF
GHMLKIFLENGENITTPKFAHAFRNLTFEGYDGPVTLDDWGDVDSTMVLLYTSVDTKKYKVLLTY
DTHVNKTYPVDMSPTFTWKNSKL (SEQ ID NO:229)

[0405] The expression vector (pLKTOK107) provided a C-terminal IgG1Fc region to fuse with the GCC sequence. This vector comprised an exon with the IgG1 hinge, CH2 and CH3 domains, mutated to eliminate an unpaired cysteine from the CH1 fragment in the exon. This IgG1Fc region was further mutated at lysine 235 and glycine 237 to alanines. The construct was expressed recombinantly in human embryonic kidney (HEK) 293 cells transfected with the gene for SV40 T-antigen as secreted GCC sequence (amino acid residues 24 to 430 of SEQ ID NO:228) fused to a C-terminal human IgG1 Fc. The protein, named TOK107-hIg (alt. name hGCC-ECD/hIgG1 Fc, SEQ ID NO:317), was purified by protein A chromatography and size exclusion chromatography.

[0406] GCC antigen was also prepared by subcloning the above fusion protein into an expression vector such as pLKTOK111, which allows for fusion of the murine IgG2a transmembrane region onto the C-terminus. When this construct is expressed recombinantly in CHO cells, the GCC extracellular domain is detected on the cell surface. High cell surface expression of the GCC-Ig fusion protein (SEQ ID NO:318) is achieved when the pLKTOK111 vector is co-transfected with pLKTOK123, which comprises

murine CD79a (MB-1) and CD79b (B29). Clone #27 from this transfection (CHO-GCC#27) was used as immunogen. HT-29-GCC#2 cells also were used as immunogen.

[0407] For screening of hybridoma supernatants and purified mAbs by ELISA, the nucleic acid encoding a GCC fusion construct was cloned into a pCMV1 expression vector (Sigma). Purification tags: FLAG-tag (in the N-terminus) and His-tag (in the C-terminus) were cloned into the construct as well. The fusion protein construct was transfected into 293 cells, expressed, and recombinant protein was purified over and Anti-FLAG® M2-Agarose Affinity column (Sigma).

[0408] **Reagents and Cell lines**. HEK293 cells, CHO, and T84 human colon cancer cells and were obtained from ATCC and maintained according to ATCC protocols.

[0409] **Mice**: Female C57BL/6 mice, 4-6 weeks old, were purchased from Taconic Farms, Inc. (Germantown, NY) for the generation of the murine hybridomas. Xenomice, bred in-house until 4-6 weeks old, producing human IgG2 antibodies were obtained from Abgenix, Inc. (Fremont, CA) for the generation of the human hybridomas. All animals were acquired and maintained according to the guidelines of the Institutional Animal Care and Use Committee of Millennium Pharmaceuticals, Inc.

[0410] **Cell Lines:** The cell lines used for functional assays were cell pairs of GCC transfected cells and vector control HEK293 or HT29 cells. HT29 cells were transfected with the full length GCC under control of the EF-1α promoter or empty vector (pLKTOK4) and selected in G418. The GCC in these cells was confirmed to have a cGMP response when contacted with the ST peptide (1-18 or 5-18). HEK293 cells were transfected full length GCC under control of the CMV promoter or empty vector (pN8mycSV40) and selected in blasticidin. The GCC in these cells has a myc tag. The clones selected for highest GCC expression were 293-GCC#2, HT29-GCC#2 and HT29-GCC#5. The HT29-GCC#2 also were used as immunogens for generating anti-GCC antibody molecules. Additional GCC-expressing cells are CT26 cells. To develop the GCC-expressing CT26 cell line, pTOK58D vector was used. Full length GCC was cloned into the site normally used for heavy chain cloning and luciferase was cloned into the site normally used for light chain cloning. After transfection into CT26 cells, independent expression of both GCC and luciferase was confirmed. Surface expression of GCC was confirmed by flow cytometry using the 5F9 antibody. Clone #32 was selected for further studies.

[0411] The T84 colon cancer cell line endogenously expresses GCC. Taqman analysis of GCC in a broad cell line panel revealed that T84 was the only cell line that express mRNA for GCC. Staining for GCC with a GCC selective mAb on cell pellets of T84 cells showed significant GCC protein expression .

[0412] Quantitation of GCC receptor levels with radiolabeled ligand (ST-toxin) suggested that the 293-GCC#2 cell expressed more GCC than T84 cells while the HT29-GCC#2 or #5 expressed the fewest GCC molecules per cell.

Cell line	**Whole cell binding assay (receptor /cell)**
HT-29-GCC#2/#5	100,000
T84 endogenous GCC	300,000
293-GCC	600,000

[0413] **Generation of murine mAbs by protein immunization**: Human GCC extracellular domain/human Ig fusion protein (TOK107-hIg, 50 μg) was suspended in Dulbecco's phosphate buffered saline (PBS; GIBCO, Grand Island, NY) and emulsified with an equal volume of complete Freund's adjuvant (Sigma Chemical Co., St. Louis, MO). C57BL/6 mice were immunized by injection of the emulsion at three subcutaneous sites and one intraperitoneal (i.p.) site. Two weeks after the initial immunization, the mice were given a booster immunization i.p. with 25 μg TOK107-hIg in incomplete Freund's adjuvant. One week later, a small amount of blood was collected from the tail vein and the serum binding activity against TOK107-Ig was titered by ELISA. Mice were selected for fusion when their titer exceeded 1:24,300 by ELISA or 1:500 by FACS. The selected mice were boosted by injection of 25 μg TOK107-hIg in PBS. Four days later, one mouse was euthanized and a spleen cell suspension was prepared and washed with PBS for fusion with P3 cells. One month later, spleen cells from another mouse were prepared for fusion with P3 cells. The fused cells were tested for production of antibodies which specifically bound to GCC by ELISA for binding TOK107-hIg compared to a nonGCC antigen or to the Fc region of IgG and by FACS for binding to T84 cells, or Caco-2 cells or HT-29 clone #2 cells compared to vector control and compared to non-GCC-expressing MCF-7 cells. Isotype was determined using ISOSTRIP® mouse monoclonal antibody isotyping kit

(Roche Diagnostics Mannheim Germany). These immunization schemes and hybridoma fusions produced the 1D3, 8E12, 3G1 and 10B8 murine anti-GCC antibody molecules.

[0414] Generation of human mAbs. *XENOMOUSE* genetically engineered mice (Abgenix, Fremont, CA) (8 to 10 weeks old) were immunized for production of human monoclonal antibodies. See, Mendez et al. *Nature Genetics* 15:146-156 (1997), Green and Jakobovits *J. Exp. Med.* 188:483-495 (1998). Several immunization schemes were employed. In one scheme, one hundred micrograms of human GC-C extracellular domain/human Ig fusion protein (TOK107-hIg) were suspended in Dulbecco's phosphate buffered saline (PBS; GIBCO, Grand Island, NY) and emulsified with an equal volume of complete Freund's adjuvant (Sigma Chemical Co., St. Louis, MO). *XENOMOUSE*^{TM} were immunized by injection of the emulsion at three subcutaneous sites, base of tail and one intraperitoneal (i.p.) site. Fourteen days after the initial immunization, the mice were given a booster immunization with 50 μg TOK107-hIg in incomplete Freund's adjuvant. Sera testing indicated insufficient titer so after a few weeks rest, a second booster of 50 μg human TOK107-hIg was given. Two weeks later, a small amount of blood was collected from the tail vein and the serum activity against TOK107-Ig was titered by ELISA and against HT29-GCC#2 cells by FACS. Mice were selected for fusion when their titer exceeded 1:24,300 by ELISA or 1:500 by FACS. Nearly three months after that boost, mice were boosted with 10^7 HT-29 #2 cells and the next day boosted with 50 μg TOK107-hIg, both in incomplete Freund's adjuvant. A mouse immunized with this scheme produced the 5F9 and the 1D2 human anti-GCC antibody molecules. A mouse immunized with this scheme produced the 5F9 and the 1D2 human anti-GCC antibody molecules.

Four days later, the mice were euthanized and spleen cell suspensions were prepared and washed with PBS for the fusion. The fused cells were tested for production of antibodies which specifically bound to GCC by ELISA for binding TOK107-hIg compared to a nonGCC antigen or to the Fc region of IgG and by FACS for binding to T84 cells or HT-29 clone #2 cells compared to vector control and compared to non-GCC-expressing MCF-7 cells. Isotype was determined using ELISA or by FACS using IgG or IgM specific secondary antibodies. A mouse immunized with this scheme produced the 5F9 and the 1D2 human anti-GCC antibody molecules.

[0415] In another scheme, CHO-GCC#27 cells (5×10^6) comprising the pkTOK111 vector and expressing the GCC extracellular domain on their surfaces were used as the immunogen two times with two weeks between BIP (base of tail + intraperitoneal) immunizations. After sampling blood to identify anti-GCC reactivity by ELISA against TOK107-hIg, the mice were boosted with HT-29 GCC #2 cells (either three weeks or more than two months since the previous boost). Four days after the last boost, the respective spleen was harvested for cell fusion. The fused cells were tested for production of antibodies which specifically bound to GCC by ELISA for binding TOK107-hIg compared to a nonGCC antigen or to the Fc region of IgG and by FACS for binding to HT-29 clone #2 cells compared to vector control, T84 cells or non-GCC-expressing MCF-7 cells. Isotype was determined using ELISA. These immunization schemes and hybridoma fusions produced the 5H3, 6H8, 8C2, 10C10, 10D3 and 1C9 human anti-GCC antibody molecules.

[0416] **Hybridomas that produce human mAb**: Spleen cells were counted and mixed with SP 2/0 myeloma cells (ATCC No. CRL8-006, Rockville, MD) that are incapable of secreting either heavy or light chain immunoglobulin chains at a spleen:myeloma ratio of 2:1. Cells were fused with polyethylene glycol 1450 (ATCC) in 12 96-well tissue culture plates in HAT selection medium according to standard procedures. Between 10 and 21 days after fusion, hybridoma colonies became visible and culture supernatants were harvested then screened by ELISA and FACS.

[0417] **SLAM technology-based antibody generation:** Monoclonal antibodies were also isolated by Abgenix's SLAM technology (Babcook et al PNAS 93:7843-7848 (1996)). The initial step in this method was to immunize XENOMOUSE mice were immunized with GCC antigen by a scheme among those described below. Then the SLAM (Selected Lymphocyte Antibody Method) step involves first identifying within a large population of lymphoid cells a single lymphocyte that is producing an antibody with a desired specificity or function, and then rescuing from that lymphocyte the genetic information that encodes the specificity of the antibody. The variable region of such a lymphocyte (initially producing an IgG2 or IgG4 antibody) is amplified and transferred to a vector bearing the IgG1 isotype.

[0418] Immunization schemes for the SLAM antibodies (e.g., Abx-229, -012, -221, -020, -338, -106, -198 or -393) included using TOK-hIg or TOK-hIg conjugated to keyhole limpet hemocyanin. Immunizations were either through the foot pad or a combination of the base of the tail and intraperitoneal. The initial immunization of 10 μg immunogen included either TITERMAX® gold adjuvant or complete Freund's adjuvant. Six to eight boosts with 5 μg of immunogen were performed, using either Alum, TITERMAX® gold adjuvant or incomplete Freund's adjuvant. If TITERMAX gold was the initial adjuvant, alum was the boost adjuvant and boosts were performed at 3 to 4 day intervals. If the initial immunization and boosts employed complete then incomplete Freund's adjuvants, intervals between boosts were performed at about two week intervals. Sera tests of titers at the fourth to sixth boost sometimes were followed by additional boosts. The final boost prior to harvest four days later employed the immunogen in PBS.

[0419] **Analysis of mAb by ELISA.** High-protein binding 96-well EIA plates (Costar/Corning, Inc. Corning, NY) were coated with 50 μl/well of a 2 μg/ml solution (0.1 μg/well) of TOK107-hIg and incubated overnight at 4°C. The excess solution was aspirated and the plates were washed with PBS/0.05% Tween-20 (three times), then blocked with 1% bovine serum albumin (BSA, fraction V, Sigma Chemical Co., MO) for 1 hr at room temperature (RT) to inhibit non-specific binding. The BSA solution was removed and 50 μl/well of hybridoma supernatant from each fusion plate well were added. The plates were then incubated for 45 min. at 37 °C and washed three times with PBS/0.05% Tween-20. Horseradish peroxidase (HRP)-conjugated goat anti-mouse or anti-human IgG F(ab)2 (H&L) (Jackson Research Laboratories, Inc., West Grove, PA) diluted 1:4000 in 1% BSA/PBS was added to each well and then the plates were incubated for 45 min. at 37°C. After washing, 50 μl/well of ABTS solution (Zymed, South San Francisco, CA) was added. The intensity of the green color of positive wells at 405 nm was assessed on a Vmax microtitre plate reader (Molecular Devices Corp., Sunnyvale, CA). All hybridoma wells that gave a positive response were then expanded to 24-well cultures, subcloned by limiting dilution and analyzed by ELISA and FACS. The three best producing subclones were expanded further.

[0420] **Analysis of mAb by flow cytometry.** Flow cytometry (FACS) screening was done on all the fusion plate supernatants in parallel to the ELISA screening. HT-29 clone #2 or untransfected HT-29 cells were grown in T225 flasks (Costar/Corning, Inc.,

Corning, NY) in DMEM (GIBCO) supplemented 10% fetal bovine serum (GIBCO). Cells were detached from the flask surface using Versene (GIBCO), collected and washed twice with DMEM, then once with 1% BSA/PBS solution. The cells were re-suspended in 1% BSA/PBS and $2x10^6$ cells were added to each well of V-bottomed 96-well plates (Costar) and centrifuged for 5 min. at 2500 RPM (wash). The wash solution was discarded and 50 µl/well of supernatant from each fusion plate well wash added. A plate sealer (Linbro/MP Biomedicals, LLC, Solon, OH) was applied and the plates were then gently vortexed to resuspend and mix the cells with the supernatants and incubated at 4°C (on ice) for 30 min. The plates were then washed with cold 1% BSA/PBS (three times) and 50 µl/well FITC-conjugated donkey anti-mouse IgG F(Ab)2 (H&L) or FITC-conjugated goat anti-human IgG F(Ab)2 (H&L) (Jackson) diluted 1:50 was added to each well for 30 min. at 4°C (on ice in dark). The plates were again washed three times in cold 1% BSA/PBS and fixed in cold 1% paraformaldehyde (Sigma)/PBS. The cells were transferred to cluster tubes (Costar) and analyzed on a FACScalibur flow cytometer (Becton Dickenson, San Jose, CA). Any hybridoma wells that showed a positive shift were then expanded to 24-well cultures, subcloned by limiting dilution.

[0421] Internalization assay. Internalization of anti-GCC antibody molecules was tested in both GCC-expressing cells and vector control cells, using immunofluorescence microscopy. Cells were grown on coverslips and placed on ice for 10 minutes prior to incubation with 10 µg/ml antibody in cold culture medium for 20 minutes on ice. For internalization, antibody-containing medium was replaced with fresh culture medium and the cells were shifted to 37°C for 2-3 hours or maintained on ice. After rinsing in PBS and a brief fixation in 4% paraformaldehyde at room temperature, cells were permeabilized for 15 min in 0/5% TRITON X-100. The localization of the test antibody was determined using a fluorescently labeled anti-IgG antibody by laser scanning confocal microscopy. Antibody molecules localized to the cell surface of GCC-expressing cells when on ice. Upon incubation at 37°C, 5F9 showed punctuate staining within the cell membrane, indicative of internalization. No internalization was detected with vector cells.

[0422] Summary of Properties of Anti-GCC Antibody Molecules. Most of the antibodies generated herein were tested in a number of the assays described above. Table 7 summarizes the *in vitro* properties for each. (T84=human colon tumor cells,

MCF7=human breast tumor cells, WB=western blot, IP=immunoprecipitation, IHC=immunohistochemistry; internalization used T84 cells compared to MCF-7 cells)

Table 7. Properties of anti-GCC antibody molecules

	ELISA		FACS							
Ab	TOK1 07-hIg	TOK8 2-hIg	HT-29#2	HT-29	T84	MCF7	WB	IP	IHC	Internali-zation
8F1	+	+/-	+	+/-	+	+/-	+		+	
3G1	+	-	+	-	+	-	-	+	+	+
10B8	+	-	+	-	+	-	-	+	+	
5H3	+	-	+	-	+	-	-	+	+	+
6H8	+	-	+	-	+	-	-	+		+
8C2	+	-	+	-	+	-	-	+	+	+
10C10	-	-	+	-	+	-	-	+		
10D3	+	-	+	-	+	-	+	+		
1D2	+	-	+	-	+	-	-	+		
4A12	+	-	+	-	+	-	-	+		
5F9	+	-	+	-	+	-	+	+	+	+
1C9	+	-	+	-	+	-	-	+		
Abx-012	+		+				-	+	+	+
Abx-015	+		-				+	+		
Abx-020	+		+				-	+		+
Abx-106	+		+					+		-
Abx-198	+		+					+		+
Abx-221	+		+					+		+

Abx-229	+		+					+		+
Abx-252	+		+					+		+
Abx-338	+		+					+		+
Abx-393	+		+					-		+

[0423] Additionally, some antibodies were tested for their ability to inhibit the ST peptide-induced calcium ion flux in GCC-expressing cells. The cGMP assay was performed in HT29-GCC#18 cells in the presence of 50 nM ST in the presence or absence of anti-GCC antibody molecules. There was dose-dependent inhibition of the calcium ion flux by 5F9. Other antibodies, 5H3 and Abx-338 also inhibited the calcium ion flux induced by ST.

[0424] **Estimate of relative affinity of anti-GCC antibody molecules.** The relative affinities (EC50; antibody concentration for half maximal binding) of some anti-GCC antibody molecules were estimated from ELISA measurements against TOK107-hIg and by FACS measurements with GCC-expressing cells. The following table displays some results.

Table 8. EC50 of anti-GCC antibody molecules

Antibody	EC50, TOK107-hIg, M	EC50, Cells, M
5F9	3.65×10^{-8}	1.24×10^{-9}
5H3	4.16×10^{-9}	4.7×10^{-7}
Abx-338	4.9×10^{-12}	9.0×10^{-8}
3G1	2.28×10^{-8}	5.8×10^{-10}
Abx-229	2.95×10^{-8}	
Abx-221	6.55×10^{-9}	
Abx-020	4.58×10^{-9}	
Abx-012	5.55×10^{-10}	

Abx-198	4.77×10^{-8}	

[0425] **Measurement of affinity of anti-GCC antibody molecules.** A BIACORE™ T100 system (GE Healthcare, Piscataway, NJ) was used to measure the affinity of anti-GCC 5F9 antibody at 22°C.

[0426] Step 1: MAb 5F9 (Prep A) was diluted to 20 μg/mL in 10 mM sodium acetate, pH 4.0 and Reference 5F9 MAb (Prep B) was diluted to 10 μg/mL in 10 mM sodium acetate, pH 4.0. Each mAb was covalently immobilized to several CM4 BIACORE chips using standard amine coupling. For each CM4 chip prepared, Prep A 5F9 was immobilized over two flow cells at around 75-100 RU while Prep B 5F9 was immobilized to one flow cell at around 70-80 RU. The remaining fourth flow cell of each CM4 chip was used as the reference flow cell.

[0427] Step 2: The stock concentration of GCC-ECD-Fc (TOK107-hIg) was determined using the methods detailed by Pace et al. in *Protein Science*, 4:2411 (1995), and Pace and Grimsley in *Current Protocols in Protein Science* 3.1.1-3.1.9 (2003).

[0428] Step 3: For each prepared CM4 chip described in Step 1, GCC-ECD-Fc was injected for 2 minutes at a concentration range of 202 nM – 1.6 nM (2x serial dilution) followed by a 7 minute dissociation. Samples were randomly injected in triplicate with several buffer inject cycles interspersed for double referencing. To obtain more significant off-rate decay data, three additional 101 nM GCC- ECD-Fc injections and three additional buffer injections were performed with a 2 minute injection and a 4 hour dissociation time. A flow rate of 100 μL/min was used for all experiments and all surfaces were regenerated with a 20 second pulse of 10mM Glycine-HCl (pH 2.0). All samples were prepared in the running buffer which was Hepes-buffered saline, 0.005% polysorbate 20, pH 7.4 (HBS-P) with 100 μg/mL of BSA added.

[0429] Step 4: All sensorgram (plot of surface plasmon resonance vs time) data were processed with Scrubber 2.0 software (BioLogic Software, Campbell, Australia) and globally fit to a 1:1 interaction model including a term for the mass transport constant k_m using CLAMP™ software (Myszka and Morton *Trends Biochem. Sci.* 23:149-150 (1998)).

[0430] The 1:1 model provided a very good fit to the data as long as the mAb immobilization levels were kept low enough so that the R_{max} resulting from the global

analysis of the sensorgram data was at least below 12 RU for each surface. In most cases, one of the two Prep A 5F9 surfaces had an R_{max} too low (below 2 RU) for reliable kinetic measurements. Data from two flow cells of GCC-ECD-Fc binding to Prep A 5F9 from the same CM4 chip were simultaneously fit whenever possible, however. When mAb surfaces were prepared resulting in a higher R_{max} (> 12 RU), sensorgrams clearly showed complex kinetics and thus a 1:1 model fit the data poorly. This isn't surprising due to the fact that GCC-ECD-Fc is a bivalent construct and a higher surface density of immobilized mAb most likely increases the probability that the GCC-ECD-Fc binds avidly to the surface. Replicates reported for this study include only those data that fit well to the 1:1 interaction model. The resulting K_D's and rate constants of all replicates for Prep A 5F9 and the Prep B reference mAb are listed in Table 9 and Table 10, respectively.

Table 9: GCC-Fc binding to immobilized Prep A 5F9 mAb

Replicate	R_{max} (RU)	k_a ($M^{-1}s^{-1}$)	k_d (s^{-1})	K_D (pM)
A	11	1.06×10^5	1.19×10^{-5}	112
B	8	1.20×10^5	1.10×10^{-5}	91.7
C	5	1.07×10^5	2.15×10^{-5}	201
D	9	1.22×10^5	1.11×10^{-5}	91.0
E	6,4	9.64×10^4	1.77×10^{-5}	184
Avg. (95% Conf. Int.)		$1.10 (0.13) \times 10^5$	$1.46 (0.59) \times 10^{-5}$	136 (65)

Table 10: GCC-Fc binding to immobilized Prep B 5F9 mAb

Replicate	R_{max} (RU)	k_a ($M^{-1}s^{-1}$)	k_d (s^{-1})	K_D (pM)
F	9	9.68×10^4	7.64×10^{-6}	78.9
G	8	1.20×10^5	1.24×10^{-5}	103
H	7	9.09×10^4	9.57×10^{-6}	105
I	12	1.21×10^5	1.54×10^{-5}	127

Avg. (95% Conf. Int.)		1.07 (0.25) X 10^5	1.13 (0.54) X 10^{-5}	103 (31)

Conjugation of Toxins to Antibodies

[0431] **Maytansines.** Mouse anti-human (MAH)-IgG-DM1, and anti-GCC-DM1 were generated according to a one-step process for the production of cytotoxic conjugates of maytansinoids as described in U.S. Patent No. 6,441,163.

[0432] Briefly, maytansinoids were conjugated to antibodies using published procedures. DM1 was conjugated to antibodies using SMCC heterobifunctional crosslinker (succinimidyl-4-(N-maleimidomethyl)cyclohexane-1-carboxylate; Chari et al. *Cancer Research* 52:127-131 (1992). DM4 was conjugated to antibodies using SPDB heterobifunctional crosslinker (Widdison et al. *J. Med. Chem.* 49:4392-4408 (2006)). Conjugated antibody is separated from unreacted reaction by-products by gel filtration chromatography using a SEPHADEX™ G-25 column.

[0433] **Auristatins.** Conjugation by auristatins can be performed using published procedures (e.g., Doronina *et al., Nature Biotech.*, 21: 778-784 (2003)). In general, auristatins are linked to cysteines of antibody chains. Linkage to cysteines is accomplished first by reduction of disulfide bonds in the antibody molecule. Control of the reduction process seeks to limit the reduction to some, but not necessarily all, interchain disulfide bonds. Consequently, auristatins are able to bind at the free cysteines. Quenching of the conjugation reaction is followed by removal of reaction by-products and buffer exchange to the desired formulation.

[0434] In brief, an anti-GCC antibody molecule at 7.6 mg/mL is pre-equilibrated at 37°C, and then a 15% volume of 500 mM sodium borate, pH 8.0 is added to raise the pH to 7.5-8.0. The solution also contains 1 mM DTPA. The antibody is partially reduced by adding 2.6 equivalents of *tris*(2-carboxyethyl)phosphine (TCEP) per mole of anti-GCC antibody molecule and stirring at 37 °C. After 28 minutes, the solution of reduced anti-GCC antibody molecule is placed on ice, then treated immediately with 4.8-4.9 molar equivalents (relative to anti-GCC antibody molecule) of drug linker (e.g., mc-vc-MMAF or mc-vc-MMAE or mc-MMAF) as a 20.5 mM solution in DMSO. Additional DMSO is

introduced to bring the mixture to 10% DMSO by volume. The reaction mixture is stirred on ice for ~90 minutes before treatment with a 5-fold molar excess of N-acetyl cysteine (relative to mc-vc-MMAF). The conjugate is isolated by tangential flow filtration, first being concentrated to ~10 mg/mL, then diafiltered with ~10 diavolumes of PBS. The resulting antibody drug conjugates had an average drug loading of about four drug-linker units per antibody. For convenience, in the following Examples and attached Figures, auristatin immunoconjugates are referred to in the following abbreviated format, irrespective of drug loading: "Ab-vc-MMAF" refers to an anti-GCC antibody molecule conjugated with mc-vc-MMAF; "Ab-vc-MMAE" refers to an anti-GCC antibody molecule conjugated with mc-vc-MMAE; and "Ab-mc-MMAF" refers to an anti-GCC antibody molecule conjugated with mc-MMAF. Immunoconjugates comprising specific anti-GCC antibody molecules are referred to in the same format, *.e.g.*, 5F9-vc-MMAF, 5F9-vc-MMAE, and 5F9-mc-MMAF.

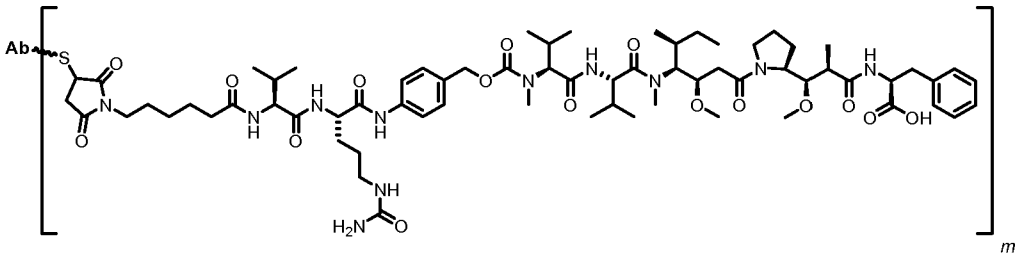
[0435] To prepare antibody drug conjugates with an average drug loading of about two drug-linker units per antibody, the protocol (above) is modified by reducing the amount of TCEP by 50%. The amount of drug linker is also reduced by 50%. The corresponding antibody drug conjugate is abbreviated as Ab-vc-MMAF(2).

Preparation of 5F9 vcMMAE

[0436] Using a method similar to the general method set forth above, the 5F9 mAb was conjugated to an auristatin derivative designated MMAE (Formula (***XIII***)) using a vc (Val-Cit) linker described herein to create the immunoconjugate designated 5F9 vcMMAE. The conjugation of the vc linker to MMAE (Seattle Genetics, Inc., Bothell, WA) was completed as previously described (see, e.g., US 2006/0074008).

[0437] Briefly, a 17.8 mg/mL solution of the 5F9 mAb in 100 mM acetate at pH 5.8 was adjusted to pH 8 with 0.3 M sodium phosphate dibasic, yielding a final mAb concentration of 11.3 mg/ml. Then, DTPA was added for a 1 mM final concentration in the reaction mixture. The mAb was then partially reduced by adding 2.28 molar equivalents of TCEP (relative to moles of mAb), and then stirred at 37°C for 1.5 hours. The partially reduced mAb solution was then cooled to 4°C, and 4.4 molar equivalents of vcMMAE (relative to moles of antibody) were added as a 20.3 mM solution in DMSO. The mixture was stirred for 30 minutes at 22°C, then for 15 additional minutes following the addition of 5 molar equivalents of N-acetylcysteine (relative to moles of vcMMAE).

Excess quenched vcMMAE and other reaction components were removed by ultrafiltration/diafiltration of the immunoconjugate with 10 diavolumes of PBS, pH 7.4. The resulting immunoconjugate was designated 5F9 vcMMAE and has the following formula:



where Ab is the 5F9 mAb, and *m* is from 1 to 8. The average drug loading (*m*) was about 3.6.

[0438] **Cytotoxicity assays.** To measure each antibody's ability to bind, internalize and kill target expressing cells, cytotoxicity assays were performed. In this assay, cells were incubated with various concentrations of the unconjugated primary anti-GCC antibody and a fixed non-toxic concentration of DM1-conjugated anti-human Fc secondary antibody(indirect cytotoxicity) or with various concentrations of toxin conjugated anti-GCC mAb (direct cytotoxicity). Cell viability was measured by WST assay after 4 days incubation. The relative potency of human anti-GCC antibodies on 293-GCC#2 cells is shown in Table 8 and was determined using a DM1 conjugated mouse anti-human IgG mAb (MAH-IgG was purified from clone HP607 (CRL1753, ATCC). 5F9 and 229 are the most potent anti-GCC mAb with LD50's of 26 and 78 pM. Although not shown here, the error is generally within 20% of these averages, as measured by range of replicates or standard deviation of > 2 replicates.

Table 11. Cytotoxicity assay results for anti-GCC antibodies on 293-GCC#2 cells

Anti-GCC Ab	LD50 (pM)
5F9	26
229	78
106	166

221	207
338	267
12	279
20	569
5H3	722
10D3	1596
8C2	2038
10C10	2443
1D2	>3055
6H8	>4818
393	>5400
198	>5400

[0439] **Cell surface binding.** Binding of unconjugated 5F9 or 5F9 conjugated to auristatins, was evaluated by in indirect immunofluorescence assay using flow cytometry. 1 X 10^6 cells/ well were plated in a V-bottom 96 well plate and incubated on ice for 1 hour with serial antibody dilutions of 1-0.001 μg/ml. Cells were washed twice with 3% FBS in ice cold PBS and incubated with 1:200 mouse anti-human PE IgG (Southern Biotech 2043-09) for 1 hour on ice. Cells were washed again and analyzed by flow cytometry on a BD FACS Canto II flow cytometer. Data was analyzed using FACS Canto II system software and mean fluorescence intensities were determined.

[0440] **Epitope mapping.** Multiple strategies were initiated to identify epitopes.

Peptide array. 20-mer peptides, with 15 aa overlap were generated, covering the extracellular domain (ECD) into the transmembrane domain of GCC (aa 1-440). Peptides were synthesized and provided as arrays, immobilized on glass slides. Arrays were hybridized with each of the anti-GCC antibodies to determine if linear peptides were sufficient for binding. Abx-198 bound peptides 55 and 56, while 3G1, 8F1 and 10B8 antibodies bound peptides 55, 56 and 57. The sequence,

ILVDLFNDQYLEDNVTAPDYMKNVLVLTLS (SEQ ID NO:225) is spanned by these peptides. A region of overlap among the peptides is LEDNVTAPDY (SEQ ID NO:314). Abx-012, Abx-338 and Abx-106 bound peptides 71 and 72. The sequence, FAHAFRNLTFEGYDGPVTLDDWGDV (SEQ ID NO:226), and the sequence RNLTFEGYDGPVTLD (SEQ ID NO:315) overlaps the two peptides.

[0441] Cell surface binding to GCC truncation mutants. Truncation mutants of the GCC ECD were generated (FL mature peptide and 8 truncations (Δ1-32, Δ1-49, Δ1-94, Δ1-128, Δ1-177, Δ1-226, Δ1-279, Δ1-229 and Δ1-379), as FLAG tagged constructs (pFLAG-CMV-3), representing approximately 50 aa deletion increments. Constructs were expressed in 293 cells, followed by immunoprecipitation by the anti-GCC antibody molecule and Western blotting for the FLAG epitope in lysates of 293 cells transfected with the GCC ECD mutants. Antibody 5F9 binds cells with the Δ1-32 mutation, but not cells with the Δ1-49 mutation. The binding of 5F9 to GCC was lost when the protein is truncated between aa 33-50 suggesting that this region is involved in the recognition of 5F9 to its binding epitope on GCC. However, since the rat and mouse GCC sequences are identical to human GCC in this region, and 5F9 does not bind mouse or rat GCC, 5F9 antibody likely binds a conformational epitope formed by the presence of amino acids 33 to 50 of human GCC.

EXAMPLE 2. Toxin-linker selection / ADC characterization

[0442] In an antibody drug conjugate (ADC) strategy, the conjugation of highly potent toxins to antibodies, the cytotoxicity of the toxin can be directed to tumors in a target-specific manner, delivering the toxin to antigen expressing tumor cells without affecting antigen negative cells in normal tissues thus reducing systemic toxicity. Auristatin (analog of dolastatin 10) and maytansine class toxins were evaluated as ADCs with anti-GCC mAb. These toxins are all inhibitors of microtubule polymerization, acting as anti-mitotics. Tests in which cells were contacted with free toxins indicated that the cytotoxicity of free toxins did not distinguish between cells with GCC expression and control cells without GCC. These free toxins were potent against the 293-vector, 293-GCC#2 cells, in HT29-vector vs. HT29-GCC#5 cells as shown in Table 9.

Table 12. Cytotoxicity of free toxins

	MMAE		MMAF		DM1		DM4	
Cell line	LD50	SD	LD50	SD	LD50	SD	LD50	SD
293 vector	0.07	6	3.37	2.34	2.83	2.00	0.79	0.79
293 GCC#2	4	3	2.07	1.48	2.96	2.23	0.83	1.03
HT29	4	1	5.21	1.91	2.69	1.09	0.57	0.27
HT29 GCC#5	7	4	7.65	3.32	1.00	0.14	0.40	0.17

[0443] The chemistry by which the different toxins are conjugated to antibodies differs and affects linker stability. Linker stability affects the therapeutic window by impacting drug release in the blood or nontarget tissues vs. drug release at the tumor. The ideal ADC linker has high stability while in the blood, but efficient release upon target mediated cell entry.

Auristatins

[0444] Three auristatin-linker pairs were evaluated. To first evaluate these conjugates *in vitro* and then determine which toxin-linker for large scale in vivo studies, 5F9 was conjugated to vcMMAE, vcMMAF and mcMMAF (20mgs per conjugate).

[0445] Auristatins are synthetic toxins related to the natural product dolastatin 10. MMAE and MMAF differ subtly, with the MMAF form having a carboxylic acid group in the R2 position, reducing cell permeability and potency as free toxin. MMAE is a Pgp drug pump substrate, while MMAF is not.

[0446] Auristatins are conjugated to interchain cysteines through a process of partial antibody reduction, reaction with a maleimido drug derivative, quenching with excess cysteine, concentration and buffer exchange into PBS. The auristatins can be attached with a cathepsin B sensitive dipeptide linker, which is cleaved upon cellular uptake, or with a noncleavable linker.

[0447] In the vcMonoMethylAuristatin linker, a valine citrulline dipeptide linkage is attached to the drug through a p-amino benzyl carbamate (PAB) group and to the

antibody through a maleidimido caproyl conjugation group. Upon internalization, the dipeptide linker is cleaved by the lysosomal protease cathepsin B, the PAB group self destructs, and free toxin is released. This linker was designed to maintain serum stability while maximizing intracellular drug release by cathepsin B.

[0448] Auristatins can also be linked to antibodies through noncleavable linkers such as MMAF directly attached to the maleimido conjugation group, with no peptidase sensitive linker. MC conjugated ADC's are also effective at target mediated cell kill.

[0449] The mechanism of drug release for noncleavable auristatin conjugates is thought to be through general antibody degradation in lysosomes. Through LC/MS studies it has been reported that Ab-mcMMAF conjugates release toxin in the form of a single cysteine-adduct.

Binding of antibody drug conjugates

[0450] All of the 5F9 antibody drug conjugates bound to 293-GCC#2 cells equally well. Table 10 shows the mean fluorescence intensity of 5F9 conjugates at increasing concentrations 293-GCC#2 cells. Other studies determined that the 5F9-SPDB-DM4 conjugate bound 293-GCC#2 cells in a concentration-dependent manner, whereas the 209-SPDB-DM4 antibody did not bind.

Table 13. Chart of MFIs from binding assay of 5F9 and 5F9 conjugates in 293 GCC #2 cells:

	μg/ml of 5F9 or 5F9 conjugate					
	0.001	0.004	0.016	0.063	0.25	1
5F9	500	937	2465	6615	7816	8026
vcMMAE	445	696	1787	4854	7296	7416
vcMMAF	440	707	1502	4830	7563	7779
mcMMAF	483	776	2106	5353	7398	7585

[0451] The 5F9-auristatin toxin conjugates were tested in direct cytotoxicity assays of a variety of cells which been transfected with GCC nucleic acid and selected for expression of GCC. A survey of the level of surface expression of GCC found that 293 GCC#2 cells express high amounts of GCC; HT 29 #2 and CT 26 #2.5 cells express GCC at intermediate to low levels; CT 26 #32 cells express GCC at high levels; and HT 29 GCC #5 and HT 29 GCC #18 express low amounts of GCC. Table 11 shows a compilation of multiple studies yielding cytotoxicity data for the three auristatin conjugates in cells expressing target, or in wild-type cells or vector control cells. Target enhanced killing is observed in all cases of 5F9-conjugated toxins on 293 GCC #2 cells, with a greatly increased window when using MMAF vs. MMAE. Both the cleavable and noncleavable forms of MMAF were similarly potent. As a negative control, antibody drug conjugates were also made with sc209 antibody, which is a human IgG1 monoclonal antibody raised against an unrelated target, with no reactivity to GCC. Direct cytotoxicity assays with 209 ADCs vs. 5F9 vcMMAF ADC showed target enhanced cell kill in the 293 cell model and the HT29 cell model. A comparison of 5F9-conjugated toxin activity among the cell lines indicates that the level of cytotoxicity has some correlation with the amount of GCC expressed by the cells. These data suggest that at least some cell lines expressing the most GCC were more susceptible to the cytotoxic activity of the conjugate than were cells expressing lower amounts of GCC. See Example 1 for relative GCC numbers per cell. Another factor in differences of cytotoxicity levels may be differences in internalization or intracellular processing of the conjugates, which may vary among wild type cell lines.

Table 14. Cytotoxicity of anti-GCC auristatin ADCs.

	LD 50 (nM) of 5F9 conjugates			LD50 (nM) of 209 conjugates
Cell line	**vcMMAE**	**vcMMAF**	**mcMMAF**	
293 Vector	128	> 10	> 10	
293 GCC # 2	0.37	0.001	0.002	
293 Vector	1.8	>10	>10	
293 GCC # 2	0.13	0.005	0.007	

293 Vector		>10		>10
293 GCC # 2		0.0004		>10
HT 29 WT	84	> 10	> 10	
HT 29 GCC #2	24.1	0.127	3.1	
CT 26 WT	> 500	> 10	> 10	
CT 26 GCC #2.5	> 500	> 10	> 10	
CT 26 GCC #32	267	0.004	0.064	
HT 29 vector	520.6	> 10,000	> 10,000	
HT 29 GCC #5	653.5	563.2	> 10,000	
HT 29 GCC #18	554.6	> 10,000	> 10,000	
HT29	0.93	>10	>10	
HT29 GCC#5	0.59	0.32	>10	
HT29		>10		>10
HT29 GCC#5		0.035		≥10

[0452] If these potencies translate *in vivo*, with equal efficacy between mc and vcMMAF, the higher predicted MTD for mcMMAF would suggest a larger therapeutic window for this conjugate.

Maytansines

[0453] The 5F9-maytansine ADCs showed potent target enhanced killing in the 293-GCC#2 cells (Table 12). Interestingly, the 5F9-maytansine conjugates both showed target enhanced killing in the 293 model, however no target enhanced killing was observed in the HT29 model, raising concern about the utility of this model for in vivo evaluation of the maytansine conjugates. Again, the reasons for this difference are not readily explicable, but may be attributed to different receptor densities and/or differences in the internalization or processing of the conjugates within cells. As a negative control,

antibody drug conjugates were also made with sc209 antibody, which is a human IgG1 monoclonal antibody to an unrelated target, with no reactivity to GCC. Direct cytotoxicity assays with 209 ADCs vs. 5F9 ADCs show target enhanced cell kill in the 293 cell model with all 5F9 conjugates. In the HT29 cell model, 5F9-DMx conjugates and 209-DMx conjugates kill equally well, indicating a non-target specific mechanism of killing in those cells.

Table 15 Cytotoxicity of anti-GCC maytansine ADCs

	LD50 (nM)			
Cell line	5F9-SMCC-DM1	209-SMCC-DM1	5F9-SPDB-DM4	209-SPDB-DM4
293 vector	25.3		10.4	
293 GCC#2	<0.004		<0.004	
293 vector	32	11	13	7.4
293 GCC#2	<0.000004	6.7	<0.000004	4.8
HT29	22.4		7.7	
HT29 GCC#5	20.8		9.1	
HT29	22	12	4.8	2.1
HT29 GCC#5	30	22	5.8	4.2

EXAMPLE 3: *In vivo* evaluation

Tumor models:

[0454] In vivo cytotoxicity of 5F9 ADCs were evaluated in mouse xenograft models. The initial *in vivo* work was done with the HT29-GCC#5 and #18 cell lines. The 293-GCC#2 cell line also was tested for *in vivo* growth and was developed as a serially transplantable trocar model.

[0455] To address the question of whether the GCC expression level in the xenograft model was relevant to the level of GCC expression in patients with metastatic colon cancer, GCC expression levels were compared by IHC analyses of xenograft tissue, human primary colon tumors and metastases. A panel of fresh frozen cell lines and tissues were utilized for GCC quantitation by rIHC with a mouse mAb to GCC 3G1. For IHC quantitation, scoring was done using a semi-quantitative 0-3 score system. If tumor model GCC levels $\leq$ clinical GCC levels, modeling will likely be accurate or overestimate the exposure needed clinically. If tumor model GCC levels > clinical GCC levels, modeling may underestimate the exposure needed clinically.

[0456] While there was some variability in the expression of GCC in metastatic samples, expression by the HT29-GCC#5 and #18 cells was in the range of many of the metastatic samples. By IHC, the staining of GCC on the HT29-GCC#5 and #18 cells was equivalent or lower than on the metastatic cells. This data suggests that our tumor models express GCC at levels comparable to the levels found in clinical samples of metCRC.

[0457] Table 16 represents the scintillation counts for various tissues harvested at the 192 hour timepoint with averages for three animals represented. 5F9 preferentially accumulated in HT29-GCC#5 tumors vs. HT29-vector tumors, while 209 did not show much differential accumulation. This result provided support that a 5F9 antibody drug conjugates could be expected to accumulate in GCC expressing tumors. In all other tissues evaluated, there was little difference in the levels of 5F9 vs. mAb 209 antibody accumulation.

In vivo distribution of radiolabeled 5F9 in HT29-GCC#5 & HT29-vector tumor-bearing mice

[0458] A radioimaging study in tumor bearing mice was performed to evaluate tumor targeting and in vivo biodistribution of the anti-GCC antibody 5F9 and a negative control antibody sc209 (human IgG1 monoclonal antibody targeting an unrelated cell surface target). The antibodies were radiolabeled with ^{111}In using DTPA as a bifunctional chelator. The *in vivo* behavior, including tumor targeting and biodistribution in normal tissues over time, was investigated with a murine dual-tumor model with both GCC(-) and

GCC(+) tumors. *In vivo* images (SPECT/CT) were acquired, and tissue radioactivity counting was used to supplement the spatial resolution.

[0459] Subcutaneous tumors were grown in nude mice, with HT29-vector tumors on the right and HT29-GCC#5 tumors on the left. Antibodies were dosed at 0.3 mCi = 15 μg per animal. There were three animals per group, and groups were harvested at 1h, 24h, 48h, 72h, 120h and 192h.

[0460] A survey of tissues from animals in the 192h group indicated that both 5F9 and 209 accumulated to a similar degree in most normal tissues (e.g., blood, heart, stomach, small intestine, large intestine, muscle and skin) and in HT29-vector control tumors. Ab 209 accumulated to slightly higher levels than 5F9 in liver and 5F9 accumulated to slightly higher levels than 209 in lungs, spleen and kidneys. In the HT29-GCC#5 tumors, 5F9 preferentially accumulated at levels more than two-fold higher than the 209 levels. This result provided support that a 5F9 antibody drug conjugates could be expected to accumulate in GCC expressing tumors.

[0461] To understand the kinetics of antibody accumulation in tumors, tumor data for each antibody was obtained for all time points throughout the study. The only tissue that showed accumulation is the 5F9 antibody in the GCC expressing tumor. The radioactivity level in all other tissues remained relatively flat, with little difference between the 5F9 levels and 209 levels. 5F9 preferentially accumulated in HT29-GCC#5 tumors, while 209 did not show any accumulation. This result provided support that a 5F9 antibody drug conjugate could be expected to accumulate in GCC expressing tumors.

Table 16. Accumulation of ^{111}In-labeled GCC specific mAb but not control mAb to tumors expressing GCC.

	Mean % ID 5F9	Mean % ID ctr IgG
1hr	2.816+/-0.133	2.494+/-0.167
24hr	3.057+/-0.107	3.010+/-0.630
72hr	4.485+/-1.029	3.564+/-0.152
120hr	5.162+/-1.012	3.412+/-0.048
192hr	6.550+/-1.015	2.782+/-0.085

[0462] Accumulation of radiolabeled 5F9 in GCC expressing tumors over 7 days supported a once weekly dosing schedule.

Pilot efficacy studies in HT29-GCC#5 s.c. tumors

[0463] Studies were performed to determine efficacious conjugates and dosage regimens in mice bearing HT29-GCC#5 tumors. Mice were dosed with single or multiple doses. These studies determined that there was toxicity at too frequent dosing at higher levels of toxin conjugate (e.g., 150 μg/kg 5F9vcMMAF on a q3d x 5 schedule). Another study determined that q14d x 5 schedule was too infrequent in this model to allow some toxin conjugates to show significant efficacy vs. controls. Additionally, a PD study with maytansinoid-antibody conjugates in this model demonstrated dose-dependent phosphohistone accumulation only with the DM4 toxin, not the DM1 toxin. Another study in this model showed some tumor growth inhibition by the non-specific 209 –toxin conjugate. These results suggested that other in vivo models needed to be evaluated.

PK/PD study with 5F9 ADCs in mice carrying 293-GCC#2 tumors.

[0464] An alternative tumor model used 293-GCC#2 cells. A PD study for 5F9 ADCs in 293-GCC#2 tumor bearing mice was performed. Mice were dosed with single doses of 5F9vcMMAF at 75ug/kg or 150ug/kg and serum was taken at timepoints from 1hr through 4 days for PD analysis of phosphohistone H3 to test antimitotic effects of the toxin on tumor cells. Phospho-histone H3 was detected by antibody (Upstate

Biotechnology, now Millipore, Billerica, MA) staining of paraffin embedded sections of tumors. The data in Table 17 shows that each of the ADCs caused a significant increase in the pH3 positive cell population in the tumors indicating that each of them at both 75 and 150 μg/kg toxin dose equivalents was able to reach the tumors and have the desired anti-mitotic effect on the tumor cells.

Table 17. The PD response as assessed by arrest of cells in mitosis (% pH3 positive tumor cells) following a single iv dose of 5F9 ADCs.

	Average % Tumor cells pH3 positive	SD
Vehicle control	2.556801	2.37707
5F9-vcMMAE 75 μg/kg 1hr	4.525187	0.178882
4hr	2.551616	1.688255
8hr	4.243988	0.352938
24hr	9.8199	4.82057
48hr	8.692061	4.756786
96hr	8.628345	1.065456
5F9-vcMMAE 150 μg/kg 1hr	3.334943	1.351667
4hr	2.78543	1.690216
8hr	4.575611	1.130484
24hr	13.78776	3.343155

48hr	14.26067	5.448921
96hr	14.67942	1.827724
5F9-vcMMAF 75 μg/kg 1hr	4.235245	0.617585
4hr	4.18364	0.846752
8hr	4.930098	0.54746
24hr	20.22484	2.453935
48hr	9.920771	3.788795
96hr	10.38187	1.896461
5F9-vcMMAF 150 μg/kg 1hr	3.465674	1.341187
4hr	4.416646	0.807636
8hr	8.594385	4.005021
24hr	21.53718	7.25212
48hr	15.15814	4.28407
96hr	11.12288	2.150476
5F9-mcMMAF 75 μg/kg 1hr	5.365582	1.14198
4hr	4.044478	0.992449
8hr	8.228597	3.098222
24hr	14.10734	1.611093

48hr	19.37223	8.146504
96hr	7.749388	1.180759
5F9-mcMMAF 150 μg/kg 1hr	3.212482	0.509604
4hr	4.722554	1.577531
8hr	9.105349	5.963128
24hr	27.51416	10.96057
48hr	13.34043	3.414961
96hr	15.60917	3.386154

[0465] Similar studies measured the phosphohistone levels in 293-GCC#2 tumor-bearing mice treated with 5F9vcMMAF, 5F9-SPDB-DM4 and 5F9-SMCC-DM1. Mice were dosed with single doses at 150ug/kg and serum was taken at timepoints from 1hr through 21 days for PK analysis of both total antibody and toxin-conjugated antibody. The percentage of phosphohistone H3 positive cells in 293-GCC#2 tumors increased in response to all three ADCS: 5F9vcMMAF, 5F9-SMCC-DM1 and 5F9-SPDB-DM4. Maximal phosphohistone H3 levels were 3- to 5-fold increased over baseline, with peaks at 24 hours post-injection.

Efficacy study with 5F9vcMMAF and 5F9-DMx in 293-GCC#2 s.c. tumors

[0466] 5F9-SPDB-DM4, 5F9-SMCC-DM1 and 5F9vcMMAF were tested for efficacy in the 293-GCC#2 tumor model at two doses (75 μg/kg and 150 μg /kg toxin), on a q14d x 5 schedule. Specifically, this study included vehicle-treated control, Sc209-DM1 (150 μg/kg DM1 eq), Sc209-DM4 (150 μg/kg DM4 eq), Sc209-vcMMAF (150 μg/kg MMAF eq), 5F9-DM1 (150 μg/kg DM1 eq), 5F9-DM1 (75 μg/kg DM1 eq), 5F9-DM4 (150 μg/kg DM4 eg), 5F9-DM4 (75 μg/kg DM4 eq), 5F9-vcMMAF (150 μg/kg MMAF

eq), and 5F9-vcMMAF (75 μg/kg MMAF eq). Taconic females mice bearing 293-GCC#2 cells (10 mice per group) were used.

[0467] Figure 1 depicts tumor growth in 293-GCC#2 bearing SCID mice treated with 5F9vc-MMAF, -DM1, and -DM4 on a q14d schedule. Dose-dependent efficacy was observed with 5F9-SPDB-DM4 in the 293-GCC#2 model, while the 209-SPDB-DM4 control had no effect. 5F9-SMCC-DM1 was also efficacious, however less so than 5F9-SPDB-DM4 at 150ug/kg. 5F9vcMMAF (75ug/kg and 150ug/kg) was the most efficacious, however 209vcMMAF also had some activity. Therefore at these doses and schedules, 5F9-SPDB-DM4 had the greatest efficacious differential from its control conjugate.

Efficacy study with 5F9vcMMAF and 5F9-DMx in 293-GCC#2 s.c. tumors

[0468] 5F9-SPDB-DM4 and 5F9-SMCC-DM1 were tested for efficacy in the 293-GCC#2 tumor model at two doses (75ug/kg and 150ug/kg toxin) on a q7d x 5 schedule. Specifically, this study included vehicle-treated control, 5F9 alone (15 mg/kg), DM1 (300 μg/kg), DM4 (300 μg/kg), Sc209-DM1 (150 μg/kg DM1 eq), Sc209-DM4 (150 μg/kg DM4 eq), Sc209-vcMMAF (150 μg/kg MMAF eq), 5F9-DM1 (150 μg/kg DM1 eq), 5F9-DM1 (75 μg/kg DM1 eq), 5F9-DM4 (150 μg/kg DM4 eq), and 5F9-DM4 (75 μg/kg DM4 eq). Taconic females mice bearing 293-GCC#2 cells (10 mice per group) were used.

Efficacy study with auristatin conjugates in 293 GCC#2 tumors

[0469] 293 GCC#2 tumor-bearing SCID mice were treated with 5F9 conjugates with vc MMAE, vcMMAF or mcMMAF at three doses in comparison with 209 conjugates of these toxins or with free toxins or vehicle control. Doses were administered iv on a q7d x 4 schedule. Tumors were harvested at days 3, 7, 10, 13 and 17. The tumors in mice treated with control reagents demonstrated a continual increase in volume. Tumors treated with 5F9 auristatin conjugates showed dose- and time-dependent inhibition of this tumor growth. Table 18 provides a summary of the results (TGI=tumor growth inhibition, T/C=treatment/control, TGD=tumor growth delay, CR/PR=complete response/partial response; p value=measure to judge statistical significance, NS=not significant).

Table 18. Analysis of Auristatin ADCs in 293 GCC#2 tumor-bearing mice.

Groups	TGI	T/C	TGD	CR/PR	P value
209-vcMMAE 300 μg/kg	24.5	0.76	0.9	0	0.38>0.05 NS
209-vcMMAF 150 μg/kg	29.4	0.71	1.4	0	0.27>0.05 NS
209-mcMMAE 150 μg/kg	36.5	0.63	1.4	0	0.15>0.05 NS
Free MMAE 300 μg/kg	35.6	0.64	2	0	0.18>0.05 NS
Free mcMMAF 150 μg/kg	-3.4	1.03	-1.3	0	0.73>0.05 NS
5F9-vcMMAE 300 μg/kg	96.9	0.03		9/10 PR	<0.001
5F9-vcMMAE 150 μg/kg	83.5	0.17		2/10 PR	<0.01
5F9-vcMMAF 150 μg/kg	97	0.03		9/10 PR	<0.001
5F9-mcMMAF 150 μg/kg	97	0.03		9/10 PR	<0.001
5F9-vcMMAE 75 μg/kg	54.5	0.45	4.4		0.01<p<0.05
5F9-vcMMAF 75 μg/kg	88.5	0.12		6/10 PR	<0.001
5F9-mcMMAF 75 μg/kg	87.5	0.13		7/10 PR	=0.001
5F9-vcMMAF 37.5 μg/kg	65.2	0.35	7.1		=0.01
5F9-mcMMAF 37.5 μg/kg	63.6	0.36	5.8		=0.01

[0470] All three of these ADCs were efficacious in the 293 GCC#2 model on a q7d schedule. 5F9-vcMMAF and 5F9-mcMMAF are more potent than 5F9-vcMMAE, which correlates with *in vivo* PD (pHisH3) and *in vitro* cytotoxicity data.

Efficacy study with 5F9vcMMAF and 5F9-DMx in T84 s.c. tumors

[0471] 5F9-SPDB-DM4 and 5F9-SMCC-DM1 were tested for efficacy in the T84 tumor model at two doses (75ug/kg and 150ug/kg toxin) on a q7d x 5 schedule. Specifically, this study included vehicle-treated control, 5F9 alone (15 mg/kg), DM1 (300 μg/kg), DM4 (300 μg/kg), Sc209-DM1 (150 μg/kg DM1 eq), Sc209-DM4 (150 μg/kg

DM4 eq), Sc209-vcMMAF (150 μg/kg MMAF eq), 5F9-DM1 (150 μg/kg DM1 eq), 5F9-DM1 (75 μg/kg DM1 eq), 5F9-DM4 (150 μg/kg DM4 eq), and 5F9-DM4 (75 μg/kg DM4 eq). Taconic females mice bearing T84 cells (10 mice per group) were used.

Immunohistochemistry

[0472] Detection and measurement of relative amounts of GCC in tissues such as biopsies and xenografts can be performed by immunohistochemistry. Frozen tissue sections are fixed in a 1:1 solution of acetone and methanol for 20 min. at room temperature. Slides are washed in 1 x PBS for 5 minutes. Slides are processed with an automatic staining device, such as Ventana Discovery XT automated stainer (Ventana Medical Systems, Tucson, AZ) using manufacturers suggested reaction buffer. Anti-GCC antibodies are diluted to 5 μg/ml in 5% goat serum. For human anti-GCC antibodies, e.g., 5F9, detecting secondary antibody is a 1:500 solution of goat anti-human biotinylated antibody in Dako Protein block (Dako, Carpinteria, CA). After autostainer process the antibody reaction, the slides are removed from the autostainer, rinsed in reaction buffer, dehydrated through standard series until xylene and given coverslips with a xylene-based mounting media.

Efficacy study of ADCs in a primary tumor model

[0473] Models of primary colorectal carcinoma and gastric cancer are developed as subcutaneous tumors in mice. 5F9-vcMMAE and 5F9-mcMMAF ADCs are tested in PHTX-11c primary tumor-bearing mice. Doses are administered iv on a q7d x 4 schedule. Conjugates of toxins with 209 are administered to control mice.

Antitumor Activity of ADCs in a primary tumor model

[0474] Two similar studies were conducted to determine the *in vivo* antitumor activity of 5F9-vcMMAE and to compare the antitumor activity of 5F9-vcMMAE to free toxin MMAE and to non-immune vcMMAE antibody toxin conjugate (209-vcMMAE) in PHTX-9c primary human colon tumor xenograft mice at various doses and dosing schedules and to determine the re-growth kinetics following treatment. Female CB-17 SCID mice (eight weeks old) were inoculated subcutaneously (SC) into the flank with PHTX-9c tumor fragments (2 mm x 2 mm). Tumor growth was monitored twice per week using vernier calipers and the mean tumor volume was calculated using the formula (0.5 ×

[length × width^2]). When the mean tumor volume reached approximately 150 mm^3 (Study A) or 160 mm^3 (Study B), animals were randomized into treatment groups (n = 10/group for Study A and n = 9/group for Study B).

[0475] Mice were treated (Study A) on a once weekly (QW) dosing schedule (3 doses) with 0.938, 1.875, 3.75, or 7.5 mg/kg 5F9-vcMMAE intravenously (IV) for 20 days or controls, which included vehicle (0.9% saline), 0.075 or 0.15 mg/kg MMAE IV on a QW schedule, or 1.875 or 3.75 mg/kg 209-vcMMAE IV on QW dosing schedules for 20 Days. In the second study (Study B), mice were treated with 0.938, 1.875, 3.75, 7.5, or 10.0 mg/kg 5F9-vcMMAE IV on a QW schedule (3 doses) or 3.75 mg/kg IV on a twice weekly (BIW) schedule (6 doses), or controls including vehicle, 7.5 or 10 mg/kg 209-vcMMAE, or 0.135 or 0.18 mg/kg MMAE administered IV on a QW schedule for 20 days. Doses were administered on Days 1, 8, and 15 for the QW schedule and Days 1, 4, 8, 11, 15, and 18 for the BIW schedule. The dose of free MMAE was calculated to match the amount of MMAE in the immunoconjugate doses by the following rationale: The equivalent dose of MMAE is 1.8% of the MLN0264 dose. The equivalent dose of linker + MMAE is 4% of the 5F9-vcMMAE dose. These calculations are based on a mean 3.9 MMAE molecules per antibody and a free antibody molecular weight of 150 kD. Actual antibody molecular weight will vary slightly due to degree of glycosylation.

[0476] Tumor volume and body weight were measured twice weekly and were continued beyond the treatment period to measure regrwoth kinetics, as evidenced by tumor growth delay (TGD). Tumor volume measurements were continued until tumor volume reached 10% of the body weight in a single mouse within a treatment group, at which time the group was terminated. The percentage of tumor growth inhibition (TGI) ([mean tumor volume of the control group – mean tumor volume of a treated group] / mean tumor volume of the control group; a T/C ratio) was determined on Day 20. The T/C ratios across a treatment group were compared to the T/C ratios of the control group using a two-tailed Welch's t-test. Because the entire group was terminated if one tumor reached the size limit (approx. 1000 mm^3), TGD could not be calculated for groups where the average regrowth was slow.

[0477] The differences in the tumor growth trends over time between pairs of treatment groups were assessed using linear mixed effects regression models. These models account for the fact that each animal was measured at multiple time points. A

separate model was fit for each comparison, and the areas under the curve (AUC) for each treatment group were calculated using the predicted values from the model. The percent decrease in AUC (dAUC) relative to the reference group was then calculated. A statistically significant *P* value (< 0.05) suggests that the trends over time for the two treatment groups were different. Results are summarized in Tables 19 and 20, below.

[0478] Antitumor activity was observed in all 5F9-vcMMAE-treated groups in both studies and the effect was shown to be dose-dependent. The results of the two studies were comparable. In mice treated with 5F9-vcMMAE at 0.938 mg/kg, IV on a QW schedule, TGI was 20.7-21.4%, p value was <0.05 compared with vehicle group. In the 1.875 mg/kg treated group administered IV, on a QW schedule TGI was 41.3-44.7%, p value was <0.001. In 3.75 mg/kg treated group administered IV, on a QW schedule TGI was 65.3-65.7% (p <0.001) compared with vehicle group. 5F9-vcMMAE administered at 7.5 mg/kg IV QW yielded a TGI of 84.1-84.3% (p<0.001) and 10 mg/kg IV QW (Study B only) yielded a TGI of 91.2% (p<0.001). When 3.75 mg/kg was administered IV on a BIW schedule (S), significant inhibition was observed with a TGI of 84.9% (p<0.001).

[0479] Moderate antitumor activity was observed at the higher doses of 209-vcMMAE of 7.5 and 10.0 mg/kg with TGI of 35.7 and 45.4%, respectively (p<0.001) but low doses of 209-vcMMAE (1.875 and 3.75 mg/kg) exhibited no inhibition (p>0.05). The antitumor activity observed by the high 209-vcMMAE is likely due to nonspecific activity by the MMAE portion of the immunoconjugate.

[0480] Administration of free toxin MMAE yielded mixed results: 0.075, 0.135, and 0.15 mg/kg administered IV QW yielded no tumor growth inhibition (p>0.05) but administration of 0.18 mg/kg IV QW resulted in TGI of 50.4% (p<0.001).

[0481] The greatest maximum body weight loss observed during treatment period was 2.3% on day 7 in the free toxin 0.18 mg/kg MMAE group of Study B and the 0.938 mg/kg 5F9-vcMMAE group of the same study. This indicates the drug was well-tolerated.

[0482] Tumor volume measurements were continued beyond the treatment period until tumor volume reached 10% of the body weight in a single mouse within a treatment group and then the treatment group was terminated. In these studies, tumor re-growth appeared to be dose-dependent.

Table 19. Study A results of treatment of primary human colon tumor Xenograft in SCID mice.

Treatment	Dose (mg/kg)	Method of Administration/ frequency	TGI	BW change (mean maximum percent)	TGD (days) /(or days until first tumor >1000 mm^3)
Vehicle	0	IV QW × 3 doses	N/A	-0.2	0
209-vcMMAE	1.875	IV QW × 3 doses	-2.0 (p>0.05)	8.3	0.6
209-vcMMAE	3.75	IV QW × 3 doses	4.5 (p>0.05)	6.9	0.4
MMAE	0.075	IV QW × 3 doses	5.0 (p>0.05)	8.3	1.0
MMAE	0.15	IV QW × 3 doses	11.1 (p>0.05)	10.8	2.0
5F9-vcMMAE	0.938	IV QW × 3 doses	21.4 (p>0.05)	9.0	3.3
5F9-vcMMAE	1.875	IV QW × 3 doses	44.7 (p>0.001)	10.6	8.2
5F9-vcMMAE	3.75	IV QW × 3 doses	65.3 (p>0.001)	9.0	17.8
5F9-vcMMAE	7.5	IV QW × 3 doses	84.1 (p>0.001)	7.5	(>58 days first tumor)

Table 20. Study B results of treatment of primary human colon tumor Xenograft in SCID mice.

Treatment	Dose (mg/kg)	Method of Administration/ frequency	TGI	BW change (mean maximum percent)	TGD (days) /(or days until first tumor >1000 mm^3)
Vehicle	0	IV QW × 3 doses	N/A	-1.8	0
209-vcMMAE	7.5	IV QW × 3 doses	35.7 (p>0.001)	4.2	4.2
209-vcMMAE	10.0	IV QW × 3 doses	45.4 (p>0.001)	2.6	11.3
MMAE	0.135	IV QW × 3 doses	2.2 (p>0.05)	9.3	0.2
MMAE	0.18	IV QW × 3 doses	50.4 (p>0.001)	-2.3	8.6
5F9-vcMMAE	0.938	IV QW × 3 doses	20.7 (p>0.001)	-2.3	3.8

5F9-vcMMAE	1.875	IV QW × 3 doses	41.3 (p>0.001)	5.6	6.6
5F9-vcMMAE	3.75	IV QW × 3 doses	65.7 (p>0.001)	-2.2	16
5F9-vcMMAE	3.75	IV BIW x 6 doses	84.9 (p>0.001)	-1.8	31.9
5F9-vcMMAE	7.5	IV QW × 3 doses	84.3 (p>0.001)	6.5	(>47 days first tumor)
5F9-vcMMAE	10.0	IV QW × 3 doses	91.2 (p>0.001)	7.2	(>56 days first tumor)

Pilot efficacy study with naked 5F9 anti hGCC antibody in CT26 hGCC/luc #32 disseminated model (balb/c mice)

[0483] This model tests the ability of naked antibodies to bind to GCC-expressing tumor cells in the circulation and prevent establishment of new tumors. Female balb/c mice were inoculated by i.v. with CT26 hGCC/luc #32 cells at $1x10^5$/mouse and $5x10^5$/mouse. Vehicle 0.9% NaCl and non-specific antibody (naked 209) were administered to control groups for comparison to administration of naked 5F9. Both antibodies were engineered (in the pLKTOK58 vector) to have the IgG1 isotype, so their Fc regions could elicit an antibody-dependent cell-mediated cytotoxic response after binding to cell surface antigens (i.e., GCC for 5F9 and an unrelated target for 209). Dosing was started one day before inoculation by i.v, with a dosing schedule of once/week i.v x4 (q7d x 4). Tumor growth was monitored by Xenogen imaging system twice a week. Body weight and survival were monitored twice a week as well. Lung weight and images including MRI images were taken at the end of this study.

[0484] As shown in Figure 2, both 5F9 groups (40mg/kg and 10mg/kg; $1x10^5$/mouse) show efficacy (on day 34p.i: T/C (treatment/control) is 0.04 to 0.05). T/C for the 5F9 group is 0.18 to 0.14 on day 34p.i compared to the 209 group. T/C for the 209 40mg/kg group is 0.64 compared to 0.9% NaCl (Normal Saline) group. No benefit was seen with 5F9 in $5x10^5$ groups.

[0485] Lung weight of each group at the end of this study was shown in Figure 3. T test: vehicle vs. 209 40mg/kg P=0.4; vehicle vs. 5F9 40mg/kg P<0.05; vehicle vs. 5F9 10mg/kg P <0.01. Visual inspection of lungs confirmed fewer tumor nodules in the 5F9-

treated groups than in the vehicle or 209-treated groups. *In vivo* MRI of the mice showed massive lung tumor exfiltration to surrounding tissues and heart displacement in vehicle-treated mice. In a 5F9 40 mg/kg-treated mouse, normal lung presentation was seen without evidence of tumor.

[0486] A survival curve is shown in Figure 4. Significant increase in survival with 5F9 treated groups ($1x10^5$) was observed and there was no difference between 5F9 10 and 40 mg/kg groups.

EXAMPLE 4: Generating an antibody production cell line

[0487] To generate a stable CHO cell line clone expressing 5F9 with a productivity of >600mg/L, expression vectors for 5F9 were generated by subcloning light chain variable region (SEQ ID NO:19) and heavy chain variable region (SEQ ID NO:17) into the pLKTOK58 expression vector, containing WT human IgG1 Fc and the neomycin resistance gene. Expression of the 5F9 variable region-IgG1 fusion product is under control of the EF-1a promoter.

Cloning and sequencing of the anti-GCC human monoclonal antibody 5F9 variable regions

[0488] Total RNA was isolated (Qiagen's RNeasy kit) from human hybridoma 46.5F9 subclone 8.2. This hybridoma carries the "standard" published Kappa constant region of the light chain (GenBank accession # AW383625, or BM918539) and the "standard" published IgG2 constant region of the heavy chain (GenBank accession # BX640623, or AJ294731). 5' race-ready, poly-G tailed cDNA was synthesized by traditional methods (Nature Methods 2, 629-630 (2005)). The light chain variable region was PCR amplified from cDNA by 5' race using a poly-C anchor oligo in combination with a reverse primer specific for the Kappa constant region. The heavy chain variable region was amplified with a reverse primer specific for the IgG2 constant region in multiple combinations with forward primers specific to the known heavy chain leader sequences. PCR products were TOPO® cloned (Invitrogen™, Life Technologies, Inc.) and sequenced with M13F and M13R primers.

Construction of mammalian expression vectors carrying anti-GCC human monoclonal antibody 5F9

[0489] Mammalian expression vectors carrying the 5F9 light and heavy variable regions were constructed to generate production CHO cell lines. For the native construct, the variable regions of the 5F9 light and heavy chains were sub-cloned into pLKTOK58D (US Patent Application # 20040033561). This vector carries two mammalian selection markers: neomycin resistance and DHFR/methotrexate (for amplification). The vector allows co-expression of both light and heavy chains from tandem EF1alpha promoters, each located upstream of the vector's leader-Kappa constant and leader-IgG1 (wild type Fc) constant regions. For sub-cloning, the variable regions of the light and heavy chains were PCR amplified from sequence-confirmed TOPO clones with gene-specific primers containing unique restriction sites for directional cloning into the junctions of the respective leader-Kappa and leader-IgG1 regions of the vector. The sequences of the primers are as follows (5F9 variable region-specific sequences in bold font):

Native 5F9 light chain leader-variable primers:

forward NotI

5'*ataagaatGCGGCCGCCTCACCATGGGATGGAGCTGTATCATCCTCTTCTTGGTAGCAACA GCTACAGGTGTCCACTCC***GAAATAGTGATGACGCAGTCTCCAGCCACCCTG**-3' (SEQ ID NO: 234)

reverse BsiWI

5'- *GCCACCGTACG***TTTGATTTCCACGTTGGTCCCTTGGCCGAACGTC**-3' (SEQ ID NO:235)

Native 5F9 heavy chain leader-variable primers

forward EcoRI

5'ccgGAATTCCTCACCATGGGATGGAGCTGTATCATCCTCTTCTTGGTAGCAACAGCT ACAGGTGTCCACTCC**CAGGTGCAGCTACAGCAGTGGGGCGCAGGAC**-3' (SEQ ID NO:236)

reverse BlpI

5'-GGAGGCTGAGC**TGACGGTGACCAGGGTTCCCTGGCCCCAGTGGTC**-3' (SEQ ID NO: 237)

[0490] Clones were confirmed by double stranded DNA sequencing of both the light and heavy chains.

[0491] Two transfection methods were used to introduce the constructs into CHO cells: the traditional MPI process and the Crucell process. CHO cell transfections were initiated with the native 5F9 construct using the traditional MPI process. Linearized and nonlinearized DNAs were used, with either electroporation or Lipopfectamine 2000 CD transfection. Approximately 30 stable pools were generated through selection in G418, non nucleoside medium and 5nM methotrexate. Based on FMAT analysis of antibody production levels, three stable pools were chosen for cloning. The pool with the highest production secreted antibody at 12.2ug/ml. These three pools have been frozen down.

[0492] Crucell STAR elements can be evaluated to make 5F9 expression vectors containing a STAR element.

5F9/hIgG1 heavy chain nucleotide sequence is:

GAATTCCTCACCATGGGATGGAGCTGTATCATCCTCTTCTTGGTAGCAACAGCTACAGGTGTCC
ACTCCCAGGTGCAGCTACAGCAGTGGGGCGCAGGACTGTTGAAGCCTTCGGAGACCCTGTCCCT
CACCTGCGCTGTCTTTGGTGGGTCTTTCAGTGGTTACTACTGGAGCTGGATCCGCCAGCCCCCAG
GGAAGGGGCTGGAGTGGATTGGGGAAATCAATCATCGTGGAAACACCAACGACAACCCGTCCC
TCAAGAGTCGAGTCACCATATCAGTAGACACGTCCAAGAACCAGTTCGCCCTGAAGCTGAGTTC
TGTGACCGCCGCGGACACGGCTGTTTATTACTGTGCGAGAGAACGTGGATACACCTATGGTAAC
TTTGACCACTGGGGCCAGGGAACCCTGGTCACCGTCAGCTCAGCCTCCACCAAGGGCCCATCGG
TCTTCCCCCTGGCACCCTCCTCCAAGAGCACCTCTGGGGGCACAGCGGCCCTGGGCTGCCTGGT
CAAGGACTACTTCCCCGAACCGGTGACGGTGTCGTGGAACTCAGGCGCCCTGACCAGCGGCGT
GCACACCTTCCCGGCTGTCCTACAGTCCTCAGGACTCTACTCCCTCAGCAGCGTGGTGACCGTG
CCCTCCAGCAGCTTGGGCACCCAGACCTACATCTGCAACGTGAATCACAAGCCCAGCAACACC
AAGGTGGACAAGAAAGTTGAGCCCAAATCTTGTGACAAAACTCACACATGCCCACCGTGCCCA
GCACCTGAACTCCTGGGGGGACCGTCAGTCTTCCTCTTCCCCCCAAAACCCAAGGACACCCTCA
TGATCTCCCGGACCCCTGAGGTCACATGCGTGGTGGTGGACGTGAGCCACGAAGACCCTGAGG
TCAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCATAATGCCAAGACAAAGCCGCGGGAGG
AGCAGTACAACAGCACGTACCGTGTGGTCAGCGTCCTCACCGTCCTGCACCAGGACTGGCTGAA
TGGCAAGGAGTACAAGTGCAAGGTCTCCAACAAAGCCCTCCCAGCCCCCATCGAGAAAACCAT
CTCCAAAGCCAAAGGGCAGCCCCGAGAACCACAGGTGTACACCCTGCCCCCATCCCGGGATGA
GCTGACCAAGAACCAGGTCAGCCTGACCTGCCTGGTCAAAGGCTTCTATCCCAGCGACATCGCC

GTGGAGTGGGAGAGCAATGGGCAGCCGGAGAACAACTACAAGACCACGCCTCCCGTGCTGGAC
TCCGACGGCTCCTTCTTCCTCTACAGCAAGCTCACCGTGGACAAGAGCAGGTGGCAGCAGGGG
AACGTCTTCTCATGCTCCGTGATGCATGAGGCTCTGCACAACCACTACACGCAGAAGAGCCTCT
CCCTGTCTCCGGGTAAATAATAGGGATAACAGGGTAATACTAGAG

(SEQ ID NO:230)

5F9/hIgG1 heavy chain protein sequence is;

MGWSCIILFLVATATGVHSQVQLQQWGAGLLKPSETLSLTCAVFGGSFSGYYWSWIRQPPGKGLE
WIGEINHRGNTNDNPSLKSRVTISVDTSKNQFALKLSSVTAADTAVYYCARERGYTYGNFDHWGQ
GTLVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQS
SGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLFP
PKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVL
HQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPS
DIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKS
LSLSPGK

(SEQ ID NO:231)

5F9/hKappa light chain nucleotide sequence is:

GCGGCCGCCTCACCATGGGATGGAGCTGTATCATCCTCTTCTTGGTAGCAACAGCTACAGGTGT
CCACTCCGAAATAGTGATGACGCAGTCTCCAGCCACCCTGTCTGTGTCTCCAGGGGAAAGAGCC
ACCCTCTCCTGCAGGGCCAGTCAGAGTGTTAGCAGAAACTTAGCCTGGTATCAGCAGAAACCTG
GCCAGGCTCCCAGGCTCCTCATCTATGGTGCATCCACCAGGGCCACTGGAATCCCAGCCAGGTT
CAGTGGCAGTGGGTCTGGGACAGAGTTCACTCTCACCATCGGCAGCCTGCAGTCTGAAGATTTT
GCAGTTTATTACTGTCAGCAGTATAAAACCTGGCCTCGGACGTTCGGCCAAGGGACCAACGTGG
AAATCAAACGTACGGTGGCTGCACCATCTGTCTTCATCTTCCCGCCATCTGATGAGCAGTTGAA
ATCTGGAACTGCCTCTGTTGTGTGCCTGCTGAATAACTTCTATCCCAGAGAGGCCAAAGTACAG
TGGAAGGTGGATAACGCCCTCCAATCGGGTAACTCCCAGGAGAGTGTCACAGAGCAGGACAGC
AAGGACAGCACCTACAGCCTCAGCAGCACCCTGACCCTGAGCAAAGCAGACTACGAGAAACAC
AAAGTCTACGCCTGCGAAGTCACCCATCAGGGCCTGAGCTCGCCCGTCACAAAGAGCTTCAAC
AGGGGAGAGTGTTAGTCTAGA

(SEQ ID NO:232)

5F9/hKappa light chain protein sequence is:

MGWSCIILFLVATATGVHSEIVMTQSPATLSVSPGERATLSCRASQSVSRNLAWYQQKPGQAPRLLI
YGASTRATGIPARFSGSGSGTEFTLTIGSLQSEDFAVYYCQQYKTWPRTFGQGTNVEIKRTVAAPSVF
IFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSK
ADYEKHKVYACEVTHQGLSSPVTKSFNRGEC

(SEQ ID NO:233)

[0493] The heavy and light chain nucleic acid sequences for 5F9 listed below were inserted into pTOK58D vector:

atgggatggagctgtatcatcctcttcttggtagcaacagctacaggtgtccactccgaaatagtgatgacgcagtctccagccaccctgtctgt
ctccagg

ggaaagagccaccctctcctgcagggccagtcagagtgttagcagaaacttagcctggtatcagcagaaacctggccagg

ctcccaggctcctcatctatggtgcatccaccagggccactggaatcccagccaggttcagtggcagtgggtctgggaca

gagttcactctcaccatcggcagcctgcagtctgaagattttgcagtttattactgtcagcagtataaaacctggcctcg

gacgttcggccaagggaccaacgtggaaatcaaacgtacggtggctgcaccatctgtcttcatcttcccgccatctgatg

agcagttgaaatctggaactgcctctgttgtgtgcctgctgaataacttctatcccagagaggccaaagtacagtggaag

gtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcaaggacagcacctacagcctcag

cagcaccctgaccctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcagggcctgagct

cgcccgtcacaaagagcttcaacaggggagagtgttag (SEQ ID NO:308)

atgggatggagctgtatcatcctcttcttggtagcaacagct

acaggtgtccactcccaggtgcagctacagcagtggggcgcaggactgttgaagccttcggagaccctgtccctcacctg

cgctgtctttggtgggtctttcagtggttactactggagctggatccgccagcccccagggaaggggctggagtggattg

gggaaatcaatcatcgtggaaacaccaacgacaacccgtccctcaagagtcgagtcaccatatcagtagacacgtccaag

aaccagttcgccctgaagctgagttctgtgaccgccgcggacacggctgtttattactgtgcgagagaacgtggatacac

ctatggtaactttgaccactggggccagggaaccctggtcaccgtcagctcagcctccaccaagggcccatcggtcttcc

ccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccg
gtgacggtgtcgtggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactcta
ctccctcagcagcgtggtgaccgtgccctccagcagcttgggcacccagacctacatctgcaacgtgaatcacaagccca
gcaacaccaaggtggacaagaaagttgagcccaaatcttgtgacaaaactcacacatgcccaccgtgcccagcacctgaa
ctcctgggggggaccgtcagtcttcctcttccccccaaaacccaaggacaccctcatgatctcccggacccctgaggtcac
atgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttcaactggtacgtggacggcgtggaggtgcataatg
ccaagacaaagccgcgggaggagcagtacaacagcacgtaccgtgtggtcagcgtcctcaccgtcctgcaccaggactgg
ctgaatggcaaggagtacaagtgcaaggtctccaacaaagccctcccagcccccatcgagaaaaccatctccaaagccaa
agggcagccccgagaaccacaggtgtacaccctgcccccatcccgggatgagctgaccaagaaccaggtcagcctgacct
gcctggtcaaaggcttctatcccagcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactacaagacc
acgcctcccgtgctggactccgacggctccttcttcctctacagcaagctcaccgtggacaagagcaggtggcagcaggg
gaacgtcttctcatgctccgtgatgcatgaggctctgcacaaccactacacgcagaagagcctctccctgtctccgggta
aataa (SEQ ID NO:309)

[0494] The sequences encoding the Abx-229 heavy and light chains sequence below were inserted into pTOK58D vector:

atggagtttgggctgagctggctttttcttgtggctatt
ttaaaaggtgtccagtgtgaggtgcagctgttggagtctgggggaggcttggtacagcctgggggtccctgagactctc
ctgtgcagcctctggattcacctttagccgctatgccatgaactgggtccgccaggctccagggaaggggctggagtggg
tctcaggtattagtgggagtggtggtaggacatactacgcagactccgtgaagggccggttcaccatctccagagacaat
tccaagaacacactatatctgcaaatgaacagcctgagagccgaggacacggccgtatattactgtgcgaaagatcgcga
tttttggagtggtccatttgactactggggccagggaaccctggtcaccgtcagctcagcctccaccaagggcccatcgg
tcttccccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttcccc
gaaccggtgacggtgtcgtggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcagg
actctactccctcagcagcgtggtgaccgtgccctccagcagcttgggcacccagacctacatctgcaacgtgaatcaca
agcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgtgacaaaactcacacatgcccaccgtgcccagca

cctgaactcctgggggggaccgtcagtcttcctcttccccccaaaacccaaggacaccctcatgatctcccggacccctga
ggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttcaactggtacgtggacggcgtggaggtgc
ataatgccaagacaaagccgcgggaggagcagtacaacagcacgtaccgtgtggtcagcgtcctcaccgtcctgcaccag
gactggctgaatggcaaggagtacaagtgcaaggtctccaacaaagccctcccagcccccatcgagaaaaccatctccaa
agccaaagggcagccccgagaaccacaggtgtacaccctgcccccatcccgggatgagctgaccaagaaccaggtcagcc
tgacctgcctggtcaaaggcttctatcccagcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactac
aagaccacgcctcccgtgctggactccgacggctccttcttcctctacagcaagctcaccgtggacaagagcaggtggca
gcaggggaacgtcttctcatgctccgtgatgcatgaggctctgcacaaccactacacgcagaagagcctctccctgtctc
cgggtaaataa (SEQ ID NO:310)

atgaggctccctgctcagcttctc
ttcctcctgctactctggctcccagataccactggagaaatagtgatgacgccgtcttcagccaccctgtctgtgtctcc
aggggagagagccaccctctcctgcagggccagtcagagtgttagtagaaacttagcctggtaccagcagaaacctggcc
aggctcccaggctcctcatctatggtgcatccaccagggccactggtatcccagccaggttcagtggcagtgggtctggg
acagaattcactctcaccatcagcagcctgcagtctgaagattttgcagtttattactgtcaccagtatagtaactggat
gtgcagttttggccaggggaccaagctggagatcaaacgtacggtggctgcaccatctgtcttcatcttcccgccatctg
atgagcagttgaaatctggaactgcctctgttgtgtgcctgctgaataacttctatcccagagaggccaaagtacagtgg
aaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcaaggacagcacctacagcct
cagcagcaccctgaccctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcagggcctga
gctcgcccgtcacaaagagcttcaacaggggagagtgttag (SEQ ID NO:311)

[0495] While this invention has been shown and described with references to provided embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention encompassed by the appended claims.

What is claimed is:

1. An anti-GCC antibody molecule, wherein the light chain variable region and the heavy chain variable region of the anti-GCC antibody molecule are selected from: the light and heavy chain sequences disclosed in Table 2 for any one of the following antibodies:

5F9;

Ab 229; or

3G1.

2. The anti-GCC antibody molecule, of claim 1, wherein said anti-GCC antibody molecule is an IgG1 antibody.

3. The anti-GCC antibody molecule of claim 1, wherein said anti-GCC antibodymolecule is not conjugated to a therapeutic agent.

4. The anti-GCC antibody molecule of claim 1, wherein said anti-GCC antibodymolecule is conjugated to a therapeutic agent.

5. The anti-GCC antibody molecule of claim 1, wherein said anti-GCC antibody molecule is conjugated to a detectable label.

6. An anti-GCC antibody molecule, comprising light chain CDR1, CDR2, and CDR3, and heavy chain CDR1, CDR2, and CDR3, disclosed in Table 5 for any one of the following antibodies:

5F9;

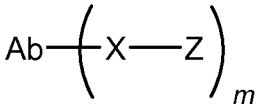
Ab 229; or

3G1.

7. The anti-GCC antibody molecule of claim 6, further comprising human or human derived light and heavy variable region frameworks.

8. The anti-GCC antibody molecule of claim 7, wherein said anti-GCC antibody is an IgG1 antibody.

9. An immunoconjugate of formula (*I*):



(*I*)

or a pharmaceutically acceptable salt thereof, wherein:

Ab is an anti-GCC antibody molecule of claim 1;

X is a linker moiety which connects Ab and Z;

Z is a therapeutic agent or a label; and

m is an integer from 1 to 15.

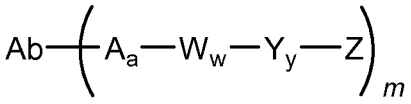
10. The immunoconjugate of claim 9, wherein Z is a detectable label.

11. The immunoconjugate of claim 9, wherein –Z is a maytansine or an auristatin.

12. The immunoconjugate of claim 9, wherein -Z is DM1 or DM4.

13. The immunoconjugate of claim 9, wherein -Z is MMAE or MMAF.

14. The immunoconjugate of claim 9, wherein the linker –X- has the formula $-A_a-W_w-Y_y-$, and the immunoconjugate is characterized by formula (*II*):



(*II*)

or a pharmaceutically acceptable salt thereof, wherein:

-A- is a Stretcher unit;

a is 0 or 1;

each –W- independently is an Amino Acid unit;

w is an integer ranging from 0 to 12;

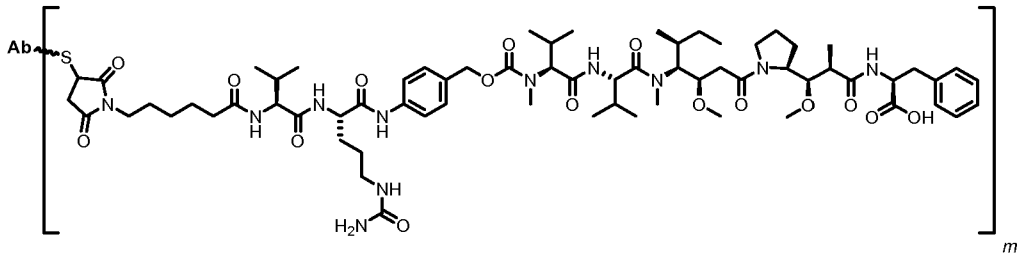
-Y- is a self-immolative Spacer unit;

y is 0, 1, or 2;

Z is a therapeutic agent or label; and

m ranges from about 1 to about 15.

15. An immunoconjugate of formula (***I-4***):



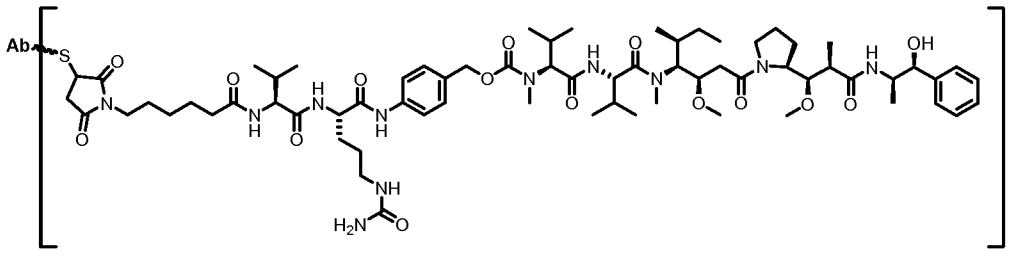
(***I-4***)

or a pharmaceutically acceptable salt thereof, wherein:

Ab is 5F9; and

m is an integer from 1 to 8.

16. An immunoconjugate of formula (***I-5***):



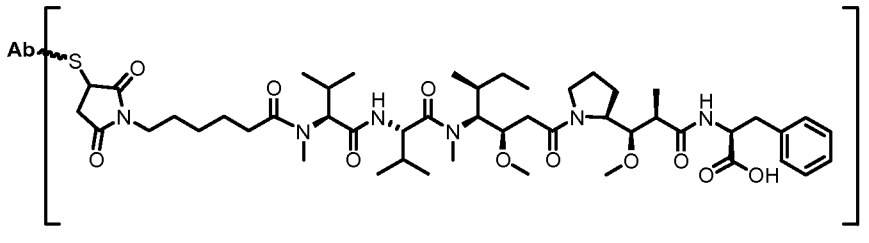
(***I-5***)

or a pharmaceutically acceptable salt thereof, wherein:

Ab is 5F9; and

m is an integer from 1 to 8.

17. An immunoconjugate of formula (***I-7***):



(***I-7***)

or a pharmaceutically acceptable salt thereof, wherein:

Ab is 5F9; and

m is an integer from 1 to 8.

18. The immunoconjugate of claim 15, wherein *m* is from 1 to 3.

19. The immunoconjugate of claim 15, wherein *m* is from 3 to 5.

20. The immunoconjugate of claim 16, wherein *m* is from 3 to 5.

21. The immunoconjugate of claim 18, wherein *m* is from 3 to 5.

22. A method of treating a subject for colon cancer, comprising administering to said subject, a therapeutically effective amount of an antibody molecule of claim 1 or 6, thereby treating said subject.

23. A method of treating a subject for colon cancer, comprising administering to said subject a therapeutically effective amount of an immunoconjugate of any one of claims 9-17.

24. Isolated nucleic acid sequences that encode an antibody molecule of claim 1 or 6.

25. A cell comprising the isolated nucleic acid sequences of claim 24.

26. A method of producing an antibodymolecule of claim 1 or 6, comprising culturing the cell of claim 25under conditions that allow production of an antibody molecule, thereby producing the antibody molecule of claim 1 or 6.

27. A vector comprising one or both of the light chain and heavy chain of an antibody molecule of claim 1 or 6.

28. A method of detecting a GCC molecule comprising contacting the molecule with an antibody molecule of claim 1 or 6 and determining if said antibody molecule, binds to said GCC molecule.