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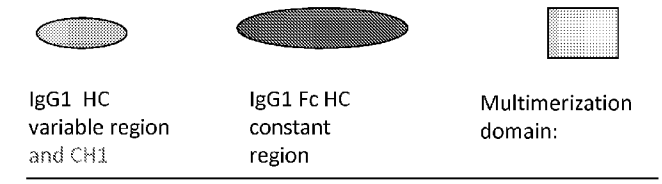
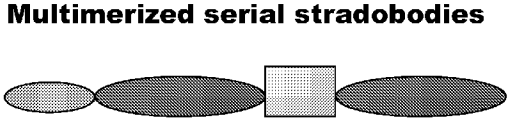
(54) Title: MOLECULES WITH ANTIGEN BINDING AND POLYVALENT FC GAMMA RECEPTOR BINDING ACTIVITY

(57) Abstract: The current invention involves biologically active proteins termed stradobodies. The stradobodies have two or more domains that create stradobody multimers. The stradobodies have both antigen-binding capacity and the ability to bind Fc receptors (FcR), and are useful in the treatment and prevention of disease.

Figure 1





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MOLECULES WITH ANTIGEN BINDING AND POLYVALENT FC GAMMA RECEPTOR BINDING ACTIVITY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 61/691,057, filed August 20, 2012, and U.S. Provisional Application No. 61/785,144, filed March 14, 2013, the contents of which are herein incorporated by reference in their entirety.

DESCRIPTION OF THE TEXT FILE SUBMITTED ELECTRONICALLY

[0002] The contents of the text file submitted electronically herewith are incorporated herein by reference in their entirety: A computer readable format copy of the Sequence Listing (filename: GLIK_009_01US_310975_2048_SeqList_ST25.txt, date recorded: March 12, 2013, file size 329 kilobytes).

FIELD OF THE INVENTION

[0003] This invention relates generally to the fields of immunology, autoimmunity, inflammation, infectious diseases, and tumor immunology. More specifically, the present invention relates to biologically active biomimetic molecules comprising immunoglobulin Fc domains and Fab domains, compositions comprising such biomimetics, and methods of making and using such biomimetics.

BACKGROUND OF THE INVENTION

[0004] Monoclonal antibody (mAb) therapy is an important and growing part of medicine. Over 30 monoclonal antibodies have been approved for various immunological diseases, infectious diseases, and cancers either in the United States or Europe, and hundreds more are under investigation. However, a common problem in monoclonal antibody therapy development is lack of adequate efficacy despite Fab and FcR binding. Because of the high

doses that are often necessary in order to achieve efficacy, adverse side effects are commonly associated with therapeutic antibodies. Further, low or altered expression of tumor and other target antigens, as well as genetic mutations that affect antibody targets or downstream effects of antibody binding, can render antibody therapies ineffective. As an example, the monoclonal antibody trastuzumab is a mAb directed specifically against the HER2/neu breast cancer antigen and commercially available under the trade name Herceptin®, is approved by the United States Food and Drug Administration for the treatment of breast cancer. Trastuzumab can be effective in patients in which HER2/neu is highly expressed; however, approximately 90% of breast cancer patients have tumors that are not classified as HER2/neu high expressing. As another example, cetuximab, a mAb directed specifically against the epidermal growth factor receptor (EGFR) and commercially available under the trade name Erbitux®, is approved by the United States Food and Drug Administration for the treatment of colon cancer. Cetuximab blocks the EGFR and arrests a downstream KRAS protein-dependent tumor proliferation pathway. From a clinical perspective, cetuximab can improve overall response rates as well as progression-free survival in patients whose tumors have wild type (WT) KRAS. Unfortunately, 30-60% of colon cancer patients have tumors with codon 12 or 13 KRAS mutations, and recent clinical trials suggest that patients with mutated KRAS do not benefit from treatment with cetuximab (summarized in Allegra et. al., Journal of Clinical Oncology, 2009 Apr 20;27(12):2091-6). Thus, there is a need for new antibody-like-based therapeutics in the treatment of cancers, as well as in the treatment of autoimmune disorders and inflammatory diseases.

[0005] Engagement and aggregation of Fc receptors, particularly low affinity receptors such as FcγRIIIa, on immune cells and especially on natural killer (NK) cells by antibodies results in activation, degranulation, and lysis of the target tumor or cell, in a process known as antibody dependent cellular cytoxicity (ADCC). Tumor cells and other cells targeted by the immune system may also be killed through complement-dependent cytoxicity (CDC), in which an antibody binds complement, leading to cell cytotoxicity; or through direct cytotoxicity (DC) resulting from direct antibody binding to antigen in the absence of NK cells or complement; or by other mechanisms such as induction of apoptosis, or interference with cellular growth or processes. There is presently a need in the art to identify means of increasing ADCC, CDC, DC,

and other mechanisms of killing tumor cells or other cells, thereby increasing the efficacy of mAb therapies. In particular, when complement-dependent pathways for cell killing are fully functional, CDC can be an effective method for killing cancer cells and other target cells. However, many cells are resistant to CDC due to cell membrane repair mechanisms and regulatory proteins such as CD59, which inhibits the complement pathway. For example, despite the high levels of expression of CD20 on B cell lymphoma and leukemia cells, many patients with B cell malignancies are unresponsive to, or become resistant to, treatment with the anti-CD20 monoclonal antibody rituximab, at least in part due to mechansims of complement inhibition (Harjunpaa et al., Scand. J. Immunol, 2000 51; 634-641). Therefore, there is a particular need for molecules that are capable of increasing CDC.

SUMMARY OF THE INVENTION

[0006] The present invention relates to biologically active biomimetic molecules comprising immunoglobulin Fc domains, Fab domains, and multimerization domains; compositions comprising such biomimetics; and methods of making and using such biomimetics. These biomimetics have broad application for treating cancers, inflammatory, autoimmune, and infectious disease conditions in which a monoclonal antibody may be used or is already in clinical use. The biomimetics of the present invention have the advantages of more potent antibody-mediated cell cytoxicity, complementmediated cell cytotoxicity, and complement c1q binding compared to a mAb whose Fab is identical to the Fab comprised in the biomimetics of the present invention. The biomimetics of the present invention also have the advantage of more potent complement-dependent cell cytoxicity and direct cytotoxicity compared to a mAb whose Fab is specific for the same antigen.

[0007] WO 2008/151088 discloses using biomimetic molecules comprising two or more Fc domains, preferably in the context of a stradomer, to which one or more Fab domains is attached, for the treatment of pathological conditions including cancers, autoimmune diseases and other inflammatory conditions, and infectious diseases. WO 2008/151088 is incorporated herein by reference in its entirety. The molecules comprising an Fab disclosed in WO

2008/151088 are termed "stradobodies" and possess the antigen binding properties of the Fab portion of a monoclonal antibody and the Fc receptor binding properties of stradomers. Thus, these stradobodies bind, cross-link, and activate multiple Fcγ receptors on effector cells simultaneously, creating avidity that cannot be accomplished by an individual mAb or immunoglobulin Fc backbone binding to an individual Fcγ receptor, even if optimized via Fc mutagenesis, defucosylation, or other methods that improve affinity between an individual mAb and an individual Fcγ receptor. Polyvalent binding of Fcγ receptors on effector cells is particularly important in the environment of low epitope expression. Low epitope expression leads to mAb Fab binding events too isolated to result in a sufficient density of Fc – Fcγ receptor binding events in close enough proximity on the effector cell to cause downstream activation of low affinity Fcγ receptors on effector cells. However, as disclosed herein, the inclusion of one or more multimerization domains in addition to the Fab and Fc domains enhances the FcγR binding activity of the stradobodies, resulting in slow dissociation characteristic of avidity, as well as antibody-dependent cell cytoxicity (ADCC), complement-mediated cytoxicity (CDC), direct cytotoxicity (DC), strong complement clq binding, and/or other mechanisms of cellular toxicity. In particular, the multimerization domains are located between two Fc domains or at the carboxy end of the Fc region in the stradobodies disclosed herein. Surprisingly, a stradobody comprising two particular multimerization domains, an isoleucine zipper and an IgG2 hinge, resulted in particularly strong multimerization, high cellular toxicity against target cells, and high c1q binding.

[0008] Nagashima et al. (Journal of Bioscience and Bioengineering 111(4): 391-6 (2011) and Molecular Immunology 45(10):2752-63 (2008)) described serial stradobodies with tandem repeats of Fc domains, as anticipated by WO 2008/151088, which resulted in enhanced ADCC relative to the parent monoclonal antibodies from which they were derived, i.e. comprising the identical Fab region. The stradobodies of the present invention, however, by virtue of the multimerization domain(s), lead to multimerization of the stradobody homodimers which in turn enhances the number of Fc domains capable of simultaneously binding FcγR and ultimately leads to far superior binding and cytotoxicity when compared with non-multimerizing compounds, such as those described in Nagashima and elsewhere.

[0009] In one aspect, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains. In a further embodiment, the one or more multimerization domains is capable of multimerizing said stradobody. In one embodiment, at least one of the one or more multimerization domains separates two or more Fc domains. In another embodiment, the at least one of the one or more multimerization domains is located at the carboxy end of the Fc region. In a preferred embodiment, one or more Fc domains is an IgG1 Fc domain.

[0010] In one embodiment, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody. In another embodiment, the multimerization domains are independently selected from the group consisting of an isoleucine zipper, an IgG2 hinge, and a GPP repeat. In another embodiment, the stradobody comprises two multimerization domains. In a further embodiment, the two multimerization domains are independently selected from the group consisting of an isoleucine zipper, an IgG2 hinge, and a GPP repeat. In a still further embodiment, the two multimerization domains are an isoleucine zipper and an IgG2 hinge. In a still further embodiment, the two multimerization domains are both an IgG2 hinge. In another embodiment, the two multimerization domains are both an isoleucine zipper. In another embodiment, the stradobody comprises three multimerization domains. In still another embodiment, the stradobody comprises four or more multimerization domains.

[0011] In one embodiment, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody, and wherein at least one of the one or more multimerization domains is an isoleucine zipper. In a further embodiment, the at least one isoleucine zipper is according to SEQ ID NO: 32, and is capable of multimerizing the stradobody. In another embodiment, at least one of the one or more multimerization domains is an IgG2 hinge domain. In a further embodiment, the at least one IgG2 hinge domain is according to SEQ ID NO: 3 and is capable of multimerizing the stradobody. In another embodiment, at least one of the one or more multimerization domains is a

GPP domain. In a further embodiment, the at least one GPP domain comprises an amino acid sequence according to SEQ ID NO:26 and is capable of multimerizing the stradobody.

[0012] In one embodiment, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody. In a further embodiment, at least one Fc domain is an IgG1 Fc domain, and the least one Fc domain comprises an IgG1 CH2, and an IgG1 CH3. In a further embodiment, the Fc domain comprises an IgG1 hinge, an IgG1 CH2, and an IgG1 CH3. In another embodiment, the stradobody comprises more than one Fc domain. In a further embodiment, each of the more than one Fc domains is an IgG1 Fc domain. In a further embodiment, each of the more than one Fc domains is an IgG3 Fc domain. In a further embodiment, each of the more than one Fc domains is an IgG2 Fc domain. In a further embodiment, each of the more than one Fc domains is an IgG4 Fc domain. In a further embodiment, the more than one Fc domains is comprised of an IgG1 Fc domain and an IgG2 Fc domain, IgG3 Fc domain, or IgG4 Fc domain.

[0013] In one embodiment, the current invention relates to a stradobody wherein the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, a first multimerization domain, a second multimerization domain, and a second Fc domain. In a further embodiment, at least one of the Fc domains is an IgG1 Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an IgG2 hinge, an isoleucine zipper, and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an isoleucine zipper, an IgG2 hinge, and a second Fc domain. In one especially preferred embodiment, the first Fc domain, isoleucine zipper, IgG2 hinge, and second Fc domain together comprise an amino acid sequence according to SEQ ID NO: 69. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an IgG2 hinge, a second IgG2 hinge, and a second Fc. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an isoleucine zipper, a second isoleucine zipper, and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an

isoleucine zipper, and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an IgG2 hinge; and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, a G4S domain, an IgG2 hinge, and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an IgG2 hinge, a G4S domain, a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, a G4S domain, an isoleucine zipper, a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an isoleucine zipper, a G4S domain, and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, a GPP domain, and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, a GPP domain, an IgG2 hinge, and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an IgG2 hinge, a GPP domain, and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, a GPP domain, an isoleucine zipper, and a second Fc domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, an isoleucine zipper, a GPP domain, and a second Fc domain. A skilled artisan will recognize that other multimerization domains can be used in place of the multimerization domains described here.

[0014] In a further embodiment, the first and the second Fc domains are IgG1 Fc domains. In another embodiment, at least one IgG1 Fc domain comprises an IgG1 CH2 and an IgG1 CH3. In a further embodiment, the IgG1 Fc domain further comprises an IgG1 hinge.

[0015] In one embodiment, the current invention relates to a composition comprising multimerized stradobodies, wherein the stradobodies comprise, from amino to carboxy terminus, an Fab domain, a first Fc domain, a first multimerization domain, a second multimerization domain, and a second Fc domain.

[0016] In one embodiment, the current invention relates to a stradobody wherein the stradobody comprises, from amino to carboxy terminus, an Fab domain, a single Fc domain, a first multimerization domain, and a second multimerization domain. In a further embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, a single Fc domain, an isoleucine zipper, and an IgG2 hinge. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, an IgG2 hinge, and an isoleucine zipper. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, and an IgG2 hinge. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, an IgG2 hinge, and a second IgG2 hinge. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, and an isoleucine zipper. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, an isoleucine zipper, and a second isoleucine zipper. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, a G4S domain, and an IgG2 hinge. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, an IgG2 hinge, and a G4S domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, a G4S domain, and an isoleucine zipper. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, an isoleucine zipper, and a G4S domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, a domain linkage, and an IgG2 hinge. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, a domain linkage, and an isoleucine zipper. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, an IgG2 hinge, and a domain linkage. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, an isoleucine zipper and a domain linkage. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, and a GPP domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, a GPP domain, and an IgG2 hinge. In another

embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, an IgG2 hinge, and a GPP domain. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, a GPP domain, and an isoleucine zipper. In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, an Fc domain, an isoleucine zipper, and a GPP domain. A skilled artisan will recognize that other multimerization domains can be used in place of the multimerization domains described here.

[0017] In a further embodiment, the Fc domain is an IgG1 Fc domain. In a further embodiment, the IgG1 Fc domain comprises an IgG1 CH2 and an IgG1 CH3. In a still further embodiment, the IgG1 Fc domain further comprises an IgG1 hinge.

[0018] In one embodiment, the current invention relates to a composition comprising multimerized stradobodies, wherein the stradobodies comprise, from amino to carboxy terminus, an Fab domain, an Fc domain, a first multimerization domain, and a second multimerization domain.

[0019] In another embodiment, the stradobody comprises, from amino to carboxy terminus, an Fab domain, two or more Fc domains, and one or more multimerization domains. In a further embodiment, the Fc domain is an IgG1 Fc domain.

[0020] In one embodiment, the current invention relates to a stradobody wherein the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, one or more multimerization domains, and a second Fc domain. In another embodiment, the current invention relates to a stradobody wherein the stradobody comprises, from amino to carboxy terminus, an Fab domain, a first Fc domain, and one or more multimerization domains. In a further embodiment, the stradobody further comprises one or more multimerization domains at the C-terminal end of the Fc region. In a further embodiment, one or more of the Fc domains is an IgG1 Fc domain.

[0021] In one embodiment, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody, and wherein the Fab domain is specific for EGFR. In one embodiment, the amino acid sequence of the Fab

domain is at least 80% homologous to SEQ ID NO: 31. In a further embodiment, the amino acid sequence of the Fab domain is at least 90% homologous to SEQ ID NO: 31. In still a further embodiment, the amino acid sequence of the Fab domain is at least 95% homologous to SEQ ID NO: 31. In yet a further embodiment, the amino acid sequence of the Fab domain is at least 99% homologous to SEQ ID NO: 31. In a yet further embodiment, the amino acid sequence of the Fab domain is SEQ ID NO: 31. In some embodiments, the one or more Fc domain is an IgG1 Fc domain.

[0022] In one embodiment, the current invention relates to a stradobody wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 33. In a further embodiment, the amino acid sequence of the stradobody is at least 85% homologous to SEQ ID NO: 33. In a still further embodiment, the amino acid sequence of the stradobody is at least 90% homologous to SEQ ID NO: 33. In a yet further embodiment, the amino acid sequence of the stradobody is at least 95% homologous to SEQ ID NO: 33. In a yet further embodiment, the amino acid sequence is at least 99% homologous to SEQ ID NO: 33. In a yet further embodiment, the amino acid sequence is SEQ ID NO: 33.

[0023] In one embodiment, the current invention relates to a stradobody wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 70. In a further embodiment, the amino acid sequence of the stradobody is at least 85% homologous to SEQ ID NO: 70. In a still further embodiment, the amino acid sequence of the stradobody is at least 90% homologous to SEQ ID NO: 70. In a yet further embodiment, the amino acid sequence of the stradobody is at least 95% homologous to SEQ ID NO: 70. In a yet further embodiment, the amino acid sequence is at least 99% homologous to SEQ ID NO: 70. In a yet further embodiment, the amino acid sequence is SEQ ID NO: 70.

[0024] In another embodiment, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody, and wherein the Fab domain is specific for HER2/neu antigen. In one embodiment, the amino acid sequence of the Fab domain is at least 80% homologous to SEQ ID NO: 34. In a further embodiment, the amino acid sequence of the Fab domain is at least 90% homologous to SEQ ID NO: 34. In still a

further embodiment, the amino acid sequence of the Fab domain is at least 95% homologous to SEQ ID NO: 34. In yet a further embodiment, the amino acid sequence of the Fab domain is at least 99% homologous to SEQ ID NO: 34. In a yet further embodiment, the amino acid sequence of the Fab domain is SEQ ID NO: 34. In some embodiments, the one or more Fc domain is an IgG1 Fc domain.

[0025] In one embodiment, the current invention relates to a stradobody wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 35. In a further embodiment, the amino acid sequence of the stradobody is at least 85% homologous to SEQ ID NO: 35. In a still further embodiment, the amino acid sequence of the stradobody is t least 90% homologous to SEQ ID NO: 35. In a yet further embodiment, the amino acid sequence of the stradobody is at least 95% homologous to SEQ ID NO: 35. In yet a further embodiment, the amino acid sequence is at least 99% homologous to SEQ ID NO: 35. In a yet further embodiment, the amino acid sequence is SEQ ID NO: 35. The skilled artisan would understand that stradobodies and in particular multimerizing stradobodies can be readily produced with an Fab directed against any tumor antigen.

[0026] In one embodiment, the current invention relates to a stradobody wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 91. In a further embodiment, the amino acid sequence of the stradobody is at least 85% homologous to SEQ ID NO: 91. In a still further embodiment, the amino acid sequence of the stradobody is at least 90% homologous to SEQ ID NO: 91. In a yet further embodiment, the amino acid sequence of the stradobody is at least 95% homologous to SEQ ID NO: 91. In a yet further embodiment, the amino acid sequence is at least 99% homologous to SEQ ID NO: 91. In a yet further embodiment, the amino acid sequence is SEQ ID NO: 91.

[0027] In another embodiment, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody, and wherein the Fab domain is specific for CD20. In one embodiment, the amino acid sequence of the Fab domain is at least 80% homologous to SEQ ID NO: 36. In a further embodiment, the amino acid sequence of the Fab domain is at least 90% homologous to SEQ ID NO: 36. In still a further

embodiment, the amino acid sequence of the Fab domain is at least 95% homologous to SEQ ID NO: 36. In yet a further embodiment, the amino acid sequence of the Fab domain is at least 99% homologous to SEQ ID NO: 36. In a yet further embodiment, the amino acid sequence of the Fab domain is SEQ ID NO: 36. In some embodiments, the one or more Fc domain is an IgG1 Fc domain.

[0028] In one embodiment, the current invention relates to a stradobody wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 37. In a further embodiment, the amino acid sequence of the stradobody is at least 85% homologous to SEQ ID NO: 37. In a still further embodiment, the amino acid sequence of the stradobody is at least 90% homologous to SEQ ID NO: 37. In a yet further embodiment, the amino acid sequence of the stradobody is at least 95% homologous to SEQ ID NO: 37. In yet a further embodiment, the amino acid sequence is at least 99% homologous to SEQ ID NO: 37. In a yet further embodiment, the amino acid sequence is SEQ ID NO: 37.

[0029] In one embodiment, the current invention relates to a stradobody wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 76. In a further embodiment, the amino acid sequence of the stradobody is at least 85% homologous to SEQ ID NO: 76. In a still further embodiment, the amino acid sequence of the stradobody is at least 90% homologous to SEQ ID NO: 76. In a yet further embodiment, the amino acid sequence of the stradobody is at least 95% homologous to SEQ ID NO: 76. In a yet further embodiment, the amino acid sequence is at least 99% homologous to SEQ ID NO: 76. In a yet further embodiment, the amino acid sequence is SEQ ID NO: 76.

[0030] In one embodiment, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody, and wherein the Fab domain is specific for a TNF superfamily member. Members of the TNF superfamily include, without limitation, TNF, TNF-α, TNF-β, Lymphotoxin (LT), Lymphotoxinβ (LTβ), OX40 Ligand, CD40 Ligand, CD95/Fas Ligand, CD27 Ligand (CD70), CD30 Ligand, CD137/4-1BB Ligand, TRAIL, TRANCE/RANKL, TWEAK/Apo-3, APRIL, BAFF/Blys, LIGHT, TL1A/VEGI, GITR Ligand, EDA-A1, and EDA-A2. In one embodiment, the stradobody

comprises an Fab domain that is specific for TNF (i.e., an anti-TNF stradobody; for example, the stradobody GB7542). In another embodiment, the stradobody comprises an Fab domain that is specific for Blys (i.e., an anti-Blys stradobody). In another embodiment, the stradobody comprises an Fab domain that is specific for TRAIL (i.e., an anti-TRAIL stradobody). In another embodiment, the stradobody comprises an Fab domain that is specific for OX40L (i.e., an anti-OX40L stradobody). In another embodiment, the stradobody comprises an Fab domain that is specific for 4-1BB (i.e., an anti-4-1BB stradobody). In another embodiment, the stradobody comprises a Fab domain that is specific for APRIL, (i.e., an anti-APRIL stradobody). In another embodiment, the stradobody comprises a Fab domain that is specific for TRANCE (i.e., an anti-TRANCE stradobody). In another embodiment, the stradobody comprises a Fab domain that is specific for LTβ (i.e., an anti-LTβ stradobody), In another embodiment, the stradobody comprises a Fab domain that is specific for CD40L (i.e., an anti-CD40L stradobody). The skilled artisan would understand that stradobodies and in particular multimerizing stradobodies can be readily produced with an Fab directed against any immune cell surface receptor.

[0031] In another embodiment, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody, and wherein the Fab domain is specific for TNF. In one embodiment, the amino acid sequence of the Fab domain is at least 80% homologous to SEQ ID NO: 67. In a further embodiment, the amino acid sequence of the Fab domain is at least 90% homologous to SEQ ID NO: 67. In still a further embodiment, the amino acid sequence of the Fab domain is at least 95% homologous to SEQ ID NO: 67. In yet a further embodiment, the amino acid sequence of the Fab domain is at least 99% homologous to SEQ ID NO: 67. In a yet further embodimient, the amino acid sequence of the Fab domain is SEQ ID NO: 67. In some embodiments, the one or more Fc domain is an IgG1 Fc domain.

[0032] In one embodiment, the current invention relates to a stradobody wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 66. In a further embodiment, the amino acid sequence of the stradobody is at least 85% homologous to SEQ ID NO: 66. In a still further embodiment, the amino acid sequence of the stradobody is at

least 90% homologous to SEQ ID NO: 66. In a yet further embodiment, the amino acid sequence of the stradobody is at least 95% homologous to SEQ ID NO: 66. In yet a further embodiment, the amino acid sequence is at least 99% homologous to SEQ ID NO: 66. In a yet further embodiment, the amino acid sequence is SEQ ID NO: 66. The skilled artisan would understand that stradobodies and in particular multimerizing stradobodies can be readily produced with an Fab directed against any cytokine or soluble receptor.

[0033] In one embodiment, the current invention relates to a stradobody wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 87. In a further embodiment, the amino acid sequence of the stradobody is at least 85% homologous to SEQ ID NO: 87. In a still further embodiment, the amino acid sequence of the stradobody is at least 90% homologous to SEQ ID NO: 87. In a yet further embodiment, the amino acid sequence of the stradobody is at least 95% homologous to SEQ ID NO: 87. In a yet further embodiment, the amino acid sequence is at least 99% homologous to SEQ ID NO: 87. In a yet further embodiment, the amino acid sequence is SEQ ID NO: 87.

[0034] In one embodiment, the stradobody of the current invention comprises an Fab domain that is specific for IFNγ, IFNα, IFNβ, IL-1, IL-2, IL-4, IL-5, IL-6, IL-8, IL-10, IL-12, IL-13, IL-15, IL-17, or IL-23. In one embodiment, the stradobody of the current invention comprises an Fab domain that is specific for a cytokine, wherein the stradobody is useful for treatment or prevention of an inflammatory or autoimmune disease. For example, in one embodiment, the stradobody is an anti-IL-2, anti-IL-8, or anti-IL-17 stradobody. The skilled artisan would understand that stradobodies and in particular multimerizing stradobodies can be readily produced with an Fab directed against any interleukin or interferon.

[0035] In one embodiment, the current invention relates to a stradobody wherein the stradobody comprises an Fab directed against one or more infectious disease antigens. The skilled artisan would understand that stradobodies and in particular multimerizing stradobodies can be readily produced with an Fab directed against any infectious disease antigen. The skilled artisan would further understand that stradobodies and in particular multimerizing stradobodies can be readily produced with an Fab derived from a monoclonal antibody that may be used or is already in clinical use for treatment or prevention of infectious disease.

[0036] For Example, multimerizing stradobodies can be produced with an Fab derived from a monoclonal antibody that may be used or is already in clinical use for neutralization of viruses, neutralization of bacteria or bacterial toxins, blocking of viral entry into host cells, blocking immune inhibitory mechanisms triggered by pathogens, blocking of immunopathogenic responses triggered by pathogens, or other means of treating or preventing infectious disease. Exemplary monoclonal antibodies in clinical use or in development for clinical use for treatment or prevention of infectious disease include, but are not limited to, palivizumab and motavizumab, both of which are specific for respiratory syncitial virus (RSV) glycoprotein F; ibalizumab, an anti-CD4 antibody for blocking human immunodeficiency virus (HIV) entry into host cells; Pro-140 and CCR5mAb004, anti-CCR5 antibodies for blocking HIV entry into host cells; F105, an anti-gp120 antibody for neutralizing envelope glycoprotein gp120 of HIV, which is also used in viral entry; sevirumab, which is specific for cytomegalovirus (CMV) envelope glycoprotein H; bavituximab, an anti-phosphatidyl serine antibody used to neutralize Hepatitis C virus (HCV); nivolumab (also known as MDX1106/BMS936558/ONO-4538) and pidilizumab (also known as CT-011), both of which are specific for the immune inhibitory molecule PD-1 on immune cells and are used as immunomodulation antibodies in HCV infection; MBL-HCV1, an HCV neutralizing antibody specific for the HCV structural protein E2; foravirumab, a rabies virus neutralizing antibody specific for glycoprotein G; ETI-204 (anthim), raxibacumab, and AVP 21D9, each of which is a *Bacillus anthracis* toxin neutralization antibody specific for *B. anthracis* protective antigen; SAR279356 and other anti-poly-N-acetyl glucosamine (PNAG) antibodies, which are useful in *Staphylococcus* and other bacterial infections, particularly multi drug-resistant infections; pagibaximab, which is specific for anti-lipoteichoic acid and used for prevention of *Staphylococcus* infection; tefibazumab, which is specific for clumping factor A and is also useful for *Staphylococcus* infection; urtoxazumab, an anti-Shiga-like toxin 2B antibody for *E. coli* infection; shigamabs, which is a cocktail of two mAbs, caStx1 and caStx2, for neutralization of *E. coli* STEC toxins Stx1 and Stx2; actoxumab (anti-*Clostridum difficile* enterotoxin A) and bezlotoxumab (anti-*C. difficile* enterotoxin B), which may be administered together as a cocktail of two antibodies known as MK3415A; panobacumab, an anti-LPS antibody used in *Pseudomonas aeruginosa* infection; KB 001, an anti-type 3 secretion system

antibody used in *P. aeruginosa* infection); and 18B7, anti-capsular polysaccharide antibody for *Cyptococcus neoformans* infection.

[0037] In one embodiment, the current invention relates to a stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody, and wherein the two or more Fc domains are capable of binding FcγR. In a further embodiment, the FcγR is FcγRIIIa. In a further embodiment, the FcγRIIIa are on effector cells. In a yet further embodiment, the FcγRIIIa are on NK cells. In another embodiment, the FcγRIIIa are on macrophages. In another embodiment, the FcγR is FcγRIIb. In a further embodiment, the FcγRIIb are on B cells. In another embodiment, the FcγRIIb are on dendritic cells.

[0038] In a further embodiment, the amino acid sequence of the two or more Fc domains is at least 80% homologous to SEQ ID NO: 2. In a further embodiment, the amino acid sequence of the two or more Fc domains is at least 90% homologous to SEQ ID NO: 2. In still a further embodiment, the amino acid sequence of the two or more Fc domains is at least 95% homologous to SEQ ID NO: 2. In yet a further embodiment, the amino acid sequence of the two or more Fc domains is at least 99% homologous to SEQ ID NO: 2. In a yet further embodiment, the amino acid sequence of the two or more Fc domains is SEQ ID NO: 2.

[0039] In one aspect, the current invention relates to a method of modulating an immune response in a subject comprising administering to the subject an effective amount of the stradobody comprising an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody.

[0040] In one embodiment, the current invention relates to a method of treating an inflammatory or autoimmune disease, an infectious disease, or a cancer in a subject in need thereof comprising administering to the subject an effective amount of a stradobody that comprises an Fab domain, one or more Fc domains, and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody. In a further embodiment, the subject has cancer. In a still further embodiment, the cancer is selected from the group consisting of colorectal cancer, head and neck cancer, fibrosarcoma,

myxosarcoma, liposarcoma, chondrosarcoma, osteogenic sarcoma, chordoma, angiosarcoma, endotheliosarcoma, lymphangiosarcoma, lymphangioendotheliosarcoma, synovioma, mesothelioma, Ewing's tumor, leiomyosarcoma, rhabdomyosarcoma, colon carcinoma, pancreatic cancer, breast cancer, ovarian cancer, prostate cancer, squamous cell carcinoma, basal cell carcinoma, adenocarcinoma, sweat gland carcinoma, sebaceous gland carcinoma, papillary carcinoma, papillary adenocarcinomas, cystadenocarcinoma, medullary carcinoma, bronchogenic carcinoma, renal cell carcinoma, hepatoma, bile duct carcinoma, choriocarcinoma, seminoma, embryonal carcinoma, Wilms' tumor, cervical cancer, testicular tumor, lung carcinoma, small cell lung carcinoma, bladder carcinoma, epithelial carcinoma, glioma, astrocytoma, medulloblastoma, craniopharyngioma, ependymoma, pinealoma, hemangioblastoma, acoustic neuroma, oligodendroglioma, meningioma, melanoma, neuroblastoma, retinoblastoma, leukemia, lymphoma, multiple myeloma, Waldenstrom's macroglobulinemia, myelodysplastic disease, heavy chain disease, neuroendocrine tumors, and Schwanoma.

[0041] In another embodiment, the subject has an autoimmune or inflammatory disease. In a further embodiment, the autoimmune or inflammatory disease is selected from the group consisting of Idiopathic Thrombocytopenic Purpura, alloimmune/autoimmune thrombocytopenia, Acquired immune thrombocytopenia, Autoimmune neutropenia, Autoimmune hemolytic anemia, Parvovirus B19-associated red cell aplasia, Acquired antifactor VIII autoimmunity, acquired von Willebrand disease, Multiple Myeloma and Monoclonal Gammopathy of Unknown Significance, Alzheimer's Disease, Sepsis, Aplastic anemia, pure red cell aplasia, Diamond-Blackfan anemia, hemolytic disease of the newborn, Immune -mediated neutropenia, refractoriness to platelet transfusion, neonatal, post-transfusion purpura, hemolytic uremic syndrome, systemic Vasculitis, Thrombotic thrombocytopenic purpura, Evan's syndrome, Guillain-Barre syndrome, Chronic Inflammatory Demyelinating Polyradiculoneuropathy, Paraproteinemic IgM demyelinating Polyneuropathy, Lambert-Eaton myasthenic syndrome, Myasthenia gravis, Multifocal Motor Neuropathy, Lower Motor Neuron Syndrome associated with anti-/GMl, Demyelination, Multiple Sclerosis, optic neuritis, Stiff Man Syndrome, Paraneoplastic cerebellar degeneration with anti-Yo antibodies, paraneoplastic encephalomyelitis, sensory neuropathy with anti-Hu antibodies, epilepsy, Encephalitis, Myelitis,

Myelopathy especially associated with Human T-cell lymphotropic virus- 1, Autoimmune Diabetic Neuropathy, Acute Idiopathic Dysautonomic Neuropathy, Kawasaki's disease, Rheumatoid arthritis, Felty's syndrome, ANCA-positive Vasculitis, Spontaneous Polymyositis, Dermatomyositis, Antiphospholipid syndromes, Recurrent spontaneous abortions, Systemic Lupus Erythematosus, Juvenile idiopathic arthritis, Raynaud's, CREST syndrome, Uveitis, Toxic Epidermal Necrolysis, Gangrene, Granuloma, Autoimmune skin blistering diseases including Pemphigus vulgaris, Bullous Pemphigoid, and Pemphigus foliaceus, Vitiligo, Streptococcal toxic shock syndrome, Scleroderma, systemic sclerosis including diffuse and limited cutaneous systemic sclerosis, Atopic dermatitis (especially steroid dependent), Inclusion Body Myositis, Necrotizing fasciitis, Inflammatory Myopathies, Myositis, Anti-Decorin (BJ antigen) Myopathy, Paraneoplastic Necrotic Myopathy, X-linked Vacuolated Myopathy, Penacillamine-induced Polymyositis, Atherosclerosis, Coronary Artery Disease, Cardiomyopathy, pernicious anemia, autoimmune chronic active hepatitis, primary biliary cirrhosis, Celiac disease, dermatitis herpetiformis, cryptogenic cirrhosis, Reactive arthritis, Crohn's disease, Whipple's disease, ulcerative colitis, sclerosing cholangitis, Graft Versus Host Disease, Antibody -mediated rejection of the graft, Post-bone marrow transplant rejection, Post-infectious disease inflammation, Lymphoma, Leukemia, Neoplasia, Asthma, Type 1 Diabetes mellitus with anti-beta cell antibodies, Sjogren's syndrome, Mixed Connective Tissue Disease, Addison's disease, Vogt-Koyanagi-Harada Syndrome, Membranoproliferative glomerulonephritis, Goodpasture's syndrome, Graves' disease, Hashimoto's thyroiditis, Wegener's granulomatosis, micropolyarterits, Churg-Strauss syndrome, Polyarteritis nodosa, and Multisystem organ failure.

[0042] The present invention further comprises methods and compositions effective for the treatment of infectious disease, including but not limited to those caused by bacterial, mycological, parasitic, and viral agents. Examples of such infectious agents include the following: staphylococcus, streptococcaceae, neisseriaaceae, cocci, enterobacteriaceae, pseudomonadaceae, vibrionaceae, campylobacter, pasteurellaceae, bordetella, francisella, brucella, legionellaceae, bacteroidaceae, clostridium, corynebacterium, propionibacterium, gram-positive bacilli, anthrax, actinomyces, nocardia, mycobacterium, treponema, borrelia, leptospira, mycoplasma, ureaplasma, rickettsia, chlamydiae, other gram-positive bacilli, other gram-

negative bacilli, systemic mycoses, other opportunistic mycoses, protozoa, nematodes, trematodes, cestodes, adenoviruses, herpesviruses (including, for example, herpes simplex virus and Epstein Barr virus, and herpes zoster virus), poxviruses, papovaviruses, hepatitis viruses, papilloma viruses, orthomyxoviruses (including, for example, influenza A, influenza B, and influenza C), paramyxoviruses, coronaviruses, picornaviruses, reoviruses, togaviruses, flaviviruses, bunyaviridae, rhabdoviruses, respiratory syncitial virus, human immunodeficiency virus and retroviruses. Exemplary infectious diseases include but are not limited to candidiasis, candidemia, aspergillosis, streptococcal pneumonia, streptococcal skin and oropharyngeal conditions, gram negative sepsis, tuberculosis, mononucleosis, influenza, respiratory illness caused by Respiratory Syncytial Virus, malaria, schistosomiasis, and trypanosomiasis.

[0043] In a further embodiment the stradobody is administered intravenously, subcutaneously, orally, nasally, intraperitoneally, sublingually, bucally, transdermally, by subcutaneous or subdermal implantation, intraduodenally, or intramuscularly. In one embodiment, the stradobody is administered intravenously. Because of the enhanced efficacy of the stradobodies of the current invention, in some embodiments the stradobodies may be administered at a lower dose intravenously compared with monoclonal antibodies specific for the same antigen. In one embodiment, the stradobody is administered intravenously at a dose of about 0.01 mg/Kg to about 1000 mg/Kg IV. In a further embodiment, the stradobody is administered at about 0.1 mg/Kg to about 100 mg/Kg IV. In yet a further embodiment, the stradobody is administered at about 0.5 mg/Kg to about 50 mg/Kg IV. In still a further embodiment, the stradobody is administered at about 1 mg/Kg to about 25 mg/Kg IV. In still a further embodiment, the stradobody is administered at about 5 mg/Kg to about 15 mg/Kg IV. In one embodiment, the stradobody is administered subcutaneously. Because of the enhanced efficacy of the stradobodies of the current invention, in some embodiments the stradobody may be administered at a lower dose subcutaneously compared with monoclonal antibodies specific for the same antigen. In one embodiment, the stradobody is administered subcutaneously at a dose of about 0.01 mg/Kg to about 1000 mg/Kg SQ. In a further embodiment, the stradobody is administered at about 0.2 mg/Kg to about 150 mg/Kg SQ. In yet a further embodiment, the stradobody is administered at about 0.5 mg/Kg to about 80 mg/Kg SQ. In still a further

embodiment, the stradobody is administered at about 2 mg/Kg to about 50 mg/Kg SQ. In still a further embodiment, the stradobody is administered at about 5 mg/Kg to about 30 mg/Kg SQ. In still a further embodiment, the stradobody is administered before, concurrently, or after a monoclonal antibody. In still a further embodiment, the stradobody administered before, concurrently, or after a monoclonal antibody has an Fab directed against the same antigen as the monoclonal antibody. In still a further embodiment, the stradobody administered before, concurrently, or after a monoclonal antibody has an Fab directed against a different antigen from the monoclonal antibody.

[0044] In a further embodiment, the stradobody is administered before, during or after administration of one or more additional pharmaceutical and/or therapeutic agents. In a further embodiment the additional pharmaceutically active agent comprises a steroid; a biologic anti-autoimmune drug such as a monoclonal antibody, a fusion protein, or an anti-cytokine; a non-biologic anti-autoimmune drug; an immunosuppressant; an antibiotic; and anti-viral agent; a cytokine; or an agent otherwise capable of acting as an immune-modulator. In still a further embodiment, the steroid is prednisone, prednisolone, cortisone, dexamethasone, mometesone testosterone, estrogen, oxandrolone, fluticasone, budesonide, beclamethasone, albuterol, or levalbuterol. In still a further embodiment, the stradobody is administered before, during or after administration of a chemotherapeutic agent. In still a further embodiment, the stradobody and the additional therapeutic agent display therapeutic synergy when administered together. In one embodiment, the stradobody is administered prior to the administration of the additional therapeutic agent. In another embodiment, the stradobody is administered at the same time as the administration of the additional therapeutic agent. In still another embodiment, the stradobody is administered after the administration with the additional therapeutic agent. In one embodiment, the stradobody is administered prior to the administration of a danger signal. In another embodiment, the stradobody is administered at the same time as the administration of a danger signal. In still another embodiment, the stradobody is administered after the administration of a danger signal.

[0045] In another embodiment, the stradobody is administered to treat humans, non-human primates (e.g., monkeys, baboons, and chimpanzees), mice, rats, bovines, horses, cats,

dogs, pigs, rabbits, goats, deer, sheep, ferrets, gerbils, guinea pigs, hamsters, bats, birds (e.g., chickens, turkeys, and ducks), fish and reptiles with species-specific or chimeric stradobody molecules. In yet another embodiment, the human is an adult or a child. In still another embodiment, the stradobody is administered to prevent autoimmune disease. In a further embodiment the stradobody is administered to prevent vaccine-associated autoimmune conditions in companion animals and livestock.

[0046] In one embodiment, the current invention relates to a stradobody wherein the stradobody displays enhanced cell killing compared to a monoclonal antibody specific for the same antigen. In one embodiment, the enhanced cell killing is mediated by ADCC. In a further embodiment, the stradobody displays ADCC that is at least 2 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays ADCC that is at least 5 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays ADCC that is at least 10 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays ADCC that is at least 20 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the enhanced cell killing is mediated by CDC. In a further embodiment, the stradobody displays CDC that is at least 2 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays CDC that is at least 5 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays CDC that is at least 10 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays CDC that is at least 20 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the enhanced cell killing is mediated by DC. In a further embodiment, the stradobody displays DC that is at least 2 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays DC that is at least 5 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays DC that is at least 10 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody

displays DC that is at least 20 times higher compared to a monoclonal antibody specific for the same antigen.

[0047] In one embodiment, the stradobody contains two or more multimerization domains, and displays enhanced cell killing compared to a stradobody containing one multimerization domain. In one embodiment, the cell killing is mediated by ADCC. In a further embodiment, stradobody with two or more multimerization domains displays ADCC that is at least 2 times higher compared to a stradobody containing one multimerization domain. In another embodiment, stradobody with two or more multimerization domains displays ADCC that is at least 5 times higher compared to a stradobody containing one multimerization domain. In another embodiment, stradobody with two or more multimerization domains displays ADCC that is at least 10 times higher compared to a stradobody containing one multimerization domain. In another embodiment, stradobody with two or more multimerization domains displays ADCC that is at least 20 times higher compared to a stradobody containing one multimerization domain. In another embodiment, the enhanced cell killing is mediated by CDC. In a further embodiment, stradobody with two or more multimerization domains displays CDC that is at least 2 times higher compared to a stradobody containing one multimerization domain. In another embodiment, stradobody with two or more multimerization domains displays CDC that is at least 5 times higher compared to a stradobody containing one multimerization domain. In another embodiment, stradobody with two or more multimerization domains displays CDC that is at least 10 times higher compared to a stradobody containing one multimerization domain. In another embodiment, stradobody with two or more multimerization domains displays CDC that is at least 20 times higher compared to a stradobody containing one multimerization domain. In another embodiment, the enhanced cell killing is mediated by DC. In a further embodiment, stradobody with two or more multimerization domains displays DC that is at least 2 times higher compared to a stradobody containing one multimerization domain. In another embodiment, stradobody with two or more multimerization domains displays DC that is at least 5 times higher compared to a stradobody containing one multimerization domain. In another embodiment, stradobody with two or more multimerization domains displays DC that is at least 10 times higher compared to a stradobody containing one multimerization domain. In another embodiment, stradobody

with two or more multimerization domains displays DC that is at least 20 times higher compared to a stradobody containing one multimerization domain.

[0048] In another embodiment, the current invention relates to a stradobody wherein the stradobody displays enhanced inhibition of cellular proliferation compared to a monoclonal antibody specific for the same antigen. In one embodiment, the stradobody inhibits cellular proliferation by at least 10% more compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody inhibits cellular proliferation by at least 20% more compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody inhibits cellular proliferation by at least 50% more compared to a monoclonal antibody specific for the same antigen. In another embodiment, the current invention relates to a stradobody that contains two or more multimerization domains, and displays enhanced inhibition of cellular proliferation compared to a stradobody containing one multimerization domain. In one embodiment, the stradobody inhibits cellular proliferation by at least 10% more compared to a stradobody containing one multimerization domain. In another embodiment, the stradobody inhibits cellular proliferation by at least 20% more compared to a stradobody containing one multimerization domain. In another embodiment, the stradobody inhibits cellular proliferation by at least 50% more compared to a stradobody containing one multimerization domain.

[0049] In one embodiment, the current invention relates to a stradobody wherein the stradobody displays enhanced complement binding compared to a monoclonal antibody specific for the same antigen. In a further embodiment, the stradobody displays enhanced complement binding compared to a monoclonal antibody specific for the same antigen. In one embodiment, the enhanced complement binding is binding to Clq. In one embodiment, the stradobody displays enhanced complement binding that is at least 2 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays enhanced complement binding that is at least 5 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays enhanced complement binding that is at least 10 times higher compared to a monoclonal antibody specific for the same antigen. In another embodiment, the stradobody displays enhanced complement binding that is at least 20 times higher compared to a monoclonal antibody specific for the same antigen. In one

embodiment, the enhanced complement binding is measured by the EC50 value. In one embodiment, the EC50 value for complement binding is at least 5 times lower for the stradobody compared to the monoclonal antibody specific for the same antigen. In another embodiment, the EC50 value for complement binding is at least 10 times lower for the stradobody compared to the monoclonal antibody specific for the same antigen. In a further embodiment, the EC50 value for complement binding is at least 20 times lower for the stradobody compared to the monoclonal antibody specific for the same antigen. In one embodiment, a multimerizing stradobody demonstrates increased complement binding relative to a non-multimerizing stradobody specific for the same antigen. In another embodiment, a multimerizing stradobody demonstrates a lower EC50 value for complement binding relative to a non-multimerizing stradobody specific for the same antigen. In a further embodiment, the EC50 value for the multimerizing stradobody is at least 2 times lower for the multimerizing stradobody compared to the non-multimerizing stradobody. In a further embodiment, the EC50 value for the multimerizing stradobody is at least 5 times lower for the multimerizing stradobody compared to the non-multimerizing stradobody.

[0050] In one embodiment, the level of complement binding exhibited by a stradobody varies depending on the Fab. Thus, in one embodiment, two stradobodies having the identical multimerizing domains and identical Fc regions but different Fab exhibit a different level of complement binding. In one embodiment, a multimerizing stradobody having an anti-CD20 Fab exhibits dramatically higher complement binding compared to a multimerizing stradobody having the identical multimerizing domains and identical Fc regions as the anti-CD20 Fab, but having an anti-TNF or an anti-HER2/neu Fab.

[0051] In one embodiment, the current invention relates to compositions comprising multimerized stradobodies. In a further embodiment, the composition comprises at least 2, at least 3, at least 4, at least 5, at least 6, at least 7, at least 8, at least 9, at least 10, or more stradobodies.

BRIEF DESCRIPTION OF THE FIGURES

[0052] Figure 1 is a schematic depiction of multimerized serial and multimerized C-terminal stradobodies and the building blocks that make up stradobodies.

[0053] Figure 2 is a schematic depiction of general structures of serial stradobodies.

[0054] Figure 3 is a schematic depiction of the structures of several serial stradobodies illustrating constructs with one or more of the indicated multimerization or linkage domains.

[0055] Figure 4 is an illustration of serial stradobody constructs.

[0056] Figure 5 is a schematic depiction of the structures of several multimerized C-terminal stradobodies illustrating constructs with one or more of the indicated multimerization domains.

[0057] Figure 6 is an illustration of multimerized C-terminal stradobody constructs.

[0058] Figure 7 is a schematic depiction of the structure of a preferred stradobody of the current invention, comprising two IgG1 Fc domains separated by an isoleucine zipper and an IgG2 hinge.

[0059] Figure 8 is a non-reducing SDS-PAGE gel showing the formation of multimers of the indicated C-terminal multimerized stradobodies, in comparison to the unaltered antibody GB2500.

[0060] Figure 9 is a non-reducing SDS-PAGE gel showing the formation of multimers of the indicated serial stradobodies, in comparison to the unaltered antibody GB2500.

[0061] Figure 10 shows the ADCC of the indicated stradobodies in comparison to the unaltered HER2/neu antibody GB2500, as measured by percent killing of target cells at a range of effector to target cell ratios.

[0062] Figure 11 shows the ADCC dose response of the indicated stradobodies in comparison to the unaltered HER2/neu antibody GB2500, as measured by percent killing of target cells at a range of stradobody concentrations.

[0063] Figure 12 shows representative plasmon resonance (Biacore) data indicating binding to and dissociation from FcγRIIIa for each indicated stradobody or unaltered antibody GB2500.

[0064] Figure 13 shows the FcγRIIIa binding data for all of the tested stradobodies or unaltered antibody GB2500.

[0065] Figure 14 depicts the correlation between Biacore binding (RU) and ADCC activity of the indicated stradobodies. ADCC activity is presented as mean of fold difference relative to GB2500 for each stradobody.

[0066] Figure 15 shows the results of the purification of a stradobody construct by ion exchange chromatography on a Mono Q column. Lane SB is the unfractionated stradobody; peaks 1, 2, and 3 on the elution chromatogram (right panel) were analyzed by non-denaturing gel (left panel).

[0067] Figure 16 shows a non-reducing (top panel) and a reducing (bottom panel) SDS-PAGE gel showing the formation of multimers of the indicated serial stradobodies, in comparison to the unaltered antibody GB2500.

[0068] Figure 17 shows the binding of the parent antibody GB2500 or the indicated serial stradobody to FcγRIIIa. GB2500 (grown in HEK or CHO cells) was tested at concentrations ranging from 3333 – 208 nM. Serial stradobodies GB2524, GB2538, GB2540, GB2542, GB2554, and GB2555 were tested at concentrations ranging from 200 – 12.5 nM.

[0069] Figure 18 is a schematic diagram of the experimental flow chart for studies involving human PBMC-SCID (hu-PBMC SCID) mice treated with tradobodies or their corresponding monoclonal antibodies.

[0070] Figure 19 shows the serum levels of human IgM over time in hu-PMBC SCID mice treated with PBS, GB4500, GB4563, or GB4542.

[0071] Figure 20 shows the number of human B cells in the peripheral blood over time in hu-PBMC SCID mice treated with PBS, GB4500, GB4563, or GB4542.

[0072] Figure 21 shows the number of human B cells in the spleens of hu-PBMC SCID mice treated with PBS, GB4500, GB4563, or GB4542.

[0073] Figure 22 shows the percent inhibition of cell proliferation mediated by GB4500 or GB4542 at the indicated concentrations of antibody or stradobody, in μg/mL. Statistical significance of GB4500 versus GB4542 was calculated using T-test; * $p<0.05$, ** $P<0.005$.

[0074] Figure 23 shows the percent inhibition of cell proliferation mediated by GB4500 or GB4542 at the indicated pmol/mL of antibody or stradobody.

[0075] Figure 24 shows the percent complement-dependent cytoxicity mediated by GB4500, GB4596, or GB4542 at the indicated concentration of antibody or stradobody, in µg/mL.

[0076] Figure 25 shows the percent complement-dependent cytoxicity mediated by GB4500 or GB4542 at the indicated pmol/mL of antibody or stradobody.

[0077] Figure 26 shows the mean tumor volume over time following intratumoral injection of PBS, GB4500, or GB4542, with or without CpG, in a mouse Raji-SCID lymphoma model.

[0078] Figure 27 shows the median tumor volume over time following intratumoral injection of PBS, GB4500, or GB4542, with or without CpG, in a mouse Raji-SCID lymphoma model.

[0079] Figure 28 shows complement Clq binding with antibody GB2500, stradobody GB2542, antibody GB7500, stradobody GB7542, antibody GB4500, and stradobody GB4542, as measured by absorbance (450nm) at the indicated stradobody or antibody concentration.

[0080] Figure 29 shows the EC50 values for binding to complement Clq for antibody GB2500, stradobody GB2542, antibody GB7500, stradobody GB7542, antibody GB4500, and stradobody GB4542.

[0081] Figure 30 shows complement Clq binding with antibody GB2500, and stradobodies GB2542, GB2554, and GB2555. GB2542 is a multimerizing stradobody, and GB2554 and GB2555 are linear stradobodies that do not contain any multimerization domains.

[0082] Figure 31 shows the EC50 values for binding to complement Clq for antibody GB2500, multimerizing stradobody GB2542, and non-multimerizing stradobodies GB2554 and GB2555.

DETAILED DESCRIPTION OF THE INVENTION

[0083] The approach to rational molecular design for antigen-binding compounds with FcR binding capacity described herein includes recombinant and/or biochemical creation of immunologically active biomimetic(s) which are surprisingly more efficient at inducing cytotoxicity including antibody-mediated cell cytoxicity, complement-dependent cell cytoxicity,

direct cell cytoxicity, and other mechanisms of cellular toxicity compared to mAbs with specificity for the same antigen. The compounds have utility for treating, for example, cancer, autoimmune and inflammatory diseases, and infectious diseases. Each embodiment is described in detail below along with specific exemplary embodiments.

[0084] As used herein, the use of the word "a" or "an" when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one."

[0085] As used herein, the terms "biomimetic", "biomimetic molecule", "biomimetic compound", and related terms, refer to a human made compound that imitates the function of another compound, such as pooled human Intravenous Immunoglobulin ("hIVIG"), a monoclonal antibody or the Fc or Fab fragment of an antibody. "Biologically active" biomimetics are compounds which possess biological activities that are the same as or similar to their naturally occurring counterparts. By "naturally occurring" is meant a molecule or portion thereof that is normally found in an organism. By naturally occurring is also meant substantially naturally occurring. "Immunologically active" biomimetics are biomimetics which exhibit immunological activity the same as or similar to naturally occurring immunologically active molecules, such as antibodies, cytokines, interleukins and other immunological molecules known in the art. In preferred embodiments, the biomimetics of the present invention are stradobodies, as defined herein.

[0086] By "homologous" is meant identity over the entire sequence of a given nucleic acid or amino acid sequence. For example, by "80% homologous" is meant that a given sequence shares about 80% identity with the claimed sequence and can include insertions, deletions, substitutions, and frame shifts. One of ordinary skill in the art will understand that sequence alignments can be done to take into account insertions and deletions to determine identity over the entire length of a sequence.

[0087] The immunologically active biomimetics of the present invention are capable of binding to one or more antigens. In some embodiments, the immunologically active biomimetics of the present invention are capable of binding to two different antigens, similar to bispecific antibodies. In other embodiments, the immunologically active biomimetics of the present

invention are capable of binding to more than two different antigens. The biomimetics of the present invention also possess one or more immune modulating activities of the IgG Fc domain and have at least a first Fc domain capable of binding FcRn, DC-SIGN, SIGN-R1 and/or an FcγR including FcγRI, FcγRII, FcγRIII and FcγRIV. In some embodiments, the biomimetics of the present invention possess a second Fc domain capable of binding FcRn, DC-SIGN, SIGN-R1 and/or an FcγR including FcγRI, FcγRII, FcγRIII and FcγRIV. Thus, when multimerized, the immunologically active biomimetics contain at least two dimeric structures, each possessing the ability to bind to one or more antigens, and the ability to bind to one or more of FcRn, DC-SIGN, SIGN-R1 and/or and FCγR.

[0088] The following paragraphs define the building blocks of the biomimetics of the present invention, both structurally and functionally, and then define the biomimetics themselves. However, it is first helpful to note that, as indicated above, each of the biomimetics of the present invention has at least two Fc domains, and at least one Fab domain. At a minimum, an Fc domain is a dimeric polypeptide (or a dimeric region of a larger polypeptide) that comprises two peptide chains or arms (monomers) that associate to form a functional Fcγ receptor binding site. Therefore, the functional form of the individual Fc fragments and Fc domains discussed herein generally exist in a dimeric (or multimeric) form. The monomers of the individual fragments and domains discussed herein are the single chains or arms that must associate with a second chain or arm to form a functional dimeric structure.

Fc regions and Fab regions

[0089] "Fc fragment" is a term of art that is used to describe the protein region or protein folded structure that is routinely found at the carboxy terminus of immunoglobulins. The Fc fragment consists of the carboxy terminal portions of the antibody heavy chains. Each of the chains in an Fc fragment is between about 220-265 amino acids in length and the chains are often linked via a disulfide bond. The Fc fragment often contains one or more independent structural folds or functional subdomains. In particular, the Fc fragment encompasses an Fc domain, defined herein as the minimum structure that binds an Fcγ receptor. An isolated Fc

fragment is comprised of two Fc fragment monomers (e.g., the two carboxy terminal portions of the antibody heavy chains; further defined herein) that are dimerized. When two Fc fragment monomers associate, the resulting Fc fragment has Fcγ receptor binding activity.

[0090] "Fab fragment" is a term of art that is used to describe the protein region or protein folded structure that contains the antigen binding domain of an antibody. Fab fragments are comprised of both a heavy chain and a light chain, and are between about 200 – 250 amino acids in length. In some embodiments, the Fab fragment is comprised of the variable region and the CH1 region of the parent antibody. The Fab fragment can be isolated from the Fc fragment of a monoclonal antibody through the use of enzymatic digestion, for example papain digestion, which is an incomplete and imperfect process (see Mihaesco C and Seligmann M. Papain Digestion Fragments Of Human IgM Globulins. Journal of Experimental Medicine, Vol 127, 431- 453 (1968)). The Fab fragment and the Fc fragment together constitutes the holo-antibody, meaning here the complete antibody.

[0091] An "Fc partial fragment" is a domain comprising less than the entire Fc fragment of an antibody, yet which retains sufficient structure to have the same activity as the Fc fragment, including Fcγ receptor binding activity. An Fc partial fragment may therefore lack part or all of a hinge region, part or all of a CH2 domain, part or all of a CH3 domain, and/or part or all of a CH4 domain, depending on the isotype of the antibody from which the Fc partial domain is derived. An example of a Fc partial fragment includes a molecule comprising the upper, core and lower hinge regions plus the CH2 domain of IgG3 (Tan, LK, Shopes, RJ, Oi, VT and Morrison, SL, Influence of the hinge region on complement activation, CIq binding, and segmental flexibility in chimeric human immunoglobulins, Proc Natl Acad Sci USA. 1990 January; 87(1): 162-166). Thus, in this example the Fc partial fragment lacks the CH3 domain present in the Fc fragment of IgG3. Another example of an Fc partial fragment includes a molecule comprising the CH2 and CH3 domains of IgG1. In this example, the Fc partial fragment lacks the hinge domain present in IgG1. Fc partial fragments are comprised of two Fc partial fragment monomers. As further defined herein, when two such Fc partial fragment monomers associate, the resulting Fc partial fragment has Fcγ receptor binding activity.

[0092] The term "Fab domain" describes the minimum region (in the context of a larger polypeptide) or smallest protein folded structure (in the context of an isolated protein) that can bind to an antigen. The Fab domain is the minimum binding region of an Fab fragment that allows binding of the molecule to an antigen. "Fab domain" is used interchangeably herein with "Fab".

[0093] As used herein, "Fc domain" describes the minimum region (in the context of a larger polypeptide) or smallest protein folded structure (in the context of an isolated protein) that can bind to or be bound by an Fc receptor (FcR). In both an Fc fragment and an Fc partial fragment, the Fc domain is the minimum binding region that allows binding of the molecule to an Fc receptor. While an Fc domain can be limited to a discrete homodimeric polypeptide that is bound by an Fc receptor, it will also be clear that an Fc domain can be a part or all of an Fc fragment, as well as part or all of an Fc partial fragment. When the term "Fc domains" is used in this invention it will be recognized by a skilled artisan as meaning more than one Fc domain. An Fc domain is comprised of two Fc domain monomers. As further defined herein, when two such Fc domain monomers associate, the resulting Fc domain has Fc receptor binding activity. Thus an Fc domain is a dimeric structure that can bind an Fc receptor.

[0094] As used herein, "Fc partial domain" describes a portion of an Fc domain. Fc partial domains include the individual heavy chain constant region domains (e.g., CHl, CH2, CH3 and CH4 domains) and hinge regions of the different immunoglobulin classes and subclasses. Thus, human Fc partial domains of the present invention include the CHl domains of IgGl, IgG2, IgG3, IgG4, IgM, IgAl, IgA2, IgD and IgE, the CH2 domains of IgGl, IgG2, IgG3, IgG4, IgM, IgAl, IgA2, IgD and IgE, the CH3 domains of IgGl, IgG2, IgG3, IgG4, IgM, IgAl, IgA2, IgD and IgE, the CH4 domains of IgM and IgE, and the hinge regions of IgGl, IgG2, IgG3, IgG4, IgM, IgAl, IgA2, IgD and IgE. The corresponding Fc partial domains in other species will depend on the immunoglobulins present in that species and the naming thereof. In one preferred embodiment, the Fc partial domains of the current invention comprise CH1, CH2, and hinge domains of IgG1. In another preferred embodiment, the Fc partial domains of the current invention comprise CH1, CH2 and hinge domains of IgG1 and the hinge domain of IgG2. The Fc partial domain of the present invention may further comprise a combination of

more than one of these domains and hinges. However, the individual Fc partial domains of the present invention and combinations thereof lack the ability to bind an FcγR. Therefore, the Fc partial domains and combinations thereof comprise less than an Fc domain. Fc partial domains may be linked together to form a peptide that has Fcγ receptor binding activity, thus forming an Fc domain. In the present invention, Fc partial domains are used with Fc domains as the building blocks to create the biomimetics of the present invention, as defined herein. Each Fc partial domain is comprised of two Fc partial domain monomers. When two such Fc partial domain monomers associate, an Fc partial domain is formed.

[0095] As indicated above, each of Fc fragments, Fc partial fragments, Fc domains and Fc partial domains are dimeric proteins or domains. Thus, each of these molecules is comprised of two monomers that associate to form the dimeric protein or domain. While the characteristics and activity of the homodimeric forms was discussed above the monomeric peptides are discussed as follows.

[0096] As used herein, an "Fc fragment monomer" is a single chain protein that, when associated with another Fc fragment monomer, comprises an Fc fragment. The Fc fragment monomer is thus the carboxy terminal portion of one of the antibody heavy chains that make up the Fc fragment of a holo-antibody (e.g., the contiguous portion of the heavy chain that includes the hinge region, CH2 domain and CH3 domain of IgG). In one embodiment, the Fc fragment monomer comprises, at a minimum, one chain of a hinge region (a hinge monomer), one chain of a CH2 domain (a CH2 domain monomer) and one chain of a CH3 domain (a CH3 domain monomer), contiguously linked to form a peptide. In another embodiment, the Fc fragment monomer comprises at least one chain of a hinge region, one chain of a CH2 domain, one chain of a CH3 domain, and one chain of a CH4 domain (a CH4 domain monomer) contiguously linked to form a peptide. In one embodiment, the CH2, CH3 and hinge domains are from different isotypes. In a particular embodiment, the Fc fragment monomer contains an IgG2 hinge domain and IgG1 CH2 and CH3 domains.

[0097] As used herein, "Fc domain monomer" describes the single chain protein that, when associated with another Fc domain monomer, comprises an Fc domain that can bind to an

Fcγ receptor. The association of two Fc domain monomers creates one Fc domain. An Fc domain monomer alone, comprising only one side of an Fc domain, cannot bind an Fcγ receptor.

[0098] As used herein, "Fc partial domain monomer" describes the single chain protein that, when associated with another Fc partial domain monomer, comprises an Fc partial domain. The association of two Fc partial domain monomers creates one Fc partial domain.

Stradomers

[0099] The stradobodies of the present invention are comprised of stradomers, and an Fab domain. In one embodiment, the stradobodies of the present invention are comprised of multimerizing stradomers and an Fab domain. Stradomers are biomimetic compounds capable of binding two or more Fc receptors, preferably two or more Fcγ receptors, and more preferably demonstrating significantly improved binding relative to an Fc domain and most preferably demonstrating slow dissociation characteristic of avidity. In one embodiment, the stradobodies of the present invention are used to bind FcRn, DC-SIGN, SIGN-R1 and/or Fcγ receptors on effector cells such as NK cells and monocyte-derived cells such as immature dendritic cells and macrophages. In another embodiment, the stradobodies of the present invention are used to bind FcγRIIb receptors on B cells. In one embodiment, the Fcγ receptors are low affinity Fcγ receptors such as FcγIIIa. The physical stradomer conformations have been previously described in U.S. Patent Application Publication No. 2010/0239633, and PCT Publication No. WO 2012/016073, both of which are incorporated by reference herein in their entireties.

[00100] A "serial stradomer" is a dimeric polypeptide comprised of two linear stradomer monomers that, when associated, form two or more Fc domains capable of binding two or more Fcγ receptors. Serial stradomers preferably have 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, or more Fc domains, as well as Fc partial domains. The Fc domains and/or Fc partial domains may be linked by domain linkages, as further defined herein.

[00101] As will be evident, the Fc fragments, Fc partial fragments, Fc domains and Fc partial domains discussed above are used in the construction of the various stradomer conformations. It is the individual Fc domain monomers and Fc partial domain monomers, also

discussed above, that self-associate to form the dimeric structures that are the stradomers that comprise the stradobodies described herein. Further, the stradomers are associated with an Fab domain to form the stradobodies of the present invention.

[00102] As used herein, the term "stradomer monomer" or "stradomer unit" refers to a single, contiguous peptide molecule that, when associated with at least a second stradomer monomer, forms a polypeptide comprising at least two Fc domains. Stradomer monomers may be associated to form stradomers by inter-stradomer monomer linkages or they may form stradomers through self-assembly via covalent and non-covalent bonds.

[00103] A stradomer monomer may have an amino acid sequence that will form one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen or more Fc domains when associated with another stradomer monomer to form a stradomer. A stradomer monomer may further have an amino acid sequence that will form one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen or more Fc partial domains when associated with another stradomer monomer to form a stradomer.

[00104] The regions of stradomer monomers that will form Fc domains and Fc partial domains in the context of a stradomer may simply be arranged from carboxy terminal to amino terminal of successive regions of the stradomer monomer molecule. The arrangement of the particular Fc domain monomers and Fc partial domain monomers permits formation of two functional Fc domains upon association of two stradomer monomers.

[00105] An Fc domain can be functionally defined by its ability to bind FcRn, DC-SIGN, SIGN-R1 and/or an Fcγ receptor. The compounds of the current invention bind to cognate canonical Fc receptors including FcγRIIIa, FcγRIIb and/or SIGN-R1 with higher affinity and / or much higher avidity than human IgG1 Fc control. Alternatively, the compounds of the current invention bind preferentially to the neonatal receptor FcRn over the Fc canonical receptors as a result of a point mutation at position 297 of the IgG1 Fc. As a result, the particular amino acid sequence of an Fc domain will vary based on the Fc partial domains that comprise the Fc domain. However, in one embodiment of the present invention the Fc domain comprises the hinge region and a CH2 domain of an immunoglobulin molecule. In a further preferred

embodiment the Fc domain comprises the hinge region, a CH2 domain and CH3 domain of an immunoglobulin molecule. In a further embodiment, the Fc domain comprises the hinge region, a CH2 domain, CH3 domain and CH4 domain of an immunoglobulin molecule. In yet another embodiment, the Fc domain comprises the hinge region, a CH2 domain and CH4 domain of an immunoglobulin molecule. In a further preferred embodiment, the Fc domain comprises a CH2 domain and CH3 domain. In a preferred embodiment, the Fc domain contains the hinge, CH2 and CH3 domain of IgG1 (SEQ ID NO:2). In another preferred embodiment, the Fc domain contains the CH2 and CH3 domains of IgG1 (SEQ ID NO: 19).

Domain Linkage

[00106] As indicated above, a "domain linkage" is a peptide linkage between Fc domain monomers and/or Fc partial domain monomers that comprise each of the individual stradomer monomers of the stradobodies of the present invention. The domain linkage may be 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, or more amino acids. A domain linkage does not occur between Fc partial domain monomers that are in their natural sequence. That is, where linked naturally contiguous portions of Fc domain monomers are used, such as the hinge region, CH2 domain and CH3 domain of IgG, these Fc partial domain monomers comprise a contiguous sequence and no domain linkage between these elements is required. In contrast, for example, when two or more Fc domain monomers or partial Fc domain monomers are linked in a manner that is not naturally occurring to form an individual stradomer monomer, domain linkages may be used. An example would be the linkage between two hinge/CH2/CH3 peptides, creating an individual stradomer monomer of a stradomer comprising: hinge/CH2/CH3/L/hinge/CH2/CH3, where "L" is the domain linkage. In the various cases described, the domain linkage may be one of the naturally occurring portions of the heavy chain that joins the hinge and CH domains in the Fc domain monomer of an antibody. Alternatively, the domain linkage may be any other amino acid sequence that provides needed spacing and flexibility between the Fc domain monomers and partial Fc domain monomers of an individual stradomer monomer and that allows the individual stradomer monomers to pair with each other to form the stradomers making up the stradobodies of the present invention. An exemplary

domain linkage is a GS linker sequence. The GS linker sequence may comprise 1, 2, 3, 4, or more repeats of GGGGS. Preferably, a GS linker sequence comprises 3 (G3S) or 4 (G4S) repeats of GGGGS.

[00107] In some embodiments, each immunologically active biomimetic compound will preferably contain at least one domain linkage in each stradomer monomer of the stradobody which will function to maintain the Fc domains of the immunologically active biomimetic within a restricted spatial region and which will facilitate FcγR activation activity, for example, by aggregating FcγRs through co-binding to the Fc domains within the immunologically active biomimetic. Preferably, the domain linkages will allow the same or a greater degree of conformational variability as is provided by the hinge domain of IgG molecules. All of the above linkages are well-known in the art.

Inter-Stradomer Monomer Linkage

[00108] A separate linkage found in the biomimetic compounds of the present invention is the "inter-stradomer monomer linkage" that occurs between two or more individual stradomer monomers that comprise the stradobodies of the present invention. While the domain linkages are short amino acid sequences that serve to link the Fc domain monomers and partial Fc domain monomers that comprise individual stradomer monomers of the biomimetic compounds to each other, the inter-stradomer monomer linkages serve to join two or more individual stradomer monomers that comprise the biomimetic compounds. The inter-stradomer monomer linkage may be any linkage capable of stably associating the individual stradomer monomers. In some embodiments, the inter-stradomer monomer linkage may be a covalent link between the stradomer monomers. Alternatively, the inter-stradomer monomer linkage between stradomer monomers may be by direct chemical cross-linking. In preferred embodiments, the stradomer monomer structures take advantage of the natural self-assembly properties between Fc domain monomers to create self-assembling stradomers comprising the stradobodies of the present invention. The skilled artisan will understand that the inter-stradomer monomer linkages permits two or more individual stradobody monomers to form the biomimetic compounds of the

stradobody comprising the present multimerizing stradobody invention and that the resulting compounds have the ability to cross-link more than one FcγR.

[00109] As discussed above, in a preferred embodiment, the inter-stradomer monomer linkage that forms a stradomer is a linkage that results from self-assembly of stradomer monomers. In one embodiment, the two stradomer monomers that comprise the stradomer are identical peptides, such that the two individual stradomer monomers that comprise the stradomer are identical in sequence. However, the skilled artisan will understand that other embodiments include stradomers where the stradomer monomers differ from each other in amino acid sequence.

[00110] Two stradomer monomers can form a stradomer by, for example, aligning in parallel such that pairing takes place between identical Fc partial domain monomers in the stradomer monomers. However, the present invention also includes embodiments where pairing occurs between non-identical Fc partial domain monomers, and embodiments where pairing occurs between identical Fc partial domain monomers in the stradomer monomers but where the alignment of the two stradomer monomers is offset.

Multimerization domains

[00111] The multimerization domain may comprise a peptide sequence that causes dimeric proteins to further multimerize. "Multimerization," as used herein, refers to the linking or binding together of multiple (i.e., two or more) individual stradobody homodimers. For example, stradobodies are multimerized when at least one stradobody homodimer (i.e., at least one homodimeric polypeptide comprising one or more Fc domains and one or more Fab domains) is attached to at least one other stradobody homodimer via a multimerization domain. Examples of peptide multimerization domains include IgG2 hinge, isoleucine zipper, collagen Glycine-Proline-Proline repeat ("GPP") and zinc fingers. The influence of glycosylation on peptide multimerization is well described in the art (e.g., Role of Carbohydrate in Multimeric Structure of Factor VIII/V on Willebrand Factor Protein. Harvey R. Gralnick, Sybil B. Williams and Margaret E. Rick. Proceedings of the National Academy of Sciences of the United States of America, Vol. 80, No. 9, [Part 1 : Biological Sciences] (May 1, 1983), pp. 2771-2774;

Multimerization and collagen binding of vitronectin is modulated by its glycosylation. Kimie Asanuma, Fumio Arisaka and Haruko Ogawa. International Congress Series Volume 1223, December 2001, Pages 97-101).

[00112] In one preferred embodiment, the multimerization domain is an IgG2 hinge. As is known in the art, the hinge region of human IgG2 can form covalent dimers (Yoo, E.M. et al. J. Immunol. 170, 3134-3138 (2003); Salfeld Nature Biotech. 25, 1369-1372 (2007)). The dimer formation of IgG2 is potentially mediated through the IgG2 hinge structure by C-C bonds (Yoo et al 2003), suggesting that the hinge structure alone can mediate dimer formation. The amount of IgG2 dimers found in human serum, however, is limited. There is no quantitative evidence of the multimerization of IgG2 beyond the dimer of the homodimer. (Yoo et al. 2003). That is, native IgG2 has not been found to form higher order multimers in human serum.

[00113] The amino acid sequence of the human IgG2 hinge monomer is as follows: ERKCCVECPPCP (SEQ ID NO: 3). Mutation of any one of the 4 cysteines in SEQ ID NO: 3 may be associated with greatly diminished multimerization of the stradobody. There are two C-X-X-C portions of the IgG2 hinge monomer. Thus, stradobodies of the present invention may comprise either the complete 12 amino acid sequence of the IgG2 hinge monomer, or either or both of the four amino acid cores, along with Fc domain monomers. While the X-X of the core structures can be any amino acid, in a preferred embodiment the X-X sequence is V-E or P-P. The skilled artisan will understand that the IgG2 hinge monomer may be comprised of any portion of the hinge sequence in addition to the core four amino acid structure, including all of the IgG2 hinge sequence and some or all of the IgG2 CH2 and CH3 domain monomer sequences. Without being bound by theory, the IgG2 hinge multimerization domain of one stradobody homodimer may form multimers by interacting with any portion of another stradobody homodimer. That is, the IgG2 hinge of one stradobody homodimer may multimerize by binding the IgG2 hinge of another stradobody homodimer, thereby forming a dimer of the homodimer, or higher order multimers while retaining increased functional binding to Fc receptors relative to natural IgG1 Fc. Alternatively, the IgG2 hinge domain of one stradobody homodimer may bind the IgG1 hinge of another stradobody homodimer, thereby forming a dimer of the homodimer, or higher order multimers while retaining increased functional binding to Fc

receptors relative to natural IgG1 Fc. It is also possible that the IgG2 hinge domain of one stradobody homodimer binds to another portion of the IgG1 Fc domain, i.e. the CH2 or CH3 domain of another stradobody homodimer to form the dimer of the homodimer, or higher order multimers while retaining increased functional binding to Fc receptors relative to natural IgG1 Fc.

[00114] In another preferred embodiment, leucine zippers may be used as multimerization domains. In another preferred embodiment, isoleucine zippers may be used as multimerization domains. Leucine and isoleucine zippers (coiled-coil domains) are known to facilitate formation of protein dimers, trimers and tetramers (Harbury et al. Science 262:1401-1407 (1993); O'Shea et al. Science 243:538 (1989)).

[00115] While the skilled artisan will understand that different types of leucine and isoleucine zippers may be used, in one embodiment the isoleucine zipper from the GCN4 transcriptional regulator modified as described (Morris et al., MoI. Immunol. 44:3112-3121 (2007); Harbury et al. Science 262:1401-1407 (1993)) is used: GGGSIKQIEDKIEEILSKIYHIENEIARIKKLIGERGHGGG (SEQ ID NO: 5). In another embodiment, the sequence of the isoleucine zipper used is: GGGSIKQIEDKIEEILSKIYHIENEIARIKKLIGERGHDI (SEQ ID NOs: 32). These isoleucine zipper sequences are only two of several possible sequences that can be used for multimerization of Fc domain monomers. While the entire sequence shown in SEQ ID NOs: 5 or 32 may be used, the underlined portion of the sequence represents the core sequence of the isoleucine zipper that may be used in the stradobodies of the present invention. Thus, stradomer monomers comprising the stradobodies of the present invention may comprise either the complete amino acid sequence of the isoleucine zipper, or the 28 amino acid core, along with one or more Fc domain monomers. The skilled artisan will also understand that the isoleucine zipper may be comprised of any portion of the zipper in addition to the core 28 amino acid structure, and thus may be comprised of more than 28 amino acids but less than the entire sequence of SEQ ID NOs: 5 or 32.

[00116] In another preferred embodiment, GPP repeats may be used as multimerization domains. GPP is an amino acid sequence found in human collagen that causes

collagen protein: protein binding. While the skilled artisan will understand that different types of GPP repeats may be used as a Multimerization Domain, in a preferred embodiment the Glycine - Proline-Proline repeats as described (Fan et al FASEB Journal 3796 vol 22 2008) is used: (SEQ ID NO:26) This Glycine-Proline-Proline repeat sequence is only one of several possible sequences that can be used for multimerization of stradobodies. While the entire sequence shown in SEQ ID NO:26 may be used, repeats of different length may also possible be used to multimerize Fc domain monomers. Likewise, repeats containing different amino acids within the GPP repeats may also be substituted.

Stradobody

[00117] The present invention is directed to stradobodies and methods of making and using stradobodies. As used herein, "stradobody" refers to a molecule comprising two or more Fc domains, to which one or more Fab domains is attached. Thus, by virtue of such Fab domains and Fc domains, stradobodies have both antigen binding capacity and Fcγ receptor binding activity. In some embodiments, the Fcγ receptor activity may be due to an ability to bind and cross-link FcγR equal to or greater than the Fc portion of a native structure holo-antibody. The Fab portion of the stradobody may comprise both a heavy and a light chain. The variable heavy chain and the light chain may be independently from any compatible immunoglobulin such as IgA1, IgA2, IgM, IgD, IgE, IgG1, IgG2, IgG3, or IgG4, and may be from the same or different Ig isotype, but preferably are from the same Ig isotype. The light chains kappa or lambda may also be from different Ig isotypes. In some embodiments, stradobodies, like stradomers, can bind two or more FcγRs and modulate immune function. In one embodiment, the stradobodies of the current invention comprise a Fab domain, one or more Fc domains, and one or more multimerization domains, wherein at least one of the one or more multimerization domains separates two or more Fc domains, or is located at the carboxy end of the Fc region. The term "Fc region" is used herein to refer to the region of the stradobody that comprises Fc domains, domain linkages, and multimerization domains. Thus, the Fc region is the region of the stradobody that does not comprise the Fab domain. Multimerization domains are described above and are amino acid sequences known to cause protein multimerization in the proteins

where they naturally occur. In one embodiment, the multimerization domains may be IgG hinges, isoleucine zippers, or a combination thereof. In a particular embodiment, the stradobody is comprised of an Fab, a first Fc domain, an isoleucine zipper, an IgG2 hinge, and a second Fc domain. The Fab comprises both a heavy chain and a light chain as found in native immunoglobulin structures.

[00118] The stradobodies of the current invention may be classified as either serial stradobodies or C-terminal stradobodies. The general structures of these stradobodies are shown in Figure 1. The serial and C-terminal stradobodies of the current invention preferably comprise an Fab domain; one or more Fc domains; and one or more multimerization domains. For example, the serial and C-terminal stradobodies of the invention preferably comprise an Fab domain; 1, 2, 3, 4, or 5 Fc domains; and 1, 2, 3, 4, or 5 multimerization domains. In some embodiments, the serial and C-terminal stradobodies of the current invention further comprise one or more spacers or flexible linkers. Serial stradobodies preferably comprise 2 or more Fc domains. For example, serial stradobodies preferably comprise 2, 3, 4, 5, or 6 Fc domains.

[00119] Serial stradobodies were designed to simultaneously bind and cross-link multiple low-affinity FcγRs by incorporating two or more Fc domains in a chimeric heavy chain. The Fc domains are separated by one or more different or the same multimerization domains, spacers, and/or flexible linkers. Serial stradobodies may be either multimerizing serial stradobodies or non-multimerizing serial stradobodies. Multimerizing serial stradobodies comprise at least one multimerization domain are associated with the formation of multimers. Multimerization domains are described above and include IgG2 hinges, isoleucine zippers, collagen GPP, and zinc fingers. Non-multimerizing serial stradobodies may not comprise a multimerization domain, but may comprise one or more domain linkage, such as a G4S linker. In some embodiments, a multimerizing serial stradobody comprises both one or more multimerization domains and one or more domain linkages. General structures of serial stradobodies are shown in Figure 2. More specific structures of exemplary serial stradobody constructs comprising one or more of the indicated multimerization domains and/or linker domains (ILZ refers to isoleucine zipper; 2H refers to IgG2 hinge; and G_4S refers to an amino acid sequence Gly_4Ser) are shown in Figure 3. Serial stradobody constructs that comprise an Fab

region specific for EGFR are shown below in Table 1. Serial stradobody constructs that comprise an Fab region specific for HER2/neu or an Fab region specific for CD20 are shown in Figure 4 and below in Table 1.

[00120] C-terminal multimerized stradobodies were designed to simultaneously bind and cross-link multiple low-affinity FcγRs by incorporating one or more multimerization domains at the C-terminal end of the Fc region and thereby promote formation of stradobody complexes able to interact with multiple Fc receptors simultaneously. Exemplary structures of C-terminal stradobodies are shown in Figure 5. C-terminal multimerized stradobodies that comprise an anti-EGFR Fab are shown in Figure 6 and below in Table 1. C-terminal multimerized stradobody constructs that comprise an anti-CD20 Fab are also shown in Figure 6 and below in Table 1. In the C-terminal stradobodies, the Fc region of the heavy chain has one or more different or the same multimerization domains, spacers, or flexible linkers on the C-terminal side. The C-terminal stradobodies shown also include a construct that contains a multimerization domain and a purification tag.

Table 1. Unaltered monoclonal antibody and stradobody constructs

Construct	Specificity
Monoclonal antibodies	
GB2500 (Trastuzumab)	HER2/neu
GB3500 (Cetuximab)	EGFR
GB4500 (Rituximab)	CD20
GB7500 (Adalimumab)	TNF
Multimerizing serial stradobodies	
GB2524	HER2/neu
GB2538	HER2/neu

Construct	Specificity
GB2540	HER2/neu
GB2542	HER2/neu
GB3524	EGFR
GB3538	EGFR
GB3540	EGFR
GB3542	EGFR
GB4524	CD20
GB4538	CD20
GB4540	CD20
GB4542	CD20
GB7524	TNF
GB7538	TNF
GB7540	TNF
GB7542	TNF
Non-multimerizing serial stradobodies	
GB2554	HER2/neu
GB2555	HER2/neu
GB3554	EGFR
GB3555	EGFR
GB4554	CD20
GB4555	CD20
GB7554	TNF
GB7555	TNF
C-terminal multimerized stradobodies	
GB2534	HER2/neu
GB2545	HER2/neu

Construct	Specificity
GB2546	HER2/neu
GB2547	HER2/neu
GB2549	HER2/neu
GB2550	HER2/neu
GB2560	HER2/neu
GB2561	HER2/neu
GB2562	HER2/neu
GB2563	HER2/neu
GB2589	HER2/neu
GB2590	HER2/neu
GB3534	EGFR
GB3545	EGFR
GB3546	EGFR
GB3547	EGFR
GB3549	EGFR
GB3550	EGFR
GB3560	EGFR
GB3561	EGFR
GB3562	EGFR
GB3563	EGFR
GB3589	EGFR
GB3590	EGFR
GB4534	CD20
GB4545	CD20
GB4546	CD20
GB4547	CD20

Construct	Specificity
GB4549	CD20
GB4550	CD20
GB4560	CD20
GB4561	CD20
GB4562	CD20
GB4563	CD20
GB4589	CD20
GB4590	CD20
GB7534	TNF
GB7545	TNF
GB7546	TNF
GB7547	TNF
GB7549	TNF
GB7550	TNF
GB7560	TNF
GB7561	TNF
GB7562	TNF
GB7563	TNF
GB7589	TNF
GB7590	TNF

[00121] The skilled artisan will recognize that the specific stradobodies described above are exemplary, and that serial stradobodies with various structures and combinations of stradomers and stradomer building blocks are possible, for example, serial multimerized C-terminal stradobodies comprising one or more multimerization domain and two or more Fc domains. Serial multimerized C-terminal stradobodies may comprise one or more

multimerization domains between two Fc domains and one or more multimerization domains at the C-terminal end of the Fc region.

[00122] Stradobodies will possess the antigen binding properties of the Fab portion and the above described stradomer properties. Such a combination will serve to bind, cross-link, and activate Fcγ receptors on effector cells at a higher rate than can be accomplished by an Fc backbone of a holo-antibody, particularly in the environment of low epitope expression (e.g. the 90% of breast cancer patients whose tumors are not classified as HER2/neu high expressors), inducing ADCC, CDC, and/or DC in a higher percentage of patients. As indicated above, one or more antigen-binding Fab domains can be added to the stradomers to form stradobodies.

[00123] We surprisingly found that stradobodies with one or more multimerization domains between two Fc domains (e.g. GB2542, GB3542, GB4542, and GB7542 corresponding to SEQ ID Nos 35, 33, 37 and 66, respectively), or located at the carboxy end of the Fc region (e.g. GB2547, GB3547, GB4547, and GB7547, corresponding to SEQ ID Nos 91, 70, 76 and 87, respectively), exhibited not only superior multimerization, but also superior binding and superior cytoxicity in comparison both to the parent mAb and to stradobodies without multimerization domains or with one or more multimerization domain located at the N-terminal end of the Fc region, including in ADCC, CDC, DC, and other mechanisms of cytoxicity. In particular, a stradobody comprising both an isoleucine zipper and an IgG2 hinge yielded particularly strong ADCC, CDC, and DC and particularly strong c1q binding. Unexpectedly, when these two multimerization domains were located between two Fc domains, multimerization, binding to FcγR, and ADCC, CDC, and DC results as well as c1q binding were particularly robust.

[00124] We surprisingly found that the presence of an Fab can dramatically alter the ability of the resulting stradobody to multimerize relative to the isolated stradomer that comprises the stradobody. More specifically, stradomers with N-terminal multimerization domains can multimerize well and function well but a stradobody comprised of the same stradomer, as disclosed in WO 2008/151088, may multimerize poorly or not at all. Conversely, it is possible for serial stradobodies with one or more multimerization domains or stradobodies with one or more C-terminal multimerization domains to multimerize better than the stradomer that comprises such stradobody.

[00125] In some embodiments, the stradobody of the invention further comprises a danger signal or damage signal. In some embodiments, the stradobody of the invention is administered to patients concurrently with, or in the same treatment cycle as, a danger signal or damage signal. Pradeu and Cooper (Front Immunol.3: Article 287, 1-9 (2012) have recently reviewed such danger signals or damage signals. In one embodiment, danger signals or damage signals that may be comprised within or administered with the stradobody of the invention include endogenous signals including CD40-L, TNF-α, IL-1β, IFNα, Intracellular nucleotides ATP or UTP, Long unmethylated CpG sequences, Heat Shock Proteins, reactive oxygen intermediates, Vasoactive Intestinal Peptide, metalloproteinase-9, degradation products of heparan sulfate, small breakdown products of hyaluronan, LDL-derived phospholipids, or LOX-1. In another embodiment, danger signals or damage signals that may be comprised within or administered with the stradobody of the invention include uric acid, high-mobility-group box 1, an inflammasome (a multiprotein complex that contains a pattern recognition receptor), IL-1 α; S100 proteins; hepatoma-derived growth factor, IL-1 α; high concentrations of adenosine 5′-triphosphatase, β-D-glucopyranosylceramide, IL-33, nanoparticles such as gold nanoparticles, or F-actin. In an especially preferred embodiment, the stradobody of the invention comprises a peptide danger signal or damage signal at the carboxy end of the stradobody, including Vasoactive Intestinal Peptide, metalloproteinase-9, Heat Shock Protein, High Mobility group 1, S-100, IL-1a, hepatoma derived growth factor, peptides that share amino acid sequence similarity of at least 70% with these peptides, and peptides that are fragments of these peptides.

[00126] In some embodiments, the stradobody of the invention comprises an Fab that is specific for EGFR. In some embodiments, the EGFR-specific Fab is derived from the monoclonal antibody cetuximab. In some embodiments, the Fab is at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% homologous to SEQ ID NO: 31.

[00127] In some embodiments, the stradobody of the invention comprises an Fab that is specific for HER2/neu. In other embodiments, the stradobody comprises an Fab that is derived from the anti-HER2/neu monoclonal antibody trastuzumab. In some embodiments, the

Fab is at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% homologous to SEQ ID NO 34.

[00128] In some embodiments, the stradobody of the invention comprises an Fab that is specific for CD20. In other embodiments, the stradobody comprises an Fab that is derived from the anti-CD20 monoclonal antibody rituximab. In some embodiments, the Fab is at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% homologous to SEQ ID NO 36.

[00129] In some embodiments, the stradobody of the invention comprises an Fab that is specific for TNF. In other embodiments, the stradobody comprises an Fab that is derived from the anti-TNF monoclonal antibody adalimumab. In some embodiments, the Fab is at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% homologous to SEQ ID NO 67.

[00130] In some embodiments, the stradobody of the invention comprises more than one Fab. In further embodiments, each of the more than one Fab is specific for a different antigen. For example, a stradobody may comprise Fabs specific for EGFR and HER2/neu; CD3 and CD19; CD3 and CD20; CD3 and carcinoembryonic antigen; CD3 and EGFR; and combinations thereof.

[00131] In certain embodiments, stradobodies comprise, from amino to carboxy terminus, an Fab domain, a first IgG1 CH2, a first IgG1 CH3, an isoleucine zipper, an IgG2 hinge, a second IgG1 CH2, and a second IgG1 CH3 (Figure 7).

[00132] In a particular embodiment, the stradobody of the invention comprises a leader amino acid sequence according to SEQ ID NO: 1, an EGFR-specific variable region and CH2 region amino acid sequence according to SEQ ID NO: 31, an IgG1 Fc domain according to SEQ ID NO: 2, an isoleucine zipper according to SEQ ID NO: 32, and an IgG2 hinge according to SEQ ID NO: 3.

[00133] In another embodiment, the amino acid sequence of the whole stradobody is according to SEQ ID NO: 33 (construct GB3542 in Table 2). In one embodiment, the stradobody is at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at

least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% homologous to SEQ ID NO: 33.

[00134] In another embodiment, the amino acid sequence of the whole stradobody is according to SEQ ID NO: 35 (construct GB2542 in Table 2). In one embodiment, the stradobody is at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% homologous to SEQ ID NO: 35.

[00135] In another embodiment, the amino acid sequence of the whole stradobody is according to SEQ ID NO: 37 (construct GB4542 in Table 2). In one embodiment, the stradobody is at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% homologous to SEQ ID NO: 37.

[00136] In another embodiment, the amino acid sequence of the whole stradobody is according to SEQ ID NO: 66 (construct GB7542 in Table 2). In one embodiment, the stradobody is at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% homologous to SEQ ID NO: 66.

Table 2. Amino acid sequences of stradobody constructs GB2542, GB3542, GB4542, and GB7542, and components of constructs GB2542, GB3542 GB4542, and GB7542.

	Sequence
Leader sequence (SEQ ID NO: 1)	METDTLLLWVLLLWVPGSTG
GB2542 Variable and CH1 regions (identical to variable and CH1 regions of trastuzumab/GB2500)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQA PGKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAY LQMNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVT VSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVT VSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQ

(SEQ ID NO: 34)	TYICNVNHKPSNTKVDKKV
GB3542 Variable and CH1 regions (identical to variable and CH1 regions of cetuximab/GB3500) (SEQ ID NO: 31)	QVQLKQSGPGLVQPSQSLSITCTVSGFSLTNYGVHWVRQS PGKGLEWLGVIWSGGNTDYNTPFTSRLSINKDNSKSQVFF KMNSLQSNDTAIYYCARALTYYDYEFAYWGQGTLVTVSA ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVS WNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQT YICNVNHKPSNTKVDKRV
GB4542 Variable and CH1 regions (identical to variable and CH1 regions of rituximab/GB4500) (SEQ ID NO: 36)	QVQLQQPGAELVKPGASVKMSCKASGYTFTSYNMHWVK QTPGRGLEWIGAIYPGNGDTSYNQKFKGKATLTADKSSST AYMQLSSLTSEDSAVYYCARSTYYGGDWYFNVWGAGTT VTVSAASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEP VTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLG TQTYICNVNHKPSNTKVDKKV
GB7542 Variable and CH1 regions (identical to variable and CH1 regions of adalimumab/GB7500) (SEQ ID NO: 67)	EVQLVESGGGLVQPGRSLRLSCAASGFTFDDYAMHWVRQ APGKGLEWVSAITWNSGHIDYADSVEGRFTISRDNAKNSL YLQMNSLRAEDTAVYYCAKVSYLSTASSLDYWGQGTLVT VSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVT VSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQ TYICNVNHKPSNTKVDKKV
IgG1 Fc (SEQ ID NO: 2)	EPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTP EVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQ YNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEK TISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPS DIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKS RWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK
Isoleucine Zipper (SEQ ID NO:32)	GGGSIKQIEDKIEEILSKIYHIENEIARIKKLIGERGHDI
IgG2 Hinge	ERKCCVECPPCP

(SEQ ID NO: 3)	
GB2542 Construct (SEQ ID NO: 35)	METDTLLLWVLLLWVPGSTGEVQLVESGGGLVQPGGSLR LSCAASGFNIKDTYIHWVRQAPGKGLEWVARIYPTNGYTR YADSVKGRFTISADTSKNTAYLQMNSLRAEDTAVYYCSR WGGDGFYAMDYWGQGTLVTVSSASTKGPSVFPLAPSSKS TSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVL QSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKK VEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRT PEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREE QYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIE KTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFY PSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVD KSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGKSLEGG GSIKQIEDKIEEILSKIYHIENEIARIKKLIGERGHDIERKCCV ECPPCPRLEGPRFEEPKSCDKTHTCPPCPAPELLGGPSVFLF PPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGV EVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYK CKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKN QVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSD GSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKS LSLSPGK
GB3542 Construct (SEQ ID NO:33)	METDTLLLWVLLLWVPGSTGQVQLKQSGPGLVQPSQSLSI TCTVSGFSLTNYGVHWVRQSPGKGLEWLGVIWSGGNTDY NTPFTSRLSINKDNSKSQVFFKMNSLQSNDTAIYYCARALT YYDYEFAYWGQGTLVTVSAASTKGPSVFPLAPSSKSTSGG TAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSG LYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKRVEPKS

	CDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTC VVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNST YRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKA KGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAV EWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQ QGNVFSCSVMHEALHNHYTQKSLSLSPGKSLEGGGSIKQI EDKIEEILSKIYHIENEIARIKKLIGERGHDIERKCCVECPPCP RLEGPRFEEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKD TLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAK TKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNK ALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKNQVSLTC LVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLY SKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPG K
GB4542 Construct (SEQ ID NO: 37)	METDTLLLWVLLLWVPGSTGQVQLQQPGAELVKPGASVK MSCKASGYTFTSYNMHWVKQTPGRGLEWIGAIYPGNGDT SYNQKFKGKATLTADKSSSTAYMQLSSLTSEDSAVYYCA RSTYYGGDWYFNVWGAGTTVTVSAASTKGPSVFPLAPSS KSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPA VLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDK KVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMIS RTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPRE EQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPI EKTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGF YPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTV DKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGKSLEG GGSIKQIEDKIEEILSKIYHIENEIARIKKLIGERGHDIERKCC

	VECPPCPRLEGPRFEEPKSCDKTHTCPPCPAPELLGGPSVFL FPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGV EVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYK CKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKN QVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSD GSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKS LSLSPGK
GB7542 Construct (SEQ ID NO: 66)	METDTLLLWVLLLWVPGSTGEVQLVESGGGLVQPGRSLR LSCAASGFTFDDYAMHWVRQAPGKGLEWVSAITWNSGHI DYADSVEGRFTISRDNAKNSLYLQMNSLRAEDTAVYYCA KVSYLSTASSLDYWGQGTLVTVSSASTKGPSVFPLAPSSKS TSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVL QSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKK VEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRT PEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREE QYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIE KTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFY PSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVD KSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGKSLEGG GSIKQIEDKIEEILSKIYHIENEIARIKKLIGERGHDIERKCCV ECPPCPRLEGPRFEEPKSCDKTHTCPPCPAPELLGGPSVFLF PPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGV EVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYK CKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKN QVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSD GSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKS LSLSPGK

[00137] It is understood that the stradobodies disclosed herein can be derived from any of a variety of species. Indeed, Fc domains, or Fc partial domains, in any one biomimetic molecule of the present invention can be derived from immunoglobulin from more than one (e.g., from two, three, four, five, or more) species. However, they will more commonly be derived from a single species. In addition, it will be appreciated that any of the methods disclosed herein (e.g., methods of treatment) can be applied to any species. Generally, the components of a biomimetic applied to a species of interest will all be derived from that species. However, biomimetics in which all the components are of a different species or are from more than one species (including or not including the species to which the relevant method is applied) can also be used.

[00138] The specific CH1, CH2, CH3 and CH4 domains and hinge regions that comprise the Fc domains and Fc partial domains of the stradobodies of the present invention may be independently selected, both in terms of the immunoglobulin subclass, as well as in the organism, from which they are derived. Accordingly, the stradobodies disclosed herein may comprise Fc domains and partial Fc domains that independently come from various immunoglobulin types such as human IgG1, IgG2, IgG3, IgG4, IgA1, IgA1, IgD, IgE, and IgM, mouse IgG2a, or dog IgGa or IgGb. Preferably, for human therapeutics the Fc domains of the current invention are of the human IgG1 isotype. Similarly each Fc domain and partial Fc domain may be derived from various species, preferably a mammalian species, including non-human primates (e.g., monkeys, baboons, and chimpanzees), humans, murine, rattus, bovine, equine, feline, canine, porcine, rabbits, goats, deer, sheep, ferrets, gerbils, guinea pigs, hamsters, bats, birds (e.g., chickens, turkeys, and ducks), fish and reptiles to produce species-specific or chimeric stradobody molecules.

[00139] The Fab may be a chimeric structure comprised of human constant regions and non-human variable regions such as the variable region from a mouse, rat, rabbit, monkey, or goat antibody. One of ordinary skill in the art would be able to make a variety of Fab chimeric structures for incorporation into stradobodies using methodologies currently available and described in the scientific literature for such constructions. Individual Fab domains, Fc domains

and partial Fc domains may also be humanized. Thus, "humanized" stradobodies may be designed analogous to "humanized" monoclonal antibodies.

[00140] One of skill in the art will realize that different Fc domains and partial Fc domains will provide different types of functionalities. For example, FcγRs bind specifically to IgG immunoglobulins and not well other classes of immunoglobulins. Thus, one of skill in the art, intending to design a stradobody with multiple Fcγ receptor binding capacity, would design stradomer Fc domains that at least incorporate the well characterized Fcγ receptor binding sequences of IgG, including those in the lower IgG hinge region and / or the IgG CH2 & CH3 domains. One of ordinary skill in the art will also understand various deleterious consequences can be associated with the use of particular Ig domains, such as the anaphylaxis associated with IgA infusions. The biomimetics disclosed herein should generally be designed to avoid such effects, although in particular circumstances such effects may be desirable.

[00141] The present invention also encompasses stradobodies comprising Fc domains and Fc partial domains having amino acids that differ from the naturally-occurring amino acid sequences of the Fc domain or Fc partial domain. Preferred Fc domains for inclusion in the biomimetic compounds of the present invention have a measurable specific binding affinity to either a holo-Fcγ receptor or a soluble extracellular domain portion of an FcγR. Primary amino acid sequences and X-ray crystallography structures of numerous Fc domains and Fc domain monomers are available in the art. See, e.g., Woof JM, Burton DR. Human antibody-Fc receptor interactions illuminated by crystal structures. Nat Rev Immunol. 2004 Feb;4(2):89-99. Representative Fc domains with Fcγ receptor binding capacity include the Fc domains from human IgG1 (SEQ ID NO: 2). These native sequences have been subjected to extensive structure-function analysis including site directed mutagenesis mapping of functional sequences. Based on these prior structure-function studies and the available crystallography data, one of skill in the art may design functional Fc domain sequence variants while preserving the Fc domain's FcγR receptor binding capacity. For example, cysteine residues may be added to enhance sulfide bonding between monomers or deleted to alter the interaction between stradomer homodimers that comprise the stradobody homodimer.

[00142] In addition, the present invention encompasses stradobodies comprising Fab domains having amino acids that differ from the amino acid sequence of the antibody from which the Fab domain is derived. Fab domains for inclusion in the biomimetic compounds of the present invention have a measurable specific binding affinity to a particular antigen. Preferably, the biomimetic compounds have a binding affinity that is greater than the binding affinity of corresponding unaltered antibodies.

[00143] The amino acid changes may decrease, increase, or leave unaltered the binding affinity of the stradobody to the Fcγ receptor or the antigen. Preferably such amino acid changes will be conservative amino acid substitutions, however, such changes include deletions, additions and other substitutions. Conservative amino acid substitutions typically include changes within the following groups: glycine and alanine; valine, isoleucine, and leucine; aspartic acid and glutamic acid; asparagine, glutamine, serine and threonine; lysine, histidine and arginine; and phenylalanine and tyrosine. Additionally, the amino acid change may enhance multimerization strength, for example by the addition of cysteine residues.

[00144] The amino acid changes may be naturally occurring or may be introduced, for example by site directed mutagenesis. The amino acid changes can occur anywhere within the Fc domain or Fab domain so long as the Fc domain retains its receptor binding function and biological activity, and the Fab domain retains its antigen binding function and biological activity. In a preferred embodiment, the polymorphism or mutation leads to enhanced receptor/antigen binding and/or enhanced multimerization or biological function. For Fc domains, the polymorphism/mutation preferably occurs at one or more of amino acid positions 233-435 according to the EU index as in Kabat et al., Sequences of Proteins of Immunological Interest, 5th Ed. Public Health Service, National Institutes of Health, Bethesda, MD (1991). Specific polymorphisms/mutations in these amino acid positions are well known in the art and can be found, for example in Shields, *et al.* (2001) "High Resolution Mapping of the Binding Site on Human IgG1 for FcγRI, FcγRII, FcγRIII and FcRn and Design of IgG1 Variants with Improved Binding to the FcγR," J. Biol. Chem., 276(9):6591-6601, which is herein incorporated by reference in its entirety.

[00145] From the above, it will be appreciated that stradobodies of the present invention include stradobodies having: (a) only naturally occurring Fab and Fc domains; (b) a mixture of naturally occurring Fab and Fc domains and Fab and Fc domains with altered amino acid sequences; and (c) only Fab and Fc domains with altered amino acid sequences. All that is required is that stradobodies containing altered amino acid sequences have at least 25%; 30%; 40%; 50%; 60%; 70%; 80%; 90%; 95%; 96%; 97%; 98%; 99%; 99.5%; or 100% or even more of the ability of a corresponding stradobody comprising Fab and Fc domains with naturally-occurring sequences to bind to antigen and to FcγR receptors.

[00146] The aforementioned Fcγ receptor and antigen binding sites occurring in the stradobodies of the present invention may be altered in sequence through genetic engineering to predictably derive binding sites with altered binding capabilities and affinities relative to a native sequence. For example, specific residues may be altered that reduce Fc domain binding of the biomimetic compounds to FcγRIIb while increasing binding to FcγRIIIa or vice versa or that reduce Fc domain binding of the biomimetic compounds to FcγRIIb while increasing binding to FcRn or vice versa. An example of an extensive mutagenesis based structure-function analysis for human IgG Fcγ receptor binding sequences is Robert L. Shields, et al. High Resolution Mapping of the Binding Site on Human IgG1 for FcγRI, FcγRII, FcγRIII, and FcRn and Design of IgG1 Variants with Improved Binding to the FcγR. J. Biol. Chem., Feb 2001; 276: 6591 - 6604. Similar studies have been performed on murine IgG Fc (mIgG Fc). Based on the structural and primary sequence homologies of native IgG Fc domains across species, one of skill in the art may translate the extensive structure-function knowledge of human IgG Fc and mouse IgG Fc to rational mutagenesis of all native Fcγ receptor binding site sequences in the biomimetic compounds of the present invention to design binding sites with particular Fcγ receptor specificities and binding affinities.

[00147] In addition to the amino acid sequence composition, the carbohydrate content of the Fc domain is known to play an important role on Fc domain structure and binding interactions with FcγR. See, e.g., Robert L. Shields, et al. Lack of Fucose on Human IgG1 N-Linked Oligosaccharide Improves Binding to Human FcγRIII and Antibody-dependent Cellular

Toxicity. J. Biol. Chem., Jul 2002; 277: 26733 - 26740 (doi:10.1074/jbc.M202069200); Ann Wright and Sherie L. Morrison. Effect of C2- Associated Carbohydrate Structure on Ig Effector Function: Studies with Chimeric Mouse-Human IgGl Antibodies in Glycosylation Mutants of Chinese Hamster Ovary Cells. J. Immunol, Apr 1998; 160: 3393 - 3402. Similarly, the extent of fucosylation of antibodies is known to play a role in antigen binding and ADCC. See, e.g., Yamane-Ohnuki and Satoh, Production of therapeutic antibodies with controlled fucosylation. Mabs. 2009 May-Jun; 1(3):230-236. Carbohydrate content may be controlled using, for example, particular protein expression systems including particular cell lines or in vitro enzymatic modification. In some embodiments, the stradobodies are defucosylated. Defucosylation is known to improve the affinity of IgG1 Fc for FcγRIIIa. Thus, the present invention includes stradobodies with the native carbohydrate content of holo-antibody from which the domains were obtained, as well as those stradobody compounds with an altered carbohydrate content. In another embodiment, a modified cell line is used to generate a preferred glycosylation pattern. In another embodiment, chemoenzymatic glycosylation is used to generate a preferred glycosylation pattern including with non-natural sugars. In another embodiment, multimer components of the stradobody are characterized by a different glycosylation pattern compared with the homodimer component of the same stradobody. In a preferred embodiment, the stradobody is enriched for multimers comprising a glycosylation pattern that enhances Fc receptor binding.

[00148] The addition to the polypeptide chain of an Fc partial domain, a multimerization region, or glycosylation changes may create a conformational change in the Fc domain permitting enhanced binding of the Fc domain to an Fcγ receptor. Thus, seemingly very minor changes to the polypeptide may also create a stradobody capable of enhanced binding of multiple Fcγ receptors or FcRn receptors or a stradobody with decreased ability to bind multiple Fcγ receptors or FcRn receptors.

[00149] The skilled artisan will further recognize that the Fc domains, and Fc partial domains used in the embodiments of the present invention need not be full-length versions. That is, the present invention encompasses the use of Fc domain monomers and Fc

partial domain monomers lacking amino acids from the amino terminus, carboxy terminus or middle of the particular Fc domain monomers and Fc partial domain monomers that comprise the stradobodies of the present invention.

[00150] For example, the binding site on human IgG immunoglobulins for Fcγ receptors has been described (e.g. Radaev, S., Sun, P., 2001. Recognition of Immunoglobulins by Fcγ Receptors. Molecular Immunology 38, 1073 - 1083; Shields, R.L. et. al., 2001. High Resolution Mapping of the Binding Site on Human IgGl for FcγRI, FcγRII, FcγRIII, and FcRn and Design of IgGl Variants with Improved Binding to the FcγR. J. Biol. Chem. 276 (9), 6591-6604). Based on that knowledge, one may remove amino acids from the Fc domain of these immunoglobulins and determine the effects on the binding interaction between the Fc domain and the receptor. Thus, the present invention encompasses IgG Fc domains having at least about 90% of the amino acids encompassing positions 233 through 338 of the lower hinge and CH2 as defined in Radaev, S., Sun, P., 2001.

[00151] Fc partial domains of IgG immunoglobulins of the present invention may include all or part of the hinge region, all or part of the CH2 domain, and all or part of the CH3 domain.

[00152] The IgG Fc partial domains having only a part of the hinge region, part of the CH2 domain or part of the CH3 domain are constructed from Fc partial domain monomers. Thus, the present invention includes IgG hinge region monomers derived from the N-terminus of the hinge region or the C-terminus of the hinge region. They can thus contain, for example, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, or 62 (up to 15 for IgGl, up to 12 for IgG2, up to 62 for IgG3, up to 12 for IgG4) amino acids of the hinge region.

[00153] The present invention also includes IgG CH2 domain monomers derived from the N-terminus of the CH2 domain or the C-terminus of the CH2 domain. They can thus contain, for example, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52,

53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, or 110 (up to 110 for IgGl and IgG3, up to 109 for IgG2 and IgG4) amino acids of the CH2 domain.

[00154] The present invention further includes IgG CH3 domain monomers derived from the N-terminus of the CH3 domain or the C-terminus of the CH3 domain. They can thus contain, for example, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, or 107 (up to 106 for IgGl and IgG3, up to 107 for IgG2 and IgG4) amino acids of the CH3 domain.

[00155] The term "isolated" polypeptide or peptide as used herein refers to a polypeptide or a peptide which either has no naturally-occurring counterpart or has been separated or purified from components which naturally accompany it, e.g., in tissues such as pancreas, liver, spleen, ovary, testis, muscle, joint tissue, neural tissue, gastrointestinal tissue, or breast tissue or tumor tissue (e.g., breast cancer tissue), or body fluids such as blood, serum, or urine. Typically, the polypeptide or peptide is considered "isolated" when it is at least 70%, by dry weight, free from the proteins and other naturally-occurring organic molecules with which it is naturally associated. Preferably, a preparation of a polypeptide (or peptide) of the invention is at least 80%, more preferably at least 90%, and most preferably at least 99%, by dry weight, the polypeptide (peptide), respectively, of the invention. Since a polypeptide or peptide that is chemically synthesized is, by its nature, separated from the components that naturally accompany it, the synthetic polypeptide or peptide is "isolated."

[00156] An isolated polypeptide (or peptide) of the invention can be obtained, for example, by extraction from a natural source (e.g., from tissues or bodily fluids); by expression of a recombinant nucleic acid encoding the polypeptide or peptide; or by chemical synthesis. A polypeptide or peptide that is produced in a cellular system different from the source from which it naturally originates is "isolated," because it will necessarily be free of components which

naturally accompany it. The degree of isolation or purity can be measured by any appropriate method, e.g., column chromatography, polyacrylamide gel electrophoresis, or HPLC analysis.

Pharmaceutical Compositions

[00157] Administration of the stradobody compositions described herein will be via any common route, orally, parenterally, or topically. Exemplary routes include, but are not limited to oral, nasal, buccal, rectal, vaginal, ophthalmic, subcutaneous, intramuscular, intraperitoneal, intravenous, intraarterial, intratumoral, spinal, intrathecal, intra-articular, intra-arterial, sub-arachnoid, sublingual, oral mucosal, bronchial, lymphatic, intra-uterine, subcutaneous, intratumor, integrated on an implantable device such as a suture or in an implantable device such as an implantable polymer, intradural, intracortical, or dermal. Such compositions would normally be administered as pharmaceutically acceptable compositions as described herein. In a preferred embodiment the isolated stradobody is administered intravenously or subcutaneously.

[00158] The term "pharmaceutically acceptable carrier" as used herein includes any and all solvents, dispersion media, coatings, antibacterial and antifungal agents, isotonic and absorption delaying agents and the like. The use of such media and agents for pharmaceutically active substances is well known in the art. Except insofar as any conventional media or agent is incompatible with the vectors or cells of the present invention, its use in therapeutic compositions is contemplated. Supplementary active ingredients also can be incorporated into the compositions.

[00159] The stradobody compositions of the present invention may be formulated in a neutral or salt form. Pharmaceutically-acceptable salts include the acid addition salts (formed with the free amino groups of the protein) and which are formed with inorganic acids such as, for example, hydrochloric or phosphoric acids, or such organic acids as acetic, oxalic, tartaric, mandelic, and the like. Salts formed with the free carboxyl groups can also be derived from inorganic bases such as, for example, sodium, potassium, ammonium, calcium, or ferric

hydroxides, and such organic bases as isopropylamine, trimethylamine, histidine, procaine and the like.

[00160] Sterile injectable solutions are prepared by incorporating the stradobody in the required amount in the appropriate solvent with various of the other ingredients enumerated above, as required, followed by filtered sterilization. Generally, dispersions are prepared by incorporating the various sterilized active ingredients into a sterile vehicle which contains the 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 preferred methods of preparation are vacuum-drying and freeze-drying techniques which yield a powder of the active ingredient plus any additional desired ingredient from a previously sterile-filtered solution thereof.

[00161] Further, one embodiment is a stradobody composition suitable for oral administration and is provided in a pharmaceutically acceptable carrier with or without an inert diluent. The carrier should be assimilable or edible and includes liquid, semi-solid, i.e., pastes, or solid carriers. Except insofar as any conventional media, agent, diluent or carrier is detrimental to the recipient or to the therapeutic effectiveness of a stradobody preparation contained therein, its use in an orally administrable a stradobody composition for use in practicing the methods of the present invention is appropriate. Examples of carriers or diluents include fats, oils, water, saline solutions, lipids, liposomes, resins, binders, fillers and the like, or combinations thereof. The term "oral administration" as used herein includes oral, buccal, enteral or intragastric administration.

[00162] In one embodiment, the stradobody composition is combined with the carrier in any convenient and practical manner, i.e., by solution, suspension, emulsification, admixture, encapsulation, microencapsulation, absorption and the like. Such procedures are routine for those skilled in the art.

[00163] In a specific embodiment, the stradobody composition in powder form is combined or mixed thoroughly with a semi-solid or solid carrier. The mixing can be carried out in any convenient manner such as grinding. Stabilizing agents can be also added in the mixing process in order to protect the composition from loss of therapeutic activity through, i.e.,

denaturation in the stomach. Examples of stabilizers for use in an orally administrable composition include buffers, antagonists to the secretion of stomach acids, amino acids such as glycine and lysine, carbohydrates such as dextrose, mannose, galactose, fructose, lactose, sucrose, maltose, sorbitol, mannitol, etc., proteolytic enzyme inhibitors, and the like. More preferably, for an orally administered composition, the stabilizer can also include antagonists to the secretion of stomach acids.

[00164] Further, the stradobody composition for oral administration which is combined with a semi-solid or solid carrier can be further formulated into hard or soft shell gelatin capsules, tablets, or pills. More preferably, gelatin capsules, tablets, or pills are enterically coated. Enteric coatings prevent denaturation of the composition in the stomach or upper bowel where the pH is acidic. See, i.e., U.S. Pat. No. 5,629,001. Upon reaching the small intestines, the basic pH therein dissolves the coating and permits the composition to be released to interact with intestinal cells, e.g., Peyer's patch M cells.

[00165] In another embodiment, the stradobody composition in powder form is combined or mixed thoroughly with materials that create a nanoparticle encapsulating the immunologically active biomimetic or to which the immunologically active biomimetic is attached. Each nanoparticle will have a size of less than or equal to 100 microns. The nanoparticle may have mucoadhesive properties that allow for gastrointestinal absorption of an immunologically active biomimetic that would otherwise not be orally bioavailable.

[00166] In another embodiment, a powdered composition is combined with a liquid carrier such as, i.e., water or a saline solution, with or without a stabilizing agent.

[00167] A specific stradobody formulation that may be used is a solution of immunologically active biomimetic protein in a hypotonic phosphate based buffer that is free of potassium where the composition of the buffer is as follows: 6 mM sodium phosphate monobasic monohydrate, 9 mM sodium phosphate dibasic heptahydrate, 50 mM sodium chloride, pH 7.0.+/- 0.1. The concentration of immunologically active biomimetic protein in a hypotonic buffer may range from 10 microgram/ml to 100 milligram/ml. This formulation may be administered via any route of administration, for example, but not limited to, intravenous administration.

[00168] Further, a stradobody composition for topical administration which is combined with a semi-solid carrier can be further formulated into a cream or gel ointment. A preferred carrier for the formation of a gel ointment is a gel polymer. Preferred polymers that are used to manufacture a gel composition of the present invention include, but are not limited to carbopol, carboxymethyl-cellulose, and pluronic polymers. Specifically, a powdered stradobody composition is combined with an aqueous gel containing an polymerization agent such as Carbopol 980 at strengths between 0.5% and 5% wt/volume for application to the skin for treatment of disease on or beneath the skin. The term "topical administration" as used herein includes application to a dermal, epidermal, subcutaneous or mucosal surface.

[00169] Further, a stradobody composition can be formulated into a polymer for subcutaneous or subdermal implantation. A preferred formulation for the implantable drug-infused polymer is an agent Generally Regarded as Safe and may include, for example, cross-linked dextran (Samantha Hart, Master of Science Thesis, "Elution of Antibiotics from a Novel Cross-Linked Dextran Gel: Quantification" Virginia Polytechnic Institute and State University, June 8, 2009) dextran-tyramine (Jin, et al. (2010) Tissue Eng. Part A. 16(8):2429-40), dextran-polyethylene glycol (Jukes, et al. (2010) Tissue Eng. Part A., 16(2):565-73), or dextran-gluteraldehyde (Brondsted, et al. (1998) J. Controlled Release, 53:7-13). One skilled in the art will know that many similar polymers and hydrogels can be formed incorporating the stradobody fixed within the polymer or hydrogel and controlling the pore size to the desired diameter.

[00170] Upon formulation, solutions are administered in a manner compatible with the dosage formulation and in such amount as is therapeutically effective to result in an improvement or remediation of the symptoms. The formulations are easily administered in a variety of dosage forms such as ingestible solutions, drug release capsules and the like. Some variation in dosage can occur depending on the condition of the subject being treated. The person responsible for administration can, in any event, determine the appropriate dose for the individual subject. Moreover, for human administration, preparations meet sterility, general safety and purity standards as required by FDA Center for Biologics Evaluation and Research standards.

[00171] The route of administration will vary, naturally, with the location and nature of the disease being treated, and may include, for example intradermal, transdermal, subdermal, parenteral, nasal, intravenous, intramuscular, subcutaneous, percutaneous, intratracheal, intraperitoneal, intratumoral, perfusion, lavage, direct injection, and oral administration.

[00172] The term "parenteral administration" as used herein includes any form of administration in which the compound is absorbed into the subject without involving absorption via the intestines. Exemplary parenteral administrations that are used in the present invention include, but are not limited to intramuscular, intravenous, intraperitoneal, intratumoral, intraocular, nasal or intraarticular administration.

[00173] In addition, the stradobody of the current invention may optionally be administered before, during or after another pharmaceutical agent.

[00174] Below are specific examples of various pharmaceutical formulation categories and preferred routes of administration, as indicated, for specific exemplary diseases:

[00175] Buccal or sub-lingual dissolvable tablet: angina, polyarteritis nodosa.

[00176] Intravenous: Idiopathic Thrombocytopenic Purpura, Inclusion Body Myositis, Paraproteinemic IgM demyelinating Polyneuropathy, Necrotizing fasciitis, Pemphigus, Gangrene, Dermatomyositis, Granuloma, Lymphoma, Sepsis, Aplastic anemia, Multisystem organ failure, Multiple Myeloma and Monoclonal Gammopathy of Unknown Significance, Chronic Inflammatory Demyelinating Polyradiculoneuropathy, Inflammatory Myopathies, Thrombotic thrombocytopenic purpura, Myositis, Anemia, Neoplasia, Hemolytic anemia, Encephalitis, Myelitis, Myelopathy especially associated with Human T-cell lymphotropic virus-1, Leukemia, Multiple sclerosis and optic neuritis, Asthma, Epidermal necrolysis, Lambert-Eaton myasthenic syndrome, Myasthenia gravis, Neuropathy, Uveitis, Guillain-Barré syndrome, Graft Versus Host Disease, Stiff Man Syndrome, Paraneoplastic cerebellar degeneration with anti-Yo antibodies, paraneoplastic encephalomyelitis and sensory neuropathy with anti-Hu antibodies, systemic vasculitis, Systemic Lupus Erythematosus, autoimmune diabetic neuropathy, acute idiopathic dysautonomic neuropathy, Vogt-Koyanagi-Harada Syndrome, Multifocal Motor Neuropathy, Lower Motor Neuron Syndrome associated with anti-/GMl, Demyelination,

Membranoproliferative glomerulonephritis, Cardiomyopathy, Kawasaki's disease, Rheumatoid arthritis, and Evan's syndrome IM - ITP, CIDP, MS, Dermatomyositis, Myasthenia Gravis, muscular dystrophy. The term "intravenous administration" as used herein includes all techniques to deliver a compound or composition of the present invention to the systemic circulation via an intravenous injection or infusion.

[00177] Dermal gel, lotion, cream or patch: vitiligo, Herpes zoster, acne, chelitis psoriasis.

[00178] Rectal suppository, gel, or infusion: ulcerative colitis, Crohn's disease, hemorrhoidal inflammation.

[00179] Oral as pill, troche, encapsulated, or with enteric coating: Crohn's disease, celiac sprue, irritable bowel syndrome, inflammatory liver disease, Barrett's esophagus.

[00180] Intra-cortical: epilepsy, Alzheimer's Disease, Multiple sclerosis, Parkinson's Disease, Huntingdon's Disease.

[00181] Intra-abdominal infusion or implant: endometriosis.

[00182] Intra-vaginal gel or suppository: bacterial, trichomonal, or fungal vaginitis.

[00183] Medical devices: coated on coronary artery stent, prosthetic joints.

[00184] The stradobodies described herein may be administered at least once daily, weekly, biweekly or monthly or potentially less frequently. A biphasic dosage regimen may be used wherein the first dosage phase comprises about 0.1% to about 300% of the second dosage phase. Because of the enhanced efficacy of the stradobodies of the current invention, in some embodiments the stradobodies may be administered at a lower dose intravenously compared with monoclonal antibodies specific for the same antigen. The effective stradobody dose is generally from about 1% to about 500% of the effective monoclonal antibody whose Fab is the same as the stradobody, more preferably, about 50% to about 100% of the effective monoclonal antibody dose. The effective monoclonal antibody dose in clinical cancer treatment varies. For the Her-2/neu monoclonal antibody, the dose is generally in the range of about 2 mg/Kg to about 4 mg/Kg administered every 7-21 days. For the EGFR monoclonal antibody the dose is generally in

the range of about 250- 400 mg/square meter which is about 5 mg/Kg - 25 mg/ Kg administered every 7-21 days.

[00185] In one embodiment, the stradobody is administered intravenously at a dose of about 0.01 mg/Kg to about 1000 mg/Kg IV. In a further embodiment, the stradobody is administered at about 0.1 mg/Kg to about 100 mg/Kg IV. In yet a further embodiment, the stradobody is administered at about 0.5 mg/Kg to about 50 mg/Kg IV. In still a further embodiment, the stradobody is administered at about 1 mg/Kg to about 25 mg/Kg IV. In still a further embodiment, the stradobody is administered at about 5 mg/Kg to about 15 mg/Kg IV. In one embodiment, the stradobody is administered subcutaneously. Because of the enhanced efficacy of the stradobodies of the current invention, in some embodiments the stradobody may be administered at a lower dose subcutaneously compared with monoclonal antibodies specific for the same antigen. In one embodiment, the stradobody is administered subcutaneously at a dose of about 0.01 mg/Kg to about 1000 mg/Kg SQ. In a further embodiment, the stradobody is administered at about 0.2 mg/Kg to about 150 mg/Kg SQ. In yet a further embodiment, the stradobody is administered at about 0.5 mg/Kg to about 80 mg/Kg SQ. In still a further embodiment, the stradobody is administered at about 2 mg/Kg to about 50 mg/Kg SQ. In still a further embodiment, the stradobody is administered at about 5 mg/Kg to about 30 mg/Kg SQ.

Therapeutic Applications of Stradobodies

[00186] Based on rational design and in vitro and in vivo validations, the stradobodies of the present invention will serve as important biopharmaceuticals for treating cancer and for modulating immune function in a variety of other contexts such as bioimmunotherapy for autoimmune diseases and inflammatory diseases and infections. Medical conditions suitable for treatment with the immunologically active biomimetics described herein include those cancers or inflammatory disease conditions in which a monoclonal antibody may be used or is already in clinical use.

[00187] In addition, exemplary medical conditions having an inflammatory component that will benefit from treatment with stradobodies include Amyotrophic Lateral Sclerosis, Huntington's Disease, Alzheimer's Disease, Parkinson's Disease, Atherogenesis,

Myocardial Infarction, Stroke, Hepatitis B, Hepatitis C, Human Immunodeficiency Virus associated inflammation, adrenoleukodystrophy, and epileptic disorders especially those believed to be associated with postviral encephalitis including Rasmussen Syndrome, West Syndrome, and Lennox-Gastaut Syndrome.

[00188] The general approach to therapy using the isolated stradobodies described herein is to administer to a subject having a disease or condition, a therapeutically effective amount of the isolated immunologically active biomimetic to effect a treatment. In some embodiments, diseases or conditions may be broadly categorized as inflammatory diseases with an imbalance in cytokine networks, an autoimmune disorder mediated by pathogenic autoantibodies or autoaggressive T cells, or an acute or chronic phase of a chronic relapsing disease or process.

[00189] "Immune modulating activities," "modulating immune response," "modulating the immune system," and "immune modulation" mean altering immune systems by changing the activities, capacities, and relative numbers of one or more immune cells, including maturation of a cell type within its cell type or into other cell types. For example, immune modulation of immature monocytes may lead to greater populations of more mature monocytes, dendritic cells, macrophages, or osteoclasts, all of which are derived from immature monocytes. As another example, immune modulation of memory B cells may lead to selective apoptosis of certain memory B cells with concomitant decreases in production of particular antibodies. As another example, immune modulation of NK cells may lead to enhanced Antibody Dependent Cell Cytotoxicity. As another example, immune modulating activities may lead to increased populations of cells with phenotypes that may otherwise not be expressed at high levels, such as CD8 beta + / CD11c + cells. As another example, immune modulating activities may lead to decreases of proinflammatory cytokines or cytokines that are commonly elevated in autoimmune diseases such as IL-6 and IL-8. As another example, immune modulating activities may lead to activation of NKT cells with subsequent secretion and cleavage of TGF-beta. For example, immune cell receptors may be bound by immunologically active biomimetics and activate intracellular signaling to induce various immune cell changes, referred to separately as "activating immune modulation." Blockading immune cell receptors to prevent receptor

activation is also encompassed within "immune modulation" and may be separately referred to as "inhibitory immune modulation."

[00190] The terms "treating" and "treatment" as used herein refer to administering to a subject a therapeutically effective amount of a stradobody of the present invention so that the subject has an improvement in a disease or condition, or a symptom of the disease or condition. The improvement is any improvement or remediation of the disease or condition, or symptom of the disease or condition. The improvement is an observable or measurable improvement, or may be an improvement in the general feeling of well-being of the subject. Thus, one of skill in the art realizes that a treatment may improve the disease condition, but may not be a complete cure for the disease. Specifically, improvements in subjects may include one or more of: decreased inflammation; decreased inflammatory laboratory markers such as C-reactive protein; decreased autoimmunity as evidenced by one or more of: improvements in autoimmune markers such as autoantibodies or in platelet count, white cell count, or red cell count, decreased rash or purpura, decrease in weakness, numbness, or tingling, increased glucose levels in patients with hyperglycemia, decreased joint pain, inflammation, swelling, or degradation, decrease in cramping and diarrhea frequency and volume, decreased angina, decreased tissue inflammation, or decrease in seizure frequency; decreases in cancer tumor burden, increased time to tumor progression, decreased cancer pain, increased survival or improvements in the quality of life; or delay of progression or improvement of osteoporosis.

[00191] The term "therapeutically effective amount" or “effective amount” as used herein refers to an amount that results in an improvement or remediation of the symptoms of the disease or condition.

[00192] As used herein, "prophylaxis" can mean complete prevention of the symptoms of a disease, a delay in onset of the symptoms of a disease, or a lessening in the severity of subsequently developed disease symptoms.

[00193] The term "subject" is used interchangeably with the term “patient” herein, and is taken to mean any mammalian subject to which stradobodies of the present invention are administered according to the methods described herein. In a specific embodiment, the methods of the present disclosure are employed to treat a human subject. The methods of the present

disclosure may also be employed to treat non-human primates (e.g., monkeys, baboons, and chimpanzees), mice, rats, bovines, horses, cats, dogs, pigs, rabbits, goats, deer, sheep, ferrets, gerbils, guinea pigs, hamsters, bats, birds (e.g., chickens, turkeys, and ducks), fish and reptiles.

[00194] In particular, the stradobodies of the present invention may be used to treat conditions including but not limited to congestive heart failure (CHF), vasculitis, rosacea, acne, eczema, myocarditis and other conditions of the myocardium, systemic lupus erythematosus, diabetes, spondylopathies, synovial fibroblasts, and bone marrow stroma; bone loss; Paget's disease, osteoclastoma; multiple myeloma; breast cancer; disuse osteopenia; malnutrition, periodontal disease, Gaucher's disease, Langerhans' cell histiocytosis, spinal cord injury, acute septic arthritis, osteomalacia, Cushing's syndrome, monoostotic fibrous dysplasia, polyostotic fibrous dysplasia, periodontal reconstruction, and bone fractures; sarcoidosis; osteolytic bone cancers, lung cancer, kidney cancer and rectal cancer; bone metastasis, bone pain management, and humoral malignant hypercalcemia, ankylosing spondylitis and other spondyloarthropathies; transplantation rejection, viral infections, hematologic neoplasias and neoplastic-like conditions for example, Hodgkin's lymphoma; non-Hodgkin's lymphomas (Burkitt's lymphoma, small lymphocytic lymphoma/chronic lymphocytic leukemia, mycosis fungoides, mantle cell lymphoma, follicular lymphoma, diffuse large B-cell lymphoma, marginal zone lymphoma, hairy cell leukemia and lymphoplasmacytic leukemia), tumors of lymphocyte precursor cells, including B-cell acute lymphoblastic leukemia/lymphoma, and T-cell acute lymphoblastic leukemia/lymphoma, thymoma, tumors of the mature T and NK cells, including peripheral T-cell leukemias, adult T-cell leukemia/T-cell lymphomas and large granular lymphocytic leukemia, Langerhans cell histiocytosis, myeloid neoplasias such as acute myelogenous leukemias, including AML with maturation, AML without differentiation, acute promyelocytic leukemia, acute myelomonocytic leukemia, and acute monocytic leukemias, myelodysplastic syndromes, and chronic myeloproliferative disorders, including chronic myelogenous leukemia, tumors of the central nervous system, e.g., brain tumors (glioma, neuroblastoma, astrocytoma, medulloblastoma, ependymoma, and retinoblastoma), solid tumors (nasopharyngeal cancer, basal cell carcinoma, pancreatic cancer, cancer of the bile duct, Kaposi's sarcoma, testicular cancer,

uterine, vaginal or cervical cancers, ovarian cancer, primary liver cancer or endometrial cancer, tumors of the vascular system (angiosarcoma and hemangiopericytoma)) or other cancer.

[00195] The stradobodies of the present invention may be used to treat autoimmune diseases. The term "autoimmune disease" as used herein refers to a varied group of more than 80 diseases and conditions. In all of these diseases and conditions, the underlying problem is that the body's immune system attacks the body itself. Autoimmune diseases affect all major body systems including connective tissue, nerves, muscles, the endocrine system, skin, blood, and the respiratory and gastrointestinal systems. Autoimmune diseases include, for example, systemic lupus erythematosus, rheumatoid arthritis, multiple sclerosis, myasthenia gravis, and type 1 diabetes.

[00196] The disease or condition treatable using the compositions and methods of the present invention may be a hematoimmunological process, including but not limited to Idiopathic Thrombocytopenic Purpura, alloimmune/autoimmune thrombocytopenia, Acquired immune thrombocytopenia, Autoimmune neutropenia, Autoimmune hemolytic anemia, Parvovirus B19-associated red cell aplasia, Acquired antifactor VIII autoimmunity, acquired von Willebrand disease, Multiple Myeloma and Monoclonal Gammopathy of Unknown Significance, Sepsis, Aplastic anemia, pure red cell aplasia, Diamond-Blackfan anemia, hemolytic disease of the newborn, Immune-mediated neutropenia, refractoriness to platelet transfusion, neonatal, post-transfusion purpura, hemolytic uremic syndrome, systemic Vasculitis, Thrombotic thrombocytopenic purpura, or Evan's syndrome.

[00197] The disease or condition may also be a neuroimmunological process, including but not limited to Guillain-Barre syndrome, Chronic Inflammatory Demyelinating Polyradiculoneuropathy, Paraproteinemic IgM demyelinating Polyneuropathy, Lambert-Eaton myasthenic syndrome, Myasthenia gravis, Multifocal Motor Neuropathy, Lower Motor Neuron Syndrome associated with anti-/GMl, Demyelination, Multiple Sclerosis and optic neuritis, Stiff Man Syndrome, Paraneoplastic cerebellar degeneration with anti-Yo antibodies, paraneoplastic encephalomyelitis, sensory neuropathy with anti-Hu antibodies, epilepsy, Encephalitis, Myelitis, Myelopathy especially associated with Human T-cell lymphotropic virus- 1, Autoimmune

Diabetic Neuropathy, Alzheimer's disease, Parkinson's disease, Huntingdon's disease, or Acute Idiopathic Dysautonomic Neuropathy.

[00198] The disease or condition may also be a Rheumatic disease process, including but not limited to Kawasaki's disease, Rheumatoid arthritis, Felty's syndrome, ANCA-positive Vasculitis, Spontaneous Polymyositis, Dermatomyositis, Antiphospholipid syndromes, Recurrent spontaneous abortions, Systemic Lupus Erythematosus, Juvenile idiopathic arthritis, Raynaud's, CREST syndrome, or Uveitis.

[00199] The disease or condition may also be a dermatoimmunological disease process, including but not limited to Toxic Epidermal Necrolysis, Gangrene, Granuloma, Autoimmune skin blistering diseases including Pemphigus vulgaris, Bullous Pemphigoid, Pemphigus foliaceus, Vitiligo, Streptococcal toxic shock syndrome, Scleroderma, systemic sclerosis including diffuse and limited cutaneous systemic sclerosis, or Atopic dermatitis (especially steroid dependent).

[00200] The disease or condition may also be a musculoskeletal immunological disease process, including but not limited to Inclusion Body Myositis, Necrotizing fasciitis, Inflammatory Myopathies, Myositis, Anti-Decorin (BJ antigen) Myopathy, Paraneoplastic Necrotic Myopathy, X-linked Vacuolated Myopathy, Penacillamine-induced Polymyositis, Atherosclerosis, Coronary Artery Disease, or Cardiomyopathy.

[00201] The disease or condition may also be a gastrointestinal immunological disease process, including but not limited to pernicious anemia, autoimmune chronic active hepatitis, primary biliary cirrhosis, Celiac disease, dermatitis herpetiformis, cryptogenic cirrhosis, Reactive arthritis, Crohn's disease, Whipple's disease, ulcerative colitis, or sclerosing cholangitis.

[00202] The disease or condition may also be Graft Versus Host Disease, Antibody-mediated rejection of the graft, Post-bone marrow transplant rejection, Postinfectious disease inflammation, Lymphoma, Leukemia, Neoplasia, Asthma, Type 1 Diabetes mellitus with anti-beta cell antibodies, Sjogren's syndrome, Mixed Connective Tissue Disease, Addison's disease, Vogt-Koyanagi-Harada Syndrome, Membranoproliferative glomerulonephritis,

Goodpasture's syndrome, Graves' disease, Hashimoto's thyroiditis, Wegener's granulomatosis, micropolyarterits, Churg-Strauss syndrome, Polyarteritis nodosa or Multisystem organ failure.

[00203] In addition to having clinical utility for treating immunological disorders, stradobodies have therapeutic use in infectious disease, cancer, and inflammatory disease treatment. The stradobodies may be used essentially following known protocols for any corresponding therapeutic antibody. The stradobodies will generally be designed to enhance the effect demonstrated on an effector cell by a monoclonal antibody, such as ADCC in cancer or decreased monocyte and DC maturation with decreased cytokine release in autoimmune disease, and thereby potentiate the immune response against the cancer relative to that which would occur using, for example, a source monoclonal antibody for the Fab portion of the stradobody.

[00204] Infectious diseases, include, but are not limited to, those caused by bacterial, mycological, parasitic, and viral agents. Examples of such infectious agents include the following: staphylococcus, streptococcaceae, neisseriaaceae, cocci, enterobacteriaceae, pseudomonadaceae, vibrionaceae, campylobacter, pasteurellaceae, bordetella, francisella, brucella, legionellaceae, bacteroidaceae, clostridium, corynebacterium, propionibacterium, gram-positive bacilli, anthrax, actinomyces, nocardia, mycobacterium, treponema, borrelia, leptospira, mycoplasma, ureaplasma, rickettsia, chlamydiae, other gram-positive bacilli, other gram-negative bacilli, systemic mycoses, other opportunistic mycoses, protozoa, nematodes, trematodes, cestodes, adenoviruses, herpesviruses (including, for example, herpes simplex virus and Epstein Barr virus, and herpes zoster virus), poxviruses, papovaviruses, hepatitis viruses, papilloma viruses, orthomyxoviruses (including, for example, influenza A, influenza B, and influenza C), paramyxoviruses, coronaviruses, picornaviruses, reoviruses, togaviruses, flaviviruses, bunyaviridae, rhabdoviruses, respiratory syncitial virus, human immunodeficiency virus and retroviruses. Exemplary infectious diseases include but are not limited to candidiasis, candidemia, aspergillosis, streptococcal pneumonia, streptococcal skin and oropharyngeal conditions, gram negative sepsis, tuberculosis, mononucleosis, influenza, respiratory illness caused by Respiratory Syncytial Virus, malaria, schistosomiasis, and trypanosomiasis.

[00205] "Cancer" herein refers to or describes the physiological condition in mammals that is typically characterized by unregulated cell growth. Examples of cancer include

but are not limited to carcinoma, lymphoma, blastoma, sarcoma (including liposarcoma, osteogenic sarcoma, angiosarcoma, endotheliosarcoma, lymphangiosarcoma, lymphangioendotheliosarcoma, leiomyosarcoma, rhabdomyosarcoma, fibrosarcoma, myxosarcoma, chondrosarcoma,), osteoclastoma, neuroendocrine tumors, mesothelioma, chordoma, synovioma, schwanoma, meningioma, adenocarcinoma, melanoma, and leukemia or lymphoid malignancies. More particular examples of such cancers include squamous cell cancer (e.g. epithelial squamous cell cancer), lung cancer including small- cell lung cancer, non-small cell lung cancer, adenocarcinoma of the lung and squamous carcinoma of the lung, small cell lung carcinoma, cancer of the peritoneum, hepatocellular cancer, gastric or stomach cancer including gastrointestinal cancer, pancreatic cancer, glioblastoma, cervical cancer, ovarian cancer, liver cancer, bladder cancer, hepatoma, breast cancer, colon cancer, rectal cancer, colorectal cancer, endometrial or uterine carcinoma, salivary gland carcinoma, kidney or renal cancer, prostate cancer, vulval cancer, thyroid cancer, hepatic carcinoma, anal carcinoma, penile carcinoma, testicular cancer, esophageal cancer, tumors of the biliary tract, Ewing's tumor, basal cell carcinoma, adenocarcinoma, sweat gland carcinoma, sebaceous gland carcinoma, papillary carcinoma, papillary adenocarcinomas, cystadenocarcinoma, medullary carcinoma, bronchogenic carcinoma, renal cell carcinoma, hepatoma, bile duct carcinoma, choriocarcinoma, seminoma, embryonal carcinoma, Wilms' tumor, testicular tumor, lung carcinoma, bladder carcinoma, epithelial carcinoma, glioma, astrocytoma, medulloblastoma, craniopharyngioma, ependymoma, pinealoma, hemangioblastoma, acoustic neuroma, oligodendroglioma, meningioma, melanoma, neuroblastoma, retinoblastoma, leukemia, lymphoma, multiple myeloma, Waldenstrom's macroglobulinemia, myelodysplastic disease, heavy chain disease, neuroendocrine tumors, Schwanoma, and other carcinomas, head and neck cancer, myeloid neoplasias such as acute myelogenous leukemias, including AML with maturation, AML without differentiation, acute promyelocytic leukemia, acute myelomonocytic leukemia, and acute monocytic leukemias, myelodysplastic syndromes, and chronic myeloproliferative disorders, including chronic myelogenous leukemia, tumors of the central nervous system, e.g., brain tumors (glioma, neuroblastoma, astrocytoma, medulloblastoma, ependymoma, and retinoblastoma), solid tumors (nasopharyngeal cancer, basal cell carcinoma, pancreatic cancer, cancer of the bile duct, Kaposi's

sarcoma, testicular cancer, uterine, vaginal or cervical cancers, ovarian cancer, primary liver cancer or endometrial cancer, tumors of the vascular system (angiosarcoma and hemangiopericytoma), hematologic neoplasias and neoplastic-like conditions for example, Hodgkin's lymphoma; non-Hodgkin's lymphomas (Burkitt's lymphoma, small lymphocytic lymphoma/chronic lymphocytic leukemia, mycosis fungoides, mantle cell lymphoma, follicular lymphoma, diffuse large B-cell lymphoma, marginal zone lymphoma, hairy cell leukemia and lymphoplasmacytic leukemia), tumors of lymphocyte precursor cells, including B-cell acute lymphoblastic leukemia/lymphoma, and T-cell acute lymphoblastic leukemia/lymphoma, thymoma, tumors of the mature T and NK cells, including peripheral T-cell leukemias, adult T-cell leukemia/T-cell lymphomas and large granular lymphocytic leukemia, osteolytic bone cancers, and bone metastasis.

[00206] Antibodies comprise Fab domains from which a stradobody may be designed. Exemplary monoclonal antibodies include but are not limited to 3F8, 8H9, abagovomab, abciximab, adalimumab, adecatumumab, afelimomab, afutuzumab, alacizumab pegol, ALD518, alemtuzumab, altumomab pentetate, amatuximab, anatumomab mafenatox, anrukinzumab (IMA-638), apolizumab, arcitumomab, aselizumab, atinumab, atlizumab (tocilizumab), atorolimumab, bapineuzumab, basiliximab, bavituximab, bectumomab, belimumab, benralizumab, bertilimumab, besilesomab, bevacizumab, biciromab, bivatuzumab mertansine, blinatumomab, blosozumab, brentuximab vedotin, briakinumab, brodalumab, canakinumab, cantuzumab mertansine, cantuzumab ravtansine, capromab pendetide, carlumab, catumaxomab, CC49, cedelizumab, certolizumab pegol, cetuximab, Ch.14.18, citatuzumab bogatox, cixutumumab, clenoliximab, clivatuzumab tetraxetan, conatumumab, crenezumab, CR6261, dacetuzumab, daclizumab, dalotuzumab, daratumumab, denosumab, detumomab, dorlimomab aritox, drozitumab, ecromeximab, eculizumab, edobacomab, edrecolomab, efalizumab, efungumab, elotuzumab, elsilimomab, enavatuzumab, enlimomab pegol, enokizumab, ensituximab, epitumomab cituxetan, epratuzumab, erlizumab, ertumaxomab, etaracizumab, etrolizumab, exbivirumab, fanolesomab, faralimomab, farletuzumab, FBTA05, felvizumab, fezakinumab, ficlatuzumab, figitumumab, flanvotumab, fontolizumab, foralumab, foravirumab, fresolimumab, fulranumab, galiximab, ganitumab, gantenerumab, gavilimomab,

gemtuzumab ozogamicin, gevokizumab, girentuximab, glembatumumab vedotin, golimumab, gomiliximab, GS6624, ibalizumab, ibritumomab tiuxetan, icrucumab, igovomab, imciromab, indatuximab ravtansine, infliximab, intetumumab, inolimomab, inotuzumab ozogamicin, ipilimumab, iratumumab, itolizumab, ixekizumab, keliximab, labetuzumab, lebrikizumab, lemalesomab, lerdelimumab, lexatumumab, libivirumab, lintuzumab, lorvotuzumab mertansine, lucatumumab, lumiliximab, mapatumumab, maslimomab, mavrilimumab, matuzumab, mepolizumab, metelimumab, milatuzumab, minretumomab, mitumomab, mogamulizumab, morolimumab, motavizumab, moxetumomab pasudotox, muromonab-CD3, nacolomab tafenatox, namilumab, naptumomab estafenatox, narnatumab, natalizumab, nebacumab, necitumumab, nerelimomab, nimotuzumab, nofetumomab merpentan, ocrelizumab, odulimomab, ofatumumab, olaratumab, olokizumab, omalizumab, onartuzumab, oportuzumab monatox, oregovomab, otelixizumab, oxelumab, ozoralizumab, pagibaximab, palivizumab, panitumumab, panobacumab, pascolizumab, pateclizumab, pemtumomab, pertuzumab, pexelizumab, pintumomab, ponezumab, priliximab, pritumumab, PRO 140, racotumomab, radretumab, rafivirumab, ramucirumab, ranibizumab, raxibacumab, regavirumab, reslizumab, rilotumumab, rituximab, robatumumab, roledumab, romosozumab, rontalizumab, rovelizumab, ruplizumab, samalizumab, sarilumab, satumomab pendetide, secukinumab, sevirumab, sibrotuzumab, sifalimumab, siltuximab, siplizumab, sirukumab, solanezumab, sonepcizumab, sontuzumab, stamulumab, sulesomab, suvizumab, tabalumab, tacatuzumab tetraxetan, tadocizumab, talizumab, tanezumab, taplitumomab paptox, tefibazumab, telimomab aritox, tenatumomab, teneliximab, teplizumab, teprotumumab, TGN1412, ticilimumab (tremelimumab), tigatuzumab, TNX-650, tocilizumab (=atlizumab), toralizumab, tositumomab, tralokinumab, trastuzumab, TRBS07, tregalizumab, tremelimumab, tucotuzumab celmoleukin, tuvirumab, ublituximab, urelumab, urtoxazumab, ustekinumab, vapaliximab, vatelizumba, vedolizumab, veltuzumab, vepalimomab, vesencumab, visilizumab, volociximab, votumumab, zalutumumab, zanolimumab, ziralimumab, and zolimomab aritox.

[00207] The stradobody of the present invention may be specific for a cytokine. For example, the stradobody of the present invention may be specific for an Interferon (such as, for example, IFNγ, IFNα, or IFNβ), IL-1, IL-2, IL-4, IL-5, IL-6, IL-8, IL-10, IL-12, IL-13, IL-

15, IL-17, or IL-23. In one embodiment, the stradobody of the current invention is specific for a cytokine, and is useful for treatment or prevention of one or more inflammatory diseases or autoimmune diseases. For example, in one embodiment, the stradobody is an anti-IL-2, anti-IL-8, or anti-IL-17 stradobody.

[00208] The term "autoimmune disease" as used herein refers to a varied group of more than 80 chronic illnesses. In all of these diseases, the underlying problem is that the body's immune system attacks the body itself. Autoimmune diseases affect all major body systems including connective tissue, nerves, muscles, the endocrine system, skin, blood, and the respiratory and gastrointestinal systems.

[00209] The autoimmune disease or condition may be a hematoimmunological process, including but not limited to Idiopathic Thrombocytopenic Purpura, alloimmune/autoimmune thrombocytopenia, Acquired immune thrombocytopenia, Autoimmune neutropenia, Autoimmune hemolytic anemia, Parvovirus B19-associated red cell aplasia, Acquired antifactor VIII autoimmunity, acquired von Willebrand disease, Multiple Myeloma and Monoclonal Gammopathy of Unknown Significance, Sepsis, Aplastic anemia, pure red cell aplasia, Diamond-Blackfan anemia, hemolytic disease of the newborn, Immune -mediated neutropenia, refractoriness to platelet transfusion, neonatal, post-transfusion purpura, hemolytic uremic syndrome, systemic Vasculitis, Thrombotic thrombocytopenic purpura, or Evan's syndrome.

[00210] The autoimmune disease or condition may be a neuroimmunological process, including but not limited to Guillain-Barre syndrome, Chronic Inflammatory Demyelinating Polyradiculoneuropathy, Paraproteinemic IgM demyelinating Polyneuropathy, Lambert-Eaton myasthenic syndrome, Myasthenia gravis, Multifocal Motor Neuropathy, Lower Motor Neuron Syndrome associated with anti-/GMl, Demyelination, Multiple Sclerosis and optic neuritis, Stiff Man Syndrome, Paraneoplastic cerebellar degeneration with anti-Yo antibodies, paraneoplastic encephalomyelitis, sensory neuropathy with anti-Hu antibodies, epilepsy, Encephalitis, Myelitis, Myelopathy especially associated with Human T-cell lymphotropic virus-1, Autoimmune Diabetic Neuropathy, or Acute Idiopathic Dysautonomic Neuropathy.

[00211] The autoimmune disease or condition may be a Rheumatic disease process, including but not limited to Kawasaki's disease, Rheumatoid arthritis, Felty's syndrome, ANCA-positive Vasculitis, Spontaneous Polymyositis, Dermatomyositis, Antiphospholipid syndromes, Recurrent spontaneous abortions, Systemic Lupus Erythematosus, Juvenile idiopathic arthritis, Raynaud's, CREST syndrome, or Uveitis.

[00212] The autoimmune disease or condition may be a dermatoimmunological disease process, including but not limited to Toxic Epidermal Necrolysis, Gangrene, Granuloma, Autoimmune skin blistering diseases including Pemphigus vulgaris, Bullous Pemphigoid, and Pemphigus foliaceus, Vitiligo, Streptococcal toxic shock syndrome, Scleroderma, systemic sclerosis including diffuse and limited cutaneous systemic sclerosis, or Atopic dermatitis (especially steroid dependent).

[00213] The autoimmune disease or condition may be a musculoskeletal immunological disease process, including but not limited to Inclusion Body Myositis, Necrotizing fasciitis, Inflammatory Myopathies, Myositis, Anti-Decorin (BJ antigen) Myopathy, Paraneoplastic Necrotic Myopathy, X-linked Vacuolated Myopathy, Penacillamine -induced Polymyositis, Atherosclerosis, Coronary Artery Disease, or Cardiomyopathy.

[00214] The autoimmune disease or condition may be a gastrointestinal immunological disease process, including but not limited to pernicious anemia, autoimmune chronic active hepatitis, primary biliary cirrhosis, Celiac disease, dermatitis herpetiformis, cryptogenic cirrhosis, Reactive arthritis, Crohn's disease, Whipple's disease, ulcerative colitis, or sclerosing cholangitis.

[00215] The autoimmune disease or condition may be Graft Versus Host Disease, Antibody -mediated rejection of the graft, Post-bone marrow transplant rejection, Post-infectious disease inflammation, Lymphoma, Leukemia, Neoplasia, Asthma, Type 1 Diabetes mellitus with anti-beta cell antibodies, Sjogren's syndrome, Mixed Connective Tissue Disease, Addison's disease, Vogt-Koyanagi-Harada Syndrome, Membranoproliferative glomerulonephritis, Goodpasture's syndrome, Graves' disease, Hashimoto's thyroiditis, Wegener's granulomatosis, micropolyarterits, Churg-Strauss syndrome, Polyarteritis nodosa or Multisystem organ failure.

[00216] In another embodiment, the stradobodies herein described could be utilized in a priming system wherein blood is drawn from a patient and transiently contacted with the stradobodies for a period of time from about one half hour to about three hours prior to being introduced back into the patient. In this form of cell therapy, the patient's own effector cells are exposed to stradobodies that are fixed on a matrix ex vivo in order to modulate the effector cells through exposure of the effector cells to the stradobodies. The blood including the modulated effector cells are then infused back into the patient. Such a priming system could have numerous clinical and therapeutic applications.

[00217] The stradobodies disclosed herein may also be readily applied to alter immune system responses in a variety of contexts to affect specific changes in immune response profiles. Altering or modulating an immune response in a subject refers to increasing, decreasing or changing the ratio or components of an immune response. For example, cytokine production or secretion levels may be increased or decreased as desired by targeting the appropriate combination of FcγRs with a stradobody designed to interact with those receptors. Antibody production may also be increased or decreased; the ratio of two or more cytokines or immune cell receptors may be changed; or additional types of cytokines or antibodies may be caused to be produced. The immune response may also be an effector function of an immune cell expressing a FcγR, including increased or decreased phagocytic potential of monocyte macrophage derived cells, increased or decreased osteoclast function, increased or decreased antigen presentation by antigen-presenting cells (e.g. Dendritic Cells), increased or decreased NK cell function, increased or decreased B-cell function, as compared to an immune response which is not modulated by an immunologically active biomimetic disclosed herein.

[00218] In a preferred embodiment, a subject with cancer or an autoimmune or inflammatory disease or infectious disease has their immune response altered comprising the step of administering a therapeutically effective amount of a stradobody described herein to a subject, wherein the therapeutically effective amount of the stradobody alters the immune response in the subject. Ideally this intervention treats the disease or condition in the subject. The altered immune response may be an increased or a decreased response and may involve altered cytokine levels including the levels of any of IL-6, IL-10, IL-8, IL-23, IL-7, IL-4, IL-12, IL-13, IL-17,

TNF-alpha and IFN-alpha. In a preferred embodiment, Il-6 or IL-8 are decreased in response to therapy. In an especially preferred embodiment, IL-6 and IL-8 are decreased in a sustained response to therapy. The invention is however not limited by any particular mechanism of action of the described biomimetics. The altered immune response may be an altered autoantibody level in the subject. The altered immune response may be an altered autoaggressive T-cell level in the subject.

[00219] For example, reducing the amount of TNF-alpha production in autoimmune diseases can have therapeutic effects. A practical application of this is anti-TNF-alpha antibody therapy (e.g. Remicade®) which is clinically proven to treat Plaque Psoriasis, Rheumatoid Arthritis, Psoriatic Arthritis, Crohn's Disease, Ulcerative Colitis and Ankylosing Spondylitis. These autoimmune diseases have distinct etiologies but share key immunological components of the disease processes related to inflammation and immune cell activity. A stradobody designed to reduce TNF-alpha production will likewise be effective in these and many other autoimmune diseases. The altered immune response profile may also be direct or indirect modulation to effect a reduction in antibody production, for example autoantibodies targeting a subject's own tissues, or altered autoaggressive T-cell levels in the subject. For example, Multiple Sclerosis is an autoimmune disorder involving autoreactive T-cells which may be treated by interferon beta therapy. See, e.g., Zafranskaya M, et al., Interferon-beta therapy reduces CD4+ and CD8+ T-cell reactivity in multiple sclerosis, Immunology 2007 May;121(l):29-39-Epub 2006 Dec 18. A stradobody design to reduce autoreactive T-cell levels will likewise be effective in Multiple Sclerosis and may other autoimmune diseases involving autoreactive T-cells.

[00220] The stradobodies described herein may be used to modulate expression of co-stimulatory molecules from an immune cell, including a dendritic cell, a macrophage, an osteoclast, a monocyte, or an NK cell or to inhibit in these same immune cells differentiation, maturation, or cytokine secretion, including interleukin-12 (IL- 12), or of increasing cytokine secretion, including interleukin-10 (IL- 10), or interleukin-6 (IL-6). A skilled artisan may also validate the efficacy of an immunologically active biomimetic by exposing an immune cell to the immunologically active biomimetic and measuring modulation of the immune cell function,

wherein the immune cell is a dendritic cell, a macrophage, an osteoclast, or a monocyte. In one embodiment the immune cell is exposed to the immunologically active biomimetic in vitro and further comprising the step of determining an amount of a cell surface receptor or of a cytokine production, wherein a change in the amount of the cell surface receptor or the cytokine production indicates a modulation of the immune cell function. In another embodiment the immune cell is exposed to the immunologically active biomimetic in vivo in a model animal for an autoimmune disease further comprising a step of assessing a degree of improvement in the autoimmune disease. The stradobodies described herein may be used to modulate expression of co-stimulatory molecules from a B cell.

[00221] The methods of the invention can be applied to any animal species and the IgG molecules from which the IgG-derived portions of Fc reagents are made can be from any animal species. Naturally, relevant animal species are those in which IgG or IgG-like molecules occur. Generally the species to which the methods are applied and the species from which the IgG-derived portions of the Fc reagents used in the methods are the same. However, they are not necessarily the same. Relevant animal species are preferably mammals and these include, without limitation, humans, non-human primates (e.g., monkeys, baboons, and chimpanzees), horses, bovine animals (e.g., bulls, cows, or oxen), pigs, goats, sheep, dogs, cats, rabbits, gerbils, hamsters, rats, and mice. Non-mammalian species include, for example, birds (e.g., chickens, turkeys, and ducks) and fish.

[00222] The stradobodies disclosed herein have a number of further applications and uses.

Examples

Example 1. Production and purification of HER2/neu-specific stradobodies

[00223] A synthetic DNA construct encoding the trastuzumab variable and CH1 region was obtained from Blue Heron Biotechnology (Bothell, WA) and fused by PCR to a corresponding Fc region containing the human IgG1 hinge, CH2 and CH3 regions to generate a reading frame encoding the full trastuzumab antibody heavy chain. cDNA was cloned into the

expression vector pOptiVec (Invitrogen) for expression in mammalian cells. Simultaneously, a similar synthetic construct was obtained containing the trastuzumab light chain and cloned into the vector pcDNA3.3 (Invitrogen). Stradobody heavy chain constructs were generated by overlapping PCR using the trastuzumab heavy chain as a template with primers encoding the multimerization domains and linker regions. PCR products were cloned into the pOptiVec expression vector by TA cloning to generate the stradobody expression constructs. Following TA cloning, all constructs were confirmed by sequencing of the complete coding frame as well as surrounding sequences. For stradobody protein expression, large scale DNA plasmid isolation was performed by endotoxin-free plasmid purification kits (Macherey Nagel) and protein produced in 293-T HEK or CHO cells by transient protein expression. Stradobody protein was expressed by co-transfection of heavy-chain and light chain DNA constructs. Stradobody protein was purified by FPLC on an AKTAxpress using protein G affinity chromatography followed by desalting on a HiPrep desalting column (GE life sciences). Stradobody constructs are shown in Table 3.

[00224] To observe the formation of stradobody multimers, purified stradobodies were analyzed by non-reducing SDS-PAGE gel. Bands of higher molecular weight relative to the unaltered antibody GB2500 indicated multimer formation in several constructs. As shown in Figure 8, several C-terminal stradobodies exhibited higher molecular weight bands relative to the unaltered protein. In particular, several high molecular weight bands were detected upon analysis of the construct GB2547. Serial stradobody constructs were also tested. As shown in Figure 9, several serial stradobody constructs, particularly multimerizing serial stradobody GB2542, exhibited higher molecular weight bands relative to the unaltered antibody GB2500.

[00225] Other stradobodies directed against targets other than HER2/neu are produced, purified, and analyzed in an analogous manner. These other stradobodies include the GB3500 series directed against EGFR, the GB4500 series directed against CD20, and the GB7500 series directed against TNF.

Example 2. Cytoxicity and binding activity of HER2/neu-specific stradobodies

[00226] Antibody-dependent cell cytotoxicity was determined for several stradobodies, in comparison to the unaltered antibody GB2500. The ADCC assay was performed on freshly isolated NK cells as effectors cells with the low HER2/neu expressing tumor cell line MDA-MB-231 as the target cell line. MDA-MB-231 cells were radioactively labeled with Cr-51, followed by a one hour incubation with one of the five following solutions: media only, media containing a non-binding human IgG1, media containing the monoclonal antibody GB2500, and media containing the stradobody to be tested. Cells were then plated out with freshly isolated human NK cells at varying NK to tumor cell ratios for four hours and the amount of killing was determined by the amount of Cr-51 released free into the media after the cells had been pelleted.

[00227] One to four independently expressed and purified protein batches from each of a total of 18 proteins, including GB2500, were tested. The effector to target cell ratios tested were 50:1, 25:1, 12.5:1 and 6.5: 1. Where the NK yield permitted, a ratio of 100:1 was used. Figure 10 shows a representative example of ADCC data, demonstrating the increased ADCC observed with GB2542 relative to GB2500 over the range of effector to target cells. Figure 10 also demonstrates the variability of two different independently purified batches of GB2500.

[00228] The compiled ADCC data on all 12 anti-HER2/neu stradobodies and GB2500 are shown in Table 3. Each row in Table 3 represents a purified and tested stradobody batch (*e.g.*, four batches of GB2542 were produced and tested). Data are presented as percent killing by NK cells isolated from the indicated donor, at the indicated ratio of effector to target cell.

[00229] The results of the study showed that surprisingly, even though the novel stradobodies and the trastuzumab antibody GB2500 share the identical Fab, several stradobodies were significantly more potent in ADCC response. GB2542 was particularly potent in ADCC assays. The rank order of the ADCC response in this particular experiment was as follows: GB2542 (multimerizing serial stradobody with two multimerization domains) > GB2547 (multimerizing C-terminal stradobody with two multimerization domains) > GB2550 (multimerizing C-terminal stradobody with one multimerization domain) > GB2500 > human Isotope control and media control.

Table 3. Compiled HER/2-neu-specific stradobody ADCC data.

NAME	Stradobody Structure	donor I 25:1	Donor I 50:1	Donor II 25:1	Donor II 50:1	Donor III 25:1	Donor III 50:1	Donor IV 25:1	Donor IV 50:1	Donor IV 100:1	Donor V 25:1
GB 2500		4.34	4.96	1.96	5.76	2.13	3.82				
GB 2500				6.56	13.13						
GB 2500						2.79	4.28	16.27	25.5	31	
GB2500								6.65	11.1	15.6	2.4
GB 2524		13.3	21.1					28.6	41.2	50.4	15.8
GB 2534								6.67	9.87	13.8	
GB2534								18.6	9.86	34.7	6.32
GB 2538				15.7	23.7						
GB2538								38.2	51.4	54.5	
GB 2540		15.7	21					26.2	39	43.6	
GB 2542											
GB 2542				17.2	26.3						
GB 2542						10.7	14.9				
GB2542								46.1	47.9	55.7	20.9
GB2542								40.5	57.2	60.4	
GB 2545						1.58	3.1				
GB2545								6.89	10.9	13.9	
GB 2546				14.9	24.1			20.8	33.6	44.3	10.6
GB 2546						5.88	9.4				
GB 2547				9.6	19.1						
GB 2547				14.3	19.4			23.2	32.9	39.8	
GB 2549		6.1	8.6								
GB2549								21.4	31.3	41.3	
GB 2550		10.8	14.6	10	14.7	4.17	6.05	17.6	26.7	30.8	4.57
GB 2554						4.16	3.8	11.9	14.5	18.9	
GB 2555						4.76	7.1	20	27.6	29.9	
GB2555								15.7	25.2	33.7	

[00230] In addition to the effector to target cell ratio response ADCC, an analysis of the stradobody concentration response ADCC was conducted. The ADCC assay was performed with concentrations of stradobodies and HER2/neu antibody varying from 0.4 to 4000 ng/mL to assess the dose response of the stradobodies. The ratio of NK cells to MDA-MB-231 target cells was kept constant at 25:1 for these experiments. The results of the study are shown in Figure 11. The concentration-dependent analysis confirmed the increased ADCC activity of stradobodies, particularly GB2542, relative to the trastuzumab antibody (GB2500). Based on this experiment, multimerizing serial stradobody GB2542 was estimated to be more than 2-log more potent in the ADCC assay than GB2500, despite the fact that the two molecules share the same Fab.

[00231] The binding strength of the stradobodies in comparison to GB2500 was assessed as measured by plasmon resonance, using a Biacore 3000 system. Recombinant human FcγRIIIa was diluted to 3ug/ml in 10mM Sodium Acetate pH 5.0 and manually immobilized onto a flow cell of a CM5 chip. Stradobodies or GB2500 were diluted to 1 µM with HBS-EP (0.01 M HEPES pH 7.4, 0.15M NaCl, 1 mM EDTA, 0.005% Surfactant P20) and perfused over the immobilized human FcγRIIIa as follows. After activation of the flow cell, 3ug/ml of the protein was injected in 1 µl increments at a flow rate of 5µl/min until an RU (resonance unit) of 400 was reached. The flow cell was then blocked with 1M Ethanolamine. Another flow cell was used as a blank control. Typically, 20µl of the diluted samples were injected at a flow rate of 20µl/min. Regeneration of the flow cell was performed by an extended wash with running buffer HBS-EP at 20 µL/min.

[00232] Examples of binding data are shown in Figure 12. The binding curve for the parental antibody GB2500, the high binder / high ADCC stradobodies GB2542 (multimerizing serial) and GB2547 (multimerizing C-terminal), and the low binders / low ADCC stradobody GB2554 (non-multimerizing serial) are shown. As a comparison, a binding curve for the mouse Fc based antibody MB2500 is included as an example of a non/low binder. The rank order of binding strength is indicated in Figure 13. Several of the stradobodies had a higher RU max than GB2500. In addition, GB2542 in this assay had the highest RU max and among the slowest rates of dissociation.

[00233] Next, the correlation between the ADCC activity and the binding measured by Biacore was evaluated. The ADCC activity was calculated as fold difference relative to the ADCC activity of the monoclonal antibody GB2500. When two GB2500 batches were measured in the same experiment for the same donor, the average ADCC was used to calculate the mean fold difference in ADCC. The binding was measured as RU max and the data presented in Figure 14. For several of the stradobodies, there was an average fold increase in ADCC higher than the parental antibody (GB2500=1). While the data set was somewhat limited in quantity and some variance in the ADCC activity was observed, there seemed to be an overall correlation between binding and ADCC activity. Importantly, for several of the high ADCC / high binding stradobodies, including GB2542 (multimerizing serial with two multimerization domains),

GB2524 (multimerizing serial with one multimerization domain and one linker), GB2547 (multimerizing C-terminal with two multimerization domains) and GB2540 (multimerizing serial with one multimerization domain), higher order forms were readily observable on the non-denaturing gels indicating a correlation between multimer formation, receptor binding, and ADCC activity.

[00234] Overall, the results of the study indicated that several of the stradobody constructs exhibited higher ADCC and stronger binding activity compared to the monoclonal antibody GB2500, which shares the same Fab as all of the stradobodies tested. The stradobody construct exhibiting the highest ADCC and strongest binding activity was GB2542, comprising an isoleucine zipper multimerization domain and an IgG2 hinge multimerization domain located between the two Fc domains. In addition, there was a significant degree of correlation between binding measured by plasmon resonance and ADCC activity.

[00235] Other stradobodies directed against targets other than HER2/neu are assessed for cytotoxicity and binding in an analogous manner. These other stradobodies include the GB3500 series directed against EGFR, the GB4500 series directed against CD20, and the GB7500 series directed against TNF.

Example 3. Further purification of stradobodies

In order to determine if stradobody multimers and monomers could be successfully separated, GB2054 was purified by ion exchange chromatography on a Mono Q column.

[00236] The results of the study, shown in Figure 15, demonstrated that higher order multimers could be separated from monomers. Multimer peaks were not easily identified in the unfractionated peak (lane SB), but were readily detectable after ion exchange. Without wishing to be bound by theory, it is thought that purification of stradobody multimers will increase the potency of the compounds.

Example 4. Enhanced multimerization and FcγRIIIa binding of stradobodies with multimerization domains

[00237] In order to more stringently assess multimerization of the serial stradobody compounds, a sensitive SDS-PAGE gel method was used to compare multimerization of stradobody constructs to one another and to the HER2 monoclonal antibody construct GB2500. 4-12% gels were used for non-reduced SDS-PAGE, and 12% gels were used for reduced SDS-PAGE. All samples were loaded at 2µg and run at 150V for approximately 2.3 hours prior to Coomassie staining.

[00238] As shown in Figure 16, the control mAb GB2500 (lane 1) and the non-multimerizing serial stradobody construct GB2555 (lane 7), which has a non-multimerizing linker between the two IgG1 Fc regions, did not multimerize. Similarly, non-multimerizing serial stradobody construct GB2554 (lane 6), which has a G4S linker domain between the two IgG1 Fc regions, exhibited little multimerization. Some multimerization was evident for multimerizing serial stradobody constructs GB2538 (lane 3) and GB2540 (lane 4), which have an isoleucine zipper or an IgG2 hinge multimerization domain, respectively, between the two IgG1 Fc regions. Multimerizing serial stradobody construct GB2524 (lane 2) has a G4S linker domain and an IgG2 hinge multimerization domain between the two IgG1 Fc regions, but multimerized poorly. In contrast to the lesser degree of multimerization of GB2538, GB2540, and GB2524, multimerizing serial stradobody construct GB2542, which has an isoleucine zipper and an IgG2 hinge between the two IgG1 Fc regions, exhibited a great deal of multimerization (lane 5).

[00239] To analyze the binding of the GB2500 parent antibody and each of the serial stradobody constructs to FcγRIIIa, a binding analysis was performed in which purified FcγRIIIa-His was loaded onto a ForteBio anti-penta-His sensor (Cat # 18-5077) at 10µg/ml. GB2500 (produced in HEK cells), GB2524, GB2538, GB2540, GB2542, GB2554, or GB2555 were incubated with the receptor in 1x kinetics buffer (ForteBio Cat # 18-5032) to measure on rate (Kon) and the sensor tip later transferred to binding buffer to measure off rate (Kdis). GB2500 antibodies were tested at concentrations ranging from 3333-208 nM, and the stradobodies were tested at concentrations ranging from 200 – 12.5 nM. KD was calculated from on and off rate using ForteBio analysis software. As shown in Table 4 and Figure 17, multimerizing serial stradobodies GB2542 and GB2538 exhibited the lowest KD, and therefore the best binding capacity.

Table 4. Kinetics binding data summary

	KD	Kon	Kon+/-	Kdis	Kdis+/-	Rmax	R2	X2
GB2500	2.75E-07	6.74E+04	3.02E+03	1.85E-02	1.28E-03	1.335	0.984	0.2903
GB2524	3.94E-09	2.38E+05	4.08E+03	9.36E-04	2.54E-05	1.1079	0.997	0.1058
GB2538	1.23E-10	2.21E+05	8.04E+03	2.71E-05	4.37E-05	1.666	0.989	0.3945
GB2540	5.11E-09	1.79E+05	4.09E+03	9.16E-04	2.73E-05	1.127	0.997	0.1335
GB2542	1.49E-10	2.28E+05	8.77E+03	3.39E-05	4.65E-05	1.362	0.987	0.3185
GB2554	4.38E-09	3.99E+05	1.34E+04	1.74E-03	6.00E-05	0.6158	0.988	0.1848
GB2555	3.14E-09	1.95E-05	2.27E+03	6.12E-04	1.82E-05	0.793	0.998	0.0296

All compounds were generated in the same CHO transient transfection system.

[00240] Binding data from other stradobodies directed against targets other than Her2/neu are analogous. These other stradobodies include the GB3500 series directed against EGFR, the GB4500 series directed against CD20, and the GB7500 series directed against TNF.

[00241] The results of the study confirmed that GB2542 exhibited superior multimerization compared to the control mAb and all other serial stradobody constructs tested, as reported above. In addition, GB2542 and GB2538 exhibited the most robust binding to FcγRIIIa. Together, the data showing superior multimerization and FcγRIIIa binding capacity of GB2542 were supportive of the data presented above with regard to the superior ADCC observed with GB2542.

Example 5. Multimerizing stradobodies reduce serum IgM and B cells in the peripheral blood in an in vivo mouse model

[00242] Severe Combined Immunodeficiency (SCID) mice were injected intraperitoneally with 5 x 10^7 human peripheral blood mononuclear cells (PBMC) at week 0. At weeks 2 through 10, mice were injected intraperitoneally with PBS, GB4500 (10nM weekly), GB4563 (1.7 nM weekly), or GB4542 (1.4nM weekly). GB4500 was injected three times per week, while PBS,

GB4563, and GB4542 were each injected one time per week. Therefore, stradobodies were administered not only less frequently relative to the monoclonal antibody, but were also given at a lower molar dose. Molarity was based on the molecular weights estimated from non-reduced SDS-PAGE. Blood samples were collected at weeks 1, 2, 3, 5, 7, 9, 10, 12, 16, and 20 relative to the adoptive transfer of human PBMC, and were evaluated for B cell numbers and serum human IgM. At the endpoint of the study (i.e., at week 21), mice were euthanized and spleens were harvested and evaluated for numbers of B cells. The experimental flow chart is shown schematically in Figure 18.

[00243] Human IgM in the serum of mice treated with PBS, GB4500, GB4563, or GB4542 was evaluated by ELISA. The stradobodies GB4563 and GB4542 were as effective as the monoclonal antibody GB4500 in decreasing human IgM levels (Figure 19).

[00244] The number of human B cells per mL of peripheral blood collected from mice treated with PBS, GB4500, GB4563, or GB4542 was evaluated by flow cytometry. The stradobodies GB4563 and GB4542 were at least as effective as the monoclonal antibody GB4500 in decreasing human B cells in the peripheral blood (Figure 20).

[00245] At the end of the study, mice were euthanized and B cells in the spleen were enumerated by flow cytometry. Stradobody GB4563 was as effective as monoclonal antibody GB4500 in decreasing the number of human B cells present in the spleen. Stradobody GB4542, was more effective than the monoclonal antibody GB4500 in decreasing the number of human B cells present in the spleen (Figure 21).

[00246] The results of the study showed that despite the fact that the stradobodies GB4563 and GB4542 were administered at lower doses compared to the monoclonal antibody GB4500, the stradobodies were at least as effective both in reducing serum human IgM levels and in reducing human B cell numbers. In addition, the anti-CD20 stradobody GB4542 induced B cell depletion better than the corresponding anti-CD20 monoclonal antibody GB4500.

Example 6. Multimerizing stradobodies inhibit proliferation of B cell lymphoma cell lines

[00247] B cell lymphoma cells (Daudi, Ramos, 454B, and 924B cell lines) were cultured in the presence of various concentrations of human IgG (negative control), monoclonal antibody

GB4500, or the stradobody GB4542 for 3 days. 0.5 µci 3H-TdR was added to the cultures, and incorporation of 3H-TdR was measured in corrected counts per minute (CCPM) 16 hours later. The inhibition of cell proliferation was calculated using the formula: (1 – experimental condition CCPM/no treatment CCPM) x 100%. The results of the study are shown in Figures 22 and 23, which are representative of 3 independent experiments. GB4542 was at least as effective at direct inhibition of cell proliferation as GB4500 in all B lymphocyte cell lines at all concentrations as measured by µg/mL (Figure 22) or in moles (Figure 23). GB4542 was significantly more effective at direct inhibition of Ramos cells, 454B cells, and 924B cells at a range of concentrations in µg/mL and at a range of pmol/mL (Figures 22 and 23).

[00248] The results of the study showed that the anti-CD20 stradobody GB4542 mediated enhanced inhibition of proliferation of B cell lymphoma cell lines in comparison to the corresponding anti-CD20 monoclonal antibody GB4500.

Example 7. Multimerizing stradobodies mediate CDC of B cell lymphoma cell lines

[00249] B cell lymphoma cells (Daudi, Ramos, 454B, and 924B cell lines) were cultured in the presence of various concentrations of human IgG (negative control), monoclonal antibody GB4500, or stradobody GB4542 or GB4596, and in the presence or absence of rabbit complement for 1 hour. The extent of cytoxicity was measured by flow cytometric analysis of annexin V / 7-AAD staining. The results of the study are shown in Figures 24 and 25, which are representative of 2 independent experiments. Stradobody GB4596 was as effective as monoclonal antibody GB4500 at CDC at all concentrations, as measured in µg/mL (Figure 24) or in moles (Figure 25). Strikingly, stradobody GB4542 was more effective than monoclonal antibody GB4500 at all concentrations tested, as measured in µg/mL (Figure 24) or in moles (Figure 25).

[00250] The results of the study indicated that B cell lymphoma cell lines exhibit increased susceptibility to CDC in the presence of the anti-CD20 stradobody GB4542, in comparison with its corresponding anti-CD20 monoclonal antibody, GB4500. These effects occur at stradobody concentrations that are at least one log order lower than traditional monoclonal antibody concentrations.

[00251] Together, the data showed that stradobodies induce equivalent or superior ADCC, CDC, DC, and inhibition of proliferation of B lymphoma cell lines when compared to the corresponding monoclonal antibody. The superior activity of stradobodies was present even when the stradobodies were tested at a lower concentration relative to the concentration of the monoclonal antibody. These results indicated that the stradobodies of the present invention offer a therapeutic benefit over traditional monoclonal antibodies or other antigen-binding molecules.

Example 8. Multimerizing stradobodies reduce mean tumor volume in an in vivo mouse model

[00252] Studies were conducted to assess the extent to which a CD20-specific stradobody exhibits tumor cell killing in vivo, relative to an anti-CD20 monoclonal antibody sharing the identical Fab. Severe Combined Immunodeficiency (SCID) mice were injected subcutaneously with 5 x 10^7 Raji cells at day 0. At day 10, tumor volume reached 100mm^3, and CD20-specific stradobody (GB4542) or monoclonal antibody (GB4500) treatment was initiated. Equimolar GB4542 (13.5 mg/kg) or GB4500 (10mg/kg) was administered 4 times daily by intratumoral injection with CpG (100µg per injection) or without CpG (PBS). Control mice received PBS alone or PBS with CpG. Tumor size was measured every 1-3 day. Tumor size was calculated as width^2 x length/2. When tumor volume reached 2000m^3, mice were euthanized.

[00253] The results of the study are shown in Figures 26 and 27. For both GB4542 with CpG and GB4500 with CpG groups, the mean (Figure 26) and median (Figure 27) tumor volume remained at or near baseline levels throughout the study (i.e., through at least day 23). Treatment with GB4500 in the absence of CpG resulted in about half the tumor volume of the PBS group at the last timepoint prior to euthanization that PBS groups were measured (day 18 of both Figures 26 and 27). Furthermore, treatment with GB4500 in the absence of CpG resulted in equal mean (Figure 26) and median (Figure 27) tumor volume compared to the PBS/CpG group at day 18, and only marginally lower mean tumor volume (Figure 26) or approximately half of the median tumor volume (Figure 27) relative to the PBS/CpG group at the final timepoint (day 23). In contrast, treatment with GB4542 in the absence of CpG resulted in a drastic reduction in mean as

well as median tumor volume through day 23 relative to the tumor volume in mice treated with GB4500 alone (Figures 26 and 27, respectively). The results of the study therefore demonstrate that GB4542 exhibits superior results relative to the corresponding monoclonal antibody with respect to mean tumor volume in vivo.

Example 9. Stradobodies reduce inflammation in an in vivo mouse model of arthritis

[00254] A collagen-induced arthritis (CIA) mouse model is employed to determine the efficacy of stradobodies in inhibiting the inflammation, pannus formation, cartilage destruction, and bone resorption associated with type II collagen arthritis in mice.

[00255] Male mice are anesthetized with Isoflurane and intradermally administered 150µl of bovine Type II collagen in Freund's complete adjuvant (with supplemental *M. tuberculosis*, 4 mg/mL; Difco) on study days 0 and 21 of the study. In this model, onset of arthritis occurs on study days 18-35. Mice are monitored for clinical signs of disease using the following clinical scoring scale:

0 = normal

1 = 1 hind or fore paw joint affected or minimal diffuse erythema and swelling

2 = 2 hind or fore paw joints affected or mild diffuse erythema and swelling

3 = 3 hind or fore paw joints affected or moderate diffuse erythema and swelling

4 = marked diffuse erythema and swelling, or 4 digit joints affected

5 = severe diffuse erythema and severe swelling of entire paw, unable to flex digits

[00256] One group of mice (n=4) is naïve (i.e., is not administered collagen). All other groups of mice are randomized after collagen administration to receive intravenous injections of PBS, GB7500 (anti-TNF monoclonal antibody), GB7542 (anti-TNF multimerizing stradobody), GB4500 (anti-CD20 monoclonal antibody), or GB4542 (anti-CD20 multimerizing stradobody), at the doses indicated below in Table 5.

Table 5. Groups of mice in collagen-induced arthritis study

Cpm	Mice	Concentration mg/ml	Dose mg/kg	Volume per dose µl	ml / vial	mg / vial	# of vials	Route	Endotoxin Level EU/mg

PBS	10			400	4.8	9.6	5	IV	<0.05
GB7500	10	0.75	15	400	4.8	3.6	5	IV	<0.07
GB7542	10	1.00	20	400	4.8	4.8	5	IV	<0.05
GB4500	10	0.75	15	400	4.8	3.6	5	IV	<0.07
GB4542	10	1.00	20	400	4.8	4.8	5	IV	<0.05

[00257] Mice are randomized into one of the five treatment groups after swelling is obviously established in at least one paw (i.e., clinical score of at least 1; the first day that the animal is graded at a clinical score of 1 is designated arthritis day 1).

[00258] Treatment with PBS, GB7500, GB7542, GB4500, or GB4542 is initiated after randomization and continued for 10 days. Body weight is determined on arthritis days 1, 3, 5, 7, 9, and 11; and paw score is determined on each of arthritis days 1 through11. Plasma, serum, and whole blood are collected on various study days to measure pharmacokinetics and/or anti-collagen responses, for example using anti-collagen ELISA assays. Animals are necropsied on arthritis day 11. Tissues, including joints, are collected and analyzed histologically.

[00259] Clinical data for paw scores are analyzed by determining the area under the dosing curve (AUC) for arthritis days. For calculation of AUC, the daily mean scores for each mouse are entered into Microsoft Excel and the area between the treatment days after the onset of disease to the termination day is computed. Means for each group are determined and % inhibition from arthritis controls is calculated using the following formula:

$$\% \text{ Inhibition} = A - B/A \times 100$$

$$A = \text{Mean Disease Control} - \text{Mean Normal}$$

$$B = \text{Mean Treated} - \text{Mean Normal}$$

[00260] Data are analyzed using a Student's t-test or Mann-Whitney U test (non parametric). If appropriate, data are further analyzed across all groups, using a one-way analysis

of variance (1-way ANOVA) or Kruskal-Wallis test (non-parametric), along with the appropriate multiple raw (untransformed) data only. Statistical tests make certain assumptions regarding the data's normality and homogeneity of variance, and further analysis may be required if testing resulted in violations of these assumptions. Significance for all tests will be set at $p \leq 0.05$.

[00261] The results of the study will demonstrate that stradobodies provide superior treatment of CIA relative to monoclonal antibodies sharing the identical Fab as the stradobody. Specifically, the study will show that treatment with multimerizing anti-CD20 stradobodies and multimerizing anti-TNF stradobodies results in reduced development and/or progression of CIA relative to anti-CD20 monoclonal antibodies or anti-TNF monoclonal antibodies, respectively. The study will show that treatment of CIA with stradobodies is superior to the corresponding monoclonal antibody despite the fact that the stradobody and its corresponding monoclonal antibody share the identical Fab.

Example 10. Multimerizing stradobodies exhibit superior C1q complement binding relative to the corresponding monoclonal antibody or to non-multimerizing stradobodies sharing the same Fab.

[00262] A complement binding assay was conducted to compare Clq binding of three multimerizing stradobodies relative to the corresponding monoclonal antibodies having the same Fabs as the multimerizing stradobodies.

[00263] ELISA plates were coated with 1μg/mL in PBS at 100μL volume of complement component C1q human serum (Sigma Cat#:C1740-0.5MG) overnight at 4°C. The plates were washed 3 times with phosphate buffered saline (PBS) containing 0.05% Tween. Non-specific binding was blocked using PBS containing 1% BSA and 0.05% Tween solution for 2h at room temperature. Coated wells were then incubated with experimental compounds at various concentrations for 2 hours at room temperature. Plates were washed 3 times with PBS containing 0.05% Tween and incubated with 1:5000 biotinylated mouse anti-human IgG1(Cat#555869, BD Biosciences) and Strepdavidin-HRP (Cat#: 7100-05 SouthernBiotech) as detection reagent for 1 hour at room temperature. Wells were washed 3 times and detected with standard TMB ELISA detection method, and absorbance was read at 450 nm.

[00264] GB4542 and the corresponding mAb sharing the same Fab (GB4500), GB7542 and the corresponding mAb sharing the same Fab (GB7500) and GB2542 and the corresponding mAb sharing the same Fab (GB2500) were tested for complement C1q binding. Surprisingly, all three of the multimerizing antibodies tested (GB4542, GB7442, and GB2542) exhibited exponentially higher complement Clq binding relative to their corresponding mAbs (Figure 28). In particular, GB4542 exhibited an extremely high level of complement Clq binding. GB4542, GB7542, and GB2542 each share the identical multimerization domains and Fc regions, and differ only in that each has a different Fab. Thus, unexpectedly, the Fab on the multimerizing stradobody affects the level of complement Clq binding.

[00265] The data were log transformed with a curve fit using GraphPad prism 5, a commercially available software, and the EC50 (in ug/ml) was calculated for each molecule tested. EC50 is the half-maximal effective concentration and refers to the concentration of a molecule that gives the half-maximal response. Strikingly, the EC50 for each stradobody was 10-20 times lower than the EC50 for the corresponding antibody (Figure 29). Specifically, the EC50 for stradobody GB7542 was 8.69, whereas the EC50 for the corresponding mAb GB7500 was 202.0; the EC50 for stradobody GB4542 was 3.25, whereas the EC50 for the corresponding mAb GB4500 was 34.5; and the EC50 for stradobody GB2542 was 11.0, whereas the EC50 for the corresponding mAb GB2500 could not be determined due to the extremely low level of Clq binding exhibited by this molecule (Figure 29). Thus, the concentration of stradobody required to give a half-maximal complement binding response was at least 10-20 times lower than that required for a monoclonal antibody having the same Fab to achieve a half-maximal complement binding response. In addition, the concentration of stradobody required to give a half-maximal complement binding response was influenced by the stradobody's Fab, and not just the multimerizing and Fc regions.Further complement binding assays were conducted to assess the complement Clq binding capacity of non-multimerizing stradobodies relative to their multimerizing counterpart or to the corresponding monoclonal antibody sharing the same Fab. In order to assess complement Clq binding, complement assays were conducted as described above using GB2500, GB2542, and the linear, non-multimerizing stradobodies GB2554 and GB2555, all four of which share the same anti Her2/neu Fab. The non-multimerizing stradobodies

GB2554 and GB2555 each exhibited superior complement Clq binding relative to the monoclonal antibody GB2500 (Figure 30); however, the multimerizing stradobody GB2542 exhibited far superior complement Clq binding compared to either of the non-multimerizing stradobodies (Figure 30). Furthermore, the EC50 value for the multimerizing stradobody GB2542 was 2.5-7.0 times lower than the EC50 values for GB2554 and GB2555. Specifically, the EC50 value for complement Clq binding for GB2542 was 3.83, whereas the EC50 value for complement Clq binding for GB2554 and GB2555 were 26.4 and 9.45, respectively (Figure 31).

[00266] The results of the study indicated that, unexpectedly, multimerizing stradobodies exhibited dramatically superior complement binding relative to the corresponding monoclonal antibody sharing the same Fab. The results also indicated that while non-multimerizing stradobodies exhibit superior complement binding relative to the corresponding monoclonal antibody sharing the same Fab, multimerizing stradobodies exhibit far superior complement binding relative to non-multimerizing stradobodies sharing the same Fab. Finally, the study showed that the Fab on the multimerizing stradobody dramatically affects the amount of Clq binding.

[00267] All, documents, patents, patent applications, publications, product descriptions, and protocols which are cited throughout this application are incorporated herein by reference in their entireties for all purposes.

[00268] The embodiments illustrated and discussed in this specification are intended only to teach those skilled in the art the best way known to the inventors to make and use the invention. Modifications and variation of the above-described embodiments of the invention are possible without departing from the invention, as appreciated by those skilled in the art in light of the above teachings. It is therefore understood that, within the scope of the claims and their equivalents, the invention may be practiced otherwise than as specifically described.

CLAIMS

1. A stradobody comprising an Fab domain; one or more Fc domains; and one or more multimerization domains, wherein the one or more multimerization domains is capable of multimerizing said stradobody.

2. The stradobody of claim 1, comprising two Fc domains and wherein the one or more multimerization domains separates the two Fc domains.

3. The stradobody of claim 1, wherein at least one of the one or more multimerization domains is located at the carboxy end of the Fc region.

4. The stradobody of claim 1, wherein the one or more multimerization domains are independently selected from the group consisting of an isoleucine zipper, an IgG2 hinge, and a GPP repeat.

5. The stradobody of claim 1, wherein the stradobody comprises at least one IgG2 hinge domain, wherein the amino acid sequence of the IgG2 hinge domain is at least 80% homologous to SEQ ID NO: 3, and wherein the IgG2 hinge is capable of multimerizing the stradobody.

6. The stradobody of claim 1, wherein the stradobody comprises at least one isoleucine zipper, wherein the amino acid sequence of the at least one isoleucine zipper is at least 80% homologous to SEQ ID NO: 32, and wherein the isoleucine zipper is capable of multimerizing the stradobody.

7. The stradobody of claim 1, wherein the stradobody comprises two multimerization domains.

8. The stradobody of claim 7, wherein the two multimerization domains are an isoleucine zipper and an IgG2 hinge.

9. The stradobody of claim 8, wherein the two multimerization domains separate two Fc domains.

10. The stradobody of claim 8, wherein the two multimerization domains are located at the carboxy end of the Fc region.

11. The stradobody of claim 1, wherein the stradobody comprises three multimerization domains.

12. The stradobody of claim 1, wherein the stradobody comprises four multimerization domains.

13. The stradobody of claim 1, wherein the at least one Fc domain is an IgG1 Fc domain.

14. The stradobody of claim 13, wherein the IgG1 Fc domain comprises an IgG1 hinge, IgG1 CH2, and IgG1 CH3.

15. The stradobody of claim 1, wherein at least one of the one or more Fc domains comprises an IgG2 hinge.

16. The stradobody of claim 15, wherein the Fc domain comprises an IgG2 hinge, IgG1 CH2, and IgG1 CH3.

17. The stradobody of claim 13, wherein the amino acid sequence of at least one IgG1 Fc domain is at least 80% homologous to SEQ ID NO: 2.

18. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) an isoleucine zipper;

(d) an IgG2 hinge; and

(e) a second Fc domain.

19. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) an IgG2 hinge;

(d) an isoleucine zipper; and

(e) a second Fc domain.

20. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) an isoleucine zipper; and

(e) a second Fc domain.

21. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) an IgG2 hinge; and

(e) a second Fc domain.

22. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) a G4S domain;

(d) an IgG2 hinge; and

(e) a second Fc domain.

23. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) an IgG2 hinge ;

(d) a G4S domain; and

(e) a second Fc domain.

24. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) a G4S domain;

(d) an isoleucine zipper; and

(e) a second Fc domain.

25. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) an isoleucine zipper;

(d) a G4S domain; and

(e) a second Fc domain.

26. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) a GPP domain; and

(d) a second Fc domain.

27. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) a GPP domain;

(d) an IgG2 hinge; and

(e) a second Fc domain.

28. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) an IgG2 hinge ;

(d) a GPP domain; and

(e) a second Fc domain.

29. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) a GPP domain;

(d) an isoleucine zipper; and

(e) a second Fc domain.

30. The stradobody of claim 2, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) a first Fc domain;

(c) an isoleucine zipper;

(d) a GPP domain; and

(e) a second Fc domain.

31. The stradobody of any one of claims 18 to 30, wherein the first and second Fc domains are IgG1 Fc domains.

32. The stradobody of claim 18, wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 33.

33. The stradobody of claim 18, wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 35.

34. The stradobody of claim 18, wherein the amino acid sequence of the stradobody is at least 80% homologous to SEQ ID NO: 37.

35. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(c) an isoleucine zipper; and

(d) an IgG2 hinge.

36. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(c) an IgG2 hinge; and

(d) an isoleucine zipper.

37. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain; and

(c) an IgG2 hinge.

38. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain; and

(c) an isoleucine zipper.

39. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(c) a G4S domain; and

(d) an IgG2 hinge.

40. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(c) a G4S domain; and

(d) an isoleucine zipper.

41. The stadobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(d) an IgG2 hinge; and

(d) a domain linkage.

42. The stadobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(c) a domain linkage; and

(d) an IgG2 hinge.

43. The stadobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(c) an Fc domain;

(d) an isoleucine zipper; and

(e) a domain linkage.

44. The stadobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(c) an Fc domain;

(d) a domain linkage; and

(e) an isoleucine zipper.

45. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain; and

(c) a GPP domain.

46. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(c) a GPP domain; and

(d) an IgG2 hinge.

47. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(c) an IgG2 hinge; and

(d) a GPP domain.

48. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(c) a GPP domain; and

(d) an isoleucine zipper.

49. The stradobody of claim 3, wherein the stradobody comprises, from amino to carboxy terminus:

(a) an Fab domain;

(b) an Fc domain;

(c) an isoleucine zipper; and

(d) a GPP domain.

50. The stradobody of any one of claims 35-49, wherein the Fc domain is an IgG1 Fc domain.

51. The stradobody of claim 50, wherein the IgG1 Fc domain comprises an IgG1 hinge, IgG1 CH2, and IgG1 CH3.

52. The stradobody of any one of claims 35-49, wherein the Fc domain comprises an IgG2 hinge.

53. The stradobody of claim 52, wherein the Fc domain comprises an IgG2 hinge, IgG1 CH2, and IgG1 CH3.

54. The stradobody of claim 1, wherein the Fab domain is specific for EGFR.

55. The stradobody of claim 54, wherein the amino acid sequence of the Fab domain is at least 80% homologous to SEQ ID NO: 31.

56. The stradobody of claim 1, wherein the Fab domain is specific for HER2/neu.

57. The stradobody of claim 56 wherein the amino acid sequence of the Fab domain is at least 80% homologous to SEQ ID NO: 34.

58. The stradobody of claim 1, wherein the Fab domain is specific for CD20.

59. The stradobody of claim 58, wherein the amino acid sequence of the Fab domain is at least 80% homologous to SEQ ID NO: 36.

60. The stradobody of claim 1, wherein the two or more Fc domains are capable of binding FcγR.

61. The stradobody of claim 60, wherein the FcγR is FcγRIIIa.

62. A method of modulating an immune response in a subject comprising administering to the subject an effective amount of the stradobody of claim 1.

63. A method of treating an inflammatory disease, autoimmune disease, infectious disease, or cancer in a subject in need thereof, comprising administering to the subject an effective amount of the stradobody of claim 1.

64. The method of claim 62 or 63, wherein the subject is a human.

65. The method of claim 62 or 63, wherein the stradobody is administered to the subject intravenously, subcutaneously, orally, nasally, intraperitoneally, sublingually, bucally, transdermally, by subcutaneous or subdermal implantation, or intramuscularly.

66. The method of claim 65, wherein the stradobody is administered intravenously at a dose of about 0.5 mg/Kg to about 50 mg/Kg.

67. The method of claim 63, wherein the subject has cancer.

68. The method of claim 67, wherein the cancer is selected from the group consisting of colorectal cancer, head and neck cancer, fibrosarcoma, myxosarcoma, liposarcoma, chondrosarcoma, osteogenic sarcoma, chordoma, angiosarcoma, endotheliosarcoma, lymphangiosarcoma, lymphangioendotheliosarcoma, synovioma, mesothelioma, Ewing's tumor, leiomyosarcoma, rhabdomyosarcoma, colon carcinoma, pancreatic cancer, breast cancer, ovarian cancer, prostate cancer, squamous cell carcinoma, basal cell carcinoma, adenocarcinoma, sweat gland carcinoma, sebaceous gland carcinoma, papillary carcinoma, papillary adenocarcinomas, cystadenocarcinoma, medullary carcinoma, bronchogenic carcinoma, renal cell carcinoma, hepatoma, bile duct carcinoma, choriocarcinoma, seminoma, embryonal carcinoma, Wilms' tumor, cervical cancer, testicular tumor, lung carcinoma, small cell lung carcinoma, bladder carcinoma, epithelial carcinoma, glioma, astrocytoma, medulloblastoma, craniopharyngioma, ependymoma, pinealoma, hemangioblastoma, acoustic neuroma, oligodendroglioma, meningioma, melanoma, neuroblastoma, retinoblastoma, leukemia, lymphoma, multiple myeloma, Waldenstrom's macroglobulinemia, myelodysplastic disease, heavy chain disease, neuroendocrine tumors, and Schwanoma.

69. The method of claim 63, wherein the subject has an autoimmune or inflammatory disease, and wherein the autoimmune or inflammatory disease is selected from the group consisting of Idiopathic Thrombocytopenic Purpura, Guillain-Barre syndrome, Myasthenia gravis, Multiple Sclerosis, optic neuritis, Kawasaki's disease, Rheumatoid arthritis, Systemic

Lupus Erythematosus, Atopic dermatitis, Atherosclerosis, Coronary Artery Disease, Cardiomyopathy, Reactive arthritis, Crohn's disease, ulcerative colitis, Graft Versus Host Disease, and Type 1 Diabetes mellitus.

70. The method of claim 63, wherein the subject has an infectious disease, and wherein the infectious disease is selected from the group consisting of candidiasis, candidemia, aspergillosis, streptococcal pneumonia, streptococcal skin and oropharyngeal conditions, gram negative sepsis, tuberculosis, mononucleosis, influenza, respiratory illness caused by Respiratory Syncytial Virus, Human Immunodeficiency Virus, Hepatitis B, Hepatitis C, malaria, schistosomiasis, Methicillin-resistant Staph aureus, Vancomycin-resistant Enterococcus, carbapenem-resistant and carbapenemase-producing Enterobacteriaceae, mycobacterial disease and trypanosomiasis.

71. The method of claim 62 or 63, wherein the stradobody is administered before, during, or after administration of one or more additional pharmaceutical and/or therapeutic agents.

72. The stradobody of claim 2, wherein said stradobody displays enhanced cellular toxicity compared to stradobodies containing one or more multimerization domains in locations other than separating two or more Fc domains.

73. The stradobody of claim 3, wherein said stradobody displays enhanced cellular toxicity compared to stradobodies containing one or more multimerization domains in locations other than at the carboxy end of the IgG1 Fc region.

74. The stradobody of claim 7, wherein said stradobody displays enhanced cell killing compared to stradobodies containing one multimerization domain.

75. The stradobody of claim 8, wherein said stradobody displays enhanced cell killing compared to stradobodies containing two multimerization domains which are not an isoleucine zipper and IgG2 hinge.

76. The stradobody of claim 72 or 73, wherein said cell killing is mediated by ADCC.

77. The stradobody of claim 72 or 73, wherein said cell killing is mediated by CDC.

78. The stradobody of claim 72 or 73, wherein said cell killing is mediated by DC.

79. A stradobody comprising an Fab domain; two or more Fc domains; and two multimerization domains wherein the two multimerization domains separate the two or more Fc domains wherein said stradobody displays enhanced cell killing compared to a stradobody containing one multimerization domain.

80. The stradobody of claim 79, wherein at least one of the two or more Fc domains is an IgG1 Fc domain.

81. A stradobody comprising an Fab domain; one or more Fc domains; and two multimerization domains wherein the two multimerization domains are located at the carboxy end of the Fc region and wherein said stradobody displays enhanced cell killing compared to a stradobody containing one multimerization domain.

82. The stradobody of claim 81, wherein at least one of the one or more Fc domains is an IgG1 Fc domain.

83. The stradobody of claim 79 or 81, wherein the two multimerization domains are an isoleucine zipper and an IgG2 hinge.

84. The stradobody of claim 1, wherein the stradobody displays enhanced cell killing compared to a monoclonal antibody specific for the same antigen.

85. The stradobody of claim 84, wherein said cell killing is mediated by ADCC.

86. The stradobody of claim 84, wherein said cell killing is mediated by CDC.

87. The stradobody of claim 84, wherein said cell killing is mediated by DC.

88. The stradobody of claim 1, wherein the stradobody displays enhanced inhibition of cellular proliferation compared to a monoclonal antibody specific for the same antigen.

89. The stradobody of claim 1, wherein the stradobody further comprises one or more danger signals.

90. The stradobody of claim 1, wherein the danger signal is selected from the group consisting of CD40-L, TNF-α, IL-1β, IFNα, Intracellular nucleotides ATP or UTP, Long unmethylated CpG sequences, Heat Shock Proteins, reactive oxygen intermediates, Vasoactive Intestinal Peptide, metalloproteinase-9, degradation products of heparan sulfate, small breakdown products of hyaluronan, LDL-derived phospholipids, LOX-1, uric acid, high-mobility-group box 1, an inflammasome, IL-1 α; S100 proteins; hepatoma-derived growth factor, IL-1 α; high concentrations of adenosine 5′-triphosphatase, β-D-glucopyranosylceramide, IL-33, nanoparticles such as gold nanoparticles, and F-actin.

91. The method of claim 62 or 63 comprising administering the stradobody of claim 89.

92. The method of claim 62 or 63 further comprising administering before, during or after treatment, an additional stradobody comprising a danger signal.

93. The stradobody of claim 18 wherein the Fab domain is specific for EGFR.

94. The stradobody of claim 93 wherein the amino acid sequence of the Fab is at least 80% homologous to SEQ ID NO: 31.

95. The stradobody of claim 18 wherein the Fab domain is specific for Her2/neu.

96. The stradobody of claim 95 wherein the amino acid sequence of the Fab is at least 80% homologous to SEQ ID NO: 34.

97. The stradobody of claim 18 wherein the Fab domain is specific for CD20.

98. The stradobody of claim 97 wherein the amino acid sequence of the Fab is at least 80% homologous to SEQ ID NO: 36.

99. The stradobody of claim 35 wherein the Fab domain is specific for EGFR.

100. The stradobody of claim 99 wherein the amino acid sequence of the Fab is at least 80% homologous to SEQ ID NO: 31.

101. The stradobody of claim 35 wherein the Fab domain is specific for Her2/neu.

102. The stradobody of claim 101 wherein the amino acid sequence of the Fab is at least 80% homologous to SEQ ID NO: 34.

103. The stradobody of claim 35 wherein the Fab domain is specific for CD20.

104. The stradobody of claim 103 wherein the amino acid sequence of the Fab is at least 80% homologous to SEQ ID NO: 36.

105. A stradobody with an amino acid sequence at least 80% homologous to SEQ ID NO: 35.

106. The stradobody of claim 105 wherein the amino acid sequence is at least 95% homologous to SEQ ID NO: 35.

107. The stradobody of claim 106 wherein the amino acid sequence is SEQ ID NO: 35.

108. A stradobody with an amino acid sequence at least 80% homologous to SEQ ID NO: 33.

109. The stradobody of claim 108 wherein the amino acid sequence is at least 95% homologous to SEQ ID NO: 33.

110. The stradobody of claim 109 wherein the amino acid sequence is SEQ ID NO: 33.

111. A stradobody with an amino acid sequence at least 80% homologous to SEQ ID NO: 37.

112. The stradobody of claim 111 wherein the amino acid sequence is at least 95% homologous to SEQ ID NO: 37.

113. The stradobody of claim 112 wherein the amino acid sequence is SEQ ID NO: 37.

114. A stradobody with an amino acid sequence at least 80% homologous to SEQ ID NO: 66.

115. The stradobody of claim 114wherein the amino acid sequence is at least 95% homologous to SEQ ID NO: 66.

116. The stradobody of claim 115 wherein the amino acid sequence is SEQ ID NO: 66.

117. A stradobody with an amino acid sequence at least 80% homologous to SEQ ID NO: 91.

118. The stradobody of claim 117 wherein the amino acid sequence is at least 95% homologous to SEQ ID NO: 91.

119. The stradobody of claim 118 wherein the amino acid sequence is SEQ ID NO: 91.

120. A stradobody with an amino acid sequence at least 80% homologous to SEQ ID NO:70.

121. The stradobody of claim 120 wherein the amino acid sequence is at least 95% homologous to SEQ ID NO: 70.

122. The stradobody of claim 121 wherein the amino acid sequence is SEQ ID NO: 70.

123. A stradobody with an amino acid sequence at least 80% homologous to SEQ ID NO: 76.

124. The stradobody of claim 123 wherein the amino acid sequence is at least 95% homologous to SEQ ID NO: 76.

125. The stradobody of claim 124 wherein the amino acid sequence is SEQ ID NO: 76.

126. A stradobody with an amino acid sequence at least 80% homologous to SEQ ID NO: 87.

127. The stradobody of claim 126 wherein the amino acid sequence is at least 95% homologous to SEQ ID NO: 87.

128. The stradobody of claim 127 wherein the amino acid sequence is SEQ ID NO: 87.

129. The stradobody of claim 1, wherein the Fab domain is specific for a member of the TNF superfamily.

130. The stradobody of claim 129, wherein the member of the TNF superfamily is selected from the group consisting of TNF, Lymphotoxin (LT), Lymphotoxinβ (LTβ), OX40 Ligand, CD40 Ligand, CD95, CD27 Ligand, CD30 Ligand, 4-1BB Ligand, TRAIL, TRANCE, TWEAK, APRIL, Blys, LIGHT, TL1A, GITR Ligand, EDA-A1, and EDA-A2.

131. The stradobody of claim 130, wherein the TNF superfamily member is TNF.

132. The stradobody of claim 131, wherein the amino acid sequence of the Fab domain is at least 80% homologous to SEQ ID NO: 67.

133. The stradobody of claim 18 wherein the Fab domain is specific for TNF.

134. The stradobody of claim 133, wherein the amino acid sequence of the Fab is at least 80% homologous to SEQ ID NO: 67.

135. The stradobody of claim 35 wherein the Fab domain is specific for TNF.

136. The stradobody of claim 135 wherein the amino acid sequence of the Fab is at least 80% homologous to SEQ ID NO: 67.

137. The stradobody of claim 1, wherein the Fab domain is specific for a cytokine

138. The stradobody of claim 137, wherein the cytokine is selected from the group consisting of IL-2, IL-8, and IL-17.

139. The stradobody of claim 1, wherein the stradobody displays enhanced complement binding compared to a monoclonal antibody specific for the same antigen.

140. The stradobody of claim 1, wherein the stradobody displays enhanced complement binding compared to a monoclonal antibody sharing the identical Fab.

141. The stradobody of claim 139 or 140, wherein the EC50 value for complement binding is at least 10 times lower for the stradobody compared to the monoclonal antibody specific for the same antigen.

142. The stradobody of claim 139 or 140, wherein the EC50 value for complement binding is at least 20 times lower for the stradobody compared to the monoclonal antibody specific for the same antigen.

143. The stradobody of claim 1, wherein the stradobody exhibits cell killing, and wherein the amount of cell killing varies depending on the Fab.

144. The stradobody of claim 143, wherein the cell killing is mediated by ADCC.

145. The stradobody of claim 143, wherein said cell killing is mediated by CDC.

146. The stradobody of claim 143, wherein said cell killing is mediated by DC.

147. A composition comprising multimerized stradobodies, wherein the stradobodies are selected from the stradobodies of any one of claims 18 – 30.

148. The composition of claim 147, comprising at least 2, at least 3, at least 4, at least 5, or at least 6 stradobodies.

Figure 1

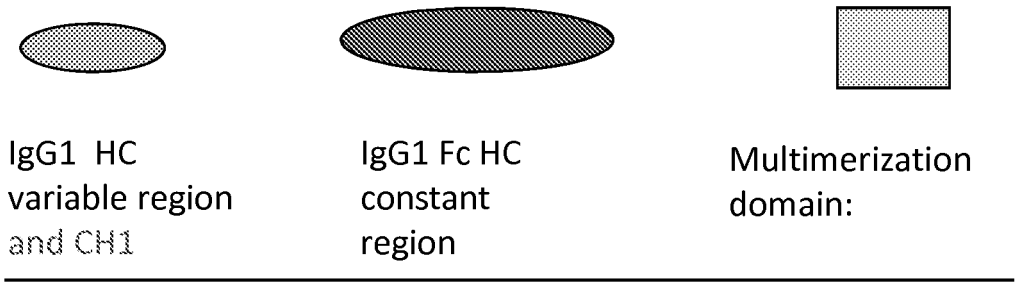
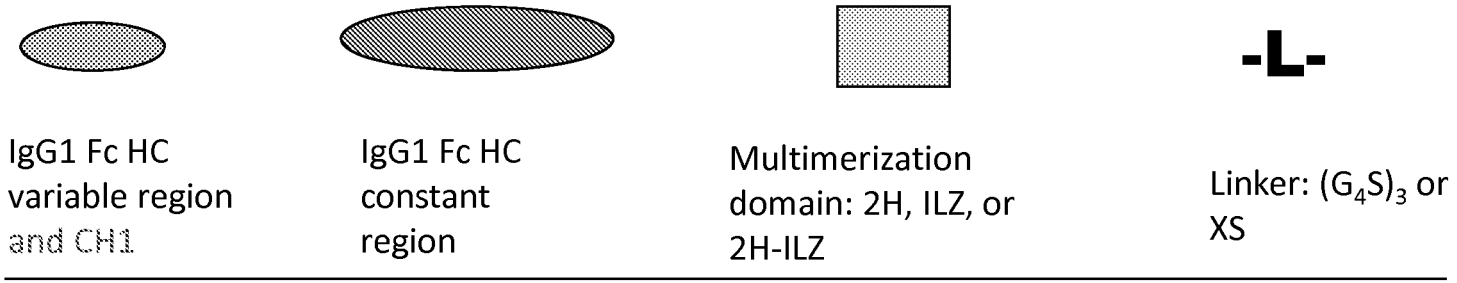

IgG1 HC variable region and CH1
IgG1 Fc HC constant region
Multimerization domain:
Multimerized serial stradobodies
Multimerized stradobodies C-terminal

Figure 2



Serial stradobodies	Number Possible
	3
-L-	2
-L-	6
-L-	6
-L-	3 use $(G_4S)_3$ only

Figure 3

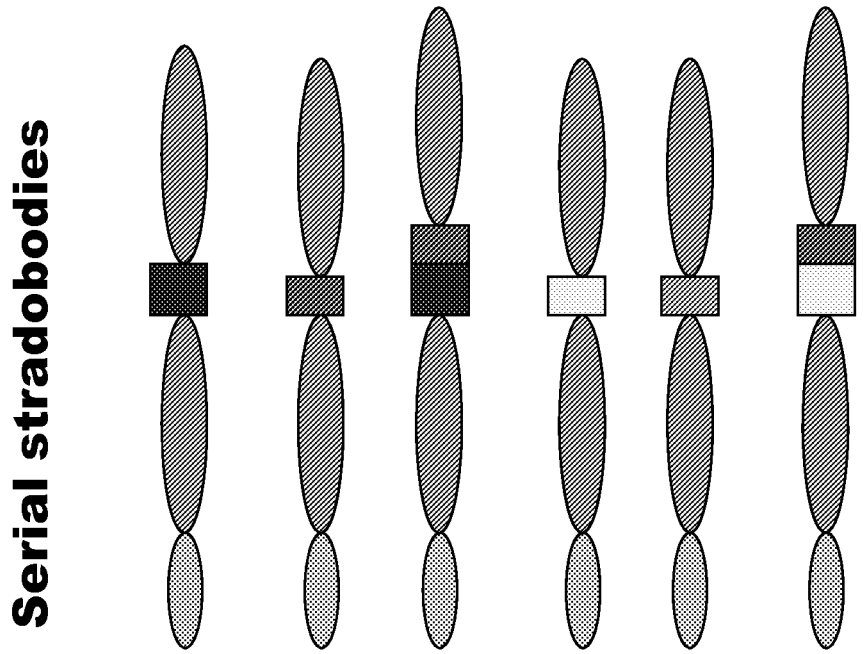

Serial stradobodies
2538 ILZ
2540 2H
2542 ILZ-2H
2554 G4S
2555 L
2524 G4S-2H

Figure 4

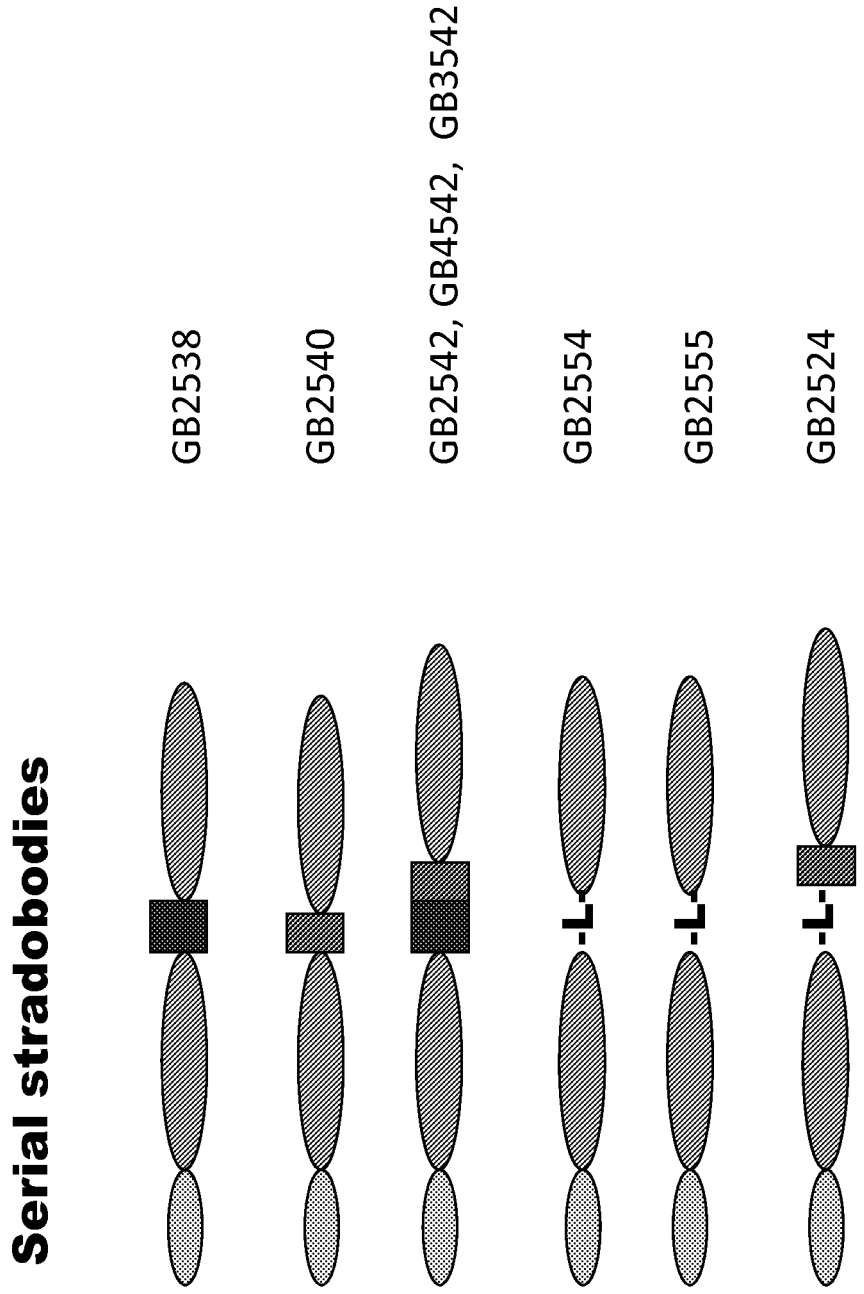

Serial stradobodies
GB2538
GB2540
GB2542, GB4542, GB3542
GB2554
GB2555
GB2524
-L-
-L-
-L-

Figure 5

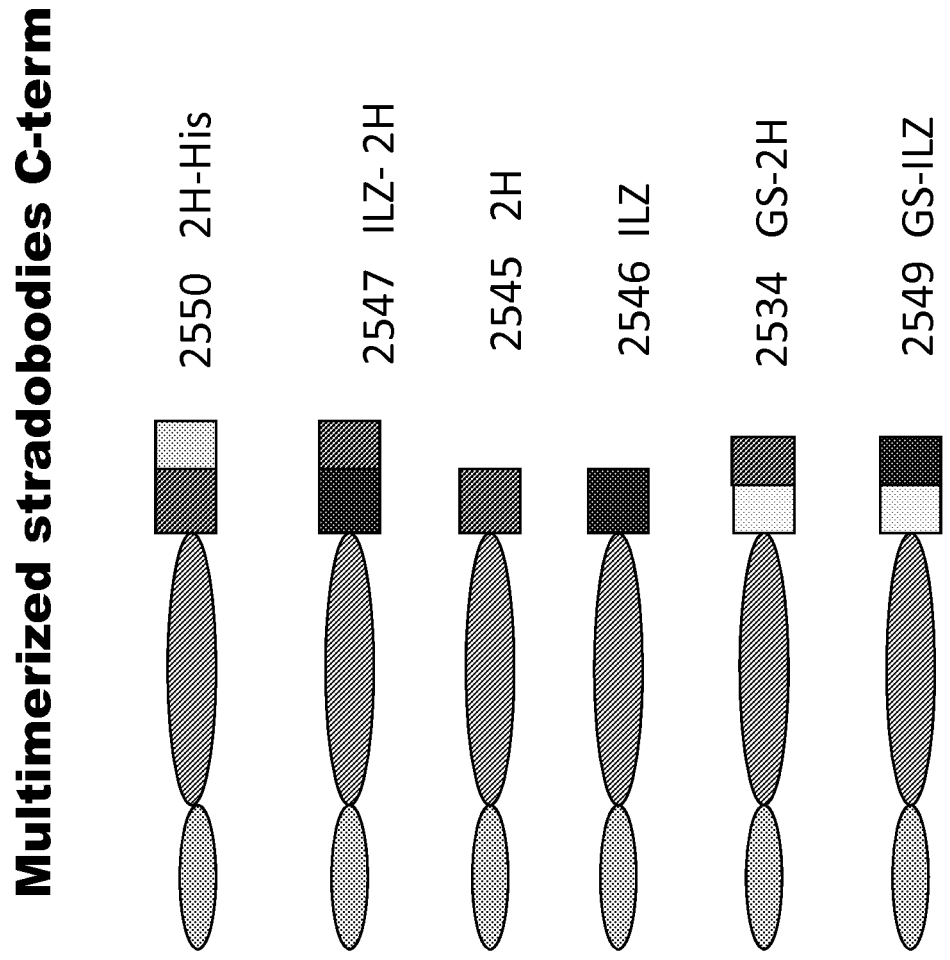

Multimerized stradobodies C-term
2550 2H-His
2547 ILZ- 2H
2545 2H
2546 ILZ
2534 GS-2H
2549 GS-ILZ

Figure 6

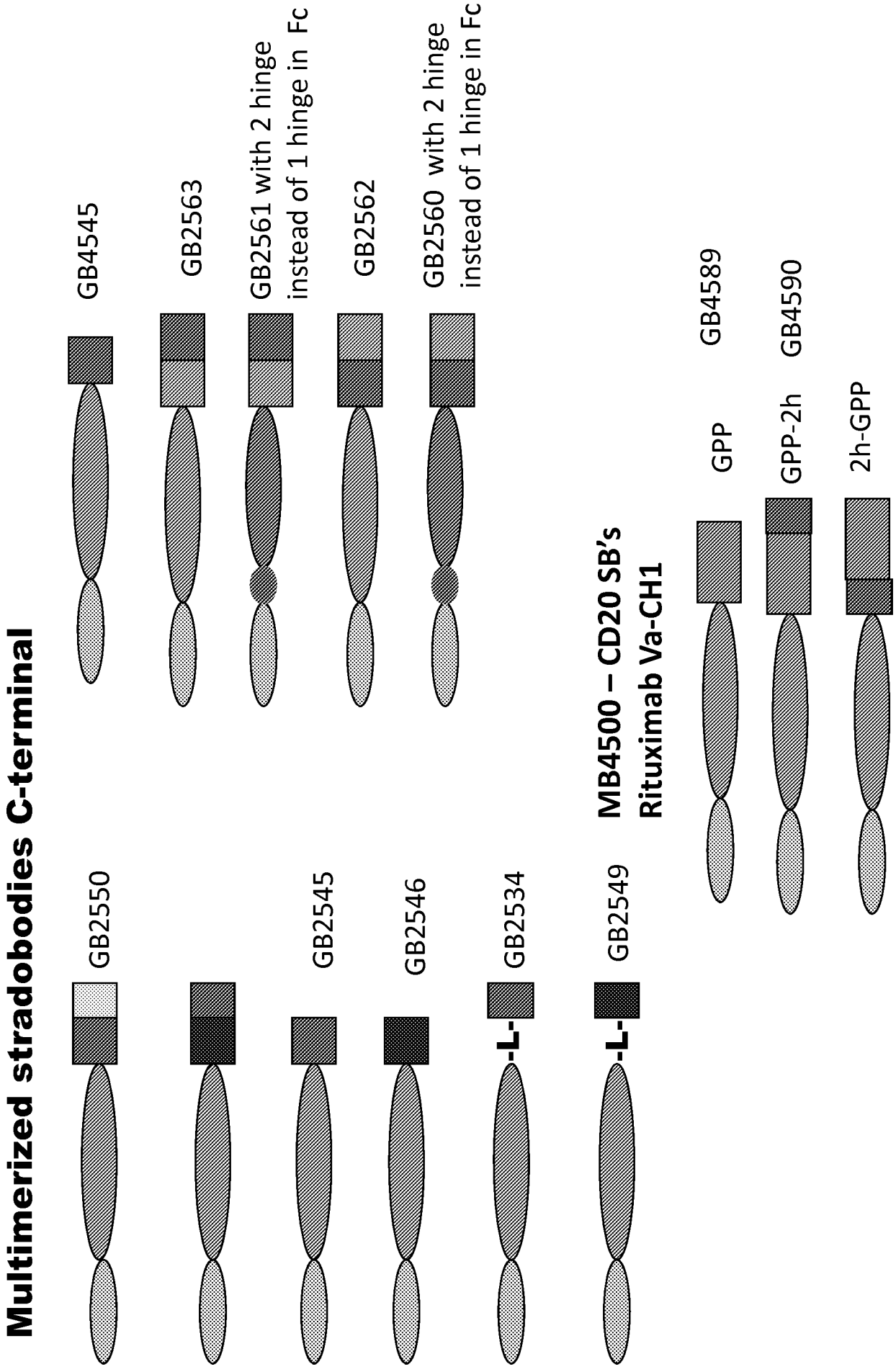

Multimerized stradobodies C-terminal
GB4545
GB2563
GB2561 with 2 hinge instead of 1 hinge in Fc
GB2562
GB2560 with 2 hinge instead of 1 hinge in Fc
GB2550
GB2545
GB2546
GB2534
-L-
GB2549
-L-
MB4500 – CD20 SB's Rituximab Va-CH1
GPP
GB4589
GPP-2h
GB4590
2h-GPP

Figure 7

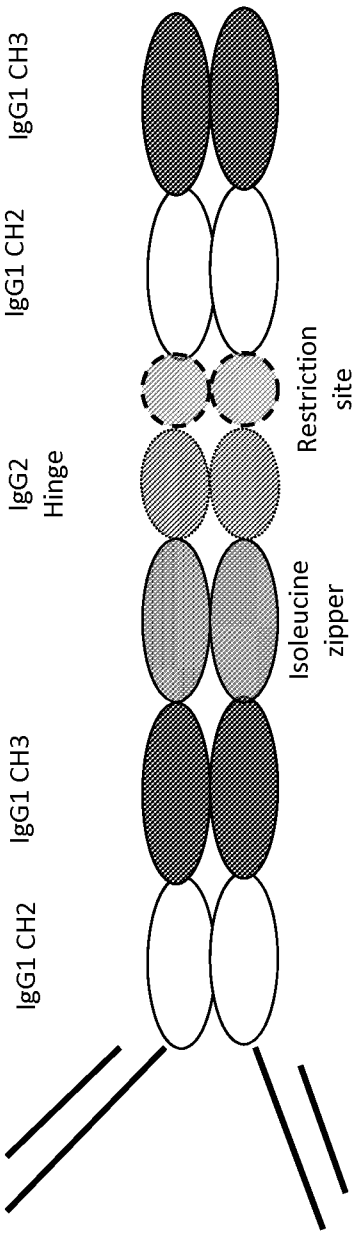

IgG1 CH3
IgG1 CH2
IgG2 Hinge
Restriction site
Isoleucine zipper
IgG1 CH3
IgG1 CH2

Figure 8

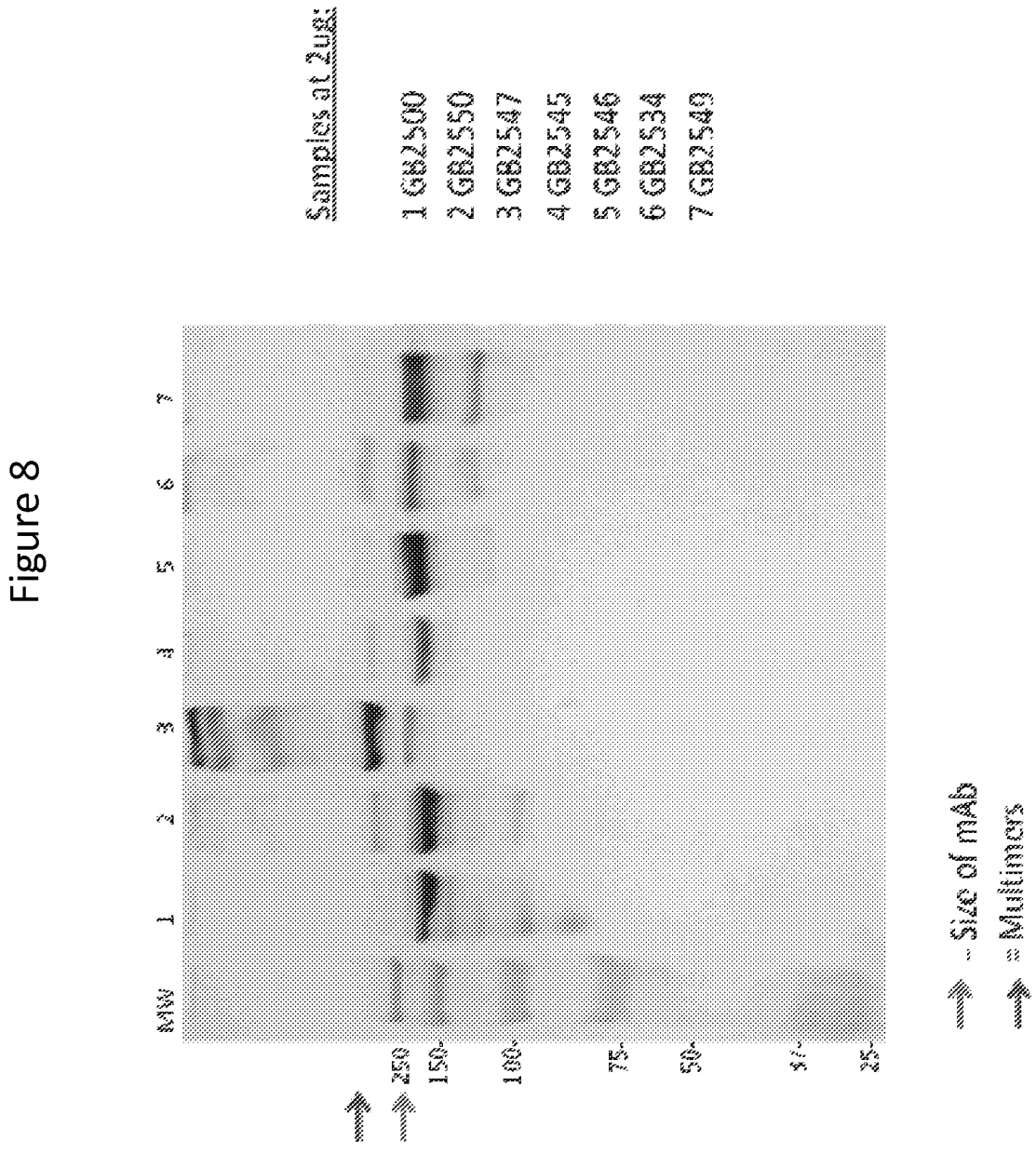

Samples at 2ug:
1 GB2500
2 GB2550
3 GB2547
4 GB2545
5 GB2546
6 GB2534
7 GB2549
MW
1
2
3
3
5
6
7
250
150
100
75
50
37
25
= Size of mAb
= Multimers

Figure 9

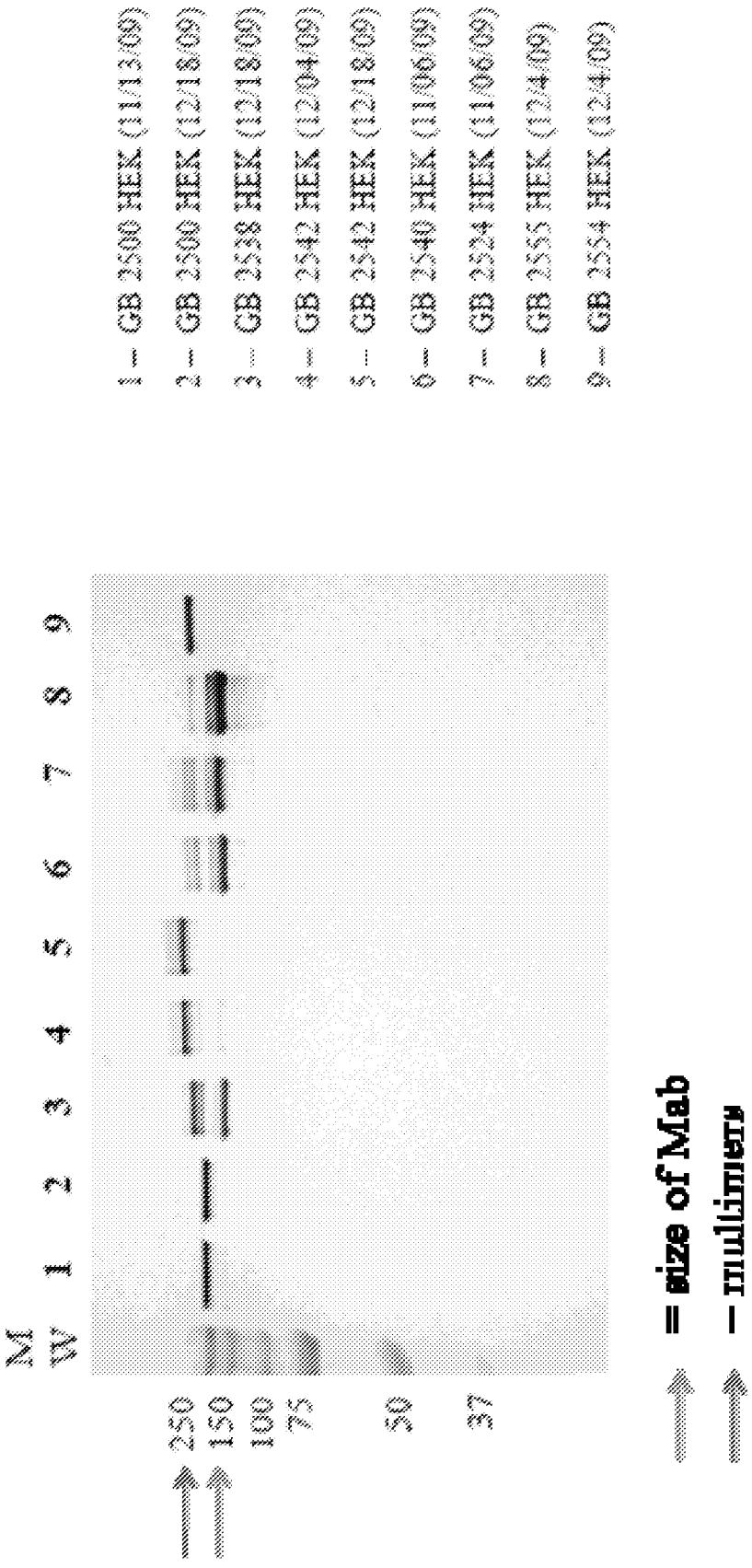

1 – GB 2500 HEK (11/13/09)
2 – GB 2500 HEK (12/16/09)
3 – GB 2538 HEK (12/18/09)
4 – GB 2542 HEK (12/04/09)
5 – GB 2542 HEK (12/18/09)
6 – GB 2540 HEK (11/06/09)
7 – GB 2524 HEK (11/06/09)
8 – GB 2555 HEK (12/4/09)
9 – GB 2554 HEK (12/4/09)
M
W 1 2 3 4 5 6 7 8 9
250
150
100
75
50
37
= size of Mab
= multimers

Figure 10

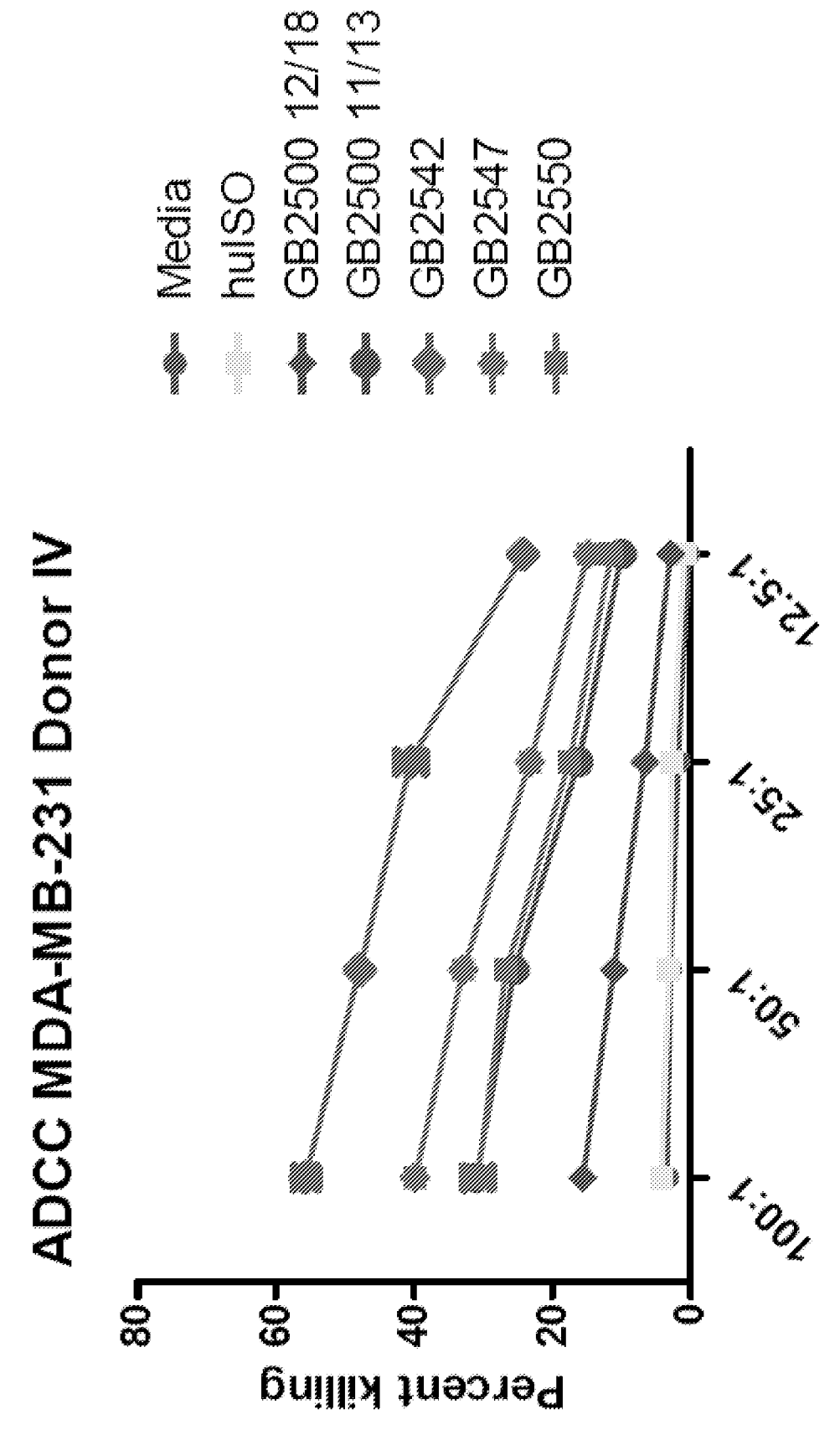

ADCC MDA-MB-231 Donor IV
Percent killing
0
20
40
60
80
100:1
50:1
25:1
12.5:1
Media
huISO
GB2500 12/18
GB2500 11/13
GB2542
GB2547
GB2550

Figure 11

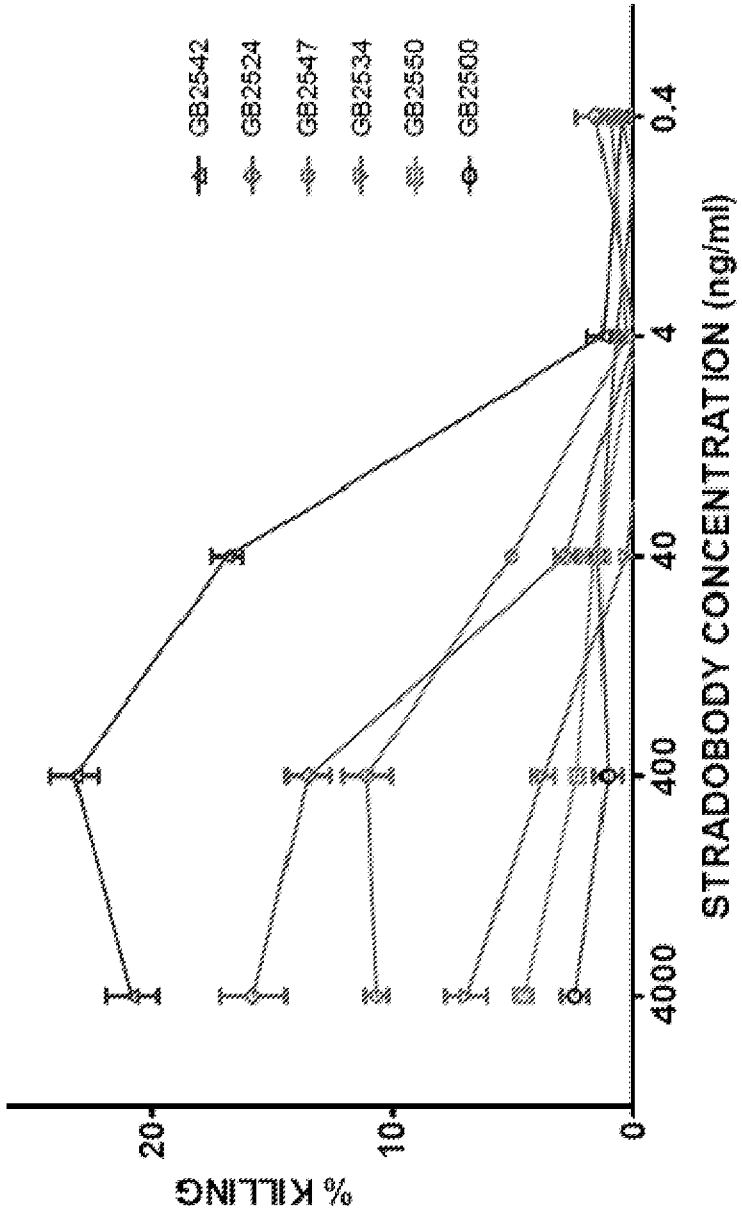

GB2542
GB2524
GB2547
GB2534
GB2550
GB2500
% KILLING
0
10
20
STRADOBODY CONCENTRATION (ng/ml)
0.4
4
40
400
4000

Figure 12

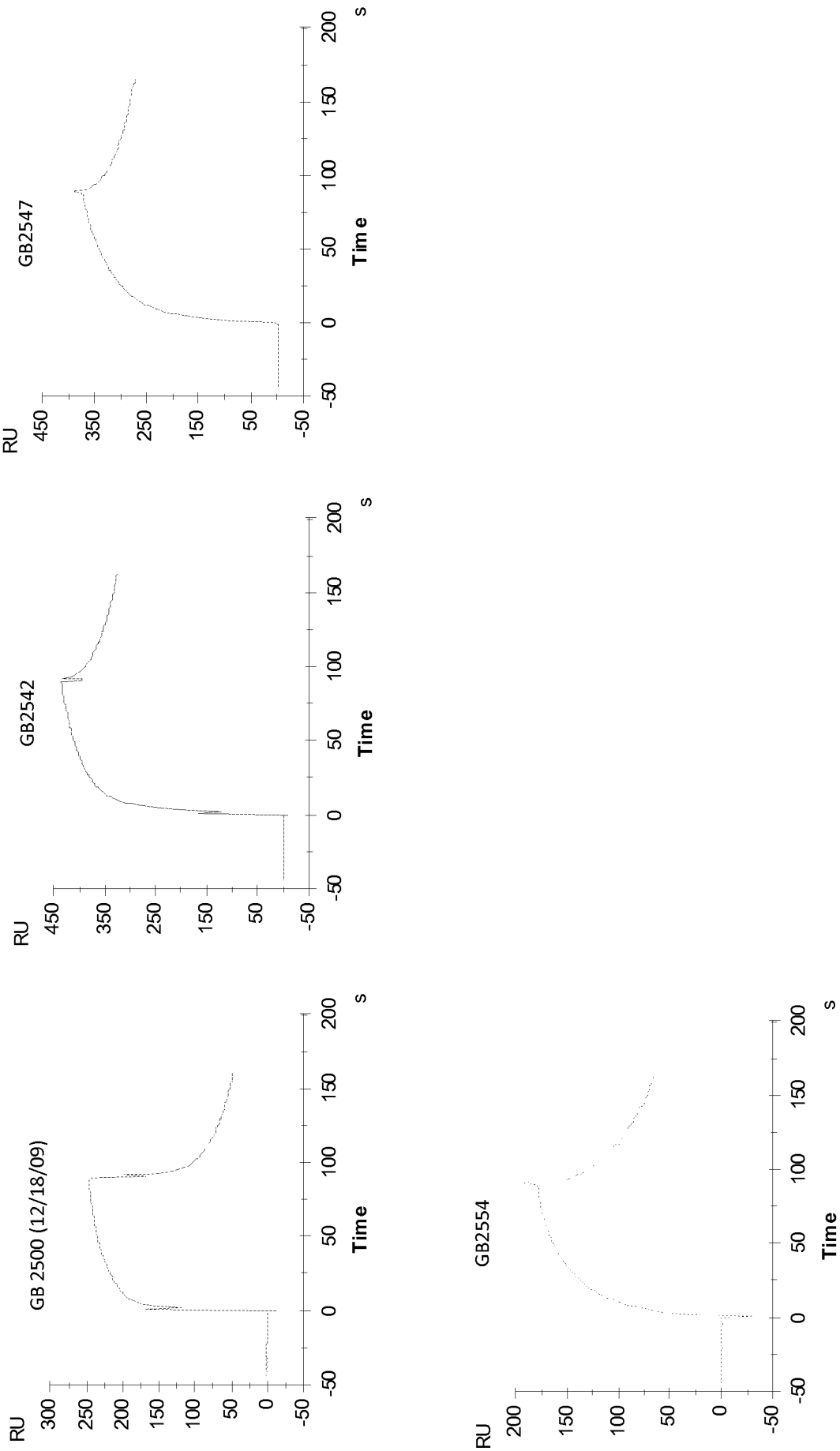

GB2547
RU
450
350
250
150
50
-50
-50
0
50
100
150
200
s
Time
GB2542
RU
450
350
250
150
50
-50
-50
0
50
100
150
200
s
Time
GB 2500 (12/18/09)
RU
300
250
200
150
100
50
0
-50
-50
0
50
100
150
200
s
Time
GB2554
RU
200
150
100
50
0
-50
-50
0
50
100
150
200
s
Time

Figure 13

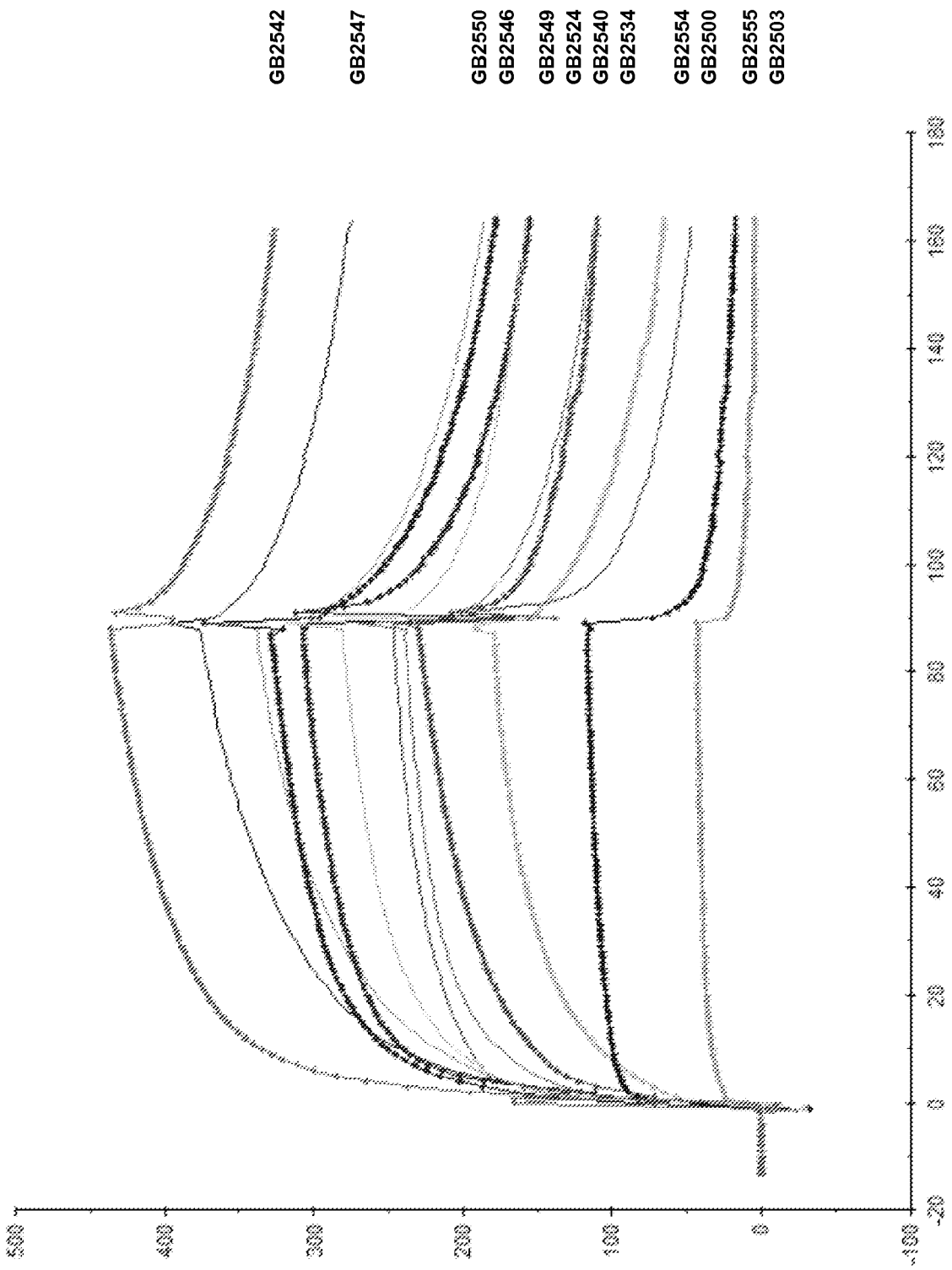

GB2542
GB2547
GB2550
GB2546
GB2549
GB2524
GB2540
GB2534
GB2554
GB2500
GB2555
GB2503
500
400
300
200
100
0
-100
-20
0
20
40
60
80
100
120
140
160
180

Figure 14

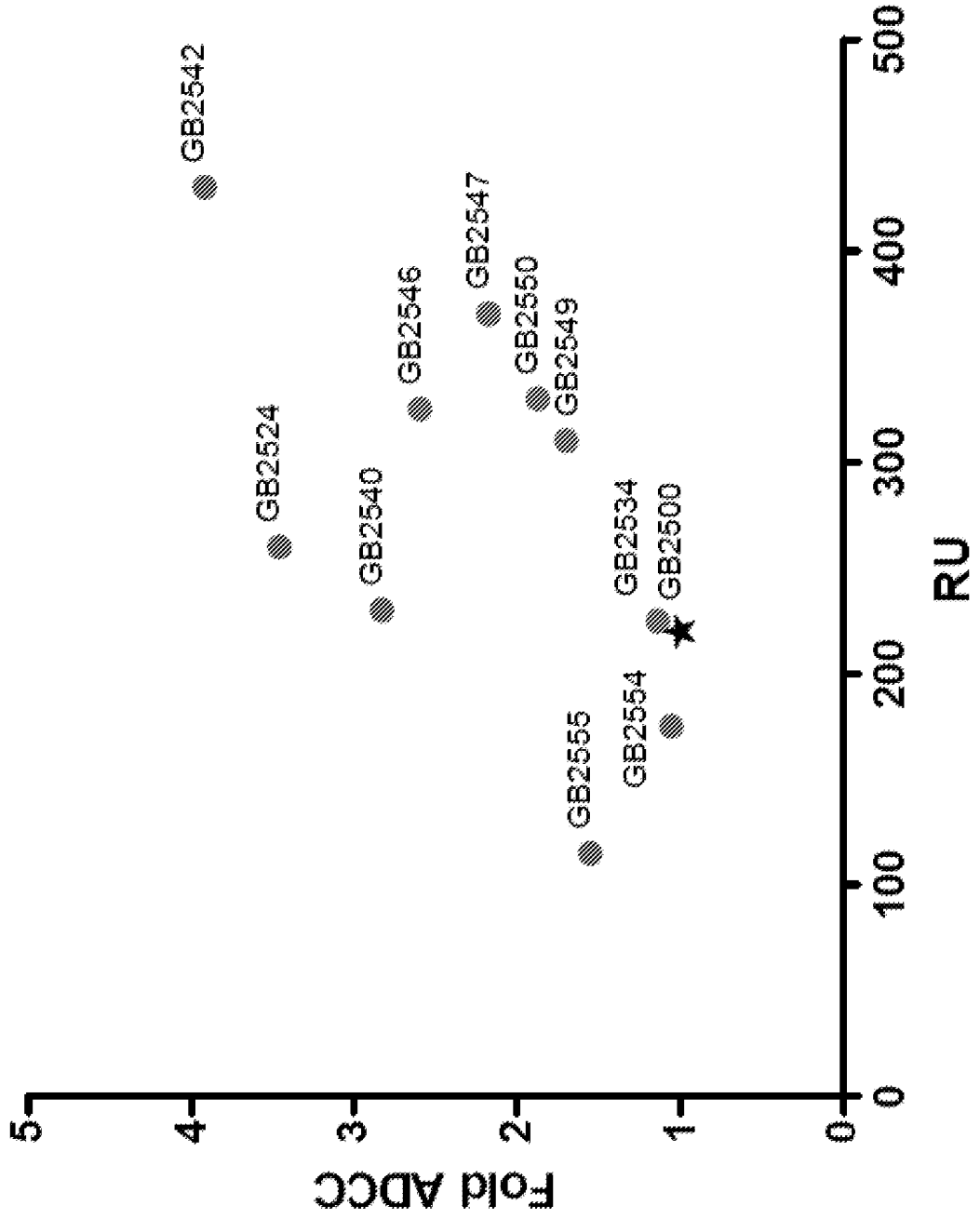

ADCC/RUmax
Fold ADCC
RU
0
1
2
3
4
5
0
100
200
300
400
500
GB2542
GB2524
GB2540
GB2546
GB2547
GB2550
GB2549
GB2534
GB2500
GB2554
GB2555

Figure 15

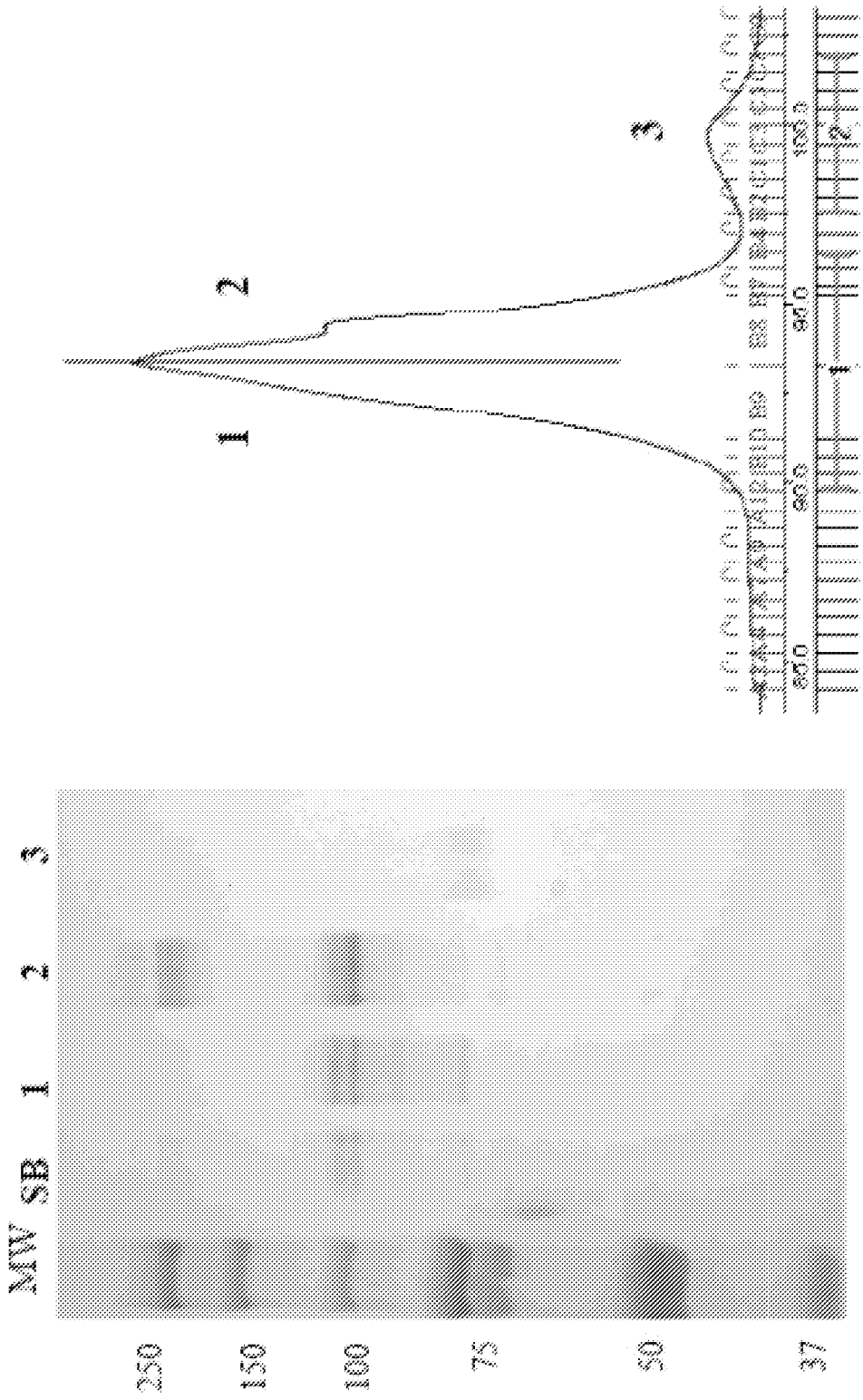
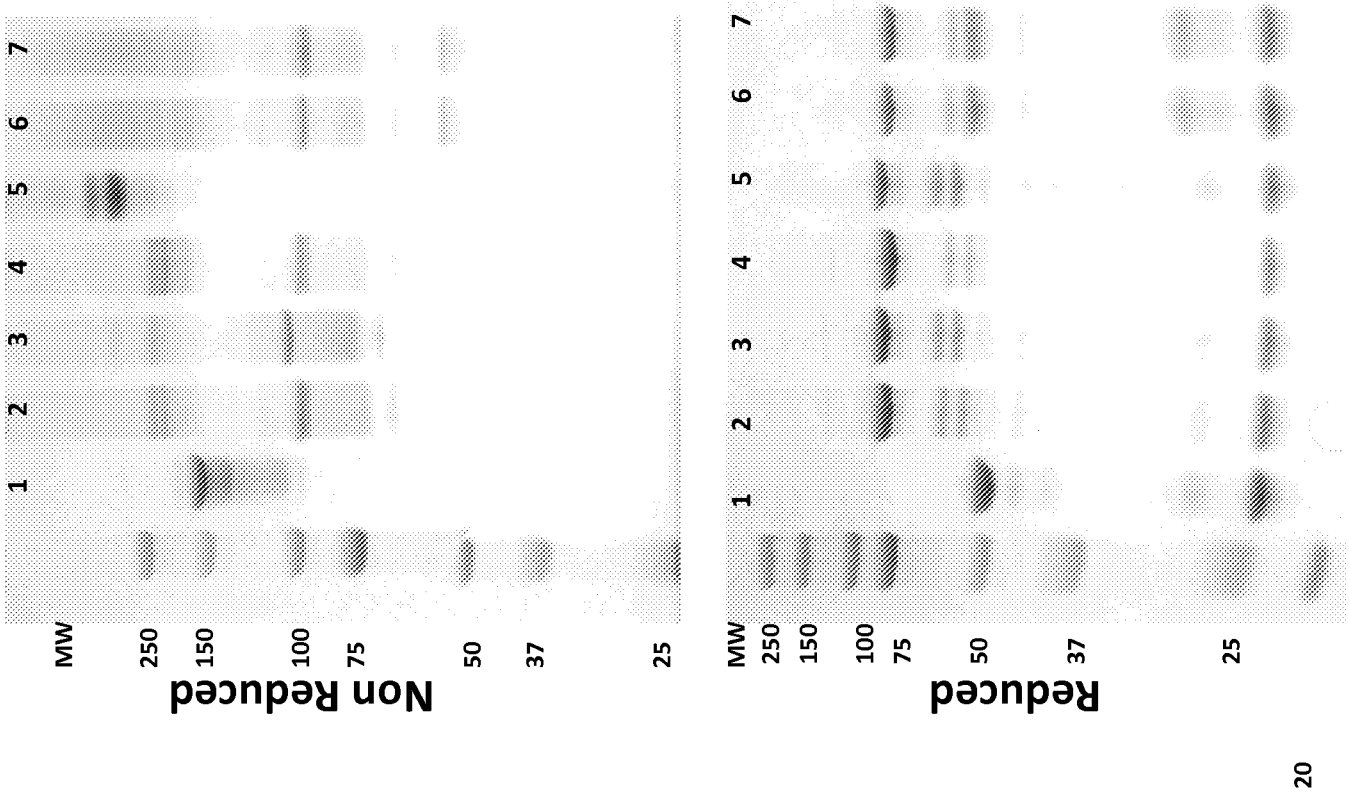


Figure 16



Constructs shown in each lane

1 GB2500 HEK T06/17/11
2 GB2524 CHO5 T07/17/12
3 GB2538 CHO5 T07/17/12
4 GB2540 CHO5 T07/17/12
5 GB2542 CHO5 T07/17/12
6 GB2554 CHO5 T07/17/12
7 GB2555 CHO5 T07/17/12

Figure 17

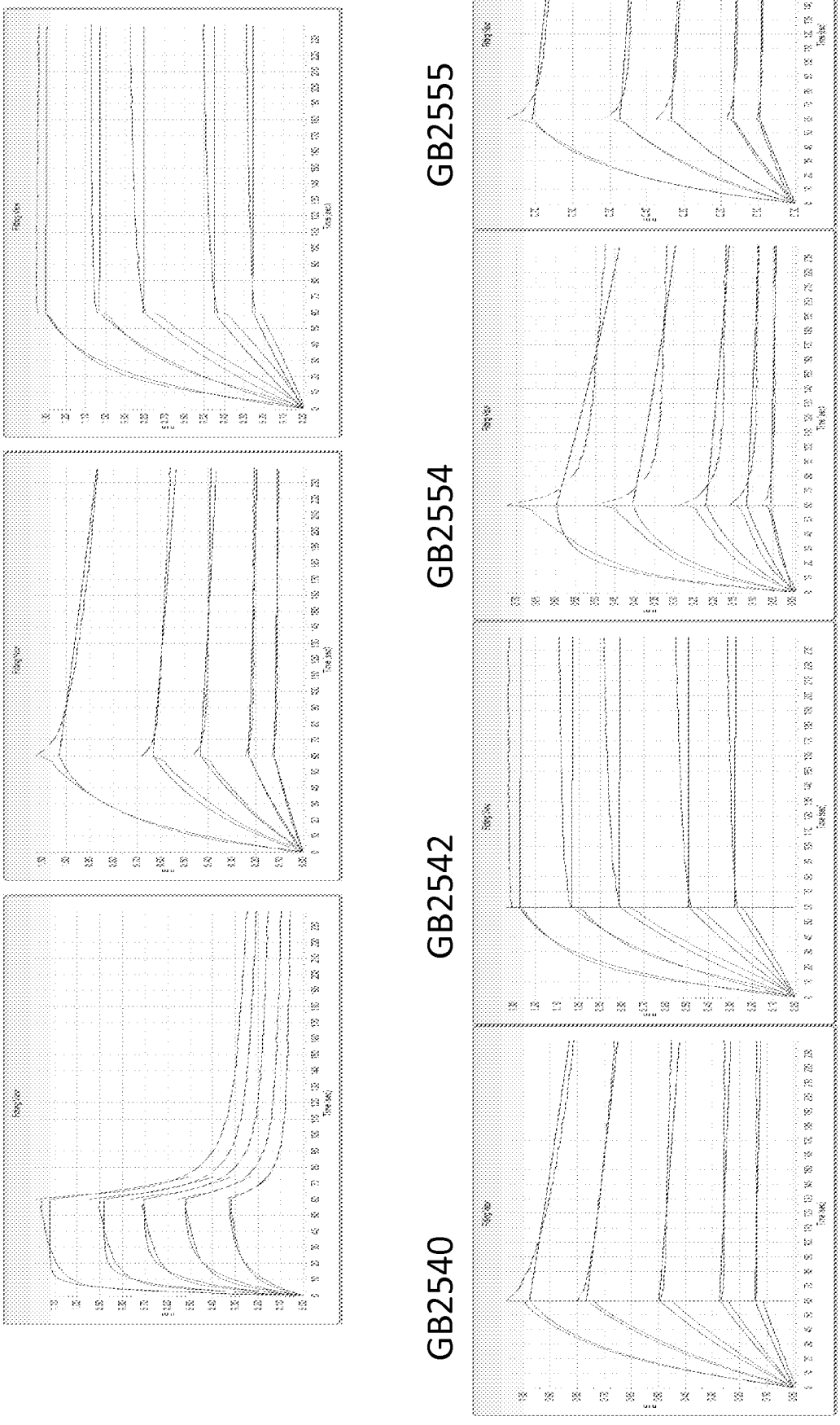


Figure 18

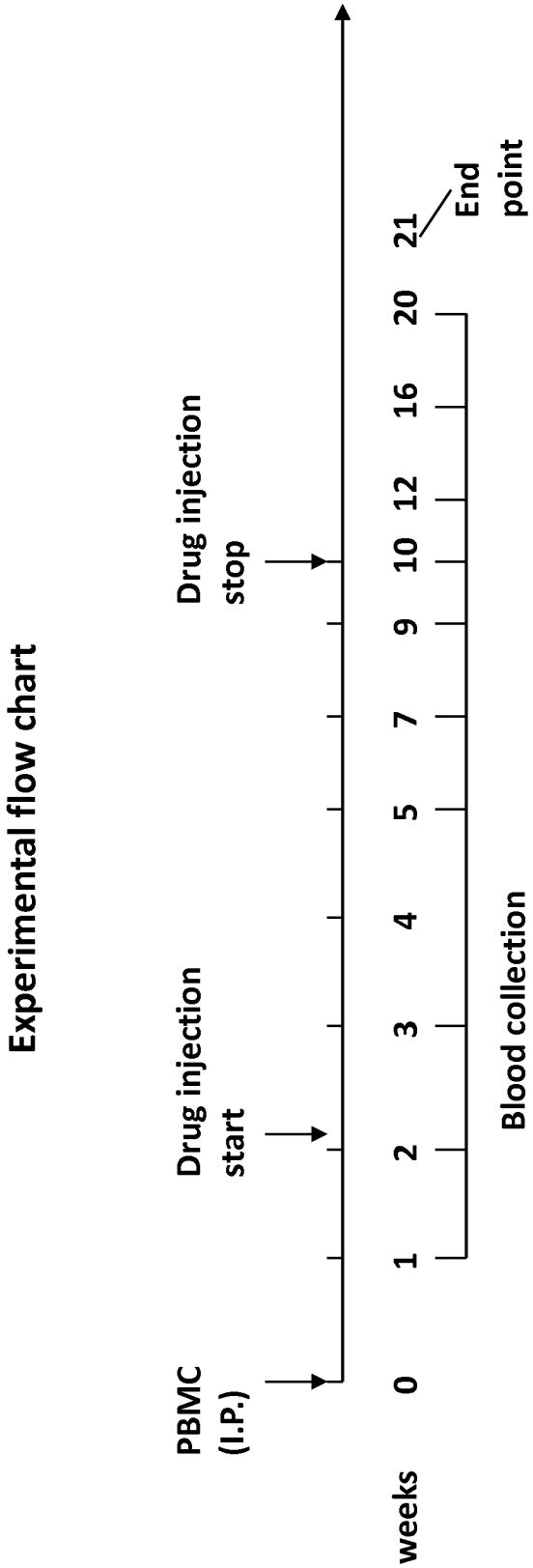

Experimental flow chart
PBMC (I.P.)
Drug injection start
Drug injection stop
Blood collection
End point
weeks
0
1
2
3
4
5
7
9
10
12
16
20
21

Figure 19

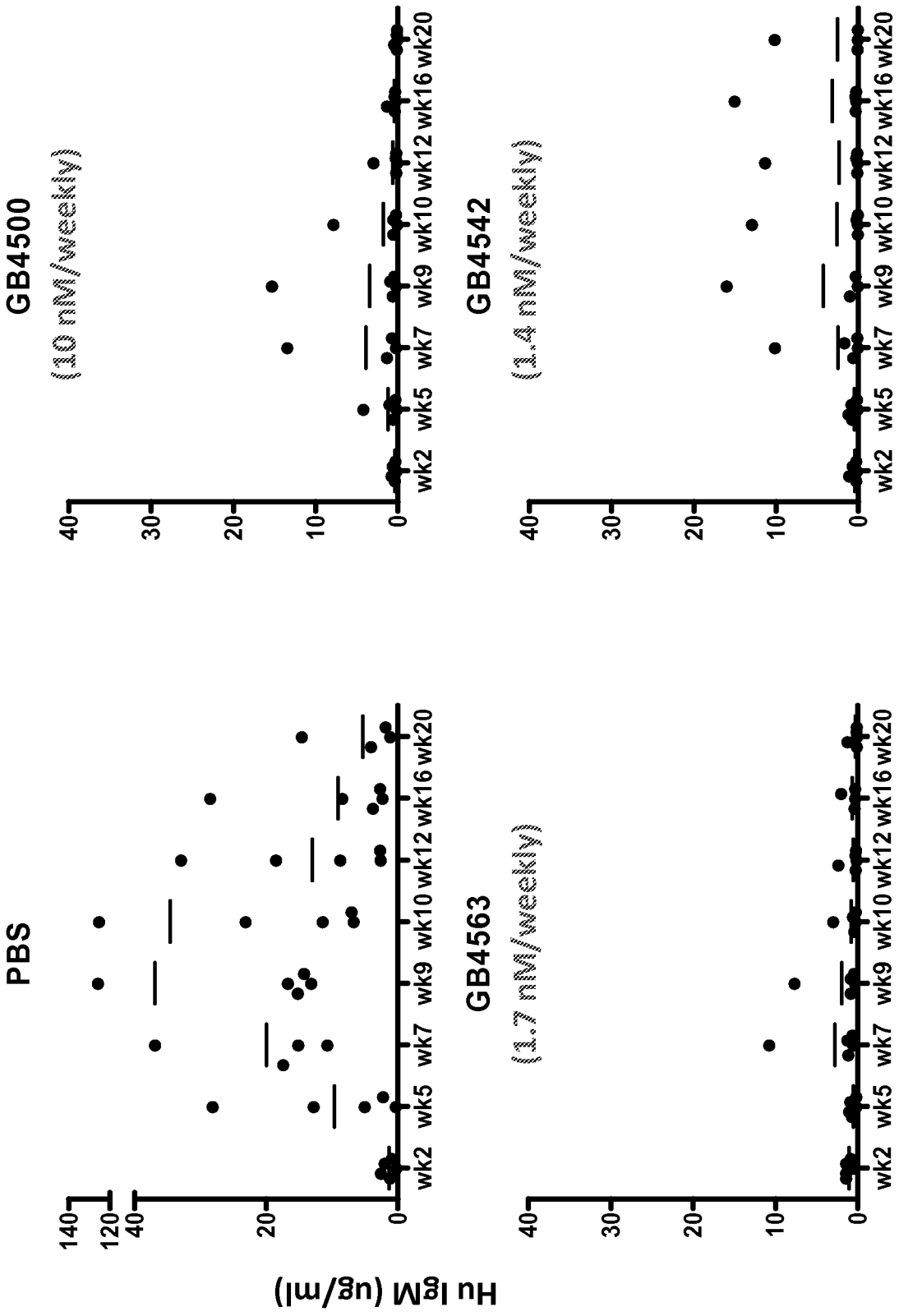

PBS
GB4500
(10 nM/weekly)
GB4563
(1.7 nM/weekly)
GB4542
(1.4 nM/weekly)
Hu IgM (ug/ml)
0
20
40
120
140
10
30
wk2
wk5
wk7
wk9
wk10
wk12
wk16
wk20

Figure 20

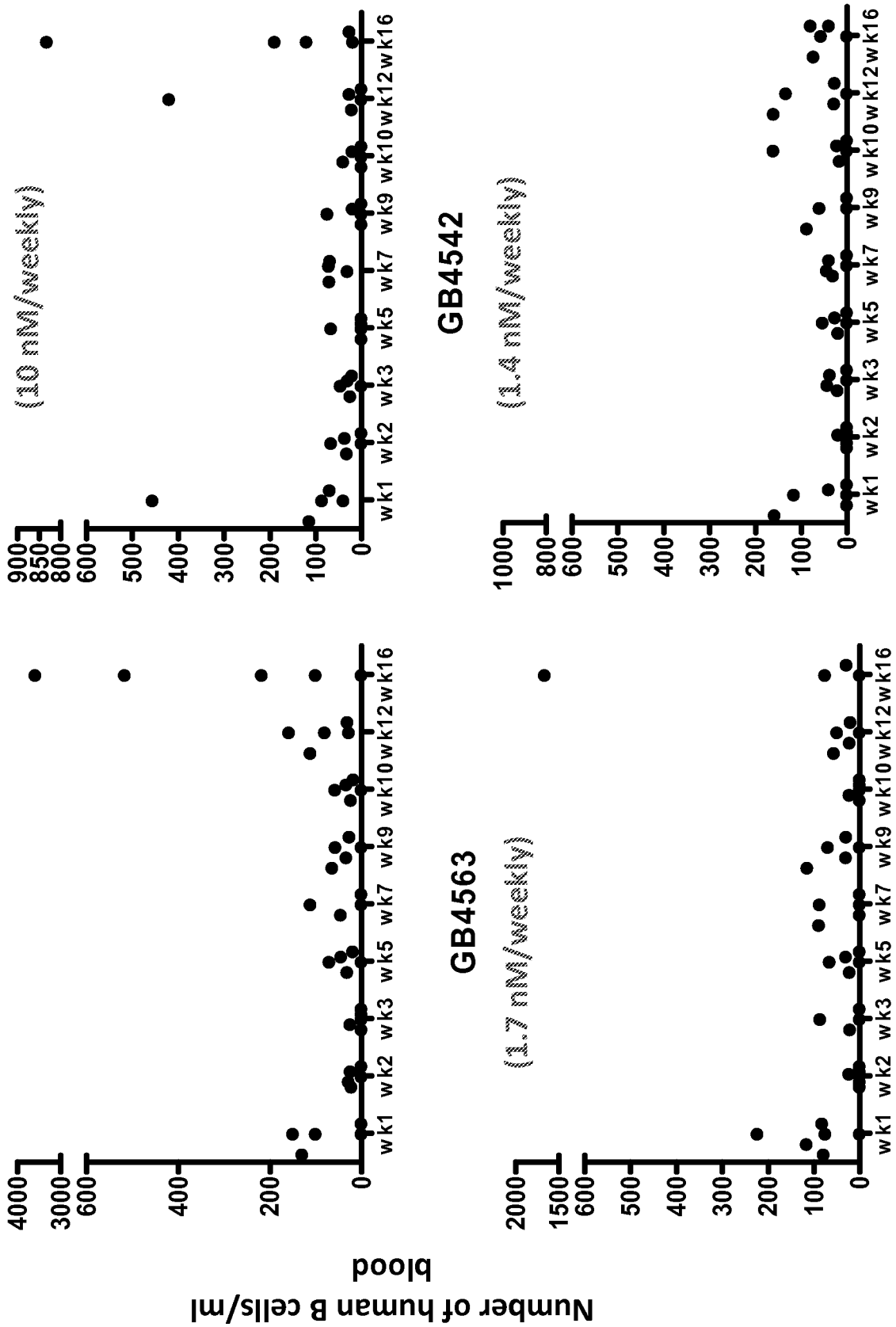

PBS
GB4500
(10 nM/weekly)
GB4563
(1.7 nM/weekly)
GB4542
(1.4 nM/weekly)
Number of human B cells/ml blood
wk1 wk2 wk3 wk5 wk7 wk9 wk10 wk12 wk16

Figure 21

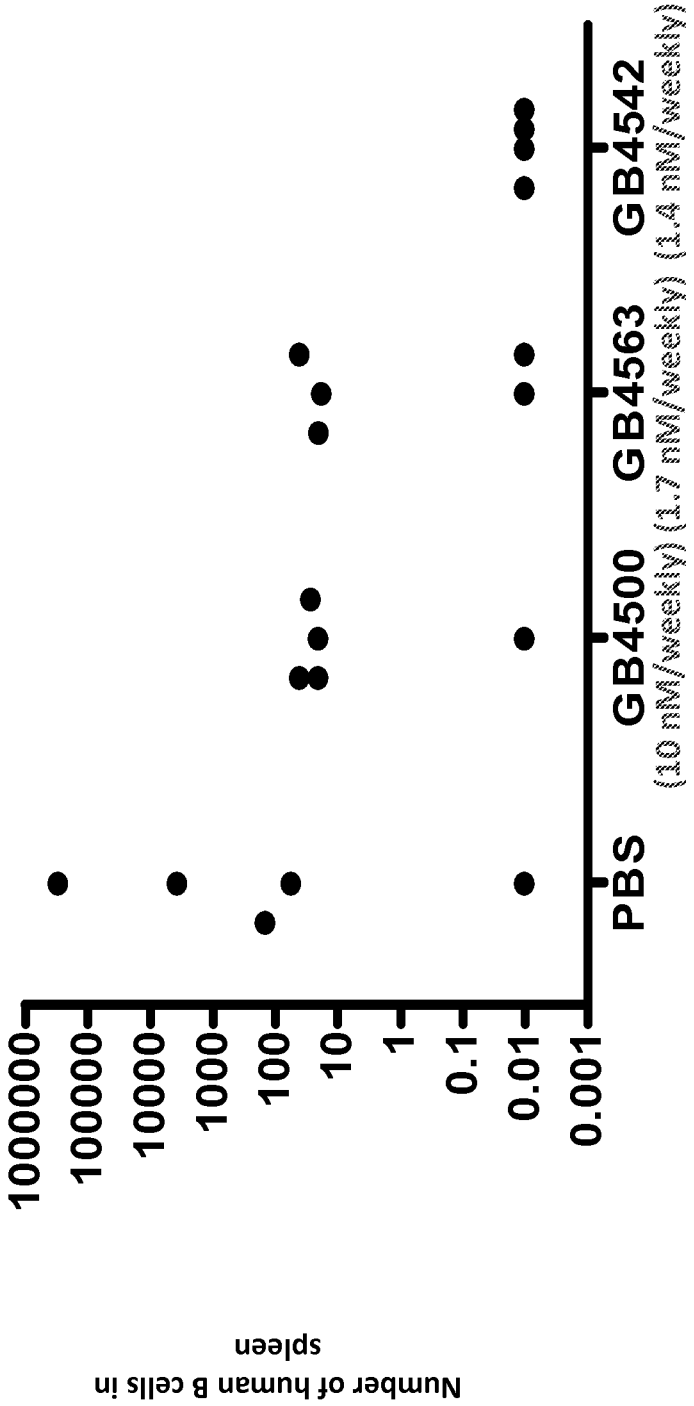

Number of human B cells in spleen
1000000
100000
10000
1000
100
10
1
0.1
0.01
0.001
PBS
GB4500 (10 nM/weekly)
GB4563 (1.7 nM/weekly)
GB4542 (1.4 nM/weekly)

Figure 22

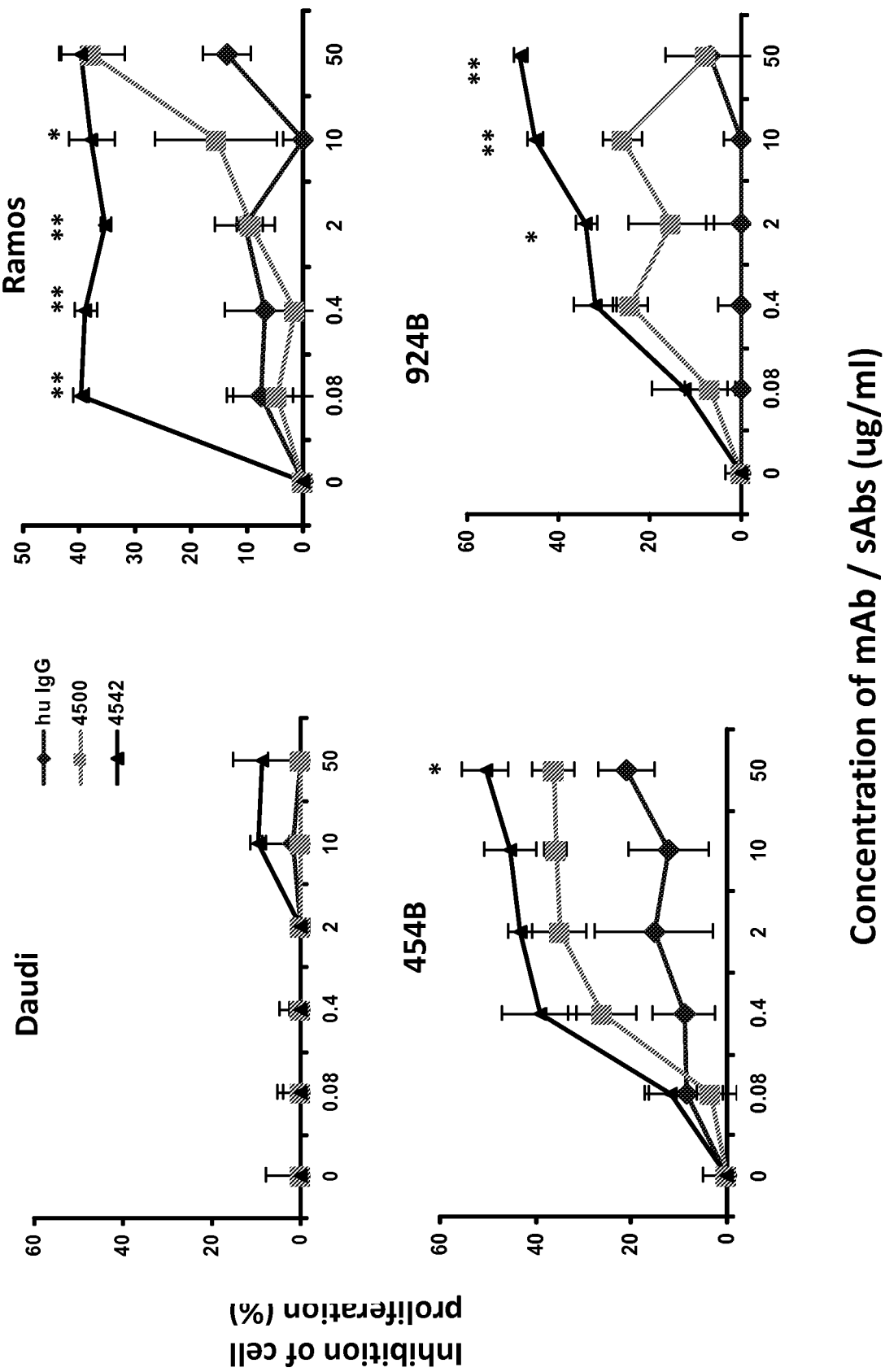

Daudi
Ramos
454B
924B
hu IgG
4500
4542
Inhibition of cell proliferation (%)
Concentration of mAb / sAbs (ug/ml)
0
0.08
0.4
2
10
50
*
**

Figure 23

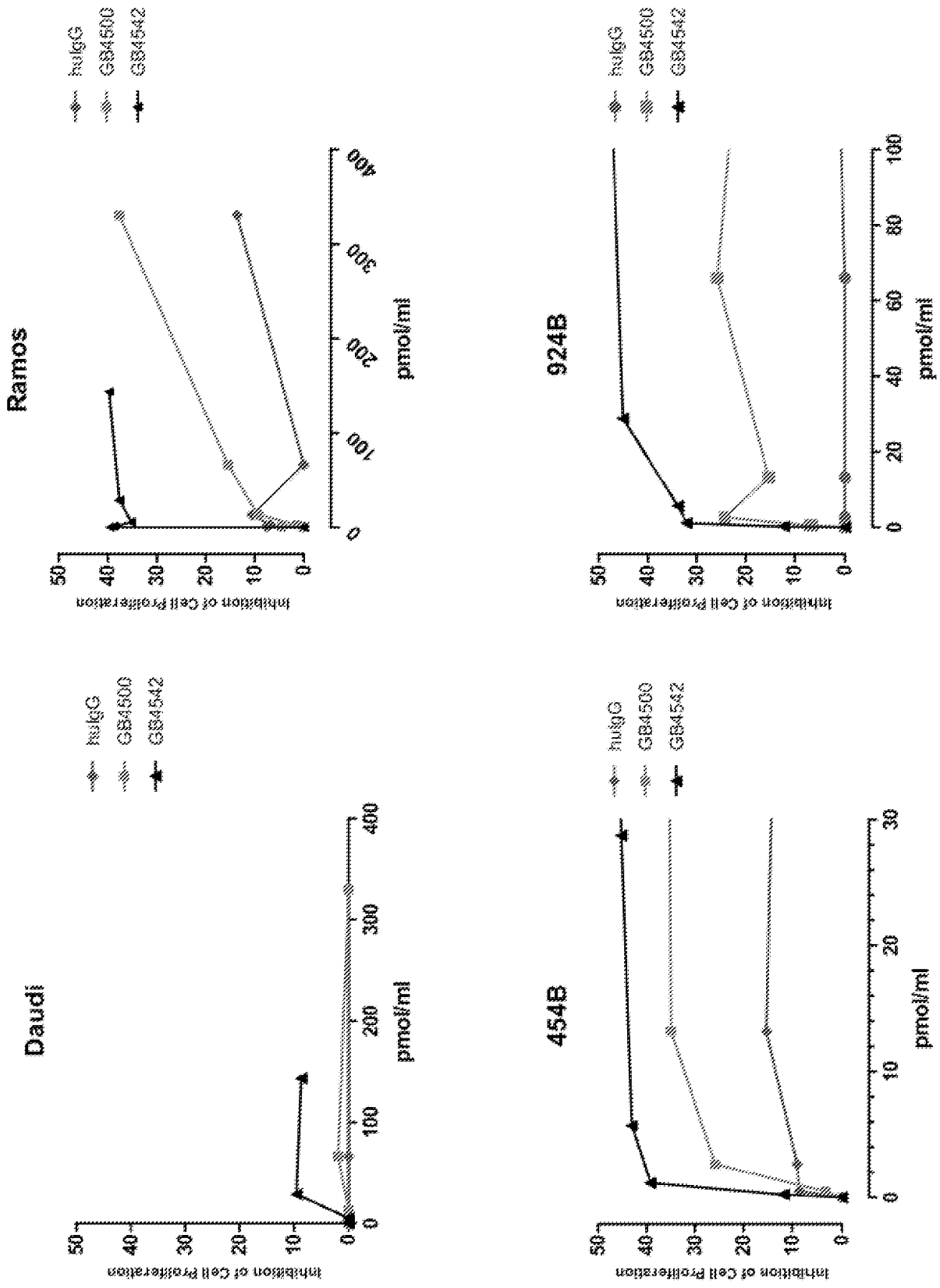

Ramos
924B
Daudi
454B
huIgG
GB4500
GB4542
Inhibition of Cell Proliferation
pmol/ml

Figure 24

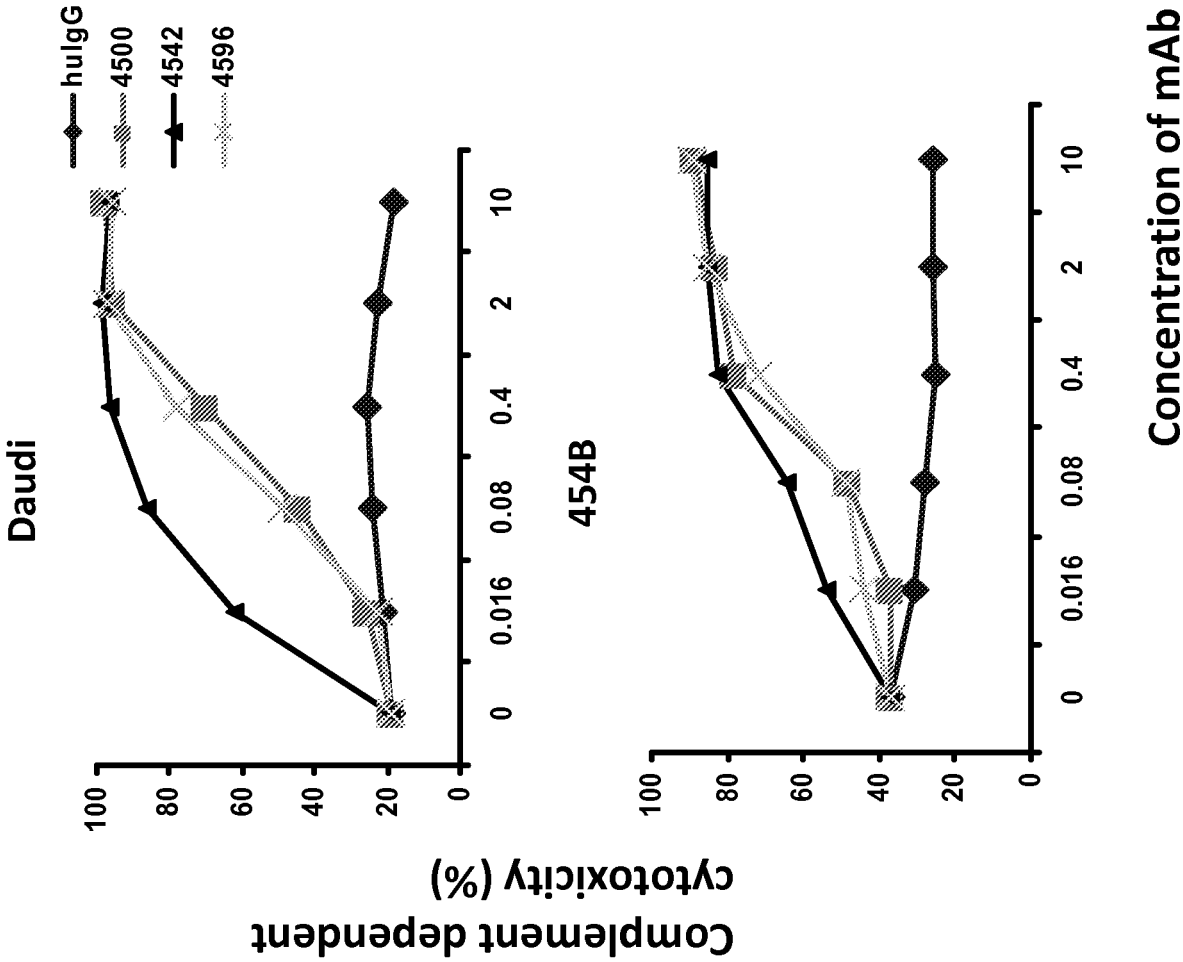

Daudi
Ramos
454B
924B
huIgG
4500
4542
4596
Complement dependent cytotoxicity (%)
Concentration of mAb / sAbs (ug/ml)
0
20
40
60
80
100
0
0.016
0.08
0.4
2
10

Figure 25

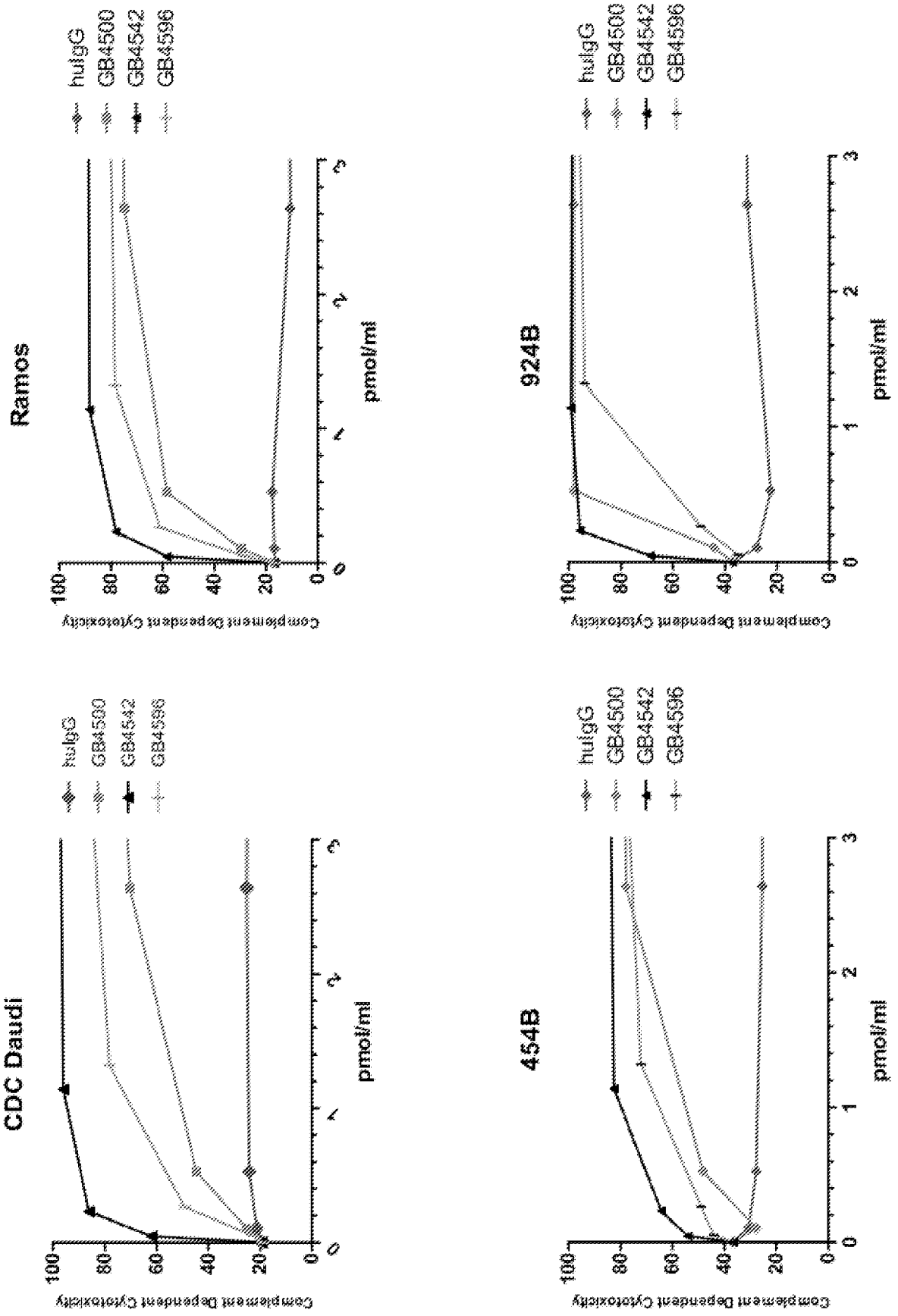

Ramos
924B
CDC Daudi
454B
huIgG
GB4500
GB4542
GB4596
Complement Dependent Cytotoxicity
pmol/ml
0
20
40
60
80
100
0
1
2
3

Figure 26

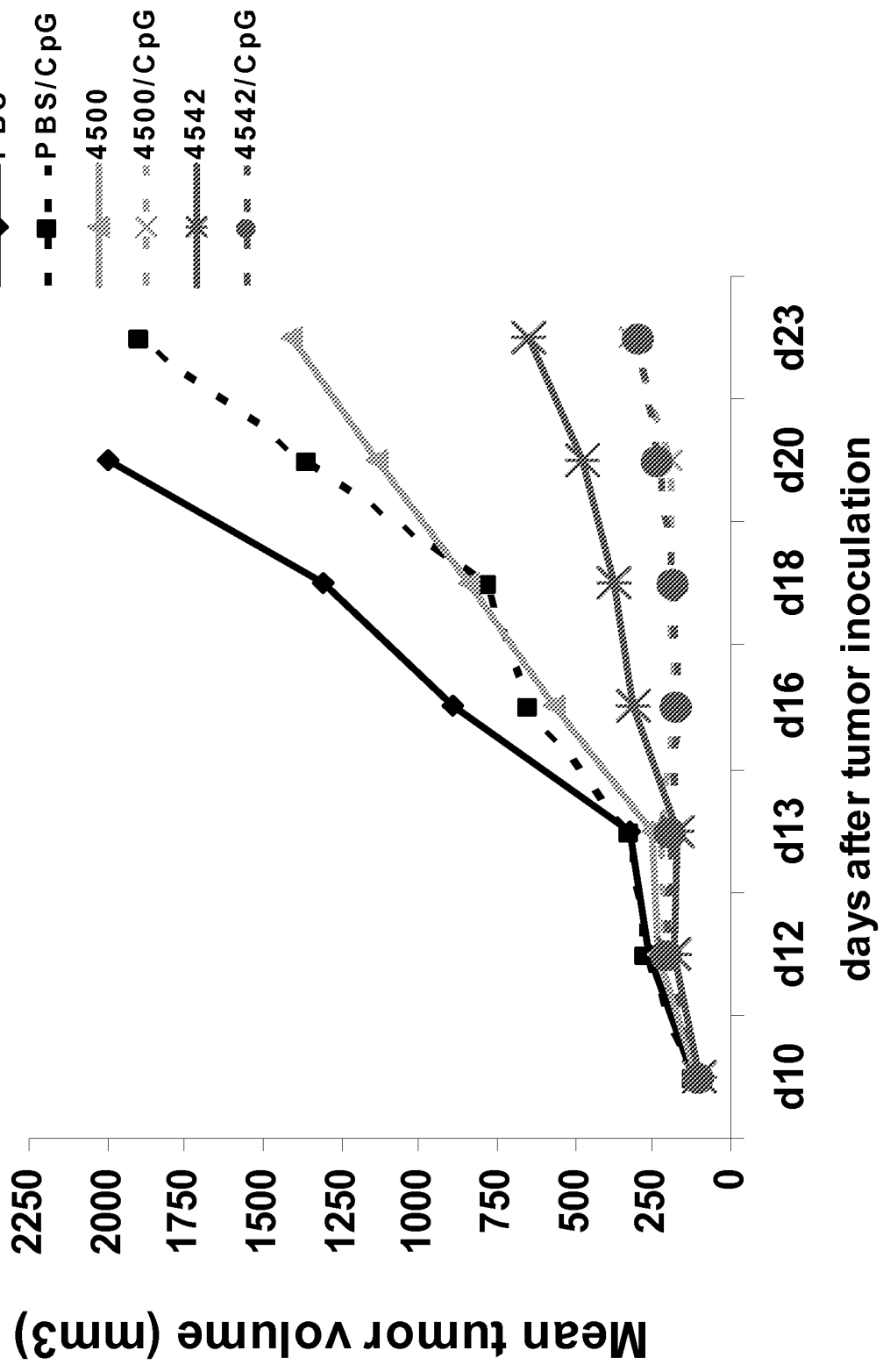

PBS
PBS/CpG
4500
4500/CpG
4542
4542/CpG
Mean tumor volume (mm3)
2250
2000
1750
1500
1250
1000
750
500
250
0
d10
d12
d13
d16
d18
d20
d23
days after tumor inoculation

Figure 27

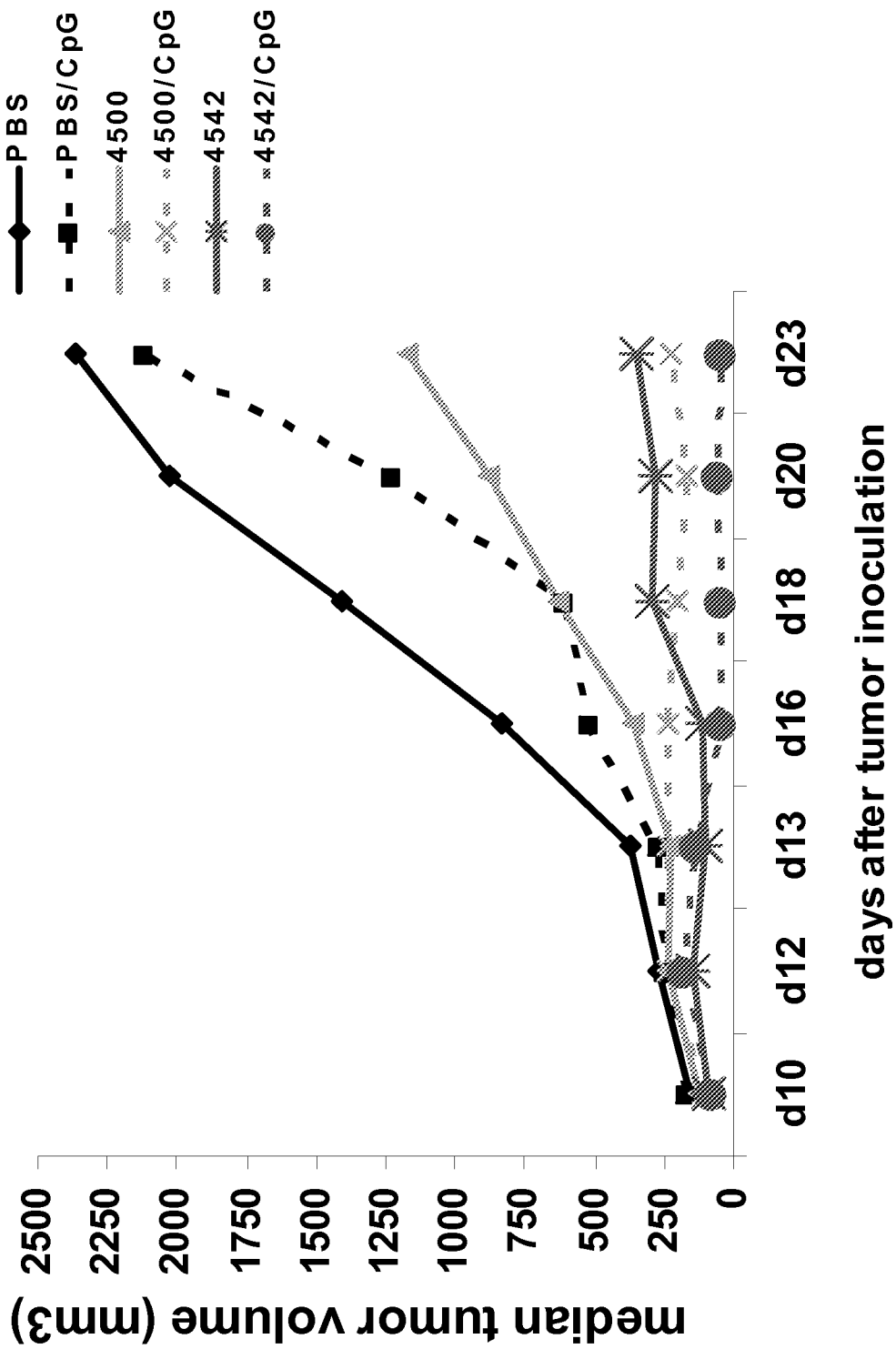

PBS
PBS/CpG
4500
4500/CpG
4542
4542/CpG
median tumor volume (mm3)
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
d10
d12
d13
d16
d18
d20
d23
days after tumor inoculation

Figure 28

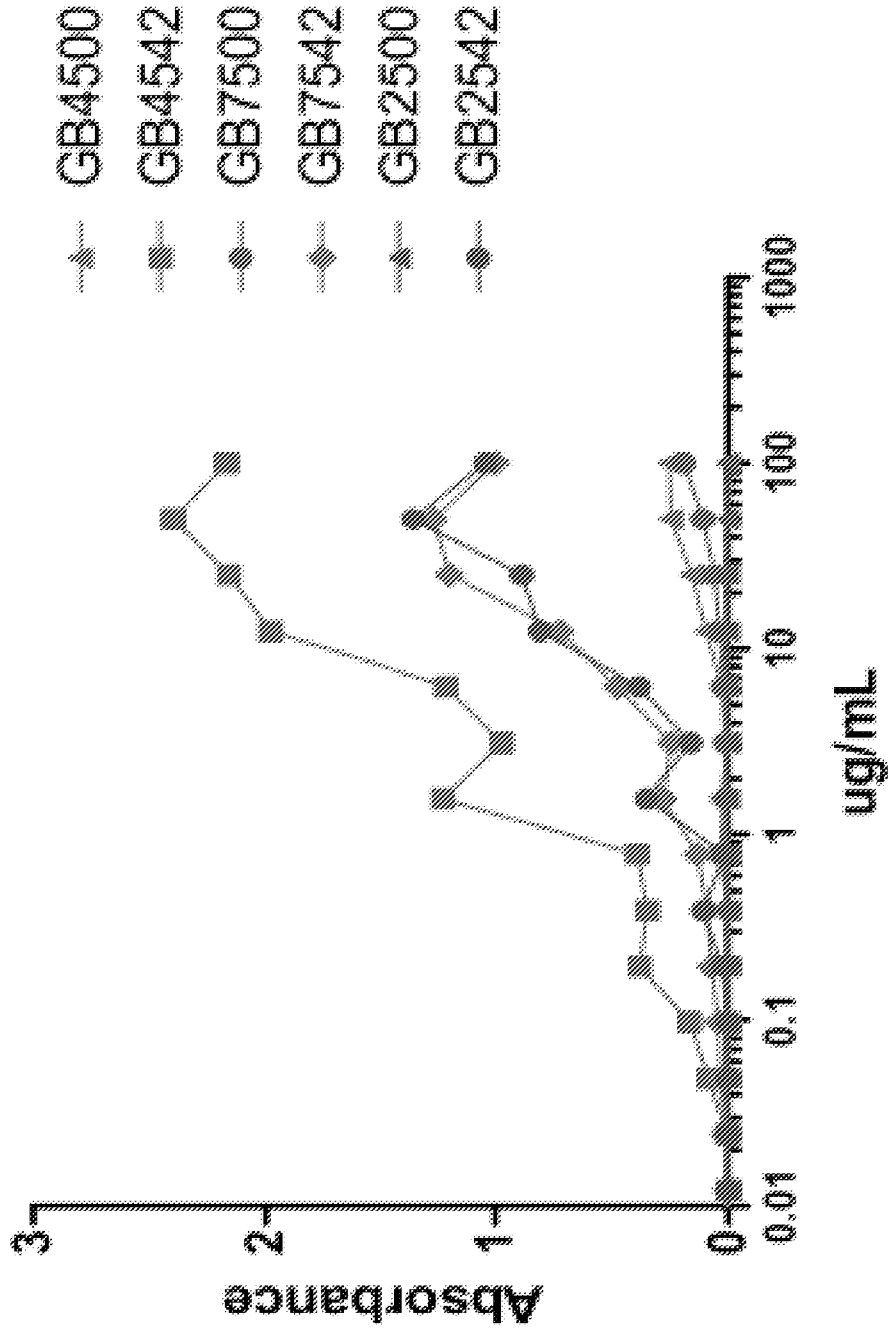

GB4500
GB4542
GB7500
GB7542
GB2500
GB2542
Absorbance
0
1
2
3
0.01
0.1
1
10
100
1000
ug/mL

Figure 29

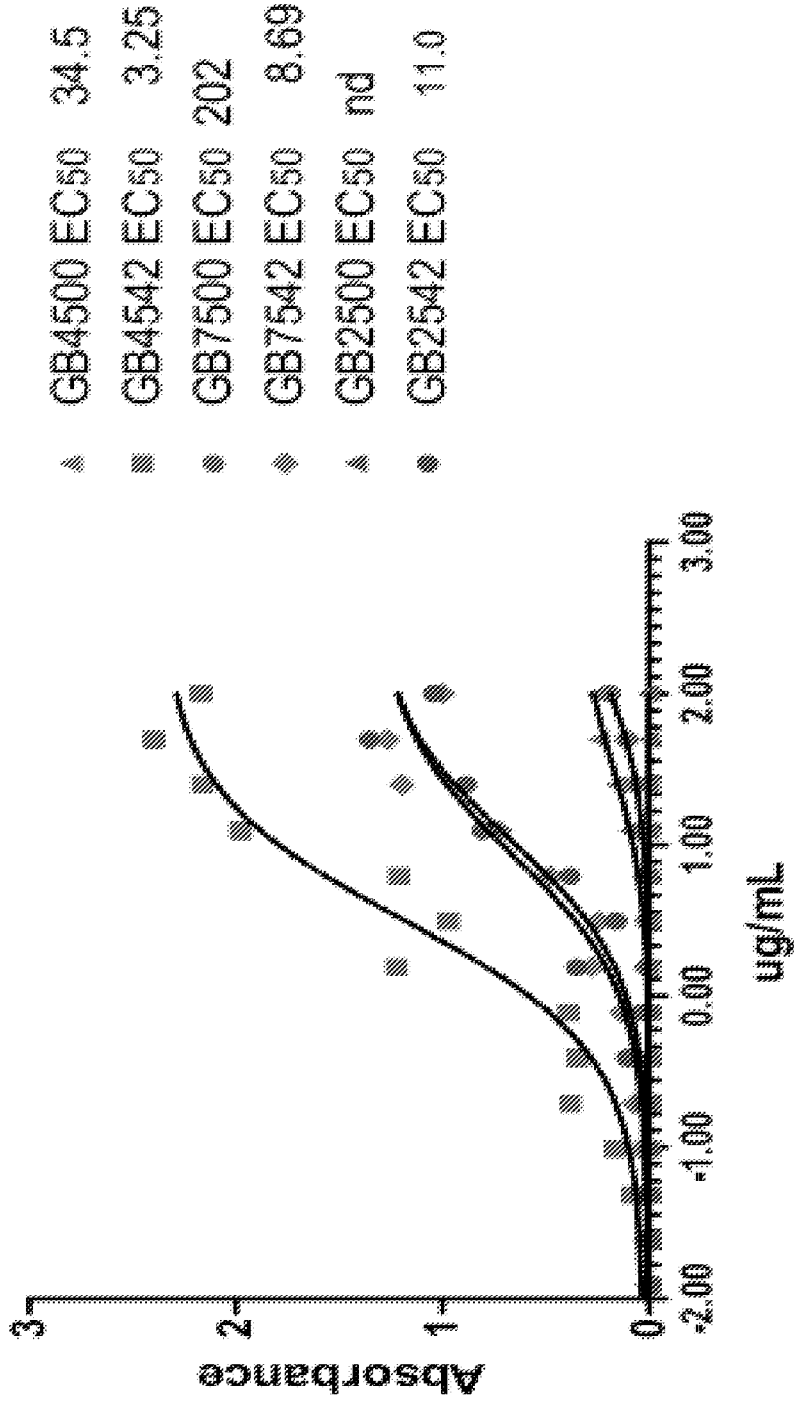

GB4500 EC50 34.5
GB4542 EC50 3.25
GB7500 EC50 202
GB7542 EC50 8.69
GB2500 EC50 nd
GB2542 EC50 11.0
Absorbance
0
1
2
3
-2.00
-1.00
0.00
1.00
2.00
3.00
ug/mL

Figure 30

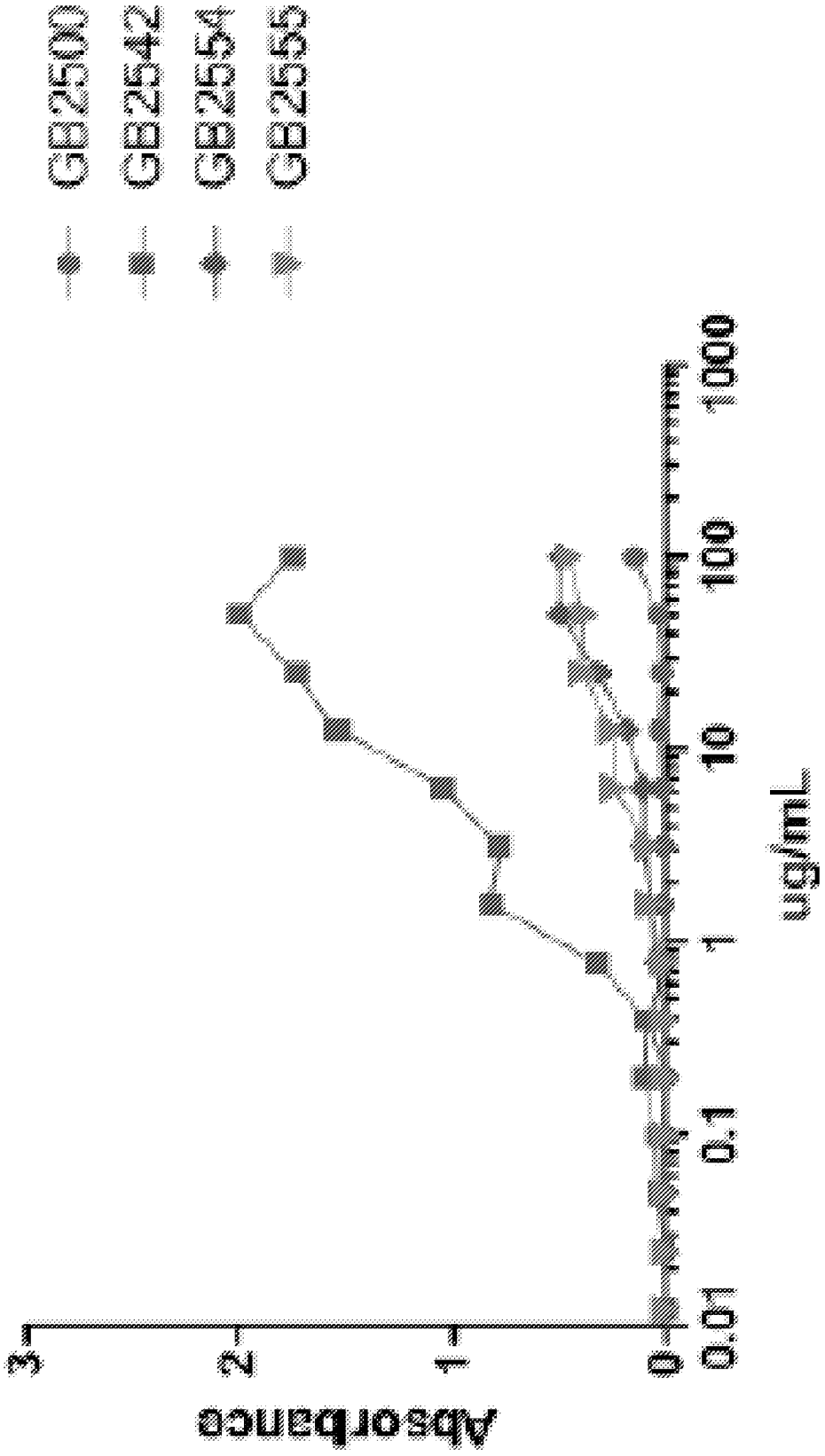
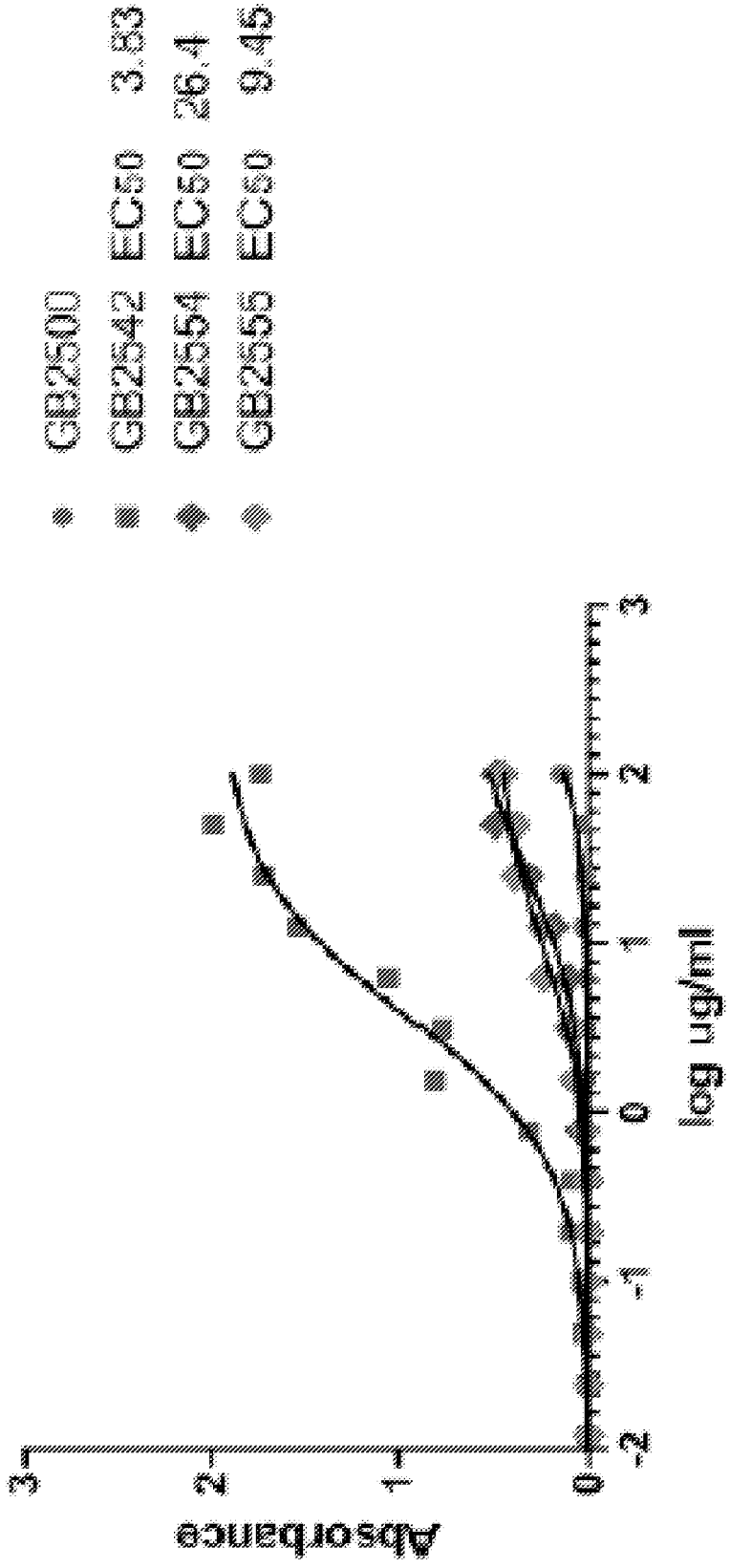

GB2500
GB2542
GB2554
GB2555
Absorbance
0
1
2
3
0.01
0.1
1
10
100
1000
ug/mL

Figure 31


GB2500
GB2542 EC50 3.83
GB2554 EC50 26.1
GB2555 EC50 9.45
Absorbance
log ug/ml
3
2
1
0
-2
-1
0
1
2
3

摘要

本发明涉及被称为斯塔都体的生物学活性蛋白质。所述斯塔都体具有产生斯塔都体多聚体的两个或更多个结构域。所述斯塔都体具有抗原结合能力和结合 Fc 受体(FcR)的能力，并且可用于治疗和预防疾病。