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(54) ANTIGEN BINDING PROTEINS

(57) The present invention concerns antigen binding proteins and fragments thereof which specifically bind B Cell Maturation Antigen (BCMA), particularly human BCMA (hBCMA) and which inhibit the binding of BAFF and

APRIL to the BCMA receptor. Further disclosed are pharmaceutical compositions, screening and medical treatment methods.

(52) Cooperative Patent Classification (CPC): (Cont.)
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Description

Field of the invention

5 [0001] The present invention relates to antigen binding proteins and fragments thereof that specifically bind B cell maturation antigen (BCMA) and in particular human BCMA (hBCMA).

10 [0002] The present invention also concerns methods of treating diseases or disorders with said antigen binding fragments, pharmaceutical compositions comprising said antigen binding fragments and methods of manufacture. Other embodiments of the present invention will be apparent from the description below.

Background of the invention

15 [0003] BCMA (CD269 or TNFRSF17) is a member of the TNF receptor superfamily. It is a non-glycosylated integral membrane receptor for the ligands BAFF and APRIL. BCMA's ligands can also bind additional receptors: TACI (Transmembrane Activator and Calcium modulator and cyclophilin ligand Interactor), which binds APRIL and BAFF; as well as BAFF-R (BAFF Receptor or BR3), which shows restricted but high affinity for BAFF. Together, these receptors and their corresponding ligands regulate different aspects of humoral immunity, B-cell development and homeostasis.

20 [0004] BCMA's expression is typically restricted to the B-cell lineage and is reported to increase in terminal B-cell differentiation. BCMA is expressed by human plasma blasts, plasma cells from tonsils, spleen and bone marrow, but also by tonsillar memory B cells and by germinal centre B cells, which have a TACI-BAFFR low phenotype (Darce et al., 2007). BCMA is virtually absent on naïve and memory B-cells (Novak et al., 2004a and b). The BCMA antigen is expressed on the cell surface so is accessible to the antibody, but is also expressed in the golgi. As suggested by its expression profile, BCMA signalling, typically linked with B-cell survival and proliferation, is important in the late stages of B-cell differentiation, as well as the survival of long lived bone marrow plasma cells (O'Connor et al., 2004) and plasmablasts (Avery et al., 2003). Furthermore, as BCMA binds APRIL with high affinity, the BCMA-APRIL signalling axis is suggested to predominate at the later stages of B-cell differentiation, perhaps being the most physiologically relevant interaction.

25 [0005] Multiple Myeloma (MM) is a clonal B-cell malignancy that occurs in multiple sites within the bone marrow before spreading to the circulation; either de novo, or as a progression from monoclonal gammopathy of undetermined significance (MGUS). It is commonly characterised by increases in paraprotein and osteoclast activity, as well as hypercalcaemia, cytopenia, renal dysfunction, hyperviscosity and peripheral neuropathy. Decreases in both normal antibody levels and numbers of neutrophils are also common, leading to a life threatening susceptibility to infection. BCMA has been implicated in the growth and survival of myeloma cell lines in vitro (Novak et al., 2004a and b; Moreaux et al., 2004).

30 [0006] BCMA expression (both transcript and protein) is reported to correlate with disease progression in MM. Using Affymetrix microarrays, it was demonstrated that the *TACI* and *BCMA* genes were over-expressed in Multiple Myeloma Cells (MMC) compared with their normal counterparts (Moreaux et al., 2004). Gene expression analysis has been used to compare human myeloma cells with purified plasma cells from patients with MGUS and from normal bone marrow as well as with primary tumour cells from B-cell lineage leukaemias (Bellucci et al., 2005). The BCMA gene was highly expressed in all myeloma samples. Although purified plasma cells from patients with MGUS had lower expression of BCMA, there was no significant difference when compared with the expression found in normal plasma cells or myeloma cells. In contrast, BCMA expression was significantly lower in B-cell Chronic Lymphocytic Leukaemia (CLL), pre-B Acute Lymphocytic Leukaemia (ALL) and T-cell ALL (T-ALL). Mouse models that transgenically over-express BAFF or APRIL have a significant increase in B-cell lymphomas (Batten et al., 2004 - BAFF; Planelles et al., 2004 - APRIL). In humans, excess BAFF and APRIL have been detected in the sera and micro-environments of patients with a number of B-cell malignancies, as well as other B-cell disorders.

45 [0007] All patent and literature references disclosed within the present specification are expressly and entirely incorporated herein by reference.

Brief Description of Figures

50 [0008]

Figure 1: FMAT Binding Assay - Figure showing the results of the FMAT assay for CA8 antibody binding to human and cyno BCMA expressing HEK293 cells. Human chimeric CA8 binds well to human and cyno BCMA expressing cells.

55 **Figure 2: ELISA Binding Assay** - Figure showing the ELISA results for CA8 antibodies binding to human and cyno BCMA recombinant proteins. This clearly shows that human chimeric CA8 antibodies bind to human and cyno BCMA proteins equally.

Figure 3: BiaCore Binding Assay - Figure showing the binding of CA8 to BCMA-Fc, TACI-Fc and BAFF-R-Fc proteins in the Biacore experiment. CA8 chimera antibody does not bind to TACI or BAFF-R proteins.

Figure 4: Cell binding assay - Figure showing binding of murine S307118G03, S3222110D07, S332121F02 and S332126E04 to H929 multiple myeloma cells and S3322110D07, S332121F02 and S332126E04 to the BCMA transfected ARH77 cells as determined by FACS.

Multiple myeloma cell line H929 or ARH77-hBCMA 10B5 BCMA expressing transfected cells were stained with either murine anti BCMA antibodies (solid histogram) or murine IgG2a isotype control (open histograms). Cells were analysed by FACS to detect antibody bound to the cells.

Figure 5: Cell binding assay - Figure showing binding of chimeric CA8 to a panel of multiple myeloma cell lines as determined by FACS. Binding to H929, OPM-2, JJN-3 and U266 was tested by flow cytometry and mean fluorescence intensity (MFI) values measured to determine binding. Synagis was used as an irrelevant isotype control.

Figure 6: Cell binding assay - Figure showing binding curves of humanised CA8 variants to BCMA transfected ARH77 cells (A) and multiple myeloma H929 cells (B) as determined by FACS. Humanised variants J6M0, J6M1, J6M2, J9M0, J9M1 and J9M2 were tested by flow cytometry and mean fluorescence intensity (MFI) values measured to determine binding compared to the CA8 chimera.

Figure 7: Ligand neutralisation assays -

(A and B) Figure showing the ability of CA8 and J6M0 to neutralise binding of recombinant BAFF or APRIL to recombinant BCMA coated on an ELISA plate. OD values were used to calculate the antibody mediated inhibition of the maximal signal achieved by the relevant ligand alone binding to recombinant BCMA. Data is reported as percentage inhibition of the maximal signal. Antibodies tested were chimeric CA8 and humanised CA8 version J6M0 in both wild type and afucosylated (Potelligent) form.

(A) Neutralisation of BAFF ligand binding; **(B)**- Neutralisation APRIL ligand binding.

(C) - Figure showing the ability of J6M0 BCMA antibody in inhibition of BAFF or APRIL induced phosphorylation of NFKappaB in H929 cells. H-929 cells were washed 3 times to remove any sBCMA and resuspended in serum free medium. J6M0 potelligent antibody was added to a 96 well plate to give a final well concentrations up to 100ug/ml along with BAFF or APRIL ligand to give a final well concentration of 0.6 or 0.2 ug/ml respectively. H-929 cells were then plated at 7.5x10⁴cells/well in serum free medium. 30 minutes later the cells were lysed and phosphorylated NFkappaB levels measured using a MSD pNFkappaB assay. MSD reader 502819. This is data from one independent experiments. Each data point is the mean/sd of two replicates.

Figure 8: ADCC assay - Figure showing ADCC activity of chimeric CA8 and defucosylated (Fc enhanced) CA8 with target cells expressing BCMA.

Human NK cells were incubated with europium labelled ARH77 10B5 BCMA transfected target cells in the presence of varying concentrations of antibody. Europium release from the target cells was measured and specific lysis calculated. **(A)** ADCC dose response curves of chimeric CA8 compared to isotype control . **(B)** ADCC dose response curves for chimeric CA8 and defucosylated chimeric CA8 (Fc enhanced), against the BCMA expressing cell line ARH77 10B5.

Figure 9: ADCC assay - Figure showing ADCC assay on CA8 humanised antibodies using ARH77 BCMA expressing target cells.

Human PBMC were incubated with europium labelled ARH77 BCMA transfected target cells in the presence of a range of concentrations of the J5, J6, J7, J8 or J9 series of humanised CA8 antibodies. Europium release from the target cells was measured and specific lysis calculated. EC50 values are shown in ug/ml.

Figure 10: ADCC assay - Figure showing ADCC activity of chimeric, S332121F02 **(A)**, S3322110D07 **(B)** S307118G03 **(C)** and humanised S307118G03 H3L0 **(D)** against ARH7710B5 target cells with purified NK cells as effector cells. Human NK target cells were incubated with europium labelled ARH77 10B5 BCMA transfected target cells in the presence of varying concentrations of antibody. Europium release from the target cells was measured and specific lysis calculated.

Figure 11: Viability assay dose response curves - Figure showing dose response curves in a cell viability assay for chimeric CA8 antibody, chimeric CA8-vcMMAE and chimeric CA8-mcMMAF antibody-drug conjugates in human multiple myeloma cell lines **(A)** NCI-H929 **(B)** U266-B1 **(C)** JJN3 and **(D)** OPM2. Antibody was added to the cells

and the number of viable cells after 96 hours measured using CellTiterGlo. Data points represent the mean of triplicate CellTiterGlo measurements. Error bars represent standard error.

Figure 12: Impact of CA8 chimeric antibody on cell cycle.

- (A) Cell cycle histograms of NCI-H929 cells treated with unconjugated chimeric CA8, chimeric CA8-vcMMAE ADC or chimeric CA8-mcMMAF ADC at 50ng/mL for the timepoints indicated. Paclitaxel (100nM) was used as a positive control for G2/M cell cycle arrest and cell death. Control human IgG1 was used as a negative control. Cell cycle analysis was carried out at the times shown on the graphs.
 (B) Quantification of the 4N DNA cell population indicative of G2/M arrest and (C) sub-2N DNA cell population indicative of cell death for each of the treatments indicated. Cells were seeded in 12-well plates (2×10^5 cells per well in 1mL of RPMI + 10% FBS). Antibody or ADC was added 6 hours after cell seeding.

Figure 13: Impact of chimeric CA8 on phospho-histone H3.

Chimeric CA8 ADC treatment results in increased phospho-Histone H3 staining of NCI-H929 cells. (A,B) Dot plots of cells stained with propidium iodide to measure DNA content (FL3-H) x-axis and anti-phospho-Histone H3 (Thr11) antibody (FL1-H) y-axis after treatment with either Control IgG (A) or chimeric CA8-mcMMAF (B). (C) Quantification of phospho-Histone H3 positive NCI-H929 cells after a 48 hour treatment with the indicated concentrations of chimeric CA8 ADCs. Paclitaxel (100nM) was used as a positive control for mitotic arrest and control chimera IgG1 was used as a negative control. Cells were seeded in 12-well plates (2×10^5 cells per well in 1mL of RPMI + 10% FBS). Antibody or ADC was added 6 hours after cell seeding.

Figure 14: Impact of chimeric CA8 on Annexin-V.

- Chimeric CA8 ADC treatment results in increased Annexin-V staining of NCI-H929 cells.
 (A) Histograms of Annexin-V-FITC (FL1-H; top panels) and Live cell propidium iodide staining (FL3-H; bottom panels) after treatment with increasing concentrations of chimeric CA8 ADCs (B) Quantification of Annexin-V positive NCI-H929 cells after a 96 hour treatment with the indicated concentrations of chimeric CA8 ADCs. Paclitaxel (100nM) was used as a positive control for apoptosis and control chimera IgG1 was used as a negative control. Cells were seeded in 12-well plates (2×10^5 cells per well in 1mL of RPMI + 10% FBS). Antibody or ADC was added 6 hours after cell seeding.

Figure 15: Viability assay dose response curves - Figure showing dose response curves for the unconjugated (Naked) and vcMMAE and mcMMAF antibody-drug conjugates of chimeric CA8 or humanized J6M0 antibodies. Antibody drug conjugates were tested against human multiple myeloma cell lines NCI-H929 and OPM2.

Figure 16: Viability assay dose response curves - Figure showing dose response curves for the unconjugated antibodies, vcMMAE and mcMMAF antibody-drug conjugates of murine anti-BCMA antibodies S332121F02, S322110D07, S332126E04 and S307118G03 in human multiple myeloma cell lines NCI-H929 and U266-B1.

Figure 17 ADCC activity of ADC J6M0 molecules - Figure showing ADCC assay on J6M0 antibodies using ARH77 BCMA expressing target cells. Human PBMC were incubated with europium labelled ARH77 BCMA transfected target cells in the presence of a range of concentrations of J6M0 WT and potent BCMA antibodies conjugated to MMAE, MMAF, or unconjugated Europium release was monitored on the Victor 2 1420 multilabel reader.

Figure 18 ADCC dose response curves of CA8 J6M0 Potelligent against a panel of 5 multiple myeloma lines - Human PBMC were incubated with multiple myeloma target cells in the presence of varying concentrations of CA8 J6M0 potent antibody at an E:T ratio of 50:1 for 18 hours. The percentage of target cells remaining in the effector plus target mixture was then measured by FACS using a fluorescently labelled anti-CD138 antibody to detect the target cells and the percent cytotoxicity calculated. A) Example dose response curves for CA8 J6M0 potent against the five multiple myeloma cell lines tested. Each data point is from a singlicate value.

Figure 19 Effect of dose escalation of J6M0 and drug conjugated J6M0 on the growth and establishment of NCI-H929 cells in CB.17 SCID mice Calculated tumour volumes of NCI-H929 tumours in CB17 SCID mice following twice weekly intraperitoneal dosing of either 50 or 100ug J6M0 anti-BCMA or IgG1 isotype control unconjugated, or conjugated to MMAE or MMAF for 2 weeks. Data points represent mean tumour volume of n=5 per group

Figure 20- Determination of soluble BCMA levels in serum from healthy volunteers and myeloma patients.

Serum samples were collected from MM patient samples were from a variety of stages (progressive disease, remission, relapsed, newly diagnosed, and others). The samples shown in the figure are those from serum diluted 1/500 prior to the assay.

5 A Human BCMA/TNFRSF17 sandwich ELISA kit from R&D Systems which measures soluble human BCMA levels was used to detect BCMA following the standard protocol provided with the kit.

Summary of the Invention

[0009] The present invention provides antigen binding proteins which bind to membrane bound targets and wherein the antigen binding protein is capable of internalisation. In a further embodiment there is provided an immunoconjugate comprising the antigen binding protein of the present invention and a cytotoxic agent. In a further embodiment the antigen binding protein has ADCC effector function for example the antigen binding protein has enhanced ADCC effector function.

[0010] The present invention provides antigen binding proteins which specifically bind to BCMA, for example antibodies which specifically bind to BCMA and which inhibit the binding of BAFF and/or APRIL to the BCMA receptor. The present invention also provides antigen binding proteins which specifically bind to BCMA and which inhibits the binding of BAFF and/or APRIL to BCMA wherein the antigen binding protein is capable of binding to Fc_γRIIIA or is capable of Fc_γRIIIA mediated effector function.

[0011] The antigen binding proteins of the present invention specifically bind to BCMA and inhibit the binding of BAFF and/or APRIL to BCMA wherein the antigen binding protein has enhanced binding to Fc_γRIIIA or has enhanced Fc_γRIIIA mediated effector function. In one embodiment the antigen binding protein is capable of internalisation.

[0012] In one aspect of the invention there is provided an antigen binding protein which binds to non-membrane bound BCMA, for example to serum BCMA.

[0013] In one embodiment of the present invention there is provided an immunoconjugate comprising the antigen binding protein of the present invention and a cytotoxic agent.

[0014] In a further embodiment the antigen binding proteins are conjugated to a toxin such as an auristatin. In yet a further embodiment the drug conjugate is vcMMAE or mcMMAF. In one embodiment the immunoconjugate is also ADCC enhanced.

[0015] The antigen binding proteins may be related to, or derived from a murine monoclonal antibody CA8. The CA8 murine heavy chain variable region amino acid sequence is provided as SEQ ID NO. 7 and the CA8 murine light chain variable region amino acid sequence is provided as SEQ ID NO. 9.

[0016] The antigen binding proteins may be related to, or derived from a murine monoclonal antibody S336105A07. The S336105A07 murine heavy chain variable region amino acid sequence is provided as SEQ ID NO. 140 and the S336105A07 murine light chain variable region amino acid sequence is provided as SEQ ID NO. 144.

[0017] Other murine monoclonal antibodies from which antigen binding proteins of the present invention may also be derived are included in Table C.

[0018] The heavy chain variable regions (VH) of the antigen binding proteins may comprise the following CDRs or variants of these CDR's (as defined by Kabat (Kabat et al; Sequences of proteins of Immunological Interest NIH, 1987)):

CDRH1 is provided as SEQ ID NO. 1 or SEQ ID NO. 182

40 CDRH2 is provided as SEQ ID NO. 2 or SEQ ID NO. 183

CDRH3 is provided as SEQ ID NO. 3 or SEQ ID NO. 184

[0019] The light chain variable regions (VL) of the antigen binding proteins may comprise the following CDRs or variants of these CDR's (as defined by Kabat (Kabat et al; Sequences of proteins of Immunological Interest NIH, 1987)):

45 CDRL1 is provided as SEQ ID NO. 4 or SEQ ID NO. 185

CDRL2 is provided as SEQ ID NO. 5 or SEQ ID NO. 186

CDRL3 is provided as SEQ ID NO. 6 or SEQ ID NO. 187

50 **[0020]** The invention also provides a polynucleotide sequence encoding a heavy chain variable region of any of the antigen-binding proteins described herein, and a polynucleotide encoding a light chain variable region of any of the antigen-binding proteins described herein.

[0021] The invention also provides a polynucleotide sequence encoding a heavy chain of any of the antigen-binding proteins described herein, and a polynucleotide encoding a light chain of any of the antigen-binding proteins described herein.

[0022] Such polynucleotides represent the coding sequence which corresponds to the equivalent polypeptide sequences, however it will be understood that such polynucleotide sequences could be cloned into an expression vector along with a start codon, an appropriate signal sequence and a stop codon.

[0023] The invention also provides a recombinant transformed or transfected host cell comprising one or more polynucleotides encoding a heavy chain and/or a light chain of any of the antigen-binding proteins described herein.

[0024] The invention further provides a method for the production of any of the antigen-binding proteins described herein which method comprises the step of culturing a host cell comprising a first and second vector, said first vector comprising a polynucleotide encoding a heavy chain of any of the antigen-binding proteins described herein and said second vector comprising a polynucleotide encoding a light chain of any of the antigen-binding proteins described herein, in a suitable culture media, for example serum-free culture media.

[0025] The invention further provides a pharmaceutical composition comprising an antigen-binding protein as described herein and a pharmaceutically acceptable carrier.

[0026] In a further aspect, the present invention provides a method of treatment or prophylaxis of a disease or disorder responsive to inhibiting or blocking BCMA such as the modulation of the interaction between BCMA and its ligands, BAFF or APRIL which method comprises the step of administering to said patient a therapeutically effective amount of the antigen binding protein thereof as described herein.

[0027] It is therefore an object of the present invention to provide a therapeutic approach to the treatment of B cell related disorders or diseases such as antibody mediated or plasma cell mediated diseases or plasma cell malignancies such as for example Multiple Myeloma (MM). In particular it is an object of the present invention to provide antigen binding proteins, especially antibodies that specifically bind BCMA (e.g. hBCMA) and modulate (i.e. inhibit or block) the interaction between BCMA and its ligands such as BAFF and/or APRIL in the treatment of diseases and disorders responsive to modulation of that interaction.

[0028] In another aspect of the present invention there is provided a method of treating a human patient afflicted with a B cell related disorders or diseases such as antibody mediated or plasma cell mediated diseases or plasma cell malignancies such as for example Multiple Myeloma (MM) which method comprises the step of administering to said patient a therapeutically effective amount of the antigen binding protein as described herein.

[0029] In another aspect of the present invention there is provided a method of treating a human patient afflicted with Rheumatoid Arthritis, Psoriasis, Type 1 Diabetes Mellitus or Multiple Sclerosis which method comprises the step of administering to said patient a therapeutically effective amount of the antigen binding protein as described herein.

Detailed Description of the Invention

[0030] The present invention provides antigen binding proteins which bind to membrane bound targets and wherein the antigen binding protein is capable of internalisation. In a further embodiment there is provided an immunoconjugate comprising the antigen binding protein of the present invention and a cytotoxic agent. In a further embodiment the antigen binding protein has ADCC effector function for example the antigen binding protein has enhanced ADCC effector function.

[0031] In one such embodiment there is provided antigen binding proteins or fragments thereof which specifically bind to BCMA, for example which specifically binds human BCMA (hBCMA) and which inhibit the binding of BAFF and/or APRIL to the BCMA receptor.

[0032] In a further embodiment the antigen binding proteins or fragments specifically bind to BCMA and inhibit the binding of BAFF and/or APRIL to BCMA wherein the antigen binding proteins or fragments thereof have the ability to bind to Fc_YRIIIA and mediate Fc_YRIIIA mediated effector functions, or have enhanced Fc_YRIIIA mediated effector function.

[0033] In one embodiment of the invention as herein provided the antigen binding proteins are capable of internalisation.

[0034] In one aspect of the invention there is provided an antigen binding protein according to the invention as herein described which binds to non-membrane bound BCMA, for example to serum BCMA.

[0035] In one aspect of the invention there is provided an antigen binding protein as herein described wherein the antigen binding protein comprises CDRH3 of SEQ ID NO.3 or a variant of SEQ ID NO. 3.

[0036] In one aspect of the invention there is provided an antigen binding protein as herein described wherein the antigen binding protein comprises CDRH3 of SEQ ID NO.184 or a variant of SEQ ID NO. 184.

[0037] In a further aspect of the invention there is provided an antigen binding protein as herein described wherein the antigen binding protein further comprises one or more of: CDR H1 of SEQ. ID. NO: 1, CDRH2: SEQ. ID. NO: 2; CDRL1: SEQ. ID. NO: 4, CDRL2: SEQ. ID. NO: 5 and/or CDRL3: SEQ. ID. NO: 6 and or variants thereof.

[0038] In yet a further aspect the antigen binding protein comprises CDR H3 of SEQ. ID. NO: 3; CDRH2: SEQ. ID. NO: 2; CDR H1 of SEQ. ID. NO:1; CDRL1: SEQ. ID. NO: 4: CDRL2: SEQ. ID. NO: 5 and CDRL3: SEQ. ID. NO: 6.

[0039] In yet a further aspect the antigen binding protein comprises CDR H3 of SEQ. ID. NO: 184: CDRH2: SEQ. ID. NO: 183: CDR H1 of SEQ. ID. NO:182: CDRL1: SEQ. ID. NO: 185: CDRL2: SEQ. ID. NO: 186 and CDRL3: SEQ. ID. NO: 187.

[0040] In one aspect of the invention the antigen binding protein has enhanced effector function. In another aspect the

antigen binding protein is conjugated to a cytotoxic agent. In yet a further embodiment the antigen binding protein has both enhanced effector function and is conjugated to a cytotoxic agent.

[0041] The antigen binding proteins of the present invention may comprise heavy chain variable regions and light chain variable regions of the invention which may be formatted into the structure of a natural antibody or functional fragment or equivalent thereof. An antigen binding protein of the invention may therefore comprise the VH regions of the invention formatted into a full length antibody, a (Fab')2 fragment, a Fab fragment, or equivalent thereof (such as scFV, bi- tri- or tetra-bodies, Tandabs etc.), when paired with an appropriate light chain. The antibody may be an IgG1, IgG2, IgG3, or IgG4; or IgM; IgA, IgE or IgD or a modified variant thereof. The constant domain of the antibody heavy chain may be selected accordingly. The light chain constant domain may be a kappa or lambda constant domain. Furthermore, the antigen binding protein may comprise modifications of all classes e.g. IgG dimers, Fc mutants that no longer bind Fc receptors or mediate C1q binding. The antigen binding protein may also be a chimeric antibody of the type described in WO86/01533 which comprises an antigen binding region and a non-immunoglobulin region.

[0042] The constant region is selected according to any functionality required e.g. an IgG1 may demonstrate lytic ability through binding to complement and/or will mediate ADCC (antibody dependent cell cytotoxicity).

[0043] The antigen binding proteins of the present invention are derived from the murine antibody having the variable regions as described in SEQ ID NO:7 and SEQ ID NO:9 or non-murine equivalents thereof, such as rat, human, chimeric or humanised variants thereof, for example they are derived from the antibody having the variable heavy chain sequences as described in SEQ ID NO:11, SEQ ID NO:13, SEQ ID NO:15, SEQ ID NO:17, SEQ ID NO:19, SEQ ID NO:21, SEQ ID NO:23, SEQ ID NO:25, SEQ ID NO:27 and SEQ ID NO:29 and/or the variable light chain sequences as described in SEQ ID NO:31, SEQ ID NO:33 and/or SEQ ID NO:35.

[0044] In another embodiment the antigen binding proteins of the present invention are derived from an antibody having the variable heavy chain sequences as described in SEQ ID NO:116 or SEQ ID NO:118 and/or the variable light chain sequences as described in SEQ ID NO:120, or SEQ ID NO:122.

[0045] In another embodiment the antigen binding proteins of the present invention are derived from an antibody having the variable heavy chain sequences as described in SEQ ID NO:140 and/or the variable light chain sequences as described in SEQ ID NO:144.

[0046] In one aspect of the invention there is provided an antigen binding protein comprising an isolated heavy chain variable domain selected from any one of the following: SEQ ID NO:11, SEQ ID NO:13, SEQ ID NO:15, SEQ ID NO:17, SEQ ID NO:19, SEQ ID NO:21, SEQ ID NO:23, SEQ ID NO:25, SEQ ID NO:27, SEQ ID NO:29, SEQ ID NO:116 or SEQ ID NO:118.

[0047] In another aspect of the invention there is provided an antigen binding protein comprising an isolated light chain variable domain selected from any one of the following: SEQ ID NO:31, SEQ ID NO:33 or SEQ ID NO:35, SEQ ID NO:120 or SEQ ID NO:122.

[0048] In a further aspect of the invention there is provided an antigen binding protein comprising an isolated heavy chain variable domain selected from any one of the following: SEQ ID NO:11, SEQ ID NO:13, SEQ ID NO:15, SEQ ID NO:17, SEQ ID NO:19, SEQ ID NO:21, SEQ ID NO:23, SEQ ID NO:25, SEQ ID NO:27 and SEQ ID NO:29 and an isolated light chain variable domain selected from any one of the following: SEQ ID NO:31, SEQ ID NO:33 and/or SEQ ID NO:35.

[0049] In one aspect the antigen binding protein of the present invention comprises a heavy chain variable region encoded by SEQ. ID. NO:23 and a light chain variable region encoded by SEQ. ID. NO:31

[0050] In one aspect the antigen binding protein of the present invention comprises a heavy chain variable region encoded by SEQ. ID. NO:27 and a light chain variable region encoded by SEQ. ID. NO:31.

[0051] In one aspect the antigen binding protein of the present invention comprises a heavy chain variable region encoded by SEQ. ID. NO:29 and a light chain variable region encoded by SEQ. ID. NO:31.

[0052] In one aspect the antigen binding protein of the present invention comprises a heavy chain variable region encoded by SEQ. ID. NO:116 and a light chain variable region encoded by SEQ. ID. NO:120

[0053] In one aspect the antigen binding protein of the present invention comprises a heavy chain variable region encoded by SEQ. ID. NO:118 and a light chain variable region encoded by SEQ. ID. NO:122

[0054] In one aspect there is provided a polynucleotide encoding an isolated variable heavy chain said polynucleotide comprising SEQ. ID. NO. 12, or SEQ. ID. NO. 14, or SEQ. ID. NO. 16, or SEQ. ID. NO. 18, or SEQ. ID. NO. 20, or SEQ. ID. NO. 22, or SEQ. ID. NO. 24, or SEQ. ID. NO. 26, or SEQ. ID. NO. 28, or SEQ. ID. NO. 30 or SEQ. ID. NO. 117 or SEQ. ID. NO. 119 or SEQ. ID. NO. 141..

[0055] In one aspect there is provided a polynucleotide encoding an isolated variable light chain said polynucleotide comprising SEQ. ID. NO. 32, or SEQ. ID. NO. 34, or SEQ. ID. NO. 36 or SEQ. ID. NO. 121 or SEQ. ID. NO. 123 or SEQ. ID. NO. 145.

[0056] In a further aspect there is provided a polynucleotide encoding an isolated variable heavy chain said polynucleotide comprising SEQ. ID. NO. 24, or SEQ. ID. NO. 28 or SEQ. ID. NO. 30 and a polynucleotide encoding an isolated variable light chain said polynucleotide comprising SEQ. ID. NO. 32, or SEQ. ID. NO. 34.

[0057] In yet a further aspect there is provided a polynucleotide encoding an isolated variable heavy chain said polynucleotide comprising SEQ. ID. NO. 24 and a polynucleotide encoding an isolated variable light chain said polynucleotide comprising SEQ. ID. NO.32.

5 [0058] In yet a further aspect there is provided a polynucleotide encoding an isolated variable heavy chain said polynucleotide comprising SEQ. ID. NO. 117 and a polynucleotide encoding an isolated variable light chain said polynucleotide comprising SEQ. ID. NO.121.

[0059] In yet a further aspect there is provided a polynucleotide encoding an isolated variable heavy chain said polynucleotide comprising SEQ. ID. NO. 119 and a polynucleotide encoding an isolated variable light chain said polynucleotide comprising SEQ. ID. NO.123.

10 [0060] In yet a further aspect there is provided a polynucleotide encoding an isolated variable heavy chain said polynucleotide comprising SEQ. ID. NO. 141 and a polynucleotide encoding an isolated variable light chain said polynucleotide comprising SEQ. ID. NO.145.

[0061] In a further aspect the antigen binding protein may comprise any one of the variable heavy chains as described herein in combination with any one of the light chains as described herein.

15 [0062] In one aspect the antigen binding protein is an antibody or antigen binding fragment thereof comprising one or more CDR's according to the invention described herein, or one or both of the heavy or light chain variable domains according to the invention described herein. In one embodiment the antigen binding protein binds primate BCMA. In one such embodiment the antigen binding protein additionally binds non-human primate BCMA, for example cynomolgus macaque monkey BCMA.

20 [0063] In another aspect the antigen binding protein is selected from the group consisting of a dAb, Fab, Fab', F(ab')₂, Fv, diabody, triabody, tetrabody, miniantibody, and a minibody.,

[0064] In one aspect of the present invention the antigen binding protein is a humanised or chimaeric antibody, in a further aspect the antibody is humanised.

[0065] In one aspect the antibody is a monoclonal antibody.

25 [0066] In one aspect of the present invention there is provided an antibody with the heavy chain sequence as set forth in SEQ ID NO: 55 or SEQ ID NO: 59 or SEQ ID NO: 61.

[0067] In one aspect of the present invention there is provided an antibody with the light chain sequence as set forth in SEQ ID NO: 63 or SEQ ID NO: 65.

30 [0068] In a further aspect of the invention there is provided an antibody with the heavy chain sequence of SEQ ID NO: 55 and a light chain sequence as set forth in SEQ ID NO: 63.

[0069] In one embodiment there is provided an antigen binding protein which competes with an antigen binding protein of the invention as herein described. In one such embodiment there is therefore provided an antigen binding protein which competes with an antigen binding protein which comprises the heavy chain variable sequence of SEQ ID NO 23 and the light chain variable region of SEQ ID NO 31.

35 [0070] In a further embodiment there is therefore provided an antigen binding protein which competes with an antigen binding protein which comprises a heavy chain variable sequence selected from one of SEQ ID NO 27, SEQ ID NO 29, SEQ ID NO 116, SEQ ID NO 118 and SEQ ID NO 140 and a light chain variable region selected from one of SEQ ID NO 31, SEQ ID NO 120, SEQ ID NO 122 and SEQ ID NO 144.

40 [0071] In another aspect the antigen binding protein binds to human BCMA with high affinity for example when measured by Biacore the antigen binding protein binds to human BCMA with an affinity of 20nM or less or an affinity of 15nM or less or an affinity of 5nM or less or an affinity of 1000 pM or less or an affinity of 500pM or less or an affinity of 400pM or less, or 300pM or less or for example about 120pM. In a further embodiment the antigen binding protein binds to human BCMA when measured by Biacore of between about 100pM and about 500pM or between about 100pM and about 400pM, or between about 100pM and about 300pM. In one embodiment of the present invention the antigen binding protein binds BCMA with an affinity of less than 150pm.

45 [0072] In one such embodiment, this is measured by Biacore, for example as set out in Example 4.

50 [0073] In another aspect the antigen binding protein binds to human BCMA and neutralises the binding of the ligands BAFF and/or APRIL to the BCMA receptor in a cell neutralisation assay wherein the antigen binding protein has an IC50 of between about 1nM and about 500nM, or between about 1nM and about 100nM, or between about 1nM and about 50nM, or between about 1nM and about 25nM, or between about 5nM and about 15nM. In a further embodiment of the present invention the antigen binding protein binds BCMA and neutralises BCMA in a cell neutralisation assay wherein the antigen binding protein has an IC50 of about 10nM.

[0074] In one such embodiment, this is measured by a cell neutralisation assay, for example as set out in Example 4.6.

55 [0075] The antigen binding proteins, for example antibodies of the present invention may be produced by transfection of a host cell with an expression vector comprising the coding sequence for the antigen binding protein of the invention. An expression vector or recombinant plasmid is produced by placing these coding sequences for the antigen binding protein in operative association with conventional regulatory control sequences capable of controlling the replication and expression in, and/or secretion from, a host cell. Regulatory sequences include promoter sequences, e.g., CMV

promoter, and signal sequences which can be derived from other known antibodies. Similarly, a second expression vector can be produced having a DNA sequence which encodes a complementary antigen binding protein light or heavy chain. In certain embodiments this second expression vector is identical to the first except insofar as the coding sequences and selectable markers are concerned, so to ensure as far as possible that each polypeptide chain is functionally expressed. Alternatively, the heavy and light chain coding sequences for the antigen binding protein may reside on a single vector.

[0076] A selected host cell is co-transfected by conventional techniques with both the first and second vectors (or simply transfected by a single vector) to create the transfected host cell of the invention comprising both the recombinant or synthetic light and heavy chains. The transfected cell is then cultured by conventional techniques to produce the engineered antigen binding protein of the invention. The antigen binding protein which includes the association of both the recombinant heavy chain and/or light chain is screened from culture by appropriate assay, such as ELISA or RIA. Similar conventional techniques may be employed to construct other antigen binding proteins.

[0077] Suitable vectors for the cloning and subcloning steps employed in the methods and construction of the compositions of this invention may be selected by one of skill in the art. For example, the conventional pUC series of cloning vectors may be used. One vector, pUC19, is commercially available from supply houses, such as Amersham (Buckinghamshire, United Kingdom) or Pharmacia (Uppsala, Sweden). Additionally, any vector which is capable of replicating readily, has an abundance of cloning sites and selectable genes (e.g., antibiotic resistance), and is easily manipulated may be used for cloning. Thus, the selection of the cloning vector is not a limiting factor in this invention.

[0078] The expression vectors may also be characterized by genes suitable for amplifying expression of the heterologous DNA sequences, e.g., the mammalian dihydrofolate reductase gene (DHFR). Other vector sequences include a poly A signal sequence, such as from bovine growth hormone (BGH) and the betaglobin promoter sequence (betaglopro). The expression vectors useful herein may be synthesized by techniques well known to those skilled in this art.

[0079] The components of such vectors, e.g. replicons, selection genes, enhancers, promoters, signal sequences and the like, may be obtained from commercial or natural sources or synthesized by known procedures for use in directing the expression and/or secretion of the product of the recombinant DNA in a selected host. Other appropriate expression vectors of which numerous types are known in the art for mammalian, bacterial, insect, yeast, and fungal expression may also be selected for this purpose.

[0080] The present invention also encompasses a cell line transfected with a recombinant plasmid containing the coding sequences of the antigen binding proteins of the present invention. Host cells useful for the cloning and other manipulations of these cloning vectors are also conventional. However, cells from various strains of E. Coli may be used for replication of the cloning vectors and other steps in the construction of antigen binding proteins of this invention.

[0081] Suitable host cells or cell lines for the expression of the antigen binding proteins of the invention include mammalian cells such as NS0, Sp2/0, CHO (e.g. DG44), COS, HEK, a fibroblast cell (e.g., 3T3), and myeloma cells, for example it may be expressed in a CHO or a myeloma cell. Human cells may be used, thus enabling the molecule to be modified with human glycosylation patterns.

[0082] Alternatively, other eukaryotic cell lines may be employed. The selection of suitable mammalian host cells and methods for transformation, culture, amplification, screening and product production and purification are known in the art. See, e.g., Sambrook et al., cited above.

[0083] Bacterial cells may prove useful as host cells suitable for the expression of the recombinant Fabs or other embodiments of the present invention (see, e.g., Plückthun, A., Immunol. Rev., 130:151-188 (1992)). However, due to the tendency of proteins expressed in bacterial cells to be in an unfolded or improperly folded form or in a non-glycosylated form, any recombinant Fab produced in a bacterial cell would have to be screened for retention of antigen binding ability. If the molecule expressed by the bacterial cell was produced in a properly folded form, that bacterial cell would be a desirable host, or in alternative embodiments the molecule may express in the bacterial host and then be subsequently re-folded. For example, various strains of E. Coli used for expression are well-known as host cells in the field of biotechnology. Various strains of B. Subtilis, Streptomyces, other bacilli and the like may also be employed in this method.

[0084] Where desired, strains of yeast cells known to those skilled in the art are also available as host cells, as well as insect cells, e.g. Drosophila and Lepidoptera and viral expression systems. See, e.g. Miller et al., Genetic Engineering, 8:277-298, Plenum Press (1986) and references cited therein.

[0085] The general methods by which the vectors may be constructed, the transfection methods required to produce the host cells of the invention, and culture methods necessary to produce the antigen binding protein of the invention from such host cell may all be conventional techniques. Typically, the culture method of the present invention is a serum-free culture method, usually by culturing cells serum-free in suspension. Likewise, once produced, the antigen binding proteins of the invention may be purified from the cell culture contents according to standard procedures of the art, including ammonium 16eroxidi precipitation, affinity columns, column chromatography, gel electrophoresis and the like. Such techniques are within the skill of the art and do not limit this invention. For example, preparations of altered antibodies are described in WO 99/58679 and WO 96/16990.

[0086] Yet another method of expression of the antigen binding proteins may utilize expression in a transgenic animal,

such as described in U. S. Patent No. 4,873,316. This relates to an expression system using the animals casein promoter which when transgenically incorporated into a mammal permits the female to produce the desired recombinant protein in its milk.

[0087] In a further embodiment of the invention there is provided a method of producing an antibody of the invention which method comprises the step of culturing a host cell transformed or transfected with a vector encoding the light and/or heavy chain of the antibody of the invention and recovering the antibody thereby produced.

[0088] In accordance with the present invention there is provided a method of producing an anti-BCMA antibody of the present invention which binds to and neutralises the activity of human BCMA which method comprises the steps of;

- 10 providing a first vector encoding a heavy chain of the antibody;
- providing a second vector encoding a light chain of the antibody;
- transforming a mammalian host cell (e.g. CHO) with said first and second vectors;
- culturing the host cell of step (c) under conditions conducive to the secretion of the antibody from said host cell into said culture media;
- 15 recovering the secreted antibody of step (d).

[0089] Once expressed by the desired method, the antibody is then examined for in vitro activity by use of an appropriate assay. Presently conventional ELISA assay formats are employed to assess qualitative and quantitative binding of the antibody to BCMA. Additionally, other in vitro assays may also be used to verify neutralizing efficacy prior to subsequent 20 human clinical studies performed to evaluate the persistence of the antibody in the body despite the usual clearance mechanisms.

[0090] The dose and duration of treatment relates to the relative duration of the molecules of the present invention in the human circulation, and can be adjusted by one of skill in the art depending upon the condition being treated and the general health of the patient. It is envisaged that repeated dosing (e.g. once a week or once every two weeks or once 25 every 3 weeks) over an extended time period (e.g. four to six months) maybe required to achieve maximal therapeutic efficacy..

[0091] In one embodiment of the present invention there is provided a recombinant transformed, transfected or transduced host cell comprising at least one expression cassette, for example where the expression cassette comprises a polynucleotide encoding a heavy chain of an antigen binding protein according to the invention described herein and further comprises a polynucleotide encoding a light chain of an antigen binding protein according to the invention described herein or where there are two expression cassettes and the 1st encodes the light chain and the second encodes the heavy chain. For example in one embodiment the first expression cassette comprises a polynucleotide encoding a heavy chain of an antigen binding protein comprising a constant region or antigen binding fragment thereof which is linked to a constant region according to the invention described herein and further comprises a second cassette comprising a polynucleotide encoding a light chain of an antigen binding protein comprising a constant region or antigen binding fragment thereof which is linked to a constant region according to the invention described herein for example the first expression cassette comprises a polynucleotide encoding a heavy chain selected from SEQ. ID. NO:56, or SEQ. ID. NO: 60 or SEQ. ID. NO: 62 and a second expression cassette comprising a polynucleotide encoding a light chain selected from SEQ. ID. NO: 64 or SEQ. ID. NO: 66.

[0092] In another embodiment of the invention there is provided a stably transformed host cell comprising a vector comprising one or more expression cassettes encoding a heavy chain and/or a light chain of the antibody comprising a constant region or antigen binding fragment thereof which is linked to a constant region as described herein. For example such host cells may comprise a first vector encoding the light chain and a second vector encoding the heavy chain, for example the first vector encodes a heavy chain selected from SEQ. ID. NO: 55, or SEQ. ID. NO: 59 or SEQ. ID. NO: 61 and a second vector encoding a light chain for example the light chain of SEQ ID NO: 63 or SEQ. ID. NO: 65. In one such example the first vector encodes a heavy chain selected from SEQ. ID. NO: 55 and a second vector encoding a light chain for example the light chain of SEQ ID NO: 63.

[0093] In another embodiment of the present invention there is provided a host cell according to the invention described herein wherein the cell is eukaryotic, for example where the cell is mammalian. Examples of such cell lines include CHO or NS0.

[0094] In another embodiment of the present invention there is provided a method for the production of an antibody comprising a constant region or antigen binding fragment thereof which is linked to a constant region according to the invention described herein which method comprises the step of culturing a host cell in a culture media, for example serum- free culture media.

[0095] In another embodiment of the present invention there is provided a method according to the invention described herein wherein said antibody is further purified to at least 95% or greater (e.g. 98% or greater) with respect to said antibody containing serum- free culture media.

[0096] In yet another embodiment there is provided a pharmaceutical composition comprising an antigen binding

protein and a pharmaceutically acceptable carrier.

[0097] In another embodiment of the present invention there is provided a kit-of-parts comprising the composition according to the invention described herein described together with instructions for use.

[0098] The mode of administration of the therapeutic agent of the invention may be any suitable route which delivers the agent to the host. The antigen binding proteins, and pharmaceutical compositions of the invention are particularly useful for parenteral administration, i.e., subcutaneously (s.c.), intrathecally, intraperitoneally, intramuscularly (i.m.) or intravenously (i.v.). In one such embodiment the antigen binding proteins of the present invention are administered intravenously or subcutaneously.

[0099] Therapeutic agents of the invention may be prepared as pharmaceutical compositions containing an effective amount of the antigen binding protein of the invention as an active ingredient in a pharmaceutically acceptable carrier. In one embodiment the prophylactic agent of the invention is an aqueous suspension or solution containing the antigen binding protein in a form ready for injection. In one embodiment the suspension or solution is buffered at physiological pH. In one embodiment the compositions for parenteral administration will comprise a solution of the antigen binding protein of the invention or a cocktail thereof dissolved in a pharmaceutically acceptable carrier. In one embodiment the carrier is an aqueous carrier. A variety of aqueous carriers may be employed, e.g., 0.9% saline, 0.3% glycine, and the like. These solutions may be made sterile and generally free of particulate matter. These solutions may be sterilized by conventional, well known sterilization techniques (e.g., filtration). The compositions may contain pharmaceutically acceptable auxiliary substances as required to approximate physiological conditions such as pH adjusting and buffering agents, etc. The concentration of the antigen binding protein of the invention in such pharmaceutical formulation can vary widely, i.e., from less than about 0.5%, usually at or at least about 1% to as much as about 15 or 20% by weight and will be selected primarily based on fluid volumes, viscosities, etc., according to the particular mode of administration selected.

[0100] Thus, a pharmaceutical composition of the invention for intravenous infusion could be made up to contain about 250 ml of sterile Ringer's solution, and about 1 to about 30 or 5 mg to about 25 mg of an antigen binding protein of the invention per ml of Ringer's solution. Actual methods for preparing parenterally administrable compositions are well known or will be apparent to those skilled in the art and are described in more detail in, for example, Remington's Pharmaceutical Science, 15th ed., Mack Publishing Company, Easton, Pennsylvania. For the preparation of intravenously administrable antigen binding protein formulations of the invention see Lasmar U and Parkins D "The formulation of Biopharmaceutical products", Pharma. Sci.Tech.today, page 129-137, Vol.3 (3rd April 2000); Wang, W "Instability, stabilisation and formulation of liquid protein pharmaceuticals", Int. J. Pharm 185 (1999) 129-188; Stability of Protein Pharmaceuticals Part A and B ed Ahern T.J., Manning M.C., New York, NY: Plenum Press (1992); Akers,M.J. "Excipient-Drug interactions in Parenteral Formulations", J.Pharm Sci 91 (2002) 2283-2300; Imamura, K et al "Effects of types of sugar on stabilization of Protein in the dried state", J Pharm Sci 92 (2003) 266-274; Izutsu, Kkojima, S. "Excipient crystallinity and its protein-structure-stabilizing effect during freeze-drying", J Pharm. Pharmacol, 54 (2002) 1033-1039; Johnson, R, "Mannitol-sucrose mixtures-versatile formulations for protein peroxidise19g19n", J. Pharm. Sci, 91 (2002) 914-922; and Ha,E Wang W, Wang Y.j. "Peroxide formation in polysorbate 80 and protein stability", J. Pharm Sci, 91, 2252-2264,(2002) the entire contents of which are incorporated herein by reference and to which the reader is specifically referred.

[0101] In one embodiment the therapeutic agent of the invention, when in a pharmaceutical preparation, is present in unit dose forms. The appropriate therapeutically effective dose will be determined readily by those of skill in the art. Suitable doses may be calculated for patients according to their weight, for example suitable doses may be in the range of about 0.1 to about 20mg/kg, for example about 1 to about 20mg/kg, for example about 10 to about 20mg/kg or for example about 1 to about 15mg/kg, for example about 10 to about 15mg/kg or for example 1-5mg/kg. In one embodiment the antibody is given 1-5mg/kg every 3 weeks. To effectively treat conditions such as Multiple myeloma, SLE or IPT in a human, suitable doses may be within the range of about 0.1 to about 1000 mg, for example about 0.1 to about 500mg, for example about 500mg, for example about 0.1 to about 100mg, or about 0.1 to about 80mg, or about 0.1 to about 60mg, or about 0.1 to about 40mg, or for example about 1 to about 100mg, or about 1 to about 50mg, of an antigen binding protein of this invention, which may be administered parenterally, for example subcutaneously, intravenously or intramuscularly. Such dose may, if necessary, be repeated at appropriate time intervals selected as appropriate by a physician.

[0102] The antigen binding proteins described herein can be lyophilized for storage and reconstituted in a suitable carrier prior to use. This technique has been shown to be effective with conventional immunoglobulins and art-known peroxidise and reconstitution techniques can be employed.

[0103] In another aspect of the invention there is provided an antigen binding protein as herein described for use in a medicament.

[0104] In one aspect of the present invention there is provided an antigen binding protein according to the invention as herein described for use in the treatment of rheumatoid arthritis, Type 1 Diabetes Mellitus, multiple sclerosis or psoriasis wherein said method comprises the step of administering to said patient a therapeutically effective amount of the antigen

binding protein as described herein.

[0105] In one embodiment of the present invention, methods are provided for treating cancer in a human comprising administering to said human an antigen binding protein that specifically binds to BCMA. In some instances the antigen binding protein is part of an immunoconjugate.

[0106] In another aspect of the present invention there is provided an antigen binding protein according to the invention as herein described for use in the treatment of a B-cell mediated or plasma cell mediated disease or antibody mediated disease or disorder selected from Multiple Myeloma (MM), chronic lymphocytic leukemia (CLL), Non-secretory multiple myeloma, Smoldering multiple myeloma, Monoclonal gammopathy of undetermined significance (MGUS), Solitary plasmacytoma (Bone, Extramedullary), Lymphoplasmacytic lymphoma (LPL), Waldenström's Macroglobulinemia, Plasma cell leukemia, Primary Amyloidosis (AL), Heavy chain disease, Systemic lupus erythematosus (SLE), POEMS syndrome / osteosclerotic myeloma, Type I and II cryoglobulinemia, Light chain deposition disease, Goodpasture's syndrome, Idiopathic thrombocytopenic purpura (ITP), Acute glomerulonephritis, Pemphigus and Pemphigoid disorders, and Epidermolysis bullosa acquisita; or any Non-Hodgkin's Lymphoma B-cell leukemia or Hodgkin's lymphoma (HL) with BCMA expression or any diseases in which patients develop neutralising antibodies to recombinant protein replacement therapy wherein said method comprises the step of administering to said patient a therapeutically effective amount of the antigen binding protein as described herein.

[0107] B-cell disorders can be divided into defects of B-cell development/immunoglobulin production (immunodeficiencies) and excessive/uncontrolled proliferation (lymphomas, leukemias). As used herein, B-cell disorder refers to both types of diseases, and methods are provided for treating B-cell disorders with an antigen binding protein.

[0108] In a particular aspect, the disease or disorder is selected from the group consisting of Multiple Myeloma (MM), Chronic Lymphocytic Leukaemia (CLL), Solitary Plasmacytoma (Bone, Extramedullary), Waldenström's Macroglobulinemia.

[0109] In one aspect of the present invention the disease is Multiple Myeloma, Smoldering Multiple Myeloma (SMM) or Solitary Plasmacytoma (Bone, Extramedullary).

[0110] In one aspect of the present invention the disease is Multiple Myeloma.

[0111] In one aspect of the present invention the disease is Systemic lupus erythematosus (SLE)

[0112] In one aspect of the present invention the disease is Idiopathic thrombocytopenic purpura (ITP)

[0113] Use of the antigen binding protein as described herein in the manufacture of a medicament for the treatment of diseases and disorders as described herein is also provided.

[0114] For example in one aspect of the invention there is provided the use of the antigen binding protein as described herein for use in the treatment or prophylaxis of diseases and disorders responsive to modulation (such as inhibiting or blocking) of the interaction between BCMA and the ligands BAFF and APRIL.

[0115] In another aspect of the invention there is provided the use of the antigen binding protein as described herein for use in the treatment or prophylaxis of an antibody mediated or plasma cell mediated disease or disorder selected from rheumatoid arthritis, Type 1 Diabetes Mellitus, multiple sclerosis or psoriasis.

[0116] In another aspect of the invention there is provided the use of the antigen binding protein as described herein for use in the treatment or prophylaxis of an antibody mediated or plasma cell mediated disease or disorder selected from Multiple Myeloma (MM), chronic lymphocytic leukemia (CLL), Monoclonal gammopathy of undetermined significance (MGUS), Smoldering multiple myeloma (SMM), Solitary Plasmacytoma (Bone, Extramedullary), Waldenström's Macroglobulinemia , Primary Amyloidosis (AL), Heavy chain disease, Systemic lupus erythematosus (SLE), POEMS syndrome / osteosclerotic myeloma, Type I and II cryoglobulinemia, Light chain deposition disease, Goodpastures syndrome, Idiopathic thrombocytopenic purpura (ITP), Acute glomerulonephritis, Pemphigus and Pemphigoid disorders and Epidermolysis bullosa acquisita, any Non-Hodgkin Lymphoma and Leukemia with BCMA expression or any diseases in which patients develop neutralising antibodies to recombinant protein replacement therapy wherein said method comprises the step of administering to said patient a therapeutically effective amount of the antigen binding protein as described herein.

[0117] In one aspect, the invention provides a pharmaceutical composition comprising an antigen binding protein of the present invention or a functional fragment thereof and a pharmaceutically acceptable carrier for treatment or prophylaxis of rheumatoid arthritis, Type 1 Diabetes Mellitus, multiple sclerosis or psoriasis or an antibody mediated or plasma cell mediated disease or disorder selected from selected from Multiple Myeloma (MM), chronic lymphocytic leukemia (CLL), Monoclonal gammopathy of undetermined significance (MGUS), Smoldering multiple myeloma (SMM), Solitary Plasmacytoma (Bone, Extramedullary), Waldenström's Macroglobulinemia , Primary Amyloidosis (AL), Heavy chain disease, Systemic lupus erythematosus (SLE), POEMS syndrome / osteosclerotic myeloma, Type I and II cryoglobulinemia, Light chain deposition disease, Goodpastures syndrome, Idiopathic thrombocytopenic purpura (ITP), Acute glomerulonephritis, Pemphigus and Pemphigoid disorders and Epidermolysis bullosa acquisita, any Non-Hodgkin Lymphoma and Leukemia with BCMA expression or any diseases in which patients develop neutralising antibodies to recombinant protein replacement therapy wherein said method comprises the step of administering to said patient a therapeutically effective amount of the antigen binding protein as described herein.

[0118] In another embodiment of the present invention there is provided a method of treating a human patient afflicted with rheumatoid arthritis, Type 1 Diabetes Mellitus, multiple sclerosis or psoriasis or an antibody mediated or plasma cell mediated disorder or disease which method comprises the step of administering a therapeutically effective amount of the antigen binding protein according to the invention as described herein, for example there is provided a method of treating a human patient afflicted with an antibody mediated or plasma cell mediated disease or disorder selected from In another aspect of the present invention there is provided an antigen binding protein according to the invention as herein described for use in the treatment of an antibody mediated or plasma cell mediated disease or disorder selected from Multiple Myeloma (MM), Chronic Lymphocytic Leukaemia (CLL)Monoclonal gammopathy of undetermined significance (MGUS), Smoldering multiple myeloma (SMM), Solitary Plasmacytoma (Bone, Extramedullary), Waldenström's Macroglobulinemia , Primary Amyloidosis (AL), Heavy chain disease, Systemic lupus erythematosus (SLE), POEMS syndrome / osteosclerotic myeloma, Type I and II cryoglobulinemia, Light chain deposition disease, Goodpastures syndrome, Idiopathic thrombocytopenic purpura (ITP), Acute glomerulonephritis, Pemphigus and Pemphigoid disorders and Epidermolysis bullosa acquisita, any Non-Hodgkin Lymphoma and Leukemia with BCMA expression or any diseases in which patients develop neutralising antibodies to recombinant protein replacement therapy wherein said method 10 comprises the step of administering a pharmaceutical composition comprising an antigen binding protein according to the invention herein in combination with a pharmaceutically acceptable carrier.

[0119] In a further embodiment there is provided a method of treating a human patient afflicted with Multiple Myeloma (MM).

20 Definitions

[0120] As used herein, the terms "cancer," "neoplasm," and "tumor" are used interchangeably and, in either the singular or plural form, refer to cells that have undergone a malignant transformation that makes them pathological to the host organism. Primary cancer cells can be readily distinguished from non-cancerous cells by well-established techniques, particularly histological examination. The definition of a cancer cell, as used herein, includes not only a primary cancer cell, but any cell derived from a cancer cell ancestor. This includes metastasized cancer cells, and in vitro cultures and cell lines derived from cancer cells. When referring to a type of cancer that normally manifests as a solid tumor, a "clinically detectable" tumor is one that is detectable on the basis of tumor mass; e.g., by procedures such as computed tomography (CT) scan, magnetic resonance imaging (MRI), X-ray, ultrasound or palpation on physical examination, and/or which is detectable because of the expression of one or more cancer-specific antigens in a sample obtainable from a patient. Tumors may be a hematopoietic (or hematologic or hematological or blood-related) cancer, for example, cancers derived from blood cells or immune cells, which may be referred to as "liquid tumors." Specific examples of clinical conditions based on hematologic tumors include leukemias such as chronic myelocytic leukemia, acute myelocytic leukemia, chronic lymphocytic leukemia and acute lymphocytic leukemia; plasma cell malignancies such as multiple myeloma, MGUS and Waldenstrom's macroglobulinemia; lymphomas such as non-Hodgkin's lymphoma, Hodgkin's lymphoma; and the like.

[0121] The cancer may be any cancer in which an abnormal number of blast cells or unwanted cell proliferation is present or that is diagnosed as a hematological cancer, including both lymphoid and myeloid malignancies. Myeloid malignancies include, but are not limited to, acute myeloid (or myelocytic or myelogenous or myeloblastic) leukemia (undifferentiated or differentiated), acute promyeloid (or promyelocytic or promyelogenous or promyeloblastic) leukemia, acute myelomonocytic (or myelomonoblastic) leukemia, acute monocytic (or monoblastic) leukemia, erythroleukemia and megakaryocytic (or megakaryoblastic) leukemia. These leukemias may be referred together as acute myeloid (or myelocytic or myelogenous) leukemia (AML). Myeloid malignancies also include myeloproliferative disorders (MPD) which include, but are not limited to, chronic myelogenous (or myeloid) leukemia (CML), chronic myelomonocytic leukemia (CMML), essential thrombocythemia (or thrombocytosis), and polycythemia vera (PCV). Myeloid malignancies also include myelodysplasia (or myelodysplastic syndrome or MDS), which may be referred to as refractory anemia (RA), refractory anemia with excess blasts (RAEB), and refractory anemia with excess blasts in transformation (RAEBT); as well as myelofibrosis (MFS) with or without agnogenic myeloid metaplasia.

[0122] Hematopoietic cancers also include lymphoid malignancies, which may affect the lymph nodes, spleens, bone marrow, peripheral blood, and/or extranodal sites. Lymphoid cancers include B-cell malignancies, which include, but are not limited to, B-cell non-Hodgkin's lymphomas (B-NHLs). B-NHLs may be indolent (or low-grade), intermediate-grade (or aggressive) or high-grade (very aggressive). Indolent B-cell lymphomas include follicular lymphoma (FL); small lymphocytic lymphoma (SLL); marginal zone lymphoma (MZL) including nodal MZL, extranodal MZL, splenic MZL and splenic MZL with villous lymphocytes; lymphoplasmacytic lymphoma (LPL); and mucosa-associated-lymphoid tissue (MALT or extranodal marginal zone) lymphoma. Intermediate-grade B-NHLs include mantle cell lymphoma (MCL) with or without leukemic involvement, diffuse large cell lymphoma (DLBCL), follicular large cell (or grade 3 or grade 3B) lymphoma, and primary mediastinal lymphoma (PML). High-grade B-NHLs include Burkitt's lymphoma (BL), Burkitt-like lymphoma, small non-cleaved cell lymphoma (SNCCL) and lymphoblastic lymphoma. Other B-NHLs include immuno-

blastic lymphoma (or immunocytoma), primary effusion lymphoma, HIV associated (or AIDS related) lymphomas, and post-transplant lymphoproliferative disorder (PTLD) or lymphoma. B-cell malignancies also include, but are not limited to, chronic lymphocytic leukemia (CLL), prolymphocytic leukemia (PLL), Waldenstrom's macroglobulinemia (WM), hairy cell leukemia (HCL), large granular lymphocyte (LGL) leukemia, acute lymphoid (or lymphocytic or lymphoblastic) leukemia, and Castleman's disease. NHL may also include T-cell non-Hodgkin's lymphoma s(T-NHLs), which include, but are not limited to T-cell non-Hodgkin's lymphoma not otherwise specified (NOS), peripheral T-cell lymphoma (PTCL), anaplastic large cell lymphoma (ALCL), angioimmunoblastic lymphoid disorder (AILD), nasal natural killer (NK) cell / T-cell lymphoma, gamma/delta lymphoma, cutaneous T cell lymphoma, mycosis fungoides, and Sezary syndrome.

[0123] Hematopoietic cancers also include Hodgkin's lymphoma (or disease) including classical Hodgkin's lymphoma, nodular sclerosing Hodgkin's lymphoma, mixed cellularity Hodgkin's lymphoma, lymphocyte predominant (LP) Hodgkin's lymphoma, nodular LP Hodgkin's lymphoma, and lymphocyte depleted Hodgkin's lymphoma. Hematopoietic cancers also include plasma cell diseases or cancers such as multiple myeloma (MM) including smoldering MM, monoclonal gammopathy of undetermined (or unknown or unclear) significance (MGUS), plasmacytoma (bone, extramedullary), lymphoplasmacytic lymphoma (LPL), Waldenström's Macroglobulinemia, plasma cell leukemia, and primary amyloidosis (AL). Hematopoietic cancers may also include other cancers of additional hematopoietic cells, including polymorphonuclear leukocytes (or neutrophils), basophils, eosinophils, dendritic cells, platelets, erythrocytes and natural killer cells. Tissues which include hematopoietic cells referred herein to as "hematopoietic cell tissues" include bone marrow; peripheral blood; thymus; and peripheral lymphoid tissues, such as spleen, lymph nodes, lymphoid tissues associated with mucosa (such as the gut-associated lymphoid tissues), tonsils, Peyer's patches and appendix, and lymphoid tissues associated with other mucosa, for example, the bronchial linings.

[0124] The term "antigen binding protein" as used herein refers to antibodies, antibody fragments and other protein constructs which are capable of binding to and neutralising human BCMA.

[0125] The terms Fv, Fc, Fd, Fab, or F(ab)2 are used with their standard meanings (see, e.g., Harlow et al., Antibodies A Laboratory Manual, Cold Spring Harbor Laboratory, (1988)).

[0126] The term "antibody" is used herein in the broadest sense and specifically covers monoclonal antibodies (including full length monoclonal antibodies), polyclonal antibodies, multispecific antibodies (e.g. bispecific antibodies)

[0127] The term "monoclonal antibody" as used herein refers to an antibody obtained from a population of substantially homogenous antibodies i.e. the individual antibodies comprising the population are identical except for possible naturally occurring mutations that may be present in minor amounts. Monoclonal antibodies are highly specific being directed against a single antigenic binding site. Furthermore, in contrast to polyclonal antibody preparations which typically include different antibodies directed against different determinants (epitopes), each monoclonal antibody is directed against a single determinant on the antigen.

[0128] A "chimeric antibody" refers to a type of engineered antibody in which a portion of the heavy and/ or light chain is identical with or homologous to corresponding sequences in antibodies derived from a particular donor antibody class or subclass, while the remainder of the chain(s) is identical with or homologous to corresponding sequences in antibodies derived from another species or belonging to another antibody class or subclass, as well as fragments of such antibodies, so long as they exhibit the desired biological activity (US Patent No. 4, 816,567 and Morrison et al. Proc. Natl. Acad. Sci. USA 81:6851-6855) (1984)).

[0129] A "humanised antibody" refers to a type of engineered antibody having its CDRs derived from a non-human donor immunoglobulin, the remaining immunoglobulin-derived parts of the molecule being derived from one (or more) human immunoglobulin(s). In addition, framework support residues may be altered to preserve binding affinity (see, e.g., Queen et al., Proc. Natl Acad Sci USA, 86:10029-10032 (1989), Hodgson et al., Bio/Technology, 9:421 (1991)). A suitable human acceptor antibody may be one selected from a conventional database, e.g., the KABAT® database, Los Alamos database, and Swiss Protein database, by homology to the nucleotide and amino acid sequences of the donor antibody. A human antibody characterized by a homology to the framework regions of the donor antibody (on an amino acid basis) may be suitable to provide a heavy chain constant region and/or a heavy chain variable framework region for insertion of the donor CDRs. A suitable acceptor antibody capable of donating light chain constant or variable framework regions may be selected in a similar manner. It should be noted that the acceptor antibody heavy and light chains are not required to originate from the same acceptor antibody. The prior art describes several ways of producing such humanised antibodies - see for example EP-A-0239400 and EP-A-054951.

[0130] For nucleic acids, the term "substantial identity" indicates that two nucleic acids, or designated sequences thereof, when optimally aligned and compared, are identical, with appropriate nucleotide insertions or deletions, in at least about 80% of the nucleotides, at least about 90% to about 95%, or at least about 98% to about 99.5% of the nucleotides. Alternatively, substantial identity exists when the segments will hybridize under selective hybridization conditions, to the complement of the strand. "Identity," means, for polynucleotides and polypeptides, as the case may be, the comparison calculated using an algorithm provided in (1) and (2) below:

(1) Identity for polynucleotides is calculated by multiplying the total number of nucleotides in a given sequence by

the integer defining the percent identity divided by 100 and then subtracting that product from said total number of nucleotides in said sequence, or:

$$5 \quad nn \leq xn - (xn \cdot y),$$

wherein nn is the number of nucleotide alterations, xn is the total number of nucleotides in a given sequence, y is 0.95 for 95%, 0.97 for 97% or 1.00 for 100%, and • is the symbol for the multiplication operator, and wherein any non-integer product of xn and y is rounded down to the nearest integer prior to subtracting it from xn. Alterations of a polynucleotide sequence encoding a polypeptide may create nonsense, missense or frameshift mutations in this coding sequence and thereby alter the polypeptide encoded by the polynucleotide following such alterations.

10 (2) Identity for polypeptides is calculated by multiplying the total number of amino acids by the integer defining the percent identity divided by 100 and then subtracting that product from said total number of amino acids, or:

$$15 \quad na \leq xa - (xa \cdot y),$$

wherein na is the number of amino acid alterations, xa is the total number of amino acids in the sequence, y is 0.95 for 95%, 0.97 for 97% or 1.00 for 100%, and • is the symbol for the multiplication operator, and wherein any non-integer product of xa and y is rounded down to the nearest integer prior to subtracting it from xa

20 [0131] For nucleotide and amino acid sequences, the term "identical" indicates the degree of identity between two nucleic acid or amino acid sequences when optimally aligned and compared with appropriate insertions or deletions.

[0132] "Isolated" means altered "by the hand of man" from its natural state, has been changed or removed from its original environment, or both. For example, a polynucleotide or a polypeptide naturally present in a living organism is not "isolated," but the same polynucleotide or polypeptide separated from the coexisting materials of its natural state is "isolated", including but not limited to when such polynucleotide or polypeptide is introduced back into a cell, even if the cell is of the same species or type as that from which the polynucleotide or polypeptide was separated.

[0133] Throughout the present specification and the accompanying claims the term "comprising" and "comprises" incorporates "consisting of" and "consists of". That is, these words are intended to convey the possible inclusion of other elements or integers not specifically recited, where the context allows.

[0134] The term "specifically binds" as used throughout the present specification in relation to antigen binding proteins of the invention means that the antigen binding protein binds human BCMA (hBCMA) with no or insignificant binding to other human proteins. The term however does not exclude the fact that antigen binding proteins of the invention may also be cross-reactive with other forms of BCMA, for example primate BCMA. For example in one embodiment the antigen binding protein does not bind to TACI or BAFF-R.

[0135] The term "inhibits" as used throughout the present specification in relation to antigen binding proteins of the invention means that the biological activity of BCMA is reduced in the presence of the antigen binding proteins of the present invention in comparison to the activity of BCMA in the absence of such antigen binding proteins. Inhibition may be due but not limited to one or more of blocking ligand binding, preventing the ligand activating the receptor, and/or down regulating the BCMA. Inhibits can also refer to an antigen binding protein binding to BCMA and causing cell apoptosis or ADCC. The antibodies of the invention may neutralise the activity of the BCMA ligands BAFF and/or APRIL binding to BCMA. Levels of neutralisation can be measured in several ways, for example by use of the assays as set out in the examples below, for example in 4.4 in an H929 cell NFkB signalling assay. The BCMA ligands BAFF and APRIL are able to induce NFkB signalling and downstream events following binding to BCMA. The neutralisation of BCMA in this assay is measured by assessing the ability of anti-BCMA monoclonal antibodies to inhibit BAFF or APRIL driven NFkB induction.

[0136] If an antibody or antigen binding fragment thereof is capable of neutralisation then this is indicative of inhibition of the interaction between human BAFF or APRIL and BCMA. Antibodies which are considered to have neutralising activity against human BCMA would have an IC50 of less than 30 micrograms/ml, or less than 20 micrograms/ml, or less than 10 micrograms/ml, or less than 5 micrograms/ml or less than 1 micrograms/ml or less than 0.1 micrograms/ml in the H929 stimulation assay as set out in Example 4.4

[0137] "CDRs" are defined as the complementarity determining region amino acid sequences of an antibody which are the hypervariable domains of immunoglobulin heavy and light chains. There are three heavy chain and three light chain CDRs (or CDR regions) in the variable portion of an immunoglobulin. Thus, "CDRs" as used herein may refer to all three heavy chain CDRs, or all three light chain CDRs (or both all heavy and all light chain CDRs, if appropriate).

[0138] CDRs provide the majority of contact residues for the binding of the antibody to the antigen or epitope. CDRs of interest in this invention are derived from donor antibody variable heavy and light chain sequences, and include analogs of the naturally occurring CDRs, which analogs also share or retain the same antigen binding specificity and/or

neutralizing ability as the donor antibody from which they were derived.

[0139] The CDR sequences of antibodies can be determined by the Kabat numbering system (Kabat et al; (Sequences of proteins of Immunological Interest NIH, 1987), alternatively they can be determined using the Chothia numbering system (Al-Lazikani et al., (1997) JMB 273,927-948), the contact definition method (MacCallum R.M., and Martin A.C.R. and Thornton J.M, (1996), Journal of Molecular Biology, 262 (5), 732-745) or any other established method for numbering the residues in an antibody and determining CDRs known to the skilled man in the art

[0140] Other numbering conventions for CDR sequences available to a skilled person include "AbM" (University of Bath) and "contact" (University College London) methods. The minimum overlapping region using at least two of the Kabat, Chothia, AbM and contact methods can be determined to provide the "minimum binding unit". The minimum binding unit may be a sub-porton of a CDR.

[0141] Table A below represents one definition using each numbering convention for each CDR or binding unit. The Kabat numbering scheme is used in Table X to number the variable domain amino acid sequence. It should be noted that some of the CDR definitions may vary depending on the individual publication used.

Table A

	Kabat CDR	Chothia CDR	AbM CDR	Contact CDR	Minimum binding unit
H1	31-35/35A/35B	26-32/33/34	26-35/35A/35B	30-35/35A/35B	31-32
H2	50-65	52-56	50-58	47-58	52-56
H3	95-102	95-102	95-102	93-101	95-101
L1	24-34	24-34	24-34	30-36	30-34
L2	50-56	50-56	50-56	46-55	50-55
L3	89-97	89-97	89-97	89-96	89-96

[0142] Throughout this specification, amino acid residues in antibody sequences are numbered according to the Kabat scheme. Similarly, the terms "CDR", "CDRL1", "CDRL2", "CDRL3", "CDRH1", "CDRH2", "CDRH3" follow the Kabat numbering system as set forth in Kabat et al; Sequences of proteins of Immunological Interest NIH, 1987.

[0143] The terms "Variant" refers to at least one, two or three amino acid changes in the sequence. These amino acid changes may be deletion, substitution or addition but are preferably substitution. In one such embodiment the substitutions are conservative substitutions.

[0144] In an alternative embodiment the variant sequence contains at least one substitution whilst retaining the canonical of the antigen binding protein.

[0145] The complementarity determining regions (CDRs) L1, L2, L3, H1 and H2 tend to structurally exhibit one of a finite number of main chain conformations. The particular canonical structure class of a CDR is defined by both the length of the CDR and by the loop packing, determined by residues located at key positions in both the CDRs and the framework regions (structurally determining residues or SDRs). Martin and Thornton (1996; J Mol Biol 263:800-815) have generated an automatic method to define the "key residue" canonical templates. Cluster analysis is used to define the canonical classes for sets of CDRs, and canonical templates are then identified by analysing buried hydrophobics, hydrogen-bonding residues, and e.g. conserved glycines. The CDRs of antibody sequences can be assigned to canonical classes by comparing the sequences to the key residue templates and scoring each template using identity or similarity matrices.

[0146] The terms "VH" and "VL" are used herein to refer to the heavy chain variable domain and light chain variable domain respectively of an antibody.

[0147] As used herein the term "domain" refers to a folded protein structure which has tertiary structure independent of the rest of the protein. Generally, domains are responsible for discrete functional properties of proteins and in many cases may be added, removed or transferred to other proteins without loss of function of the remainder of the protein and/or of the domain. An "antibody single variable domain" is a folded polypeptide domain comprising sequences characteristic of antibody variable domains. It therefore includes complete antibody variable domains and modified variable domains, for example, in which one or more loops have been replaced by sequences which are not characteristic of antibody variable domains, or antibody variable domains which have been truncated or comprise N- or C-terminal extensions, as well as folded fragments of variable domains which retain at least the binding activity and specificity of the full-length domain.

[0148] The phrase "immunoglobulin single variable domain" refers to an antibody variable domain (VH, VHH, VL) that specifically binds an antigen or epitope independently of a different V region or domain. An immunoglobulin single

variable domain can be present in a format (e.g., homo- or hetero-multimer) with other, different variable regions or variable domains where the other regions or domains are not required for antigen binding by the single immunoglobulin variable domain (i.e., where the immunoglobulin single variable domain binds antigen independently of the additional variable domains). A "domain antibody" or "dAb" is the same as an "immunoglobulin single variable domain" which is

5 capable of binding to an antigen as the term is used herein. An immunoglobulin single variable domain may be a human antibody variable domain, but also includes single antibody variable domains from other species such as rodent (for example, as disclosed in WO 00/29004), nurse shark and Camelid VHH dAbs. Camelid VHH are immunoglobulin single variable domain polypeptides that are derived from species including camel, llama, alpaca, dromedary, and guanaco, which produce heavy chain antibodies naturally devoid of light chains. Such VHH domains may be humanised according
10 to standard techniques available in the art, and such domains are still considered to be "domain antibodies" according to the invention. As used herein "VH" includes camelid VHH domains. NARV are another type of immunoglobulin single variable domain which were identified in cartilaginous fish including the nurse shark. These domains are also known as Novel Antigen Receptor variable region (commonly abbreviated to V(NAR) or NARV). For further details see Mol. Immunol. 44, 656-665 (2006) and US20050043519A.

15 [0149] The term "Epitope-binding domain" refers to a domain that specifically binds an antigen or epitope independently of a different V region or domain, this may be a domain antibody (dAb), for example a human, camelid or shark immunoglobulin single variable domain or it may be a domain which is a derivative of a scaffold selected from the group consisting of CTLA-4 (Evibody); lipocalin; Protein A derived molecules such as Z-domain of Protein A (Affibody, SpA),
20 A-domain (Avimer/Maxibody); Heat shock proteins such as GroEL and GroES; 29eroxidise29g (trans-body); ankyrin repeat protein (DARPin); peptide aptamer; C-type lectin domain (Tetranectin); human γ -crystallin and human ubiquitin (affilins); PDZ domains; scorpion toxinkunitz type domains of human protease inhibitors; and fibronectin (adnectin); which has been subjected to protein engineering in order to obtain binding to a ligand other than the natural ligand.

25 [0150] CTLA-4 (Cytotoxic T Lymphocyte-associated Antigen 4) is a CD28-family receptor expressed on mainly CD4+ T-cells. Its extracellular domain has a variable domain-like Ig fold. Loops corresponding to CDRs of antibodies can be substituted with heterologous sequence to confer different binding properties. CTLA-4 molecules engineered to have different binding specificities are also known as Evibodies. For further details see Journal of Immunological Methods 248 (1-2), 31-45 (2001) Lipocalins are a family of extracellular proteins which transport small hydrophobic molecules such as steroids, bilins, retinoids and lipids. They have a rigid β -sheet secondary structure with a number of loops at the open end of the conical structure which can be engineered to bind to different target antigens. Anticalins are between
30 160-180 amino acids in size, and are derived from lipocalins. For further details see Biochim Biophys Acta 1482: 337-350 (2000), US7250297B1 and US20070224633

35 [0151] An affibody is a scaffold derived from Protein A of Staphylococcus aureus which can be engineered to bind to antigen. The domain consists of a three-helical bundle of approximately 58 amino acids. Libraries have been generated by randomisation of surface residues. For further details see Protein Eng. Des. Sel. 17, 455-462 (2004) and EP1641818A1

[0152] 40 Avimers are multidomain proteins derived from the A-domain scaffold family. The native domains of approximately 35 amino acids adopt a defined disulphide bonded structure. Diversity is generated by shuffling of the natural variation exhibited by the family of A-domains. For further details see Nature Biotechnology 23(12), 1556 - 1561 (2005) and Expert Opinion on Investigational Drugs 16(6), 909-917 (June 2007)

[0153] 45 A Transferrin is a monomeric serum transport glycoprotein. Transferrins can be engineered to bind different target antigens by insertion of peptide sequences in a permissive surface loop. Examples of engineered transferrins scaffolds include the Trans-body. For further details see J. Biol. Chem 274, 24066-24073 (1999).

[0154] 50 Designed Ankyrin Repeat Proteins (DARPs) are derived from Ankyrin which is a family of proteins that mediate attachment of integral membrane proteins to the cytoskeleton. A single ankyrin repeat is a 33 residue motif consisting of two α -helices and a β -turn. They can be engineered to bind different target antigens by randomising residues in the first α -helix and a β -turn of each repeat. Their binding interface can be increased by increasing the number of modules (a method of affinity maturation). For further details see J. Mol. Biol. 332, 489-503 (2003), PNAS 100(4), 1700-1705 (2003) and J. Mol. Biol. 369, 1015-1028 (2007) and US20040132028A1.

[0155] 55 Fibronectin is a scaffold which can be engineered to bind to antigen. Adnectins consists of a backbone of the natural amino acid sequence of the 10th domain of the 15 repeating units of human fibronectin type III (FN3). Three loops at one end of the β -sandwich can be engineered to enable an Adnectin to specifically recognize a therapeutic target of interest. For further details see Protein Eng. Des. Sel. 18, 435-444 (2005), US20080139791, WO2005056764 and US6818418B1.

[0156] 60 Peptide aptamers are combinatorial recognition molecules that consist of a constant scaffold protein, typically thioredoxin (TrxA) which contains a constrained variable peptide loop inserted at the active site. For further details see Expert Opin. Biol. Ther. 5, 783-797 (2005).

[0157] 65 Microbodies are derived from naturally occurring microproteins of 25-50 amino acids in length which contain 3-4 cysteine bridges - examples of microproteins include KalataB1 and conotoxin and knottins. The microproteins have a loop which can be engineered to include up to 25 amino acids without affecting the overall fold of the microprotein. For

further details of engineered knottin domains, see WO2008098796.

[0158] Other epitope binding domains include proteins which have been used as a scaffold to engineer different target antigen binding properties include human γ -crystallin and human ubiquitin (affilins), kunitz type domains of human protease inhibitors, PDZ-domains of the Ras-binding protein AF-6, scorpion toxins (charybdotoxin), C-type lectin domain (tetranectins) are reviewed in Chapter 7 - Non-Antibody Scaffolds from Handbook of Therapeutic Antibodies (2007, edited by Stefan Dubel) and Protein Science 15:14-27 (2006). Epitope binding domains of the present invention could be derived from any of these alternative protein domains.

[0159] As used herein, the term "antigen-binding site" refers to a site on a protein which is capable of specifically binding to antigen, this may be a single domain, for example an epitope-binding domain, or it may be paired VH/VL domains as can be found on a standard antibody. In some embodiments of the invention single-chain Fv (ScFv) domains can provide antigen-binding sites.

[0160] The terms "mAbdAb" and "dAbmAb" are used herein to refer to antigen-binding proteins of the present invention. The two terms can be used interchangeably, and are intended to have the same meaning as used herein.

[0161] The term "antigen binding protein" as used herein refers to antibodies, antibody fragments for example a domain antibody (dAb), ScFv, Fab, Fab2, and other protein constructs. Antigen binding molecules may comprise at least one Ig variable domain, for example antibodies, domain antibodies (dAbs), Fab, Fab', F(ab')2, Fv, ScFv, diabodies, mAbdAbs, affibodies, heteroconjugate antibodies or bispecific antibodies. In one embodiment the antigen binding molecule is an antibody. In another embodiment the antigen binding molecule is a dAb, i.e. an immunoglobulin single variable domain such as a VH, VHH or VL that specifically binds an antigen or epitope independently of a different V region or domain. Antigen binding molecules may be capable of binding to two targets, i.e. they may be dual targeting proteins. Antigen binding molecules may be a combination of antibodies and antigen binding fragments such as for example, one or more domain antibodies and/or one or more ScFvs linked to a monoclonal antibody. Antigen binding molecules may also comprise a non-Ig domain for example a domain which is a derivative of a scaffold selected from the group consisting of CTLA-4 (Eviobody); lipocalin; Protein A derived molecules such as Z-domain of Protein A (Affibody, SpA), A-domain (Avimer/Maxibody); Heat shock proteins such as GroEl and GroES; 31eroxidise31g (trans-body); ankyrin repeat protein (DARPin); peptide aptamer; C-type lectin domain (Tetranectin); human γ -crystallin and human ubiquitin (affilins); PDZ domains; scorpion toxin/kunitz type domains of human protease inhibitors; and fibronectin (adnectin); which has been subjected to protein engineering in order to obtain binding to OSM. As used herein "antigen binding protein" will be capable of antagonising and/or neutralising human OSM. In addition, an antigen binding protein may inhibit and/or block OSM activity by binding to OSM and preventing a natural ligand from binding and/or activating the gp130 receptor.

[0162] The term "Effector Function" as used herein is meant to refer to one or more of Antibody dependant cell mediated cytotoxic activity (ADCC), Complement-dependant cytotoxic activity (CDC) mediated responses, Fc-mediated phagocytosis and antibody recycling via the FcRn receptor. For IgG antibodies, effector functionalities including ADCC and ADCP are mediated by the interaction of the heavy chain constant region with a family of Fc receptors present on the surface of immune cells. In humans these include Fc γ RI (CD64), Fc γ RII (CD32) and Fc γ RIII (CD16). Interaction between the antigen binding protein bound to antigen and the formation of the Fc/Fc complex induces a range of effects including cytotoxicity, immune cell activation, phagocytosis and release of inflammatory cytokines.

[0163] The interaction between the constant region of an antigen binding protein and various Fc receptors (FcR) is believed to mediate the effector functions of the antigen binding protein. Significant biological effects can be a consequence of effector functionality, in particular, antibody-dependent cellular cytotoxicity (ADCC), fixation of complement (complement dependent cytotoxicity or CDC), and half-life/clearance of the antigen binding protein. Usually, the ability to mediate effector function requires binding of the antigen binding protein to an antigen and not all antigen binding proteins will mediate every effector function.

[0164] Effector function can be measured in a number of ways including for example via binding of the Fc γ RIII to Natural Killer cells or via Fc γ RI to monocytes/macrophages to measure for ADCC effector function. For example an antigen binding protein of the present invention can be assessed for ADCC effector function in a Natural Killer cell assay. Examples of such assays can be found in Shields et al, 2001 The Journal of Biological Chemistry, Vol. 276, p6591-6604; Chappel et al, 1993 The Journal of Biological Chemistry, Vol 268, p25124-25131; Lazare et al, 2006 PNAS, 103; 4005-4010.

[0165] Examples of assays to determine CDC function include that described in 1995 J Imm Meth 184:29-38.

[0166] Some isotypes of human constant regions, in particular IgG4 and IgG2 isotypes, essentially lack the functions of a) activation of complement by the classical pathway; and b) antibody-dependent cellular cytotoxicity. Various modifications to the heavy chain constant region of antigen binding proteins may be carried out depending on the desired effector property. IgG1 constant regions containing specific mutations have separately been described to reduce binding to Fc receptors and therefore reduce ADCC and CDC (Duncan et al. Nature 1988, 332; 563-564; Lund et al. J. Immunol. 1991, 147; 2657-2662; Chappel et al. PNAS 1991, 88; 9036-9040; Burton and Woof, Adv. Immunol. 1992, 51; 1-84; Morgan et al., Immunology 1995, 86; 319-324; Hezareh et al., J. Virol. 2001, 75 (24); 12161-12168).

[0167] In one embodiment of the present invention there is provided an antigen binding protein comprising a constant region such that the antigen binding protein has reduced ADCC and/or complement activation or effector functionality.

In one such embodiment the heavy chain constant region may comprise a naturally disabled constant region of IgG2 or IgG4 isotype or a mutated IgG1 constant region. Examples of suitable modifications are described in EP0307434. One example comprises the substitutions of alanine residues at positions 235 and 237 (EU index numbering).

[0168] Human IgG1 constant regions containing specific mutations or altered glycosylation on residue Asn297 have also been described to enhance binding to Fc receptors. In some cases these mutations have also been shown to enhance ADCC and CDC (Lazar et al. PNAS 2006, 103; 4005-4010; Shields et al. J Biol Chem 2001, 276; 6591-6604; Nechansky et al. Mol Immunol, 2007, 44; 1815-1817).

[0169] In one embodiment of the present invention, such mutations are in one or more of positions selected from 239, 332 and 330 (IgG1), or the equivalent positions in other IgG isotypes. Examples of suitable mutations are S239D and I332E and A330L. In one embodiment the antigen binding protein of the invention herein described is mutated at positions 239 and 332, for example S239D and I332E or in a further embodiment it is mutated at three or more positions selected from 239 and 332 and 330, for example S239D and I332E and A330L. (EU index numbering).

[0170] In an alternative embodiment of the present invention, there is provided an antigen binding protein comprising a heavy chain constant region with an altered glycosylation profile such that the antigen binding protein has enhanced effector function. For example, wherein the antigen binding protein has enhanced ADCC or enhanced CDC or wherein it has both enhanced ADCC and CDC effector function. Examples of suitable methodologies to produce antigen binding proteins with an altered glycosylation profile are described in WO2003011878, WO2006014679 and EP1229125, all of which can be applied to the antigen binding proteins of the present invention.

[0171] The present invention also provides a method for the production of an antigen binding protein according to the invention comprising the steps of:

- a) culturing a recombinant host cell comprising an expression vector comprising the isolated nucleic acid as described herein, wherein the FUT8 gene encoding alpha-1,6-fucosyltransferase has been inactivated in the recombinant host cell; and
- b) recovering the antigen binding protein.

[0172] Such methods for the production of antigen binding proteins can be performed, for example, using the POTELLIGENT™ technology system available from BioWa, Inc. (Princeton, NJ) in which CHOK1SV cells lacking a functional copy of the FUT8 gene produce monoclonal antibodies having enhanced antibody dependent cell mediated cytotoxicity (ADCC) activity that is increased relative to an identical monoclonal antibody produced in a cell with a functional FUT8 gene. Aspects of the POTELLIGENT™ technology system are described in US7214775, US6946292, WO0061739 and WO0231240 all of which are incorporated herein by reference. Those of ordinary skill in the art will also recognize other appropriate systems.

[0173] In one embodiment of the present invention there is provided an antigen binding protein comprising a chimaeric heavy chain constant region for example an antigen binding protein comprising a chimaeric heavy chain constant region with at least one CH2 domain from IgG3 such that the antigen binding protein has enhanced effector function, for example wherein it has enhanced ADCC or enhanced CDC, or enhanced ADCC and CDC functions,. In one such embodiment, the antigen binding protein may comprise one CH2 domain from IgG3 or both CH2 domains may be from IgG3.

[0174] Also provided is a method of producing an antigen binding protein according to the invention comprising the steps of:

- a) culturing a recombinant host cell comprising an expression vector comprising an isolated nucleic acid as described herein wherein the expression vector comprises a nucleic acid sequence encoding an Fc domain having both IgG1 and IgG3 Fc domain amino acid residues; and
- b) recovering the antigen binding protein.

[0175] Such methods for the production of antigen binding proteins can be performed, for example, using the COMPLEGENT™ technology system available from BioWa, Inc. (Princeton, NJ) and Kyowa Hakko Kogyo (now, Kyowa Hakko Kirin Co., Ltd.) Co., Ltd. In which a recombinant host cell comprising an expression vector in which a nucleic acid sequence encoding a chimeric Fc domain having both IgG1 and IgG3 Fc domain amino acid residues is expressed to produce an antigen binding protein having enhanced complement dependent cytotoxicity (CDC) activity that is increased relative to an otherwise identical antigen binding protein lacking such a chimeric Fc domain. Aspects of the COMPLEGENT™ technology system are described in WO2007011041 and US20070148165 each of which are incorporated herein by reference. In an alternative embodiment CDC activity may be increased by introducing sequence specific mutations into the Fc region of an IgG chain. Those of ordinary skill in the art will also recognize other appropriate systems.

[0176] It will be apparent to those skilled in the art that such modifications may not only be used alone but may be used in combination with each other in order to further enhance effector function.

[0177] In one such embodiment of the present invention there is provided an antigen binding protein comprising a

heavy chain constant region which comprises a mutated and chimaeric heavy chain constant region for example wherein an antigen binding protein comprising at least one CH2 domain from IgG3 and one CH2 domain from IgG1, wherein the IgG1 CH2 domain has one or more mutations at positions selected from 239 and 332 and 330 (for example the mutations may be selected from S239D and I332E and A330L) such that the antigen binding protein has enhanced effector function, for example wherein it has one or more of the following functions, enhanced ADCC or enhanced CDC, for example wherein it has enhanced ADCC and enhanced CDC. In one embodiment the IgG1 CH2 domain has the mutations S239D and I332E.

[0178] In an alternative embodiment of the present invention there is provided an antigen binding protein comprising a chimaeric heavy chain constant region and which has an altered glycosylation profile. In one such embodiment the heavy chain constant region comprises at least one CH2 domain from IgG3 and one CH2 domain from IgG1 and has an altered glycosylation profile such that the ratio of fucose to mannose is 0.8:3 or less, for example wherein the antigen binding protein is defucosylated so that said antigen binding protein has an enhanced effector function in comparison with an equivalent antigen binding protein with an immunoglobulin heavy chain constant region lacking said mutations and altered glycosylation profile, for example wherein it has one or more of the following functions, enhanced ADCC or enhanced CDC, for example wherein it has enhanced ADCC and enhanced CDC. In an alternative embodiment the antigen binding protein has at least one IgG3 CH2 domain and at least one heavy chain constant domain from IgG1 wherein both IgG CH2 domains are mutated in accordance with the limitations described herein.

[0179] In one aspect of the invention there is provided a method of producing an antigen binding protein according to the invention described herein comprising the steps of:

- 20 a) culturing a recombinant host cell containing an expression vector containing an isolated nucleic acid as described herein, said expression vector further comprising a Fc nucleic acid sequence encoding a chimeric Fc domain having both IgG1 and IgG3 Fc domain amino acid residues, and wherein the FUT8 gene encoding alpha-1,6-fucosyltransferase has been inactivated in the recombinant host cell; and
- 25 b) recovering the antigen binding protein .

[0180] Such methods for the production of antigen binding proteins can be performed, for example, using the ACCRETAMAB™ technology system available from BioWa, Inc. (Princeton, NJ) which combines the POTELLIGENT™ and COMPLEGENT™ technology systems to produce an antigen binding protein having both ADCC and CDC enhanced activity that is increased relative to an otherwise identical monoclonal antibody lacking a chimeric Fc domain and which has fucose on the oligosaccharide

[0181] In yet another embodiment of the present invention there is provided an antigen binding protein comprising a mutated and chimeric heavy chain constant region wherein said antigen binding protein has an altered glycosylation profile such that the antigen binding protein has enhanced effector function, for example wherein it has one or more of the following functions, enhanced ADCC or enhanced CDC. In one embodiment the mutations are selected from positions 239 and 332 and 330, for example the mutations are selected from S239D and I332E and A330L. In a further embodiment the heavy chain constant region comprises at least one CH2 domain from IgG3 and one Ch2 domain from IgG1. In one embodiment the heavy chain constant region has an altered glycosylation profile such that the ratio of fucose to mannose is 0.8:3 or less for example the antigen binding protein is defucosylated, so that said antigen binding protein has an enhanced effector function in comparison with an equivalent non-chimaeric antigen binding protein or with an immunoglobulin heavy chain constant region lacking said mutations and altered glycosylation profile.

Immunoconjugates

[0182] Also provided is an immunoconjugate (interchangeably referred to as "antibody-drug conjugates," or "ADCs") comprising an antigen binding protein according to the invention as herein described including, but not limited to, an antibody conjugated to one or more cytotoxic agents, such as a chemotherapeutic agent, a drug, a growth inhibitory agent, a toxin (e.g., a protein toxin, an enzymatically active toxin of bacterial, fungal, plant, or animal origin, or fragments thereof), or a radioactive isotope (i.e., a radioconjugate).

[0183] Immunoconjugates have been used for the local delivery of cytotoxic agents, i.e., drugs that kill or inhibit the growth or proliferation of cells, in the treatment of cancer (Lambert, J. (2005) Curr. Opinion in Pharmacology 5:543-549; Wu et al. (2005) Nature Biotechnology 23(9):1137-1146; Payne, G. (2003) i 3:207-212; Syrigos and Epenetos (1999) Anticancer Research 19:605-614; Niculescu-Duvaz and Springer (1997) Adv. Drug Deliv. Rev. 26:151-172; U.S. Pat. No. 4,975,278). Immunoconjugates allow for the targeted delivery of a drug moiety to a tumor, and intracellular accumulation therein, where systemic administration of unconjugated drugs may result in unacceptable levels of toxicity to normal cells as well as the tumor cells sought to be eliminated (Baldwin et al., Lancet (Mar. 15, 1986) pp. 603-05; Thorpe (1985) "Antibody Carriers Of Cytotoxic Agents In Cancer Therapy: A Review," in Monoclonal Antibodies '84: Biological And Clinical Applications (A. Pinchera et al., eds) pp. 475-506. Both polyclonal antibodies and monoclonal antibodies

have been reported as useful in these strategies (Rowland et al., (1986) *Cancer Immunol. Immunother.* 21:183-87). Drugs used in these methods include daunomycin, doxorubicin, methotrexate, and vindesine (Rowland et al., (1986) *supra*). Toxins used in antibody-toxin conjugates include bacterial toxins such as diphtheria toxin, plant toxins such as ricin, small molecule toxins such as geldanamycin (Mandler et al (2000) *J. Natl. Cancer Inst.* 92(19):1573-1581; Mandler et al (2000) *Bioorganic & Med. Chem. Letters* 10:1025-1028; Mandler et al (2002) *Bioconjugate Chem.* 13:786-791), maytansinoids (EP 1391213; Liu et al., (1996) *Proc. Natl. Acad. Sci. USA* 93:8618-8623), and calicheamicin (Lode et al (1998) *Cancer Res.* 58:2928; Hinman et al (1993) *Cancer Res.* 53:3336-3342). In one embodiment, the present invention includes immunoconjugates having the following general structure:



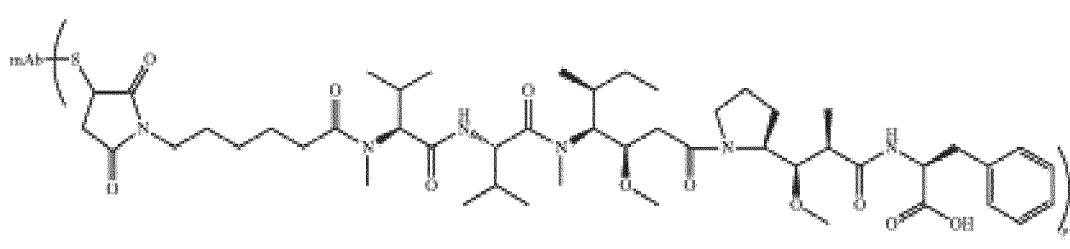
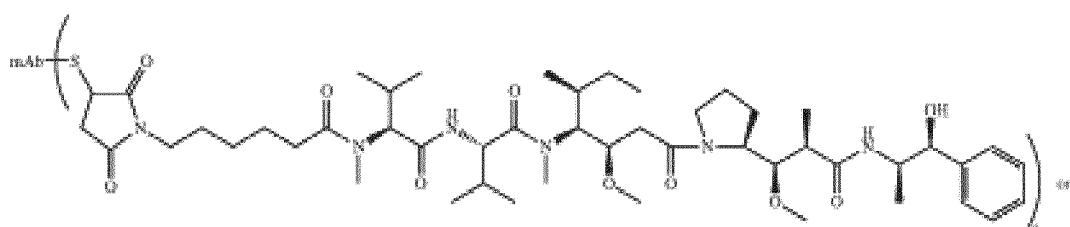
[0184] Wherein ABP is an antigen binding protein

[0185] Linker is either absent or any a cleavable or non-cleavable linker described herein

[0186] Ctx is any cytotoxic agent described herein

15 n is 0, 1, 2, or 3 and
m is 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10.

20 [0187] Examples of antibodies linked by an MC linker with auristatins such as MMAE and MMAF are depicted in the following structures:



35 [0188] In certain embodiments, an immunoconjugate comprises an antigen binding protein, including but not limited to, an antibody and a chemotherapeutic agent or other toxin. Chemotherapeutic agents useful in the generation of immunoconjugates are described herein. Enzymatically active toxins and fragments thereof that can be used include diphtheria A chain, nonbinding active fragments of diphtheria toxin, exotoxin A chain (from *Pseudomonas aeruginosa*), ricin A chain, abrin A chain, modeccin A chain, alpha-sarcin, *Aleurites fordii* proteins, dianthin proteins, *Phytolaca americana* proteins (PAPI, PAPII, and PAP-S), momordica charantia inhibitor, curcin, crotin, sapaonaria officinalis inhibitor, gelonin, mitogellin, restrictocin, phenomycin, enomycin, and the trichothecenes. See, e.g., WO 93/21232 published Oct. 28, 1993. A variety of radionuclides are available for the production of radioconjugated antibodies. Examples include 211At, 212Bi, 131I, 131In, 90Y, and 186Re.

40 [0189] Antigen binding proteins of the present invention may also be conjugated to one or more toxins, including, but not limited to, a calicheamicin, maytansinoids, dolastatins, aurostatins, a trichothecene, and CC1065, and the derivatives of these toxins that have toxin activity. Suitable cytotoxic agents include, but are not limited to, an auristatin including dovaline-valine-dolaisoleanine-dolaproline-phenylalanine (MMAF) and monomethyl auristatin E (MMAE) as well as ester forms of MMAE, a DNA minor groove binding agent, a DNA minor groove alkylating agent, an enediyne, a lexitropsin, a duocarmycin, a taxane, including paclitaxel and docetaxel, a puromycin, a dolastatin, a maytansinoid, and a vinca alkaloid. Specific cytotoxic agents include topotecan, morpholino-doxorubicin, rhizoxin, cyanomorpholino-doxorubicin, dolastatin-10, echinomycin, combretatstatin, chalicheamicin, maytansine, DM-1, DM-4, netropsin. Other suitable cyto-

toxic agents include anti-tubulin agents, such as an auristatin, a vinca alkaloid, a podophyllotoxin, a taxane, a baccatin derivative, a cryptophysin, a maytansinoid, a combretastatin, or a dolastatin. Antitubulin agent include dimethylvaline-valine-dolaisoleuine-dolaproine-phenylalanine-p-phenylened- iamine (AFP), MMAF, MMAE, auristatin E, vincristine, vinblastine, vindesine, vinorelbine, VP-16, camptothecin, paclitaxel, docetaxel, epothilone A, epothilone B, nocodazole, colchicines, colcimid, estramustine, cemadotin, discodermolide, maytansine, DM-1, DM-4 or eleutherobin.

[0190] Antibody drug conjugates were produced by conjugating the small molecule anti-tubulin agent monomethylauristatin E (MMAE) or monomethylauristatin F (MMAF) to the antibodies. In the case of MMAE the linker consists of a thiol-reactive maleimide, a caproyl spacer, the dipeptide valine-citrulline, and p-aminobenzoyloxycarbonyl, a self-immolative fragmenting group. In the case of MMAF a protease-resistant maleimidocaproyl linker is used. The conjugation process leads to heterogeneity in drug-antibody attachment, varying in both the number of drugs bound to each antibody molecule (mole ratio [MR]), and the site of attachment. The most prevalent species is the material with an MR = 4; less prevalent are materials with MR of 0, 2, 6, and 8. The overall average drug-to-antibody MR is approximately 4.

Production of Immunoconjugates

[0191] The points of attachment are cysteines produced by mild reduction of the interchain disulfides of the antibody which is carried out whilst antibodies are immobilised on Protein G affinity resin (thus enabling the use of large reagent excesses without intermediate purifications). While immobilized, a large excess of TCEP will fully reduce the interchain disulfides but has no impact upon the binding of the antibody to the resin.

[0192] The number of thiols per antibody generated by this procedure depends upon the source and isotype of the antibodies. For example, human (and mouse-human chimeric) IgG1s have 4 reducible disulfides, and thus generate 8 thiols upon full reduction, whereas murine IgG1s have 5 reducible disulfides and produce 10 thiols. If ADCs with the maximal drug loading (e.g., 10 drugs per antibody for the murine IgG1s) are desired, then the maleimido-drug-linker can simply be added to the immobilized antibodies in sufficient excess to ensure complete conjugation. However, ADCs with fewer drugs per antibody can also be prepared from fully reduced antibodies by including a biologically inert capping agent such as N-ethyl maleimide (NEM) which occupies some of the available thiols on the antibody. When the maleimido-drug-linker and the capping agent are added simultaneously to the fully reduced antibody and in large excess (at least 3-fold), the two maleimide electrophiles compete for the limiting number of available thiols. In this fashion, the drug loading is determined by the relative thiol reaction rates of the drug-linker and capping agent, and thus can be considered to be under kinetic control. The relative reaction rates of maleimido-drug-linkers do vary significantly, and thus the molar ratio of drug-linker to NEM present in a reaction mix must be determined empirically to arrive at a panel of ADCs with a desired level of drug loading. The mole fraction of the drug linkers SGD-1006 (vcMMAE) and SGD-1269 (mcMMAF) in NEM mixtures which yield ADCs with approximately 4 drugs per antibody are summarized in Table 2 for common human and murine IgG isotypes.

Auristatins and Dolastatins

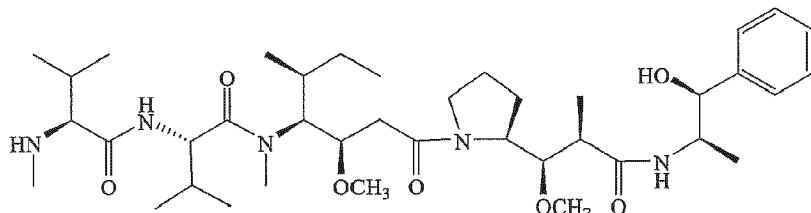
[0193] In some embodiments, the immunoconjugate comprises an antigen binding protein or antibody conjugated to dolastatins or dolostatin peptidic analogs and derivatives, the auristatins (U.S. Pat. Nos. 5,635,483; 5,780,588). Dolastatins and auristatins have been shown to interfere with microtubule dynamics, GTP hydrolysis, and nuclear and cellular division (Woyke et al. (2001) *Antimicrob. Agents and Chemother.* 45(12):3580-3584) and have anticancer (U.S. Pat. No. 5,663,149) and antifungal activity (Pettit et al. (1998) *Antimicrob. Agents Chemother.* 42:2961-2965). The dolastatin or auristatin (which are pentapeptide derivatives of dolastatins) drug moiety may be attached to the antibody through the N (amino) terminus or the C (carboxyl) terminus of the peptidic drug moiety (WO 02/088172).

[0194] Exemplary auristatin embodiments include the N-terminus linked monomethylauristatin drug moieties DE and DF, disclosed in "Monomethylvaline Compounds Capable of Conjugation to Ligands," U.S. Patent No. 7,498,298, the disclosure of which is expressly incorporated by reference in its entirety. As used herein, the abbreviation "MMAE" refers to monomethyl auristatin E. As used herein the abbreviation "MMAF" refers to dovaline-valine-dolaisoleuine-dolaproine-phenylalanine.

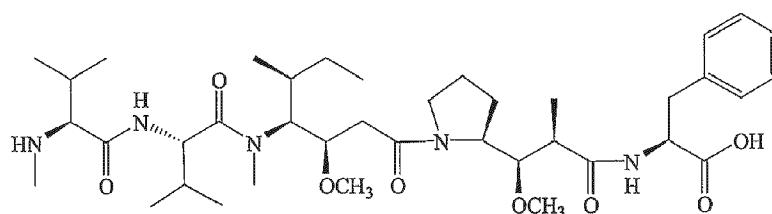
[0195] Typically, peptide-based drug moieties can be prepared by forming a peptide bond between two or more amino acids and/or peptide fragments. Such peptide bonds can be prepared, for example, according to the liquid phase synthesis method (see E. Schroder and K. Lubke, "The Peptides," volume 1, pp 76-136, 1965, Academic Press) that is well known in the field of peptide chemistry. The auristatin/dolastatin drug moieties may be prepared according to the methods of: U.S. Pat. No. 5,635,483; U.S. Pat. No. 5,780,588; Pettit et al. (1989) *J. Am. Chem. Soc.* 111:5463-5465; Pettit et al. (1998) *Anti-Cancer Drug Design* 13:243-277; Pettit, G. R., et al. *Synthesis*, 1996, 719-725; and Pettit et al. (1996) *J. Chem. Soc. Perkin Trans. 15:859-863. See also Doronina (2003) *Nat Biotechnol* 21(7):778-784; "Monomethylvaline Compounds Capable of Conjugation to Ligands," U.S. Patent No. 7,498,298, filed Nov. 5, 2004, hereby incorporated by reference in its entirety (disclosing, e.g., linkers and methods of preparing monomethylvaline compounds such as*

MMAE and MMAF conjugated to linkers). Biologically active organic compounds which act as cytotoxic agents, specifically pentapeptides, are disclosed in US Patent Nos. 6,884,869; 7,498,298; 7,098,308; 7,256,257; and 7,423,116.. Monoclonal antibodies linked with MMAE adn MMAF as well as various derivatives of auristatins and methods of making them are described in US Patent NO. 7,964,566.

5 [0196] Examples of auristatins include MMAE and MMAF the structures of which are shown below:



MMAE



MMAF

Maytansine and Maytansinoids

30 [0197] Maytansinoids are mitotic inhibitors which act by inhibiting tubulin polymerization. Maytansine was first isolated from the east African shrub *Maytenus serrata* (U.S. Pat. No. 3,896,111). Subsequently, it was discovered that certain microbes also produce maytansinoids, such as maytansinol and C-3 maytansinol esters (U.S. Pat. No. 4,151,042). Highly cytotoxic maytansinoid drugs can be prepared from ansamitocin precursors produced by fermentation of microorganisms such as *Actinosynnema*. Methods for isolating ansamitocins are described in US Patent No. 6,573,074. Synthetic maytansinol and derivatives and analogues thereof are disclosed, for example, in U.S. Pat. Nos. 4,137,230; 4,248,870; 4,256,746; 4,260,608; 4,265,814; 4,294,757; 4,307,016; 4,308,268; 4,308,269; 4,309,428; 4,313,946; 4,315,929; 4,317,821; 4,322,348; 4,331,598; 4,361,650; 4,364,866; 4,424,219; 4,450,254; 4,362,663; and 4,371,533.

35 [0198] Antibody-maytansinoid conjugates are prepared by chemically linking an antibody to a maytansinoid molecule without significantly diminishing the biological activity of either the antibody or the maytansinoid molecule. See, e.g., U.S. Pat. No. 5,208,020. An average of 3-4 maytansinoid molecules conjugated per antibody molecule has shown efficacy in enhancing cytotoxicity of target cells without negatively affecting the function or solubility of the antibody, although even one molecule of toxin/antibody would be expected to enhance cytotoxicity over the use of naked antibody. Maytansinoids are well known in the art and can be synthesized by known techniques or isolated from natural sources. Suitable maytansinoids are disclosed, for example, in U.S. Pat. No. 5,208,020 and in the other patents and nonpatent publications referred to hereinabove. Maytansinoids are maytansinol and maytansinol analogues modified in the aromatic ring or at other positions of the maytansinol molecule, such as various maytansinol esters. Methods for preparing maytansinoids for linkage with antibodies are disclosed in US Patent Nos. 6,570,024 and 6,884,874.

Calicheamicin

50 [0199] The calicheamicin family of antibiotics is capable of producing double-stranded DNA breaks at sub-picomolar concentrations. For the preparation of conjugates of the calicheamicin family, see U.S. Pat. Nos. 5,712,374, 5,714,586, 5,739,116, 5,767,285, 5,770,701, 5,770,710, 5,773,001, 5,877,296 (all to American Cyanamid Company). Structural analogues of calicheamicin which may be used include, but are not limited to, .gamma.1I, .alpha.2I, .alpha.3I, N-acetyl-.gamma.1I, PSAG and .theta.1I (Hinman et al., Cancer Research 53:3336-3342 (1993), Lode et al., Cancer Research 58:2925-2928 (1998) and the aforementioned U.S. patents to American Cyanamid). Another anti-tumor drug that the antibody can be conjugated is QFA which is an antifolate. Both calicheamicin and QFA have intracellular sites of action and do not readily cross the plasma membrane. Therefore, cellular uptake of these agents through antibody mediated internalization greatly enhances their cytotoxic effects.

Other Cytotoxic Agents

[0200] Other antitumor agents that can be conjugated to the antibodies include BCNU, streptozocin, vincristine and 5-fluorouracil, the family of agents known collectively LL-E33288 complex described in U.S. Pat. Nos. 5,053,394, 5,770,710, as well as esperamicins (U.S. Pat. No. 5,877,296).

[0201] Enzymatically active toxins and fragments thereof which can be used include diphtheria A chain, nonbinding active fragments of diphtheria toxin, exotoxin A chain (from *Pseudomonas aeruginosa*), ricin A chain, abrin A chain, modeccin A chain, alpha-sarcin, Aleurites fordii proteins, dianthin proteins, *Phytolaca americana* proteins (PAPI, PAPII, and PAP-S), momordica charantia inhibitor, curcin, crotin, saponaria officinalis inhibitor, gelonin, mitogellin, restrictocin, phenomycin, enomycin and the trichothecenes. See, for example, WO 93/21232 published Oct. 28, 1993.

[0202] The present invention further contemplates an immunoconjugate formed between an antibody and a compound with nucleolytic activity (e.g., a ribonuclease or a DNA endonuclease such as a deoxyribonuclease; DNase).

[0203] For selective destruction of the tumor, the antibody may comprise a highly radioactive atom. A variety of radioactive isotopes are available for the production of radioconjugated antibodies. Examples include At211, I131, I125, Y90, Re186, Re188, Sm153, Bi212, P32, Pb212 and radioactive isotopes of Lu. When the conjugate is used for detection, it may comprise a radioactive atom for scintigraphic studies, for example tc99m or I123, or a spin label for nuclear magnetic resonance (NMR) imaging (also known as magnetic resonance imaging, mri), such as iodine-123 again, iodine-131, indium-111, fluorine-19, carbon-13, nitrogen-15, oxygen-17, gadolinium, manganese or iron.

[0204] The radio- or other labels may be incorporated in the conjugate in known ways. For example, the peptide may be biosynthesized or may be synthesized by chemical amino acid synthesis using suitable amino acid precursors involving, for example, fluorine-19 in place of hydrogen. Labels such as tc99m or I123, Re186, Re188 and In111 can be attached via a cysteine residue in the peptide. Yttrium-90 can be attached via a lysine residue. The IODOGEN method (Fraker et al. (1978) Biochem. Biophys. Res. Commun. 80: 49-57) can be used to incorporate iodine-123. "Monoclonal Antibodies in Immunoscintigraphy" (Chatal, CRC Press 1989) describes other methods in detail.

Preparation of ADCs

[0205] In antibody drug conjugates, the antibody can be conjugated directly to the cytotoxic agent or via a linker. Suitable linkers include, for example, cleavable and non-cleavable linkers. A cleavable linker is typically susceptible to cleavage under intracellular conditions. Suitable cleavable linkers include, for example, a peptide linker cleavable by an intracellular protease, such as lysosomal protease or an endosomal protease. In exemplary embodiments, the linker can be a dipeptide linker, such as a valine-citrulline (val-cit) or a phenylalanine-lysine (phe-lys) linker. Other suitable linkers include linkers hydrolyzable at a pH of less than 5.5, such as a hydrazone linker. Additional suitable cleavable linkers include disulfide linkers.

[0206] Bristol-Myers Squibb has described particular lysosomal enzyme-cleavable antitumor drug conjugates. See, for example, U.S. Pat. No. 6,214,345. Seattle Genetics has published applications U.S. Pat. Appl. 2003/0096743 and U.S. Pat. Appl. 2003/0130189, which describe p-aminobenzylethers in drug delivery agents. The linkers described in these applications are limited to aminobenzyl ether compositions.

[0207] Conjugates of the antigen binding protein and cytotoxic agent may be made using a variety of bifunctional protein coupling agents such as N-succinimidyl-3-(2-pyridylthio)propionate (SPDP), succinimidyl-4-(N-maleimidomethyl) cyclohexane-1-carboxylate (SMCC), iminothiolane (IT), bifunctional derivatives of imidoesters (such as dimethyl adipimidate HCl), active esters (such as disuccinimidyl suberate), aldehydes (such as glutaraldehyde), bis-azido compounds (such as bis(p-azidobenzoyl) hexanediamine), bis-diazonium derivatives (such as bis-(p-diazoniumbenzoyl)-ethylenediamine), diisocyanates (such as toluene 2,6-diisocyanate), and bis-active fluorine compounds (such as 1,5-difluoro-2,4-dinitrobenzene).

[0208] Additionally the linker may be composed of one or more linker components. Exemplary linker components include 6-maleimidocaproyl ("MC"), maleimidopropanoyl ("MP"), valine-citrulline ("val-cit"), alanine-phenylalanine ("ala-phe"), p-aminobenzoyloxycarbonyl ("PAB"), N-Succinimidyl 4-(2-pyridylthio)pentanoate ("SPP"), N-Succinimidyl 4-(N-maleimidomethyl)cyclohexane-1 carboxylate ("SMCC"), and N-Succinimidyl(4-iodo-acetyl)aminobenzoate ("SIAB"). Additional linker components are known in the art and some are described herein. See also "Monomethylvaline Compounds Capable of Conjugation to Ligands," U.S. Patent No. US7,498,298, filed Nov. 5, 2004, the contents of which are hereby incorporated by reference in its entirety.

[0209] Linkers may also comprises amino acids and/or amino acid analogs. Amino acid linker components include a dipeptide, a tripeptide, a tetrapeptide or a pentapeptide. Exemplary dipeptides include: valine-citrulline (vc or val-cit), alanine-phenylalanine (af or ala-phe). Exemplary tripeptides include: glycine-valine-citrulline (gly-val-cit) and glycine-glycine-glycine (gly-gly-gly). Amino acid residues which comprise an amino acid linker component include those occurring naturally, as well as minor amino acids and non-naturally occurring amino acid analogs, such as citrulline. Amino acid linker components can be designed and optimized in their selectivity for enzymatic cleavage by a particular enzyme, for

example, a tumor-associated protease, cathepsin B, C and D, or a plasmin protease.

[0210] Antigen binding proteins and antibodies may be made reactive for conjugation with linker reagents. Nucleophilic groups on antibodies include, but are not limited to: (i) N-terminal amine groups, (ii) side chain amine groups, e.g., lysine, (iii) side chain thiol groups, e.g. cysteine, and (iv) sugar hydroxyl or amino groups where the antibody is glycosylated.

5 Amine, thiol, and hydroxyl groups are nucleophilic and capable of reacting to form covalent bonds with electrophilic groups on linker moieties and linker reagents including: (i) active esters such as NHS esters, HOBT esters, haloformates, and acid halides; (ii) alkyl and benzyl halides such as haloacetamides; (iii) aldehydes, ketones, carboxyl, and maleimide groups. Certain antibodies have reducible interchain disulfides, i.e. cysteine bridges. Antibodies may be made reactive for conjugation with linker reagents by treatment with a reducing agent such as DTT (dithiothreitol). Each cysteine bridge will thus form, theoretically, two reactive thiol nucleophiles. Additional nucleophilic groups can be introduced into antibodies through the reaction of lysines with 2-iminothiolane (Traut's reagent) resulting in conversion of an amine into a thiol. Reactive thiol groups may be introduced into the antibody (or fragment thereof) by introducing one, two, three, four, or more cysteine residues (e.g., preparing mutant antibodies comprising one or more non-native cysteine amino acid residues).

10 **[0211]** Antigen binding proteins and antibodies may also be modified to introduce electrophilic moieties, which can react with nucleophilic substituents on the linker reagent or drug. The sugars of glycosylated antibodies may be oxidized, e.g. with periodate oxidizing reagents, to form aldehyde or ketone groups which may react with the amine group of linker reagents or drug moieties. The resulting imine Schiff base groups may form a stable linkage, or may be reduced, e.g., by borohydride reagents to form stable amine linkages. In one embodiment, reaction of the carbohydrate portion of a 15 glycosylated antibody with either glucose oxidase or sodium meta-periodate may yield carbonyl (aldehyde and ketone) groups in the protein that can react with appropriate groups on the drug (Hermanson, Bioconjugate Techniques). In another embodiment, proteins containing N-terminal serine or threonine residues can react with sodium meta-periodate, resulting in production of an aldehyde in place of the first amino acid (Geoghegan & Stroh, (1992) Bioconjugate Chem. 3:138-146; U.S. Pat. No. 5,362,852). Such aldehydes can be reacted with a drug moiety or linker nucleophile.

20 **[0212]** Nucleophilic groups on a drug moiety include, but are not limited to: amine, thiol, hydroxyl, hydrazide, oxime, hydrazine, thiosemicarbazone, hydrazine carboxylate, and arylhydrazide groups capable of reacting to form covalent bonds with electrophilic groups on linker moieties and linker reagents including: (i) active esters such as NHS esters, HOBT esters, haloformates, and acid halides; (ii) alkyl and benzyl halides such as haloacetamides; (iii) aldehydes, 25 ketones, carboxyl, and maleimide groups.

30 **[0213]** In some embodiments, the linker is cleavable by a cleaving agent that is present in the intracellular environment (e.g., within a lysosome or endosome or caveolea). The linker can be, e.g., a peptidyl linker that is cleaved by an intracellular peptidase or protease enzyme, including, but not limited to, a lysosomal or endosomal protease. Typically, the peptidyl linker is at least two amino acids long or at least three amino acids long. Cleaving agents can include cathepsins B and D and plasmin, all of which are known to hydrolyze dipeptide drug derivatives resulting in the release 35 of active drug inside target cells (see, e.g., Dubowchik and Walker, 1999, Pharm. Therapeutics 83:67-123). Peptidyl linkers may be cleavable by enzymes that are present cells. For example, a peptidyl linker that is cleavable by the thiol-dependent protease cathepsin-B, which is highly expressed in cancerous tissue, can be used (e.g., a Phe-Leu or a Gly-Phe-Leu-Gly (SEQ ID NO:50) linker). Other such linkers are described, e.g., in U.S. Pat. No. 6,214,345. In specific 40 embodiments, the peptidyl linker cleavable by an intracellular protease is a Val-Cit linker or a Phe-Lys linker (see, e.g., U.S. Pat. No. 6,214,345, which describes the synthesis of doxorubicin with the val-cit linker). One advantage of using intracellular proteolytic release of the therapeutic agent is that the agent is typically attenuated when conjugated and the serum stabilities of the conjugates are typically high.

45 **[0214]** In other embodiments, the cleavable linker is pH-sensitive, i.e., sensitive to hydrolysis at certain pH values. Typically, the pH-sensitive linker hydrolyzable under acidic conditions. For example, an acid-labile linker that is hydrolyzable in the lysosome (e.g., a hydrazone, semicarbazone, thiosemicarbazone, cis-aconitic amide, orthoester, acetal, ketal, or the like) can be used. (See, e.g., U.S. Pat. Nos. 5,122,368; 5,824,805; 5,622,929; Dubowchik and Walker, 1999, Pharm. Therapeutics 83:67-123; Neville et al., 1989, Biol. Chem. 264:14653-14661.) Such linkers are relatively stable under neutral pH conditions, such as those in the blood, but are unstable at below pH 5.5 or 5.0, the approximate pH of the lysosome. In certain embodiments, the hydrolyzable linker is a thioether linker (such as, e.g., a thioether attached 50 to the therapeutic agent via an acylhydrazone bond (see, e.g., U.S. Pat. No. 5,622,929)).

55 **[0215]** In yet other embodiments, the linker is cleavable under reducing conditions (e.g., a disulfide linker). A variety of disulfide linkers are known in the art, including, for example, those that can be formed using SATA (N-succinimidyl-5-acetylthioacetate), SPDP (N-succinimidyl-3-(2-pyridylidithio)propionate), SPDB (N-succinimidyl-3-(2-pyridylidithio)butyrate) and SMPT (N-succinimidyl-oxycarbonyl-alphamethyl-alpha-(2-pyridyl-dithio)toluene)-, SPDB and SMPT (See, e.g., Thorpe et al., 1987, Cancer Res. 47:5924-5931; Wawrzynczak et al., In Immunoconjugates: Antibody Conjugates in Radioimaging and Therapy of Cancer (C. W. Vogel ed., Oxford U. Press, 1987. See also U.S. Pat. No. 4,880,935.)

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

(Lau et al., 1995, Bioorg-Med-Chem. 3(10):1305-12).

[0217] Typically, the linker is not substantially sensitive to the extracellular environment. As used herein, "not substantially sensitive to the extracellular environment," in the context of a linker, means that no more than about 20%, typically no more than about 15%, more typically no more than about 10%, and even more typically no more than about 5%, no more than about 3%, or no more than about 1% of the linkers, in a sample of ADC or ADC derivative, are cleaved when the ADC or ADC derivative present in an extracellular environment (e.g., in plasma). Whether a linker is not substantially sensitive to the extracellular environment can be determined, for example, by incubating independently with plasma both (a) the ADC or ADC derivative (the "ADC sample") and (b) an equal molar amount of unconjugated antibody or therapeutic agent (the "control sample") for a predetermined time period (e.g., 2, 4, 8, 16, or 24 hours) and then comparing the amount of unconjugated antibody or therapeutic agent present in the ADC sample with that present in control sample, as measured, for example, by high performance liquid chromatography.

[0218] In other, non-mutually exclusive embodiments, the linker promotes cellular internalization. In certain embodiments, the linker promotes cellular internalization when conjugated to the therapeutic agent (i.e., in the milieu of the linker-therapeutic agent moiety of the ADC or ADC derivative as described herein). In yet other embodiments, the linker promotes cellular internalization when conjugated to both the therapeutic agent and the antigen binding protein or antibody or derivative thereof (i.e., in the milieu of the ADC or ADC derivative as described herein).

[0219] A variety of linkers that can be used with the present compositions and methods are described in WO 2004010957 entitled "Drug Conjugates and Their Use for Treating Cancer, An Autoimmune Disease or an Infectious Disease" filed Jul. 31, 2003, and U.S. Provisional Application No. 60/400,403, entitled "Drug Conjugates and their use for treating cancer, an autoimmune disease or an infectious disease", filed Jul. 31, 2002 (the disclosure of which is incorporated by reference herein).

[0220] Alternatively, a fusion protein comprising the antigen binding protein and cytotoxic agent may be made, e.g., by recombinant techniques or peptide synthesis. The length of DNA may comprise respective regions encoding the two portions of the conjugate either adjacent one another or separated by a region encoding a linker peptide which does not destroy the desired properties of the conjugate.

[0221] In yet another embodiment, the antibody may be conjugated to a "receptor" (such as streptavidin) for utilization in tumor pre-targeting wherein the antibody-receptor conjugate is administered to the patient, followed by removal of unbound conjugate from the circulation using a clearing agent and then administration of a "ligand" (e.g., avidin) which is conjugated to a cytotoxic agent (e.g., a radionucleotide).

[0222] The term "Non Human antibody or antibody fragment thereof" as used herein is meant to refer to antibodies or fragments thereof which originate from any species other than human wherein human includes chimeric antibodies.

[0223] The term "donor antibody" refers to an antibody (monoclonal, and/or recombinant) which contributes the amino acid sequences of its variable domains, CDRs, or other functional fragments or analogs thereof to a first immunoglobulin partner, so as to provide the altered immunoglobulin coding region and resulting expressed altered antibody with the antigenic specificity and neutralizing activity characteristic of the donor antibody.

[0224] The term "acceptor antibody" refers to an antibody (monoclonal and/or recombinant) heterologous to the donor antibody, which contributes all (or any portion, but preferably all) of the amino acid sequences encoding its heavy and/or light chain framework regions and/or its heavy and/or light chain constant regions to the first immunoglobulin partner. The human antibody is the acceptor antibody. The term "Human acceptor sequence" as used herein is meant to refer to a framework of an antibody or antibody fragment thereof comprising the amino acid sequence of a VH or VL framework derived from a human antibody or antibody fragment thereof or a human consensus sequence framework into which CDR's from a non-human species may be incorporated.

[0225] The term "incorporation" of CDR's or hypervariable regions as used herein encompasses any means by which the non-human CDR's are situated with the human acceptor framework. It will be appreciated that this can be achieved in various ways, for example, nucleic acids encoding the desired amino acid sequence can be generated by mutating nucleic acids encoding the non-human variable domain sequence so that the framework residues thereof are changed to human acceptor framework residues, or by mutating nucleic acid encoding the human variable domain sequence so that the CDR's are changed to non-human residues, or by synthesizing nucleic acids encoding the desired sequence. In one embodiment the final sequence is generated *in silico*.

[0226] The present invention is now described by way of example only. The appended claims may include a generalisation of one or more of the following examples.

Examples**Example 1 Monoclonal Antibody Generation and Selection**

5 1.1 Immunisation strategies

- [0227] The anti human BCMA mAb murine parental CA8 was identified from hybridomas derived from mice immunized with full length human BCMA. A BALB/c mouse was immunized i.p. with 25 µg of recombinant (rBCMA) protein combined with CFA. The mouse was boosted three times at one-month intervals with 25 µg of full length rBCMA protein + 10 µg monophosphoryl lipid A-stable emulsion (MPL-SE) (Corixa Corporation, Seattle, WA) and given a pre-fusion boost of 30 µg rBCMA protein i.v. 3 days prior to fusion. Hybridomas were either generated and cloned using the ClonaCell-HY hybridoma cloning kit (StemCell Technologies, Vancouver, BC) or using a conventional method. In the conventional method, B cells from the spleens of the immunized animals were fused with Sp2/0 myeloma cells in the presence of PEG (Sigma-Aldrich, St. Louis, MO). After overnight recovery, fused cells were plated at limiting dilution in 96-well plates and subjected to hypoxanthine-aminopterin-thymidine selection. Hybridoma culture supernatants were examined for the presence of anti-BCMA antibodies by ELISA and flow cytometry-
- [0228] The anti human BCMA mAb murine parental S307118G03 was identified from hybridomas derived from SJL mice immunized with recombinant human BCMA/TNFRSF17-Fc chimera (R&D 193-Fc) using the RIMMS method (Rapid immunisation multiple sites). At Day 0, 5ug protein per mouse was emulsified in AS02a adjuvant at 2 sites on back (over haunches and over shoulders) and subjacent to the major lymph nodes at 4 sites on front. On day 6 and day 11 2.5ug protein per mouse in RIBI adjuvant was injected subjacent to the major lymph nodes at 4 sites on front. On day 14 the animals were sacrificed. The lymph nodes and spleen were excised, disrupted and a PEG1500 induced somatic cell fusion performed using a 3:1 ratio with mouse myeloma cells X63 AG8 653.GFP.Bcl-2.11 (BioCat 112754; R17209/58). The fusion was plated out into 10 × 96 well plates and screened directly from these.
- [0229] The anti human BCMA mAb murine parental S336105A07 was identified from hybridomas derived from identical immunisations. The lymph nodes and spleen were excised at day 14, disrupted, and a Cytopulse electrofusion was performed using a 1:1 ratio with mouse myeloma cells X63 AG8 653.GFP.Bcl-2.11 (BioCat 112754; R17209/58). The fusion was plated out into omnitrays containing semi solid medium prior to picking into 10 × 96 well plates and was screened directly from these 5 days later.
- [0230] The anti human BCMA murine parental mAbs S332121F02 and S332126E04 were identified from hybridomas derived from SJL mice immunized with recombinant Fc fusion of the extracellular domain of human BCMA (4-53)BCMA using the RIMMS method (Rapid immunisation). At Day 0, 5ug protein per mouse was emulsified in AS02a adjuvant at 2 sites on back (over haunches and over shoulders) and subjacent to the major lymph nodes at 4 sites on front. On day 6 5ug recombinant cyto BCMA-Fc protein per mouse in RIBI adjuvant was injected subjacent to the major lymph nodes at 4 sites on front. On day 11 2.5ug recombinant human BCMA-Fc and 2.5ug recombinant cyto BCMA-Fc per mouse in RIBI adjuvant was injected subjacent to the major lymph nodes at 4 sites on front. On day 14 the animals were sacrificed and cells treated as for S307118G03.
- [0231] The anti human BCMA murine parental mAb S322110D07 was identified from hybridomas derived from SJL mice immunised with recombinant Fc fusion of the extracellular domain of human BCMA (4-53) in complex with recombinant human April (R&D 5860-AP/CF) premixed at 1:1 molar ratio. The mice were immunized i.p. with 5ug April/Cyto BCMA-Fc complex in PBS, suspended in RIBI adjuvant, 100ul dose per mouse and boosted 3 times at 3-4 week intervals with 2.5ug April/Cyto BCMA-Fc complex in PBS, suspended in RIBI adjuvant, 100ul dose per mouse injected via intraperitoneal route and given a pre-fusion boost of the same immunogen 1 day prior to fusion and treated as for S307118G03.
- [0232] The anti human BCMA mAb murine parental S335115G01 and S335122F05 were identified from hybridomas derived from SJL mice immunized with a mixture of recombinant Fc fusion of the extracellular domain of human BCMA (4-53) and recombinant Fc fusion of the extracellular domain of cyto BCMA (4-52) using the RIMMS method (Rapid immunisation multiple sites). At Day 0, 2, 5ug of each protein per mouse was emulsified in AS02a adjuvant and injected at 2 sites on the back (over haunches and over shoulders) and subjacent to the major lymph nodes at 4 sites on front. On day 6 and day 11 2.5ug of each protein per mouse in RIBI adjuvant was injected subjacent to the major lymph nodes at 4 sites on front. On day 14 the animals were sacrificed. The lymph nodes and spleen were excised, disrupted and a Cytopulse electrofusion was performed using a 1:1 ratio with mouse myeloma cells X63 AG8 653.GFP.Bcl-2.11 (BioCat 112754; R17209/58). The fusion was plated out into omnitrays containing semi solid medium prior to picking into 32 × 96 well plates and was screened directly from these 5 days later.

Example 2 Humanisation.**2.1 Cloning of CA8 Hybridoma Variable Regions**

5 [0233] Total RNA was extracted from CA8 hybridoma cells, heavy and light variable domain cDNA sequence was then generated by reverse transcription and polymerase chain reaction (RT-PCR). The forward primer for RT-PCR was a mixture of degenerate primers specific for murine immunoglobulin gene leader-sequences and the reverse primer was specific for the antibody constant regions. Reverse primers specific for IgG1, IgG2a and IgG2b were used in this case as the isotype was unknown. To design the primers, DNA multiple sequence alignments of the leader sequences of the
 10 mouse V_H and V_k genes were generated.

2.2 Cloning of chimeric CA8

15 [0234] The DNA expression constructs encoding the chimeric antibody were prepared *de novo* by build-up of overlapping oligonucleotides including restriction sites for cloning into mammalian expression vectors as well as a human signal sequence. *HindIII* and *SpeI* restriction sites were introduced to frame the VH domain containing the signal sequence for cloning into mammalian expression vectors containing the human $\gamma 1$ constant region. *HindIII* and *BsiWI* restriction sites were introduced to frame the VL domain containing the signal sequence for cloning into mammalian expression vector containing the human kappa constant region.
 20

2.3 Cloning of the humanised CA8 variants

25 [0235] The DNA expression constructs encoding the humanised antibody variants were prepared *de novo* by build-up of overlapping oligonucleotides including restriction sites for cloning into mammalian expression vectors as well as a human signal sequence. *HindIII* and *SpeI* restriction sites were introduced to frame the VH domain containing the signal sequence for cloning into mammalian expression vectors containing the human $\gamma 1$ constant region. *HindIII* and *BsiWI* restriction sites were introduced to frame the VL domain containing the signal sequence for cloning into mammalian expression vector containing the human kappa constant region.

30 2.4 Expression of the recombinant CA8 antibodies (including antibody quantification)

35 [0236] Expression plasmids encoding the heavy and light chains respectively were transiently co-transfected into HEK 293 6E cells and expressed at small scale to produce antibody. Antibodies were quantified by ELISA. ELISA plates were coated with anti human IgG (Sigma I3382) at 1mg/ml and blocked with blocking solution (4% BSA in Tris buffered saline). Various dilutions of the tissue culture supernatants were added and the plate was incubated for 1 hour at room temperature. Dilutions of a known standard antibody were also added to the plate. The plate was washed in TBST and binding was detected by the addition of a peroxidise labelled anti human kappa light chain antibody (Sigma A7164) at a dilution of 1/1000 in blocking solution. The plate was incubated for 1 hour at room temp before washing in TBST. The plate was developed by addition of OPD substrate (Sigma P9187) and colour development stopped by addition of 2M H₂SO₄.
 40 Absorbance was measured at 490nm and a standard curve plotted using data for the known standard dilutions. The standard curve was used to estimate the concentration of antibody in the tissue culture supernatants. Larger scale antibody preparations were purified using protein A and concentrations were measured using a Nanodrop (Thermo Scientific).

45 Table 1. Design of CA8 variable heavy and light humanised variants

Humanised VH	Template	Backmutations (Kabat#)
J0	Straight graft of CA8 VH CDRs onto IGHV1_69 + JH1 minigene	None
J1	J0	G27Y, S30T
J2	J1	A93T
J3	J2	A24G, K73T
J4	J3	M48I, V67A.
J5	J3	N99D
J6	J0	N99D

(continued)

Humanised VH	Template	Backmutations (Kabat#)
J7	J1	N99D
J8	J2	N99D
J9	J4	N99D
M0	Straight graft of CA8 VL CDRs onto IGKV1_39 + JK2 minigene	None
M1	M0	F71Y
M2	M1	M4L. K45E.

2.5 Defucosylated antibody production

[0237] To generate defucosylated antibodies the heavy and light chains respectively were co-transfected into CHO DG44 MS705 BioWa cells and expressed at scale to produce antibody. Briefly, 30µg DNA was linearised overnight with Not1, the DNA was ethanol precipitated and re-dissolved in TE buffer. From culture, 2.4X10⁷ BioWa DG44 cells were obtained and washed in 14ml of warmed PBS-sucrose. The cells were spun and the pellet resuspended in 1.6ml of PBS-sucrose. Half (0.8ml) of aforementioned cells, suspended in PBS-sucrose, were added to a BioRad cuvette with the 30µg of linearised DNA (in 50µl TE buffer). A BioRad GenePulser was programmed to 380V with a capacitance of 25µF and the cuvette was entered for electroporation. The resulting 850ul of electroporated cells and DNA were added to (80ml) warmed SFM512 medium (including phenol red, 2XHT (nucleosides), glutamax and Gibco supplement4). Finally, the resulting 80ml of cell suspension was transferred (150µl/well) to each well of one of 4 × 96-well plates. After 48 hours, the medium was changed to nucleoside free by removing approximately 130µl of conditioned and replacing with 150µl of fresh selection medium SFM512 medium (including phenol red and glutamax). Every 3-4 days, 130-150µl of conditioned medium was removed and replaced with fresh, selection medium. Wells were monitored for colour change and assayed for IgG concentration as discussed previously.

2.6 Additional antibodies - Cloning of Hybridoma Variable Regions

[0238] Total RNA was extracted from S307118G03, S332121F02, S332126E04, S322110D07, S336105A07, S335115G01 and S335122F05 hybridoma cells. Heavy and light variable domain cDNA sequence was then generated by reverse transcription and polymerase chain reaction (RT-PCR). The forward primer for RT-PCR was a mixture of degenerate primers specific for murine immunoglobulin gene leader-sequences and the reverse primer was specific for the antibody constant regions, in this case isotype IgG2a. Primers were designed based on a strategy described by Jones and Bendig (Bio/Technology 9:88, 1991). RT-PCR was carried out for both V-region sequences to enable subsequent verification of the correct V-region sequences. DNA sequence data was obtained for the V-region products generated by the RT-PCR.

2.7 Additional antibodies - Cloning of the chimeras

[0239] The DNA expression constructs encoding the chimeric antibodies were prepared de novo by infusion advantage PCR cloning (Clonetech) of the V-gene PCR products into mammalian expression vectors. This cloning method enabled fusion the murine variable regions to human IgG1 H chain and kappa L chain constant regions.

2.8 S307118G03 - Cloning of the humanized variants

[0240] Cloning was carried out as for paragraph 2.3.

2.9 S307118G03 Expression of the recombinant antibodies

[0241] Expression plasmids encoding the relevant heavy and light chains (listed in Table 8 below) were transiently co-transfected into HEK 293 6E cells and expressed at small scale to produce antibody. The antibodies were Protein A purified from the supernatants and quantified using the Nanodrop spectrophotometer. 8 below) were transiently co-transfected into HEK 293 6E cells and expressed at small scale to produce antibody. The antibodies were Protein A purified from the supernatants and quantified using the Nanodrop spectrophotometer.

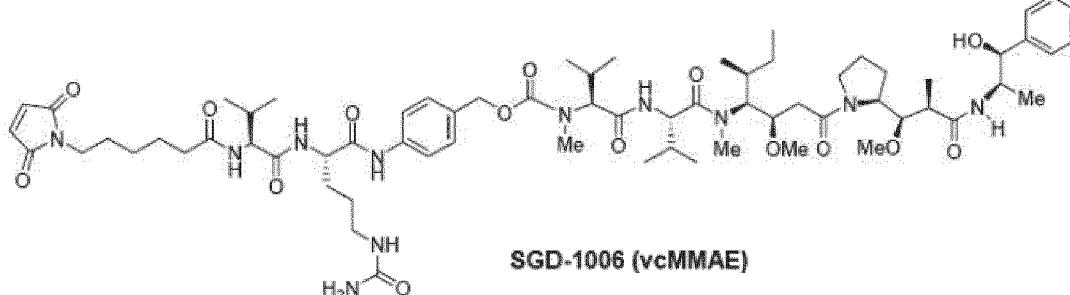
Example 3 Conjugation of antibodies to vcMMAE and mcMMAF to form antibody drug conjugates (ADC)

[0242]

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Table B Chemical structures of drug-linkers

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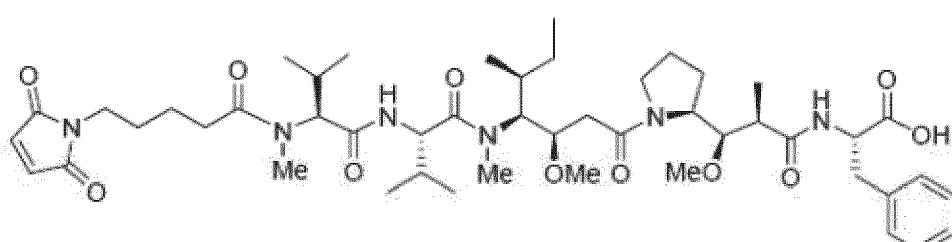


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SGD-1006 (vcMMAE)

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SGD-1269 (mcMMAF)

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[0243] Gammabind Plus Protein G Sepharose (GE Healthcare) resin slurry (75 uL) was added to each well of a deep well (2 mL capacity) filter plate. The antibodies to be conjugated were grouped by species and isotype and up to 0.5 mg of each antibody transferred to each well of the plate. Each antibody was transferred to two separate wells to facilitate the preparation of two conjugates, with the drug-linkers SGD-1006 and SGD-1269. The filter plate was then shaken at 1200 RPM for 2 hours at 5 °C to bind the antibodies to the resin. The filter plate was then centrifuged at 500x g for 3 minutes to ensure complete pulldown of all fluids and resin to the bottom of the each well.

[0244] The bound antibodies were then reduced by adding 500 uL of 10 mM TCEP in 100 mM KPO₄, 150 mM NaCl, pH 7, 1mM EDTA and shaking for 30 minutes at 22 °C. Following reduction, the plate was again centrifuged to remove the TCEP solution and subsequently washed with PBS + 1mM EDTA, 1 mL per well. The wash solution was removed by centrifugation and the process repeated 3 times for a total of 4 washes. The bound and reduced antibodies were then conjugated using a mixture of NEM and drug linker prepared in accordance with the mole fractions indicated in Table 2.

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Table 2.

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Antibody (species / isotype)	Reducible Disulfides	SGD-1006 mole fraction	SGD-1269 mole fraction
Human IgG1*	4	0.675	0.688
Murine IgG1	5	0.500	0.586
Murine IgG2a	5	0.500	0.586

(continued)

Antibody (species / isotype)	Reducible Disulfides	SGD-1006 mole fraction	SGD-1269 mole fraction
Murine IgG2b	6	0.463	0.481
* also for murine / human IgG1 chimerics			

[0245] Separate mixtures of NEM and drug linker were thus prepared for each antibody species / isotype using 10 mM DMSO stock solutions of SGD-1006, SGD-1269 (See Table B) and NEM. When mixed at the appropriate ratio the total maleimide concentration was therefore still 10 mM, and this value was used to calculate the volume of maleimide solution to be added to each well. For example for a murine IgG1 with 5 reducible disulfides (10 available thiols when reduced) 0.5 mg of antibody at 150 kD is 3.33 nmol corresponding to 33.3 nmol of thiol. A 3-fold excess is therefore 100 nmol of total maleimide or 10 μ L of the 10 mM drug linker / NEM mix. For the SGD-1269 conjugate this mix would then be prepared with 5.86 μ L of SGD-1269 and 4.14 μ L of NEM. The maleimide mix would then be diluted into 500 μ L of PBS prior to addition to the immobilized reduced antibody. In practice, since multiple antibodies of each isotype were conjugated simultaneously a single SGD-1269 / NEM mixed solution for each isotype was prepared by multiplying the number of wells containing that isotype by 10 μ L per well then diluting into a volume of PBS equal to 500 μ L times the number of wells. In like fashion a total of eight drug-linker / NEM mixes were prepared-four with SGD-1006 and four with SGD-1269-and diluted into PBS. These mixes were then added to the reduced antibodies (500 μ L per well) and the plate was shaken for 30 minutes at 22 °C. The plate was then centrifuged as above to remove the excess reaction solution, and subsequently washed 4 times with PBS as before.

[0246] The bound ADCs were then eluted by adding 200 μ L of 50 mM glycine pH 2.5 to each well and shaking the plate for 3 minutes at 1200 RPM. While shaking 20 μ L of neutralization buffer (1M potassium phosphate, pH 7.4, 500 mM NaCl, 0.2% Tween-20) was added to each well of a 1 mL collection plate. The ADCs were then eluted into the collection plate by spinning at 1500x g for 6 minutes. The collection plate was then shaken briefly to ensure complete mixing of the neutralization buffer.

[0247] The concentration of each ADC was then determined with an absorbance plate reader by transferring the solutions into a UV assay plate (Costar model 3635, Corning) and measuring the optical density at 280 nm. An average IgG extinction coefficient of 1.45 mL mg-1 cm-1 was used to provide an adequate estimation of ADC concentration across the panel. To confirm successful conjugation, a reversed phase protein HPLC method (described below) was used to estimate the drug loading of the isotype controls. For the plate containing the humanization variants of CA8 this method was used to estimate the loading of all ADCs directly.

[0248] The reversed phase protein chromatography method for determining drug loading employs the PLRP-S polymeric stationary phase (Agilent Technologies). Since the antibodies were fully reduced during the conjugation process all of the antibody subunits elute from the column as single polypeptide chains allowing the subpopulations of light and heavy chain species with varying levels of drug loading to be evaluated separately. Thus, the analysis of these data allow for the calculation of the average light chain drug loading and the average heavy chain drug loading as independent factors which can then be combined to determine average antibody drug loading with the basic knowledge that each antibody is comprised of two light and two heavy chains. The chromatographic conditions were as follows: A PLRP-S column, 1000 Å, 50 x 2.1 mm, 8 um particle size (Agilent Technologies) with water + 0.05% TFA as mobile phase A and acetonitrile + 0.01% TFA as mobile phase B; elution with a linear gradient of 27% B to 42% B in 12.5 minutes.

[0249] Anti-BCMA antibodies were conjugated with SGD-1006 and SGD-1269 in three separate batches over a period of seven months. In the first batch a total of 29 antibodies were conjugated (resulting in 58 ADCs). The drug loading of each isotype control determined by PLRP chromatography and the data are summarized in Table 3.

Table 3.

Isotype	SGD-1006 loading	SGD-1269 loading
clgG1 (control P)	4.23	4.35
clgG1 (control M)	4.42	4.41
mlgG1	4.26	4.04
mlgG2a	4.51	4.57
mlgG2b	4.39	4.18

[0250] For the second batch an additional 25 antibodies were conjugated (resulting in 50 ADCs). The drug loading of

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each isotype control was again determined by PLRP chromatography and the data are summarized in Table 4.

Table 4.

Isotype	SGD-1006 loading	SGD-1269 loading
c IgG1	3.96	3.78
m IgG1	3.95	3.32
m IgG2a	4.53	3.60
m IgG2b	4.32	3.49

[0251] In the third batch 30 antibodies were conjugated (resulting in 60 ADCs), including 13 humanized variants of CA8. In this final batch, the drug loading of all ADCs were determined and are summarized in the following two plate maps. (Table 5 & 6)

Table 5.

	drug loading									
	1	2	3	4	5	6	7	8	9	10
A	3.7	4.0	3.6	3.8	3.8	3.5	3.9	2.8	3.8	3.8
B	3.7	3.6	3.5	3.7	40	3.4	3.7	3.3	3.8	3.9
C	3.6	3.8	3.5	3.7	3.6	3.3	3.8	47	3.8	3.7
D	3.4	38	38	3.9	3.9	3.4	32	4.8	3.8	3.9
E	3.9		3.8	3.9	3.4	3.6		3.3	3.7	3.4
F	37			40	36	3.5			38	3.7
G	3.6			3.6		3.4			3.7	
H				3.6					3.6	
	SGD-1006 (vc-MMAE) ADCs					SGD-1269 (mc-MMAF) ADCs				
	3.7	38	3.6	3.8	3.4	37	38	3.7		
	4.1%	5.1%	3.4%	4.8%	2.8%	8.5%	24.1%	3.4%		

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Table 6.

	mlgG 1	mlgG2a	mlgG2b	humanized	mlgG1	mlgG2a	mlgG2b	humanized
A	control	2	3	4	5	6	7	8
B	S336106D07	S336105A07	S336107G08	CA8 J6M0	CA8 J8M2	control	control	CA8 J6M0
C	S335115G03	S335122F05	S336104A09	CA8 J6M1	CA8 J9M0	S336106D07	S336105A07	CA8 J6M1
D	S335115G01	S335128A12	S335107H11	CA8 T7M0	CA8 J9M2	S335115G03	S335122F05	S336104A09
E	S335106E08		S335119E11	CA8 J7M1	CA8 Fc ENH	S335115G01	5335128A12	5335107H11
F	S335132E01			CA8 J7M2	GRITS28785	S335106E08		CA8 J7M1
G	S341106G02			CA8 J8M0	S341106G02			CA8 Fc ENH
H				CA8 J8M1			CA8 JSM1	
								SGD-1269 (vc-MMAE) ADCs
								SGD-1006 (vc-MMAE) ADCs

[0252] Mean drug loading and %CV are indicated for each isotype series at the bottom. An uncharacteristically large variability in drug loading was observed for the SGD-1269 ADCs prepared with mlgG2b antibodies; the reason for this is unclear. Also, the Fc-enhanced CA8 antibodies yielded somewhat lower drug loading levels than the other CA8 human variants; to address this, additional Fc-enhanced CA8 was conjugated in a solution-phase reaction to better match the drug loading achieved for the other antibodies.

Example 4 - Binding Data

4.1 FMAT binding assay to show binding of Chimeric CA8 to cells expressing human or cyo BCMA.

[0253] Cryopreserved transfected human, cyo BCMA and mock transfected HEK293 cells were recovered from LN2 storage. Assay wells were prepared with human chimeric CA8 antibody, at a range of different concentrations, mixed with human BCMA HEK293, cyo BCMA HEK293 and mock transfected cells respectively. Anti-human IgG FMAT Blue secondary conjugate was added for detection of human chimeric CA8. The assay plates were left for a minimum of 90 minutes before the result was read on the ABI8200 (FMAT) plate reader.

[0254] This showed that the CA8 antibody in chimeric form binds well to both human and cyo BCMA proteins expressed on HEK293 cells.

[0255] Results are shown in Figure 1.

4.2 ELISA experiment showing binding of chimeric CA8 to recombinant BCMA protein

[0256] Chimeric CA8 antibodies were tested for binding to human BCMA and cyo BCMA expressed as Fc fusions. Human BCMA-Fc and cyo BCMA-Fc were coated to ELISA plates and the plates were blocked using BSA to reduce non specific binding. CA8 chimeric antibodies were added in a concentration range from 5ug/ml to 0.1ug/ml to the human and cyo BCMA coated ELISA plates. Any bound human chimeric CA8 antibody was detected using anti-human IgG HRP conjugated secondary antibody as appropriate. HRP substrate (TMB) was added to develop the ELISA. This showed that CA8 antibody binds to recombinant human and cyo BCMA in an ELISA assay.

[0257] Results are shown in Figure 2.

4.3 Biacore experiment to show CA8 antibody binding to BCMA and TACI proteins to determine cross reactivity with TACI protein.

[0258] CA8 chimera antibody was injected and captured on protein A. (A protein A derivitised sensorchip was used). Residual protein A binding was blocked with an injection of a high concentration of human IgG solution. BCMA-Fc, TACI-Fc or BAFF-R-Fc solutions were then tested for binding to the antibody. The 3 proteins were injected in sequence and binding events were measured. The surface was regenerated between injection of each protein.

[0259] Sensorgrams were analysed in the Biaevaluation program. Double reference subtraction was done to remove instrument noise and any non-specific binding from the sensorgram curves.

[0260] This showed that CA8 was specific for binding to BCMA binding and not to TACI and BAFFR.

[0261] Binding of the CA8 antibody to BCMA-Fc, TACI-Fc and BAFF-R-Fc was plotted out as shown in Figure 3.

4.4 Cell binding and neutralisation data

4.4.1 Binding of murine anti BCMA antibodies to multiple myeloma cells and BCMA expressing cells

[0262] Multiple myeloma cell line H929 and ARH77-hBCMA 10B5 BCMA expressing transfectant cells were stained with murine S332211D07, S333212F02 or S332126E04 or murine isotype control at 5 µg/mL. Multiple myeloma cell line H929 was stained with murine S307118G03. Cells were incubated for 20 mins at room temperature (RT) and then washed with FACS buffer (PBS + 0.5% BSA + 0.1% sodium azide) to remove unbound antibody. Cells were incubated with a secondary PE labelled antimouse IgG antibody for 15 minutes at RT and then washed with FACS buffer to remove unbound antibody. Cells were analysed by FACS to detect antibody bound to the cells.

[0263] The results (Figure 4) showed that all 4 murine antibodies bound to the H929 multiple myeloma cell line and the three antibodies tested on ARH77 BCMA transfected cells bound to these.

55 4.4.2 Binding curve of chimeric CA8 to multiple myeloma cells as determined by FACS

[0264] A panel of multiple myeloma cell lines were used to determine the binding of chimeric CA8. Cell lines H929, OPM-2, JJN-3 and U266 were stained with either chimeric CA8 or irrelevant antibody (Synagis) at varying concentrations

for 20 minutes at RT. Cells were then washed with FACS buffer (PBS + 0.5% BSA + 0.1% sodium azide) to remove unbound antibody. Cells were incubated with a secondary PE labelled anti-human IgG antibody for 15 minutes at RT and then washed with FACS buffer to remove unbound antibody. Cells were analysed by FACS and mean fluorescence intensity (MFI) values measured to determine binding.

5 [0265] Results showed that chimeric CA8 bound to multiple myeloma cell lines H929, OPM-2, JJN-3 & U266 in a dose dependent manner (Figure 5).

4.4.3 Binding of humanised CA8 to BCMA transfected cells as determined by FACS

10 [0266] ARH77-hBCMA 10B5 BCMA expressing transfectant cells or H929 cells were stained with either chimeric CA8 or humanised variants of CA8 designated J6M0, J6M1, J6M2, J9M0, J9M1, J9M2 at varying concentrations for 20 minutes at RT. Cells were then washed with FACS buffer (PBS + 0.5% BSA + 0.1% sodium azide) to remove unbound antibody. Cells were incubated with a secondary PE labelled anti-human IgG antibody for 15 minutes at RT and then washed with FACS buffer to remove unbound antibody. Cells were analysed by FACS and mean fluorescence intensity (MFI) values measured to determine binding.

15 [0267] Results showed that chimeric CA8 and all antibodies tested apart from J9M2 bound to ARH77-hBCMA 10B5 BCMA expressing transfectant cells and H929 cells in a dose dependent manner (Figure 6).

20 4.5 Demonstration of ability of CA8 and the humanised version J6M0 to neutralise binding of BAFF or APRIL to recombinant BCMA.

[0268] The aim of this assay was to assess the ability of antibody CA8, and humanised version J6M0 in both wild type and afucosylated (Potelligent) form, at various concentrations, to neutralise the binding ability of either BCMA ligand, BAFF or APRIL.

25 [0269] 96 well flat bottomed plates were coated overnight with 1 μ g/mL solution of recombinant human BCMA Fc 4-53 in PBS. Following a wash step using 0.05% TWEEN20, plates were blocked with 2% Bovine Serum Albumin solution in PBS for 1 hour at room temperature. Plates were washed as before and 40 μ L of each antibody (murine IgG, murine CA8, and chimeric CA8), starting at 10 μ g/mL, titrated at 1 in 2 in duplicate was added to the relevant wells and incubated for 1 hour at room temperature. 40 μ L of 2% BSA was added to the relevant control wells. 10 μ L of either recombinant 30 human BAFF (2149-BF/CF, R&D Systems) or recombinant human APRIL (5860-AP/CF, R&D Systems) was added at 30ng/mL and 750ng/mL respectively, giving a final concentration of 6ng/mL and 150ng/mL respectively in each well. Equivalent volume of 2% BSA was added to the relevant control wells. Plates were allowed to incubate for 2 hours at room temperature, after which they were washed as before. Biotinylated anti-human ligand (BAFF BAF124 or APRIL BAF884, R&D Systems) was added to the relevant wells at 50ng/mL and incubated for 1 hour. Following a wash step, 35 50 μ L of a 1:4000 dilution of Streptavidin-HRP (Amersham RPN4401) was added to each well and incubated for 30 minutes at room temperature. The wash process was repeated again followed by the addition of 100 μ L of Tetramethylbenzidine substrate solution (T8665, Sigma) into each well. Plates were incubated for 20-25 minutes at room temperature, wrapped in foil. The reaction was stopped with the addition of 100 μ L of 1M H₂SO₄. Optical density was determined at 450nm using Spectromax reader. See Figure 7A and B.

40 [0270] In a plate based assay for neutralisation of binding of BAFF or APRIL to BCMA, the EC50 values calculated for chimeric CA8 were 0.695 μ g/mL and 0.773 μ g/mL respectively. The values for the humanised J6M0 were 0.776ng/ml and 0.630ng/ml. The values for the J6M0 potelligent version were 0.748 and 0.616ng/ml respectively..

45 4.6 Effect of chimerised CA8 and humanised J6M0 BCMA antibody on BAFF or APRIL induced phosphorylation of NFkB in H929 cells.

[0271] In one set of experiments, H-929 cells were plated at 75,000cells/well in a 96 well plate in serum free medium. The chimeric CA8 antibody was added 24 hours later to give final well concentrations up to 200ug/ml. Ten minutes later, BAFF or APRIL ligand were added to the cells to give final well concentrations of 0.6 or 0.3ug/ml respectively. After 30 minutes the cells were lysed and phosphorylated NfkappaB levels measured using a MSD pNfkappaB assay.

50 [0272] The chimeric BCMA antibody CA8 neutralised both BAFF and APRIL induced NfkappaB cell signalling in H-929 cells. It was particularly potent at neutralising BAFF induced NfkappaB cell signalling in this cell type with a mean IC50 of 10nM, compared to 257nM for APRIL induced NfkappaB cell signalling.

55 Measured data for 2 experiments

[0273] IC50s were 10nM for BAFF induced NfkappaB neutralisation and 257nM for APRIL induced NfkappaB neutralisation (mean of 2 independent experiments) are shown in Table 7.

Table 7

	BAFF induced IC50		APRIL induced IC50	
	ug/ml	nM	ug/ml	nM
BCMA antibody CA8	1.5	10	38.5	256.7

[0274] A further set of experiments were carried out to aim to understand why there was such a discrepancy between the potency in neutralisation of APRIL and BAFF in the cell based system. Following the discovery of the soluble form of BCMA the experimental design was changed to include a step where the H929 cells were washed prior to the assay to reduce the interference from the antibody binding to soluble BCMA. H-929 cells were washed 3 times to remove any sBCMA and resuspended in serum free medium. J6MO potelligent antibody was added to a 96 well plate to give a final well concentrations up to 100ug/ml along with BAFF or APRIL ligand to give a final well concentration of 0.6 or 0.2 ug/ml respectively. H-929 cells were then plated at 7.5x104cells/well in serum free medium. 30 minutes later the cells were lysed and phosphorylated NFkappaB levels measured using a MSD pNFkappaB assay. This is data from one experiment. Each data point is the mean/sd of two replicates. The data from this experiment is shown in Figure 7c. The IC50s for inhibition of BAFF and APRIL signalling were determined as 0.91ug/ml and 2.43ug/ml respectively.

4.7 ProteOn analysis of anti-BCMA CA8 chimeric and humanised constructs

[0275] The initial screen of CA8 chimeric and humanised variants was carried out on the ProteOn XPR36 (Biorad). The method was as follows; Protein A was immobilised on a GLC chip (Biorad, Cat No: 176-5011) by primary amine coupling, CA8 variants were then captured on this surface and recombinant human BCMA (in house or commercial US Biological, B0410) materials (run 2 only)) passed over at 256, 64, 16, 4, 1nM with a 0nM injection (i.e. buffer alone) used to double reference the binding curves, the buffer used is the HBS-EP buffer. 50mM NaOH was used to regenerate the capture surface. The data was fitted to the 1:1 model using the analysis software inherent to the ProteOn XPR36.. Run 1 corresponds to the first screen of humanised CA8 variants (J0 to J5 series) and run 2 to the second screen of humanised CA8 variants (J5 to J9 series). Both runs were carried out at 25°C.

[0276] The data obtained from run1 are set out in Table 8 and data from run 2 are set in Table 9 Several molecules in the Run 2 (Table 09) failed to give affinity values measurable by ProteOn, this was due to the off-rate being beyond the sensitivity of the machine in this assay, this does however indicate that all these molecules bind tightly to recombinant human BCMA. From Run 1 the data indicates that some constructs did not show any binding to recombinant cyno BCMA.,

Table 8: Run 1-Kinetics analyses of anti-BCMA molecules against Recombinant Human BCMA

Sample name	Human in house BCMA			Cyno in house BCMA		
	ka	kd	KD (nM)	ka	kd	KD (nM)
CA8 humanised J5MO	2.16E+05	1.88E-05	0.087	3.25E+05	8.14E-06	0.025
CA8 humanised J5M2	2.67E+05	3.21E-05	0.12	4.30E+05	4.70E-05	0.109
CA8 humanised J5M1	2.97E+05	4.32E-05	0.145	4.81E+05	5.41E-05	0.112
CA8 humanised J4M1	2.54E+05	7.04E-05	0.278	3.50E+05	7.10E-05	0.203
CA8 humanised J4M2	2.51E+05	7.06E-05	0.281	3.44E+05	6.15E-05	0.179
CA8 humanised JOM2	2.25E+05	6.97E-05	0.31	3.26E+05	1.84E-04	0.563
CA8 humanised J3M2	2.66E+05	9.64E-05	0.362	3.69E+05	5.87E-05	0.159
CA8 humanised JOM1	2.31E+05	8.60E-05	0.373	3.32E+05	1.67E-04	0.503
CA8 humanised JOMO	2.45E+05	1.06E-04	0.435	3.58E+05	2.32E-04	0.648
CA8 humanised J3M1	2.85E+05	1.25E-04	0.438	4.04E+05	7.93E-05	0.196
CA8 humanised J2M2	2.05E+05	9.87E-05	0.482	2.98E+05	3.17E-05	0.106
CA8 Chimera	2.41E+05	1.25E-04	0.519	3.82E+05	1.74E-04	0.457
CA8 humanised J2M1	2.04E+05	1.72E-04	0.842	2.96E+05	6.46E-05	0.218

(continued)

	Sample name	Human in house BCMA			Cyno in house BCMA		
		ka	kd	KD (nM)	ka	kd	KD (nM)
5	CA8 humanised J4MO	2.42E+05	2.20E-04	0.906	3.34E+05	2.89E-04	0.866
10	CA8 humanised J1M2	2.15E+05	2.46E-04	1.14	3.19E+05	9.67E-05	0.303
15	CA8 humanised J3M0	2.08E+05	2.85E-04	1.37	2.93E+05	1.54E-04	0.526
20	CA8 humanised J1M1	2.27E+05	3.43E-04	1.51	3.33E+05	1.47E-04	0.442
25	CA8 humanised J2MO	1.95E+05	3.77E-04	1.94	2.81E+05	1.51E-04	0.538
30	CA8 humanised J1M0	1.78E+05	5.02E-04	2.82	2.47E+05	2.10E-04	0.849
35	S307118G03 Chimera	4.75E+05	1.95E-03	4.11	No	Analysable	Binding
40	S307118G03 humanised H3L1	4.69E+05	2.28E-03	4.86	No	Analysable	Binding
45	S307118G03 humanised H3LO	2.86E+05	1.52E-03	5.31	No	Analysable	Binding
50	S307118G03 humanised H2LO	3.78E+05	2.41E-03	6.36	No	Analysable	Binding
55	S307118G03 humanised H2L1	3.38E+05	2.15E-03	6.37	No	Analysable	Binding
	S307118G03 humanised H4L1	No	Analysable	Binding	No	Analysable	Binding

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Table 9. Run 2-Kinetics analyses of anti-BCMA molecules against Recombinant Human BCMA For antibodies J8M0, J9M0, J8M1, J9M1, J7M2, J5M0, J7M1, J7M0, J8M2, J9M1, J5M2, J5M1 the off rate was beyond the sensitivity of the assay hence no data shown.

Sample Name	Human in house BCMA			commercial human BCMA			Cyno in house BCMA		
	ka	kd	KD (nM)	ka	kd	KD (nM)	ka	kd	KD (nM)
CA8 Chimera	2.51E+0 5	103E -04	0.41 2	7.05E+0 5	9.79E -05	0.13 9	5.89E+0 4	1.21E-04	2.060
CA8 humanised J6M1	2.17E+0 5	2.70E -05	0.12 4	5.92E+0 5	3.75E -05	0.06 3	4.88E+0 4	2.58E-04	5300
CA8 humanised J6M0	2.40E+0 5	7.40E -05	0.30 8	6.23E+0 5	5.37E -05	0.08 6	5.64E+0 4	3.18E-04	5.630
CA8 humanised J6M2	2.01E+0 5	406E -05	0.20 2	5.63E+0 5	3.97E -05	0.07 1	4.41E+0 4	3.02E-04	6.860
S307118G03 H5L0	No Analysable Binding		V weak signal		No	Analysable	Binding		
S307118G03 H5L1	No Analysable Binding		V weak signal		No	Analysable	Binding		
S307118G03Chimera	4.79E+0 5	1.65E -03	3.44	1.55E+0 6	1.48E -03	0.95 6	No	Analysable	Binding

4.8 BIACore analysis of anti-BCMA CA8 chimeric and humanised constructs (J7 to J9 series)

[0277] Protein A was immobilised on a CM5 chip (GE Healthcare, Cat No: BR-1005-30) by primary amine coupling and this surface was then used to capture the antibody molecules. Recombinant human BCMA (US Biological, B0410) was used as analyte at 256nM, 64nM, 16nM, 4nM and 1nM. Regeneration of the capture surface was carried out using 50mM NaOH. All binding curves were double referenced with a buffer injection (i.e. OnM) and the data was fitted to the using the 1:1 model inherent to T100 evaluation software. The run was carried out at 37°C, using HBS-EP as the running buffer.

[0278] The results showed the molecules tested with the exception of J9M2 bind to recombinant human BCMA, with similar affinity as the chimeric molecule. Data generated from this experiment are presented in table 10.

Table 10: Kinetics analysis of anti-BCMA humanised molecules against Recombinant Human BCMA

		Human commercial BCMA			Cyno in house BCMA		
Sample name		ka	kd	KD (nM)	ka	kd	KD (nM)
CA8 humanised J9M1	1.96E+07	3.50E-04	0.018	6.77E+05	2.99E-04	0.442	
CA8 humanised J9MO	4.95E+06	1.74E-04	0.035	7.03E+05	3.24E-04	0.46	
CA8 Chimera	3.27E+07	1.18E-03	0.036	1.15E+06	3.49E-04	0.305	
CA8 humanised J8M1	2.66E+06	1.34E-04	0.05	2.82E+05	3.62E-04	1.284	
CA8 humanised	2.44E+06	1.26E-04	0.052	3.89E+05	4.18E-04	1.076	
J8MO							
CA8 humanised J7M1	2.35E+06	1.31E-04	0.056	3.70E+05	3.91E-04	1.057	
CA8 humanised J8M2	2.63E+06	1.50E-04	0.057	3.83E+05	5.06E-04	1.324	
CA8 humanised J7M2	2.37E+06	1.35E-04	0.057	3.46E+05	4.47E-04	1.293	
CA8 humanised J7MO	2.36E+06	1.51E-04	0.064	3.21E+05	3.67E-04	1.143	
CA8 humanised J9M2	No	Analysable	Binding	4.88E+05	2.52E-04	0.515	

4.9 BIACore analysis of anti-BCMA CA8 chimeric and humanised constructs J6M0 and J9M0

[0279] Protein A was immobilised on a CM5 chip (GE Healthcare, Cat No: BR-1005-30) by primary amine coupling and this surface was then used to capture the antibody molecules. Recombinant human BCMA (US Biological, B0410) was used as analyte at 256nM, 64nM, 16nM, 4nM and 1nM. Regeneration of the capture surface was carried out using 50mM NaOH. All binding curves were double referenced with a buffer injection (i.e. OnM) the data was fitted to the using the 1:1 model inherent to T100 evaluation software. The run was carried out at 25°C and 37°C for experiment 1 and only 37°C for experiment 2 using HBS-EP as the running buffer.

[0280] The both runs identified J9M0 as the best molecule in term of overall affinity to human BCMA. Data generated from this experiment are presented in table 11.

Table 11 Kinetics analyses of anti-BCMA humanised molecules against Human BCMA

Sample	Human commercial BCMA								
	25°C			37°C					
	Experiment 1			Experiment 1			Experiment 2		
Sample	ka	kd	KD (nM)	ka	kd	KD (nM)	ka	kd	KD (nM)
J9M0	1.59E+06	3.38E-05	0.021	3.75E+06	1.58E-04	0.042	3.62E+06	1.89E-04	0.052
J6M0	1.01E+06	1.22E-04	0.121	2.12E+06	1.48E-03	0.698	3.78E+06	1.88E-03	0.498

(continued)

	Human commercial BCMA								
	25°C			37°C					
	Experiment 1			Experiment 1			Experiment 2		
Sample	ka	kd	KD (nM)	ka	kd	KD (nM)	ka	kd	KD (nM)
Chimera CA8	1.88E+06	2.63E-04	0.140	1.72E+07	8.72E-04	0.051	1.88E+07	1.04E-03	0.055

4.10. ProteOn analysis of new anti-BCMA chimeric constructs

[0281] The initial screen of the new chimeric variants from the second batch of hybridomas was carried out on the ProteOn XPR36 (Biorad). The method was as follows; Protein A was immobilised on a GLM chip (Biorad, Cat No: 176-5012) by primary amine coupling, anti-BCMA variants were then captured on this surface and recombinant human BCMA (in house material) passed over at 256, 64, 16, 4, 1nM with a 0nM injection (i.e. buffer alone) used to double reference the binding curves, the buffer used is the HBS-EP buffer. Regeneration of the capture surface was carried out using 50mM NaOH. The data was fitted to the 1:1 model using the analysis software inherent to the ProteOn XPR36. The run was carried out at 25°C.

[0282] Data generated from this experiment are presented in table 12.

Table 12: Kinetics analyses of anti-BCMA humanised molecules against Human BCMA

		In house human BCMA		
Sample name		ka	kd	KD (nM)
S332110D07		3.11E+05	3.77E-03	12.100
S332121F02		3.73E+05	6.45E-03	17.300

Example 5 Cell Killing Assays.

5.1 ADCC potencies of chimeric CA8 and defucosylated chimeric CA8 version in ARH77 cells expressing BCMA

[0283] Human natural killer (NK) cells were incubated with europium labelled ARH77 BCMA transfected target cells (10B5) in the presence of varying concentrations of antibody at an E:T ratio of 5:1 for 2 hours. Europium release from the target cells was measured and specific lysis calculated.

[0284] Result: Chimeric CA8 and defucosylated chimeric CA8 killed BCMA expressing target cells via ADCC. The defucosylated chimeric antibody showed more potent ADCC activity, as measured by a higher percent lysis achieved with all the target cells tested and a ten-fold lower EC₅₀ on the high BCMA expressing target cell line 10B5, compared to the parent chimeric antibody. See Figure 8A and 8B.

5.2 ADCC activity of CA8 humanised antibodies using ARH77 BCMA expressing target cells and PBMC as effectors

[0285] Human PBMC were incubated with europium labelled ARH77 BCMA transfected target cells (10B5) in the presence of varying concentrations of humanised versions of CA8 antibody (5ug/ml to 0.005ug/ml) at an E:T ratio of 5:1 for 2 hours. Europium release from the target cells was measured and specific lysis calculated.

Result:

[0286] Result: All the J5, J6, J7 J8 & J9 series of humanised variants of CA8 showed ADCC activity against the ARH77 high BCMA expressing cell line 10B5 in a dose dependent manner. ADCC was at a similar level as that found in the experiments using chimeric CA8 molecule. See Figure 9.

5.3 ADCC potencies of chimeric S322110F02, S322110D07 and S307118G03 and humanised S307118G03 H3L0 against ARH77 10B5 cells expressing BCMA with purified NK cells as effector cells

5 [0287] Human natural killer (NK) target cells were incubated with europium labelled ARH77 BCMA transfected target cells (10B5) in the presence of varying concentrations of antibody at an E:T ratio of 5:1 for 2 hours. Europium release from the target cells was measured and specific lysis calculated. Result: all 4 antibodies tested showed ADCC activity against ARH77 10B5 cells. See Figure 10.

10 5.4 Antibody-Drug Conjugate (ADC) activity of Chimeric CA8 ADCs.

15 [0288] Measuring ADC activity of chimeric CA8 antibody, chimeric CA8-mcMMAF antibody drug conjugates and chimeric CA8-vcMMAE antibody drug conjugates against human multiple myeloma cell lines. Multiple Myeloma cell lines were treated with chimeric CA8 antibody-drug conjugates to determine the ADC concentrations required for growth inhibition and death.

20 [0289] The antibody drug conjugates tested were added to wells containing multiple myeloma cells at concentrations ranging from 1ug/ml to 5ng/ml. The plates were incubated at 37°C for 96 hours at which point viable cells were quantitated using Cell titre Glo. The unconjugated chimeric CA8 antibody showed no significant growth inhibitory activity at the antibody concentrations that were tested. The chimeric CA8-mcMMAF antibody-drug conjugate showed greater growth inhibitory activity than the chimeric CA8-vcMMAE antibody-drug conjugate in all 4 of the multiple myeloma cell lines that were tested. See Figure 11 and Table 13

Table 13 IC₅₀ values represented in ng/mL for the chimeric CA8-vcMMAE and the chimeric CA8-mcMMAF antibody-drug conjugates in 4 different multiple myeloma cell lines

Multiple Myeloma cell lines	IC ₅₀ (ng/mL)	
	CA8 chimera - vcMMAE	CA8 chimera - mcMMAF
NCI-H929	29.5	8.8
U266-B1	18.9	9.7
JJN3	21.8	12.4
OPM2	92.7	58.1

35 5.5 Measuring cell cycle arrest activity of chimeric CA8 antibody, chimeric CA8-mcMMAF antibody drug conjugates and chimeric CA8-vcMMAE antibody drug conjugates against human multiple myeloma cell line H929.

40 [0290] To determine the mechanism that chimeric CA8 Antibody Drug Conjugates (ADC's) cause growth inhibition in multiple myeloma cells, the cell cycle of NCI-H929 cells was monitored by measuring cellular DNA content through fixed cell propidium iodide staining at multiple timepoints following chimeric CA8 antibody and chimeric CA8 ADC treatment.

45 [0291] At the chimeric CA8 ADC concentration tested (50ng/mL), the chimeric CA8-mcMMAF ADC caused significant G2/M cell cycle arrest (4N DNA content) which peaked at 48 hours. At the later timepoints 48, 72 and 96 hours, treatment with the chimeric CA8-mcMMAF ADC resulted in accumulation of a cell population with sub-2N DNA content, which is representative of cell death. At the 50ng/mL concentration tested the chimeric CA8-vcMMAE ADC had no significant effect on G2/M cell cycle arrest or sub-G1 accumulation. See Figure 12.

50 5.6 Phospho-Histone-H3 (Thr11) staining as a marker for chimeric CA8-mcMMAF antibody drug conjugate and chimeric CA8-vcMMAE antibody drug conjugate induced mitotic arrest.

[0292] To determine if the accumulation of cells with 4N DNA content is a specific result of mitotic arrest induced by the chimeric CA8 ADCs NCI-H929 cells were stained with an anti-phospho-Histone H3 antibody following treatment with increasing concentrations of unconjugated chimeric CA8, chimeric CA8-vcMMAE or chimeric CA8-mcMMAF for 48 hours.

55 [0293] Treatment with chimeric CA8 ADCs resulted in a dose-dependent accumulation of NCI-H929 cells that stained positive for 65eroxidi-Histone H3 (Thr11), a specific marker of mitotic cells. The chimeric CA8-mcMMAF ADC caused accumulation of 65eroxidi-Histone H3 positive cells at lower concentrations than the chimeric CA8-vcMMAE ADC. See Figure 13.

5.7 Measuring apoptosis in NCI-H929 cells in response to chimeric CA8 ADCs by staining for Annexin V.

[0294] To determine if the accumulation of cells with sub-2N DNA content is a specific result of apoptosis induced by the chimeric CA8 ADCs, NCI-H929 cells were stained with an anti-Annexin-V antibody following treatment with increasing concentrations of unconjugated chimeric CA8, chimeric CA8-vcMMAE or chimeric CA8-mcMMAF for 48 hours. Treatment with chimeric CA8 ADCs resulted in a dose-dependent accumulation of NCI-H929 cells that stained positive for Annexin-V, a specific marker of apoptosis. The chimeric CA8-mcMMAF ADC caused accumulation of Annexin-V positive cells at lower concentrations than the chimeric CA8- vcMMAE ADC. See Figure 14.

10 5.8 Antibody-Drug Conjugate (ADC) activity of humanised variants of CA8 anti-BCMA antibody-drug conjugates.

Cells were plated in 96-well plates (4,000 cells per well in 100uL of RPMI + 10% FBS)

15 [0295] Naked antibody or ADC was added 6 hours after cell seeding and plates were incubated for 144 hours. Growth inhibition in the presence of the antibodies or ADCs was measured at 144 hours using Cell Titre glo. Data points represent the mean of triplicate CellTiterGlo measurements. Error bars represent standard error.

20 [0296] Multiple Myeloma cell lines NCI-H929 and OPM2 were treated with humanized CA8 anti-BCMA antibody-drug conjugates to determine the ADC concentrations required for growth inhibition and death. The mcMMAF and vcMMAE antibody-drug conjugate forms of these antibodies showed significant growth inhibitory activity comparable to that found with the CA8 chimera. Variant J6M0 showed higher potency than the chimera and data is shown in figure 15 in H929 cells and OPM2 cells.. The mcMMAF antibody-drug conjugate showed greater growth inhibitory activity than the vcMMAE antibody-drug conjugate for all antibodies in both cell lines tested. Results for all humanized variants are shown in Table 14.

Table 14. IC₅₀ values represented in ng/mL for the anti BCMA antibody-drug conjugates in NCI-H929 and U266-B1 cells

	NCI-H929 mcMMAF	vcMMAE	OPM2 mcMMAF	vcMMAE
	Average IC ₅₀ (ng/mL)			
CA8 chimera	11.64	37.96	57.04	80.01
CA8 J6M0	5.97	27.67	87.22	121.2
CA8 J6M1	14.6	51.89	205.6	239.9
CA8 J6M2	9.5	39.71	112.9	144.7
CA8 J7M0	18.97	52.25	93.27	127.1
CA8 J7M1	17.87	43.97	95.35	107.5
CA8 J7M2	31.63	55.13	102.6	115.9
CA8 J8M0	15.67	59.94	89.95	132
CA8 J8M1	17.04	46.55	82.96	115.8
CA8 J8M2	15.08	55.98	72.63	124.5
CA8 J9M0	14.95	48.5	58.6	109.8
CA8J9M1	15.19	55.1	55.88	115
CA8 J9M2	20.87	55.77	80.35	111.7

5.9 Antibody-Drug Conjugate (ADC) activity of other murine anti-BCMA antibody-drug conjugates.

45 Cells were plated in 96-well plates (4,000 cells per well in 100uL of RPMI + 10% FBS)

[0297] Antibody or ADC was added 6 hours after cell seeding and plates were incubated for 144 hours. Growth inhibition in the presence of the ADCs was measured at 144 hours using Cell Titre glo. The mean of triplicate CellTiterGlo measurements are shown. Table 15a and 15b are from experiments carried out at different times on different series of antibodies. Multiple Myeloma cell lines NCI-H929 and U266-B1 were used for antibodies in Table 15a.

[0298] The mcMMAF and vcMMAE antibody-drug conjugate forms of murine antibodies S322110D07, S332121F02 and S332136E04 showed significant growth inhibitory activity. The mcMMAF antibody-drug conjugate showed greater growth inhibitory activity than the vcMMAE antibody-drug conjugate in all of the murine anti-BCMA antibodies tested where activity was seen. IC₅₀ figures are shown in Table 15a. See Figure 16 for dose response curves for these three antibodies and also S107118G03. Error bars represent standard error. NCI-H929, U266-B1, JJN3 and OPM2 cells for antibodies in Table 15b were treated with a different series of murine anti-BCMA antibody-drug conjugates to determine the ADC concentrations required for growth inhibition and death. IC₅₀ figures are shown in Table 15b. All 5 antibodies

shown on the table had significant ADC activity.

Table 15a. IC₅₀ values represented in ng/mL for the anti BCMA antibody-drug conjugates in NCI-H929 and U266-B1 cells

Antibody	IC ₅₀ (ng/mL)		U266-B1	
	NCI-H929	-vcMMAE	-mcMMAF	-vcMMAE
S322110D07 mlgG1	28.4	6.7	—	53.3
S332121F02 mlgG1	24.5	7	—	2.3
S332126E04 mlgG1	46.8	9.7	—	27.1
				33.3
				2.5
				10.6

Table 15b IC₅₀ values represented in ng/mL for the anti BCMA antibody-drug conjugates in NCI-H929, U266-B1, JJN3 and OPM2 cells

	NCI-H929		U266B1		JJN3		OPM2
	Average IC ₅₀ (ng/mL)	vcMMAE	mcMMAF	vcMMAE	mcMMAF	vcMMAE	mcMMAF
S335115G01	14.9	4.2	38.8	18.5	73.9	45.8	162.4
S336105A07	17.8	5.1	21.4	9.3	54.2	23.2	95.5
S335122F05	10.9	4.2	21.1	14.1	29.5	25.5	98.4
S335106E08	19.2	7.9	36.8	32.6	189.8	214.1	243.9
S335128A12	86.3	28.3	101.8	104.1	>500	>500	>500

5.10 ADCC potency of conjugated, afucosylated J6M0 (Potelligent)

[0299] Afucosylated J6M0 conjugated to MMAE or MMAF was tested in ADCC assays using BCMA transfectants to ensure that its ADCC activity was not compromised by the conjugation. Europium labelled ARH77-10B5 cells were incubated with various J6M0 WT and Potelligent BCMA antibodies at concentrations up to 10000ng/ml for 30 minutes prior to the addition of PBMCs (PBMC: target cell ratio 50:1). Two hours later an aliquot of cell media was sampled and mixed with enhancement solution. After 30 minutes on a plate shaker, europium release was monitored on the Victor 2 1420 multi-label reader. Datapoints represent means of triplicate values. This data is representative of 2 experiments.

[0300] There were no significant differences in ADCC potency between the unconjugated and ADC forms of J6M0 Potelligent. In the same experiment a wild type version of J6M0 was included to show how the potency compares to the afucosylated version. As expected, defucosylation resulted in a lower EC₅₀ and higher maximal lysis. No lysis was observed with the Fc disabled form of J6M0. (Figure 17)

5.11 ADCC potency of afucosylated J6M0 on MM cell lines

[0301] Human PBMC were incubated with multiple myeloma target cells at an E:T ratio of 50:1 in presence of varying concentrations of afucosylated (Potelligent) J6M0. The percentage of target cells remaining in the effector + target cell mixture after 18 hours was measured by FACS using a fluorescently labelled anti-CD138 antibody to detect the target cells and the percent lysis calculated. This is representative of several experiments.

[0302] J6M0 Potelligent antibody showed ADCC activity against all five multiple myeloma target cell lines tested. This was important to test since earlier studies were carried out using transfected cells. Results are shown in Figure 18. Full dataset with multiple donors is shown in Table 16. The potencies were all in a similar range as those found with the transfectants. The ADCC activity was not directly related to BCMA surface expression on these cell lines.

Table 16 EC₅₀ values generated on 13 independent assays using 11 donors (designated A-K) across the five multiple myeloma cell lines.

Donor	EC ₅₀ (ng/mL)				
	H929	RPMI 8226	JJN-3	OPM-2	U266
A	1.43	NA	1.64	NA	NA

(continued)

Donor	EC ₅₀ (ng/mL)				
	H929	RPMI 8226	JJN-3	OPM-2	U266
B	0.57	NA	NA	NA	NA
C	0.73	NA	1.01	NA	NA
C	1.81	NA	NA	NA	NA
A	2.05	NA	NA	NA	NA
D	NA	4.09	NA	NA	NA
E	NA	NA	14.4	NA	NA
F	218	NA	NA	NA	NA
G	NA	NA	26.3	NA	NA
H	4.79	NA	111.3	NA	NA
I	NA	NA	40.1	NA	NA
J	2.19	20.4	4.89	NA	NA
K	ND	ND	4.52	4.15	9.04

Example 6. Xenograft data

[0303] 6.1 Murine xenografts of human MM cell lines were tested to ensure that antibody potency detected in vitro can also be demonstrated in vivo. The cell line selected for xenograft studies was NCI-H929 which is sensitive to ADC and ADCC killing in vitro. Studies were carried out in immunocompromised CB.17 SCID mice which lack T and B cells but maintain NK cells to allow for ADCC activity. However it should be noted that although human IgG1 can engage murine Fc receptors, the Potelligent enhancement does not improve the affinity as it does with human Fc receptors.

6.2 Impact of unconjugated and MMAE or MMAF conjugated J6M0 on NCI-H929 tumour growth.

[0304] In order to independently analyze both the ADCC and ADC activities of J6M0 we tested J6M0 antibody in the presence and absence of MMAF or MMAE conjugation. By testing the unconjugated J6M0, any anti-tumour effects could be attributed to some combination of ADDC and functional inhibitory activity.

[0305] Mice with NCI-H929 tumours that had reached a volume of 200 mm³ on average were treated with a human IgG1 control or the J6M0 antibody (unconjugated, MMAE or MMAF) twice weekly at a dose of 50 ug or 100ug, for 2 weeks. Results from this study show that a 100 ug dose of the J6M0-MMAF conjugate resulted in elimination of tumours in those mice which have completed the dosing. The J6M0-MMAF mice were maintained for 40 days after the last dose with no recurrence of tumour occurring. These results from this experiment demonstrate that MMAF conjugation had increased anti-tumour activity over both unconjugated J6M0 antibody and J6M0-MMAE conjugate See Figure 19.

Example 7 Evaluation of Soluble BCMA Levels from MM Patient Serum

[0306] 7.1 It is currently unknown whether BCMA is present extracellularly and can be detected in the blood. In this work, we determined the serum level of human BCMA from MM patients. Serum samples from 54 MM and plasma cell dyscrasia patients and 20 normal control samples were analyzed by ELISA. Human Subject Approval was obtained from Western Institutional Review Board.

7.2 Assessment of Serum Human BCMA Levels

[0307] Blood, from patients and normal controls in the clinic, were collected in serum collection tubes. MM patient samples were from a variety of stages (progressive disease, remission, relapsed, newly diagnosed, and others). The Blood samples were spun at 10,000 rpm for 10 minutes and serum transferred into sterile micro-centrifuge plastic tubes.

[0308] A Human BCMA/TNFRSF17 ELISA kit from R& D Systems (catalog # DY193E) which measures soluble human BCMA levels was used to detect BCMA following the standard protocol supplied with the kit.

[0309] Briefly, 96 well micro-plates were coated with 100ul per well capture antibody and incubated overnight at 4oC. The plates were washed three times with wash buffer (0.05% Tween 20 in PBS, pH 7.2) and blocked with 300ul of 1% BSA in PBS at room temperature for 2 hours. The plates were washed three times with washing buffer. 100ul of serum sample or standard was added into each well and incubated for 2 hours at room temperature. The plates were washed

5 three times with washing buffer and then 100ul of the detection antibody was added to each well and incubated 2 hours at room temperature. 100ul of Streptavidin-HRP was added in each well after washing plates three times and incubated in dark room for 20 minutes. The plates were washed three times and added 50ul stop solution and then determined by micro-plate reader with 570nM wavelength.

[0310] A series of assays were carried out in order to determine the serum dilution factor appropriate for the levels of BCMA which were present. A dilution factor of 1:500 was found to be suitable for the majority of samples and is the dilution factor used in the data shown in Figure 20. The full data set is shown in Table 17.

[0311] Patient and normal control serum samples diluted and run in triplicates had BCMA levels determined. The serum levels of BCMA were significantly elevated in the sera from MM patients compared with normal controls in this study. When the disease subset was divided further there was a trend towards elevated serum levels of BCMA in the sera from progressing MM patients compared with those in remission.. This is the first report identifying serum BCMA in any human disease and suggests that these levels may be a novel biomarker for monitoring disease status and therapeutic response of MM patients and for other patients with plasma cell mediated diseases.

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Table 17. Figures represent serum concentration of soluble BCMA in ng/ml calculated from samples diluted at 1/50, 1/500 and 1/5000. P values were calculated using the one tailed T-Test and 95% significance values are below the table.

1-5000	Normal	Myeloma: Progressive	Myeloma: Stable	Myeloma: Remission	Myeloma: Other	MGUS	Other Plasma Cell Dyscrasias
Mean	14.130	500.804	154.762	151.201	94.457	84.912	22.838
1-500 Triplicate	Normal	Myeloma: Progressive	Myeloma: Stable	Myeloma: Remission	Myeloma: Other	MGUS	Other Plasma Cell Dyscrasias
Mean	15.901	215.877	81.135	43.294	97.584	53.894	22.838
1-500 Single	Normal	Myeloma: Progressive	Myeloma: Stable	Myeloma: Remission	Myeloma: Other	MGUS	Other Plasma Cell Dyscrasias
Mean		16.620	207.028	61.576	42.796	71.372	40.623
1-50 Trial 1	Normal	Myeloma: Progressive	Myeloma: Stable	Myeloma: Remission	Myeloma: Other	MGUS	Other Plasma Cell Dyscrasias
Mean		25.568	129.544	41.983	40.507	65.120	42.067
1-50 Trial 2	Normal	Myeloma: Progressive	Myeloma: Stable	Myeloma: Remission	Myeloma: Other	MGUS	Other Plasma Cell Dyscrasias
Mean		17.160	119.220	34.567	34.264	54.780	26.333
P-Values (One Tailed T-Test, 95% Significance)							
-1-500 Single							
Normal vs Progressive: p=.0010*							
Progressive vs Remission: p=.0146*							
-1-500 Triplicate							
Normal vs Progressive: p=.0004*							
Progressive vs Remission: p=.0091*							
-1-50 Trial 1							
Normal vs Progressive: p=.0171*							
Progressive vs Remission: p=.0777							
-1-50 Trial 2							
Normal vs Progressive: p=.0184*							
Progressive vs Remission: p=.0876							
* shows significance							

Sequence Summary (Table C)

[0312]

	Description	Amino acid sequence	Polynucleotide sequence
5	CA8 CDRH1	SEQ.ID.NO:1	n/a
10	CA8 CDRH2	SEQ.ID.NO:2	n/a
15	CA8 CDRH3	SEQ.ID.NO:3	n/a
20	CA8 CDRL1	SEQ.ID.NO:4	n/a
25	CA8 CDRL2	SEQ.ID.NO:5	n/a
30	CA8 CDRL3	SEQ.ID.NO:6	n/a
35	CA8 V _H domain (murine)	SEQ.I.D.NO:7	SEQ.I.D.NO:8
40	CA8 V _L domain (murine)	SEQ.I.D.NO:9	SEQ.I.D.NO:10
45	CA8 Humanised V _H J0	SEQ.I.D.NO:11	SEQ.ID.NO:12
50	CA8 Humanised V _H J1	SEQ.I.D.NO:13	SEQ.I.D.NO:14
55	CA8 Humanised V _H J2	SEQ.I.D.NO:15	SEQ.I.D.NO:16
	CA8 Humanised V _H J3	SEQ.I.D.NO:17	SEQ.I.D.NO:18
	CA8 Humanised V _H J4	SEQ.I.D.NO:19	SEQ.I.D.NO:20
	CA8 Humanised V _H J5	SEQ.I.D.NO:21	SEQ.I.D.NO:22
	CA8 Humanised V _H J6	SEQ.I.D.NO:23	SEQ.I.D.NO:24
	CA8 Humanised V _H J7	SEQ.I.D.NO:25	SEQ.I.D.NO:26
	CA8 Humanised V _H J8	SEQ.I.D.NO:27	SEQ.I.D.NO:28
	CA8 Humanised V _H J9	SEQ.I.D.NO:29	SEQ.I.D.NO:30
	CA8 Humanised V _L M0	SEQ.I.D. NO:31	SEQ.I.D.NO:32
	CA8 Humanised V _L M1	SEQ.I.D. NO:33	SEQ.I.D.NO:34
	CA8 Humanised V _L M2	SEQ.I.D. NO:35	SEQ.ID.NO:36
	Human BCMA CD33-hBCMA ECD (1-53) TEV-Fc	SEQ.I.D.NO:37	SEQ.I.D.NO:38
	Human BCMA CD33-hBCMA ECD (4-53) TEV-Fc	SEQ.I.D.NO:39	SEQ.I.D.NO:40
	Cyno BCMA CD33 cyno BCMA ECD (4-52) TEV-Fc	SEQ.I.D.NO:41	SEQ.I.D.NO:42
	CA8 J0 Humanised heavy chain	SEQ.I.D.NO:43	SEQ.I.D.NO:44
	CA8 J1 Humanised heavy chain	SEQ.I.D.NO:45	SEQ.I.D.NO:46
	CA8 J2 Humanised heavy chain	SEQ.I.D.NO:47	SEQ.I.D.NO:48
	CA8 J3 Humanised heavy chain	SEQ.I.D.NO:49	SEQ.I.D.NO:50
	CA8 J4 Humanised heavy chain	SEQ.ID.NO:51	SEQ.I.D.NO:52
	CA8 J5 Humanised heavy chain	SEQ.ID.NO:53	SEQ.I.D.NO:54
	CA8 J6 Humanised heavy chain	SEQ.ID.NO:55	SEQ.I.D.NO:56
	CA8 J7 Humanised heavy chain	SEQ.ID.NO:57	SEQ.I.D.NO:58
	CA8 J8 Humanised heavy chain	SEQ.ID.NO:59	SEQ.I.D.NO:60
	CA8 J9 Humanised heavy chain	SEQ.ID.NO:61	SEQ.I.D.NO:62

(continued)

	Description	Amino acid sequence	Polynucleotide sequence
5	CA8 M0 Humanised light chain	SEQ.ID.NO:63	SEQ.I.D.NO:64
	CA8 M1 Humanised light chain	SEQ.ID.NO:65	SEQ.I.D.NO:66
	CA8 M2 Humanised light chain	SEQ.ID.NO:67	SEQ.I.D.NO:68
10	S307118G03 V _H domain (murine)	SEQ.ID.NO:69	SEQ.I.D.NO:70
	S307118G03 V _L domain (murine)	SEQ.ID.NO:71	SEQ.I.D.NO:72
	S307118G03 heavy chain (chimeric)	SEQ.ID.NO:73	SEQ.ID.NO:74
15	S307118G03 light chain(chimeric)	SEQ.ID.NO:75	SEQ.I.D.NO:76
	S307118G03 Humanised V _H H0	SEQ.ID.NO:77	SEQ.I.D.NO:78
	S307118G03 Humanised V _H H1	SEQ.ID.NO:79	SEQ.I.D.NO:80
20	S307118G03 humanised V _H H2	SEQ.ID.NO:81	SEQ.I.D.NO:82
	S307118G03 humanised V _H H3	SEQ.ID.NO:83	SEQ.I.D.NO:84
	S307118G03 humanised V _H H4	SEQ.ID.NO:85	SEQ.I.D.NO:86
25	S307118G03 humanised V _H H5	SEQ.ID.NO:87	SEQ.I.D.NO:88
	S307118G03 humanised V _L L0	SEQ.ID.NO:89	SEQ.I.D.NO:90
	S307118G03 humanised V _L L1	SEQ.ID.NO:91	SEQ.I.D.NO:92
30	S307118G03 CDRH1	SEQ.ID.NO:93	
	S307118G03 CDRH2	SEQ.ID.NO:94	
	S307118G03 CDRH3	SEQ.ID.NO:95	
35	S307118G03 CDRL1	SEQ.ID.NO:96	
	S307118G03 CDRL2	SEQ.ID.NO:97	
	S307118G03 CDRL3	SEQ.ID.NO:98	
40	S307118G03 humanised H5 CDRH3	SEQ.ID.NO:99	
	S307118G03 H0 Humanised heavy chain	SEQ.I.D.NO:100	SEQ.I.D.NO:101
	S307118G03 H1 humanised heavy chain	SEQ.I.D.NO:102	SEQ.I.D.NO:103
45	S307118G03 H2 humanised heavy chain	SEQ.I.D.NO:104	SEQ.I.D.NO:105
	S307118G03 H3 humanised heavy chain	SEQ.I.D.NO:106	SEQ.I.D.NO:107
	S307118G03 H4 humanised heavy chain	SEQ.I.D.NO:108	SEQ.I.D.NO:109
50	S307118G03 H5 humanised heavy chain	SEQ.I.D.NO:110	SEQ.I.D.NO:111
	S307118G03 L0 humanised light chain	SEQ.ID.NO:112	SEQ.ID.NO:113
	S307118G03 L1 humanised light chain	SEQ.ID.NO:114	SEQ.ID.NO:115
55	S332121F02 murine variable heavy chain	SEQ.I.D.NO:116	SEQ.I.D.NO:117
	S332121F02 chimeric variable heavy chain	SEQ.I.D.NO:118	SEQ.I.D.NO:119
	S332121F02 murine variable light chain	SEQ.ID.NO:120	SEQ.I.D.NO:121
55	S332121F02 chimeric variable light chain	SEQ.I.D.NO:122	SEQ.I.D.NO:123
	S322110D07 murine variable heavy chain	SEQ.I.D.NO:124	SEQ.I.D.NO:125
	S322110D07 chimeric heavy chain	SEQ.ID.NO:126	SEQ.I.D.NO:127
	S322110D07 murine variable light chain	SEQ.I.D.NO:128	SEQ.I.D.NO:129

(continued)

	Description	Amino acid sequence	Polynucleotide sequence
5	S322110D07 chimeric light chain	SEQ.ID.NO:130	SEQ.ID.NO:131
	S332126E04 murine variable heavy chain	SEQ.I.D.NO:132	SEQ.I.D.NO:133
	S332126E04 Chimeric heavy chain	SEQ.ID.NO:134	SEQ.ID.NO:135
10	S332126E04 murine variable light chain	SEQ.ID.NO:136	SEQ.I.D.NO:137
	S332126E04 Chimeric light chain	SEQ.ID.NO:138	SEQ.ID.NO:139
	S336105A07 murine variable heavy chain	SEQ.I.D.NO:140	SEQ.I.D.NO:141
	S336105A07 Chimeric heavy chain	SEQ.ID.NO:142	SEQ.ID.NO:143
15	S336105A07 murine variable light chain	SEQ.I.D.NO:144	SEQ.I.D.NO:145
	S336105A07 chimeric light chain	SEQ.I.D.NO:146	SEQ.I.D.NO:147
	S335115G01 murine variable heavy chain	SEQ.I.D.NO:148	SEQ.I.D.NO:149
	S335115G01 Chimeric heavy chain	SEQ.ID.NO:150	SEQ.I.D.NO:151
20	S335115G01 murine variable light chain	SEQ.ID.NO:152	SEQ.I.D.NO:153
	S335115G01 Chimeric light chain	SEQ.I.D.NO:154	SEQ.ID.NO:155
	S335122F05 murine variable heavy chain	SEQ.I.D.NO:156	SEQ.I.D.NO:158
25	S335122F05 Chimeric heavy chain	SEQ.ID.NO:158	SEQ.ID.NO:159
	S335122F05 murine variable light chain	SEQ.ID.NO:160	SEQ.I.D.NO:161
	S335122F05 Chimeric light chain	SEQ.I.D.NO:162	SEQ.ID.NO:163
30	S332121F02 CDRH1	SEQ.I.D.NO: 164	
	S332121F02 CDRH2	SEQ.I.D.NO: 165	
	S332121F02 CDRH3	SEQ.I.D.NO: 166	
	S332121F02 CDRL1	SEQ.I.D.NO: 167	
35	S332121F02 CDRL2	SEQ.I.D.NO: 168	
	S332121F02 CDRL3	SEQ.I.D.NO: 169	
	S322110D07 CDRH1	SEQ.I.D.NO: 170	
	S322110D07 CDRH2	SEQ.I.D.NO: 171	
40	S322110D07 CDRH3	SEQ.I.D.NO: 172	
	S322110D07CDRL1	SEQ.I.D.NO: 173	
	S322110D07CDRL2	SEQ.I.D.NO: 174	
45	S322110D07CDRL3	SEQ.I.D.NO: 175	
	S332126E04CDRH1	SEQ.I.D.NO: 176	
	S332126E04 CDRH2	SEQ.I.D.NO: 177	
	S332126E04 CDRH3	SEQ.I.D.NO: 178	
50	S332126E04 CDRL1	SEQ.I.D.NO: 179	
	S332126E04 CDRL2	SEQ.I.D.NO: 180	
	S332126E04 CDRL3	SEQ.I.D.NO: 181	
55	S336105A07 CDRH1	SEQ.I.D.NO: 182	
	S336105A07 CDRH2	SEQ.I.D.NO: 183	
	S336105A07 CDRH3	SEQ.I.D.NO: 184	

(continued)

	Description	Amino acid sequence	Polynucleotide sequence
5	S336105A07 CDRL1	SEQ.I.D.NO: 185	
	S336105A07 CDRL2	SEQ.I.D.NO: 186	
	S336105A07 CDRL3	SEQ.I.D.NO: 187	
10	S335115G01 CDRH1	SEQ.I.D.NO: 188	
	S335115G01 CDRH2	SEQ.I.D.NO: 189	
	S335115G01 CDRH3	SEQ.I.D.NO: 190	
	S335115G01 CDRL1	SEQ.I.D.NO: 191	
15	S335115G01 CDRL2	SEQ.I.D.NO: 192	
	S335115G01 CDRL3	SEQ.I.D.NO: 193	
	S335122F05 CDRH1	SEQ.I.D.NO: 194	
	S335122F05 CDRH2	SEQ.I.D.NO: 195	
20	S335122F05 CDRH3	SEQ.I.D.NO: 196	
	S335122F05 CDRL1	SEQ.I.D.NO: 197	
	S335122F05 CDRL2	SEQ.I.D.NO: 198	
25	S335122F05 CDRL3	SEQ.I.D.NO: 199	

SEQUENCE LISTING

30 [0313]

SEQ ID 1 - CA8 CDRH1
NYWMH
 SEQ ID 2 - CA8 CDRH2
ATYRGHSDTYYNQKFKG
 SEQ ID 3 - CA8 CDRH3
GAIYNGYDVLDN
 SEQ ID 4 - CA8 CDRL1
SASQDISNYLN
 SEQ ID 5 - CA8 CDRL2
YTSNLHS
 SEQ ID 6 - CA8 CDRL3
QQYRKLPWT
 SEQ ID 7 - CA8 V_H domain (murine)

45

EVQLQQSGAVLARPGASVKMSCKGSGYFTFTNYWMHWVKQRPGQGLEWIGATYRGHSDTYYNQKF
KGKAKLTAVTSTSTAYMELSSLTNEDSAVYYCTRGAIYNGYDVLDNWGQGTLTVSS

50

SEQ ID 8 - CA8 V_H domain (murine) (Polynucleotide)

55

GAGGTGCAGCTGCAGCAGAGCGGCCGTGCTGGCCAGGCCGGAGCTAGCGTGAAGATGAG
 CTGCAAGGGCAGCGGCTACACCTCACCAACTACTGGATGCAGCTGGGTGAAACAGAGGCCGG
 5 CCAGGGACTGGAGTGGATCGGCCACCTACAGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAGGGCAAGGCCAAGCTGACCGCCGTGACCTAACCGACCGCCTACATGGAACGTGAG
 CAGCCTGACCAACGAGGACAGCGCCGTCTATTACTGCACCAGGGGCCATCTACAACGGCTA
 CGACGTGCTGGACAATTGGGCCAGGGAACACTAGTGACCGTGTCCAGC

10 SEQ ID 9 - CA8 V_L domain (murine)

DIQLTQTTSSLSASLGDRVTSICSAQDISNYLNWYQQKPDGTVELVIYTSLHSGVPSRFSGSGSG
 15 TDYSLTIGYLEPEDVATYYCQQYRKLPWTFGGSKLEIKR

SEQ ID 10 - CA8 V_L domain (murine) (Polynucleotide)

20 GATATCCAGCTGACCCAGACCACAAGCAGCCTGAGCGCCTCCCTGGCGACAGGGTGACCATT
 AGCTGCAGGCCAGCCAGGACATCAGCAACTACCTGAACCTGGTACCGACAGCAGAAGCCGACGGC
 ACCGTGGAGCTCGTGATCTACTACACCTCCAACCTGCACAGCGCGTGCCAGCAGGTTCTCTG

25 GCAGCGGCAGCGGCACCGACTACAGCCTGACCATCGGCTATCTGGAGCCGAGGGACGTCGCCA
 CCTACTACTGCCAGCAGTACAGGAAGCTGCCCTGGACCTTCGGCGGAGGCCTAAGCTGGAGA
 TTAAGCGT

30 SEQ ID 11 - CA8 Humanised V_H J0

QVQLVQSGAEVKPGSSVKVSCKASGGTFSNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 35 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCARGAIYNGYDVLNWGQGTLTVSS

SEQ ID 12 - CA8 Humanised V_H J0 (Polynucleotide)

40 CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGCGGCACCTTCAGCAACTACTGGATGCAGCTGGGTGAGGCAGGCCCG
 GACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGA
 45 AGTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCGCCTACATGGAACGTGA
 GCAGCCTCAGGAGCGAGGACACCGCTGTGTATTACTGCGCCAGGGGCCATCTACAACGGCT
 ACGACGTGCTGGACAACGGGCCAGGGCACACTAGTGACCGTGTCCAGC

50 SEQ ID 13 - CA8 Humanised V_H J1

QVQLVQSGAEVKPGSSVKVSCKASGYTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCARGAIYNGYDVLNWGQGTLTVSS

55 SEQ ID 14 - CA8 Humanised V_H J1 (Polynucleotide)

5 CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGGCTACACCTCACCAACTACTGGATGCACTGGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCCTACATGGAACTGAG
 10 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCGCCAGGGGCCATCTAACACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

10 SEQ ID 15 - CA8 Humanised V_H J2

15 QVQLVQSGAEVKPGSSVKVSCKASGYTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCTRGAIYNGYDVLNWGQGTLTVSS

SEQ ID 16 - CA8 Humanised V_H J2 (Polynucleotide)

20 CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGGCTACACCTCACCAACTACTGGATGCACTGGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCCTACATGGAACTGAG
 25 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGGCCATCTAACACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

30 SEQ ID 17 - CA8 Humanised V_H J3

35 QVQLVQSGAEVKPGSSVKVSCKGSYFTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADTSTSTAYMELSSLRSEDTAVYYCTRGAIYNGYDVLNWGQGTLTVSS

SEQ ID 18 - CA8 Humanised V_H J3 (Polynucleotide)

40 CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGGCAGCGGCTACACCTCACCAACTACTGGATGCACTGGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGGTGACCATCACCGCCGACACGAGCACCAGCACCCTACATGGAACTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGGCCATCTAACACGGCTA
 45 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

SEQ ID 19 - CA8 Humanised V_H J4

50 QVQLVQSGAEVKPGSSVKVSCKGSYFTFTNYWMHWVRQAPGQGLEWIGATYRGHSDTYYNQKF
 KGRATLTADTSTSTAYMELSSLRSEDTAVYYCTRGAIYNGYDVLNWGQGTLTVSS

SEQ ID 20 - CA8 Humanised V_H J4 (Polynucleotide)

CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGGCAGCGGCTACACCTCACCAACTACTGGATGCAGCTGGGTGAGGCAGGCCCGG
 5 ACAGGGCCTGGAGTGGATCGGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGCGACCCCTCACCGCCGACACGAGCACCAGCACCCTACATGGAAGTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGGCCATCTACACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

10 SEQ ID 21 - CA8 Humanised V_H J5

QVQLVQSGAEVKPGSSVKVSCKGSYTFNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 15 FKGRVTITADTSTSTAYMELSSLRSEDTAVYYCTRGAIYDGYDVLDNWGQGTLTVSS

SEQ ID 22 - CA8 Humanised V_H J5 (Polynucleotide)

CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGGCAGCGGCTACACCTCACCAACTACTGGATGCAGCTGGGTGAGGCAGGCCCGG
 20 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGTGACCATCACCGCCGACACGAGCACCAGCACCCTACATGGAAGTGAG
 25 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGGCCATCTACGACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

30 SEQ ID 23 - CA8 Humanised V_H J6

QVQLVQSGAEVKPGSSVKVSCKASGGTFSNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCARGAIYDGYDVLDNWGQGTLTVSS

35 SEQ ID 24 - CA8 Humanised V_H J6 (Polynucleotide)

CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGCGGACCTTCAGCAACTACTGGATGCAGCTGGGTGAGGCAGGCCCG
 40 GACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGA
 AGTTCAAGGGCCGGTGACCATCACCGCCGACAAGAGCACCAGCACCCTACATGGAAGTGAG
 GCAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCGCCAGGGGCCATCTACGACGGCT
 45 ACGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

SEQ ID 25 - CA8 Humanised V_H J7

QVQLVQSGAEVKPGSSVKVSCKASGYTFNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 50 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCARGAIYDGYDVLDNWGQGTLTVSS

SEQ ID 26 - CA8 Humanised V_H J7 (Polynucleotide)

5 CAGGTGCAGCTGGTCCAGAGCGGCGCCGAAGTGAAGAAGGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGGCTACACCTCACCAACTACTGGATGCACTGGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCGCTACATGGAAGTGAG
 10 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCGCCAGGGGCCATCTACGACGGCTA
 CGACGTGCTGGACAACTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

10 SEQ ID 27 - CA8 Humanised V_H J8

15 QVQLVQSGAEVKKPGSSVKVSCKASGYTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCTRGAIYDGYDVLDNWGQGTLTVSS

20 SEQ ID 28 - CA8 Humanised V_H J8 (Polynucleotide)

25 CAGGTGCAGCTGGTCCAGAGCGGCGCCGAAGTGAAGAAGGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGGCTACACCTCACCAACTACTGGATGCACTGGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCGCTACATGGAAGTGAG
 30 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCAACCAGGGGCCATCTACGACGGCTA
 CGACGTGCTGGACAACTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

30 SEQ ID 29 - CA8 Humanised V_H J9

35 QVQLVQSGAEVKKPGSSVKVSCKGSYTFNYWMHWVRQAPGQGLEWIGATYRGHSDTYYNQKF
 KGRATLTADTSTSTAYMELSSLRSEDTAVYYCTRGAIYDGYDVLDNWGQGTLTVSS

40 SEQ ID 30 - CA8 Humanised V_H J9 (Polynucleotide)

45 CAGGTGCAGCTGGTCCAGAGCGGCGCCGAAGTGAAGAAGGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGGCAGCGGCTACACCTCACCAACTACTGGATGCACTGGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGCGACCTCACCGCCGACACGAGCACCAGCACCGCTACATGGAAGTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCAACCAGGGGCCATCTACGACGGCTA
 50 CGACGTGCTGGACAACTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

50 SEQ ID 31 - CA8 Humanised V_L M0

55 DIQMTQSPSSLSASVGDRVITCSASQDISNYLNWYQQKPGKAPKLLIYYTSNLHSGVPSRFSGSGS
 GTDFTLTSSLQPEDFATYYCQQYRKLPWTFGQGKLEIKR

55 SEQ ID 32 - CA8 Humanised V_L M0 (Polynucleotide)

GACATCCAGATGACCCAGAGCCCTAGCTCACTGAGGCCAGCGTGGCGACAGGGTGACCATT
 5 ACCTGCTCCGCCAGGCAGGACATCAGCAACTACCTGAACCTGGTACCAGCAGAAGCCGGCAAG
 GCCCCCCAAGCTGCTGATCTACTACACCTCCAACCTGCACTCCGGCGTCCCAGCAGGTTCAGCG
 GAAGCGGCAGCGGCACCGATTACACCTGACCATCTCCAGCCTGCAGCCCGAGGACTTCGCCA
 CCTACTACTGCCAGCAGTACAGGAAGCTCCCTGGACTTCGCCAGGGCACCAAACGGAGAT
 CAAGCGT

10 SEQ ID 33 - CA8 Humanised V_L M1

DIQMTQSPSSLSASVGDRVITCSASQDISNYLNWYQQKPGKAPKLLIYYTSNLHSGVPSRFSGSGS
 15 GTDYTLTISSLQPEDFATYYCQQYRKLPWTFGQGTKEIKR

SEQ ID 34 - CA8 Humanised V_L M1 (Polynucleotide)

GACATCCAGATGACCCAGAGCCCTAGCTCACTGAGGCCAGCGTGGCGACAGGGTGACCATT
 20 ACCTGCTCCGCCAGGCAGGACATCAGCAACTACCTGAACCTGGTACCAGCAGAAGCCGGCAAG
 GCCCCCCAAGCTGCTGATCTACTACACCTCCAACCTGCACTCCGGCGTCCCAGCAGGTTCAGCG
 GAAGCGGCAGCGGCACCGATTACACCTGACCATCTCCAGCCTGCAGCCCGAGGACTTCGCCA
 25 CCTACTACTGCCAGCAGTACAGGAAGCTCCCTGGACTTCGCCAGGGCACCAAACGGAGAT
 CAAGCGT

30 SEQ ID 35 - CA8 Humanised V_L M2

DIQLTQSPSSLSASVGDRVITCSASQDISNYLNWYQQKPGKAPELVIYYTSNLHSGVPSRFSGSGSG
 TDYTLTISSLQPEDFATYYCQQYRKLPWTFGQGTKEIKR

35 SEQ ID 36 - CA8 Humanised V_L M2 (Polynucleotide)

GACATCCAGCTGACCCAGAGCCCTAGCTCACTGAGGCCAGCGTGGCGACAGGGTGACCATT
 40 ACCTGCTCCGCCAGGCAGGACATCAGCAACTACCTGAACCTGGTACCAGCAGAAGCCGGCAAG
 GCCCCCCGAGCTGGTGATCTACTACACCTCCAACCTGCACTCCGGCGTCCCAGCAGGTTCAGC
 GGAAGCGGCAGCGGCACCGATTACACCTGACCATCTCCAGCCTGCAGCCCGAGGACTTCGCC
 ACCTACTACTGCCAGCAGTACAGGAAGCTCCCTGGACTTCGCCAGGGCACCAAACGGAGA
 45 TCAAGCGT

SEQ ID 37 - Human BCMA CD33-hBCMA ECD (1-53) TEV-Fc

50 MPLLLLLPLLWAGALAMLQMQGQCSQNEYFDLLLHACIPCQLRCSSNTPLTCQRYCNAVTNSVKG
 TNSGENLYFQGDPKSCDKTHCPVCPAPEELLGGPSVFLPPPKPKDTLMISRTPEVTCVVVDVSHEDP
 EVKFNWYVDGVEVHNALKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISK
 AKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSDGSFF
 55 LYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 38 - Human BCMA CD33-hBCMA ECD (1-53) TEV-Fc (Polynucleotide)

ATGCCGCTGCTGCTACTGCTGCCCTGCTGTGGCAGGGCGCTAGCTATGCTGCAGATGGCC
 GGCCAGTGCAGCCAGAACGAGTACCTCGACAGCCTGCTGCACGCCTGCATCCCTGCCAGCTG
 5 AGATGCAGCAGCAACACACCCCTCTGACCTGCCAGAGATACTGCAACGCCAGCGTGACCAACA
 GCGTGAAGGGACCAACTCCGGAGAGAACCTGTACTTCAAGGGGATCCAAATCTTGTGACAA
 AACTCACACATGCCACCCTGCCCAGCACCTGAACCTCTGGGGGACCGTCAGTCTCCTCTTC
 CCCCCAAAACCCAAGGACACCCCTCATGATCTCCGGACCCCTGAGGTACATGCGTGGTGGT
 10 GACGTGAGCCACGAAGACCCCTGAGGTCAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCAT
 AATGCCAAGACAAAGCCGGGGAGGAGCAGTACAACACAGCACGTACCGTGTGGTCAGCGTCCTC
 ACCGTCTGCACCAGGACTGGCTGAATGGCAAGGAGTACAAGTGCAAGGTCTCCAACAAAGCCC
 15 TCCCAGCCCCATCGAGAAAACCCTCTCAAAGCCAAGGGCAGCCCCGAGAGGCCACAGGTGT
 ACACCCTGCCCCATCCGGATGAGCTGACCAAGAACAGGTAGCCTGACCTGCCTGGTCA
 AAGGCTTCTATCCAGCGACATGCCGTGGAGTGGAGAGCAATGGGAGCCGGAGAACAACT
 ACAAGACCACGCCCTCCCGTGCTGGACTCCGACGGCTCCTCTACAGCAAGCTACCGT
 20 GGACAAGAGCAGGTGGCAGCAGGGAACGTCTTCTCATGCTCCGTATGCATGAGGCTCTGCA
 CAACCACACCGCAGAACGACCTCTCCGTCTCCGGTAAA

SEQ ID 39- Human BCMA CD33-hBCMA ECD (4-53) TEV-Fc

25 MPLLLLLPLLWAGALAMAGQCSQNNEYFDSLHACIPCQLRCSSNTPPLTCQRYCNASVTNSVKGTNS
 GENLYFQGDPKSCDKTHTCPCTPAPELLGGPSVFLPPPKDLMISRTPEVTCVVVDVSHEDPEVK
 30 FNWYVDGVEVHNNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAG
 QPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSDGSFFLYS
 KLTVDKSRWQQGNVFCSVVMHEALHNHYTQKSLSLSPGK

35 SEQ ID 40 - Human BCMA CD33-hBCMA ECD (4-53) TEV-Fc (Polynucleotide)

ATGCCGCTGCTGCTACTGCTGCCCTGCTGTGGCAGGGCGCTAGCTATGGCCGCCAGTGC
 AGCCAGAACGAGTACCTCGACAGCCTGCTGCACGCCTGCATCCCTGCCAGCTGAGATGCAGC
 40 AGCAACACACCCCTCTGACCTGCCAGAGATACTGCAACGCCAGCGTGACCAACAGCGTGAGG
 GCACCAACTCCGGAGAGAACCTGTACTTCAAGGGGATCCAAATCTTGTGACAAAACACAC
 ATGCCACCGTGCCAGCACCTGAACCTCTGGGGGACCGTCAGTCTCCTCTCCCCCAAAA

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CCCAAGGACACCCTCATGATCTCCGGACCCCTGAGGTACATGCGTGGTGGACGTGAGC
 CACGAAGACCTGAGGTCAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCATAATGCCAG
 5 ACAAAAGCCGCGGGAGGAGCAGTACAACAGCACGTACCGTGTGGTCAGCGTCCTCACCGTCCTG
 CACCAGGACTGGCTGAATGGCAAGGGAGTACAAGTGCAAGGTCTCCAACAAAGCCCTCCCAGCC
 CCCATCGAGAAAACCATCTCCAAGCCAAAGGGCAGCCCCGAGAGGCCACAGGTGTACACCCCTG
 10 CCCCCATCCCAGGATGAGCTGACCAAGAACCGAGTCAGCCTGACCTGCCTGGTCAAAGGCTTCT
 ATCCCAGCGACATCGCCGTGGAGTGGAGAGCAATGGCAGCCGGAGAACAACTACAAGACCA
 CGCCTCCCGTGCTGGACTCCGACGGCTCCTCTTCTACAGCAAGCTCACCGTGGACAAGAG
 CAGGTGGCAGCAGGGAACGTCTTCTCATGCTCCGTATGCATGAGGCTCTGCACAAACCAACTAC
 15 ACGCAGAAGAGCCTCTCCCTGTCTCCGGTAAA

SEQ ID 41- Cynomolgous BCMA CD33 cyto BCMA ECD (4-52) TEV-Fc

20 MPLLLLLPLLWAGALAMARQCSQNEYFDSLLHDCKPCQLRCSSTPPLTCQRYCNASMTNSVKGMNS
 GENLYFQGDPKSCDKHTCPPCPAPELGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVK
 FNWYVDGVEVHNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTIKG
 25 QPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSDGSFFLYS
 KLTVDKSRWQQGNVFCSVVMHEALHNHYTQKSLSLSPGK

SEQ ID 42 - Cynomolgous BCMA CD33 cyto BCMA ECD (4-52) TEV-Fc (Polynucleotide)

30 ATGCCGCTGCTACTGCTGCCCTGCTGTGGCAGGGCGCTAGCTATGCCAGACAGTGC
 AGCCAGAACGAGTACTTCGACAGCCTGCTGCACGACTGCAAGCCCTGCCAGCTGAGATGCAGC
 AGCACACCTCCTCTGACCTGCCAGAGATACTGCAACGCCAGCATGACCAACAGCGTGAAGGGCA
 35 TGAACCTCGGAGAGAACCTGTACTTCAAGGGATCCAAATCTTGACAAAACACACATGC
 CCACCGTGCCAGCACCTGAACCTCTGGGGGACCGTCAGTCTCCTCTCCCCAAAACCCA
 AGGACACCTCATGATCTCCGGACCCCTGAGGTACATGCGTGGTGGACGTGAGCCACG
 40 AAGACCTGAGGTCAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCATAATGCCAAGACAAA
 GCCGCGGGAGGAGCAGTACAACAGCACGTACCGTGTGGTCAGCGTCCTCACCGTCCTGCACCA
 GGACTGGCTGAATGGCAAGGAGTACAAGTGAAGGTCTCAACAAAGCCCTCCAGCCCCATC
 GAGAAAACCATCTCAAAGCCAAAGGGCAGCCCCGAGAGGCCACAGGTGTACACCCCTGCC
 45 TCCCGGGATGAGCTGACCAAGAACAGGTACAGCCTGACCTGCCTGGTCAAAGGCTTCTATCCA
 GCGACATCGCCGTGGAGTGGAGAGCAATGGCAGCCGGAGAACAACTACAAGACCACGCC
 CCGTGCTGGACTCCGACGGCTCCTCTTCTACAGCAAGCTCACCGTGGACAAGAGCAGGTG
 50 GCAGCAGGGAACGTCTTCTCATGCTCCGTATGCATGAGGCTCTGCACAAACCAACTACACGCAG
 AAGAGCCTCTCCCTGTCTCCGGTAAA

SEQ ID 43- CA8 J0 Humanised heavy chain

QVQLVQSGAEVKPGSSVKVSCKASGGTFSNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCARGAIYNGYDVLNWGQGTLTVSSASTKGPSVF
 5 PLAPSSKSTSGGTAALGCLVKDYFPEPVTSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSL

GTQTYICNVNHPKNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTC
 VVVDVSHEDPEVKFNWYVDGVEVHNAKTPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNK
 10 ALPAPIEKTIKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTT
 PPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

15 SEQ ID 44 - CA8 J0 Humanised heavy chain (Polynucleotide)

CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCCCGAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGCGGCCACCTTCAGCAACTACTGGATGCACGGTGAGGCAGGCCCG
 20 GACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGA
 AGTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCAGGCCATCATGGAAGTGA
 GCAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCGCCAGGGGCCATCTACAACGGCT
 25 ACGACGTGCTGGACAACGGGCCAGGGCACACTAGTAGCGGTGTCAGCGCCAGCACCAAGG
 GCCCGAGCGTGTCCCCCTGGCCCCAGCAGCAAGAGCACCAGCGGCCAGGCCGCGCT
 GGCTGCCTGGTGAAGGACTACTTCCCCGAACCGGTGACCGTGTGCCTGGAACAGCGGAGCC
 ACCAGCGCGTGCACACCTCCCCCGCTGCTGCAGAGCAGCGGCCGTACAGCCTGAGCAGC
 30 GTGGTGACCGTCCCCAGCAGCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAG
 CCCAGCAACACCAAGGTGGACAAGAAGGTGGAGGCCAAGAGCTGTGACAAGACCCACACCTGC
 CCCCCCTGCCCTGCCCCCGAGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCT
 35 AAGGACACCCCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGTGGATGTGAGCCAC
 GAGGACCCCTGAGGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC
 AAGCCCCAGGGAGGGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGTGCAC
 CAGGATTGGCTGAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCCTG
 40 TCGAGAAAACCATCAGCAAGGCCAAGGGCAGCCCAGAGAGGCCAGGTGTACACCCCTGCC
 CTAGCAGAGATGAGCTGACCAAGAACCGAGGTGTCCCTGACCTGCCTGGTGAAGGGCTTACCC
 CAGCGACATCGCCGTGGAGTGGAGAGCAACGGCCAGCCCAGAGAACACTACAAGACCACCC
 45 CCCTGTGCTGGACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 TGGCAGCAGGGCAACGTGTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACC
 CAGAAGAGCCTGAGCCTGCCCCGGCAAG

50 SEQ ID 45- CA8 J1 Humanised heavy chain

QVQLVQSGAEVKPGSSVKVSCKASGYTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCARGAIYNGYDVLNWGGTLTVSSASTKGPSVF
 5 PLAPSSKSTSGGTAALGCLVKDYFPEPVTVWSNSGALTSGVHTFPALQSSGLYSLSSVTPSSL
 GTQTYICNVNHKPSNTKVDKKVEPKSCDKTHCPVCPAPEELLGGPSVFLFPPKPKDLMISRTPEVTC
 VVVDVSHEDPEVKFNWYVDGVEVHNNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNK
 10 ALPAPIEKTIASKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGOPENNYKTT
 PPVLDSDGSFFYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSPGK

SEQ ID 46 - CA8 J1 Humanised heavy chain (Polynucleotide)

15 CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGGCTACACCTCACCAACTACTGGATGCAGCTGGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 20 GTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCACGCTACATGGAACGTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCGCCAGGGGCCATCTAACACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGG
 25 GCCCCAGCGTGTCCCCCTGGCCCCCAGCAGCAAGAGCACCAGCGGCCACAGCCGCCCTG
 GGCTGCCTGGTGAAGGACTACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTG
 ACCAGCGCGTGCACACCTCCCCCGTGTGAGAGCAGCGGCCCTGTACAGCCTGAGCAGC
 GTGGTGACCGTGCCCAGCAGCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAG
 30 CCCAGCAACACCAAGGTGGACAAGAAGGTGGAGGCCAAGAGCTGTGACAAGACCCACACCTGC
 CCCCCCTGCCCTGCCCCCGAGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCT
 AAGGACACCCCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCAC
 35 GAGGACCCCTGAGGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC
 AAGCCCAGGGAGGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGTGCAC
 CAGGATTGGCTAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCCTGCCCTA
 40 TCGAGAAAACCATCAGCAAGGCCAAGGGCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCT
 CTAGCAGAGATGAGCTGACCAAGAACCGAGGTGTCCCTGACCTGCTGGTGAAGGGCTTACCC
 CAGCGACATGCCGTGGAGTGGAGAGCAACGCCAGCCCAGAACAACATAAGACCACCC
 CCCTGTGCTGGACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 45 TGGCAGCAGGGCAACGTGTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACC
 CAGAAGAGCCTGAGCCTGCCCCGGCAAG

SEQ ID 47 - CA8 J2 Humanised heavy chain

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55

QVQLVQSGAEVKPGSSVKVSCKASGYTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCTRGAIYNGDVLDNWQQGLTVSSASTKGPSVF
 5 PLAPSSKSTSGGTAALGCLVKDYFPEPVTVWSNSGALTSGVHTFPALQSSGLYSLSSVTPSSL
 GTQTYICNVNHPKSNTKVDKKVEPKSCDKTHCPCPAPELLGGPSVFLFPPKPKDLMISRTPEVTC
 VVVDVSHEDPEVKFNWYVDGVEVHNAKTPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNK
 10 ALPAPIEKTIASKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGOPENNYKTT
 PPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSPGK

SEQ ID 48 - CA8 J2 Humanised heavy chain (Polynucleotide)

15 CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGGCTACACCTCACCAACTACTGGATGCAGCTGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 20 GTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCCTACATGGAACTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGGCCATCTAACACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGG
 25 GCCCCAGCGTGTCCCCCTGGCCCCCAGCAGCAAGAGCACCAGCGCCGGCACAGCCGCTG

 GGCTGCCTGGTAAGGACTACTTCCCCAACCGGTGACCGTGTGGAACAGCGGAGCCCTG
 ACCAGCGCGTGCACACCTCCCCGCCGTGCTCAGAGCAGCGGCCGTACAGCCTGAGCAGC
 30 GTGGTGACCGTCCCCAGCAGCAGCAGCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAG
 CCCAGCAACACCAAGGTGGACAAGAAGGTGGAGCCAAGAGCTGTGACAAGACCCACACCTGC
 CCCCCCTGCCCTGCCCGAGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCT
 35 AAGGACACCCCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCAC
 GAGGACCCCTGAGGTGAAGTTCACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC
 AAGCCCAGGGAGGAGCAGTACAACAGCACCTACCGGGTGGTGTCCGTGCTGACCGTGCTGCAC
 40 CAGGATTGGCTAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCCTGCCCTA
 TCGAGAAAACCATCAGCAAGGCCAAGGGCCAGCCCAGAGAGGCCAGGGTGTACACCCTGCCCT
 CTAGCAGAGATGAGCTGACCAAGAACCAAGGTGTCCCTGACCTGCCTGGTAAGGGCTTCTACCC
 CAGCGACATGCCGTGGAGTGGAGAGCAACGCCAGCCCAGAGAACAACTACAAGACCACCC
 45 CCCTGTGCTGGACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 TGGCAGCAGGGCAACGTGTTAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACC
 CAGAAGAGCCTGAGCCTGCCCCGGCAAG

50 SEQ ID 49- CA8 J3 Humanised heavy chain

QVQLVQSGAEVKPGSSVKVSCKGSGYFTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADTSTSTAYMELSSLRSEDTAVYYCTRGAIYNGDVLDNWQGQTLTVSSASTKGPSVF
 5 PLAPSSKSTSGGTAALGCLVKDYFPEPVTVWSNSGALTSGVHTFPAPLQSSGLYSLSSVTPSSL
 GTQTYICNVNHKPSNTKVDKKVEPKSCDKTHCPCCPAPELLGGPSVFLFPPKPDKTLMISRTPEVTC
 VVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNK
 10 ALPAPIEKTIASKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGOPENNYKTT
 PPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSPGK

SEQ ID 50 - CA8 J3 Humanised heavy chain (Polynucleotide)

15 CAGGTGCAGCTGGTCCAGAGCGGCGCCGAAGTGAAGAAGGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGGCAGCGGCTACACCTTACCAACTACTGGATGCACGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 20 GTTCAAGGGCCGGGTGACCATCACCGCCGACACGAGCACCAGCACCCTACATGGAAGTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGCGCCATCTAACACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGG
 25 GCCCCAGCGTGTCCCCCTGGCCCCCAGCAGCAAGAGCACCAGCGGCGGCACAGCCGCCCTG
 GGCTGCCTGGTGAAGGACTACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTG
 ACCAGCGCGTGCACACCTCCCCCGTGCTGCAGAGCAGCGGCTGTACAGCCTGAGCAGCAG
 GTGGTGACCGTGCCCAGCAGCAGCCTGGGACCCAGACCTACATCTGTAACGTGAACCACAAG
 30 CCCAGCAACACCAAGGTGACAAGAAGGTGGAGCCCCAAGAGCTGTGACAAGACCCACACCTGC
 CCCCCCTGCCCTGCCCCCGAGCTGCTGGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCT
 AAGGACACCCCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCAC
 35 GAGGACCCCTGAGGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC

 AAGCCCAGGGAGGGAGCACTACAACAGCACCTACCGGGTGGTGTCCGTGCTGACCGTGCTGCAC
 40 CAGGATTGGCTGAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCCTGCCCTA
 TCGAGAAAACCATCAGCAAGGCCAAGGGCCAGCCCAGAGAGGCCAGGGTGTACACCCCTGCC
 CTAGCAGAGATGAGCTGACCAAGAACCAAGGTGTCCCTGACCTGCCTGGTAAGGGCTTCTACCC
 CAGCGACATGCCGTGGAGTGGGAGAGCAACGCCAGCCCAGAGAACAACTACAAGACCACCC
 45 CCCTGTGCTGGACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 TGGCAGCAGGGCAACGTGTTAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACC
 CAGAAGAGCCTGAGCCTGCCCCGGCAAG

50 SEQ ID 51 - CA8 J4 Humanised heavy chain

QVQLVQSGAEVKKPGSSVKVSCKGSGYFTFTNYWMHWVRQAPGQGLEWIGATYRGHSDTYYNQKF
 KGRATLTADTSTSTAYMELSSLRSEDTAVYYCTRGAIYNGYDVLNWGQGTLVTVSSASTKGPSVFP
 5 LAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVTPSSLG
 TQTYICNVNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLPPPKPKDTLMISRTPETCV
 VWDVSHEDPEVKFNWYVDGVEVHNAAKTPREEQYNSTYRVSVLVLHQDWLNGKEYKCKVSNKA
 10 LPAPIEKTIISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTP
 PVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 52 - CA8 J4 Humanised heavy chain (Polynucleotide)

15 CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGGCAGCGGCTACACCTTACCAACTACTGGATGCAGCTGGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATCGGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 20 GTTCAAGGGCCGGCGACCCCTCACCGCCGACACGAGCACCAGCACCCTACATGGAAGTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGCGCCATCTAACACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGG
 25 GCCCCAGCGTGTCCCCCTGGCCCCCAGCAGCAAGAGCACCAGCGCCGGCACAGCCGCCCTG
 GGCTGCCTGGTGAAGGACTACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTG
 ACCAGCGCGTGCACACCTCCCCCGTGTGAGAGCAGCAGCGGCCCTGTACAGCCTGAGCAGC
 30 GTGGTGACCGTGCAGCAGCAGCAGCTGGGACCCAGACCTACATCTGTAACGTGAACCACAAG
 CCCAGCAACACCAAGGTGGACAAGAAGGTGGAGCCCCAAGAGCTGTGACAAGACCCACACCTGC
 CCCCCCTGCCCTGCCCCGAGCTGCTGGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCT
 AAGGACACCCCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCAC
 35 GAGGACCCCTGAGGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC
 AAGCCCAGGGAGGGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGTGAC
 CAGGATTGGCTGAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCCTGCCCTA
 40 TCGAGAAAACCATCAGCAAGGCCAAGGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCT
 CTAGCAGAGATGAGCTGACCAAGAACCGAGGTGTCCCTGACCTGCTGGTGAAGGGCTTCTACCC
 CAGCGACATGCCGTGGAGTGGGAGAGCAACGCCAGCCCAGAACAACATAAGACCACCC
 CCCTGTGCTGGACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 45 TGGCAGCAGGGCAACGTGTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACC
 CAGAAGAGCCTGAGCCTGTCCTGGCAAG

50 SEQ ID 53 - CA8 J5 Humanised heavy chain

QVQLVQSGAEVKPGSSVKVSCKSGSGYFTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADTSTSTAYMELSSLRSEDTAVYYCTRGAIYDGYDVLNWGQGTLTVSSASTKGPSVF
 5 PLAPSSKSTSGGTAALGCLVKDYFPEPVTSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSSL
 GTQTYICNVNHKPSNTKVDKKVEPKSCDKTHCPCPAPELLGGPSVFLFPPKPKDLMISRTPEVTC
 WVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNK
 10 ALPAPIEKTIASKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTT
 PPVLDSDGSFFYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSPGK

SEQ ID 54 - CA8 J5 Humanised heavy chain (Polynucleotide)

15 CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGGCAGCGGCTACACCTCACCAACTACTGGATGCACGGTGAGGCAGGCCCGG
 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 20 GTTCAAGGGCGGGTGACCATCACCGCCGACACGAGCACCAGCACCACATGGAACTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGGCCATCTACGACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGG
 25 GCCCCAGCGTGTCCCCCTGGCCCCCAGCAGCAAGAGCACCAGCGCCGGCACAGCCGCCCTG
 GGCTGCCTGGTGAAGGACTACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTG
 ACCAGCGCGTGCACACCTCCCCCGCTGCTGCAGAGCAGCGGCCGTACAGCCTGAGCAGC
 GTGGTGACCGTGCCCAGCAGCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAG
 30 CCCAGCAACACCAAGGTGGACAAGAAGGTGGAGGCCAACAGAGCTGTGACAAGACCCACACCTGC
 CCCCCCTGCCCTGCCCCCGAGCTGCTGGAGGCCAACCGCTGTTCCCTGTTCCCCCAAGCCT
 AAGGACACCCCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCAC
 35 GAGGACCCCTGAGGTGAAGTTCACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC
 AAGCCCAGGGAGGGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGTGCAC
 CAGGATTGGCTAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCCTGCCCTA
 40 TCGAGAAAACCATCAGCAAGGCCAAGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCT
 CTAGCAGAGATGAGCTGACCAAGAACCGAGGTGTCCCTGACCTGCCTGGTAAGGGCTTACCC
 CAGCGACATGCCGTGGAGTGGAGAGCAACGCCAGCCCAGAGAACAACTACAAGACCACCC
 CCCTGTGCTGGACAGCGATGGCAGCTTCCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 45 TGGCAGCAGGGCAACGTGTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACC
 CAGAAGAGCCTGAGCCTGCCCCGGCAAG

SEQ ID 55 - CA8 J6 Humanised heavy chain

50 QVQLVQSGAEVKPGSSVKVSCKASGGTFSNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCARGAIYDGYDVLNWGQGTLTVSSASTKGPSVF
 55 PLAPSSKSTSGGTAALGCLVKDYFPEPVTSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSSL

GTQTYICNVNHPNSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPPKDTLMISRTPEVTC
 VVVDSHEDPEVKFNWYVDGVEVHNNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNK
 5 ALPAPIEKTIASKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTT
 PPVLSDSGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 56 - CA8 J6 Humanised heavy chain (Polynucleotide)

10 CAGGTGCAGCTGGTCCAGAGCGGCCGAAGTGAAGAAGCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGCGGCCACCTTCAGCAACTACTGGATGCACGGGTGAGGCAGGCCCG
 GACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGA
 15 AGTTCAAGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCGCCTACATGGAACCTGA
 GCAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCGCCAGGGGCCATCTACGACGGCT
 ACGACGTGCTGGACAACACTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGG
 20 GCCCCAGCGTGTCCCCCTGGCCCCCAGCAGCAAGAGCACCAGCGGGCACAGCCGCCCTG
 GGCTGCCTGGTAAGGACTACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTG
 ACCAGCGCGTGACACCTCCCCCGCTGCTGCAGAGCAGCGCCGTACAGCCTGAGCAGC
 25 GTGGTGACCGTGGCCAGCAGCAGCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAG
 CCCAGCAACACCAAGGTGGACAAGAAGGTGGAGGCCAAGAGCTGTGACAAGACCCACACCTGC
 CCCCCCTGCCCTGCCCGAGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCT
 AAGGACACCCCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCAC
 30 GAGGACCCCTGAGGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC
 AAGCCCAGGGAGGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCAC
 CAGGATTGGCTGAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCTGCCCTA
 35 TCGAGAAAACCATCAGCAAGCCAAGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCC
 CTAGCAGAGATGAGCTGACCAAGAACCGAGGTGTCCCTGACCTGCCTGGTAAGGGCTTCTACCC
 CAGCGACATGCCGTGGAGTGGAGAGCAACGCCAGCCCAGAACACTACAAGACCAACCC
 CCCTGTGCTGGACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 40 TGGCAGCAGGGCAACGTGTTAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACC
 CAGAAGAGCCTGAGCCTGCCCTGGCAAG

SEQ ID 57 - CA8 J7 Humanised heavy chain

45 QVQLVQSGAEVKPGSSVKVSKASGYTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCARGAIYDGYDVLNWGQGTLTVSSASTKGPSVF
 PLAPSSKSTSGGTAALGCLVKDYFPEPVTVWSNSGALTSGVHTFPAVLQSSGLYSLSVVTVPSS
 50 GTQTYICNVNHPNSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPPKDTLMISRTPEVTC
 VVVDSHEDPEVKFNWYVDGVEVHNNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNK
 ALPAPIEKTIASKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTT
 55 PPVLSDSGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 58 - CA8 J7 Humanised heavy chain (Polynucleotide)

CAGGTGCAGCTGGTCCAGAGCGGCGCCGAAGTGAAGAAGCCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGGCTACACCTTACCAACTACTGGATGCACTGGGTGAGGCAGGCCCGG
 5 ACAGGGCCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCCTACATGGAAGTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCGCCAGGGGCCATCTACGACGGCTA
 10 CGACGTGCTGGACAACGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCAGGAG
 GCCCGAGCGTGTCCCCCTGGCCCCAGCAGCAAGAGCACCAGCGGGCACAGCCGCCCTG
 GGCTGCCTGGTAAGGACTACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTG
 ACCAGCGCGTGACACCTCCCCGCGTGCTGCAGAGCAGCGGCCTGTACAGCCTGAGCAGC
 15 GTGGTGACCGTGCAGCAGCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAG
 CCCAGCAACACCAAGGTGGACAAGAAGGTGGAGGCCAAGAGCTGTGACAAGACCCACACCTGC
 CCCCCCTGCCCTGCCCCCGAGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCT
 20 AAGGACACCCCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCAC
 GAGGACCCCTGAGGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC
 AAGCCCAGGGAGGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCAC
 CAGGATTGGCTGAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCCTGCCCTA
 25 TCGAGAAAACCATCAGCAAGGCCAAGGGCCAGCCCAGAGAGGCCAGGTGTACACCTGCCCT
 CTAGCAGAGATGAGCTGACCAAGAACCCAGGTGTCCCTGACCTGCCTGGTAAGGGCTTACCC
 CAGCGACATGCCGTGGAGTGGAGAGCAACGCCAGCCCAGAGAACAACTACAAGACCACCC
 30 CCCTGTGCTGGACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 TGGCAGCAGGGCAACGTGTTAGCTGCTCCGTATGCACGAGGCCCTGCACAATCACTACACC
 CAGAAGAGCCTGAGCCTGCCCCGGCAAG
 35 SEQ ID 59 - CA8 J8 Humanised heavy chain

QVQLVQSGAEVKKPGSSVKVSKASGYTFTNYWMHWVRQAPGQGLEWMGATYRGHSDTYYNQK
 FKGRVTITADKSTSTAYMELSSLRSEDTAVYYCTRGAIYDGYDVLDNWGQGTLTVSSASTKGPSVF
 40 PLAPSSKSTSGGTAALGCLVKDYFPEPVTVWSNSGALTSGVHTFPAPLQSSGLYSLSVVTPSSL
 GTQTYICNVNHPKSNTKVDKKVEPKSCDKTHCPGCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTC
 VVVDVSHEDEPKFNWYVDGVEVHNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNK
 45 ALPAPIEKTIKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTT
 PPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

50 SEQ ID 60 - CA8 J8 Humanised heavy chain (Polynucleotide)

CAGGTGCAGCTGGTCCAGAGCGGCGCCGAAGTGAAGAAGCCCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGCCAGCGGCTACACCTTACCAACTACTGGATGCACTGGGTGAGGCAGGCCCGG
 5 ACAGGGCTGGAGTGGATGGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCCGGGTGACCATCACCGCCGACAAGAGCACCAGCACCCTACATGGAACGTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGGCCATCTACGACGGCTA
 10 CGACGTGCTGGACAACGGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGG
 GCCCCAGCGTGTCCCCCTGGCCCCAGCAGCAAGAGCACCAGCGCCGGCACAGCCGCCCTG

 GGCTGCCTGGTGAAGGACTACTTCCCCAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTG
 15 ACCAGCGCGTGCACACCTCCCCGCGTGTGCAAGAGCAGCGGCTGTACAGCCTGAGCGAGC
 GTGGTACCGTCCCCAGCAGCAGCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAG
 CCCAGCAACACCAAGGTGGACAAGAAGGTGGAGGCCAAGAGCTGTGACAAGACCCACACCTGC
 20 CCCCCCTGCCCTGCCCCGAGCTGCTGGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCT
 AAGGACACCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCAC
 GAGGACCCCTGAGGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC
 AAGCCCAGGGAGGGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCAC
 25 CAGGATTGGCTGAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCCTGCCCC
 TCGAGAAAACCATCAGCAAGGCCAAGGGCAGCCCAGAGAGGCCAGGGTGTACACCCCTGCC
 CTAGCAGAGATGAGCTGACCAAGAACCCAGGTGTCCCTGACCTGCCTGGTAAGGGCTTCTACCC
 30 CAGCGACATGCCGTGGAGTGGAGAGCAACGCCAGCCCAGAGAACAACTACAAGACCACCC
 CCTGTGCTGGACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 TGGCAGCAGGGCAACGTGTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACC
 CAGAAGAGCCTGAGCCTGCCCCGGCAAG
 35

SEQ ID 61 - CA8 J9 Humanised heavy chain

QVQLVQSGAEVKPGSSVKVSCKGSYTFNYWMHWVRQAPGQGLEWIGATYRGHSDTYNNQKF
 40 KGRATLTADTSTSTAYMELSSLRSEDTAVYYCTRGAIYDGYDVLDNWQGQTLVTVSSASTKGPSVFP
 LAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPVLQSSGLYSLSSVTPSSSLG
 TQTYICNVNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLPPPKPKDTLMISRTPEVTCV
 45 VVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKA
 LPAPIEKTIASKAGQPREPVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTP
 PVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

50 SEQ ID 62 - CA8 J9 Humanised heavy chain (Polynucleotide)

CAGGTGCAGCTGGTCCAGAGCGGCGCCGAAGTGAAGAAGCCCCGGCAGCTCCGTGAAAGTGAG
 CTGCAAGGGCAGCGGCTACACCTTACCAACTACTGGATGCACTGGGTGAGGCAGGCCCGG
 5 ACAGGGCCTGGAGTGGATCGCGCCACCTACAGGGGCCACAGCGACACCTACTACAACCAGAA
 GTTCAAGGGCAGGGCGACCCCTCACCGCCGACACGAGCACCAGCACCCTACATGGAAGTGAG
 CAGCCTCAGGAGCGAGGACACCGCTGTATTACTGCACCAGGGGCCATCTACGACGGCTA
 CGACGTGCTGGACAACCTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGG
 10 GCCCCAGCGTGTCCCCCTGGCCCCAGCAGCAAGAGCACCAGCGGGCACAGCCGCCCTG
 GGCTGCCTGGTGAAGGACTACTTCCCCAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTG
 ACCAGCGCGTGACACCTCCCCCGCTGCTGCAGAGCAGCGGCCCTGTACAGCCTGAGCAGC
 15 GTGGTGACCGTGCCAGCAGCAGCAGCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAG
 CCCAGCAACACCAAGGTGGACAAGAAGGTGGAGGCCAAGAGCTGTGACAAGACCCACACCTGC
 CCCCCCTGCCCTGCCCCCGAGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCCCAAGCCT
 20 AAGGACACCCCTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGTGGATGTGAGCCAC
 GAGGACCCCTGAGGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACC

AAGCCCAGGGAGGAGCAGTACAACAGCACCTACCGGGTGGTGTCCGTGCTGACCGTGCTGCAC
 25 CAGGATTGGCTGAACGGCAAGGAGTACAAGTGTAAAGGTGTCCAACAAGGCCCTGCCTGCCCTA
 TCGAGAAAACCATCAGCAAGGCCAAGGGCCAGCCCAGAGAGGCCAGGGTGTACACCTGCC
 30 CTAGCAGAGATGAGCTGACCAAGAACCAAGGTGTCCCTGACCTGCCTGGTGAAGGGCTTCTACCC
 CAGCGACATGCCGTGGAGTGGAGAGCAACGCCAGCCCAGAGAACAACTACAAGACCACCC
 CCCTGTGCTGGACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGA
 TGGCAGCAGGGCAACGTGTTAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACC
 35 CAGAAGAGCCTGAGCCTGCCCCGGCAAG

SEQ ID 63 - CA8 M0 Humanised light chain

DIQMTQSPSSLSASVGDRVITCSASQDISNYLNWYQQKPGKAPKLLIYYTSNLHSGVPSRFSGSGS
 40 GTDFTLTISLQPEDFATYYCQQYRKLPWTFGQQTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCLL
 NNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTTLSKADYEKHKVYACEVTHQGLS
 SPVTKSFNRGEC

45 SEQ ID 64 - CA8 M0 Humanised light chain (Polynucleotide)

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GACATCCAGATGACCCAGAGGCCCTAGCTCACTGAGGCCAGCGTGGCGACAGGGTGACCATT
 ACCTGCTCCGCCAGGCAGGACATCAGCAACTACCTGAACCTGGTACCGAGCAGAACGGCGAAG
 5 GCCCCCAAGCTGCTGATCTACTACACCTCCAACCTGCACTCCGGCGTGCCAGCAGGTTCAGCG
 GAAGCGGCAGCGGCACCGATTACCCCTGACCATCTCCAGCCTGCAGCCCAGGGACTTCGCA
 CCTACTACTGCCAGCAGTACAGGAAGCTCCCTGGACTTCGCCAGGGCACCAAACGGAGAT
 CAAGCGTACGGTGGCCGCCCCAGCGTGTTCATCTTCCCCCCCAGCGATGAGCAGCTGAAGAG
 10 CGGCACCGCCAGCGTGGTGTCTGCTGAACAACCTTACCCCCGGAGGCCAAGGTGCAGTG
 GAAGGTGGACAATGCCCTGCAGAGCGAACAGCCAGGAGAGCGTACCGAGCAGGACAGCA
 AGGACTCCACCTACAGCCTGAGCAGCACCCCTGACCCCTGAGCAAGGCCACTACGAGAACACA
 15 AGGTGTACGCCTGTGAGGTGACCCACCAGGGCTGTCCAGCCCCGTGACCAAGAGCTTCAACC
 GGGCGAGTGC

SEQ ID 65 - CA8 M1 Humanised light chain

20 DIQMTQSPSSLSASVGDRVITCSASQDISNYLNWYQQKPGKAPKLLIYYTSNLHSGVPSRFSGSGS
 GTDYTLTISSLQPEDFATYYCQQYRKLPWTFGQGTKEIKRTVAAPSVIFPPSDEQLKSGTASVVCLL
 NNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTTLSKADYEKHKVYACEVTHQGLS
 25 SPVTKSFNRGEC

SEQ ID 66 - CA8 M1 Humanised light chain (Polynucleotide)

30 GACATCCAGATGACCCAGAGGCCCTAGCTCACTGAGGCCAGCGTGGCGACAGGGTGACCATT
 ACCTGCTCCGCCAGGCAGGACATCAGCAACTACCTGAACCTGGTACCGAGCAGAACGGCGAAG
 GCCCCCAAGCTGCTGATCTACTACACCTCCAACCTGCACTCCGGCGTGCCAGCAGGTTCAGCG
 GAAGCGGCAGCGGCACCGATTACCCCTGACCATCTCCAGCCTGCAGCCCAGGGACTTCGCA
 35 CCTACTACTGCCAGCAGTACAGGAAGCTCCCTGGACTTCGCCAGGGCACCAAACGGAGAT

CAAGCGTACGGTGGCCGCCCCAGCGTGTTCATCTTCCCCCCCAGCGATGAGCAGCTGAAGAG
 40 CGGCACCGCCAGCGTGGTGTCTGCTGAACAACCTTACCCCCGGAGGCCAAGGTGCAGTG
 GAAGGTGGACAATGCCCTGCAGAGCGAACAGCCAGGAGAGCGTACCGAGCAGGACAGCA
 AGGACTCCACCTACAGCCTGAGCAGCACCCCTGACCCCTGAGCAAGGCCACTACGAGAACACA
 45 AGGTGTACGCCTGTGAGGTGACCCACCAGGGCTGTCCAGCCCCGTGACCAAGAGCTTCAACC
 GGGCGAGTGC

SEQ ID 67 - CA8 M2 Humanised light chain

50 DIQLTQSPSSLSASVGDRVITCSASQDISNYLNWYQQKPGKAPELVIYYTSNLHSGVPSRFSGSGSG
 TDYTLTISSLQPEDFATYYCQQYRKLPWTFGQGTKEIKRTVAAPSVIFPPSDEQLKSGTASVVCLLN
 NFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTTLSKADYEKHKVYACEVTHQGLSS
 55 PVTKSFNRGEC

SEQ ID 68 - CA8 M2 Humanised light chain (Polynucleotide)

GACATCCAGCTGACCCAGAGGCCCTAGCTCACTGAGGCCAGCGTGGCGACAGGGTGACCATT
 ACCTGCTCCGCCAGGCAGGACATCAGCAACTACCTGAACCTGGTACCGAGCAGAAGCCGGCAAG
 5 GCCCCCGAGCTGGTGATCTACTACACCTCAACCTGCACCTCCGGCGTGCAGCCCAGCAGGTTAGC
 GGAAGCGGCAGCGGCACCGATTACACCCCTGACCATCTCCAGCCTGCAGCCCAGGACTTCGCC
 ACCTACTACTGCCAGCAGTACAGGAAGCTCCCTGGACTTCGGCCAGGGCACCAAACGGAGA
 TCAAGCGTACGGTGGCCGGCCCCAGCGTGTTCATCTCCCCCCCCAGCGATGAGCAGCTGAAGA
 10 CGGGCACCGCCAGCGTGGTGTCTGCTGAACAACTTCTACCCCCGGGAGGCCAAGGTGCAGT
 GGAAGGTGGACAATGCCCTGCAGAGCGAACAGCCAGGAGAGCGTACCGAGCAGGACAGC
 AAGGACTCCACCTACAGCCTGAGCAGCACCTGAGCAAGGCCACTACGAGAACAC
 15 AAGGTGTACGCCTGTGAGGTGACCCACCAGGGCTGTCCAGCCCCGTGACCAAGAGCTTCAAC
 CGGGGCGAGTGC

SEQ ID 69 - S307118G03 mouse variable heavy

20 EVQLQQSGPELVKPGASVKISCKASGYTFDYYMKWVKQSHGKSLEWIGEIYPNNGITYNQFKKGK
 ATLTVDKSSSTAYMELRSLTSEDSAVYYCANGYEFVYWGQGTLTVSA

SEQ ID 70 - S307118G03 mouse variable heavy (DNA sequence)

25 GAGGTCCAGTTGCAACAACTGGACCTGAGCTGGTAAGCCTGGGCTTCAGTGAAGATATCCT
 GTAAGGCTTCTGGATAACACATTCACTGACTACTACATGAAGTGGGTGAAGCAGAGCCATGGAAA
 30 GAGCCTTGAGTGGATTGGAGAGATTATCCTAATAATGGTGGTATTACCTACAAACCAGAAGTTCA
 AGGGCAAGGCCACATTGACTGTAGACAAGTCCTCCAGCACAGCCTACATGGAGCTCCGCAGCCT
 GACATCTGAGGACTCTGCAGTCTATTACTGTGCAAATGGTACGAGTTGTTACTGGGGCCAAG
 35 GGACTCTGGTCACTGTCTTGCA

SEQ ID 71 - S307118G03 mouse variable light

40 DIQMTQTASSLSASLGDRVТИСSASQGISNYLNWYQQKPDGTVKLLIYTSSLHSGVPSRFSGSGSG
 TDYSLTISNLEPEDIATYYCQQYSKLPWTFGGGTKLEIKR

SEQ ID 72 - S307118G03 mouse variable light (DNA sequence)

45 GATATCCAGATGACACAGACTGCATCCTCCCTGTCTGCCTCTCTGGGAGACAGAGTCACCATCA
 GTTGCAGTGCAAGTCAGGGCATTAGCAATTATTTAACTGGTATCAGCAGAAACCAGATGGAAC
 GTTAAACTCCTGATCTATTACACATCAAGTTACACTCAGGAGTCCCATCAAGGTTAGTGGCAG
 50 TGGGTCTGGGACAGATTATTCTCTACCATCAGCAACCTGGAACCTGAAGATATTGCCACTTACT
 ATTGTCAGCAGTATAGTAAGCTTCCGTGGACGTTGGAGGCACCAAGCTGGAAATCAAACG
 G

SEQ ID 73 - S307118G03 chimeric heavy chain

55

EVQLQQSGPELVKPGASVKISCKASGYTFDYYMKWVKQSHGKSLEWIGEIYPNNGITYNQFKKGK
 ATLTVDKSSSTAYMELRSLTSEDSAVYYCANGYEFVYWGQGTLTVSAAKTTAPSVFPLAPSSKSTS
 5 GGTAAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPALQSSGLYSLSSVTVPSSSLGTQTYICNVN
 HKPSNTKVDKKVEPKSCDKTHTCPCPAPELLGGPSVFLPPKPKDTLMISRTPEVTCVVVDVSHED
 PEVKFNWYVGVEVHNNAKTPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIKTIS
 10 KAKGQPREPQVTLPSSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSDGSF
 FLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 74 - S307118G03 chimeric heavy chain (DNA sequence)

15 GAGGTCCAGTTGCAACAATCTGGACCTGAGCTGGTAAGCCTGGGCTTCAGTGAAGATATCCT
 GTAAGGCTCTGGATACACATTCACTGACTACTACATGAAGTGGGTGAAGCAGAGCCATGGAAA
 GAGCCTTGAGTGGATTGGAGAGATTATCCTAATAATGGTGGTATTACCTACAACCAGAACGTTCA
 20 AGGGCAAGGCCACATTGACTGTAGACAAGTCCTCCAGCACAGCCTACATGGAGCTCCGCAGCCT
 GACATCTGAGGACTCTGCAGTCTATTACTGTGCAAATGGTTACGAGTTGTTACTGGGGCCAAG
 GGACTCTGGTCACTGTCTGCAGCCAAAACAACAGCCCCCAGCGTGTCCCCCTGGCCCCAG
 25 CAGCAAGAGCACCAGCGGGGGCACAGCCGCCCTGGGCTGCCTGGTAAGGACTACTTCCCCGA
 ACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTGACCAGCGCGTGACACCTCCCCGCCGT
 GCTGCAGAGCAGCGGCCTGTACAGCCTGAGCAGCGTGGTGACCGTGCCTGGCAGCAGCAGCCTGG
 GCACCCAGACCTACATCTGTAACGTGAACCACAAGCCCAGCAACACCAAGGTGGACAAGAAGGT
 30 GGAGCCAAGAGCTGTGACAAGACCCACACCTGCCCTGCCCTGCCCTGAGCTGCTGGG
 AGGCCCCAGCGTGTCCCTGTTCCCCCAAGCCTAAGGACACCCCTGATGATCAGCAGAACCCCC
 GAGGTGACCTGTGTGGTGGATGTGAGCCACGAGGACCCCTGAGGTGAAGTTCAACTGGTAC
 GTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGCCCAGGGAGGAGCAGTACAACAGCACC
 35 TACCGGGTGGTGTCCGTGCTGACCGTGCTGCACCAGGATTGGCTAACGGCAAGGAGTACAAG
 TGTAAGGTGTCCAACAAGGCCCTGCCCTGCCCTATCGAGAAAACCATCAGCAAGGCCAAGGGCC
 AGCCCAGAGAGCCCCAGGTGTACACCCCTGCCCTAGCAGAGATGAGCTGACCAAGAACCCAGG
 40 TGTCCCTGACCTGCCGTGGTAAGGGCTTCTACCCAGCGACATGCCGTGGAGTGGAGAGCA
 ACGGCCAGCCCAGAACAACTACAAGACCACCCCCCTGTGCTGGACAGCGATGGCAGCTTCT
 45 TCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAGGGCACGTGTTAGCTGCT
 CCGTGATGCACGAGGCCCTGCACAATCACTACACCCAGAACAGAGCCTGAGCCTGCCCTGGCA
 AG

50 SEQ ID 75 - S307118G03 chimeric light chain

DIQMTQTASSLSASLGDRVТИCSASQGISNYLNWYQQKPDGTVKLIYYTSSLHSGVPSRFSGSGSG
 TDYSLTISNLEPEDIATYYCQQYSKLPWTFGGGTKLELKRTVAAPSVIFPPSDEQLKSGTASVVCLLN
 55 NFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYLSSTLTSKADYEKHKVYACEVTHQGLSS
 PVTKSFRNRGEC

SEQ ID 76 - S307118G03 chimeric light chain (DNA sequence)

GATATCCAGATGACACAGACTGCATCCTCCCTGTCTGCCTCTCTGGGAGACAGAGTCACCATCA
 5 GTTGCAGTGCAAGTCAGGGCATTAGCAATTATTAACTGGTATCAGCAGAAACCAGATGGAACCT
 GTTAAACTCCTGATCTATTACACATCAAGTTACACTCAGGAGTCCCCTCAAGGTTAGTGGCAG
 TGGGTCTGGGACAGATTATTCTCTCACCATCAGCAACCTGGAACCTGAAGATATTGCCACTTACT
 10 ATTGTCAAGCAGTATAGTAAGCTTCCGTGGACGTTGGTGGAGGCACCAAGCTGGAGCTGAAACG
 TACGGTGGCCGCCCGCAGCGTGTTCATCTTCCCCCCCAGCGATGAGCAGCTGAAGAGCGGCAC
 CGCCAGCGTGGTGTCTGCTGAACAACCTTCTACCCCCGGGAGGCCAAGGTGCAGTGGAAAGGT
 GGACAATGCCCTGCAGAGCGGCAACAGCCAGGAGAGCGTGACCGAGCAGGACAGCAAGGACT
 15 CCACCTACAGCCTGAGCAGCACCCCTGACCCCTGAGCAAGGCCACTACGAGAAGCACAAGGTGT
 ACGCCTGTGAGGTGACCCACCAGGGCCTGTCCAGCCCCGTGACCAAGAGCTTCAACCAGGGCG
 AGTGC

20 SEQ ID 77 - S307118G03 humanised H0 variable heavy

QVQLVQSGAEVKPGSSVKVSCKASGGTFSDYYMKWVRQAPGQGLEWMGEIYPNNGITYNQKFK
 GRVTITADKSTSTAYMELSSLRSEDTAVYYCARGYEFVYWGQGTLTVSS

25 SEQ ID 78 - S307118G03 humanised H0 variable heavy (DNA sequence)

CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
 30 CTGCAAGGCTAGCGCGGCCACCTTCAGCGACTACTACATGAAGTGGGTGAGGCAGGCCCG
 CCAGGGACTGGAGTGGATGGCGAGATCTACCCCAACAACGGGGCATCACCTACAACCAGAA
 GTTCAAGGGCAGGGTGACCATCACCGCCGACAAAAGCACCAGCACCGCCTACATGGAAGTGAG
 35 CAGCCTGAGGAGCGAGGACACCGCCGTGTACTACTGCGCCAGGGCTACGAGTTCGTGTATTG
 GGGCCAGGGCACACTAGTGACCGTGTCCAGC

SEQ ID 79 - S307118G03 humanised H1 variable heavy

40 QVQLVQSGAEVKPGSSVKVSCKASGYFTDYYMKWVRQAPGQGLEWMGEIYPNNGITYNQKFK
 GRVTITADKSTSTAYMELSSLRSEDTAVYYCARGYEFVYWGQGTLTVSS

45 SEQ ID 80 - S307118G03 humanised H1 variable heavy (DNA sequence)

CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
 CTGCAAGGCTAGCGGCTACACCTTCACCGACTACTACATGAAGTGGGTGAGGCAGGCCCG
 50 CCAGGGACTGGAGTGGATGGCGAGATCTACCCCAACAACGGGGCATCACCTACAACCAGAA
 GTTCAAGGGCAGGGTGACCATCACCGCCGACAAAAGCACCAGCACCGCCTACATGGAAGTGAG
 CAGCCTGAGGAGCGAGGACACCGCCGTGTACTACTGCGCCAGGGCTACGAGTTCGTGTATTG
 GGGCCAGGGCACACTAGTGACCGTGTCCAGC

55 SEQ ID 81 - S307118G03 humanised H2 variable heavy

QVQLVQSGAEVKPGSSVKVSCKASGYTFTDYYMKWVRQAPGQGLEWMGEIYPNNGGITYNQKFK
GRVTITADKSTSTAYMELSSLRSEDTAVYYCANGYEFVYWGQGTLTVSS

5 SEQ ID 82 - S307118G03 humanised H2 variable heavy (DNA sequence)

CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
CTGCAAGGCTAGCGGCTACACCTTACCGACTACTACATGAAGTGGTGAGGCAGGCCCCGG
10 CCAGGGACTGGAGTGGATGGCGAGATCTACCCAAACAACGGGGCATCACCTACAACCAGAA
GTTCAAGGGCAGGGTGACCATCACGCCGACAAAAGCACCAGCACCGCTACATGGAAGTGAG
CAGCCTGAGGAGCGAGGACACGCCGTGTACTACTGCGCCAACGGTACGAGTTCGTGTATTG
15 GGGCCAGGGCACACTAGTGACCGTGTCCAGC

SEQ ID 83 - S307118G03 humanised H3 variable heavy

20 QVQLVQSGAEVKPGSSVKVSCKASGYTFTDYYMKWVRQAPGQGLEWIGEIYPNNGGITYNQKFKG
RATLTVDKSTSTAYMELSSLRSEDTAVYYCANGYEFVYWGQGTLTVSS

SEQ ID 84 - S307118G03 humanised H3 variable heavy (DNA sequence)

25 CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
CTGCAAGGCTAGCGGCTACACCTTACCGACTACTACATGAAGTGGTGAGGCAGGCCCCGG
CCAGGGACTGGAGTGGATAGGCGAGATCTACCCAAACAACGGGGCATCACCTACAACCAGAA
30 GTTCAAGGGCAGGGCACCCTCACCGTCGACAAAAGCACCAGCACCGCTACATGGAAGTGAG
CAGCCTGAGGAGCGAGGACACGCCGTGTACTACTGCGCCAACGGTACGAGTTCGTGTATTG
GGGCCAGGGCACACTAGTGACCGTGTCCAGC

35 SEQ ID 85 - S307118G03 humanised H4 variable heavy

QVQLVQSGAEVKPGSSVKVSCKASGYTFTDYYMKWVRQAPGQGLEWMGEIYPNNGGITYNQKFK
40 GRVTITADKSTSTAYMELSSLRSEDTAVYYCADGYEFVYWGQGTLTVSS

SEQ ID 86 - S307118G03 humanised H4 variable heavy (DNA sequence)

CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
45 CTGCAAGGCTAGCGGCTACACCTTACCGACTACTACATGAAGTGGTGAGGCAGGCCCCGG
CCAGGGACTGGAGTGGATGGCGAGATCTACCCAAACAACGGGGCATCACCTACAACCAGAA
GTTCAAGGGCAGGGTGACCATCACGCCGACAAAAGCACCAGCACCGCTACATGGAAGTGAG
50 CAGCCTGAGGAGCGAGGACACGCCGTGTACTACTGCGCCACGGTACGAGTTCGTGTATTG
GGGCCAGGGCACACTAGTGACCGTGTCCAGC

55 SEQ ID 87 - S307118G03 humanised H5 variable heavy

QVQLVQSGAEVKPGSSVKVSCKASGYTFTDYYMKWVRQAPGQGLEWIGEIYPNNGGITYNQKFKG
RATLTVDKSTSTAYMELSSLRSEDTAVYYCANGYEFDYWGQGTLTVSS

EP 4 338 754 A2

SEQ ID 88 - S307118G03 humanised H5 variable heavy (DNA sequence)

5 CAGGTGCAGCTGGTGCAGAGCGCGCCGAAGTGAAGAAGCCGGCTCCAGCGTAAGGTGAG
CTGCAAGGCTAGCGGCTACACCTCACCGACTACTACATGAAGTGGGTGAGGCAGGCCCGG
CCAGGGACTGGAGTGGATAGGCGAGATCTACCCAAACAACGGGGCATCACCTACAACCAGAA
GTTCAAGGGCAGGGCGACCCTCACCGTCGACAAAAGCACCAGCACCGCCTACATGGAAGTGAG
10 CAGCCTGAGGAGCGAGGACACCGCCGTGTACTACTGCGCCAACGGCTACGAGTTGACTATTG
GGGCCAGGGCACACTAGTGACCGTGTCCAGC

SEQ ID 89 - S307118G03 humanised L0 variable light

15 DIQMTQSPSSLSASVGDRVITCSASQGISNYLNWYQQKPGKAPKLLIYYTSSLHSGVPSRFSGSGS
GTDFTLTSSLQPEDFATYYCQQYSKLPWTFGQGTKLEIKR

20 SEQ ID 90 - S307118G03 humanised L0 variable light (DNA sequence)

GACATCCAGATGACCCAGAGCCCCCTCAAGCCTGAGCGCCAGCGTGGCGACAGGGTACTATC
ACCTGCAGCGCCTCCCAGGGCATCAGCAACTACCTGAACCTGGTACCGAGCAGAACCGGCAAG
25 GCCCTAAGCTGCTGATCTACTACACCAGCAGCCTGCACAGCGCGTGCCAGCAGGTTCTCC
GGCAGCGGCAGCGGAACCGACTTCACCCCTGACCATTAGCAGCCTCCAGCCGAGGACTTCGCC
ACCTACTACTGCCAGCAGTACAGCAAGCTGCCCTGGACCTTCGGCCAGGGCACCAAATGGAG
30 ATCAAGCGT

SEQ ID 91 - S307118G03 humanised L1 variable light

DIQMTQSPSSLSASVGDRVITCSASQGISNYLNWYQQKPGKAPKLLIYYTSSLHSGVPSRFSGSGS
35 GTDYTLTSSLQPEDFATYYCQQYSKLPWTFGQGTKLEIKR

SEQ ID 92 - S307118G03 humanised L1 variable light (DNA sequence)

40 GACATCCAGATGACCCAGAGCCCCCTCAAGCCTGAGCGCCAGCGTGGCGACAGGGTACTATC
ACCTGCAGCGCCTCCCAGGGCATCAGCAACTACCTGAACCTGGTACCGAGCAGAACCGGCAAG
GCCCTAAGCTGCTGATCTACTACACCAGCAGCCTGCACAGCGCGTGCCAGCAGGTTCTCC
GGCAGCGGCAGCGGAACCGACTACCCCTGACCATTAGCAGCCTCCAGCCGAGGACTTCGCC
45 ACCTACTACTGCCAGCAGTACAGCAAGCTGCCCTGGACCTTCGGCCAGGGCACCAAATGGAG
ATCAAGCGT

SEQ ID 93 - S307118G03 CDRH1

50 DYYMK

SEQ ID 94 - S307118G03 CDRH2

EIYPNNGGITYNQKFKG

SEQ ID 95 - S307118G03 CDRH3

GYEFVY

55 SEQ ID 96 - S307118G03 CDRL1

SASQGISNYLN

SEQ ID 97 - S307118G03 CDRL2

YTSSLHS

SEQ ID 98 - S307118G03 CDRL3

QQYSKLPWT

SEQ ID 99 - S307118G03 humanised H5 CDRH3

GYEFDY

5 SEQ ID 100 - S307118G03 humanised H0 heavy chain

QVQLVQSGAEVKPGSSVKVSCKASGGTFSYYMKWVRQAPGQGLEWMGEIYPNNGITYNQKFK
 10 GRVTITADKSTSTAYMELSSLRSEDTAVYYCARGYEFVYWGQGTLVTVSSASTKGPSVFPLAPSSKS
 TSGGTAALGCLVKDYFPEPVTVWSNSGALTSGVHTFPALQSSGLYSLSSVTVPSSSLGTQTYICN
 VNHKPSNTKVDKKVEPKSCDKTHCCPCPAPELLGGPSVFLFPPKPKDLMISRTPEVTCVVVDVSH
 15 EDPEVKFNWYVDGVEVHNAKTPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEK
 TISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSD
 GSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

20 SEQ ID 101 - S307118G03 humanised H0 heavy chain (polynucleotide)

CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
 CTGCAAGGCTAGCGCGGCCACCTTCAGCGACTACTACATGAAGTGGGTGAGGCAGGCCCGG
 25 CCAGGGACTGGAGTGGATGGCGAGATCTACCCAAACAACGGGGCATCACCTACAACCAGAA
 GTTCAAGGGCAGGGTGACCATCACCGCCGACAAAGCACCAGCACCGCCTACATGGAAGTGA
 CAGCCTGAGGAGCGAGGACACCGCCGTGTACTACTGCGCCAGGGCTACGAGTTCTGTATTG
 GGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGGGCCCAGCGTGTCCCT
 30 GGCCCCCAGCAGCAAGAGCACCAGCGCCGACAGCCGCCCTGGCTGCCCTGGTAAGGACT
 ACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTGACCAGCGCGTGCACACCT
 TCCCCGCCGTGCTGCAGAGCAGCGCCCTGTACAGCCTGAGCAGCGTGGTACCGTGCCAGCA
 35 GCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAGCCCAGCAACACCAAGGTGG

ACAAGAAGGTGGAGCCAAGAGCTGTGACAAGACCCACACCTGCCCTGCCCTGCCCTGCCCT
 AGCTGCTGGAGGGCCCAGCGTGTCCCTGTTCCCCCAAGCCTAAGGACACCCGTATGATCA
 40 GCAGAACCCCCCGAGGTGACCTGTGTGGATGTGAGCCACGAGGACCCCTGAGGTGAAGT
 TCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGCCCAGGGAGGAGCAGT
 ACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGTGACCAGGATTGGCTGAACGGCA
 45 AGGAGTACAAGTGTAAAGGTGTCACACAAGGCCCTGCCCTGCCCTATCGAGAAAACCATCAGCAA
 GGCCAAGGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAGATGAGCTGAC
 CAAGAACCGAGGTGTCCTGACCTGCCGTGGTAAGGGCTTCTACCCCAAGCGACATGCCGTGGA
 50 GTGGGAGAGCAACGCCAGCCCAGAACACTACAAGACCACCCCTGTGCTGGACAGCGA
 TGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAGGGCACGT
 GTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACCCAGAACAGGCCCTGAGCCTG
 TCCCCCTGGCAAG

55 SEQ ID 102 - S307118G03 humanised H1 heavy chain

QVQLVQSGAEVKPGSSVKVSCKASGYTFTDYYMKWVRQAPGQGLEWMGEIYPNNGITYNQKFK
 GRVTITADKSTSTAYMELSSLRSEDTAVYYCARGYEFVYWGQGLTVSSASTKGPSVFPLAPSSKS
 5 TSGGTAALGCLVKDYFPEPVTSWNNSGALTSGVHTFPAVLQSSGLYSLSSVTPSSLGTQTYICN
 VNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLPPPKDTLMISRTPEVTCVVVDVSH
 EDPEVKFNWYVDGVEVHNNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEK
 10 TISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPPVLDSD
 GSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 103 - S307118G03 humanised H1 heavy chain (DNA sequence)

15 CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCAGCGTGAAGGTGAG
 CTGCAAGGCTAGCGGCTACACCTCACCGACTACTACATGAAGTGGTGAGGCAGGCCCCGG
 CCAGGGACTGGAGTGGATGGCGAGATCTACCCAACAACGGGGCATCACCTACAACCAGAA
 20 GTTCAAGGGCAGGGTGACCATCACCGCCGACAAAGCACCAGCACCGCCTACATGGAAGTGAG
 CAGCCTGAGGAGCGAGGACACCGCCGTGTACTACTGCGCCAGGGCTACGAGTTCGTGTATTG
 GGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGGGCCCAGCGTGTCCCCCT
 25 GGCCCCCAGCAGCAAGAGCACAGCGGCCACAGCCGCCCTGGCTGCCTGGTAAGGACT
 ACTTCCCCGAACCGGTGACCGTGTCCGGAACAGCAGGCCCTGACCAAGCGCGTGCACACCT
 TCCCCGCCGTGCTGCAGAGCAGCGCCCTGTACAGCCTGAGCAGCGTGGTGACCGTGCAGCA
 GCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAGCCCAGCAACACCAAGGTGG
 30 ACAAGAAGGTGGAGCCCAAGAGCTGTGACAAGACCCACACCTGCCCTGCCCTGCCCTGCC
 AGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCTAAGGACACCCCTGATGATCA
 GCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCACGAGGACCCCTGAGGTGAAGT
 35 TCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGCCCAGGGAGGAGCAGT
 ACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCACCAGGATTGGCTAACGGCA
 AGGAGTACAAGTGTAAAGGTGTCAAACAAGGCCCTGCCTGCCCTATCGAGAAAACCATCAGCAA
 40 GGCCAAGGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAGATGAGCTGAC
 CAAGAACCCAGGTGCCCTGACCTGCCCTGGTAAGGGCTTCTACCCAGCGACATGCCGTGGA
 GTGGGAGAGCAACGCCAGCCCAGAAACAACATAAGACCAAGGCCAGGGAGGAGCAG
 45 TGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAGGGCACCGT
 GTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACCCAGAAGAGCCTGAGCCTG
 TCCCCCTGGCAAG

50 SEQ ID 104 - S307118G03 humanised H2 heavy chain

QVQLVQSGAEVKPGSSVKVSCKASGYTFTDYYMKWVRQAPGQGLEWMGEIYPNNGITYNQKFK
 GRVTITADKSTSTAYMELSSLRSEDTAVYYCANGYEFVYWGQGLTVSSASTKGPSVFPLAPSSKS
 5 TSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSLGTQTYICN
 VNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPDKTLMSRTPEVTCVVVDVSH
 EDPEVKFNWYVDGVEVHNNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEK
 10 TISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSD
 GSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 105 - S307118G03 humanised H2 heavy chain (DNA sequence)

15 CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
 CTGCAAGGCTAGCGGCTACACCTCACCGACTACATGAAGTGGTGAGGCAGGCCCGG
 CCAGGGACTGGAGTGGATGGCGAGATCTACCCAAACAACGGGGCATCACCTACAACCAGAA
 20 GTTCAAGGGCAGGGTGACCATCACCGCCGACAAAAGCACCAGCACCGCCTACATGGAAGTGAG
 CAGCCTGAGGAGCGAGGACACCGCCGTGTACTACTGCGCCAACGGCTACGAGTCGTGTATTG
 GGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGGGCCCCAGCGTGTCCCT
 25 GGCCCCCAGCAGCAAGAGCACCAGCGGCCACAGCCGCCCTGGCTGCCTGGTAAGGACT
 ACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTGACCAGCGCGTGCACACCT
 TCCCCGCCGTGCTGCAGAGCAGCGGCCGTACAGCCTGAGCAGCGTGGTGACCGTGCAGCA
 GCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAGCCCAGCAACACCAAGGTGG
 30 ACAAGAAGGTGGAGCCCAGAGCTGTGACAAGAGCCCACACCTGCCCTGCCCTGCCCT
 AGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCTAAGGACACCCCTGATGATCA
 GCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCACGAGGACCCCTGAGGTGAAGT
 35 TCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGCCCAGGGAGGAGCAGT
 ACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCACCAGGATTGGCTGAACGGCA
 AGGAGTACAAGTGTAAAGGTCCAACAAGGCCCTGCCCTGCCCTATCGAGAAAACCACAGCAA
 40 GGCCAAGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAGATGAGCTGAC
 CAAGAACCCAGGTGCCCTGACCTGCCCTGGTGAAGGGCTTCTACCCCAAGCGACATGCCGTGGA
 GTGGGAGAGCAACGCCAGCCCAGAACACTACAAGACCACCCCTGTGCTGGACAGCGA
 TGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAGGGCACAGT
 45 GTTCAGCTGCTCCGTATGCACGAGGCCCTGCACAATCACTACACCCAGAACAGGCCCTGAGCCTG
 TCCCCTGGCAAG

SEQ ID 106 - S307118G03 humanised H3 heavy chain

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QVQLVQSGAEVKPGSSVKVSCKASGYTFTDYYMKWVRQAPGQGLEWIGEYIPNNGGITYNQKFKG
 RATLTVDKSTSTAYMELSSLRSEDTAVYYCANGYEFVYWGQGLTVSSASTKGPSVFPLAPSSKST
 5 SGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSSLGTQTYICNV
 NHKPSNTKVDKKVEPKSCDKTHCPCPAPELLGGPSVFLPPKPKDTLMISRTPEVTCVVVDVSH
 DPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTI
 10 SKAKGQPREPQVTLPSSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSDG
 SFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 107 - S307118G03 humanised H3 heavy chain (DNA sequence)

15 CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
 CTGCAAGGCTAGCGGCTACACCTCACCGACTACTACATGAAGTGGTGAGGCAGGCCCGG
 CCAGGGACTGGAGTGGATAGGCGAGATCTACCCCAACAACGGGGCATCACCTACAACCAGAA
 20 GTTCAAGGGCAGGGCGACCCCTCACCGTCACAAAAGCACCAGCACCGCCTACATGGAAGTGAG
 CAGCCTGAGGAGCGAGGACACCGCCGTGTACTACTGCGCCAACGGCTACGAGTCGTGTATTG
 GGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGGGCCCAGCGTGTCCCCCT
 25 GGCCCCCAGCAGCAAGAGCACCAGCGCGGCACAGCCGCCCTGGCTGCCTGGTAAGGACT
 ACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTGACCAGCGCGTGCACACCT
 TCCCCGCCGTGCTGCAGAGCAGCGGCCGTACAGCCTGAGCAGCGTGGTGACCGTGCAGCAGCA
 GCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAGCCCAGCAACACCAAGGTGG
 30 ACAAGAAGGTGGAGCCCAGAGCTGTGACAAGAGCCCACACCTGCCCTGCCCTGCCCTGCCCT
 AGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCCCAGCCTAAGGACACCCCTGATGATCA
 GCAGAACCCCCCGAGGTGACCTGTGTGGATGTGAGCCACGAGGACCCCTGAGGTGAAGT
 35 TCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGCCCAGGGAGGAGCAGT
 ACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCACCAGGATTGGCTGAACGGCA
 AGGAGTACAAGTGTAAAGGTGCTAACACAAGGCCCTGCCCTGCCCTATCGAGAAAACCACAGCAA
 40 GGCCAAGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAGATGAGCTGAC
 CAAGAACCCAGGTGCTCCCTGACCTGCCTGGTGAAGGGCTTCTACCCCAAGCGACATGCCGTGGA
 GTGGGAGAGCAACGCCAGCCCAGAACACTACAAGACCACCCCCCTGTGCTGGACAGCGA
 TGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAGGGCACCGT
 45 GTTCAGCTGCTCCGTATGCACGAGGCCCTGCACAATCACTACACCCAGAACAGGCCCTGAGCCTG
 TCCCCCTGGCAAG

SEQ ID 108 - S307118G03 humanised H4 heavy chain

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QVQLVQSGAEVKKPGSSVKVSCKASGYTFTDYYMKWVRQAPGQGLEWMGEIYPNNGITYNQKFK
 GRVTITADKSTSTAYMELSSLRSEDTAVYYCADGYEFVYWGQGLTVSSASTKGPSVFPLAPSSKS
 5 TSGGTAALGCLVKDYFPEPVTSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSLGTQTYICN
 VNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSH
 EDPEVKFNWYVDGVEVHNNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEK
 10 TISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPVLDSD
 GSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 109 - S307118G03 humanised H4 heavy chain (DNA sequence)

15 CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
 CTGCAAGGCTAGCGGCTACACCTCACCGACTACTACATGAAGTGGTGAGGCAGGCCCGG
 CCAGGGACTGGAGTGGATGGCGAGATCTACCCAAACAACGGGGCATCACCTACAACCAGAA
 20 GTTCAAGGGCAGGGTACCATCACCGCCGACAAAAGCACCAGCACCGCCTACATGGAAGTGAG
 CAGCCTGAGGAGCGAGGACACCGCCGTGTACTACTGCGCCGACGGCTACGAGTTCGTGTATTG
 GGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGGGCCCAGCGTGTCCCT
 25 GGCCCCCAGCAGCAAGAGCACCAGCGCCGCACAGCCGCCCTGGCTGCCTGGTAAGGACT
 ACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTGACCAGCGCGTGCACACCT
 TCCCCGCCGTGCTGCAGAGCAGCAGGCCCTGTACAGCCTGAGCAGCGTGGTGACCGTGCAGCA
 GCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAGCCCAGCAACACCAAGGTGG
 30 ACAAGAAGGTGGAGCCCAGAGCTGTGACAAGAGCCCACACCTGCCCTGCCCTGCCCT
 AGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCCCAGCCTAAGGACACCCCTGATGATCA
 GCAGAACCCCCCGAGGTGACCTGTGTGGATGTGAGCCACGAGGACCCCTGAGGTGAAGT
 35 TCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGCCCAGGGAGGAGCAGT
 ACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCACCAGGATTGGCTGAACGGCA
 AGGAGTACAAGTGTAAAGGTCCAACAAGGCCCTGCCCTATCGAGAAAACCATCAGCAA
 40 GGCCAAGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAGATGAGCTGAC
 CAAGAACCCAGGTGCCCTGACCTGCCCTGGTGAAGGGCTTCTACCCCAAGCGACATGCCGTGGA
 GTGGGAGAGCAACGCCAGCCCAGAACACTACAAGACCACCCCTGTGCTGGACAGCGA
 TGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAGGGCACGT
 45 GTTCAGCTGCTCCGTATGCACGAGGCCCTGCACAATCACTACACCCAGAACAGGCCCTGAGCCTG
 TCCCCTGGCAAG

SEQ ID 110 - S307118G03 humanised H5 heavy chain

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QVQLVQSGAEVKPGSSVKVSCKASGYTFTDYYMKWVRQAPGQGLEWIGEYIPNNNGITYNQKFKG
 RATLTVDKSTSTAYMELSSLRSEDTAVYYCANGYEFDYWGQGLTVSSASTKGPSVFPLAPSSKST
 5 SGGTAALGCLVKDYFPEPVTSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSSLGTQTYICNV
 NHKPSNTKVDKKVEPKSCDKTHTCPCPAPELLGGPSVFLPPKPKDTLMISRTPEVTCVVVDVSH
 DPEVKFNWYVDGVEHNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTI
 10 SKAKGQPREPQVTLPSSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSDG
 SFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 111 - S307118G03 humanised H5 heavy chain (DNA sequence)

15 CAGGTGCAGCTGGTGCAGAGCGGCCGAAGTGAAGAAGCCGGCTCCAGCGTGAAGGTGAG
 CTGCAAGGCTAGCGGCTACACCTCACCGACTACTACATGAAGTGGTGAGGCAGGCCCGG
 CCAGGGACTGGAGTGGATAGGCGAGATCTACCCAAACAACGGGGCATCACCTACAACCAGAA
 20 GTTCAAGGGCAGGGCGACCCTCACCGTCGACAAAAGCACCAGCACCCTACATGGAACTGAG
 CAGCCTGAGGAGCGAGGACACCGCCGTGTACTACTGCGCCAACGGTACGAGTTGACTATTG
 25 GGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGGGCCCAGCGTGTCCCCCT
 GGCCCCCAGCAGCAAGAGCACCAGCGCGGCACAGCCGCCCTGGCTGCCTGGTGAAGGACT
 ACTTCCCCGAACCGGTGACCGTGTCCCTGAAACAGCGGAGCCCTGACCAGCGCGTGCACACCT
 30 TCCCCGCCGTGCTGCAGAGCAGCGGCCTGTACAGCCTGAGCAGCGTGGTACCGTGCCAGCA
 GCAGCCTGGCACCCAGACCTACATCTGAAACGTGAACCACAAGCCCAGCAACACCAAGGTGG
 ACAAGAAGGTGGAGCCAAAGAGCTGTGACAAGACCCACACCTGCCCTGCCCTGCCCTG
 35 AGCTGCTGGAGGCCCCAGCGTGTCCCTGTTCCCCCTGACCGCTAACGGACACCCGTGATGATCA
 GCAGAACCCCCCGAGGTGACCTGTGTGGTGGATGTGAGCCACGAGGACCCCTGAGGTGAAGT
 TCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGCCCAGGGAGGAGCAGT
 ACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCACCAGGATTGGCTAACGGCA
 40 AGGAGTACAAGTGTAAAGGTGCAACAAGGCCCTGCCCTATCGAGAAAACCATCAGCAA
 GGCCAAGGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAGATGAGCTGAC
 CAAGAACCGAGGTGCTCCCTGACCTGCCCTGGTGAAGGGCTTCTACCCAGCGACATGCCGTGGA
 GTGGGAGAGCAACGCCAGCCCAGAGAACAACTACAAGACCAACCCCCCTGTGCTGGACAGCGA
 45 TGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAGGGCAACGT
 GTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACCCAGAAGAGCCTGAGCCTG
 TCCCCCTGGCAAG

50 SEQ ID 112 - S307118G03 humanised L0 light chain

DIQMTQSPSSLSASVGDRVITCSASQGISNYLNWYQQKPGKAPKLIYYTSSLHSGVPSRFSGSGS
 GTDFTLTISLQPEDFATYYCQQYSKLPWTFGQGTLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCLL
 55 NNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYLSSTTLSKADYEHKVYACEVTHQGLS
 SPVTKSFNRGEC

EP 4 338 754 A2

SEQ ID 113 - S307118G03 humanised L0 light chain (DNA sequence)

GACATCCAGATGACCCAGAGCCCCCTAAGCCTGAGCGCCAGCGTGGCGACAGGGTACTATC
5 ACCTGCAGCGCCTCCCAGGGCATCAGCAACTACCTGAACCTGGTACCAGCAGAACGCCGGCAAG
GCCCTAAGCTGCTGATCTACTACACCAGCAGCCTGCACAGCGCGTGCCAGCAGGTTCTCC
10 GGCAGCGGCAGCGGAACCGACTTCACCCCTGACCATTAGCAGCCTCCAGCCCAGGGACTTCGCC
ACCTACTACTGCCAGCAGTACAGCAAGCTGCCCTGGACCTTCGGCCAGGGCACCAAACGGAG
15 ATCAAGCGTACGGTGGCCGGCCCCCAGCGTGTTCATCTTCCCCCCCAGCGATGAGCAGCTGAAG
AGCGGCACCGCCAGCGTGGTGTCTGCTGAACAACCTTACCCCCGGGAGGCAAGGTGCAG
TGGAAGGTGGACAATGCCCTGCAGAGCGGAACAGCCAGGAGAGCGTGACCGAGCAGGACAG
20 CAAGGACTCCACCTACAGCCTGAGCAGCACCCCTGACCCCTGAGCAAGGCCACTACGAGAAGCA
CAAGGTGTACGCCGTGAGGTGACCCACCAGGGCTGTCCAGCCCCGTGACCAAGAGCTTCAA
CCGGGGCGAGTGC

SEQ ID 114 - S307118G03 humanised L1 light chain

DIQMTQSPSSLSASVGDRVITCSASQGISNYLNWYQQKPGKAPKLLIYTSSLHSGVPSRFSGSGS
25 GTDYTLTISSLQPEDFATYYCQQYSKLPWTFGQGTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCLL
NNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSLTLSKADYEKHKVYACEVTHQGLS
SPVTKSFNRGEC

SEQ ID 115 - S307118G03 humanised L1 light chain (DNA sequence)

GACATCCAGATGACCCAGAGCCCCCTAAGCCTGAGCGCCAGCGTGGCGACAGGGTACTATC
ACCTGCAGCGCCTCCCAGGGCATCAGCAACTACCTGAACCTGGTACCAGCAGAACGCCGGCAAG
35 GCCCTAAGCTGCTGATCTACTACACCAGCAGCCTGCACAGCGCGTGCCAGCAGGTTCTCC
GGCAGCGGCAGCGGAACCGACTACACCCCTGACCATTAGCAGCCTCCAGCCCAGGGACTTCGCC
ACCTACTACTGCCAGCAGTACAGCAAGCTGCCCTGGACCTTCGGCCAGGGCACCAAACGGAG
40 ATCAAGCGTACGGTGGCCGGCCCCCAGCGTGTTCATCTTCCCCCCCAGCGATGAGCAGCTGAAG
AGCGGCACCGCCAGCGTGGTGTCTGCTGAACAACCTTACCCCCGGGAGGCAAGGTGCAG
TGGAAGGTGGACAATGCCCTGCAGAGCGGAACAGCCAGGAGAGCGTGACCGAGCAGGACAG
45 CAAGGACTCCACCTACAGCCTGAGCAGCACCCCTGACCCCTGAGCAAGGCCACTACGAGAAGCA
CAAGGTGTACGCCGTGAGGTGACCCACCAGGGCTGTCCAGCCCCGTGACCAAGAGCTTCAA
CCGGGGCGAGTGC

SEQ ID 116 - S332121F02 murine variable heavy chain

50 EVQLQQSGPVLVKPGASV р KM SCEASGY TFTD YY MNW V K Q SH GK T LEW IGV IN PY NGG TD Y N Q K F K
GKA TLTV DK SS STAY MEL NS LTSE DSA VYY CARS VY DYPFD Y W G Q GT L VT V SS

55 SEQ ID 117 S332121F02 murine variable heavy chain (DNA sequence)

GAGGTGCAGCTGCAGCAGAGCGGGCCCGTGTGGTAAGCCTGGAGCCAGCGTGAAAATGAG
 CTGCGAAGCCAGCGGCTACACCTCACCGACTACTACATGAACACTGGGTGAAGCAGAGGCCACGG
 CAAGACCCCTGGAGTGGATCGCGTGATCAACCCCTACAACGGGGCACCGACTACAACCAGAA
 5 GTTCAAGGGCAAGGCCACTCTGACCGTGACAAGAGAGCTCCAGCACCGCCTACATGGAACGTAA
 CAGCCTCACCTCTGAGGACAGCGCCGTCTATTACTGCGCCAGGAGCGTGTACGACTACCCCTTC
 GACTACTGGGGCAGGGCACACTAGTGACCGTGTCCAGC

10 SEQ ID 118 - S332121F02 chimeric heavy chain

EVQLQQSGPVLVKPGASVKSCEASGYFTDYYMNWVKQSHGKTLIEWIGVINPYNGTDYNQKFK
 15 GKATLTVKSSSTAYMELNSLTSEDSAVYYCARSVYDYPFDYWQGQTLVTSSASTKGPSVFPLAPS
 SKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSSLGTQTYI
 CNVNHKPSNTKVDKKVEPKSCDKTHCPPCPAPELLGGPSVFLFPPKPKDLMISRTPEVTCVVVDV
 SHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPI
 20 EKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLD
 SDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSPGK

SEQ ID 119 - S332121F02 chimeric heavy chain (DNA sequence)

GAGGTGCAGCTGCAGCAGAGCGGGCCCGTGTGGTAAGCCTGGAGCCAGCGTGAAAATGAG
 25 CTGCGAAGCCAGCGGCTACACCTCACCGACTACTACATGAACACTGGGTGAAGCAGAGGCCACGG
 CAAGACCCCTGGAGTGGATCGCGTGATCAACCCCTACAACGGGGCACCGACTACAACCAGAA

30 GTTCAAGGGCAAGGCCACTCTGACCGTGGACAAGAGAGCTCCAGCACCGCCTACATGGAACGTAA
 CAGCCTCACCTCTGAGGACAGCGCCGTCTATTACTGCGCCAGGAGCGTGTACGACTACCCCTTC
 GACTACTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGGGCCCCAGCGT
 GTTCCCCCTGGCCCCCAGCAGCAAGAGCACCAAGCGCCGGCACAGCCGCCCTGGCTGCCCTGG

35 TGAAGGACTACTTCCCCGAACCGGTGACCGTGTCTGGAACAGCGGAGCCCTGACCAGCGCG
 TGACACCTTCCCCGCCGTGCTGCAGAGCAGCGCCGTACAGCCTGAGCAGCGTGGTGACCG

TGCCCAGCAGCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAGGCCAGAACAC
 CAAGGTGGACAAGAAGGTGGAGGCCAAGAGAGCTGTGACAAGACCCACACCTGCCCCCTGCC

40 TGCCCCCGAGCTGCTGGAGGCCAGCGTGTCTGGTCCCCCAAGCCTAAGGACACCC
 GATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGTGGATGTGAGCCACGAGGACCTGA
 GGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGGCCAGGGA

45 GGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCACCAGGATTGGCT
 GAACGGCAAGGAGTACAAGTGAAGGTGTCCAACAAGGCCCTGCCTGCCCTATCGAGAAAACC
 ATCAGCAAGGCCAAGGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAGAT

GAGCTGACCAAGAACCAAGGTGTCCCTGACCTGCCTGGTAAGGGCTTCTACCCCAAGCGACATC
 50 GCCGTGGAGTGGAGAGCAACGGCCAGCCCAGAACACTACAAGACCAACCCCCCTGTGCTG
 GACAGCGATGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGACAAGAGCAGATGGCAGCAG

GGCAACGTGTTAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACCCAGAAGAGCC
 TGAGCCTGTCCCCGGCAAG

55 SEQ ID 120 - S332121F02 murine variable light chain

DIVLTQSPASLAVALGQRATISCRASESVSIHGTHLMHWYQQKPGQPPKLLIYAASNLESGVPARFSG
SGSETDFTLNIHPVEEEDAATYFCQQSIEDPRTFGGGTKLEIK

5 SEQ ID 121 - S332121F02 murine variable light chain (DNA sequence)

GACATCGTCCTGACCCAGAGCCCCGCCAGCCTGGCCGTGAGCCTGGGCCAGAGGGCCACAATC
AGCTGCAGGGCCTCTGAGTCCGTGAGCATCCACGGCACCCACCTGATGCACTGGTATCAGCAG
10 AAGCCCCGCCAGCCTCCAAAGCTGCTGATCTACGCCGCCAGCAACCTGGAGAGCGGCGTGCCC
GCTAGGTTCAAGCGGAAGCGGCAGCGAGACCGACTTCACCCTGAACATCCACCCCGTGGAGGAG
GAAGACGCCGCCACCTACTTCTGCCAGCAGAGCATCGAGGACCCCAGGACCTCGGCGGGGGC
15 ACCAAGCTCGAGATTAAGCGT

SEQ ID 122 - S332121F02 chimeric light chain

MGWSCIILFLVATATGVHSDIVLTQSPASLAVALGQRATISCRASESVSIHGTHLMHWYQQKPGQPPK
20 LLIYAASNLESGVPARFSGSGSETDFTLNIHPVEEEDAATYFCQQSIEDPRTFGGGTKLEIKRTVAAPS
VFIFPPSDEQLKSGTASVVCLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTL
SKADYEHKVYACEVTHQGLSPVTKSFRGEC

25 SEQ ID 123 - S332121F02 chimeric light chain (DNA sequence)

ATGGGCTGGTCCTGCATCATCCTGTTCTGGTGGCCACCGCCACCGCGTGCACAGCGACATC
GTCCTGACCCAGAGCCCCGCCAGCCTGGCCGTGAGCCTGGGCCAGAGGGCCACAATCAGCTG
30 CAGGGCCTCTGAGTCCGTGAGCATCCACGGCACCCACCTGATGCACTGGTATCAGCAGAACGCC
CGGCCAGCCTCCAAAGCTGCTGATCTACGCCGCCAGCAACCTGGAGAGCGGCGTCCCCGCTAG
GTTCAGCGGAAGCGGCAGCGAGACCGACTTCACCCTGAACATCCACCCCGTGGAGGAGGAAGA
CGCCGCCACCTACTTCTGCCAGCAGAGCATCGAGGACCCCAGGACCTCGGCGGGGGCACCAA
35 GCTCGAGATTAAGCGTACGGTGGCCCCCCAGCGTGTTCATCTTCCCCCCCAGCGATGAGCA
GCTGAAGAGCGGCACCGCCAGCGTGGTGTCTGCTGAACAACTTCTACCCCGGGAGGCCAA
GGTGCAGTGGAAAGGTGGACAATGCCCTGCAGAGCGGCAACAGCCAGGAGAGCGTGACCGAGC

40 AGGACAGCAAGGACTCCACCTACAGCCTGAGCAGCACCTGACCCCTGAGCAAGGCCGACTACG
AGAAGCACAAGGTGTACGCTGTGAGGTGACCCACCAGGGCCTGTCCAGCCCCGTGACCAAGA
GCTTCAACCGGGCGAGTGC

45 SEQ ID 124 - S322110D07 murine variable heavy chain

EVQLQQSGPELVKPGTSVKIPCKTSGYIFTDYSIDWVKQSHGKSLEWIGDIDPNYGDPIYNHKFKGKA
50 TLTVDRSSSTAYMELRSLTSEDTAVYFCARRATGTDWFAFWGQGTLTVSS

SEQ ID 125 - S322110D07 murine variable heavy chain (DNA sequence)

GAGGTGCAGCTGCAGCAGAGCGGGCCCCGAGCTGGTGAACCCGGCACCGCGTGAAGATCCC
 CTGCAAGACCTCTGGCTACATCTCACCGACTACAGCATCGACTGGGTGAAGCAGAGGCCACGGC
 AAGTCTCTGGAGTGGATTGGGACATCGACCCCAACTACGGCGACCCCATCTACAACCACAAGT
⁵ TCAAGGGCAAGGCCACCCCTGACCGTGGACAGGAGCAGCAGCACCGCCTACATGGAACTCAGGA
 GCCTGACCAGCGAGGACACCGCCGTATTTTGCGCCAGGAGGGCCACCGGACTGATTGGT
 TCGCCTCTGGGCCAGGGCACACTAGTGACCGTGTCCAGC

¹⁰ SEQ ID 126 - S322110D07 chimeric heavy chain

EVQLQQSGPELVKPGTSVKIPCKTSGYIFTDYSIDWVKQSHGKSLEWIGDIDPNYGDPIYNHKFKGKA
¹⁵ TLTVDRSSSTAYMELRSLTSEDTAVYFCARRATGTDWFAFWGQGTLTVSSASTKGPSVFPLAPSSK
 STSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSSLGTQTYIC
 NVNHKPSNTKVDKKVEPKSCDKTHTCPVCPAPELLGGPSVFLPPKPKDTLMISRTPEVTCVVVDVS
 HEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIE
²⁰ KTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSPGK

SEQ ID 127 - S322110D07 chimeric heavy chain (DNA sequence)

²⁵ GAGGTGCAGCTGCAGCAGAGCGGGCCCCGAGCTGGTGAACCCGGCACCGCGTGAAGATCCC
 CTGCAAGACCTCTGGCTACATCTCACCGACTACAGCATCGACTGGGTGAAGCAGAGGCCACGGC
 AAGTCTCTGGAGTGGATTGGGACATCGACCCCAACTACGGCGACCCCATCTACAACCACAAGT
³⁰ TCAAGGGCAAGGCCACCCCTGACCGTGGACAGGAGCAGCAGCACCGCCTACATGGAACTCAGGA
 GCCTGACCAGCGAGGACACCGCCGTATTTTGCGCCAGGAGGGCCACCGGACTGATTGGT
 TCGCCTCTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGGGCCCCAGCG
 TGTTCCCCCTGGCCCCCAGCAGCAAGAGCACAGCGGGCACAGCCGCCCCCTGGCTGCCTG
³⁵ GTGAAGGACTACTTCCCCAACCGGTGACCGTGTCTGGAACAGCGGAGCCCTGACCAGCGGC
 GTGCACACCTCCCCGCCGTGCTGCAGAGCAGCGGCCTGTACAGCCTGAGCAGCGTGGTGACC
 GTGCCAGCAGCAGCCTGGCACCCAGACCTACATCTGAACGTGAACCACAAGCCCAGCAAC
 ACCAAGGTGGACAAGAAGGTGGAGGCCAAGAGCTGTGACAAGACCCACACCTGCCCTGC
⁴⁰ CCTGCCCGAGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCTAAGGACACC
 CTGATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGTGGATGTGAGCCACGAGGACCT
 GAGGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGCCCAGG
⁴⁵ GAGGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGTGACCAGGATTGG
 CTGAACGGCAAGGAGTACAAGTGAAGGTGCCAACAAGGCCCTGCCTGCCCTATCGAGAAAA
 CCATCAGCAAGGCCAAGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAG
 ATGAGCTGACCAAGAACCAAGGTGCTCCCTGACCTGCCTGGTAAGGGCTTCTACCCAGCGACAT
⁵⁰ CGCCGTGGAGTGGAGAGCAACGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAG
 GGACAGCGATGGCAGCTTCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCA
 GGGCAACGTGTTAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACCCAGAAAGAG
 CCTGAGCCTGTCCCCCTGGCAAG

⁵⁵ SEQ ID 128 - S322110D07 murine variable light chain

DIQMTQSPASLSVSGETVTITCRASENIYNNLAWYQQKQGKSPQLLVYAA
TQYSLKINSQSGDFGTYYCQHFWGTPLTFGAGTKLELKR

5 SEQ ID 129 - S322110D07 murine variable light chain (DNA sequence)

GACATCCAGATGACCCAGAGCCCCGCTAGCCTCAGCGTGTCCGTCGGCGAGACCGTGACCATC
ACCTGCAGGCCAGCGAGAACATCTACAACAACTGGCCTGGTATCAGCAGAAGCAGGGCAAA
10 AGCCCCCAGCTGCTGGTGTACGCCGCCACCATTCTGGCCGACGGCGTCCCCAGCAGGTTCTCT
GGAAGCGGCAGCGGCACCCAGTACAGCCTGAAGATCAACAGCCTGCAGAGCGGGGACTCGG
CACCTACTACTGCCAGCACTTCTGGGGACTCCCCGTACCTTCGGAGCOCGGCACCAAGCTGGA
15 GCTGAAGCGT

15 SEQ ID 130 - S322110D07 chimeric light chain

DIQMTQSPASLSVSGETVTITCRASENIYNNLAWYQQKQGKSPQLLVYAA
TQYSLKINSQSGDFGTYYCQHFWGTPLTFGAGTKLELKRTVAAPSVFIFPPSDEQLKSGTASVVCLL
20 NNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTSKADYEKHKVYACEVTHQGLS
SPVTKSFRNRGEC

25 SEQ ID 131 - S322110D07 chimeric light chain (DNA sequence)

GACATCCAGATGACCCAGAGCCCCGCTAGCCTCAGCGTGTCCGTCGGCGAGACCGTGACCATC
ACCTGCAGGCCAGCGAGAACATCTACAACAACTGGCCTGGTATCAGCAGAAGCAGGGCAAA
30 AGCCCCCAGCTGCTGGTGTACGCCGCCACCATTCTGGCCGACGGCGTCCCCAGCAGGTTCTCT
GGAAGCGGCAGCGGCACCCAGTACAGCCTGAAGATCAACAGCCTGCAGAGCGGGGACTCGG
CACCTACTACTGCCAGCACTTCTGGGGACTCCCCGTACCTTCGGAGCOCGGCACCAAGCTGGA
35 GCTGAAGCGTACGGTGGCCGCCAGCGTGTTCATCTTCCCCCCCAGCGATGAGCAGCTGAA
GAGCGGCACCGCCAGCGTGGTGTCTGCTGAACAACCTCTACCCCCGGGAGGCCAAGGTGCA
GTGGAAGGTGGACAATGCCCTGCAGAGCGAACAGCCAGGAGAGCGTGACCGAGCAGGACA
GCAAGGACTCCACCTACAGCCTGAGCAGCACCTGACCCCTGAGCAAGGCCACTACGAGAAGC
40 ACAAGGTGTACGCCCTGTGAGGTGACCCACCAGGGCTGTCCAGCCCCGTACCAAGAGCTTA
ACCGGGCGAGTGC

SEQ ID 132 - S332126E04 murine variable heavy chain

45 QVQLQQPGAEVKPGASVKLSCKASGYTFTNYWMHWVKQRPGQGLEWIGIIPNSGSTNYNEKF
KS KATLTVDKSSSTAYMQLSSLTSEDSAVYYCARGIYDYPFAYWGQGTLVTVSS

SEQ ID 133 - S332126E04 murine variable heavy chain (DNA sequence)

50 CAGGTGCAGCTCCAGCAGCCCCGGAGCCGA
CTGGTGAAGCCCCGGAGCCAGCGTCAA
ACTGTCC
TGCAAGGCCAGCGGCTACACCTTACCA
AACTACTGGATGC
ACTGGGTGAAGCAGAGGCC
CAGGGCCTGGAGTGGATCGGC
ATCATCCACCC
AACAGCGGGAGC
ACCAACTACAC
GAGAAG
TTCAAGAGCAAGGCC
ACCC
CTGACCGTGG
ACAAGAGC
AGCAGC
ACTGC
CTACATGC
AGCTGAGC
55 AGCCTGAC
CCAGCGAGG
ACAGCG
CTGTG
ACTACTG
CGCCAGGG
CATCTAC
GACTACCC
CTGC
CTATTGGGG
CCAGGG
CACACTAG
TGACCGTGT
CCAGC

SEQ ID 134 - S332126E04 Chimeric heavy chain

5 QVQLQQPGAEVKPGASVKLSCKASGYTFTNYWMHWVKQRPGQGLEWIGIHPNSGSTNYNEKFKS
 KATLTVKSSSTAYMQLSSLTSEDAVYYCARGIYDYPFAYWGQGTLVTVSSASTKGPSVFPLAPSS
 KSTSGGTAALGCLVKDYFPEPVTVWSNSGALTSGVHTFPALQSSGLYSLSSVTPSSSLGTQTYI
 CNVNHKPSNTKVDKKVEPKSCDKTHCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDV
 SHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVSVLVLHQDWLNGKEYKCKVSNKALPAPI

10 EKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLD
 SDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSPGK

SEQ ID 135 - S332126E04 Chimeric heavy chain (DNA sequence)

15 CAGGTGCAGCTCCAGCAGCCCCGGAGCCGAUTGGTGAAGGCCGGAGCCAGCGTCAAACGTCC
 TGCAAGGCCAGCGGCTACACCTCACCAACTACTGGATGCACTGGGTGAAGCAGAGGCCGGC
 CAGGGCCTGGAGTGGATCGGCATCATCCACCCAAACAGCAGGGAGCACCACACTAACGAGAAG
 20 TTCAAGAGCAAGGCCACCCGTGACCGTGGACAAGAGCAGCAGCAGCACTGCCATACATGCAGCTGAGC
 AGCCTGACCAGCGAGGACAGCGCTGTACTACTGCGCCAGGGCATCTACGACTACCCCTTC
 GCCTATTGGGCCAGGGCACACTAGTGACCGTGTCCAGCGCCAGCACCAAGGGCCCCAGCGTG
 TCCCCCTGGCCCCCAGCAGCAAGAGCACCAGCAGCGGGCACAGCCGCCCTGGCTGCCTGGT
 25 GAAGGACTACTTCCCCGAACCGGTGACCGTGTCTGGAACAGCGGAGCCCTGACCAGCGCGT
 GCACACCTTCCCCGCCGTGCTGCAGAGCAGCGGCCCTGTACAGCCTGAGCAGCGTGGTACCGT
 GCCCAGCAGCAGCCTGGCACCCAGACCTACATCTGTAACGTGAACCACAAGCCCAGCAACAC
 CAAGGTGGACAAGAAGGTGGAGCCAAGAGCAGCTGTGACAAGACCCACACCTGCCCTGGCC
 30 TGCCCCCGAGCTGCTGGAGGCCAGCGTGTCTGGTCCCTGTTCCCCCCTGGCTAAGGACACCC
 GATGATCAGCAGAACCCCCGAGGTGACCTGTGTGGTGGATGTGAGCCACGAGGACCTGA
 GGTGAAGTTCAACTGGTACGTGGACGGCGTGGAGGTGACAATGCCAAGACCAAGCCCAGGGA
 35 GGAGCAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCCTGCACCAGGATTGGCT
 GAACGGCAAGGAGTACAAGTGTAAAGGTGTCACAACAGGCCCTGCCTGCCCTATCGAGAAAACC
 ATCAGCAAGGCCAACGGCCAGCCCAGAGAGCCCCAGGTGTACACCCCTGCCCTAGCAGAGAT
 GAGCTGACCAAGAACCCAGGTGTCCCTGACCTGCCTGGTAAGGGCTTACCCAGCGACATC
 40 GCCGTGGAGTGGAGAGCAACGGCCAGCCCAGAGAACAACTACAAGACCAACCCCTGTGCTG
 GACAGCGATGGCAGCTTCTCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAG
 GGCAACGTGTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACCCAGAACAGGCC
 TGAGCCTGCTCCCTGGCAAG

45 SEQ ID 136 - S332126E04 murine variable light chain

DIVLTQSPASLAVALGQRATISCRASESVSIHGTHLMHWYQQKPGQPPKLIYASNLESGVPARFSG
 50 SGSETDFTLNIHPVEEDAATYFCQQSIEDPYTFGGGTKLEIKR

SEQ ID 137 - S332126E04 murine variable light chain (DNA sequence)

GACATCGTCTGACCCAGTCTCCCGCTAGCCTGGCCGTGTCTGGGCCAGAGGGCCACAATC
 AGCTGCAGGGCCAGCGAGAGCGTCAGCATTCACGGCACCCACCTGATGCACTGGTACCAGCAG
 AAGCCCGGCCAGCCTCCAAAGCTCCTGATCTACGCCGCCAGCAACCTGGAAAGCGGAGTGCCC
 5 GCCAGGTTCAGCGGCAGCGGCTCCGAGACCGACTTCACCCCTAACATCCACCCCGTGGAGGAG
 GAGGACGCCGCCACCTACTTCTGCCAGCAGAGCATCGAGGACCCCTACACCTCGGCGGCCGC
 ACCAAGCTGGAGATCAAGCGTSEQ ID 138 - S332126E04 Chimeric light chain
 DIVLTQSPASLAVSLGQRATISCRASESVSIHGTHLMHWYQQKPGQPPKLLIYASNLESGVPARFSG
 10 SGSETDFTLNIHPVEEDAATYFCQQSIEDPYTFGGGTKEIKRTVAAPSVFIFPPSDEQLKSGTASVV
 CLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTTLSKADYEKHKVYACEVTHQ
 GLSSPVTKSFNRGEC

15 SEQ ID 139 - S332126E04 Chimeric light chain (DNA sequence)

GACATCGTCTGACCCAGTCTCCCGCTAGCCTGGCCGTGTCTGGGCCAGAGGGCCACAATC
 20 AGCTGCAGGGCCAGCGAGAGCGTCAGCATTCACGGCACCCACCTGATGCACTGGTACCAGCAG
 AAGCCCGGCCAGCCTCCAAAGCTCCTGATCTACGCCGCCAGCAACCTGGAAAGCGGAGTGCCC
 GCCAGGTTCAGCGGCAGCGGCTCCGAGACCGACTTCACCCCTAACATCCACCCCGTGGAGGAG
 25 GAGGACGCCGCCACCTACTTCTGCCAGCAGAGCATCGAGGACCCCTACACCTCGGCGGCCGC
 ACCAAGCTGGAGATCAAGCGTACGGTGGCCGCCAGCGTGGTGTCTGCTAACAACTTCTACCCCCGGAG
 GAGCAGCTGAAGAGCGGCACCGCCAGCGTGGTGTCTGCTAACAACTTCTACCCCCGGAG
 30 GCCAAGGTGCAGTGGAAAGGTGGACAATGCCCTGCAGAGCGGAAACAGCCAGGAGAGCGTGAC
 CGAGCAGGACAGCAAGGACTCCACCTACAGCCTGAGCAGCACCTGACCCTGAGCAAGGCCGA
 CTACGAGAAGCACAAGGTGTACGCCCTGTGAGGTGACCCACCAGGGCTGTCCAGCCCCGTGAC
 CAAGAGCTTCAACCGGGGCGAGTGC

35 SEQ ID 140 - S336105A07 murine variable heavy chain

EVKLLQSGGGLVQPGGSLKLSCAASGIDFSRYWMSVRRAPGKGLEWIGEINPDRSTINYAPSLKDK
 40 FIISRDNAKNTLYLQMSKVRSEDTALYYCAVFYYDYEGAMDYWGQGTSVTVSS
 SEQ ID 141 - S336105A07 murine variable heavy chain (DNA sequence)
 GAGGTGAAGCTTCTCCAGTCTGGAGGTGGCCTGGTGCAGCCTGGAGGATCCCTGAAACTCTCCT
 GTGCAGCCTCAGGAATCGATTTAGTAGATACTGGATGAGTTGGTTCGGCGGGCTCCAGGGAA
 45 AGGACTAGAATGGATTGGAGAAATTAAATCCAGATAGGAGTACAATCAACTATGCACCATCTCAA
 AGGATAAAATTATCATCTCCAGAGACAACGCCAAAAATACGCTGTACCTGCAAATGAGCAAAGTG
 AGATCTGAGGACACAGCCTTATTACTGTGCAGTTCTACTATGATTACGAGGGTGCTATGGA
 CTACTGGGTCAAGGAACCTCAGTCACCGTCTCCTCA

50 SEQ ID 142 - S336105A07 Chimeric heavy chain

55

EVKLLQSGGGLVQPGGSLKLSCAASGIDFSRYWMSVRRAPGKGLEWIGEINPDRSTINYAPSLKDK
 5 FIIISRDNAKNTLYLQMSKVRSEDTALYYCAVFYYDYE GAMDYWGQQGTSVTSSAKTTAPSVFPLAPS
 SKSTSGGTAALGCLVKDVFPEPVTVWSNNSGALTSGVHTFPAVLQSSGLYSLSSVTVPSQLGTQTYI
 CNVNHKPSNTKVDDKKVEPKSCDKHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDV
 SHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPI
 EKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLD
 10 SDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID 143 - S336105A07 Chimeric heavy chain (DNA sequence)

15 GAGGTGAAGCTTCTCCAGTCTGGAGGTGGCCTGGTGCAGCCTGGAGGATCCCTGAAACTCTCCT
 GTGCAGCCTCAGGAATCGATTTAGTAGATACTGGATGAGTTGGGTCGGCGGGCTCCAGGGAA
 AGGACTAGAACGGATTGGAGAAATTAAATCCAGATAGGAGTACAATCAACTATGCACCATCTCAA
 AGGATAAATTATCATCTCCAGAGACAACGCCAAAATACGCTGTACCTGCAAATGAGCAAAGTG
 20 AGATCTGAGGACACAGCCTTATTACTGTGCAGTTTCTACTATGATTACGAGGGTGCTATGGA
 CTACTGGGTCAAGGAACCTCAGTCACCGTCTCCTCAGCCAAAACAACAGCCCCCAGCGTGTTC
 CCCCTGGCCCCCAGCAGCAAGAGCACCAGCGGCGCACAGCCGCCCTGGCTGCCTGGTGA
 GGACTACTCCCCGAACCGGTGACCGTGTCTGGAACAGCGGAGCCCTGACCAGCGCGTGCA
 25 CACCTTCCCCGCCGTGCTGCAGAGCAGCGGCCTGTACAGCCTGAGCAGCGTGGTGACCGTGCC
 CAGCAGCAGCCTGGGACCCAGACCTACATCTGTAACGTGAACCACAAGCCCAGCAACACCAAG
 GTGGACAAGAAGGTGGAGGCCAAGAGCTGTGACAAGACCCACACCTGCCCCCTGCCCTGCC
 CCCGAGCTGCTGGGAGGCCAGCGTGTCTGTTCCCTGTTCCCCCAAGCCTAAGGACACCCCTGATG
 30 ATCAGCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCACGAGGACCCCTGAGGTG
 AAGTTCAACTGGTACGTGGACGGCGTGGAGGTGCACATGCCAAGACCAAGGCCAGGGAGGAG
 CAGTACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCACCAGGATTGGCTGAAC
 GGCAAGGAGTACAAGTGTAAAGGTCCAACAAGGCCCTGCCTGCCCTATCGAGAAAACCATCA
 35 GCAAGGCCAAGGCCAGCCCAGAGAGGCCAGGTGTACACCCCTGCCCTAGCAGAGATGAGC
 TGACCAAGAACCAAGGTGTCCCTGACCTGCCTGGTGAAGGGTTCTACCCAGCGACATGCCGT
 40 GGAGTGGGAGAGCAACGCCAGCCAGAACAACATAAGACCCACCCCCCTGTGCTGGACAG
 CGATGGCAGCTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAGGGCAA
 CGTGTTCAGCTGCTCCGTGATGCACGAGGCCCTGCACAATCACTACACCCAGAAGAGCCTGAGC
 CTGTCCCCGGCAAG
 45

SEQ ID 144 - S336105A07 murine variable light chain

DIVMTSQKFMSTSVGDRVSVTCKASQNVDTNVAWYQQKPGQSPKALIYSASYRFSGVPDRFTGSG
 50 SGTDFTLTISNVQSEDLAEYFCQQYNSFPFTFGSGTKLEIKR

SEQ ID 145 - S336105A07 murine variable light chain (DNA sequence)

5 GACATTGTGATGACCCAGTCTAAAAATTCATGTCCACATCAGTAGGAGACAGGGTCAGCGTCAC
 CTGCAAGGCCAGTCAGAATGTGGACTAAATGTAGCCTGGTATCAACAAAAACCAGGGCAATCTC
 CTAAGCACTGATTTACTCGGCATCCTACCGGTTAGTGGAGTCCCTGATCGCTTCACAGGCAGT
 GGATCTGGGACAGATTCACTCTACCACATCAGCAATGTGCAGTCTGAAGACTTGGCAGAGTATT
 CTGTCAGCAATATAACAGCTTCCATTACGTTCTGGCTCGGGACAAAGTTGGAAATAAACGTC

10 SEQ ID 146 - S336105A07 chimeric light chain

15 DIVMTQSQKFMSTSVGDRVSVTCKASQNVDTNVAWYQQKPGQSPKALIYSASYRFSGVPDRFTGSG
 SGTDFTLTISNVQSEDLAEYFCQQYNSFPFTFGSGTKLEIKRTVAAPSVFIPPSDEQLKSGTASVVCL
 LNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYLSSTTLSKADYEKHKVYACEVTHQGL
 SSPVTKSFNRGEC

20 SEQ ID 147 - S336105A07 chimeric light chain (DNA sequence)

25 GACATTGTGATGACCCAGTCTAAAAATTCATGTCCACATCAGTAGGAGACAGGGTCAGCGTCAC
 CTGCAAGGCCAGTCAGAATGTGGACTAAATGTAGCCTGGTATCAACAAAAACCAGGGCAATCTC
 CTAAGCACTGATTTACTCGGCATCCTACCGGTTAGTGGAGTCCCTGATCGCTTCACAGGCAGT
 GGATCTGGGACAGATTCACTCTACCACATCAGCAATGTGCAGTCTGAAGACTTGGCAGAGTATT
 CTGTCAGCAATATAACAGCTTCCATTACGTTCTGGCTCGGGACAAAGTTGGAAATAAACGTA
 CGGTGGCCGCCCGCAGCGTGTTCATCTTCCCCCCCAGCGATGAGCAGCTGAAGAGCGGCCACCG
 CCAGCGTGGTGTCTGCTGAACAACCTCTACCCCCGGGAGGCCAAGGTGCAGTGGAAAGGTGG
 30 ACAATGCCCTGCAGAGCGGCAACAGCCAGGAGAGCGTGACCGAGCAGGACAGCAAGGACTCCA
 CCTACAGCCTGAGCAGCACCCCTGACCCCTGAGCAAGGCCACTACGAGAAGCACAAGGTGTACG
 CCTGTGAGGTGACCCACCAGGGCCTGTCAGCCCCGTGACCAAGAGCTCAACCAGGGCGAGT
 GC

35 SEQ ID 148 - S335115G01 murine variable heavy chain

40 PVQLQQPGTELVRPGTSVKLSCKASGYTFTSYWMHWVKQRPGQGLEWIGVIDPSDSYTNYNQKF
 GKATLTVDTSSSTAYMQLSSLTSEDSAVYYCARQVFDPMDYWQGQGTSVTVSS

SEQID 149 - S335115G01 murine variable heavy chain (DNA sequence)

45 CCGGTCCAAGTGCAGCAGCCTGGACTGAGCTGGTGAGGCCTGGGACTTCAGTGAAGTTGTCC
 TGCAAGGCTTCTGGCTACACCTCACCAAGCTACTGGATGCACTGGTAAAGCAGAGGCCTGGAC
 AAGGCCTTGAGTGGATCGGAGTGATTGATCCTCTGATAGTTACTAACTACAATCAAAGTTCA
 AGGGCAAGGCCACATTGACTGTAGACACATCCTCCAGCACAGCCTACATGCAGCTCAGCAGCCT
 50 GACATCTGAGGAAGTCTGCGGTCTATTACTGTGCAAGACAGGTGTTGACTATCCTATGGACTACT
 GGGGTCAAGGAACCTCAGTCACCGTCTCCTCA

SEQ ID 150 - S335115G01 Chimeric heavy chain

55 PVQLQQPGTELVRPGTSVKLSCKASGYTFTSHWMHWVKQRPGQGLEWIGVIDPSDSYTNYNQKF
 GKATLTVDTSSSTAYMQLSSLTSEDSAVYYCARQVFDPMDYWQGQGTLTVSSASTKGPSVFPLAP
 SSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPALQSSGLYSLSSVTPSSSLGTQT

YICNVNHPNSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLPPPKDTLMISRTPEVTCVVVD
 VSHEDPEVKFNWYVDGVEVHNAKTPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAP
 5 IEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLD
 SDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSPGK

SEQ ID 151 - S335115G01 Chimeric heavy chain (DNA sequence)

10 CCGGTCCAAC TG CAG CAG CCT GGG ACT GAG CT GGT GAG GC CT GGG ACT TC AGT GA AG TT GT CC
 TG CA AGG CT T CT GG CT AC AC CCT ACC AG CC ACT GG AT GC ACT GGG TA AGC AG AGG CCT GG AC
 15 AAGG CCT T GAG TG AT CGG AGT GATT GAT CCT CT GAT AG TT ACT AA CT ACA AT CAA AG TT CA
 AGGG CA AGG CC AC ATT GACT GT TAG AC AC AT CCT CC AGC AC AG CCT AC AT GC AG CT CAG CAG CCT
 GAC AT CT GAG G ACT CT GCG GT CT ATT ACT GT GCA AG AC AGG T GT T GACT AT CCT AT GG ACT ACT
 GGG GT CA AGG AAC ACT AGT GACC GT GT CC AG CG CC AGC ACCA AGG G CCCC AG CGT GT T CCCCC
 TGG CCCCC AGC AG CA AG AG CACC AG CG G CGG CAC AG CC G CC T GGG CT GC CT GG T GA AGG AC
 20 TACT T CCCCC G AACC GGT GACC GT GT CC T GGA AC AG CG G AG CC CT GACC AG CG G CGT GC AC ACC
 TT CCCCC GCG GT GCT GCA GAG CAG CGG C CT GT AC AG C CT GAG C AG CGT GT T GACC GT GCC CAG C
 AGC AG C CT GGG CAC CC AG AC CT AC AT CT GT A AC GT GA ACC ACA AG CC CAG CA AC ACCA AG GT G
 25 GACA AGA AGG T GG AG CC CA AG AG C GT GT GACA AG ACC AC AC CT G CCCCC C T G C C T G C C C C
 GAG CT GCT GGG AGG CCCC AG CGT GT T C CT GT T CCCCC CCA AG C CT AAGG AC ACC CT GAT GAT C
 AGC AGA ACC CCCC AG GT GAC CT GT GT GG AT GT GAG CC AC GAG G ACC CT GAG GT GA AG
 TT CA ACT TGG TAC GT GG AC GG CGT GG AG GT GC AC AAT GCA AG ACC AAG CC CAG GG AGG AGC AG
 30 TACA AC AGC AC C T ACC GGG T GG GT CC GT GCT GAC CGT GCT G C ACC AGG AT T GG CT GA AC GGC
 AAGG AGT ACA AGT GT AAG GT T CCA ACA AGG CC CT G C C C T AT CG AG AAA ACC AT CAG CA
 AGG CC AAGG CC AG CC CAG AG AG G C C C CAG GT GT AC ACC CT G C C C C T AG C AG AG AT GAG CT GA
 CCA AGA ACC AG GT GT CC CT GAC CT G C CT GG T GA AGG G CT T CAC CC CAG CG AC AT G C C G T GG
 35 AGT GGG AG AG CA AC GG CC AG C C C GAG A AC A ACT ACA AG ACC ACC C C C T GT G CT GG AC AG CG
 AT GG CAG CT T CT C CT GT AC AG CA AG CT GAC CGT GG AC AAG AG C AG AT GG CAG C AGG G CA AC G
 TG TT CAG CT G C T C CGT GAT G CAC GAG G C C T G CAC A AT CACT AC ACC CAG A AG AG C CT GAG C CT
 GT C C C T GG C AAG
 40

SEQ ID 152 - S335115G01 murine variable light chain

DIVLTQSPASLA VSLGQRAT ISCRASE SVI HGTHLMHWY QQKPGQPPKLLI YAASNLES GPV PARF SG
 45 SGSETDFTLN IHPV EEDA AT YFCQQSIE DPWT FG GG TKLE IKR

SEQ ID 153 - S335115G01 murine variable light chain (DNA sequence)

50 GAC ATT GT GCT GAC CC AAT CT CC AG CT T TT GG CT GT GT CT TAG GG CAG AG GG CC ACC AT CT
 CCT GCA GAG CC AGT GAA AGT GT CAG T ATT CAT GG T ACT C AT TTA AT G C ACT GG T ACC A AC AG AAA
 CC AGG AC AG CC ACC CAA ACT CCT CAT CT AT GCT GCA CCT AGA AT CT GG AGT CC CT GCCA
 GG TT CAG TGG CAG TGG GT CT GAG AC AG ACT T CAC C CT CA AC AT CC AT CCT GT GG AGG AGG AGGA
 55 TG CT GCA AC CT ATT CT GT CAG CAA AGT ATT GAG G AT CC GT GG AC GT T CG GT GG AGG CAC CA AG
 CT GG AAT CAA AC GT

SEQ ID 154 - S335115G01 Chimeric light chain

DIVLTQSPASLAvgQRATISCRASESVSIHGTHLMHWYQQKPGQPPKLLIYAASNLESGVPARFSG
 SGSETDFTLNIHPVEEDAATYFCQQSIEDPWTFGGGTKEINRTVAAPSVIFPPSDEQLKSGTASVV
 CLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTTLSKADYEKHKVYACEVTHQ
 5 GLSSPVTKSFNRGEC

SEQ ID 155 - S335115G01 Chimeric light chain (DNA sequence)

GACATTGTGCTGACCCAATCTCCAGCTTGGCTGTCTCTAGGGCAGAGGCCACCACATCT
 CCTGCAGAGCCAGTGAAAGTGTCACTATTGACTCATGGTACCTATTAAATGCACGGTACCAACAGAAA
 CCAGGACAGCCACCCAAACTCCTCATCTATGCTGCATCCAACCTAGAACATCTGGAGTCCTGCCA
 15 GGTTCACTGGCAGTGGCTTGAGACAGACTTCACCCCTAACATCCATCCTGTGGAGGAGGAGGA
 TGCTGCAACCTATTCTGTCAAGAACATGGATCCGTGGACGTTGGTGGAGGAGGACCAAG
 CTGGAAATCAATCGTACGGTGGCCCGCCCCAGCGTGGTCTGCTGAACAACTTCTACCCCCGGGAGGCAAGG
 20 TGCAGTGGAAAGGTGGACAATGCCCTGCAGAGCGGAAACAGCCAGGAGAGCGTACCGAGCAG
 GACAGCAAGGACTCCACCTACAGCCTGAGCAGCACCCCTGAGCAAGGCCACTACGAG
 AAGCACAAGGTGTACGCCGTGAGGTGACCCACCAGGGCTGTCCAGCCCCGTGACCAAGAGC
 TTCAACCAGGGCGAGTGC

25 SEQ ID 156 - S335122F05 murine variable heavy chain

QVQLQQSGAELVRPGASVTLCKASGYTFTDYEMHWVKQTPVHGLEWIGAIDPETGGTAYNQKFKG
 30 KAILTADKSSSTAYMELRSLTSEDSAVYYCTRSIYDYYFDYWQGQTTLVSS

SEQ ID 157 - S335122F05 murine variable heavy chain (DNA sequence)

CAGGTTCAACTGCAGCAGTCTGGGCTGAGCTGGTAGGCCTGGGCTTCAGTGACGCTGTCC
 35 TGCAAGGCTTCGGCTACACATTACTGACTATGAAATGCACTGGGTGAAGCAGACACCTGTGC
 ATGGCCTGGAATGGATTGGAGCTATTGATCCTGAAACTGGTGGTACTGCCTACAATCAGAAAGTTC
 AAGGGCAAGGCCATACTGACTGCAGACAAATCCTCCAGCACGCCTACATGGAGCTCCGCAGCC
 40 TGACATCTGAGGACTCTGCCGTCTATTACTGTACAAGATCGATTATGATTACTACTTGACTACT
 GGGGCCAAGGCACCACTCTCACAGTCTCCTCA

SEQ ID 158 - S335122F05 Chimeric heavy chain

45 QVQLQQSGAELVRPGASVTLCKASGYTFTDYEMHWVKQTPVHGLEWIGAIDPETGGTAYNQKFKG
 KAILTADKSSSTAYMELRSLTSEDSAVYYCTRSIYDYYFDYWQGQTTLVSSAKTPPSVFPLAPSSK
 STSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPVLQSSGLYSLSSVTVPSSSLGTQTYIC
 50 NVNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVLFPPKPKDTLMISRTPEVTCVVVDVS
 HEDPEVKFNWYVDGVEVHNNAKTPREEQYNSTYRVSVLTVLHQDWLNGKEYKCKVSNKALPAPIE
 KTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLD
 DGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

55 SEQ ID 159 - S335122F05 Chimeric heavy chain (DNA sequence)

CAGGTTCAACTGCAGCAGTCTGGGCTGAGCTGGTGAGGCCTGGGCTTCAGTGACGCTGTCC
 TGCAAGGCTTCGGCTACACATTACTGACTATGAAATGCACTGGTGAAGCAGACACCTGTGC
 ATGGCCTGGAATGGATTGGAGCTATTGATCCTGAAACTGGTGGTACTGCCTACAATCAGAAGTTC
 5 AAGGGCAAGGCCATACTGACTGCAGACAAATCCTCCAGCACGCCTACATGGAGCTCCGAGCC
 TGACATCTGAGGACTCTGCCGTCTATTACTGTACAAGATCGATTATGATTACTACTTGACTACT
 GGGGCCAAGGCACCCTCACAGTCTCCTCAGCCAAAACGACACCCCCCAGCGTGTCCCCCT
 10 GGCCCCCAGCAGCAAGAGCACCAGCGGCGGCACAGCCGCCCTGGCTGCCGTGAAGGACT
 ACTTCCCCGAACCGGTGACCGTGTCCCTGGAACAGCGGAGCCCTGACCAGCGGTGACACCT
 TCCCCGCCGTGCTGCAGAGCAGCAGCCTGTACAGCCTGAGCAGCGTGGTGAACCGTGCCAGCA
 GCAGCCTGGCACCCAGACCTACATGTAACGTGAACCACAAGCCCAGCAACACCAAGGTGG
 15 ACAAGAAGGTGGAGGCCAAGAGCTGTGACAAGACCCACACCTGCCCTGCCCTGCCAGCA
 AGCTGCTGGAGGCCAGCGTGTCCCTGTTCCCCCAAGCCTAAGGACACCCGTATGATCA
 GCAGAACCCCCGAGGTGACCTGTGTGGATGTGAGCCACGAGGACCCGTGAGGTGAAGT
 TCAACTGGTACGTGGACGGCGTGGAGGTGCACAATGCCAAGACCAAGCCCAGGGAGGAGCAGT
 20
 ACAACAGCACCTACCGGGTGGTCCGTGCTGACCGTGCTGCACCAGGATTGGCTGAACGGCA
 AGGAGTACAAGTGTAAAGGTGTCACAACAAGGCCCTGCCTGCCCTATCGAGAAAACCATCAGCAA
 25 GCCAAGGGCCAGCCCAGAGAGCCCCAGGTGTACACCCCTGCCCTAGCAGAGATGAGCTGAC
 CAAGAACCGAGGTGTCCTGACCTGCCTGGTGAAGGGCTCTACCCCGAGCAGCATGCCGTGGA
 GTGGGAGAGCAACGCCAGCCGAGAACAACTACAAGACCACCCCCCTGTGCTGGACAGCGA
 TGGCAGCTTCTCCTGTACAGCAAGCTGACCGTGGACAAGAGCAGATGGCAGCAGGGCACGT
 30 GTTCAGCTGCTCCGTATGCACGAGGCCCTGCACAATCACTACACCCAGAACAGGCTGAGCCTG
 TCCCCTGGCAAG

SEQ ID 160 - S335122F05 murine variable light chain

35 DIVLTQSPASLA VSLGQRATISCRASESVSIHGTHLMHWYQQKPGQPPKLLIYAASNLESGVPARFSG
 GGSETDFTLNIHPVEEEDGATYFCQQSIEYPRTFGGGTKLEINR
 SEQ ID 161 – S335122F05 murine variable light chain (DNA sequence)
 40 GACATTGTGCTGACCCAATCTCCAGCTTGGCTGTCTAGGGCAGAGGCCACCATCT
 CCTGCAGAGCCAGTGAAAGTGTCACTATTGTTACTCATGGTACCTATTAAATGCACTGGTACCAACAGAAA
 CCAGGACAGCCACCCAAACTCCTCATCTATGCTGCATCCAACCTAGAACATCTGGAGTCCCTGCCA
 GGTTCACTGGCGGTGGTCTGAGACAGACTTCACCCTAACATCCATCCTGTGGAGGAGGAGG
 45 ATGGTGCAACCTATTCTGTCAAGCAAAGTATTGAGTATCCTCGGACGTTGGTGGAGGCACCAA
 GCTGGAAATCAATCGT

SEQ ID 162 - S335122F05 Chimeric light chain

50 DIVLTQSPASLA VSLGQRATISCRASESVSIHGTHLMHWYQQKPGQPPKLLIYAASNLESGVPARFSG
 GGSETDFTLNIHPVEEEDGATYFCQQSIEYPRTFGGGTKLEINRTVAAPSVIFPPSDEQLKSGTASVV
 CLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTTLSKADYEKHKVYACEVTHQ
 55 GLSSPVTKSFNRGEC

SEQ ID 163 - S335122F05 Chimeric light chain (DNA sequence)

GACATTGTGCTGACCCAAATCTCCAGCTTGGCTGTCTCTAGGGCAGAGGGGCCACCACATCT
 CCTGCAGAGCCAGTGAAAGTGTCACTATTGACTCATTTAACATGCACGGTACCAACAGAAA
 CCAGGACAGCCACCCAAACTCCTCATCTATGCTGCATCCAACCTAGAACATCTGGAGTCCCTGCCA
 5 GGTCAGTGGCGGTGGGCTTGAGACAGACTCACCCCTAACATCCATCCTGTGGAGGAGGAGG
 ATGGTGCAACCTATTCTGTCAAGCAAAGTATTGAGTATCCTCGACGTTGGAGGACCAA
 GCTGGAAATCAATCGTACGGTGGCCGCCCCAGCGTGTTCATCTTCCCCCCCAGCGATGAGCA
 10 GCTGAAGAGCGGCACCGCCAGCGTGGTGTCTGCTGAACAACCTCTACCCCCGGAGGCCAA
 GGTGCAGTGGAAAGGTGGACAATGCCCTGCAGAGCGAACAGCCAGGAGAGCGTGACCGAGC
 AGGACAGCAAGGACTCCACCTACAGCCTGAGCAGCACCCGTGACCCGTGAGCAAGGCCGACTACG
 AGAAGCACAAGGTGTACGCCTGTGAGGTGACCCACCAGGGCCTGTCCAGCCCCGTGACCAAGA
 15 GCTTCAACCAGGGCGAGTGC

SEQ.I.D.NO: 164 - S332121F02 CDRH1
 DYYNM
 SEQ.I.D.NO: 165 - S332121F02 CDRH2
 20 VINPYNGGTDYNQKFG
 SEQ.I.D.NO: 166 - S332121F02 CDRH3
 SVYDYPFDY
 SEQ.I.D.NO: 167 - S332121F02 CDRL1
 RASESVSIHGTHLMH
 25 SEQ.I.D.NO: 168 - S332121F02 CDRL2
 AASNLES
 SEQ.I.D.NO: 169 - S332121F02 CDRL3
 QQSIEDPRT
 SEQ.I.D.NO: 170 - S322110D07 CDRH1
 30 DYSID
 SEQ.I.D.NO: 171 - S322110D07 CDRH2
 DIDPNYGDPIYNHKFKG
 SEQ.I.D.NO: 172 - S322110D07 CDRH3
 RATGTDWFAF
 35 SEQ.I.D.NO: 173 - S322110D07CDRL1
 RASENIYNNLA
 SEQ.I.D.NO: 174 - S322110D07 CDRL2
 AATILAD
 SEQ.I.D.NO: 175 - S322110D07 CDRL3
 40 QHFWGTPLT
 SEQ.I.D.NO: 176 - S332126E04CDRH1
 NYWMH
 SEQ.I.D.NO: 177 - S332126E04 CDRH2
 IIHPNSGSTNYNEKFKS
 45 SEQ.I.D.NO: 178 - S332126E04 CDRH3
 GIYDYPFAY
 SEQ.I.D.NO: 179 - S332126E04 CDRL1
 RASESVSIHGTHLMH
 SEQ.I.D.NO: 180 - S332126E04 CDRL2
 50 AASNLES
 SEQ.I.D.NO: 181 - S332126E04 CDRL3
 QQSIEDPYT
 SEQ.I.D.NO: 182 - S336105A07 CDRH1
 RYWMS
 55 SEQ.I.D.NO: 183 - S336105A07 CDRH2
 EINPDRSTINYAPSLKD
 SEQ.I.D.NO: 184 - S336105A07 CDRH3
 FYYDYEGAMDY

SEQ.I.D.NO: 185 - S336105A07 CDRL1
 KASQNVDTNVA
 SEQ.I.D.NO: 186 - S336105A07 CDRL2
 SASYRFS
 5 SEQ.I.D.NO: 187 - S336105A07 CDRL3
 QQYNSFPFT
 SEQ.I.D.NO: 188 - S335115G01 CDRH1
 SYWMH
 SEQ.I.D.NO: 189 - S335115G01 CDRH2
 10 VIDPSDSYTNYNQKFKG
 SEQ.I.D.NO: 190 - S335115G01 CDRH3
 QVFDYPMDY
 SEQ.I.D.NO: 191 - S335115G01 CDRL1
 RASESVSIHGTHLMH
 15 SEQ.I.D.NO: 192 - S335115G01 CDRL2
 AASNLES
 SEQ.I.D.NO: 193 - S335115G01 CDRL3
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 SEQ.I.D.NO: 194 - S335122F05 CDRH1
 20 DYEMH
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 25 SEQ.I.D.NO: 197 - S335122F05 CDRL1
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 30 QQSIEYPRT

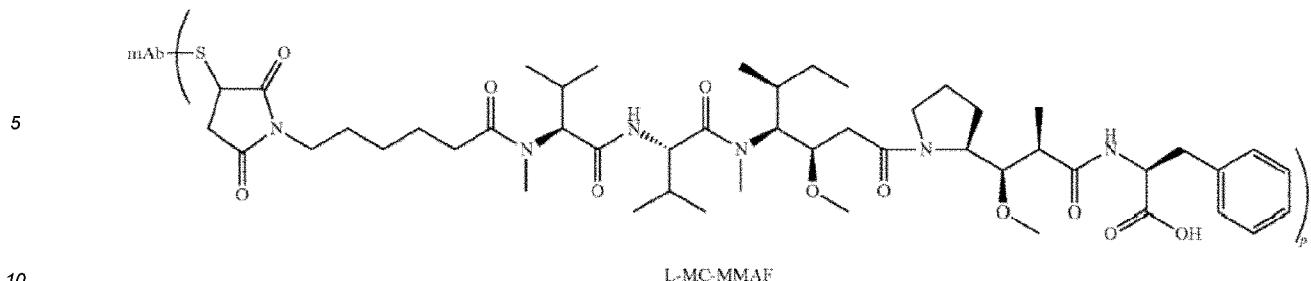
[0314] Preferred embodiments are set out in the following numbered paragraphs:

1. An antigen binding protein which specifically binds to BCMA and which inhibits the binding of BAFF and/or APRIL to the BCMA receptor wherein the antigen binding protein comprises one or more of:
 - CDRH1 of SEQ. ID. NO: 1
 - CDRH2 of SEQ. ID. NO: 2
 - CDRH3 of SEQ ID NO.3 or a variant of SEQ ID NO. 3
- 35 40 CORL1 of SEQ. ID. NO: 4
 CDRL2 of SEQ. ID. NO: 5 and/or
 CDRL3 of SEQ. ID. NO: 6.
2. An antigen binding protein according to paragraph 1 wherein the antigen binding protein comprises: CDRH1 of SEQ. ID. NO: 1
 - CDRH2 of SEQ. ID. NO: 2
 - CDRH3 of SEQ ID NO.3 or a variant of SEQ ID NO. 3
 - CORL1 of SEQ. ID. NO: 4
- 45 50 CDRL2 of SEQ. ID. NO: 5 and
 CDRL3 of SEQ. ID. NO: 6.
3. An antigen binding protein according to paragraph 1 or 2 wherein the CDRH3 variant of SEQ ID NO:3 comprises the mutation N99D.
- 55 55 4. An antigen binding protein according to any preceding paragraph wherein the antigen binding protein does not bind to TacI.

5. The antigen binding protein according to any preceding paragraph wherein the antigen binding protein additionally binds non-human primate BCMA.
- 5 6. The antigen binding protein according to any one of the preceding paragraphs and wherein the antigen binding protein binds BCMA with an affinity of less than 150pM.
- 10 7. An antigen binding protein according to any preceding paragraph which comprises a heavy chain variable region of SEQ. ID. NO:23 and a light chain variable region of SEQ. ID. NO:31.
- 15 8. An antigen binding protein according to any preceding paragraph which comprises a heavy chain of SEQ. ID. NO:55 and a light chain of SEQ. ID. NO:63.
- 15 9. An antigen binding protein according to any preceding paragraph wherein the antigen binding protein is a humanised monoclonal antibody.
- 20 10. An antigen binding protein according to paragraph 7 wherein the antibody is an IgG1 isotype.
- 20 11. An immunoconjugate comprising the antigen binding protein of any one of paragraphs 1 to 10 and a cytotoxic agent.
- 25 12. The immunoconjugate of paragraph 11 wherein the antigen binding protein is linked to the cytotoxic agent via a linker.
- 25 13. The immunoconjugate of paragraph 11 or 12 wherein the cytotoxic agent is an auristatin or a dolostatin.
- 30 14. The immunoconjugate of any one of paragraphs 11 to 13 wherein the cytotoxic agent is selected from MMAE and MMAF.
- 30 15. The immunoconjugate of any one of paragraphs 11 to 14 wherein the cytotoxic agent is covalently bound to said antigen binding protein.
- 35 16. The immunoconjugate of any one of paragraphs 11 to 15 wherein said linker is a cleavable linker.
- 35 17. The immunoconjugate of any one of paragraphs 11 to 15 wherein said linker is a non-cleavable linker.
- 40 18. The immunoconjugate of any one of paragraphs 11 to 17 wherein the linker is selected from 6-maleimidocaproyl (MC), maleimidopropanoyl (MP), valine-citrulline (val-cit), alanine-phenylalanine (ala-phe), p-aminobenzoyloxycarbonyl (PAB), N-Succinimidyl 4-(2-pyridylthio)pentanoate (SPP), N-succinimidyl 4-(N-maleimidomethyl)cyclohexane-1 carboxylate (SMCC), and N-Succinimidyl (4-iodo-acetyl) aminobenzoate (SIAB).
- 45 19. An antigen binding protein or immunoconjugate according to any one preceding paragraph for use in treating a human patient afflicted with an inflammatory disorder or disease or a B cell lymphoma such as Multiple Myeloma (MM) or Chronic Lymphocytic Leukaemia (CLL).
- 45 20. A pharmaceutical composition comprising an antigen binding protein or immunoconjugate according to any preceding paragraph and a pharmaceutically acceptable carrier.
- 50 21. Use of the composition of paragraph 20 in treating a human patient afflicted with an inflammatory disorder or disease.
- 50 22. Use of the composition of paragraph 20 in treating a human patient afflicted with a B cell lymphoma such as Multiple myeloma (MM) or Chronic Lymphocytic Leukaemia (CLL).

55 **Claims**

1. An immunoconjugate having the structure:



wherein mAb is an anti-B cell maturation antigen (CD269) antibody comprising a heavy chain variable region sequence of SEQ ID NO: 23 and a light chain variable region sequence of SEQ ID NO: 31; and p is 0, 2, 4, 6, or 8.

- 15
2. The immunoconjugate according to claim 1, wherein the antibody comprises a heavy chain sequence of SEQ ID NO: 55 and a light chain sequence of SEQ ID NO: 63.
 3. The immunoconjugate according to any preceding claim, wherein the antibody is a monoclonal antibody.

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 4. The immunoconjugate according to any preceding claim, wherein the antibody has enhanced binding to Fc_YRIIIA or has enhanced Fc_YRIIIA mediated effector function.
 5. The immunoconjugate according to any preceding claim, wherein the antibody is defucosylated.

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 6. The immunoconjugate according to any preceding claim, wherein the antibody is an IgG1 isotype.
 7. The immunoconjugate according to any preceding claim, wherein p is 4.

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 8. A pharmaceutical composition comprising the immunoconjugate according to any preceding claim and a pharmaceutically acceptable carrier.
 9. An immunoconjugate according to any of claims 1-7 or a pharmaceutical composition according to claim 8 for use in treating a human patient afflicted with a B-cell disease or disorder selected from Multiple Myeloma (MM), chronic lymphocytic leukemia (CLL), Non-secretory multiple myeloma, Smoldering multiple myeloma, Monoclonal gammopathy of undetermined significance (MGUS), Solitary plasmacytoma (Bone, Extramedullary), Lymphoplasmacytic lymphoma (LPL), Waldenstrom's Macroglobulinemia, Plasma cell leukemia, Primary Amyloidosis (AL), Heavy chain disease, Systemic lupus erythematosus (SLE), POEMS syndrome / osteosclerotic myeloma, Type I and II cryoglobulinemia, Light chain deposition disease, Goodpasture's syndrome, Idiopathic thrombocytopenic purpura (ITP), Acute glomerulonephritis, Pemphigus and Pemphigoid disorders, and Epidermolysis bullosa acquisita; or any Non-Hodgkin's Lymphoma B-cell leukemia or Hodgkin's lymphoma (HL).

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 10. The immunoconjugate or pharmaceutical composition for use according to claim 9, wherein the B-cell disease is Multiple Myeloma (MM).

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 11. An anti-B cell maturation antigen (CD269) antibody for use in treating a human patient afflicted with rheumatoid arthritis, Type 1 diabetes mellitus, multiple sclerosis or psoriasis, wherein the antibody comprises a heavy chain sequence of SEQ ID NO: 55 and a light chain sequence of SEQ ID NO: 63.

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 12. The anti-B cell maturation antigen (CD269) antibody according to claim 11, wherein the antibody comprises a heavy chain sequence of SEQ ID NO: 55 and a light chain sequence of SEQ ID NO: 63.
 13. The anti-B cell maturation antigen (CD269) antibody according to any one of claims 11-12, wherein the antibody is a monoclonal antibody.

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 14. The anti-B cell maturation antigen (CD269) antibody according to any one of claims 11-13, wherein the antibody has enhanced binding to Fc_YRIIIA or has enhanced Fc_YRIIIA mediated effector function.

- 15.** The anti-B cell maturation antigen (CD269) antibody according to any one of claims 11-14, wherein the antibody is defucosylated.

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Figure 1:

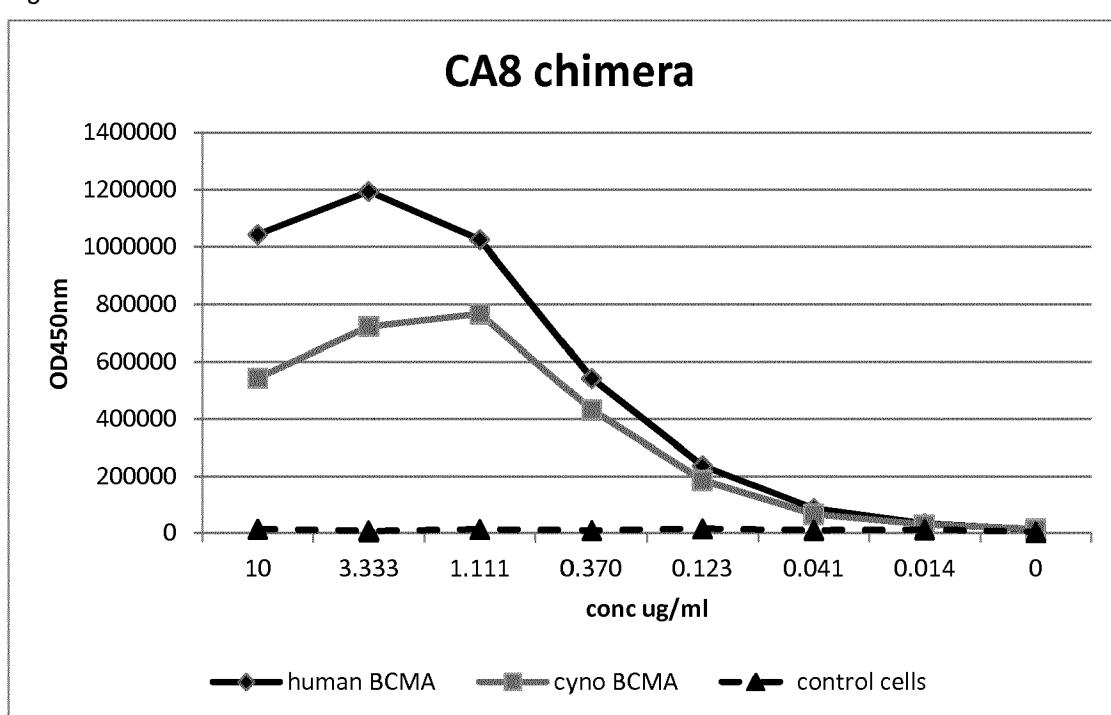


Figure 2:

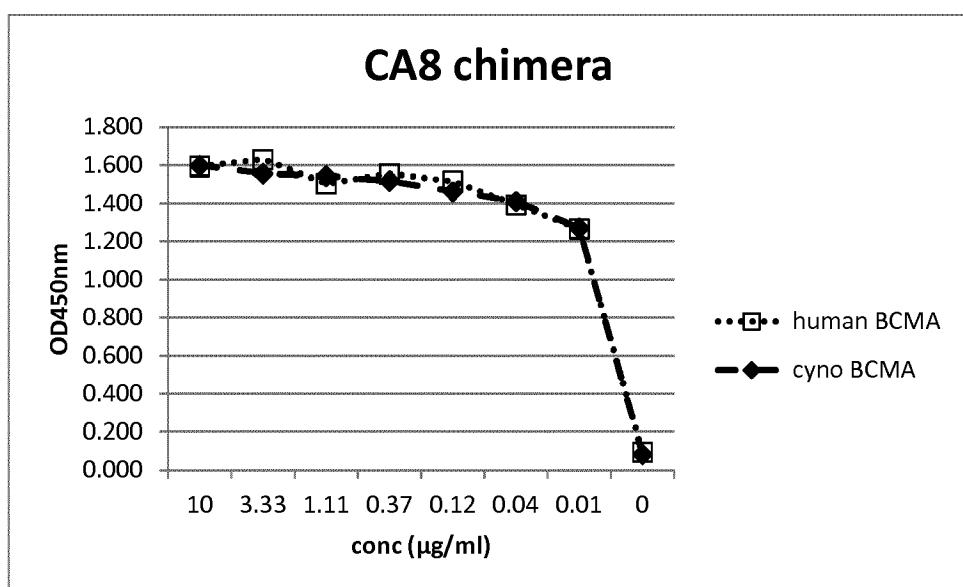


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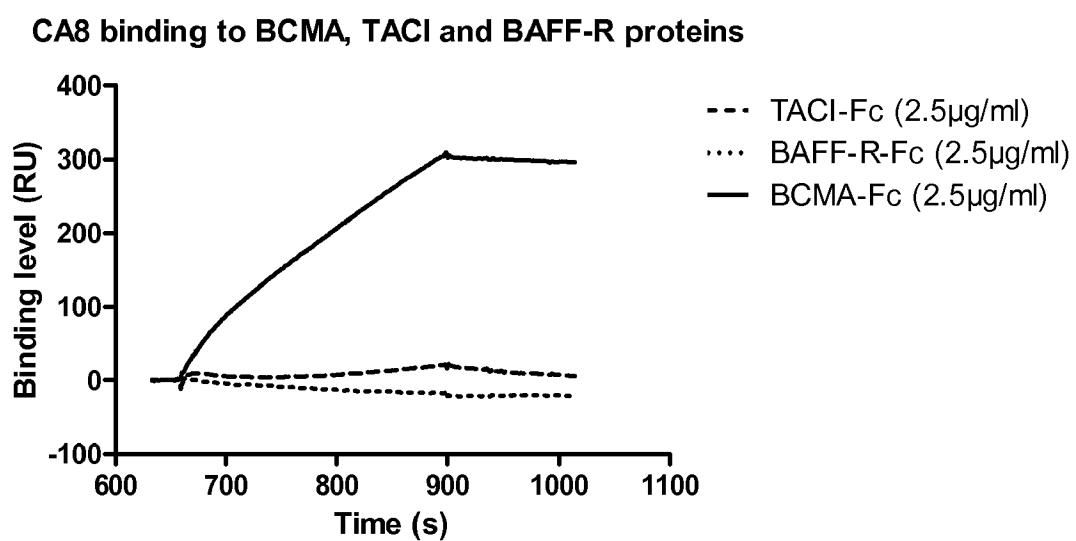


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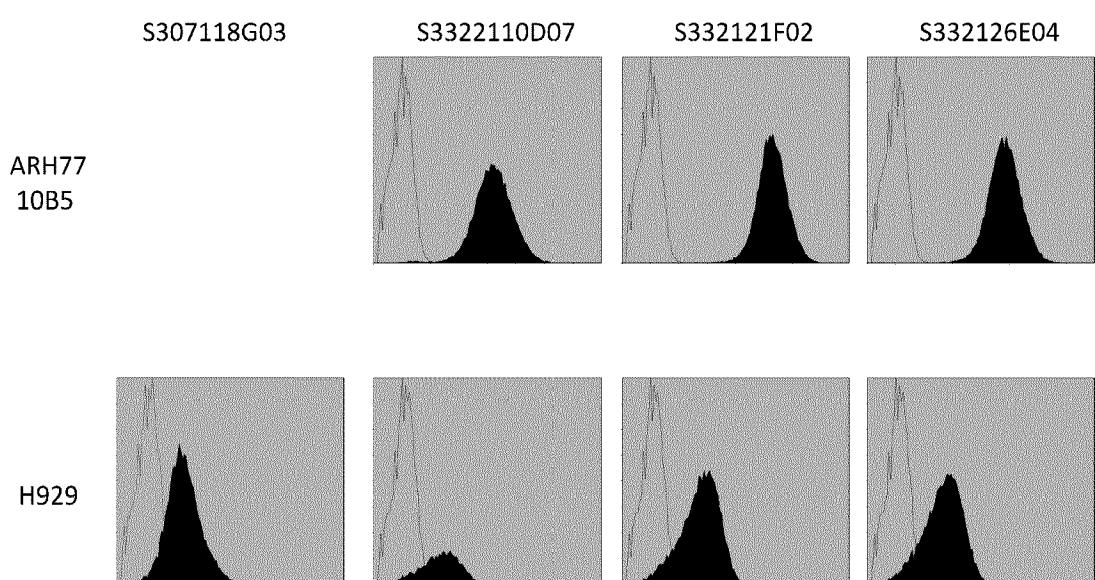


Figure 5.

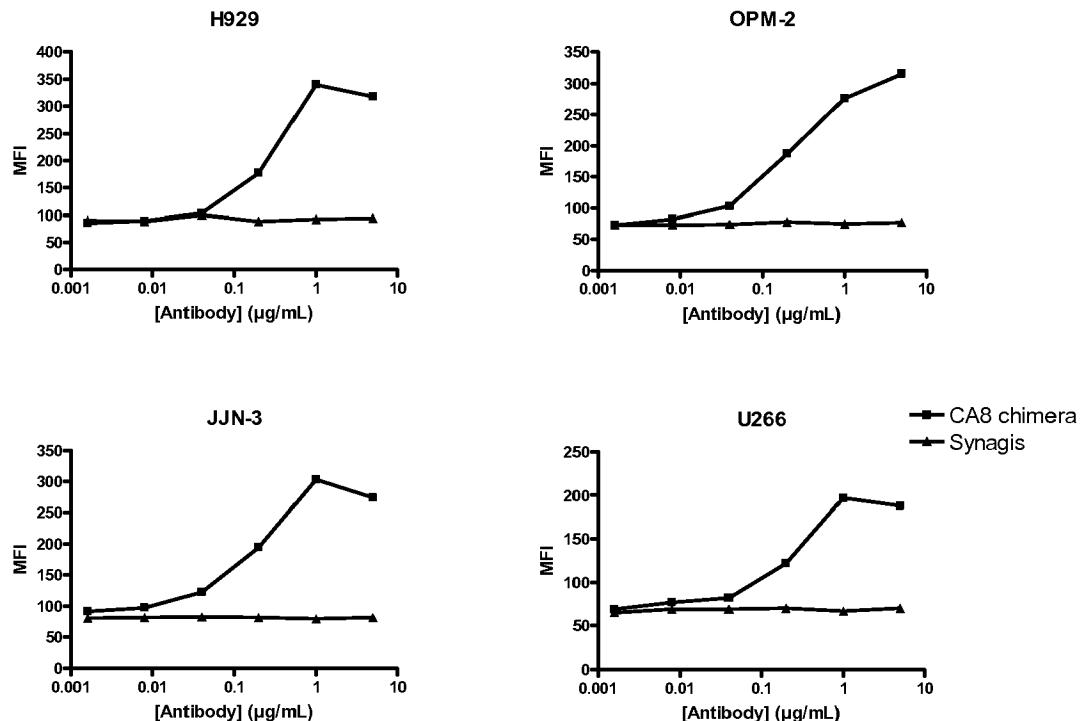
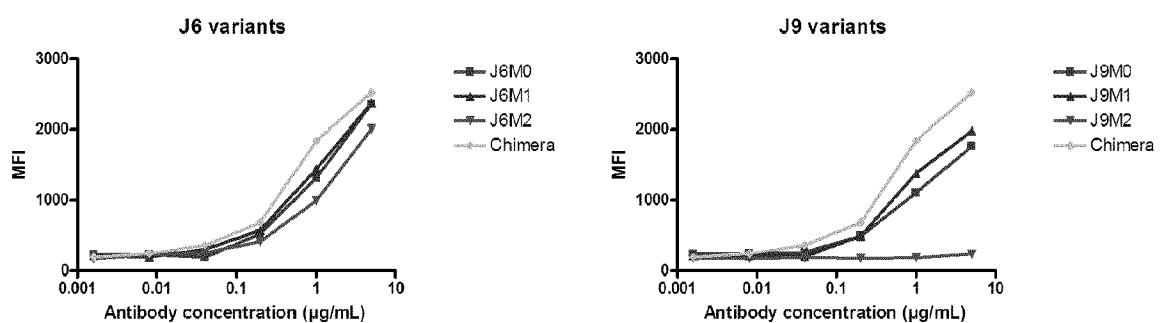


Figure 6.

A- Binding to ARH-77 10B5 cells



B - Binding to H929 cells

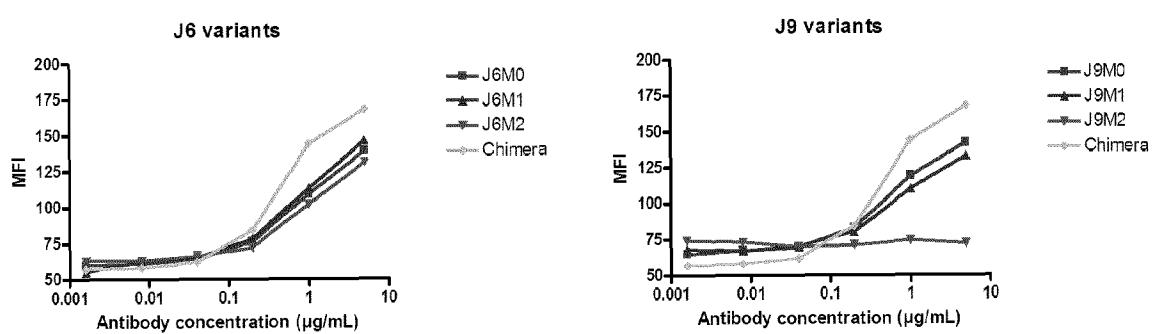
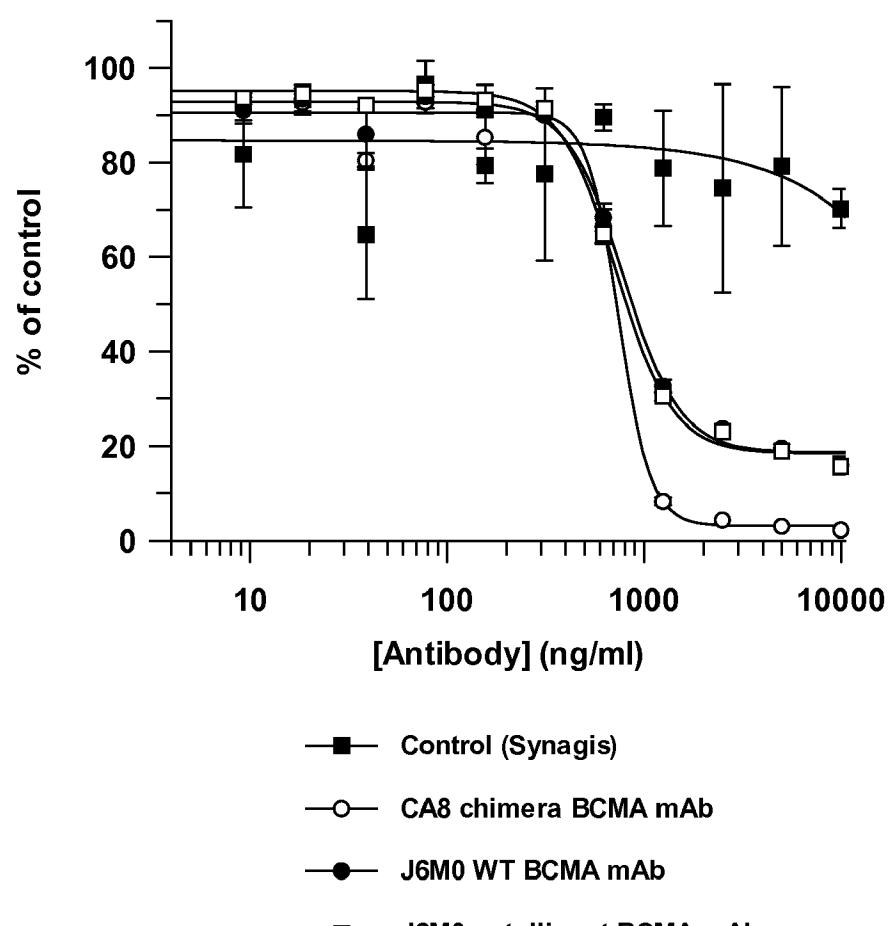
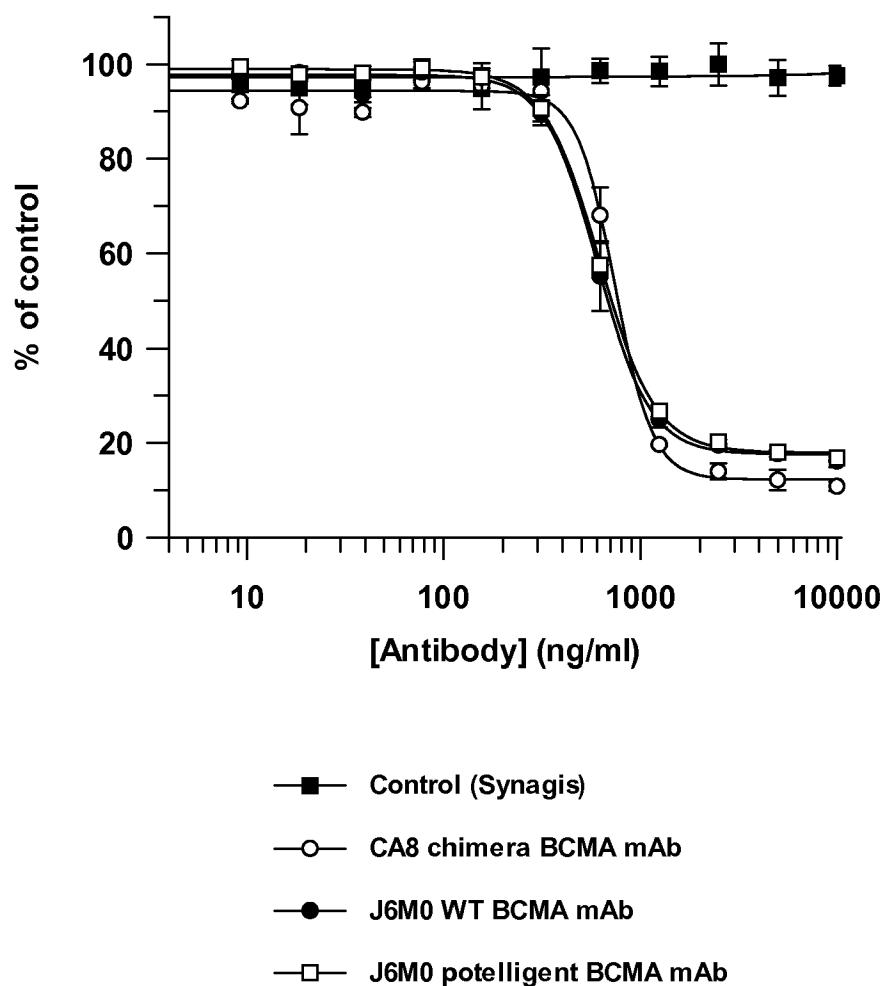


Figure 7

(A)



(B)



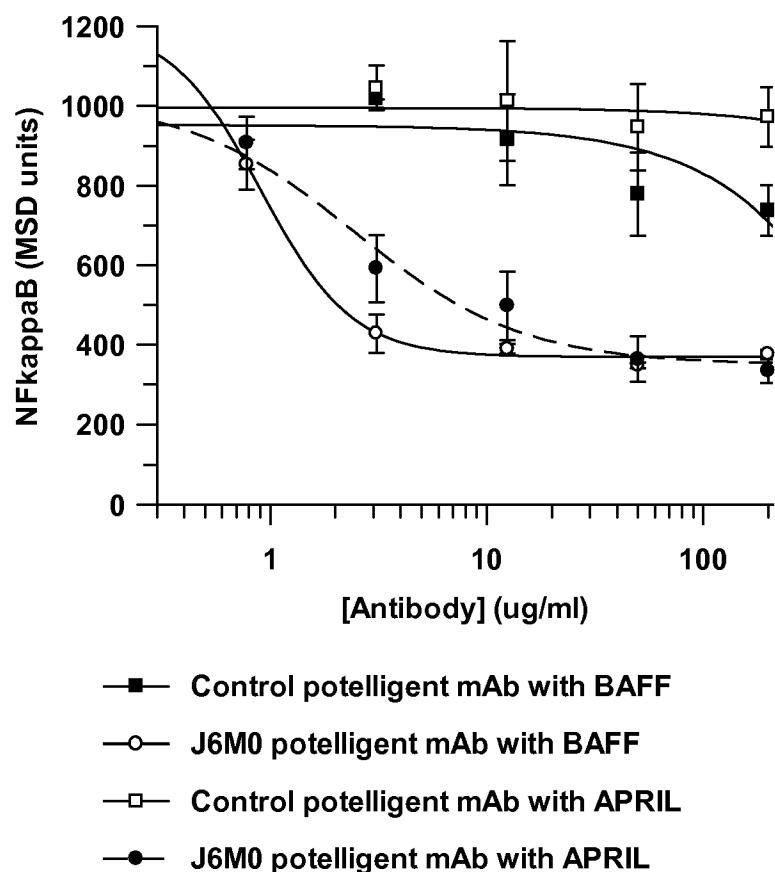
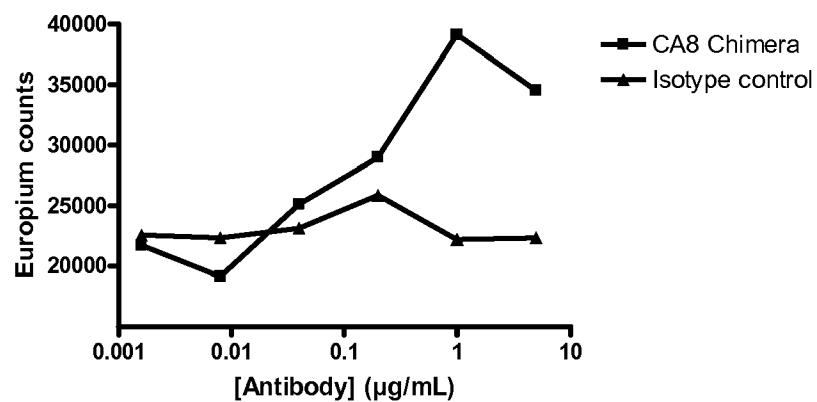


Figure 8:.

(A)



(B)

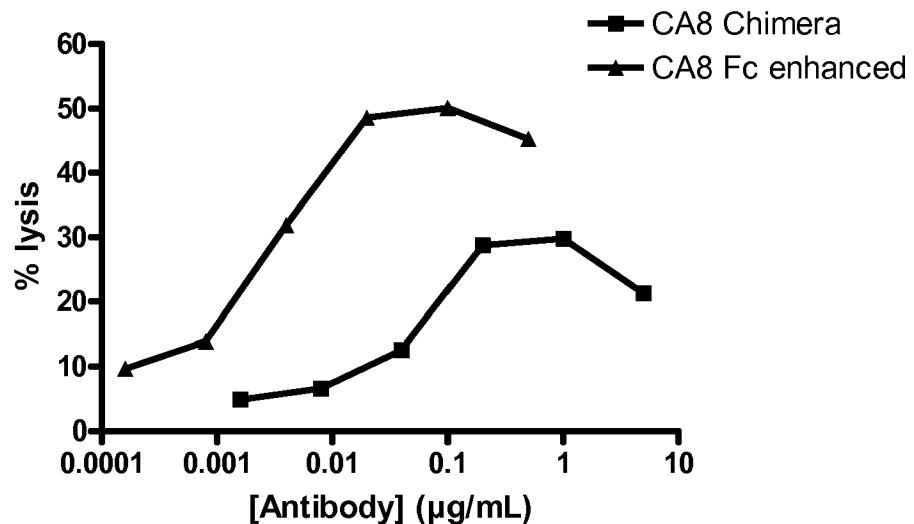


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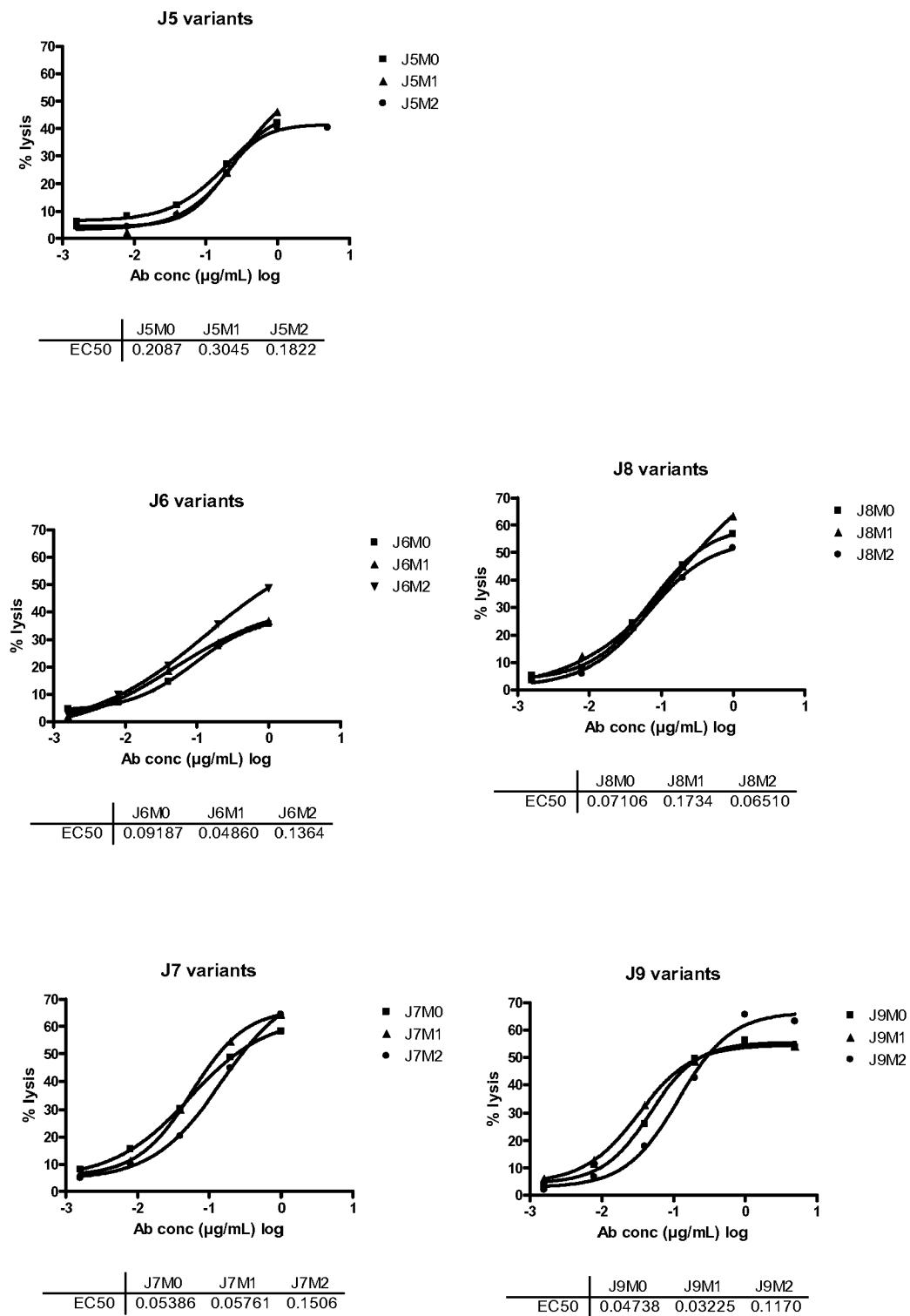
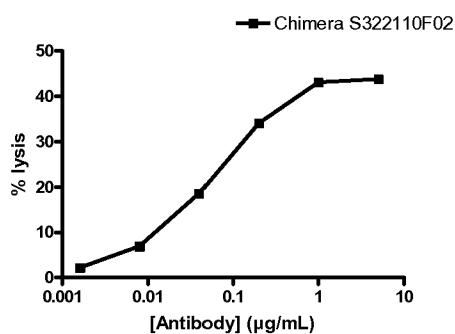
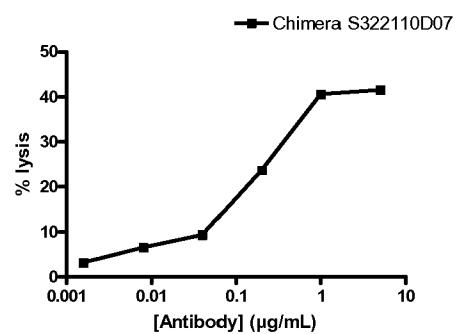


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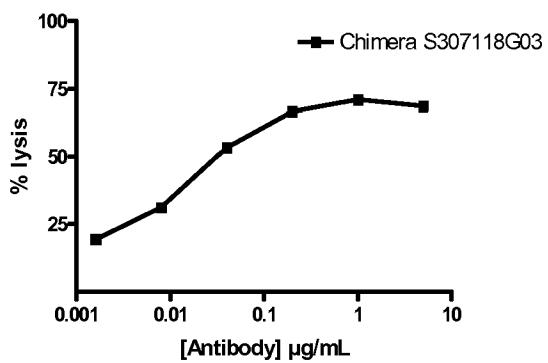
A



B



C



D

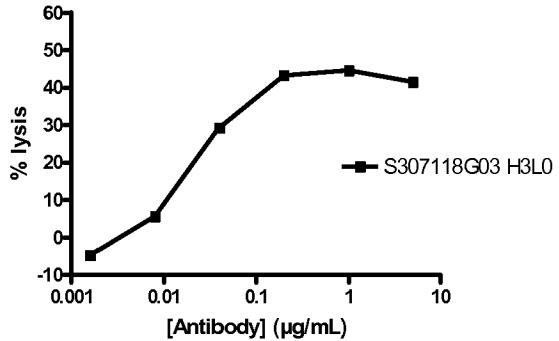


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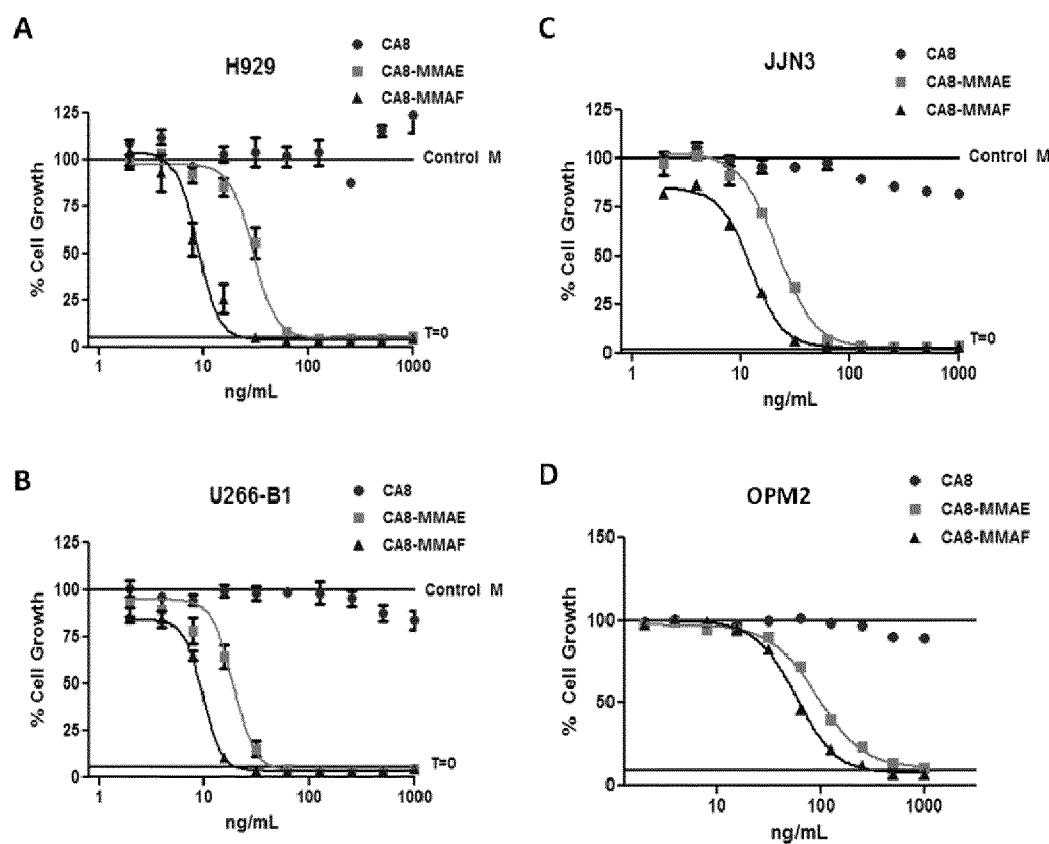


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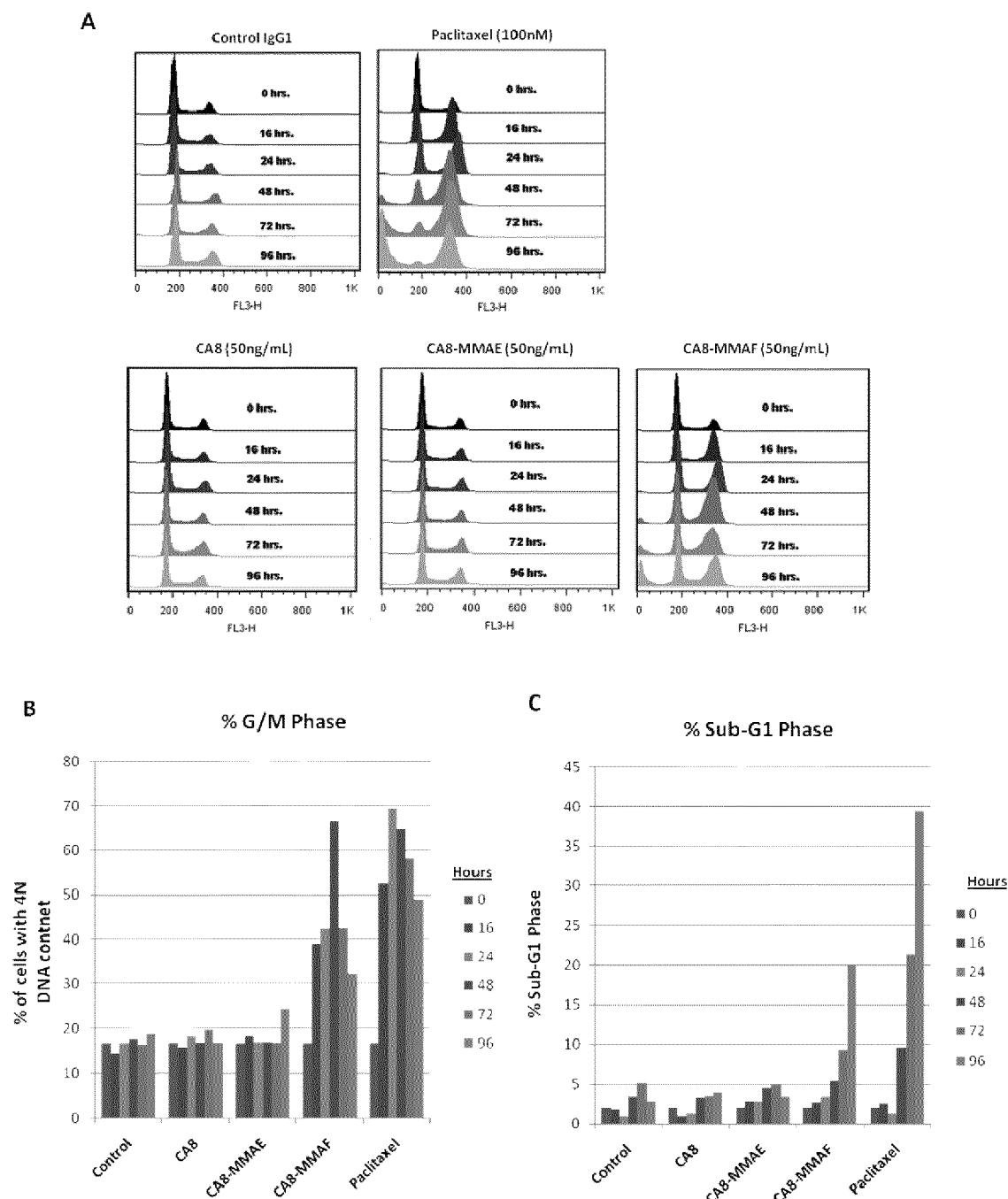


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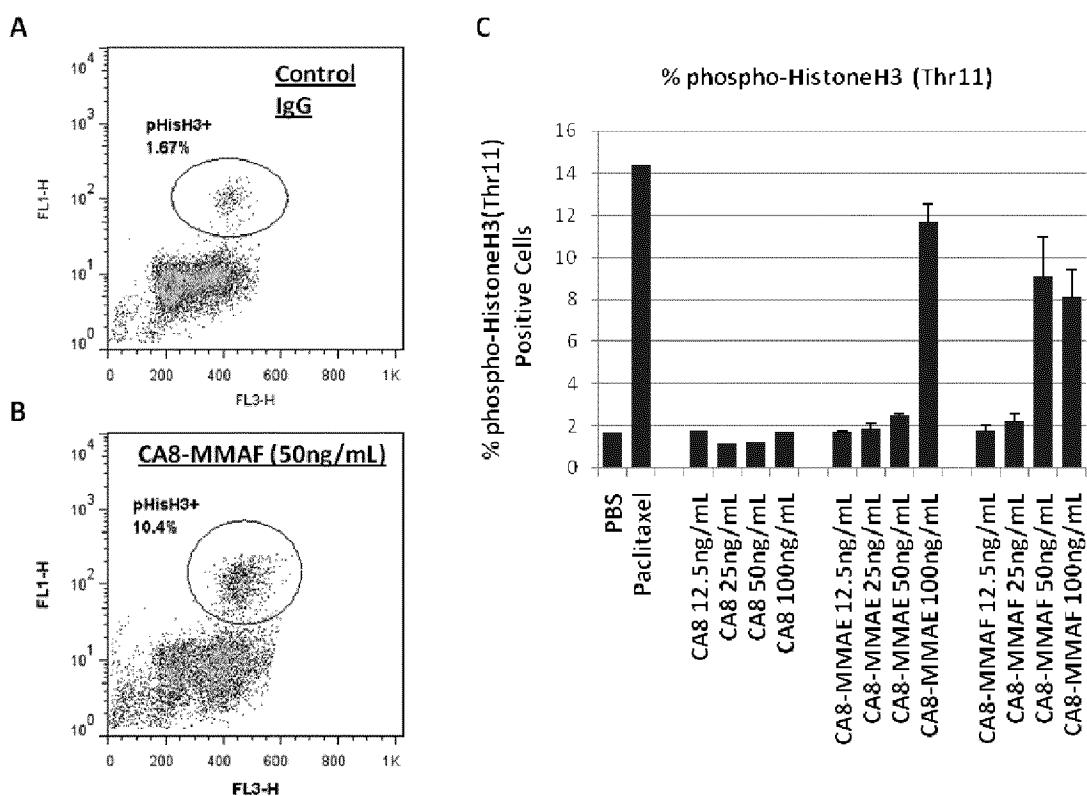


Figure 14:

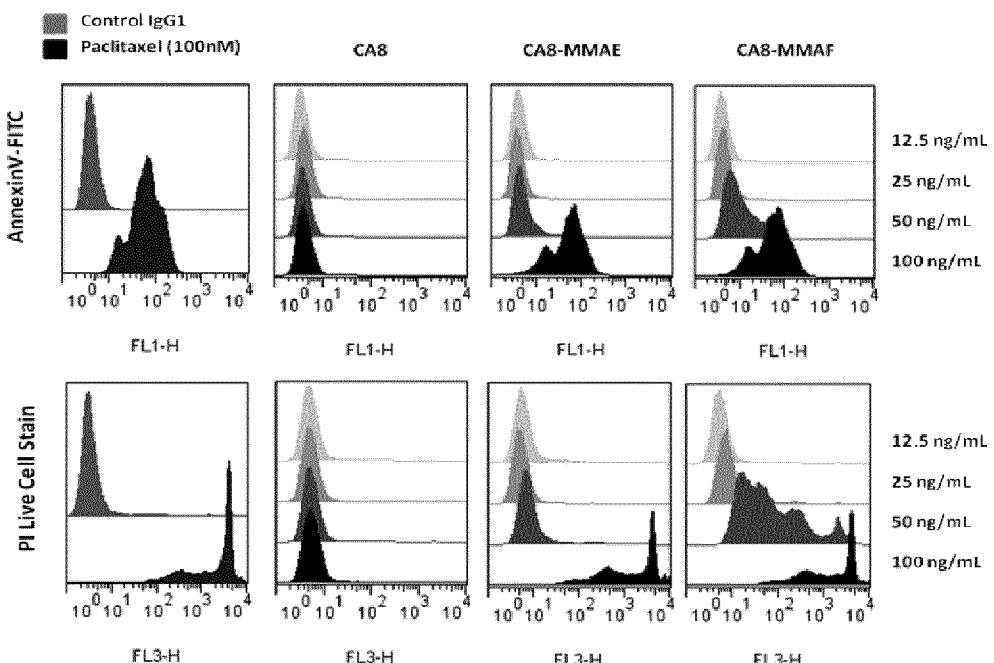
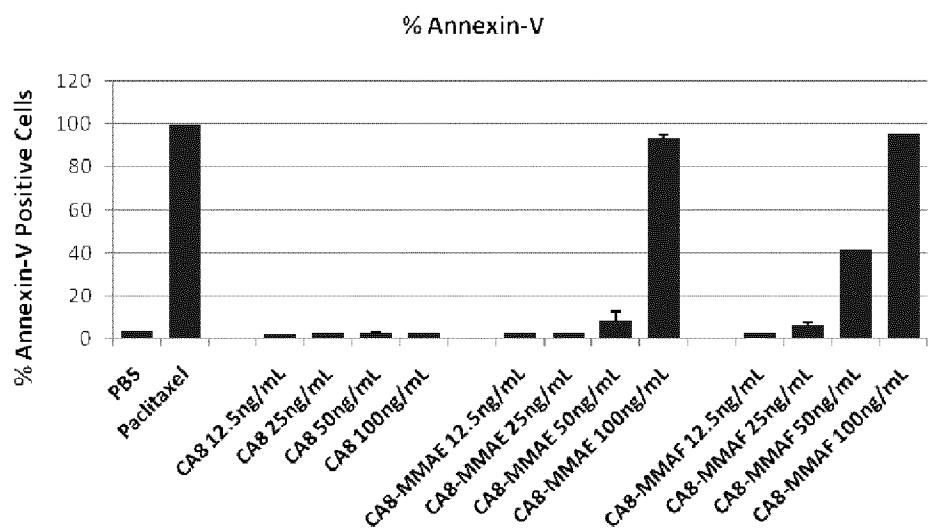
A**B**

Figure 15:

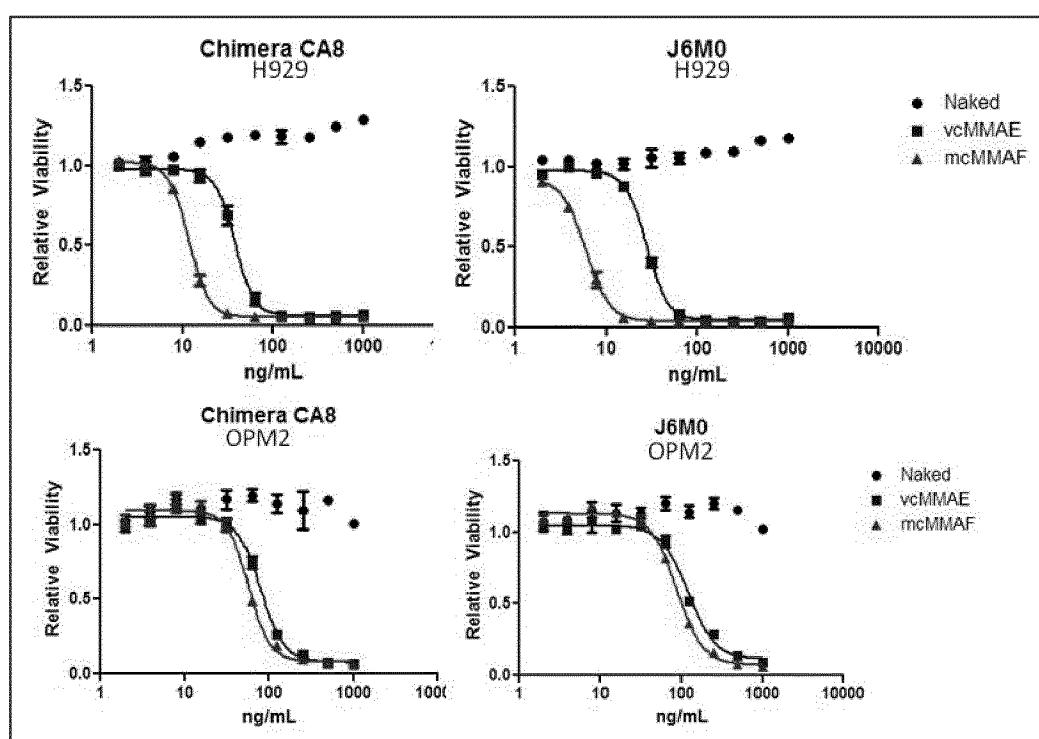


Figure 16:

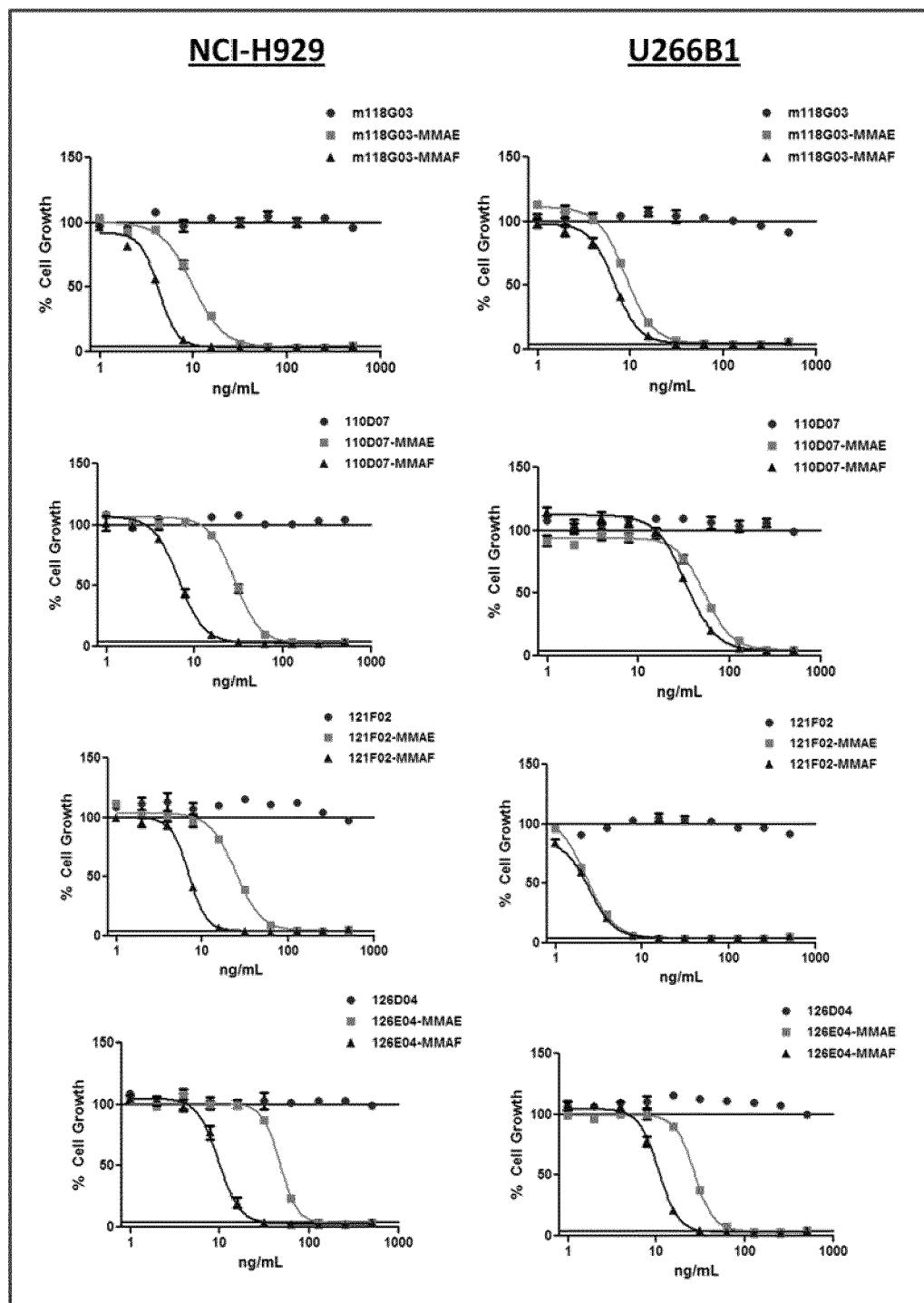


Figure 17.

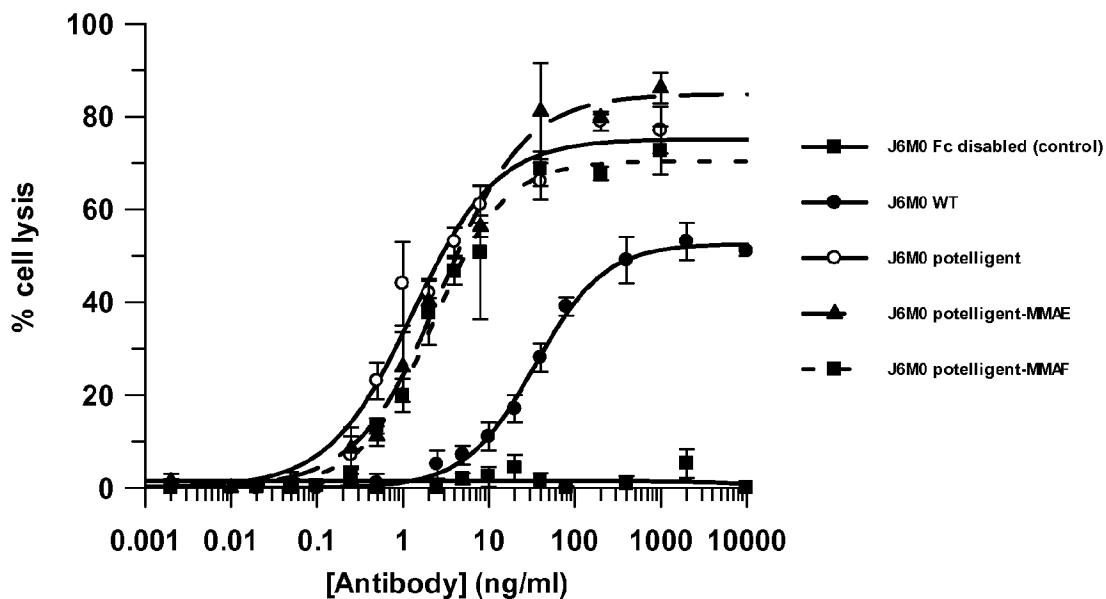
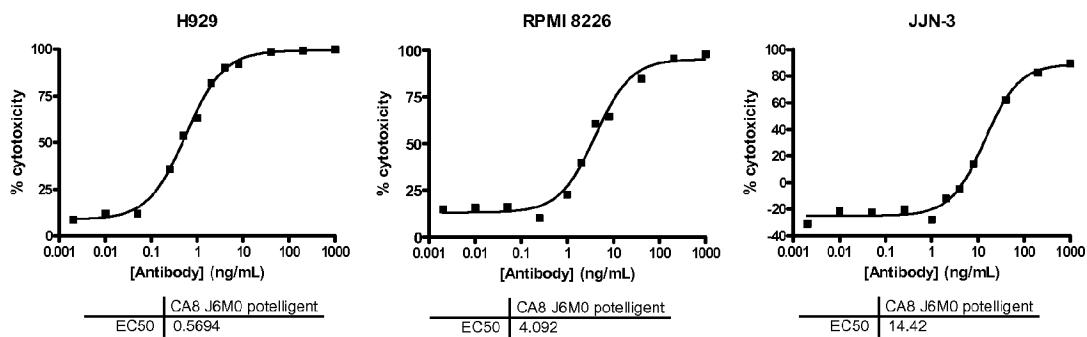


Figure 18

A



B

Figure 19.

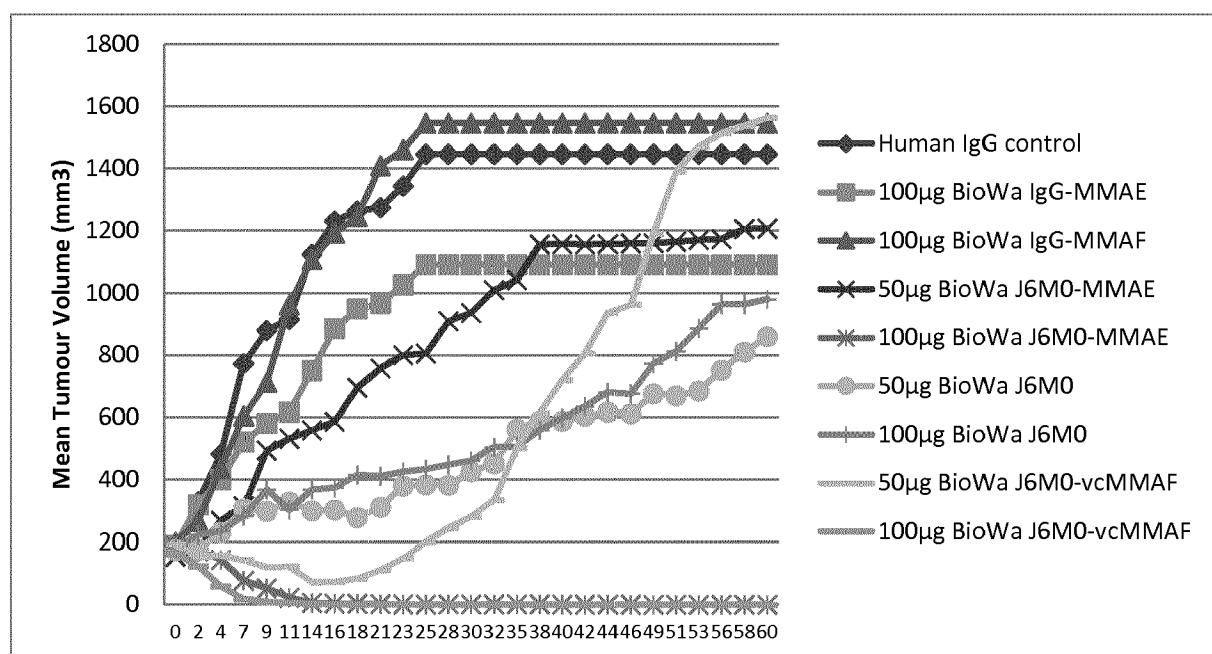
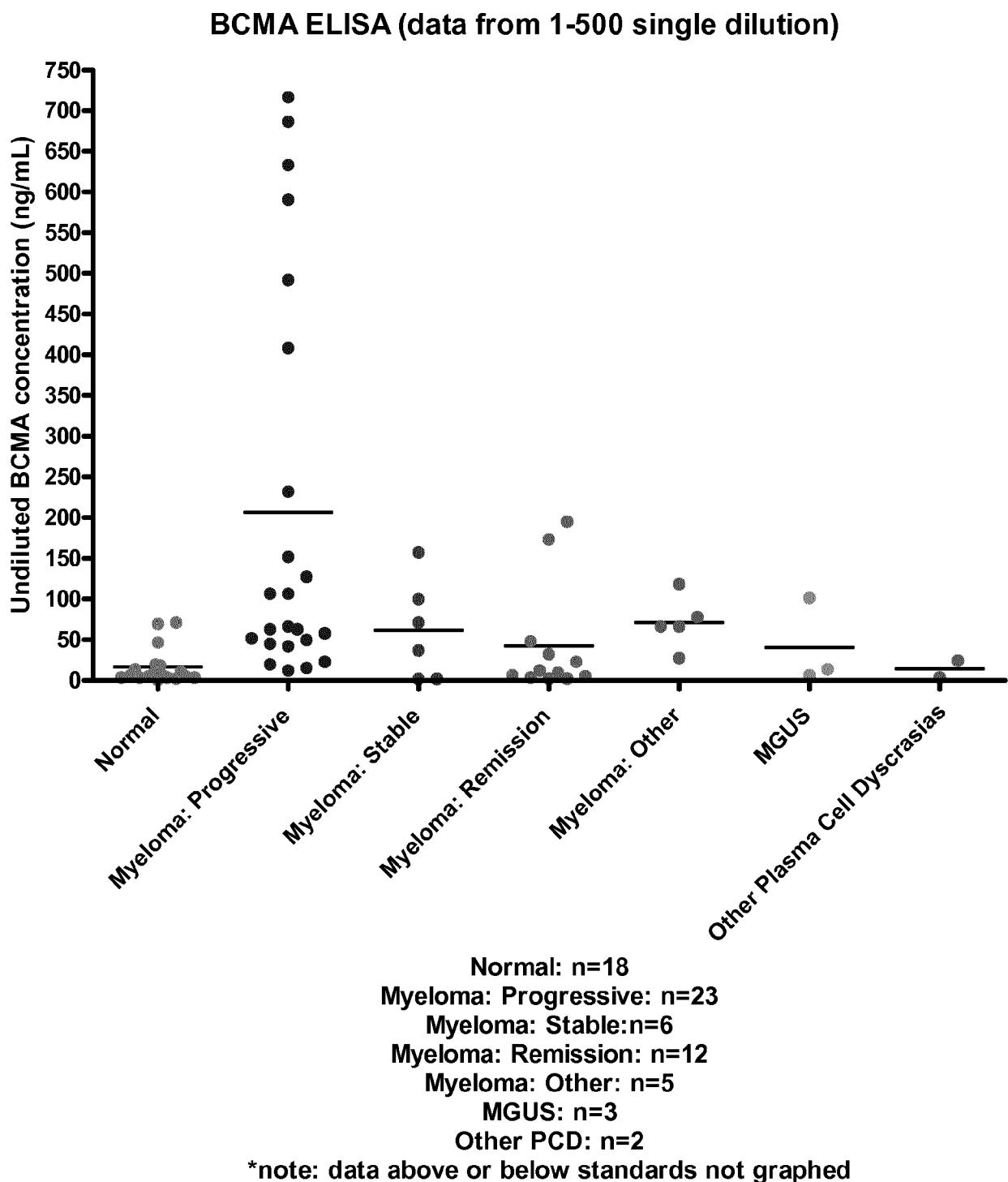


Figure 20



REFERENCES CITED IN THE DESCRIPTION

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摘要

本发明涉及抗原结合蛋白及其片段，所述抗原结合蛋白及其片段特异性结合 B 细胞成熟抗原 (BCMA)、特别是人 BCMA (hBCMA) 并且抑制 BAFF 和 APRIL 对 BCMA 受体的结合。进一步公开了药物组合物，筛选和医学治疗方法。