

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property

Organization

International Bureau

(43) International Publication Date

25 February 2021 (25.02.2021)



(10) International Publication Number

WO 2021/032960 A1

(51) International Patent Classification:

A61P 35/00 (2006.01)

C07K 16/28 (2006.01)

A61K 35/17 (2015.01)

C12N 5/0783 (2010.01)

Published:

— with international search report (Art. 21(3))

— with sequence listing part of description (Rule 5.2(a))

(21) International Application Number:

PCT/GB2020/051955

(22) International Filing Date:

14 August 2020 (14.08.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1911799.3

16 August 2019 (16.08.2019)

GB

2010760.3

13 July 2020 (13.07.2020)

GB

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(81) Designated States (unless otherwise indicated, for every

kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every

kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) Title: NOVEL ANTI-TCR DELTA VARIABLE I ANTIBODIES

(57) Abstract: The invention relates to anti-V δ 1 antibodies or fragments thereof.



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NOVEL ANTI-TCR DELTA VARIABLE 1 ANTIBODIES

FIELD OF THE INVENTION

The invention relates to antibodies and fragments thereof directed to the T cell receptor of gamma delta T cells.

BACKGROUND OF THE INVENTION

The growing interest in T cell immunotherapy for cancer has focused on the evident capacity of subsets of CD8+ and CD4+ alpha beta ($\alpha\beta$) T cells to recognize cancer cells and to mediate host-protective functional potentials, particularly when de-repressed by clinically mediated antagonism of inhibitory pathways exerted by PD-1, CTLA-4, and other receptors. However, $\alpha\beta$ T cells are MHC-restricted which can lead to graft versus host disease.

Gamma delta T cells ($\gamma\delta$ T cells) represent a subset of T cells that express on their surface a distinct, defining $\gamma\delta$ T-cell receptor (TCR). This TCR is made up of one gamma (γ) and one delta (δ) chain, each of which undergoes chain rearrangement but have a limited number of V genes as compared to $\alpha\beta$ T cells. The main TRGV gene segments encoding V γ are TRGV2, TRGV3, TRGV4, TRGV5, TRGV8, TRGV9 and TRGV11 and non-functional genes TRGV10, TRGV11, TRGVA and TRGVB. The most frequent TRDV gene segments encode V δ 1, V δ 2, and V δ 3, plus several V segments that have both V δ and V α designation (Adams *et al.*, 296:30-40 (2015) *Cell Immunol.*). Human $\gamma\delta$ T cells can be broadly classified based on their TCR chains, as certain γ and δ types are found on cells more prevalently, though not exclusively, in one or more tissue types. For example, most blood-resident $\gamma\delta$ T cells express a V δ 2 TCR, commonly V γ 9V δ 2, whereas this is less common among tissue-resident $\gamma\delta$ T cells such as those in the skin, which more frequently use the V δ 1 TCR paired with gamma chains, for example often paired with V γ 4 in the gut.

To exploit $\gamma\delta$ T cells for immunotherapy requires either a means to expand the cells *in situ* or to harvest them and expand them *ex vivo* prior to re-infusion. The latter approach has previously been described using the addition of exogenous cytokines, for example see WO2017/072367 and WO2018/212808. Methods for expanding a patients' own $\gamma\delta$ T cells has been described using pharmacologically modified forms of hydroxy-methyl but-2-enyl pyrophosphate (HMBPP) or clinically-approved aminobisphosphonates. By these approaches, over 250 cancer patients have been treated, seemingly safely, but with only rare incidences of complete remission. However, there is still a need for activating agents that have the proven capacity to expand large numbers of $\gamma\delta$ T cells.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, there is provided a human, isolated anti-TCR delta variable 1 (anti-V δ 1) antibody or fragment thereof, which binds to an epitope of a variable delta 1 (V δ 1) chain of a $\gamma\delta$ T cell receptor (TCR) comprising one or more amino acid residues within amino acid regions:

- (i) 3-20 of SEQ ID NO: 1; and/or
- (ii) 37-77 of SEQ ID NO: 1.

According to a further aspect of the invention, there is provided an isolated anti-V δ 1 antibody or fragment thereof, which comprises one or more of:

a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-25;

a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 26-37 and SEQUENCES: A1-A12 (of Table 2); and/or

a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 38-61.

According to a further aspect of the invention, there is provided an isolated anti-V δ 1 antibody or fragment thereof, which comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-85.

According to another aspect of the invention, there is provided an isolated anti-V δ 1 antibody or fragment thereof which comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 86-97.

According to a further aspect of the invention, there is provided an isolated anti-V δ 1 antibody or fragment thereof with an EC50 value for downregulation of a $\gamma\delta$ TCR upon binding which is less than 0.5 μ g/ml, such as less than 0.06 μ g/ml.

According to a further aspect of the invention, there is provided an isolated anti-V δ 1 antibody or fragment thereof with an EC50 value for $\gamma\delta$ T cell degranulation upon binding which is less than 0.05 μ g/ml, such as less than 0.005 μ g/ml, in particular less than 0.002 μ g/ml.

According to a further aspect of the invention, there is provided an isolated anti-V δ 1 antibody or fragment thereof with an EC50 value for $\gamma\delta$ T cell killing upon binding which is less than 0.5 μ g/ml, such as less than 0.055 μ g/ml, in particular less than 0.020 μ g/ml.

According to a further aspect of the invention, there is provided a polynucleotide sequence encoding the anti-V δ 1 antibody or fragment thereof comprising a sequence having at least 70% sequence identity with SEQ ID NO: 99-110.

- 5 According to a further aspect of the invention, there is provided a polynucleotide sequence encoding the anti-V δ 1 antibody or fragment thereof consisting of a sequence of SEQ ID NO: 99-110.

- 10 According to a further aspect of the invention, there is provided an expression vector comprising the VH region of SEQ ID NO: 99-110.

According to a further aspect of the invention, there is provided an expression vector comprising the VL region of SEQ ID NO: 99-110.

- 15 According to a further aspect of the invention, there is provided a cell comprising the polynucleotide sequence or the expression vector as defined herein.

- 20 According to a further aspect of the invention, there is provided a composition comprising the antibody or fragment thereof as defined herein.

According to a further aspect of the invention, there is provided a pharmaceutical composition comprising the antibody or fragment thereof as defined herein, together with a pharmaceutically acceptable diluent or carrier.

- 25 According to a further aspect of the invention, there is provided an isolated antigen comprising an amino acid sequence having at least 80% sequence identity with SEQ ID NO: 123 for use in generating an anti-V δ 1 antibody or fragment thereof.

- 30 According to a further aspect of the invention, there is provided a method of generating an anti-V δ 1 antibody or fragment thereof comprising:

- (i) designing a series of antigens comprising a TCR delta variable 1 (V δ 1) amino acid sequence wherein the CDR3 sequence of the V δ 1 is the same for all antigens in the series;
- (ii) exposing a first antigen designed in step (i) to an antibody library;
- (iii) isolating the antibodies or fragments thereof which bind to the antigen;
- 35 (iv) exposing the isolated antibodies or fragments thereof to a second antigen designed in step (i); and

(v) isolating the antibodies or fragments thereof which bind to both the first and second antigen.

According to a further aspect of the invention, there is provided an antibody obtained by the method as defined herein.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1: ELISA Detection of Directly Coated Antigen with Anti-V δ 1Ab (REA173, Miltenyi Biotec). Detection was seen only with those antigens which contain the V δ 1 domain.

Leucine zipper (LZ) format seems more potent than Fc format which is consistent with cell-based flow competition assay (data not shown).

Figure 2: Polyclonal phage DELFIA data for DV1 selections. A) Heterodimer selections: heterodimeric LZ TCR format in round 1 and 2, with deselections on heterodimeric LZ TCR in both rounds. B) Homodimer selections: round 1 performed using homodimeric Fc fusion TCR with deselection on human IgG1 Fc followed by round 2 on heterodimeric LZ TCR with deselection on heterodimeric LZ TCR. Each graph contains two bars for each target to represent selections from different libraries.

Figure 3: IgG capture: left) Sensorgrams of interaction of anti-L1 IgG with L1, right) steady state fits, if available. All experiments were performed at room temperature on MASS-2 instrument. Steady state fitting according to Langmuir 1:1 binding.

Figure 4: Results of TCR Downregulation Assay for clones 1245_P01_E07, 1252_P01_C08, 1245_P02_G04, 1245_P01_B07 and 1251_P02_C05 (A) or clones 1139_P01_E04, 1245_P02_F07, 1245_P01_G06 1245_P01_G09, 1138_P01_B09, 1251_P02_G10 and 1252_P01_C08 (B).

Figure 5: Results of T cell degranulation Assay for clones 1245_P01_E07, 1252_P01_C08, 1245_P02_G04, 1245_P01_B07 and 1251_P02_C05 (A) or clones 1139_P01_E04, 1245_P02_F07, 1245_P01_G06, 1245_P01_G09, 1138_P01_B09, and 1251_P02_G10 (B).

Figure 6: Results of Killing Assay (THP-1 flow-based assay) for clones 1245_P01_E07, 1252_P01_C08, 1245_P02_G04, 1245_P01_B07 and 1251_P02_C05 (A) or clones 1139_P01_E04, 1245_P02_F07, 1245_P01_G06, 1245_P01_G09, 1138_P01_B09 and 1251_P02_G10 (B).

Figure 7: Epitope mapping data for 1245_P01_E07. Graphical representation of epitope binding site of 1245_P01_E07 on SEQ ID NO: 1.

5 **Figure 8: Epitope mapping data for 1252_P01_C08.** Graphical representation of epitope binding site of 1252_P01_C08 on SEQ ID NO: 1.

Figure 9: Epitope mapping data for 1245_P02_G04. Graphical representation of epitope binding site of 1245_P02_G04 on SEQ ID NO: 1.

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Figure 10: Epitope mapping data for 1251_P02_C05. Graphical representation of epitope binding site of 1251_P02_C05 on SEQ ID NO: 1.

15 **Figure 11: Epitope mapping data for 1141_P01_E01.** Graphical representation of epitope binding site of 1141_P01_E01 on SEQ ID NO: 1.

DETAILED DESCRIPTION OF THE INVENTION

Definitions

20 Unless defined otherwise, all technical and scientific terms used herein have the meaning commonly understood by a person skilled in the art to which this invention belongs. As used herein, the following terms have the meanings ascribed to them below.

Gamma delta ($\gamma\delta$) T cells represent a small subset of T cells that express on their surface a distinct, defining T Cell Receptor (TCR). This TCR is made up of one gamma (γ) and one delta (δ) chain. Each chain contains a variable (V) region, a constant (C) region, a transmembrane region and a cytoplasmic tail. The V region contains an antigen binding site. There are two major sub-types of human $\gamma\delta$ T cells: one that is dominant in the peripheral blood and one that is dominant in non-haematopoietic tissues. The two sub-types may be defined by the type of δ and/or γ present on the cells. For example, $\gamma\delta$ T cells that are dominant in peripheral blood primarily express the delta variable 2 chain (V δ 2). $\gamma\delta$ T cells that are dominant in non-haematopoietic tissues (*i.e.* are tissue-resident) primarily express the delta variable 1 chain. References to “V δ 1 T cells” refer to $\gamma\delta$ T cells with a V δ 1 chain, *i.e.* V δ 1+ cells.

35 References to “delta variable 1” may also referred to as V δ 1 or Vd1, while a nucleotide encoding a TCR chain containing this region may be referred to as “TRDV1”. Antibodies or fragments thereof which interact with the V δ 1 chain of a $\gamma\delta$ TCR, are all effectively antibodies

or fragments thereof which bind to V δ 1 and may be referred to as “anti-TCR delta variable 1 antibodies or fragments thereof” or “anti-V δ 1 antibodies or fragments thereof”.

Additional references are made herein to other delta chains such as the “delta variable 2” chain. These can be referred to in a similar manner. For example, delta variable 2 chains can be referred to as V δ 2, while a nucleotide encoding a TCR chain containing this region may be referred to as “TRDV2”. In preferred embodiments antibodies or fragments thereof which interact with the V δ 1 chain of a $\gamma\delta$ TCR, do not interact with other delta chains such as V δ 2

References to ‘gamma variable chains’ are also made herein. These may be referred to as γ -chains or V γ , while a nucleotide encoding a TCR chain containing this region may be referred to as TRGV. For example, TRGV4 refers to V γ 4 chain. In a preferred embodiment, antibodies or fragments thereof which interact with the V δ 1 chain of a $\gamma\delta$ TCR, do not interact with gamma chains such as V γ 4.

The term “antibody” includes any antibody protein construct comprising at least one antibody variable domain comprising at least one antigen binding site (ABS). Antibodies include, but are not limited to, immunoglobulins of types IgA, IgG, IgE, IgD, IgM (as well as subtypes thereof). The overall structure of Immunoglobulin G (IgG) antibodies assembled from two identical heavy (H)-chain and two identical light (L)-chain polypeptides is well established and highly conserved in mammals (Padlan (1994) *Mol. Immunol.* 31:169-217).

A conventional antibody or immunoglobulin (Ig) is a protein comprising four polypeptide chains: two heavy (H) chains and two light (L) chains. Each chain is divided into a constant region and a variable domain. The heavy (H) chain variable domains are abbreviated herein as V_H, and the light (L) chain variable domains are abbreviated herein as V_L. These domains, domains related thereto and domains derived therefrom, may be referred to herein as immunoglobulin chain variable domains. The V_H and V_L domains (also referred to as V_H and V_L regions) can be further subdivided into regions, termed “complementarity determining regions” (“CDRs”), interspersed with regions that are more conserved, termed “framework regions” (“FRs”). The framework and complementarity determining regions have been precisely defined (Kabat *et al.* Sequences of Proteins of Immunological Interest, *Fifth Edition* U.S. Department of Health and Human Services, (1991) NIH Publication Number 91-3242). There are also alternative numbering conventions for CDR sequences, for example those set out in Chothia *et al.* (1989) *Nature* 342: 877-883. In a conventional antibody, each V_H and V_L is composed of three CDRs and four FRs, arranged from amino-terminus to carboxy-terminus in the following order: FR1, CDR1, FR2, CDR2, FR3, CDR3, FR4. The conventional antibody

tetramer of two heavy immunoglobulin chains and two light immunoglobulin chains is formed with the heavy and the light immunoglobulin chains inter-connected by e.g. disulphide bonds, and the heavy chains similarly connected. The heavy chain constant region includes three domains, CH1, CH2 and CH3. The light chain constant region is comprised of one domain, CL. The variable domain of the heavy chains and the variable domain of the light chains are binding domains that interact with an antigen. The constant regions of the antibodies typically mediate the binding of the antibody to host tissues or factors, including various cells of the immune system (e.g. effector cells) and the first component (C1q) of the classical complement system.

A fragment of the antibody (which may also referred to as "antibody fragment", "immunoglobulin fragment", "antigen-binding fragment" or "antigen-binding polypeptide") as used herein refers to a portion of an antibody (or constructs that contain said portion) that specifically binds to the target, the delta variable 1 (V δ 1) chain of a $\gamma\delta$ T cell receptor (e.g. a molecule in which one or more immunoglobulin chains is not full length, but which specifically binds to the target). Examples of binding fragments encompassed within the term antibody fragment include:

- (i) a Fab fragment (a monovalent fragment consisting of the VL, VH, CL and CH1 domains);
- (ii) a F(ab')₂ fragment (a bivalent fragment consisting of two Fab fragments linked by a disulphide bridge at the hinge region);
- (iii) a Fd fragment (consisting of the VH and CH1 domains);
- (iv) a Fv fragment (consisting of the VL and VH domains of a single arm of an antibody);
- (v) a single chain variable fragment, scFv (consisting of VL and VH domains joined, using recombinant methods, by a synthetic linker that enables them to be made as a single protein chain in which the VL and VH regions pair to form monovalent molecules);
- (vi) a VH (an immunoglobulin chain variable domain consisting of a VH domain);
- (vii) a VL (an immunoglobulin chain variable domain consisting of a VL domain);
- (viii) a domain antibody (dAb, consisting of either the VH or VL domain);
- (ix) a minibody (consisting of a pair of scFv fragments which are linked via CH3 domains);
- and
- (x) a diabody (consisting of a noncovalent dimer of scFv fragments that consist of a VH domain from one antibody connected by a small peptide linker a VL domain from another antibody).

"Human antibody" refers to antibodies having variable and constant regions derived from human germline immunoglobulin sequences. Human subjects administered with said human antibodies do not generate cross-species antibody responses (for example termed HAMA

responses - human-anti-mouse antibody) to the primary amino acids contained within said antibodies. Said human antibodies may include amino acid residues not encoded by human germline immunoglobulin sequences (e.g. mutations introduced by random or site-specific mutagenesis or by somatic mutation), for example in the CDRs and in particular CDR3.

5 However, the term is not intended to include antibodies in which CDR sequences derived from the germline of another mammalian species, such as a mouse, have been grafted onto human framework sequences. Human antibodies that are prepared, expressed, created or isolated by recombinant means, such as antibodies expressed using a recombinant expression vector transfected into a host cell, antibodies isolated from a recombinant, combinatorial human
10 antibody library, antibodies isolated from an animal (e.g. a mouse) that is transgenic for human immunoglobulin genes or antibodies prepared, expressed, created or isolated by any other means that involves splicing of human immunoglobulin gene sequences to other DNA sequences, may also be referred to as “recombinant human antibodies”.

15 Substituting at least one amino acid residue in the framework region of a non-human immunoglobulin variable domain with the corresponding residue from a human variable domain is referred to as “humanisation”. Humanisation of a variable domain may reduce immunogenicity in humans.

20 “Specificity” refers to the number of different types of antigens or antigenic determinants to which a particular antibody or fragment thereof can bind. The specificity of an antibody is the ability of the antibody to recognise a particular antigen as a unique molecular entity and distinguish it from another. An antibody that “specifically binds” to an antigen or an epitope is a term well understood in the art. A molecule is said to exhibit “specific binding” if it reacts
25 more frequently, more rapidly, with greater duration and/or with greater affinity with a particular target antigen or epitope, than it does with alternative targets. An antibody “specifically binds” to a target antigen or epitope if it binds with greater affinity, avidity, more readily, and/or with greater duration than it binds to other substances.

30 “Affinity”, represented by the equilibrium constant for the dissociation of an antigen with an antigen-binding polypeptide (KD), is a measure of the binding strength between an antigenic determinant and an antigen-binding site on the antibody (or fragment thereof): the lesser the value of the KD, the stronger the binding strength between an antigenic determinant and the antigen-binding polypeptide. Alternatively, the affinity can also be expressed as the affinity
35 constant (KA), which is 1/KD. Affinity can be determined by known methods, depending on the specific antigen of interest.

Any KD value less than 10^{-6} is considered to indicate binding. Specific binding of an antibody, or fragment thereof, to an antigen or antigenic determinant can be determined in any suitable known manner, including, for example, Scatchard analysis and/or competitive binding assays, such as radioimmunoassays (RIA), enzyme immunoassays (EIA) and sandwich competition
5 assays, equilibrium dialysis, equilibrium binding, gel filtration, ELISA, surface plasmon resonance, or spectroscopy (e.g. using a fluorescence assay) and the different variants thereof known in the art.

“Avidity” is the measure of the strength of binding between an antibody, or fragment thereof,
10 and the pertinent antigen. Avidity is related to both the affinity between an antigenic determinant and its antigen binding site on the antibody and the number of pertinent binding sites present on the antibody.

“Human tissue V δ 1+ cells,” and “haemopoietic and blood V δ 1+ cells” and “tumour infiltrating
15 lymphocyte (TIL) V δ 1+ cells,” are defined as V δ 1+ cells contained in or derived from either human tissue or the haemopoietic blood system or human tumours respectively. All said cell types can be identified by their (i) location or from where they are derived and (ii) their expression of the V δ 1+ TCR.

“Modulating antibodies” are antibodies that confer a measurable change including, but not
20 limited to, a measurable change in cell cycle, and/or in cell number, and/or cell viability, and/or in one or more cell surface markers, and/or in the secretion of one or more secretory molecules (e.g., cytokines, chemokines, leukotrienes, etc.), and/or a function (such as cytotoxicity towards a target cell or diseased cell), upon contacting or binding to a cell expressing the
25 target to which the antibody binds.

A method of “modulating” a cell, or population thereof, refers to a method wherein in at least one measurable change in said cell or cells, or secretion therefrom, is triggered to generate one or more “modulated cells”.

30 An “immune response” is a measurable change in at least one cell, or one cell-type, or one endocrine pathway, or one exocrine pathway, of the immune system (including but not limited to a cell-mediated response, a humoral response, a cytokine response, a chemokine response) upon addition of a modulating antibody.

35 An “immune cell” is defined as a cell of the immune system including, but not limited to, CD34+ cells, B-Cells, CD45+ (lymphocyte common antigen) cells, Alpha-Beta T-cells, Cytotoxic T-

cells, Helper T-cells, Plasma Cells, Neutrophils, Monocytes, Macrophages, Red Blood Cells, Platelets, Dendritic Cells, Phagocytes, Granulocytes, Innate lymphoid cells, Natural Killer (NK) cells and Gamma Delta T-cells. Typically, immune cells are classified with the aid of combinatorial cell surface molecule analysis (e.g., via flow cytometry) to identify or group or cluster to differentiate immune cells into sub-populations. These can be then still further sub-divided with additional analysis. For example, CD45+ lymphocytes can further sub-divided into $\alpha\beta$ positive populations and $\alpha\beta$ negative populations.

“Model systems” are biological models or biological representations designed to aid in the understanding of how a medicine such as an antibody or fragment thereof may function as a medicament in the amelioration of a sign or symptom of disease. Such models typically include the use of *in vitro*, *ex vivo*, and *in vivo* diseased cells, non-diseased cells, healthy cells, effector cells, and tissues etc., and in which the performance of said medicaments are studied and compared.

“Diseased cells” exhibit a phenotype associated with the progression of a disease such as a cancer, an infection such as a viral infection, or an inflammatory condition or inflammatory disease. For example, a diseased cell may be a tumour cell, an autoimmune tissue cell or a virally infected cell. Accordingly said diseased cells may be defined as tumorous, or virally infected, or inflammatory.

“Healthy cells” refers to normal cells that are not diseased. They may also be referred to as “normal” or “non-diseased” cells. Non-diseased cells include non-cancerous, or non-infected, or non-inflammatory cells. Said cells are often employed alongside relevant diseased cells to determine the diseased cell specificity conferred by a medicament and/or better understand the therapeutic index of a medicament.

“Diseased-cell-specificity” is a measure of how effective an effector cell or population thereof, (such as, for example, a population of $\gamma\delta$ 1+ cells) is at distinguishing and killing diseased cells, such as cancer cells, whilst sparing non-diseased or healthy cells. This potential can be measured in model systems and may involve comparing the propensity of an effector cell, or a population of effector cells, to selectively kill or lyse diseased cells versus the potential of said effector cell/s to kill or lyse non-diseased or healthy cells. Said diseased-cell-specificity can inform the potential therapeutic index of a medicament.

“Enhanced diseased-cell specificity” describes a phenotype of an effector cell such as, for example, a $\gamma\delta$ 1+ cell, or population thereof, which has been modulated to further increase its

capacity to specifically kill diseased cells. This enhancement can be measured in a variety of ways inclusive of fold-change, or percentage increase, in diseased-cell killing specificity or selectivity.

5 Suitably, the antibody or fragment thereof (*i.e.* polypeptide) of the invention is isolated. An "isolated" polypeptide is one that is removed from its original environment. The term "isolated" may be used to refer to an antibody that is substantially free of other antibodies having different antigenic specificities (*e.g.* an isolated antibody that specifically binds V δ 1, or a fragment thereof, is substantially free of antibodies that specifically bind antigens other than V δ 1). The
10 term "isolated" may also be used to refer to preparations where the isolated antibody is sufficiently pure to be administered therapeutically when formulated as an active ingredient of a pharmaceutical composition, or at least 70-80% (w/w) pure, more preferably, at least 80-90% (w/w) pure, even more preferably, 90-95% pure; and, most preferably, at least 95%, 96%, 97%, 98%, 99%, or 100% (w/w) pure.

15

Suitably, the polynucleotides used in the present invention are isolated. An "isolated" polynucleotide is one that is removed from its original environment. For example, a naturally-occurring polynucleotide is isolated if it is separated from some or all of the coexisting materials in the natural system. A polynucleotide is considered to be isolated if, for example,
20 it is cloned into a vector that is not a part of its natural environment or if it is comprised within cDNA.

The antibody or fragment thereof may be a "functionally active variant" which also includes naturally occurring allelic variants, as well as mutants or any other non-naturally occurring
25 variants. As is known in the art, an allelic variant is an alternate form of a (poly)peptide that is characterized as having a substitution, deletion, or addition of one or more amino acids that does essentially not alter the biological function of the polypeptide. By way of non-limiting example, said functionally active variants may still function when the frameworks containing the CDRs are modified, when the CDRs themselves are modified, when said CDRs are grafted
30 to alternate frameworks, or when N- or C-terminal extensions are incorporated. Further, CDR containing binding domains may be paired with differing partner chains such as those shared with another antibody. Upon sharing with so called 'common' light or 'common' heavy chains, said binding domains may still function. Further, said binding domains may function when multimerized. Further, 'antibodies or fragments thereof' may also comprise functional variants
35 wherein the VH or VL or constant domains have been modified away or towards a different canonical sequence (for example as listed at IMGT.org) and which still function.

For the purposes of comparing two closely-related polypeptide sequences, the “% sequence identity” between a first polypeptide sequence and a second polypeptide sequence may be calculated using NCBI BLAST v2.0, using standard settings for polypeptide sequences (BLASTP). For the purposes of comparing two closely-related polynucleotide sequences, the “% sequence identity” between a first nucleotide sequence and a second nucleotide sequence may be calculated using NCBI BLAST v2.0, using standard settings for nucleotide sequences (BLASTN).

Polypeptide or polynucleotide sequences are said to be the same as or “identical” to other polypeptide or polynucleotide sequences, if they share 100% sequence identity over their entire length. Residues in sequences are numbered from left to right, *i.e.* from N- to C-terminus for polypeptides; from 5' to 3' terminus for polynucleotides.

A “difference” between sequences refers to an insertion, deletion or substitution of a single amino acid residue in a position of the second sequence, compared to the first sequence. Two polypeptide sequences can contain one, two or more such amino acid differences. Insertions, deletions or substitutions in a second sequence which is otherwise identical (100% sequence identity) to a first sequence result in reduced % sequence identity. For example, if the identical sequences are 9 amino acid residues long, one substitution in the second sequence results in a sequence identity of 88.9%. If first and second polypeptide sequences are 9 amino acid residues long and share 6 identical residues, the first and second polypeptide sequences share greater than 66% identity (the first and second polypeptide sequences share 66.7% identity).

Alternatively, for the purposes of comparing a first, reference polypeptide sequence to a second, comparison polypeptide sequence, the number of additions, substitutions and/or deletions made to the first sequence to produce the second sequence may be ascertained. An “addition” is the addition of one amino acid residue into the sequence of the first polypeptide (including addition at either terminus of the first polypeptide). A “substitution” is the substitution of one amino acid residue in the sequence of the first polypeptide with one different amino acid residue. Said substitution may be conservative or non-conservative. A “deletion” is the deletion of one amino acid residue from the sequence of the first polypeptide (including deletion at either terminus of the first polypeptide).

A “conservative” amino acid substitution is an amino acid substitution in which an amino acid residue is replaced with another amino acid residue of similar chemical structure and which is expected to have little influence on the function, activity or other biological properties of the

polypeptide. Such conservative substitutions suitably are substitutions in which one amino acid within the following groups is substituted by another amino acid residue from within the same group:

Group	Amino acid residue
Non-polar aliphatic	Glycine
	Alanine
	Valine
	Methionine
	Leucine
	Isoleucine
Aromatic	Phenylalanine
	Tyrosine
	Tryptophan
Polar uncharged	Serine
	Threonine
	Cysteine
	Proline
	Asparagine
	Glutamine
Negatively charged	Aspartate
	Glutamate
Positively charged	Lysine
	Arginine
	Histidine

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Suitably, a hydrophobic amino acid residue is a non-polar amino acid. More suitably, a hydrophobic amino acid residue is selected from V, I, L, M, F, W or C.

As used herein, numbering of polypeptide sequences and definitions of CDRs and FRs are as defined according to the Kabat system (Kabat *et al.*, 1991, herein incorporated by reference in its entirety). A “corresponding” amino acid residue between a first and second polypeptide sequence is an amino acid residue in a first sequence which shares the same position according to the Kabat system with an amino acid residue in a second sequence, whilst the amino acid residue in the second sequence may differ in identity from the first. Suitably corresponding residues will share the same number (and letter) if the framework and CDRs are the same length according to Kabat definition. Alignment can be achieved manually or by using, for example, a known computer algorithm for sequence alignment such as NCBI BLAST v2.0 (BLASTP or BLASTN) using standard settings.

References herein to an “epitope” refer to the portion of the target which is specifically bound by the antibody or fragment thereof. Epitopes may also be referred to as “antigenic determinants”. An antibody binds “essentially the same epitope” as another antibody when they both recognize identical or sterically overlapping epitopes. Commonly used methods to determine whether two antibodies bind to identical or overlapping epitopes are competition assays, which can be configured in a number of different formats (e.g. well plates using radioactive or enzyme labels, or flow cytometry on antigen-expressing cells) using either labelled antigen or labelled antibody.

Epitopes found on protein targets may be defined as “linear epitopes” or “conformational epitopes”. Linear epitopes are formed by a continuous sequence of amino acids in a protein antigen. Conformational epitopes are formed of amino acids that are discontinuous in the protein sequence, but which are brought together upon folding of the protein into its three-dimensional structure.

The term “vector”, as used herein, is intended to refer to a nucleic acid molecule capable of transporting another nucleic acid to which it has been linked. One type of vector is a “plasmid”, which refers to a circular double stranded DNA loop into which additional DNA segments may be ligated. Another type of vector is a viral vector, wherein additional DNA segments may be ligated into the viral genome. Certain vectors are capable of autonomous replication in a host cell into which they are introduced (e.g. bacterial vectors having a bacterial origin of replication and episomal mammalian and yeast vectors). Other vectors (e.g. non-episomal mammalian vectors) can be integrated into the genome of a host cell upon introduction into the host cell, and thereby are replicated along with the host genome. Moreover, certain vectors are capable of directing the expression of genes to which they are operatively linked. Such vectors are referred to herein as “recombinant expression vectors” (or simply, “expression vectors”). In general, expression vectors of utility in recombinant DNA techniques are often in the form of plasmids. In the present specification, “plasmid” and “vector” may be used interchangeably as the plasmid is the most commonly used form of vector. However, the invention is intended to include such other forms of expression vectors, such as viral vectors (e.g. replication defective retroviruses, adenoviruses and adeno-associated viruses), which serve equivalent functions, and also bacteriophage and phagemid systems. The term “recombinant host cell” (or simply “host cell”), as used herein, is intended to refer to a cell into which a recombinant expression vector has been introduced. Such terms are intended to refer not only to the particular subject cell but to the progeny of such a cell, for example, when said progeny are employed to make a cell line or cell bank which is then optionally stored, provided, sold, transferred, or employed to manufacture an antibody or fragment thereof as described herein.

References to “subject”, “patient” or “individual” refer to a subject, in particular a mammalian subject, to be treated. Mammalian subjects include humans, non-human primates, farm animals (such as cows), sports animals, or pet animals, such as dogs, cats, guinea pigs, rabbits, rats or mice. In some embodiment, the subject is a human. In alternative embodiments, the subject is a non-human mammal, such as a mouse.

The term "sufficient amount" means an amount sufficient to produce a desired effect. The term "therapeutically effective amount" is an amount that is effective to ameliorate a symptom of a disease or disorder. A therapeutically effective amount can be a "prophylactically effective amount" as prophylaxis can be considered therapy.

A disease or disorder is “ameliorated” if the severity of a sign or symptom of the disease or disorder, the frequency with which such a sign or symptom is experienced by a subject, or both, is reduced.

As used herein, “treating a disease or disorder” means reducing the frequency and/or severity of at least one sign or symptom of the disease or disorder experienced by a subject.

“Cancer,” as used herein, refers to the abnormal growth or division of cells. Generally, the growth and/or life span of a cancer cell exceeds, and is not coordinated with, that of the normal cells and tissues around it. Cancers may be benign, pre-malignant or malignant. Cancer occurs in a variety of cells and tissues, including the oral cavity (e.g., mouth, tongue, pharynx, etc.), digestive system (e.g., esophagus, stomach, small intestine, colon, rectum, liver, bile duct, gall bladder, pancreas, etc.), respiratory system (e.g., larynx, lung, bronchus, etc.), bones, joints, skin (e.g., basal cell, squamous cell, meningioma, etc.), breast, genital system, (e.g., uterus, ovary, prostate, testis, etc.), urinary system (e.g., bladder, kidney, ureter, etc.), eye, nervous system (e.g., brain, etc.), endocrine system (e.g., thyroid, etc.), and hematopoietic system (e.g., lymphoma, myeloma, leukemia, acute lymphocytic leukemia, chronic lymphocytic leukemia, acute myeloid leukemia, chronic myeloid leukemia, etc.).

As used herein, the term “about” when used herein includes up to and including 10% greater and up to and including 10% lower than the value specified, suitably up to and including 5% greater and up to and including 5% lower than the value specified, especially the value specified. The term “between”, includes the values of the specified boundaries.

Antibodies or fragments thereof

Provided herein are antibodies or fragments thereof capable of specifically binding to the delta variable 1 chain (V δ 1) of a $\gamma\delta$ T Cell Receptor (TCR).

- 5 In one embodiment, the antibody or fragment thereof is an scFv, Fab, Fab', F(ab')₂, Fv, variable domain (e.g. VH or VL), diabody, minibody or monoclonal antibody. In a further embodiment, the antibody or fragment thereof is an scFv.

10 Antibodies of the invention can be of any class, e.g. IgG, IgA, IgM, IgE, IgD, or isotypes thereof, and can comprise a kappa or lambda light chain. In one embodiment, the antibody is an IgG antibody, for example, at least one of isotypes, IgG1, IgG2, IgG3 or IgG4. In a further embodiment, the antibody may be in a format, such as an IgG format, that has been modified to confer desired properties, such as having the Fc mutated to reduce effector function, extend half life, alter ADCC, or improve hinge stability. Such modifications are well known in the art.

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In one embodiment, the antibody or fragment thereof is human. Thus, the antibody or fragment thereof may be derived from a human immunoglobulin (Ig) sequence. The CDR, framework and/or constant region of the antibody (or fragment thereof) may be derived from a human Ig sequence, in particular a human IgG sequence. The CDR, framework and/or constant region
20 may be substantially identical for a human Ig sequence, in particular a human IgG sequence. An advantage of using human antibodies is that they are low or non-immunogenic in humans.

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An antibody or fragment thereof can also be chimeric, for example a mouse-human antibody chimera.

Alternatively, the antibody or fragment thereof is derived from a non-human species, such as a mouse. Such non-human antibodies can be modified to increase their similarity to antibody variants produced naturally in humans, thus the antibody or fragment thereof can be partially or fully humanised. Therefore, in one embodiment, the antibody or fragment thereof is
30 humanised.

The anti-V δ 1 antibodies or fragments thereof as described herein may be used to modulate delta variable 1 chain (V δ 1) T cells.

35 Modulation of V δ 1 T cells may include:

- expansion of the V δ 1 T cells, e.g. by selectively increasing the number of V δ 1 T cells or promotion of survival of V δ 1 T cells;

- stimulation of the V δ 1 T cells, e.g. by increasing V δ 1 T cell potency, i.e. increasing target cell killing;
- prevention of V δ 1 T cell exhaustion, e.g. by increasing persistence of the V δ 1 T cells;
- degranulation of V δ 1 T cells;
- 5 - immunosuppression of the V δ 1 T cells, e.g. by downregulation of V δ 1 TCR cell surface expression, i.e. by causing V δ 1 TCR internalisation or reduced expression of V δ 1 TCR protein, or blocking the V δ 1 TCR from binding;
- reducing V δ 1 T cell number, e.g. by inhibition of V δ 1 T cell proliferation or by inducing V δ 1 T cell death (i.e. killing V δ 1 T cells).

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Such modulation of V δ 1 T cells may include, for example, V δ 1 T cell activation or V δ 1 T cell inhibition. In one embodiment, the V δ 1 T cells are activated upon administration of an anti-V δ 1 antibody or fragment thereof as defined herein to a patient. In an alternative embodiment, the V δ 1 T cells are inhibited upon administration of an anti-V δ 1 antibody or fragment thereof as defined herein to a patient. In an alternative embodiment, the V δ 1 T cells are not inhibited upon administration of an anti-V δ 1 antibody or fragment thereof as defined herein to a patient.

15

Antibodies targeted to epitopes

Provided herein are antibodies (or fragments thereof) which bind to an epitope of the V δ 1 chain of a $\gamma\delta$ TCR. Such binding may optionally have an effect on $\gamma\delta$ TCR activity, such as activation or inhibition.

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In one embodiment, the epitope may be an activating epitope of a $\gamma\delta$ T cell. An “activating” epitope can include, for example, stimulating a TCR function, such as cell degranulation, TCR downregulation, cytotoxicity, proliferation, mobilisation, increased survival or resistance to exhaustion, intracellular signaling, cytokine or growth factor secretion, phenotypic change, or a change in gene expression. For example, the binding of the activating epitope may stimulate expansion (*i.e.* proliferation) of the $\gamma\delta$ T cell population, preferably the V δ 1+ T cell population. Accordingly, these antibodies can be used to modulate $\gamma\delta$ T cell activation, and, thereby, to modulate the immune response. Therefore, in one embodiment, binding of the activating epitope downregulates the $\gamma\delta$ TCR. In an additional or alternative embodiment, binding of the activating epitope activates degranulation of the $\gamma\delta$ T cell. In a further additional or alternative embodiment, binding of the activating epitope activates $\gamma\delta$ T cell killing.

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Alternatively, the antibodies (or fragments thereof) may have a blocking effect by prevention of the binding or interaction of another antibody or molecule. In one embodiment, the present invention provides isolated antibodies or fragments thereof that block V δ 1 and prevent TCR

binding (e.g. through steric hinderance). By blocking V δ 1, the antibody may prevent TCR activation and/or signalling. The epitope may be an inhibitory epitope of a $\gamma\delta$ T cell. An "inhibitory" epitope can include, for example, blocking TCR function, thereby inhibiting TCR activation.

5

The epitope is preferably comprised of at least one extracellular, soluble, hydrophilic, external or cytoplasmic portion of the V δ 1 chain of a $\gamma\delta$ TCR.

In particular, the epitope does not comprise an epitope found in a hypervariable region of the V δ 1 chain of the $\gamma\delta$ TCR, in particular CDR3 of the V δ 1 chain. In a preferred embodiment, the epitope is within the non-variable region of the V δ 1 chain of the $\gamma\delta$ TCR. It will be appreciated that such binding allows for the unique recognition of the V δ 1 chain without the restriction to the sequences of the TCR which are highly variable (in particular CDR3). Various $\gamma\delta$ TCR complexes which recognise MHC-like peptides or antigen may be recognised in this way, solely by presence of the V δ 1 chain. As such, it will be appreciated that any V δ 1 chain-comprising $\gamma\delta$ TCR may be recognised using the antibodies or fragments thereof as defined herein, irrespective of the specificity of the $\gamma\delta$ TCR. In one embodiment, the epitope comprises one or more amino acid residues within amino acid regions 1-24 and/or 35-90 of SEQ ID NO: 1, e.g. the portions of the V δ 1 chain which are not part of the CDR1 and/or CDR3 sequences. In one embodiment, the epitope does not comprise amino acid residues within amino acid region 91-105 (CDR3) of SEQ ID NO: 1.

In a similar manner to the well characterised $\alpha\beta$ T cells, $\gamma\delta$ T cells utilize a distinct set of somatically rearranged variable (V), diversity (D), joining (J), and constant (C) genes, although $\gamma\delta$ T cells contain fewer V, D, and J segments than $\alpha\beta$ T cells. In one embodiment, the epitope bound by the antibodies (or fragments thereof) does not comprise an epitope found in the J region of the V δ 1 chain (e.g. one of the four J regions encoded in the human delta one chain germline: SEQ ID NO: 131 (J1*0) or 132 (J2*0) or 133 (J3*0) or 134 (J4*0)). In one embodiment, the epitope bound by the antibodies (or fragments thereof) does not comprise an epitope found in the C-region of the V δ 1 chain (e.g. SEQ ID NO: 135 (C1*0) which contains the C-terminal juxtamembrane/transmembrane regions). In one embodiment, the epitope bound by the antibodies (or fragments thereof) does not comprise an epitope found in the N-terminal leader sequence of the V δ 1 chain (e.g. SEQ ID NO: 129). The antibody or fragment may therefore only bind in the V region of the V δ 1 chain (e.g. SEQ ID NO: 130). Thus, in one embodiment, the epitope consists of an epitope in the V region of the $\gamma\delta$ TCR (e.g. amino acid residues 1-90 of SEQ ID NO: 1).

Reference to the epitope are made in relation to the V δ 1 sequence derived from the sequence described in Luoma *et al.* (2013) *Immunity* 39: 1032-1042, and RCSB Protein Data Bank entries: 4MNH and 3OMZ, shown as SEQ ID NO: 1:

5 AQKVTQAQSSVSMPVRKAVTLNCLYETSWWSYYIFWYKQLPSKEMIFLIRQGSDEQNAKS
 GRYSVNFKKAASKSVALTISALQLEDSAKYFCALGESLTRADKLIFGKGTRVTVEPNIQNPDP
 VYQLRDSKSSDKSVCLFTDFDSQTNVSQSKDSDVYITDKTVLDMRSMDFKSNSA
 VAWSNK SDFACANAFNNSIIPEDTFFPSPESS (SEQ ID NO: 1)

10 SEQ ID NO: 1 represents a soluble TCR comprising a V region (also referred to as the variable domain), a D region, a J region and a TCR constant region. The V region comprises amino acid residues 1-90, the D region comprises amino acid residues 91-104, the J region comprises amino acid residues 105-115 and the constant region comprises amino acid residues 116-209. Within the V region, CDR1 is defined as amino acid residues 25-34 of SEQ
 15 ID NO: 1, CDR2 is defined as amino acid residues 50-54 of SEQ ID NO: 1, and CDR3 is defined as amino acid residues 93-104 of SEQ ID NO: 1 (Xu *et al.*, PNAS USA 108(6):2414-2419 (2011)).

Therefore, according to an aspect of the invention, there is provided an isolated antibody or
 20 fragment thereof, which binds to an epitope of a variable delta 1 (V δ 1) chain of a $\gamma\delta$ T cell receptor (TCR) comprising one or more amino acid residues within amino acid regions:

- (i) 3-20 of SEQ ID NO: 1; and/or
- (ii) 37-77 of SEQ ID NO: 1.

25 In a further embodiment, antibodies or fragments thereof additionally recognize the polymorphic V region comprising amino acid residues 1-90 epitope of SEQ ID NO:128. Hence, amino acids 1-90 of SEQ ID NO:1 and the polymorphic germline variant sequence (amino acids 1-90 SEQ ID NO:128) may be considered interchangeable when defining epitopes described herein. Antibodies of the invention can recognize both variants of this germline
 30 sequence. By way of example, where it is stated that antibodies or fragments thereof as defined herein recognize epitopes comprising one or more amino acid residues within amino acid regions 1-24 and/or 35-90 of SEQ ID NO:1 this also refers to the same regions of SEQ ID NO:128; specifically amino acid regions 1-24 and/or 35-90 of SEQ ID NO:128.

35 In one embodiment, antibodies or fragments thereof recognize one or more amino acid residues within amino acid regions 1-90 of SEQ ID NO:1 and the equivalently located amino acids of regions 1-90 in SEQ ID NO:128. More specifically, in one embodiment antibodies or

fragments thereof as defined herein recognize a human germline epitope wherein said germline encodes either an alanine (A) or valine (V) at position 71 of SEQ ID NO:1.

5 In one embodiment, the epitope comprises one or more, such as two, three, four, five, six, seven, eight, nine, ten or more amino acid residues within the described regions.

10 In a further embodiment, the epitope comprises one or more (such as 5 or more, such as 10 or more) amino acid residues within amino acid region 3-20 of SEQ ID NO: 1. In an alternative embodiment, the epitope comprises one or more (such as 5 or more, such as 10 or more) amino acid residues within amino acid region 37-77 of SEQ ID NO: 1 (such as amino acid region 50-54). In a yet further embodiment, the epitope comprises one or more (such as 5 or more, such as 10 or more) amino acid residues within amino acid region 3-20 (such as 5-20 or 3-17) and one or more (such as 5 or more, such as 10 or more) amino acid residues within amino acid region 37-77 (such as 62-77 or 62-69) of SEQ ID NO: 1.

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It will be further understood that said antibody (or fragment thereof) does not need to bind to all amino acids within the defined range. Such epitopes may be referred to as linear epitopes. For example, an antibody which binds to an epitope comprising amino acid residues within amino acid region 5-20 of SEQ ID NO: 1 may only bind with one or more of the amino acid residues in said range, e.g. the amino acid residues at each end of the range (*i.e.* amino acids 5 and 20), optionally including amino acids within the range (*i.e.* amino acids 5, 9, 16 and 20).

20

25 In one embodiment, the epitope comprises at least one of amino acid residues 3, 5, 9, 10, 12, 16, 17, 20, 37, 42, 50, 53, 59, 62, 64, 68, 69, 72 or 77 of SEQ ID NO: 1. In further embodiments, the epitope comprises one, two, three, four, five, six, seven, eight, nine, ten, eleven or twelve amino acids selected from amino acid residues 3, 5, 9, 10, 12, 16, 17, 20, 37, 42, 50, 53, 59, 62, 64, 68, 69, 72 or 77 of SEQ ID NO: 1.

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In one embodiment, the epitope comprises one or more amino acid residues within the following amino acid regions of SEQ ID NO: 1 (or SEQ ID NO:128, as described above):

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(i) 3-17;

(ii) 5-20;

(iii) 37-53;

(iv) 50-64;

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(v) 59-72;

(vi) 59-77;

(vii) 62-69; and/or

(viii) 62-77.

In a further embodiment, the epitope comprises one or more amino acid residues within amino acid regions: 5-20 and 62-77; 50-64; 37-53 and 59-72; 59-77; or 3-17 and 62-69, of SEQ ID NO: 1. In a further embodiment, the epitope consists of one or more amino acid residues within amino acid regions: 5-20 and 62-77; 50-64; 37-53 and 59-72; 59-77; or 3-17 and 62-69, of SEQ ID NO: 1.

In a further embodiment, the epitope comprises amino acid residues: 3, 5, 9, 10, 12, 16, 17, 62, 64, 68 and 69 of SEQ ID NO: 1, or suitably consists of amino acid residues: 3, 5, 9, 10, 12, 16, 17, 62, 64, 68 and 69 of SEQ ID NO: 1. In a further embodiment, the epitope comprises amino acid residues: 5, 9, 16, 20, 62, 64, 72 and 77 of SEQ ID NO: 1, or suitably consists of amino acid residues: 5, 9, 16, 20, 62, 64, 72 and 77 of SEQ ID NO: 1. In yet further embodiment, the epitope comprises the amino acid residues: 37, 42, 50, 53, 59, 64, 68, 69, 72, 73 and 77 of SEQ ID NO: 1, or suitably consists of amino acid residues: 37, 42, 50, 53, 59, 64, 68, 69, 72, 73 and 77 of SEQ ID NO: 1. In a further embodiment, the epitope comprises the amino acid residues: 50, 53, 59, 62 and 64 of SEQ ID NO: 1, or suitably consists of amino acid residues: 50, 53, 59, 62 and 64 of SEQ ID NO: 1. In a further embodiment, the epitope comprises amino acid residues: 59, 60, 68 and 72 of SEQ ID NO: 1, or suitably consists of amino acid residues: 59, 60, 68 and 72 of SEQ ID NO: 1.

In one embodiment, the epitope comprises one or more amino acid residues within amino acid regions 5-20 and/or 62-77 of SEQ ID NO: 1. In a further embodiment, the epitope consists of one or more amino acid residues within amino acid regions 5-20 and 62-77 of SEQ ID NO: 1.

In an alternative further embodiment, the epitope comprises one or more amino acid residues within amino acid regions 5-20 or 62-77 of SEQ ID NO: 1. Antibodies or fragments thereof having such epitopes may have some or all of the sequences of 1245_P01_E07, or such antibodies or fragments thereof may be derived from 1245_P01_E07. For example, antibodies or fragments thereof having one or more CDR sequences of 1245_P01_E07 or one or both of the VH and VL sequences of 1245_P01_E07 may bind such epitopes.

In one embodiment, the epitope comprises one or more amino acid residues within amino acid region 50-64 of SEQ ID NO: 1. In a further embodiment, the epitope consists of one or more amino acid residues within amino acid region 50-64 of SEQ ID NO: 1. Antibodies or fragments thereof having such epitopes may have some or all of the sequences of 1252_P01_C08, or such antibodies or fragments thereof may be derived from 1252_P01_C08. For example,

antibodies or fragments thereof having one or more CDR sequences of 1252_P01_C08 or one or both of the VH and VL sequences of 1252_P01_C08 may bind such epitopes.

In one embodiment, the epitope comprises one or more amino acid residues within amino acid regions 37-53 and/or 59-77 of SEQ ID NO: 1. In a further embodiment, the epitope consists of one or more amino acid residues within amino acid regions 37-53 and 59-77 of SEQ ID NO: 1. In an alternative further embodiment, the epitope comprises one or more amino acid residues within amino acid regions 37-53 or 59-77 of SEQ ID NO: 1. Antibodies or fragments thereof having such epitopes may have some or all of the sequences of 1245_P02_G04, or such antibodies or fragments thereof may be derived from 1245_P02_G04. For example, antibodies or fragments thereof having one or more CDR sequences of 1245_P02_G04 or one or both of the VH and VL sequences of 1245_P02_G04 may bind such epitopes.

In one embodiment, the epitope comprises one or more amino acid residues within amino acid region 59-72 of SEQ ID NO: 1. In a further embodiment, the epitope consists of one or more amino acid residues within amino acid region 59-72 of SEQ ID NO: 1. Antibodies or fragments thereof having such epitopes may have some or all of the sequences of 1251_P02_C05, or such antibodies or fragments thereof may be derived from 1251_P02_C05. For example, antibodies or fragments thereof having one or more CDR sequences of 1251_P02_C05 or one or both of the VH and VL sequences of 1251_P02_C05 may bind such epitopes.

In one embodiment, the epitope does not comprise amino acid residues within amino acid region 11-21 of SEQ ID NO: 1. In one embodiment, the epitope does not comprise amino acid residues within amino acid region 21-28 of SEQ ID NO: 1. In one embodiment, the epitope does not comprise amino acid residues within amino acid region 59 and 60 of SEQ ID NO: 1. In one embodiment, the epitope does not comprise amino acid residues within amino acid region 67-82 of SEQ ID NO: 1.

In one embodiment, the epitope is not the same epitope bound by a commercially available anti-V δ 1 antibody, such as TS-1 or TS8.2. As described in WO2017197347, binding of TS-1 and TS8.2 to soluble TCRs was detected when the δ 1 chain included V δ 1 J1 and V δ 1 J2 sequences but not to the V δ 1 J3 chain, indicating that the binding of TS-1 and TS8.2 involved critical residues in the delta J1 and delta J2 region.

References to “within” herein include the extremities of the define range. For example, “within amino acid regions 5-20” refers to all of amino acid residues from and including residue 5 up to and including residue 20.

Various techniques are known in the art to establish which epitope is bound by an antibody. Exemplary techniques include, for example, routine cross-blocking assays, alanine scanning mutational analysis, peptide blot analysis, peptide cleavage analysis crystallographic studies and NMR analysis. In addition, methods such as epitope excision, epitope extraction and chemical modification of antigens can be employed. Another method that can be used to identify the amino acids within a polypeptide with which an antibody interacts is hydrogen/deuterium exchange detected by mass spectrometry (as described in Example 9). In general terms, the hydrogen/deuterium exchange method involves deuterium-labelling the protein of interest, followed by binding the antibody to the deuterium-labelled protein. Next, the protein/antibody complex is transferred to water and exchangeable protons within amino acids that are protected by the antibody complex undergo deuterium-to-hydrogen back-exchange at a slower rate than exchangeable protons within amino acids that are not part of the interface. As a result, amino acids that form part of the protein/antibody interface may retain deuterium and therefore exhibit relatively higher mass compared to amino acids not included in the interface. After dissociation of the antibody, the target protein is subjected to protease cleavage and mass spectrometry analysis, thereby revealing the deuterium-labelled residues which correspond to the specific amino acids with which the antibody interacts.

Antibody sequences

The isolated anti-Vδ1 antibodies, or fragments thereof, of the invention may be described with reference to their CDR sequences.

According to an aspect of the invention, there is provided an isolated anti-Vδ1 antibody or fragment thereof, which comprises one or more of:

a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-25;

a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 26-37 and SEQUENCES: A1-A12; and/or

a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 38-61.

According to one aspect of the invention, there is provided an isolated anti-Vδ1 antibody or fragment thereof, which comprises a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-25. In one embodiment, the antibody or fragment thereof comprises a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 26-37 and SEQUENCES: A1-A12 (of Table 2). In one

embodiment, the antibody or fragment thereof comprises a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 38-61.

5 In one embodiment, the antibody or fragment thereof comprises a CDR3 comprising a sequence having at least 85%, 90%, 95%, 97%, 98% or 99% sequence identity with any one of SEQ ID NOs: 2-25. In one embodiment, the antibody or fragment thereof comprises a CDR2 comprising a sequence having at least 85%, 90%, 95%, 97%, 98% or 99% sequence identity with any one of SEQ ID NOs: 26-37 and SEQUENCES: A1-A12 (of Table 2). In one
10 embodiment, the antibody or fragment thereof comprises a CDR1 comprising a sequence having at least 85%, 90%, 95%, 97%, 98% or 99% sequence identity with any one of SEQ ID NOs: 38-61.

In one embodiment, the antibody or fragment thereof comprises a CDR3 consisting of a sequence having at least 85%, 90%, 95%, 97%, 98% or 99% sequence identity with any one
15 of SEQ ID NOs: 2-25. In one embodiment, the antibody or fragment thereof comprises a CDR2 consisting of a sequence having at least 85%, 90%, 95%, 97%, 98% or 99% sequence identity with any one of SEQ ID NOs: 26-37 and SEQUENCES: A1-A12 (of Table 2). In one embodiment, the antibody or fragment thereof comprises a CDR1 consisting of a sequence having at least 85%, 90%, 95%, 97%, 98% or 99% sequence identity with any one of SEQ ID
20 NOs: 38-61.

According to a further aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-13 and/or a VL region comprising
25 a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 14-25. According to a further aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 consisting of a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-13 and/or a VL region comprising a CDR3 consisting of a sequence having at least 80% sequence identity with any
30 one of SEQ ID NOs: 14-25.

In one embodiment, the antibody or fragment thereof comprises a VH region comprising a CDR3 comprising a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 2-13 and/or a VL region comprising a CDR3 comprising a sequence having at least 90%
35 sequence identity with any one of SEQ ID NOs: 14-25. In one embodiment, the antibody or fragment thereof comprises a VH region comprising a CDR3 consisting of a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 2-13 and/or a VL region

comprising a CDR3 consisting of a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 14-25.

5 In one embodiment, the antibody or fragment thereof comprises a VH region comprising a CDR3 comprising a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 2-13 and/or a VL region comprising a CDR3 comprising a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 14-25. In one embodiment, the antibody or fragment thereof comprises a VH region comprising a CDR3 consisting of a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 2-13 and/or a VL region
10 comprising a CDR3 consisting of a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 14-25.

In one embodiment, the antibody or fragment thereof comprises a VH region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID
15 NOs: 2-13 and a VL region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 14-25. In one embodiment, the antibody or fragment thereof comprises a VH region comprising a CDR3 consisting of a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-13 and a VL region comprising a CDR3 consisting of a sequence having at least 80% sequence identity with any one of SEQ
20 ID NOs: 14-25.

According to a further aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-7, in particular 2-6, such as 2, 3
25 or 4 and a VL region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 14-19, in particular 14-18, such as 14, 15 or 16. According to a further aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 consisting of a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-7, in particular 2-6, such as 2, 3
30 or 4 and a VL region comprising a CDR3 consisting of a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 14-19, in particular 14-18, such as 14, 15 or 16.

According to a particular aspect of the invention, there is provided an antibody or fragment
35 thereof, which comprises a VH region comprising a CDR3 comprising a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 2-7, in particular 2-6, such as 2, 3 or 4 and/or a VL region comprising a CDR3 comprising a sequence having at least 90%

sequence identity with any one of SEQ ID NOs: 14-19, in particular 14-18, such as 14, 15 or 16. According to a further aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 consisting of a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 2-7, in particular 2-6, such as 2, 3 or 4 and/or a VL region comprising a CDR3 consisting of a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 14-19, in particular 14-18, such as 14, 15 or 16.

According to a further aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 comprising a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 2-7, in particular 2-6, such as 2, 3 or 4 and/or a VL region comprising a CDR3 comprising a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 14-19, in particular 14-18, such as 14, 15 or 16. According to a further aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 consisting of a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 2-7, in particular 2-6, such as 2, 3 or 4 and/or a VL region comprising a CDR3 consisting of a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 14-19, in particular 14-18, such as 14, 15 or 16.

According to a particular aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 8-13, in particular 8, 9, 10 or 11 and/or a VL region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 20-25, in particular 20, 21, 22 or 23. According to another aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 consisting of a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 8-13, in particular 8, 9, 10 or 11 and/or a VL region comprising a CDR3 consisting of a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 20-25, in particular 20, 21, 22 or 23.

According to a particular aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 comprising a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 8-13, in particular 8, 9, 10 or 11 and/or a VL region comprising a CDR3 comprising a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 20-25, in particular 20, 21, 22 or 23. According to another aspect of the invention, there is provided an antibody or fragment thereof, which comprises a

VH region comprising a CDR3 consisting of a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 8-13, in particular 8, 9, 10 or 11 and/or a VL region comprising a CDR3 consisting of a sequence having at least 90% sequence identity with any one of SEQ ID NOs: 20-25, in particular 20, 21, 22 or 23.

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According to a particular aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 comprising a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 8-13, in particular 8, 9, 10 or 11 and/or a VL region comprising a CDR3 comprising a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 20-25, in particular 20, 21, 22 or 23. According to another aspect of the invention, there is provided an antibody or fragment thereof, which comprises a VH region comprising a CDR3 consisting of a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 8-13, in particular 8, 9, 10 or 11 and/or a VL region comprising a CDR3 consisting of a sequence having at least 95% sequence identity with any one of SEQ ID NOs: 20-25, in particular 20, 21, 22 or 23.

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Embodiments which refer herein to “at least 80%” or “80% or greater”, will be understood to include all values equal to or greater than 80%, such as 85%, 90%, 95%, 97%, 98%, 99% or 100% sequence identity. In one embodiment, the antibody or fragment of the invention comprises at least 85%, such as at least 90%, at least 95%, at least 97%, at least 98% or at least 99% sequence identity to the specified sequence.

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Instead of percentage sequence identity, the embodiments may also be defined with one or more amino acid changes, for examples one or more additions, substitutions and/or deletions. In one embodiment, the sequence may comprise up to five amino acid changes, such as up to three amino acid changes, in particular up to two amino acid changes. In a further embodiment, the sequence may comprise up to five amino acid substitutions, such as up to three amino acid substitutions, in particular up to one or two amino acid substitutions. For example, CDR3 of the antibody or fragment thereof of the present invention comprises or more suitably consists of a sequence having no more than 2, more suitably no more than 1 substitution(s) compared to any one of SEQ ID NOs: 2-25.

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Suitably any residues of CDR1, CDR2 or CDR3 differing from their corresponding residues in SEQ ID NO: 2-61 and SEQUENCES: A1-A12 are conservative substitutions with respect to their corresponding residues. For example, any residues of CDR3 differing from their corresponding residues in SEQ ID NOs: 2-25 are conservative substitutions with respect to their corresponding residues.

In one embodiment, the antibody or fragment thereof comprises:

- (i) a VH region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-13;
- 5 (ii) a VH region comprising a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 26-37;
- (iii) a VH region comprising a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 38-49;
- 10 (iv) a VL region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 14-25;
- (v) a VL region comprising a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQUENCES: A1-A12; and/or
- (vi) a VL region comprising a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 50-61.

In one embodiment, the antibody or fragment thereof comprises a heavy chain with:

- (i) a VH region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-13;
- 20 (ii) a VH region comprising a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 26-37; and
- (iii) a VH region comprising a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 38-49.

In one embodiment, the antibody or fragment thereof comprises a light chain with:

- 25 (i) a VL region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 14-25;
- (ii) a VL region comprising a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQUENCES: A1-A12; and
- 30 (iii) a VL region comprising a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 50-61.

In one embodiment, the antibody or fragment thereof comprises (or consists of) a VH region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2, 3, 4, 5 or 6, such as 2, 3, 4 or 5, in particular 2, 3 or 4. In one
35 embodiment, the antibody or fragment thereof comprises (or consists of) a VH region comprising a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 26, 27, 28, 29 or 30, such as 26, 27, 28 or 29, in particular 26, 27 or 28.

In one embodiment, the antibody or fragment thereof comprises (or consists of) a VH region comprising a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 38, 39, 40, 41 or 42, such as 38, 39, 40 or 41, in particular 38, 39 or 40.

- 5 In one embodiment, the antibody or fragment thereof comprises (or consists of) a VH region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 8, 9, 10 or 11. In one embodiment, the antibody or fragment thereof comprises (or consists of) a VH region comprising a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 32, 33, 34 or 35. In one
10 embodiment, the antibody or fragment thereof comprises (or consists of) a VH region comprising a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 44, 45, 46 or 47.

- In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO:
15 2, a CDR2 comprising a sequence of SEQ ID NO: 26, and a CDR1 comprising a sequence of SEQ ID NO: 38. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 2, the CDR2 consists of a sequence of SEQ ID NO: 26, and the CDR1 consists of a sequence of SEQ ID NO: 38.

- 20 In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 3, a CDR2 sequence of SEQ ID NO: 27, and a CDR1 sequence of SEQ ID NO: 39. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 3, the CDR2 consists of a sequence of SEQ ID NO: 27, and the CDR1 consists of a sequence of SEQ ID NO: 39.

- 25 In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 4, a CDR2 comprising a sequence of SEQ ID NO: 28, and a CDR1 comprising a sequence of SEQ ID NO: 40. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 4, the CDR2 consists of a sequence of SEQ ID NO: 28, and the CDR1 consists of a sequence of
30 SEQ ID NO: 40.

- In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO:
5, a CDR2 comprising a sequence of SEQ ID NO: 29, and a CDR1 comprising a sequence of
35 SEQ ID NO: 41. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 5, the CDR2 consists of a sequence of SEQ ID NO: 29, and the CDR1 consists of a sequence of SEQ ID NO: 41.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 6, a CDR2 comprising a sequence of SEQ ID NO: 30, and a CDR1 comprising a sequence of SEQ ID NO: 42. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 6, the CDR2 consists of a sequence of SEQ ID NO: 30, and the CDR1 consists of a sequence of SEQ ID NO: 42.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 8, a CDR2 sequence of SEQ ID NO: 32, and a CDR1 sequence of SEQ ID NO: 44. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 8, the CDR2 consists of a sequence of SEQ ID NO: 32, and the CDR1 consists of a sequence of SEQ ID NO: 44.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 9, a CDR2 sequence of SEQ ID NO: 33, and a CDR1 sequence of SEQ ID NO: 45. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 9, the CDR2 consists of a sequence of SEQ ID NO: 33, and the CDR1 consists of a sequence of SEQ ID NO: 45.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 10, a CDR2 sequence of SEQ ID NO: 34, and a CDR1 sequence of SEQ ID NO: 46. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 10, the CDR2 consists of a sequence of SEQ ID NO: 34, and the CDR1 consists of a sequence of SEQ ID NO: 47.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 11, a CDR2 sequence of SEQ ID NO: 35, and a CDR1 sequence of SEQ ID NO: 47. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 11, the CDR2 consists of a sequence of SEQ ID NO: 35, and the CDR1 consists of a sequence of SEQ ID NO: 47.

In one embodiment, the antibody or fragment thereof comprises (or consists of) a VL region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 14-25, such as SEQ ID NOs: 14, 15, 16, 17 or 18 such as 14, 15, 16 or 17, in particular 14, 15 or 16. In one embodiment, the antibody or fragment thereof comprises (or consists of) a VL region comprising a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQUENCES: A1-A12 (of Table 2), such as SEQUENCES: A1, A2, A3, A4 or A5, such as A1, A2, A3 or A4, in particular A1, A2 or A3. In one embodiment, the antibody or fragment thereof comprises (or consists of) a VL region comprising a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 50-61, such as SEQ ID NOs: 50, 51, 52, 53 or 54, such as 50, 51, 52 or 53, in particular 50, 51 or 52.

In one embodiment, the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 14, a CDR2 comprising a sequence of SEQUENCE: A1, and a CDR1 comprising a sequence of SEQ ID NO: 50. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 14, the CDR2 consists of a sequence of SEQUENCE: A1, and the CDR1 consists of a sequence of SEQ ID NO: 50.

In one embodiment, the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 15, a CDR2 comprising a sequence of SEQUENCE: A2, and a CDR1 comprising a sequence of SEQ ID NO: 51. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 15, the CDR2 consists of a sequence of SEQUENCE: A2, and the CDR1 consists of a sequence of SEQ ID NO: 51.

In one embodiment, the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 16, a CDR2 comprising a sequence of SEQUENCE: A3, and a CDR1 comprising a sequence of SEQ ID NO: 52. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 16, the CDR2 consists of a sequence of SEQUENCE: A3, and the CDR1 consists of a sequence of SEQ ID NO: 52.

In one embodiment, the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 17, a CDR2 comprising a sequence of SEQUENCE: A4, and a CDR1 comprising a sequence of SEQ ID NO: 53. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 17, the CDR2 consists of a sequence of SEQUENCE: A4, and the CDR1 consists of a sequence of SEQ ID NO: 53.

In one embodiment, the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 18, a CDR2 comprising a sequence of SEQUENCE: A5, and a CDR1 comprising a sequence of SEQ ID NO: 54. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 18, the CDR2 consists of a sequence of SEQUENCE: A5, and the CDR1 consists of a sequence of SEQ ID NO: 54.

In one embodiment, the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 20, a CDR2 comprising a sequence of SEQUENCE: A7, and a CDR1 comprising a sequence of SEQ ID NO: 56. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 20, the CDR2 consists of a sequence of SEQUENCE: A7, and the CDR1 consists of a sequence of SEQ ID NO: 56.

In one embodiment, the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 21, a CDR2 comprising a sequence of SEQUENCE: A8, and a CDR1 comprising a sequence of SEQ ID NO: 57. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 21, the CDR2 consists of a sequence of SEQUENCE: A8, and the CDR1 consists of a sequence of SEQ ID NO: 57.

In one embodiment, the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 22, a CDR2 comprising a sequence of SEQUENCE: A9, and a CDR1 comprising a sequence of SEQ ID NO: 58. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 22, the CDR2 consists of a sequence of SEQUENCE: A9, and the CDR1 consists of a sequence of SEQ ID NO: 58.

In one embodiment, the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 23, a CDR2 comprising a sequence of SEQUENCE: A10, and a CDR1 comprising a sequence of SEQ ID NO: 59. In one embodiment, the CDR3 consists of a sequence of SEQ ID NO: 23, the CDR2 consists of a sequence of SEQUENCE: A10, and the CDR1 consists of a sequence of SEQ ID NO: 59.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 2, a CDR2 comprising a sequence of SEQ ID NO: 26, a CDR1 comprising a sequence of SEQ ID NO: 38, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 14, a CDR2 comprising a sequence of SEQUENCE: A1, and a CDR1 comprising a sequence of SEQ ID NO: 50. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 2, the HCDR2 consists of a sequence of SEQ ID NO: 26, the HCDR1 consists of a sequence of SEQ ID NO: 38, the LCDR3 consists of a sequence of SEQ ID NO: 14, the LCDR2 consists of a sequence of SEQUENCE: A1, and the LCDR1 consists of a sequence of SEQ ID NO: 50.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 3, a CDR2 comprising a sequence of SEQ ID NO: 27, a CDR1 comprising a sequence of SEQ ID NO: 39, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 15, a CDR2 comprising a sequence of SEQUENCE: A2, and a CDR1 comprising a sequence of SEQ ID NO: 51. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 3, the HCDR2 consists of a sequence of SEQ ID NO: 27, the HCDR1 consists of a sequence of SEQ ID NO: 39, the LCDR3 consists of a sequence of SEQ ID NO: 15, the LCDR2 consists of a sequence of SEQUENCE: A2, and the LCDR1 consists of a sequence of SEQ ID NO: 51.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 4, a CDR2 comprising a sequence of SEQ ID NO: 28, a CDR1 comprising a sequence of SEQ ID NO: 40, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 16, a CDR2 comprising a sequence of SEQUENCE: A3, and a CDR1 comprising a sequence of
5 SEQ ID NO: 52. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 4, the HCDR2 consists of a sequence of SEQ ID NO: 28, the HCDR1 consists of a sequence of SEQ ID NO: 40, the LCDR3 consists of a sequence of SEQ ID NO: 16, the LCDR2 consists of a sequence of SEQUENCE: A3, and the LCDR1 consists of a sequence of SEQ ID NO: 52.

10 In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 5, a CDR2 comprising a sequence of SEQ ID NO: 29, a CDR1 comprising a sequence of SEQ ID NO: 41, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 17, a CDR2 comprising a sequence of SEQUENCE: A4, and a CDR1 comprising a sequence of SEQ ID NO: 53. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 5,
15 the HCDR2 consists of a sequence of SEQ ID NO: 29, the HCDR1 consists of a sequence of SEQ ID NO: 41, the LCDR3 consists of a sequence of SEQ ID NO: 17, the LCDR2 consists of a sequence of SEQUENCE: A4, and the LCDR1 consists of a sequence of SEQ ID NO: 53.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 6, a CDR2 comprising a sequence of SEQ ID NO: 30, a CDR1 comprising a sequence of SEQ ID NO: 42, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 18, a CDR2 comprising a sequence of SEQUENCE: A5, and a CDR1 comprising a sequence of
20 SEQ ID NO: 54. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 6, the HCDR2 consists of a sequence of SEQ ID NO: 30, the HCDR1 consists of a sequence of SEQ ID NO: 42, the LCDR3 consists of a sequence of SEQ ID NO: 18, the LCDR2 consists of a sequence of SEQUENCE: A5, and the LCDR1 consists of a sequence of SEQ ID NO: 54.
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In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 7, a CDR2 comprising a sequence of SEQ ID NO: 31, a CDR1 comprising a sequence of SEQ ID NO: 43, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 19, a CDR2 comprising a sequence of SEQUENCE: A6, and a CDR1 comprising a sequence of
30 SEQ ID NO: 55. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 7, the HCDR2 consists of a sequence of SEQ ID NO: 31, the HCDR1 consists of a sequence of SEQ ID NO: 43, the LCDR3 consists of a sequence of SEQ ID NO: 19, the LCDR2 consists of a sequence of SEQUENCE: A6, and the LCDR1 consists of a sequence of SEQ ID NO: 55.
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In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 8, a CDR2 comprising a sequence of SEQ ID NO: 32, a CDR1 comprising a sequence of SEQ ID NO: 44, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 20, a CDR2 comprising a sequence of SEQUENCE: A7, and a CDR1 comprising a sequence of
5 SEQ ID NO: 56. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 8, the HCDR2 consists of a sequence of SEQ ID NO: 32, the HCDR1 consists of a sequence of SEQ ID NO: 44, the LCDR3 consists of a sequence of SEQ ID NO: 20, the LCDR2 consists of a sequence of SEQUENCE: A7, and the LCDR1 consists of a sequence of SEQ ID NO: 56.

10 In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 9, a CDR2 comprising a sequence of SEQ ID NO: 33, a CDR1 comprising a sequence of SEQ ID NO: 45, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 21, a CDR2 comprising a sequence of SEQUENCE: A8, and a CDR1 comprising a sequence of
15 SEQ ID NO: 57. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 9, the HCDR2 consists of a sequence of SEQ ID NO: 33, the HCDR1 consists of a sequence of SEQ ID NO: 45, the LCDR3 consists of a sequence of SEQ ID NO: 21, the LCDR2 consists of a sequence of SEQUENCE: A8, and the LCDR1 consists of a sequence of SEQ ID NO: 57.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO:
20 10, a CDR2 comprising a sequence of SEQ ID NO: 34, a CDR1 comprising a sequence of SEQ ID NO: 46, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 22, a CDR2 comprising a sequence of SEQUENCE: A9, and a CDR1 comprising a sequence of SEQ ID NO: 58. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO:
25 10, the HCDR2 consists of a sequence of SEQ ID NO: 34, the HCDR1 consists of a sequence of SEQ ID NO: 46, the LCDR3 consists of a sequence of SEQ ID NO: 22, the LCDR2 consists of a sequence of SEQUENCE: A9, and the LCDR1 consists of a sequence of SEQ ID NO: 58.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO:
30 11, a CDR2 comprising a sequence of SEQ ID NO: 35, a CDR1 comprising a sequence of SEQ ID NO: 47, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 23, a CDR2 comprising a sequence of SEQUENCE: A10, and a CDR1 comprising a sequence of SEQ ID NO: 59. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO:
35 11, the HCDR2 consists of a sequence of SEQ ID NO: 35, the HCDR1 consists of a sequence of SEQ ID NO: 47, the LCDR3 consists of a sequence of SEQ ID NO: 23, the LCDR2 consists of a sequence of SEQUENCE: A10, and the LCDR1 consists of a sequence of SEQ ID NO: 59.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 12, a CDR2 comprising a sequence of SEQ ID NO: 36, a CDR1 comprising a sequence of SEQ ID NO: 48, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 24, a CDR2 comprising a sequence of SEQUENCE: A11, and a CDR1 comprising a sequence of SEQ ID NO: 60. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 12, the HCDR2 consists of a sequence of SEQ ID NO: 36, the HCDR1 consists of a sequence of SEQ ID NO: 48, the LCDR3 consists of a sequence of SEQ ID NO: 24, the LCDR2 consists of a sequence of SEQUENCE: A11, and the LCDR1 consists of a sequence of SEQ ID NO: 60.

In one embodiment, the VH region comprises a CDR3 comprising a sequence of SEQ ID NO: 13, a CDR2 comprising a sequence of SEQ ID NO: 37, a CDR1 comprising a sequence of SEQ ID NO: 49, and the VL region comprises a CDR3 comprising a sequence of SEQ ID NO: 25, a CDR2 comprising a sequence of SEQUENCE: A12, and a CDR1 comprising a sequence of SEQ ID NO: 61. In one embodiment, the HCDR3 consists of a sequence of SEQ ID NO: 13, the HCDR2 consists of a sequence of SEQ ID NO: 37, the HCDR1 consists of a sequence of SEQ ID NO: 49, the LCDR3 consists of a sequence of SEQ ID NO: 25, the LCDR2 consists of a sequence of SEQUENCE: A12, and the LCDR1 consists of a sequence of SEQ ID NO: 61.

In one embodiment, the antibody or fragment thereof comprises one or more CDR sequences as described in **Table 2**. In a further embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1252_P01_C08 as described in **Table 2**. In an alternative embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1245_P01_E07 as described in **Table 2**. In an alternative embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1245_P02_G04 as described in **Table 2**. In an alternative embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1245_P02_B07 as described in **Table 2**. In an alternative embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1251_P02_C05 as described in **Table 2**. In an alternative embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1139_P01_E04 as described in **Table 2**. In an alternative embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1245_P02_F07 as described in **Table 2**. In an alternative embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1245_P01_G06 as described in **Table 2**. In an alternative embodiment, the antibody or

fragment thereof comprises one or more (such as all) CDR sequences of clone 1245_P01_G09 as described in **Table 2**. In an alternative embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1138_P01_B09 as described in **Table 2**. In an alternative embodiment, the antibody or fragment thereof comprises one or more (such as all) CDR sequences of clone 1251_P02_G10 as described in **Table 2**.

Suitably the VH and VL regions recited above each comprise four framework regions (FR1-FR4). In one embodiment, the antibody or fragment thereof comprises a framework region (e.g. FR1, FR2, FR3 and/or FR4) comprising a sequence having at least 80% sequence identity with the framework region in any one of SEQ ID NOs: 62-85. In one embodiment, the antibody or fragment thereof comprises a framework region (e.g. FR1, FR2, FR3 and/or FR4) comprising a sequence having at least 90%, such as at least 95%, 97% or 99% sequence identity with the framework region in any one of SEQ ID NOs: 62-85. In one embodiment, the antibody or fragment thereof comprises a framework region (e.g. FR1, FR2, FR3 and/or FR4) comprising a sequence in any one of SEQ ID NOs: 62-85. In one embodiment, the antibody or fragment thereof comprises a framework region (e.g. FR1, FR2, FR3 and/or FR4) consisting of a sequence in any one of SEQ ID NOs: 62-85.

The antibodies described herein may be defined by their full light chain and/or heavy chain variable sequences. Therefore, according to a further aspect of the invention, there is provided an isolated anti-V δ 1 antibody or fragment thereof, which comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-85. According to a further aspect of the invention, there is provided an isolated anti-V δ 1 antibody or fragment thereof, which consists of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-85.

In one embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-73. In one embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-73. In a further embodiment, the VH region comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62, 63, 64, 65 or 66, such as 62, 63, 64 or 65, in particular 62, 63 or 64. In a further embodiment, the VH region consists of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62, 63, 64, 65 or 66, such as 62, 63, 64 or 65, in particular 62, 63 or 64. In a further embodiment, the VH region comprises an amino acid sequence having at least 80% sequence identity with

any one of SEQ ID NOs: 68, 69, 70, 71, 72 or 73, such as 68, 69, 70 or 71. In a further embodiment, the VH region consists of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 68, 69, 70, 71, 72 or 73, such as 68, 69, 70 or 71.

- 5 In one embodiment, the antibody or fragment thereof comprises a VL region comprising an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 74-85. In one embodiment, the antibody or fragment thereof comprises a VL region consisting of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 74-85. In a further embodiment, the VL region comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 74, 75, 76, 77 or 78, such as 74, 75, 76 or 77, in particular 74, 75 or 76. In a further embodiment, the VL region consists of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 74, 75, 76, 77 or 78, such as 74, 75, 76 or 77, in particular 74, 75 or 76. In a further embodiment, the VL region comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 80, 81, 82, 83, 84 or 85, such as 80, 81, 82 or 83. In a further embodiment, the VL region consists of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 80, 81, 82, 83, 84 or 85, such as 80, 81, 82 or 83.

- 20 In a further embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-73 and a VL region comprising an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 74-85. In a further embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-73 and a VL region consisting of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 74-85.

- 30 In one embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 63 (1252_P01_C08). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 62 (1245_P01_E07). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 64 (1245_P02_G04). In one embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NO: 68 (1139_P01_E04). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 69 (1245_P02_F07). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 70

(1245_P01_G06). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 71 (1245_P01_G09).

5 In one embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 63 (1252_P01_C08). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 62 (1245_P01_E07). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 64 (1245_P02_G04). In an alternative embodiment, the antibody or fragment thereof comprises
10 a VH region consisting of an amino acid sequence of SEQ ID NO: 68 (1139_P01_E04). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 69 (1245_P02_F07). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 70 (1245_P01_G06). In an alternative embodiment, the antibody or fragment
15 thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 71 (1245_P01_G09).

In one embodiment, the antibody or fragment thereof comprises a VL region comprising an amino acid sequence of SEQ ID NO: 75 (1252_P01_C08). In an alternative embodiment, the
20 antibody or fragment thereof comprises a VL region comprising an amino acid sequence of SEQ ID NO: 74 (1245_P01_E07). In an alternative embodiment, the antibody or fragment thereof comprises a VL region comprising an amino acid sequence of SEQ ID NO: 76 (1245_P02_G04). In an alternative embodiment, the antibody or fragment thereof comprises a VL region comprising an amino acid sequence of SEQ ID NO: 80 (1139_P01_E04). In an
25 alternative embodiment, the antibody or fragment thereof comprises a VL region comprising an amino acid sequence of SEQ ID NO: 81 (1245_P02_F07). In an alternative embodiment, the antibody or fragment thereof comprises a VL region comprising an amino acid sequence of SEQ ID NO: 82 (1245_P01_G06). In an alternative embodiment, the antibody or fragment thereof comprises a VL region comprising an amino acid sequence of SEQ ID NO: 83
30 (1245_P01_G09).

In one embodiment, the antibody or fragment thereof comprises a VL region consisting of an amino acid sequence of SEQ ID NO: 75 (1252_P01_C08). In an alternative embodiment, the
antibody or fragment thereof comprises a VL region consisting of an amino acid sequence of
35 SEQ ID NO: 74 (1245_P01_E07). In an alternative embodiment, the antibody or fragment thereof comprises a VL region consisting of an amino acid sequence of SEQ ID NO: 76 (1245_P02_G04). In an alternative embodiment, the antibody or fragment thereof comprises

a VL region consisting of an amino acid sequence of SEQ ID NO: 80 (1139_P01_E04). In an alternative embodiment, the antibody or fragment thereof comprises a VL region consisting of an amino acid sequence of SEQ ID NO: 81 (1245_P02_F07). In an alternative embodiment, the antibody or fragment thereof comprises a VL region consisting of an amino acid sequence of SEQ ID NO: 82 (1245_P01_G06). In an alternative embodiment, the antibody or fragment thereof comprises a VL region consisting of an amino acid sequence of SEQ ID NO: 83 (1245_P01_G09).

In one embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 63 (1252_P01_C08) and a VL region comprising an amino acid sequence of SEQ ID NO: 75 (1252_P01_C08). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 62 (1245_P01_E07) and a VL region comprising an amino acid sequence of SEQ ID NO: 74 (1245_P01_E07). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 64 (1245_P02_G04) and a VL region comprising an amino acid sequence of SEQ ID NO: 76 (1245_P02_G04). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 68 (1139_P01_E04) and a VL region comprising an amino acid sequence of SEQ ID NO: 80 (1139_P01_E04). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 69 (1245_P02_F07) and a VL region comprising an amino acid sequence of SEQ ID NO: 81 (1245_P02_F07). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 70 (1245_P01_G06) and a VL region comprising an amino acid sequence of SEQ ID NO: 82 (1245_P01_G06). In an alternative embodiment, the antibody or fragment thereof comprises a VH region comprising an amino acid sequence of SEQ ID NO: 71 (1245_P01_G06) and a VL region comprising an amino acid sequence of SEQ ID NO: 83 (1245_P01_G09).

In one embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 63 (1252_P01_C08) and a VL region consisting of an amino acid sequence of SEQ ID NO: 75 (1252_P01_C08). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 62 (1245_P01_E07) and a VL region consisting of an amino acid sequence of SEQ ID NO: 74 (1245_P01_E07). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 64 (1245_P02_G04) and a VL region consisting of an amino acid sequence of SEQ ID NO: 76

(1245_P02_G04). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 68 (1139_P01_E04) and a VL region consisting of an amino acid sequence of SEQ ID NO: 80 (1139_P01_E04). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 69 (1245_P02_F07) and a VL region consisting of an amino acid sequence of SEQ ID NO: 81 (1245_P02_F07). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 70 (1245_P01_G06) and a VL region consisting of an amino acid sequence of SEQ ID NO: 82 (1245_P01_G06). In an alternative embodiment, the antibody or fragment thereof comprises a VH region consisting of an amino acid sequence of SEQ ID NO: 71 (1245_P01_G06) and a VL region consisting of an amino acid sequence of SEQ ID NO: 83 (1245_P01_G09).

For fragments comprising both the VH and VL regions, these may be associated either covalently (e.g. via disulphide bonds or a linker) or non-covalently. The antibody fragment described herein may comprise an scFv, *i.e.* a fragment comprising a VH region and a VL region joined by a linker. In one embodiment, the VH and VL region are joined by a (e.g. synthetic) polypeptide linker. The polypeptide linker may comprise a $(\text{Gly}_4\text{Ser})_n$ linker, where n = from 1 to 8, e.g. 2, 3, 4, 5 or 7. The polypeptide linker may comprise a $[(\text{Gly}_4\text{Ser})_n(\text{Gly}_3\text{AlaSer})_m]_p$ linker, where n = from 1 to 8, e.g. 2, 3, 4, 5 or 7, m = from 1 to 8, e.g. 0, 1, 2 or 3, and p = from 1 to 8, e.g. 1, 2 or 3. In a further embodiment, the linker comprises SEQ ID NO: 98. In a further embodiment, the linker consists of SEQ ID NO: 98.

In one embodiment, the antibody or fragment thereof comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 86-97. In a further embodiment, the antibody or fragment thereof comprises an amino acid sequence of any one of SEQ ID NOs: 86-97. In a yet further embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NO: 87 (1252_P01_C08). In an alternative embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NO: 86 (1245_P01_E07). In an alternative embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NO: 88 (1245_P02_G04). In an alternative embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NO: 92 (1139_P01_E04). In an alternative embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NO: 93 (1245_P02_F07). In an alternative embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NO: 94 (1245_P01_G06). In an alternative embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NO: 95 (1245_P01_G09).

In one embodiment, the antibody or fragment thereof consists of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 86-97. In a further embodiment, the antibody or fragment thereof consists of an amino acid sequence of any one of SEQ ID NOs: 86-97. In a yet further embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NO: 87 (1252_P01_C08). In an alternative embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NO: 86 (1245_P01_E07). In an alternative embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NO: 88 (1245_P02_G04). In an alternative embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NO: 92 (1139_P01_E04). In an alternative embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NO: 93 (1245_P02_F07). In an alternative embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NO: 94 (1245_P01_G06). In an alternative embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NO: 95 (1245_P01_G09).

It will be understood by a person skilled in the art that scFv constructs may be designed and made inclusive of N-terminal and C-terminal modifications to aid with translation, purification and detection. For example, at the N-terminus of an scFv sequence, an additional methionine and/or alanine amino acid residue may be included ahead of the canonical VH sequences (e.g. starting QVQ or EVQ). At the C-terminus (*i.e.* C-terminal to the canonical VL domain sequence ending as per the IMGT definition), additional sequences may be included such as (i) a partial sequence of the constant domain and/or (ii) additional synthetic sequences inclusive of tags, such as His-tags and Flag-tags, to aid with purification and detection. In one embodiment, SEQ ID NO: 124 is added to the C-terminus of any one of SEQ ID NOs: 86, 88-90, 92-97. In one embodiment, SEQ ID NO: 125 is added to the C-terminus of any one of SEQ ID NOs: 86, 88-90, 92-97. In one embodiment, SEQ ID NO: 126 is added to the C-terminus of any one of SEQ ID NOs: 87 or 91. In one embodiment, SEQ ID NO: 127 is added to the C-terminus of any one of SEQ ID NOs: 87 or 91. It is well understood that said scFv N- or C-terminal sequences are optional and can be removed, modified or substituted if alternate scFv design, translation, purification or detection strategies are adopted.

As described herein, the antibodies may be in any format. In a preferred embodiment, the antibody is in an IgG1 format. Therefore, in one embodiment, the antibody or fragment thereof comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 111-122. In a further embodiment, the antibody or fragment thereof comprises an amino acid sequence of any one of SEQ ID NOs: 111-122. In a yet further embodiment,

the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NOs: 111-116, such as SEQ ID NOs: 111-113 and 116. In a yet further embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NOs: 117-122, such as SEQ ID NOs: 117-120. In a yet further embodiment, the antibody or fragment thereof comprises an amino acid sequence of SEQ ID NOs: 111, 112, 116-120, such as SEQ ID NOs: 111, 112 or 116, or SEQ ID NOs: 117-120.

In one embodiment, the antibody or fragment thereof consists of an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 111-122. In a further embodiment, the antibody or fragment thereof consists of an amino acid sequence of any one of SEQ ID NOs: 111-122. In a yet further embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NOs: 111-116, such as SEQ ID NOs: 111-113 and 116. In a yet further embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NOs: 117-122, such as SEQ ID NOs: 117-120. In a yet further embodiment, the antibody or fragment thereof consists of an amino acid sequence of SEQ ID NOs: 111, 112, 116-120, such as SEQ ID NOs: 111, 112 or 116, or SEQ ID NOs: 117-120.

In one embodiment, the antibody binds to the same, or essentially the same, epitope as, or competes with, an antibody or fragment thereof as defined herein. One can easily determine whether an antibody binds to the same epitope as, or competes for binding with, a reference anti-V δ 1 antibody by using routine methods known in the art. For example, to determine if a test antibody binds to the same epitope as a reference anti-V δ 1 antibody of the invention, the reference antibody is allowed to bind to a V δ 1 protein or peptide under saturating conditions. Next, the ability of a test antibody to bind to the V δ 1 chain is assessed. If the test antibody is able to bind to V δ 1 following saturation binding with the reference anti-V δ 1 antibody, it can be concluded that the test antibody binds to a different epitope than the reference anti-V δ 1 antibody. On the other hand, if the test antibody is not able to bind to the V δ 1 chain following saturation binding with the reference anti-V δ 1 antibody, then the test antibody may bind to the same epitope as the epitope bound by the reference anti-V δ 1 antibody of the invention.

The present invention also includes anti-V δ 1 antibodies that compete for binding to V δ 1 with an antibody or fragment thereof as defined herein, or an antibody having the CDR sequences of any of the exemplary antibodies described herein. For example, competitive assays can be performed with the antibody of the present invention in order to determine what proteins, antibodies, and other antagonists compete for binding to the V δ 1 chain with the antibody of the present invention and/or share the epitope. These assays are readily known to those of skill in the art; they evaluate competition between antagonists or ligands for a limited number

of binding sites on a protein, e.g. V δ 1. The antibody (or fragment thereof) is immobilized or insolubilized before or after the competition and the sample bound to the V δ 1 chain is separated from the unbound sample, for example, by decanting (where the antibody was pre-insolubilized) or by centrifuging (where the antibody was precipitated after the competitive
5 reaction). Also, the competitive binding may be determined by whether the function is altered by the binding or lack of binding of the antibody to the protein, e.g. whether the antibody molecule inhibits or potentiates the enzymatic activity of, for example, a label. ELISA and other functional assays may be used, as known in the art and described herein.

10 Two antibodies bind to the same or overlapping epitope if each competitively inhibits (blocks) binding of the other to the target antigen. That is, a 1-, 5-, 10-, 20- or 100-fold excess of one antibody inhibits binding of the other by at least 50% but preferably 75%, 90% or even 99% as measured in a competitive binding assay. Alternatively, two antibodies have the same epitope if essentially all amino acid mutations in the target antigen that reduce or eliminate binding of
15 one antibody reduce or eliminate binding of the other.

Additional routine experimentation (e.g. peptide mutation and binding analyses) can then be carried out to confirm whether the observed lack of binding of the test antibody is in fact due to binding to the same epitope as the reference antibody or if steric blocking (or another
20 phenomenon) is responsible for the lack of observed binding. Experiments of this sort can be performed using ELISA, RIA, surface plasmon resonance, flow cytometry or any other quantitative or qualitative antibody-binding assay available in the art.

In some embodiments, the antibody or fragment thereof contains a modified effector function through alteration to the sugars linked to Asn 297 (EU numbering scheme). In a further said modification, Asn 297 is not fucosylated or exhibits reduced fucosylation (i.e., a defucosylated antibody or a non-fucosylated antibody). Fucosylation includes the addition of the sugar fucose to a molecule, for example, the attachment of fucose to N-glycans, O-glycans and glycolipids. Accordingly, in a defucosylated antibody, fucose is not attached to the carbohydrate chains of
25 the constant region. The antibody may be modified to prevent or inhibit fucosylation of the antibody. Typically, glycosylation modifications involve expressing said antibody or fragment thereof in a host cell containing alternate glycosylation processing capabilities either through targeted engineering or through targeted or serendipitous host or clone selection (e.g. see Example 13). These and other effector modifications are discussed further in recent reviews
30 such as by Xinhua Wang et al. (2018) Protein & Cell 9: 63-73 and by Pereira et al. (2018) mAbs 10(5): 693-711 and which are hereby incorporated.

Antibody sequence modifications

The antibodies and fragments thereof may be modified using known methods. Sequence modifications to antibody molecules described herein can be readily incorporate by those skilled in the art. The following examples are non-limiting.

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During antibody discovery and sequence recovery from phage libraries, desired antibody variable domains may be re-formatted into full length IgG by sub-cloning. To accelerate the process, variable domains are often transferred using restriction enzymes. These unique restriction sites may introduce additional/alternate amino acids and away from the canonical sequence (such canonical sequences may be found, for example, in the international ImMunoGeneTics [IMGT] information system, see <http://www.imgt.org>). These may be introduced as kappa or lambda light chain sequence modifications.

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Kappa light chain modifications

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The variable kappa light chain variable sequences may be cloned using restriction sites (e.g. Nhe1-Not1) during re-formatting into full length IgG. More specifically, at the kappa light chain N-terminus, an additional Ala-Ser sequence was introduced to support cloning. Preferably, this additional AS sequence is then removed during further development such to generate the canonical N-terminal sequence. Hence, in one embodiment, kappa light chain containing antibodies described herein do not contain an AS sequence at their N-termini, *i.e.* SEQ ID NOs: 74, 76-78 and 80-85 do not comprise the initial AS sequence. In a further embodiment, SEQ ID NOs: 74 and 76-78 do not comprise the initial AS sequence. It will be understood that this embodiment also applies to other sequences included herein which contain this sequence (e.g. SEQ ID NOs: 86, 88-90 and 92-97).

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Additional amino acid changes may be made to support cloning. For example, for the antibodies described herein, at the kappa light-chain variable-domain/constant domain border a valine-to-alanine change was introduced to support cloning. This resulted in a kappa constant domain modification. Specifically, this results in the constant domain beginning RTAAAPS (from a NotI restriction site). Preferably, this sequence can be modified during further development to generate the canonical kappa light-chain constant regions which start with RTVAAPS. Hence, in one embodiment kappa light chain containing antibodies described herein contain a constant domain starting with the sequence RTV. Therefore, in one embodiment, sequence RTAAAPS of SEQ ID NOs: 111-114 and 117-122 is replaced with sequence RTVAAPS.

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Lambda light chain modifications

Similar to the kappa example above, the lambda light chain variable domains may also be cloned by introducing restriction sites (e.g. Nhe1-Not1) during re-formatting into full length IgG. More specifically, at the lambda light chain N-terminus, an additional Ala-Ser sequence may be introduced to support cloning. Preferably, this additional AS sequence is then removed during further development such to generate the canonical N-terminal sequence. Hence, in one embodiment, lambda light chain containing antibodies described herein do not contain an AS sequence at their N-termini *i.e.* SEQ ID NOs: 75 and 79 do not comprise the initial AS sequence. It will be understood that this embodiment also applies to other sequences included herein which contain this sequence (e.g. SEQ ID NOs: 87, 91, 115 and 116). In one embodiment, SEQ ID NO: 75 does not contain the initial six residues, *i.e.* the ASSYEL sequence is removed.

As another example, for the antibodies described herein at the lambda light-chain variable-domain/constant domain border a lysine-to-alanine sequence change was introduced to support cloning. This resulted in a lambda constant domain modification. Specifically, this results in the constant domain beginning with GQPAAAPS (from a NotI restriction site). Preferably, this sequence can be modified during further development such to generate the canonical lambda light constant region which starts GQPKAAPS. Hence, in one embodiment, lambda light chain containing antibodies described herein contain a constant domain starting with the sequence GQPK. Therefore, in one embodiment, sequence GQPAAAPS of SEQ ID NO: 115 or 116 is replaced with sequence GQPKAAPS.

Heavy chain modifications

Typically, human variable heavy chain sequences start with either the basic glutamine (Q) or acidic glutamate (E). However, both such sequences are then known to convert to the acidic amino acid residue, pyro-glutamate (pE). The Q to pE conversion results in a charge change to the antibody, whilst an E to pE conversion does not change the charge of the antibody. Hence to avoid a variable charge-change over time one option is to modify a starting heavy chain sequence from Q to E in the first instance. Hence, in one embodiment, the heavy chain of antibody described herein contains a Q to E modification at the N-terminus. In particular, the initial residue of SEQ ID NOs: 62, 64 and/or 67-71 may be modified from Q to E. It will be understood that this embodiment also applies to other sequences included herein which contain this sequence (e.g. SEQ ID NOs: 86, 88, 91-97 and 111, 112, 115, 117-120).

Furthermore, the C-terminus of the IgG1 constant domain ends with PGK. However, the terminal basic lysine (K) is then often cleaved during expression (e.g. in CHO cells). This in turn results in charge change to the antibody through varied loss of the C-terminal lysine

residue. Therefore, one option is to remove the lysine in the first instance resulting in a uniform and consistent heavy chain C-terminus sequence ending in PG. Hence, in one embodiment, the heavy chain of an antibody described herein has the terminal K removed from its C-terminus. In particular, the antibody of the invention may comprise any one of SEQ ID NOs:
5 111-122 where the terminal lysine residue has been removed.

Optional allotype modifications

During antibody discovery, specific human allotypes may be employed. Optionally, the antibodies can be switched to differing human allotypes during development. By way of non-
10 limiting example, for the kappa chain there are three human allotypes designated Km1, Km1,2 and Km3 which define three Km alleles (using allotype numbering): Km1 correlates with valine 153 (IMGT V45.1) and leucine 191 (IMGT L101); Km1,2 correlates with alanine 153 (IMGT A45.1) and leucine 191 (IMGT L101); and Km3 correlates with alanine 153 (IMGT A45.1) and valine 191 (IMGT V101). Optionally, one can therefore modify a sequence from one allotype
15 to another by standard cloning approaches. For example, a L191V (IMGT L101V) change will convert a Km1,2 allotype to a Km3 allotype. For further reference on such allotypes see Jefferis and Lefranc (2009) *MAbs* 1(4):332-8, which is herein incorporated by reference.

Hence in one embodiment an antibody described herein contains amino acid substitutions
20 derived from another human allotype of the same gene. In a further embodiment, the antibody contains a L191V (IMGT L101V) substitution to the kappa chain to convert the c-domain from a km1,2 to a km3 allotype.

Antibody binding

The antibody or fragment thereof of the invention may bind to the V δ 1 chain of a $\gamma\delta$ TCR with
25 a binding affinity (KD) as measured by surface plasmon resonance of less than 1.5×10^{-7} M (*i.e.* 150 nM). In a preferred embodiment, the KD is less than 1.5×10^{-7} M (*i.e.* 150 nM). In a further embodiment, the KD is 1.3×10^{-7} M (*i.e.* 130 nM) or less, such as 1.0×10^{-7} M (*i.e.* 100 nM) or less. In a yet further embodiment, the KD is less than 5.0×10^{-8} M (*i.e.* 50 nM), such as
30 less than 4.0×10^{-8} M (*i.e.* 40 nM), less than 3.0×10^{-8} M (*i.e.* 30 nM) or less than 2.0×10^{-8} M (*i.e.* 20 nM). For example, according to one aspect, there is provided a human anti-V δ 1 antibody which binds to the V δ 1 chain of a $\gamma\delta$ TCR with a binding affinity (KD) as measured by surface plasmon resonance of less than 1.5×10^{-7} M (*i.e.* 150 nM).

35 In one aspect of the invention, there is provided an antibody or fragment thereof which binds to the V δ 1 chain of a $\gamma\delta$ TCR with a binding affinity (KD) as measured by surface plasmon

resonance of less than 4.0×10^{-8} M (*i.e.* 40 nM), less than 3.0×10^{-8} M (*i.e.* 30 nM) or less than 2.0×10^{-8} M (*i.e.* 20 nM).

In one embodiment, the binding affinity of the antibody or fragment thereof is established by coating the antibody or fragment thereof directly or indirectly (*e.g.* by capture with an anti-human IgG Fc) onto the surface of a sensor (*e.g.* an amine high capacity chip or equivalent), wherein the target bound by the antibody or fragment thereof (*i.e.* the $\gamma\delta$ 1 chain of a $\gamma\delta$ TCR) is flowed over the chip to detect binding. Suitably, a MASS-2 instrument (which may also be referred to as Sierra SPR-32) is used at 25 °C in PBS + 0.02 % Tween 20 running buffer at 30 μ l/min.

Described herein are other assays which may be used to define antibody function. For example, the antibody or fragment thereof described herein may be assessed by $\gamma\delta$ TCR engagement, *e.g.* measuring downregulation of the $\gamma\delta$ TCR upon antibody binding. Surface expression of the $\gamma\delta$ TCR following application of the antibody or fragment thereof (optionally presented on the surface of a cell) can be measured, *e.g.* by flow cytometry. The antibody or fragment thereof described herein may also be assessed by measuring $\gamma\delta$ T cell degranulation. For example, expression of CD107a, a marker for cell degranulation, can be measured following application of the antibody or fragment thereof (optionally presented on the surface of a cell) to $\gamma\delta$ T cells, *e.g.* by flow cytometry. The antibody or fragment thereof described herein may also be assessed by measuring $\gamma\delta$ T cell killing activity (to test if the antibody has an effect on the killing activity of the $\gamma\delta$ T cell). For example, target cells may be incubated with $\gamma\delta$ T cells in the presence of the antibody or fragment thereof (optionally presented on the surface of a cell). Following incubation, the culture may be stained with a cell viability dye to distinguish between live and dead target cells. The proportion of dead cells can then be measured, *e.g.* by flow cytometry.

As described herein, the antibodies or fragments thereof used in the assays may be presented on a surface, for example the surface of a cell, such as a cell comprising an Fc receptor. For example, the antibodies or fragments thereof may be presented on the surface of THP-1 cells, such as TIB-202™ cells (available from American Type Culture Collection (ATCC)). Alternatively, the antibodies or fragments thereof may be used directly in the assays.

In such functional assays, output may be measured by calculating the half maximal concentration, also referred to as "EC50" or "effective concentration at 50 percent". The term "IC50" refers to the inhibitory concentration. Both EC50 and IC50 may be measured using methods known in the art, such as flow cytometry methods. For the avoidance of doubt, the

values of EC50 in the present application are provided using IgG1 formatted antibody. Such values can be easily converted based on the molecular weight of the antibody format for equivalent values as follows:

$$(\mu\text{g/ml}) / (\text{MW in kDa}) = \mu\text{M}$$

The EC50 for downregulation of the $\gamma\delta$ TCR upon antibody (or fragment) binding may be less than 0.50 $\mu\text{g/ml}$, such as less than 0.40 $\mu\text{g/ml}$, 0.30 $\mu\text{g/ml}$, 0.20 $\mu\text{g/ml}$, 0.15 $\mu\text{g/ml}$, 0.10 $\mu\text{g/ml}$, 0.06 $\mu\text{g/ml}$ or 0.05 $\mu\text{g/ml}$. In a preferred embodiment, the EC50 for downregulation of the $\gamma\delta$ TCR upon antibody (or fragment) binding is less than 0.10 $\mu\text{g/ml}$. In particular, the EC50 for downregulation of the $\gamma\delta$ TCR upon antibody (or fragment) binding may be less than 0.06 $\mu\text{g/ml}$, such as less than 0.05 $\mu\text{g/ml}$, 0.04 $\mu\text{g/ml}$ or 0.03 $\mu\text{g/ml}$. In particular, said EC50 values are when the antibody is measured in an IgG1 format. For example, the EC50 $\gamma\delta$ TCR downregulation value can be measured using flow cytometry (*e.g.* as described in the assay of Example 6).

The EC50 for $\gamma\delta$ T cell degranulation upon antibody (or fragment) binding may be less than 0.050 $\mu\text{g/ml}$, such as less than 0.040 $\mu\text{g/ml}$, 0.030 $\mu\text{g/ml}$, 0.020 $\mu\text{g/ml}$, 0.015 $\mu\text{g/ml}$, 0.010 $\mu\text{g/ml}$ or 0.008 $\mu\text{g/ml}$. In particular, the EC50 for $\gamma\delta$ T cell degranulation upon antibody (or fragment) binding may be less than 0.005 $\mu\text{g/ml}$, such as less than 0.002 $\mu\text{g/ml}$. In a preferred embodiment, the EC50 for $\gamma\delta$ T cell degranulation upon antibody (or fragment) binding is less than 0.007 $\mu\text{g/ml}$. In particular, said EC50 values are when the antibody is measured in an IgG1 format. For example, the $\gamma\delta$ T cell degranulation EC50 value can be measured by detecting CD107a expression (*i.e.* a marker of cell degranulation) using flow cytometry (*e.g.* as described in the assay of Example 7). In one embodiment, CD107a expression is measured using an anti-CD107a antibody, such as anti-human CD107a BV421 (clone H4A3) (BD Biosciences).

The EC50 for $\gamma\delta$ T cell killing upon the antibody (or fragment) binding may be less than 0.50 $\mu\text{g/ml}$, such as less than 0.40 $\mu\text{g/ml}$, 0.30 $\mu\text{g/ml}$, 0.20 $\mu\text{g/ml}$, 0.15 $\mu\text{g/ml}$, 0.10 $\mu\text{g/ml}$ or 0.07 $\mu\text{g/ml}$. In a preferred embodiment, the EC50 for $\gamma\delta$ T cell killing upon the antibody (or fragment) binding is less than 0.10 $\mu\text{g/ml}$. In particular, the EC50 for $\gamma\delta$ T cell killing upon the antibody (or fragment) binding may be less than 0.060 $\mu\text{g/ml}$, such as less than 0.055 $\mu\text{g/ml}$, in particular less than 0.020 $\mu\text{g/ml}$ or 0.010 $\mu\text{g/ml}$. In particular, said EC50 values are when the antibody is measured in an IgG1 format. For example, the EC50 $\gamma\delta$ T cell killing value can be measured by detecting proportion of dead cells (*i.e.* using a cell viability dye) using flow cytometry following incubation of the antibody, $\gamma\delta$ T cell and target cells (*e.g.* as described in

the assay of Example 8). In one embodiment, death of the target cell is measured using a cell viability dye is Viability Dye eFluor™ 520 (ThermoFisher).

In the assays described in these aspects, the antibody or fragment thereof may be presented on the surface of a cell, such as a THP-1 cell, for example TIB-202™ (ATCC). The THP-1 cells are optionally labelled with a dye, such as CellTracker™ Orange CMTMR (ThermoFisher).

Immunoconjugates

The antibodies or fragments thereof of the present invention may be conjugated to a therapeutic moiety, such as a cytotoxin or a chemotherapeutic agent. Such conjugates may be referred to as immunoconjugates. As used herein, the term "immunoconjugate" refers to an antibody which is chemically or biologically linked to another moiety, such as a cytotoxin, a radioactive agent, a cytokine, an interferon, a target or reporter moiety, an enzyme, a toxin, a peptide or protein or a therapeutic agent. The antibody may be linked to the cytotoxin, radioactive agent, cytokine, interferon, target or reporter moiety, enzyme, toxin, peptide or therapeutic agent at any location along the molecule so long as it is able to bind its target. Examples of immunoconjugates include antibody drug conjugates and antibody-toxin fusion proteins. In one embodiment, the agent may be a second different antibody to Vδ1. In certain embodiments, the antibody may be conjugated to an agent specific for a tumor cell or a virally infected cell. The type of therapeutic moiety that may be conjugated to the anti-Vδ1 antibody and will take into account the condition to be treated and the desired therapeutic effect to be achieved. In one embodiment, the agent may be a second antibody, or fragment thereof, that binds to a molecule other than Vδ1.

Multi-specific antibodies

The antibodies of the present invention may be mono-specific or they may bind additional targets and are therefore bi-specific or multi-specific. Multi-specific antibodies may be specific for different epitopes of one target polypeptide or may be specific for more than one target polypeptide. Therefore, in one embodiment, the antibody or fragment thereof comprises a first binding specificity to Vδ1 and a second binding specificity for a second target epitope.

The second binding specificity may target an antigen on the same cell as Vδ1 or on a different cell of the same tissue type or of a different tissue type. In certain embodiments, the target epitope may be on a different cell including a different T-cell, a B-cell, a tumour cell, an autoimmune tissue cell or a virally infected cell. Alternatively, the target epitope may be on the same cell.

Polynucleotides and expression vectors

In one aspect of the invention there is provided a polynucleotide encoding the anti-V δ 1 antibody or fragment of the invention. In one embodiment, the polynucleotide comprises or
5 consists of a sequence having at least 70%, such as at least 80%, such as at least 90%, such as at least 95%, such as at least 99% sequence identity with SEQ ID NO: 99-110. In one embodiment, the expression vector comprises the VH region of SEQ ID NO: 99-110. In another embodiment, the expression vector comprises the VL region of SEQ ID NO: 99-110. In a further embodiment the polynucleotide comprises or consists of SEQ ID NO: 99-110. In a
10 further aspect there is provided a cDNA comprising said polynucleotide.

In one aspect of the invention there is provided a polynucleotide encoding the anti-V δ 1 antibody or fragment of the invention. In one embodiment, the polynucleotide comprises or consists of a sequence having at least 70%, such as at least 80%, such as at least 90%, such
15 as at least 95%, such as at least 99% sequence identity with SEQ ID NO: 99-101 or 105-108. In one embodiment, the expression vector comprises the VH region of SEQ ID NO: 99-101 or 105-108. In another embodiment, the expression vector comprises the VL region of SEQ ID NO: 99-101 or 105-108. In a further embodiment the polynucleotide comprises or consists of SEQ ID NO: 99-101 or 105-108. In a further aspect there is provided a cDNA comprising said
20 polynucleotide.

In one embodiment, the polynucleotide comprises or consists of a sequence having at least 70%, such as at least 80%, such as at least 90%, such as at least 95%, such as at least 99% sequence identity with SEQ ID NO: 99-101. In one embodiment, the expression vector
25 comprises the VH region of SEQ ID NO: 99-101. In another embodiment, the expression vector comprises the VL region of SEQ ID NO: 99-101. In a further embodiment the polynucleotide comprises or consists of SEQ ID NO: 99-101. In a further aspect there is provided a cDNA comprising said polynucleotide.

30 In one aspect of the invention there is provided a polynucleotide comprising or consisting of a sequence having at least 70%, such as at least 80%, such as at least 90%, such as at least 95%, such as at least 99% sequence identity with any one of the portions of SEQ ID NO: 99-110 which encodes CDR1, CDR2 and/or CDR3 of the encoded immunoglobulin chain variable domain. In one embodiment, the polynucleotide comprises or consists of a sequence having
35 at least 70%, such as at least 80%, such as at least 90%, such as at least 95%, such as at least 99% sequence identity with any one of the portions of SEQ ID NO: 99-101 or 105-108 which encodes CDR1, CDR2 and/or CDR3 of the encoded immunoglobulin chain variable

domain. In one embodiment, the polynucleotide comprises or consists of a sequence having at least 70%, such as at least 80%, such as at least 90%, such as at least 95%, such as at least 99% sequence identity with any one of the portions of SEQ ID NO: 99-101 which encodes CDR1, CDR2 and/or CDR3 of the encoded immunoglobulin chain variable domain.

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In one aspect of the invention there is provided a polynucleotide comprising or consisting of a sequence having at least 70%, such as at least 80%, such as at least 90%, such as at least 95%, such as at least 99% sequence identity with any one of the portions of SEQ ID NO: 99-110 which encodes FR1, FR2, FR3 and/or FR4 of the encoded immunoglobulin chain variable domain. In one embodiment, the polynucleotide comprises or consists of a sequence having at least 70%, such as at least 80%, such as at least 90%, such as at least 95%, such as at least 99% sequence identity with any one of the portions of SEQ ID NO: 99-101 or 105-108 which encodes FR1, FR2, FR3 and/or FR4 of the encoded immunoglobulin chain variable domain. In one embodiment, the polynucleotide comprises or consists of a sequence having at least 70%, such as at least 80%, such as at least 90%, such as at least 95%, such as at least 99% sequence identity with any one of the portions of SEQ ID NO: 99-101 which encodes FR1, FR2, FR3 and/or FR4 of the encoded immunoglobulin chain variable domain.

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The polynucleotides and expression vectors of the invention may also be described in reference to the amino acid sequence encoded. Therefore, in one embodiment, the polynucleotide comprises or consists of a sequence encoding the amino acid sequence of any one of SEQ ID NOs: 62 to 85. In one embodiment, the expression vector comprises a sequence encoding the amino acid sequence of any one of SEQ ID NOs: 62 to 73. In another embodiment, the expression vector comprises a sequence encoding the amino acid sequence of any one of SEQ ID NOs: 74 to 85.

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To express the antibodies, or fragments thereof, polynucleotides encoding partial or full-length light and heavy chains, as described herein, are inserted into expression vectors such that the genes are operatively linked to transcriptional and translational control sequences. Therefore, in one aspect of the invention there is provided an expression vector comprising the polynucleotide sequence as defined herein. In one embodiment, the expression vector comprises the VH region of SEQ ID NO: 99-110, such as SEQ ID NO: 99, 100, 101, 105, 106, 107 or 108. In another embodiment, the expression vector comprises the VL region of SEQ ID NO: 99-110, such as SEQ ID NO: 99, 100, 101, 105, 106, 107 or 108.

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It will be understood that the nucleotide sequences described herein comprise additional sequences encoding amino acid residues to aid with translation, purification and detection,

however alternative sequences may be used depending upon the expression system used. For example, the initial (5'-end) nine nucleotides of SEQ ID NOs: 99-110 and the final (3'-end) 36 nucleotides of SEQ ID NOs: 99-100, 102-103, 105-110, or the final (3'-end) 39 nucleotides of SEQ ID NOs: 101 and 104 are optional sequences. These optional sequences can be removed, modified or substituted if alternate design, translation, purification or detection strategies are adopted.

Mutations can be made to the DNA or cDNA that encode polypeptides which are silent as to the amino acid sequence of the polypeptide, but which provide preferred codons for translation in a particular host. The preferred codons for translation of a nucleic acid in, e.g. *E. coli* and *S. cerevisiae*, as well as mammalian, specifically human, are known.

Mutation of polypeptides can be achieved for example by substitutions, additions or deletions to a nucleic acid encoding the polypeptide. The substitutions, additions or deletions to a nucleic acid encoding the polypeptide can be introduced by many methods, including for example error-prone PCR, shuffling, oligonucleotide-directed mutagenesis, assembly PCR, PCR mutagenesis, *in vivo* mutagenesis, cassette mutagenesis, recursive ensemble mutagenesis, exponential ensemble mutagenesis, site-specific mutagenesis, gene reassembly, artificial gene synthesis, Gene Site Saturation Mutagenesis (GSSM), synthetic ligation reassembly (SLR) or a combination of these methods. The modifications, additions or deletions to a nucleic acid can also be introduced by a method comprising recombination, recursive sequence recombination, phosphothioate-modified DNA mutagenesis, uracil-containing template mutagenesis, gapped duplex mutagenesis, point mismatch repair mutagenesis, repair-deficient host strain mutagenesis, chemical mutagenesis, radiogenic mutagenesis, deletion mutagenesis, restriction-selection mutagenesis, restriction-purification mutagenesis, ensemble mutagenesis, chimeric nucleic acid multimer creation, or a combination thereof.

In particular, artificial gene synthesis may be used. A gene encoding a polypeptide of the invention can be synthetically produced by, for example, solid-phase DNA synthesis. Entire genes may be synthesized *de novo*, without the need for precursor template DNA. To obtain the desired oligonucleotide, the building blocks are sequentially coupled to the growing oligonucleotide chain in the order required by the sequence of the product. Upon the completion of the chain assembly, the product is released from the solid phase to solution, deprotected, and collected. Products can be isolated by high-performance liquid chromatography (HPLC) to obtain the desired oligonucleotides in high purity.

Expression vectors include, for example, plasmids, retroviruses, cosmids, yeast artificial chromosomes (YACs) and Epstein-Barr virus (EBV) derived episomes. The polynucleotide is ligated into a vector such that transcriptional and translational control sequences within the vector serve their intended function of regulating the transcription and translation of the polynucleotide. Expression and/or control sequences can include promoters, enhancers, transcription terminators, a start codon (*i.e.* ATG) 5' to the coding sequence, splicing signals for introns and stop codons. The expression vector and expression control sequences are chosen to be compatible with the expression host cell used. SEQ ID NO: 99-110 comprise the nucleotide sequences encoding single chain variable fragments of the invention, comprising a VH region and a VL region joined by a synthetic linker (encoding SEQ ID NO: 98). It will be understood that polynucleotides or expression vectors of the invention may comprise the VH region, the VL region or both (optionally including the linker). Therefore, polynucleotides encoding the VH and VL regions can be inserted into separate vectors, alternatively sequences encoding both regions are inserted into the same expression vector. The polynucleotide(s) are inserted into the expression vector by standard methods (*e.g.* ligation of complementary restriction sites on the polynucleotide and vector, or blunt end ligation if no restriction sites are present).

A convenient vector is one that encodes a functionally complete human CH or CL immunoglobulin sequence, with appropriate restriction sites engineered so that any VH or VL sequence can be easily inserted and expressed, as described herein. The expression vector can also encode a signal peptide that facilitates secretion of the antibody (or fragment thereof) from a host cell. The polynucleotide may be cloned into the vector such that the signal peptide is linked in-frame to the amino terminus of the antibody. The signal peptide can be an immunoglobulin signal peptide or a heterologous signal peptide (*i.e.* a signal peptide from a non-immunoglobulin protein).

In one aspect of the invention there is provided a cell (*e.g.* a host cell) comprising the polynucleotide or expression vector as defined herein. It will be understood that the cell may comprise a first vector encoding the light chain of the antibody or fragment thereof, and a second vector encoding the heavy chain of the antibody or fragment thereof. Alternatively, the heavy and light chains both encoded on the same expression vector introduced into the cell.

In one embodiment, the polynucleotide or expression vector encodes a membrane anchor or transmembrane domain fused to the antibody or fragment thereof, wherein the antibody or fragment thereof is presented on an extracellular surface of the cell.

Transformation can be by any known method for introducing polynucleotides into a host cell. Methods for introduction of heterologous polynucleotides into mammalian cells are well known in the art and include dextran-mediated transfection, calcium phosphate precipitation, polybrene-mediated transfection, protoplast fusion, electroporation, encapsulation of the polynucleotide(s) in liposomes, biolistic injection and direct microinjection of the DNA into nuclei. In addition, nucleic acid molecules may be introduced into mammalian cells by viral vectors.

Mammalian cell lines available as hosts for expression are well known in the art and include many immortalized cell lines available from the American Type Culture Collection (ATCC). These include, inter alia, Chinese hamster ovary (CHO) cells, NSO, SP2 cells, HeLa cells, baby hamster kidney (BHK) cells, monkey kidney cells (COS), human hepatocellular carcinoma cells (e.g. Hep G2), A549 cells, 3T3 cells, and a number of other cell lines. Mammalian host cells include human, mouse, rat, dog, monkey, pig, goat, bovine, horse and hamster cells. Cell lines of particular preference are selected through determining which cell lines have high expression levels. Other cell lines that may be used are insect cell lines, such as Sf9 cells, amphibian cells, bacterial cells, plant cells and fungal cells. Antigen-binding fragments of antibodies such as the scFv and Fv fragments can be isolated and expressed in *E. coli* using methods known in the art.

The antibodies are produced by culturing the host cells for a period of time sufficient to allow for expression of the antibody in the host cells or, more preferably, secretion of the antibody into the culture medium in which the host cells are grown. Antibodies can be recovered from the culture medium using standard protein purification methods.

Antibodies (or fragments) of the invention can be obtained and manipulated using the techniques disclosed for example in Green and Sambrook, *Molecular Cloning: A Laboratory Manual* (2012) 4th Edition Cold Spring Harbour Laboratory Press.

Monoclonal antibodies can be produced using hybridoma technology, by fusing a specific antibody-producing B cell with a myeloma (B cell cancer) cell that is selected for its ability to grow in tissue culture and for an absence of antibody chain synthesis.

A monoclonal antibody directed against a determined antigen can, for example, be obtained by:

- a) immortalizing lymphocytes obtained from the peripheral blood of an animal previously immunized with a determined antigen, with an immortal cell and preferably with myeloma cells, in order to form a hybridoma,
- b) culturing the immortalized cells (hybridoma) formed and recovering the cells producing the antibodies having the desired specificity.

Alternatively, the use of a hybridoma cell is not required. Antibodies capable of binding to the target antigens as described herein may be isolated from a suitable antibody library via routine practice, for example, using the phage display, yeast display, ribosomal display, or mammalian display technology known in the art. Accordingly, monoclonal antibodies can be obtained, for example, by a process comprising the steps of:

- a) cloning into vectors, especially into phages and more particularly filamentous bacteriophages, DNA or cDNA sequences obtained from lymphocytes especially peripheral blood lymphocytes of an animal (suitably previously immunized with determined antigens),
- b) transforming prokaryotic cells with the above vectors in conditions allowing the production of the antibodies,
- c) selecting the antibodies by subjecting them to antigen-affinity selection,
- d) recovering the antibodies having the desired specificity.

Pharmaceutical compositions

According to a further aspect of the invention, there is provided a composition comprising the antibody or fragment thereof as defined herein. In such embodiments, the composition may comprise the antibody, optionally in combination with other excipients. Also included are compositions comprising one or more additional active agents (e.g. active agents suitable for treating the diseases mentioned herein).

According to a further aspect of the invention, there is provided a pharmaceutical composition comprising the antibody or fragment thereof as defined herein, together with a pharmaceutically acceptable diluent or carrier. The antibodies of the invention can be incorporated into pharmaceutical compositions suitable for administration to a subject. Typically, the pharmaceutical composition comprises an antibody of the invention and a pharmaceutically acceptable carrier. As used herein, "pharmaceutically acceptable carrier" includes any and all solvents, dispersion media, coatings, antibacterial and antifungal agents, isotonic and absorption delaying agents, and the like that are physiologically compatible. Examples of pharmaceutically acceptable carriers include one or more of water, saline, salts, phosphate buffered saline, dextrose, glycerol, ethanol and the like, as well as combinations thereof. In many cases, it will be preferable to include isotonic agents, for example, sugars,

polyalcohols such as mannitol, sorbitol, or sodium chloride in the composition. Pharmaceutically acceptable substances such as wetting or minor amounts of auxiliary substances such as wetting or emulsifying agents, preservatives or buffers, which enhance the shelf life or effectiveness of the antibody or fragment thereof.

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The compositions of this invention may be in a variety of forms. These include, for example, liquid, semi-solid and solid dosage forms, such as liquid solutions (e.g. injectable and infusible solutions), dispersions or suspensions, tablets, pills, powders, liposomes and suppositories. The preferred form depends on the intended mode of administration and therapeutic application. Typical preferred compositions are in the form of injectable or infusible solutions.

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The preferred mode of administration is parenteral (e.g. intravenous, subcutaneous, intraperitoneal, intramuscular, intrathecal). In a preferred embodiment, the antibody is administered by intravenous infusion or injection. In another preferred embodiment, the antibody is administered by intramuscular or subcutaneous injection.

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Therapeutic compositions typically must be sterile and stable under the conditions of manufacture and storage. The composition can be formulated as a solution, microemulsion, dispersion, liposome, or other ordered structure suitable to high drug concentration.

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It is within the scope of the invention to use the pharmaceutical composition of the invention in therapeutic methods for the treatment of diseases as described herein as an adjunct to, or in conjunction with, other established therapies normally used in the treatment of such diseases.

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In a further aspect of the invention, the antibody, composition or pharmaceutical composition is administered sequentially, simultaneously or separately with at least one active agent.

Uses of antibodies or fragments thereof

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According to a further aspect of the invention, there is provided the use of an anti-V δ 1 antibody or fragment thereof as described herein to study antigen recognition, activation, signal transduction or function of $\gamma\delta$ T cells (in particular V δ 1 T cells). As described herein, the antibodies have been shown to be active in assays which can be used to investigate $\gamma\delta$ T cell function. Such antibodies may also be useful for inducing the proliferation of $\gamma\delta$ T cells, therefore may be used in methods of expanding $\gamma\delta$ T cells (such as V δ 1 T cells).

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Antibodies which bind to the V δ 1 chain can be used to detect $\gamma\delta$ T cells. For example, the antibody may be labelled with a detectable label or reporter molecule or used as a capture ligand to selectively detect and/or isolate V δ 1 T cells in a sample. Labelled antibodies find use in many methods known in the art, for example immunohistochemistry and ELISA.

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The detectable label or reporter molecule can be a radioisotope, such as ^3H , ^{14}C , ^{32}P , ^{35}S , or ^{125}I ; a fluorescent or chemiluminescent moiety such as fluorescein isothiocyanate, or rhodamine; or an enzyme such as alkaline phosphatase, β -galactosidase, horseradish peroxidase, or luciferase. Fluorescent labels applied to antibodies of the invention may then be used in fluorescence-activated cell sorting (FACS) methods.

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Methods of generating antibodies or fragments thereof

Described herein are soluble TCRs for use in generating antibodies. Therefore, according to an aspect of the invention, there is provided an isolated antigen comprising an amino acid sequence having at least 80% sequence identity with SEQ ID NO: 123 for use in generating an anti-V δ 1 antibody or fragment thereof. Also provided is use of an isolated antigen comprising an amino acid sequence having at least 80% sequence identity with SEQ ID NO: 123 for use in generating an anti-V δ 1 antibody or fragment thereof. In one embodiment, the isolated antigen comprises SEQ ID NO: 123.

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According to an aspect of the invention, there is provided a method of generating an anti-V δ 1 antibody or fragment thereof comprising:

- (i) designing a series of antigens comprising a TCR delta variable 1 (V δ 1) amino acid sequence wherein the CDR3 sequence of the V δ 1 is the same for all antigens in the series;
- (ii) exposing a first antigen designed in step (i) to an antibody library (e.g. by phage display);
- (iii) isolating the antibodies or fragments thereof which bind to the antigen;
- (iv) exposing the isolated antibodies or fragments thereof to a second antigen designed in step (i); and
- (v) isolating the antibodies or fragments thereof which bind to both the first and second antigen.

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Isolating antibodies (or fragments thereof) that bind to both the first and second antigen aims to provide antibodies which recognise a sequence within the variable domain, which is germline encoded and therefore the same in all clones, thus providing antibodies which recognise a wider subset of $\gamma\delta$ T cells. The series of antigens described herein may also comprise antigens (*i.e.* TCR delta variable 1 chain) in different formats. Therefore, said

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antigens may be synthetic/recombinant antigens. For example, the antigens may be presented as a leucine zipper or Fc fusion. In one embodiment, the TCR delta variable 1 (TRDV1) amino acid sequence comprises SEQ ID NO: 123. Suitable antigen sequences may be designed, for example, using the sequences described in the IMMUNOGENETICS information system database (<http://www.imgt.org>).

The antigens may also comprise additional features to aid in protein expression. For example, the recombinant TCR antigens described herein may be fused to a TCR α or TCR β constant region (see Xu *et al.* (2011) *PNAS* 108: 2414-2419).

In one embodiment, the method further comprises exposing the isolated antibodies or fragments thereof to a second series of antigens comprising a $\gamma\delta$ TCR with a different delta variable chain, such as delta variable 2 (V δ 2) or delta variable 3 (V δ 3), and then deselecting the antibodies or fragments thereof which also bind to the second series of antigens.

In a further embodiment, the second series of antigens comprising a $\gamma\delta$ TCR with a different delta variable chain comprises the same CDR3 sequence as the first series of antigens. Thus, all antigens comprise the same CDR3 sequence (from V δ 1).

In one embodiment, the first and/or second series of antigens are presented as a leucine zipper and/or Fc fusion.

In one embodiment, the series of antigens are in a heterodimeric and/or homodimeric format.

In a further embodiment, the series of antigens comprise, together with the target (*i.e.* TCR delta variable 1 chain), a paired TCR variable chain. In certain embodiments, the paired TCR variable chain is a variable γ (V γ) chain (*i.e.* the antigen is in a heterodimeric format). In one embodiment, the V δ 1 chain and the V γ chain are covalently linked by at least one disulphide bond. In further embodiments, the V δ 1 chain and the V γ chain are paired by specific heterodimerisation interaction (*e.g.* leucine zipper). In an alternative embodiment, the V δ 1 chain and the V γ chain comprise a single chain in-frame fusion. In a certain embodiment, the V δ 1 chain is N-terminal to the V γ chain. In an alternative embodiment, the V δ 1 chain is C-terminal to the V γ chain. In a further embodiment, the single chain in-frame fusion comprises an internal linker sequence. In one embodiment, antigens in the first series are in a heterodimeric format comprising a V δ 1 chain and a different V γ chain, such as V γ 2, V γ 4 or V γ 8. Selecting antibodies which bind to all formats ensures that said isolated antibodies or

fragments thereof recognize V δ 1 chains independently of the partner chain present in the heterodimer.

In an alternative embodiment, the paired TCR variable chain is another V δ chain. In a further embodiment the V δ chain is the same as the target (*i.e.* the antigen is in a homodimeric format).

Example 2 provided herein describes an example of a series of antigens that may be used. It will be understood that the (first) series of antigens comprises antigens where a TRDV1 (V δ 1) is present (*e.g.* L1, L2, L3, F1, F2, F3 and Fc1/1) and the second series of antigens comprises antigens where a V δ 1 is not present (*e.g.* L4, F9, Fc3/3, Fc4/4, Fc8/8).

In further embodiments, the series of antigens comprises the target (*i.e.* TCR delta variable 1 chain) fused in-frame to a TCR constant region. For example, said TCR constant region may be fused in-frame to the C-terminus of the V δ 1 chain. In one embodiment, the TCR constant region may be a human TCR constant region. In one embodiment, the TCR constant region is selected from the TCR α or TCR β constant region. In another embodiment, the constant region is the TCR γ constant region. In yet further embodiments, the series of antigens may comprise a further, second TCR constant region, wherein the second TCR constant region is fused in-frame to the paired TCR variable chain. In further embodiments, the second TCR constant region is selected from the TCR α or TCR β constant region. In a further embodiment, the constant region is TCR γ constant region.

It will be appreciated that the series of antigens as described herein may be presented in either soluble or linked/fused form or associated with a cell membrane. For example, for display purposes the series of antigens may be fused or tethered to inorganic or organic materials (*e.g.* beads, plates, columns or phages) or expressed on a cell surface.

According to various embodiments of the present invention, the series of antigens comprising a TCR delta variable 1 (V δ 1) amino acid sequence comprise a CDR3 sequence of the V δ 1 which is the same for all antigens. In one embodiment, the CDR3 sequence is derived from the CDR3 sequence of RCSB Protein Data Bank entries: 3OMZ.

According to a further aspect of the invention, there is provided an antibody obtained by the method as defined herein.

CLAUSES

A set of clauses defining the invention and its preferred aspects is as follows:

Clause 1. An isolated anti-V δ 1 antibody or fragment thereof, which comprises one or
5 more of:

a CDR3 comprising a sequence having at least 80% sequence identity with any one
of SEQ ID NOs: 2-25;

a CDR2 comprising a sequence having at least 80% sequence identity with any one
of SEQ ID NOs: 26-37 and SEQUENCES: A1-A12 (of Table 2); and/or

10 a CDR1 comprising a sequence having at least 80% sequence identity with any one
of SEQ ID NOs: 38-61.

Clause 2. The isolated anti-V δ 1 antibody or fragment thereof as defined in clause 1,
which comprises a VH region comprising a CDR3 comprising a sequence having at least 80%
15 sequence identity with any one of SEQ ID NOs: 2-13, such as SEQ ID NOs: 2, 3 or 4.

Clause 3. The isolated anti-V δ 1 antibody or fragment thereof as defined in clause 1 or
clause 2, which comprises a VH region comprising a CDR2 comprising a sequence having at
least 80% sequence identity with any one of SEQ ID NOs: 26-37, such as SEQ ID NOs: 26,
20 27 or 28.

Clause 4. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of
clauses 1 to 3, which comprises a VH region comprising a CDR1 comprising a sequence
having at least 80% sequence identity with any one of SEQ ID NOs: 38-49, such as SEQ ID
25 NOs: 38, 39 or 40.

Clause 5. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of
clauses 1 to 4, which comprises a VH region comprising a CDR3 comprising a sequence of
SEQ ID NO: 2, a CDR2 comprising a sequence of SEQ ID NO: 26, and a CDR1 comprising a
30 sequence of SEQ ID NO: 38.

Clause 6. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of
clauses 1 to 4, which comprises a VH region comprising a CDR3 comprising a sequence of
SEQ ID NO: 3, a CDR2 comprising a sequence of SEQ ID NO: 27, and a CDR1 comprising a
35 sequence of SEQ ID NO: 39.

Clause 7. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 4, which comprises a VH region comprising a CDR3 comprising a sequence of SEQ ID NO: 4, a CDR2 comprising a sequence of SEQ ID NO: 28, and a CDR1 comprising a sequence of SEQ ID NO: 40.

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Clause 8. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 4, which comprises a VH region comprising a CDR3 comprising a sequence of SEQ ID NO: 5, a CDR2 comprising a sequence of SEQ ID NO: 29, and a CDR1 comprising a sequence of SEQ ID NO: 41.

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Clause 9. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 8, which comprises a VL region comprising a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 14-25, such as SEQ ID NOs: 14, 15 or 16.

15

Clause 10. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 9, which comprises a VL region comprising a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQUENCES: A1-A12, such as SEQ ID NOs: A1, A2 or A3.

20

Clause 11. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 10, which comprises a VL region comprising a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 50-61, such as SEQ ID NOs: 50, 51 or 52.

25

Clause 12. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 11, which comprises a VL region comprising a CDR3 comprising a sequence of SEQ ID NO: 14, a CDR2 comprising a sequence of SEQUENCE: A1, and a CDR1 comprising a sequence of SEQ ID NO: 50.

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Clause 13. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 11, which comprises a VL region comprising a CDR3 comprising a sequence of SEQ ID NO: 15, a CDR2 comprising a sequence of SEQUENCE: A2, and a CDR1 comprising a sequence of SEQ ID NO: 51.

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Clause 14. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 11, which comprises a VL region comprising a CDR3 comprising a sequence of

SEQ ID NO: 16, a CDR2 comprising a sequence of SEQUENCE: A3, and a CDR1 comprising a sequence of SEQ ID NO: 52.

Clause 15. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 11, which comprises a VL region comprising a CDR3 comprising a sequence of SEQ ID NO: 17, a CDR2 comprising a sequence of SEQUENCE: A4, and a CDR1 comprising a sequence of SEQ ID NO: 53.

Clause 16. An isolated anti-V δ 1 antibody or fragment thereof which comprises a VH region comprising CDR1, CDR2 and CDR3 sequences as defined in clause 5 and a VL region comprising CDR1, CDR2 and CDR3 sequences as defined in clause 12.

Clause 17. An isolated anti-V δ 1 antibody or fragment thereof which comprises a VH region comprising CDR1, CDR2 and CDR3 sequences as defined in clause 6 and a VL region comprising CDR1, CDR2 and CDR3 sequences as defined in clause 13.

Clause 18. An isolated anti-V δ 1 antibody or fragment thereof which comprises a VH region comprising CDR1, CDR2 and CDR3 sequences as defined in clause 7 and a VL region comprising CDR1, CDR2 and CDR3 sequences as defined in clause 14.

Clause 19. An isolated anti-V δ 1 antibody or fragment thereof which comprises a VH region comprising CDR1, CDR2 and CDR3 sequences as defined in clause 8 and a VL region comprising CDR1, CDR2 and CDR3 sequences as defined in clause 15.

Clause 20. An isolated anti-V δ 1 antibody or fragment thereof, which comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-85.

Clause 21. The isolated anti-V δ 1 antibody or fragment thereof as defined in clause 20, which comprises a VH region comprising an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-73.

Clause 22. The isolated anti-V δ 1 antibody or fragment thereof as defined in clause 21, wherein the VH region comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62, 63 or 64.

Clause 23. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 20 to 22, which comprises a VL region comprising an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 74-85.

- 5 Clause 24. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 23, wherein the VL region comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 74, 75 or 76.

- 10 Clause 25. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 20 to 24, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 62 and a VL region comprising an amino acid sequence of SEQ ID NO: 74.

- 15 Clause 26. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 20 to 24, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 63 and a VL region comprising an amino acid sequence of SEQ ID NO: 75.

- 20 Clause 27. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 20 to 24, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 64 and a VL region comprising an amino acid sequence of SEQ ID NO: 76.

Clause 28. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 20 to 24, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 68 and a VL region comprising an amino acid sequence of SEQ ID NO: 80.

- 25 Clause 29. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 20 to 24, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 69 and a VL region comprising an amino acid sequence of SEQ ID NO: 81.

- 30 Clause 30. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 20 to 24, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 70 and a VL region comprising an amino acid sequence of SEQ ID NO: 82.

- 35 Clause 31. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 20 to 24, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 71 and a VL region comprising an amino acid sequence of SEQ ID NO: 83.

Clause 32. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 20 to 31, wherein the VH and VL region are joined by a linker, such as a polypeptide linker.

5 Clause 33. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 32, wherein the linker comprises a $(\text{Gly}_4\text{Ser})_n$ format, where $n = 1$ to 8

Clause 34. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 32 or clause 33, wherein the linker comprises a $[(\text{Gly}_4\text{Ser})_n(\text{Gly}_3\text{AlaSer})_m]_p$ linker, where n , m and p
10 $= 1$ to 8.

Clause 35. The isolated anti-Vδ1 antibody or fragment thereof as defined in any one of clauses 32 to 34, wherein the linker comprises SEQ ID NO: 98.

15 Clause 36. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 35, wherein the linker consists of SEQ ID NO: 98.

Clause 37. An isolated anti-Vδ1 antibody or fragment thereof which comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 86-97.
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Clause 38. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 37, which comprises an amino acid sequence of any one of SEQ ID NOs: 86-97.

Clause 39. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 37 or
25 clause 38, which comprises SEQ ID NO: 86.

Clause 40. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 37 or clause 38, which comprises SEQ ID NO: 87.

30 Clause 41. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 37 or clause 38, which comprises SEQ ID NO: 88.

Clause 42. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 37 or clause 38, which comprises SEQ ID NO: 92.

35 Clause 43. The isolated anti-Vδ1 antibody or fragment thereof as defined in clause 37 or clause 38, which comprises SEQ ID NO: 93.

Clause 44. The isolated anti-V δ 1 antibody or fragment thereof as defined in clause 37 or clause 38, which comprises SEQ ID NO: 94.

5 Clause 45. The isolated anti-V δ 1 antibody or fragment thereof as defined in clause 37 or clause 38, which comprises SEQ ID NO: 95.

Clause 46. An isolated anti-V δ 1 antibody or fragment thereof, which binds to the same, or essentially the same, epitope as, or competes with, an antibody or fragment thereof as defined
10 in any one of clauses 1 to 45.

Clause 47. A human, isolated anti-TCR delta variable 1 (anti-V δ 1) antibody or fragment thereof, which binds to an epitope of a variable delta 1 (V δ 1) chain of a $\gamma\delta$ T cell receptor (TCR) comprising one or more amino acid residues within amino acid regions:

- 15 (i) 3-20 of SEQ ID NO: 1; and/or
(ii) 37-77 of SEQ ID NO: 1.

Clause 48. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in clause 47, wherein the epitope comprises at least one of amino acid residues 3, 5, 9, 10, 12, 16, 17,
20 20, 37, 42, 50, 53, 59, 62, 64, 68, 69, 72 or 77 of SEQ ID NO: 1.

Clause 49. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in clause 47 or clause 48, wherein the epitope comprises one or more amino acid residues within amino acid regions: 5-20 and 62-77; 50-64; 37-53 and 59-72; 59-77; or 3-17 and 62-69, of SEQ ID
25 NO: 1.

Clause 50. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in clause 49, wherein the epitope consists of one or more amino acid residues within amino acid regions: 5-20 and 62-77; 50-64; 37-53 and 59-72; 59-77; or 3-17 and 62-69 of SEQ ID NO: 1.

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Clause 51. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 47 to 50, wherein the epitope comprises one or more amino acid residues within amino acid regions 5-20 and 62-77 of SEQ ID NO: 1.

35 Clause 52. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 47 to 50, wherein the epitope comprises one or more amino acid residues within amino acid region 50-64 of SEQ ID NO: 1.

Clause 53. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 47 to 50, wherein the epitope comprises one or more amino acid residues within amino acid regions 37-53 and 59-77 of SEQ ID NO: 1.

5

Clause 54. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 46 to 53, wherein the epitope is an activating epitope of a $\gamma\delta$ T cell.

Clause 55. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in clause 54, wherein binding of the activating epitope: (i) downregulates the $\gamma\delta$ TCR; (ii) activates degranulation of the $\gamma\delta$ T cell; and/or (iii) activates $\gamma\delta$ T cell killing.

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Clause 56. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 47 to 55, which only binds to an epitope in the V region of a V δ 1 chain of a $\gamma\delta$ TCR.

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Clause 57. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 47 to 56, which does not bind to an epitope found in CDR3 of a V δ 1 chain of a $\gamma\delta$ TCR.

Clause 58. The human isolated anti-V δ 1 antibody or fragment thereof as defined in clause 57, which does not bind to an epitope within amino acid region 91-105 (CDR3) of SEQ ID NO: 1.

25

Clause 59. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 58, which binds a variable delta 1 (V δ 1) chain of a $\gamma\delta$ T cell receptor (TCR) with a binding affinity (KD) as measured by surface plasmon resonance of less than 1.5×10^{-7} M.

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Clause 60. The isolated anti-V δ 1 antibody or fragment thereof as defined in clause 59, wherein the KD is less than 1.3×10^{-7} M or less, such as less than 1.0×10^{-7} M, in particular less than 5.0×10^{-8} M.

35

Clause 61. An isolated anti-V δ 1 antibody or fragment thereof with an EC50 value for downregulation of a $\gamma\delta$ TCR upon binding which is less than 0.5 μ g/ml.

Clause 62. An isolated anti-V δ 1 antibody or fragment thereof with an EC50 value for downregulation of a $\gamma\delta$ TCR upon binding which is less than 0.06 μ g/ml.

Clause 63. An isolated anti-V δ 1 antibody or fragment thereof with an EC50 value for $\gamma\delta$ T cell degranulation upon binding which is less than 0.05 $\mu\text{g/ml}$.

- 5 Clause 64. An isolated anti-V δ 1 antibody or fragment thereof with an EC50 value for $\gamma\delta$ T cell degranulation upon binding which is less than 0.005 $\mu\text{g/ml}$, such as less than 0.002 $\mu\text{g/ml}$.

Clause 65. The isolated anti-V δ 1 antibody or fragment thereof as defined in clause 63 or clause 64, wherein the $\gamma\delta$ T cell degranulation EC50 value is measured by detecting CD107a
10 expression.

Clause 66. An isolated anti-V δ 1 antibody or fragment thereof with an EC50 value for $\gamma\delta$ T cell killing upon binding which is less than 0.5 $\mu\text{g/ml}$.

- 15 Clause 67. An isolated anti-V δ 1 antibody or fragment thereof with an EC50 value for $\gamma\delta$ T cell killing upon binding which is less than 0.055 $\mu\text{g/ml}$, such as less than 0.020 $\mu\text{g/ml}$.

Clause 68. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 61 to 67, wherein the EC50 value is measured using flow cytometry.
20

Clause 69. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 68, which is an scFv, Fab, Fab', F(ab')₂, Fv, variable domain (e.g. VH or VL), diabody, minibody or full length antibody.

- 25 Clause 70. The isolated anti-V δ 1 antibody or fragment thereof as defined in clause 69, which is an scFv or a full length antibody, such as IgG1.

Clause 71. The isolated anti-V δ 1 antibody as defined in clause 70, which comprises an amino acid sequence having at least 80% sequence identity with of any one of SEQ ID NOs:
30 111-122.

Clause 72. The isolated anti-V δ 1 antibody as defined in clause 70 or clause 71, which comprises an amino acid sequence of any one of SEQ ID NOs: 111-122.

- 35 Clause 73. The isolated anti-V δ 1 antibody as defined in clause 71 or clause 72, which comprises SEQ ID NO: 111.

Clause 74. The isolated anti-V δ 1 antibody as defined in clause 71 or clause 72, which comprises SEQ ID NO: 112.

5 Clause 75. The isolated anti-V δ 1 antibody as defined in clause 71 or clause 72, which comprises SEQ ID NO: 116.

Clause 76. The isolated anti-V δ 1 antibody as defined in clause 71 or clause 72, which comprises SEQ ID NO: 117.

10 Clause 77. The isolated anti-V δ 1 antibody as defined in clause 71 or clause 72, which comprises SEQ ID NO: 118.

Clause 78. The isolated anti-V δ 1 antibody as defined in clause 71 or clause 72, which comprises SEQ ID NO: 119.

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Clause 79. The isolated anti-V δ 1 antibody as defined in clause 71 or clause 72, which comprises SEQ ID NO: 120.

20 Clause 80. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 79, which is human.

Clause 81. A polynucleotide sequence encoding the anti-V δ 1 antibody or fragment thereof as defined in any one of clauses 1 to 80.

25 Clause 82. A polynucleotide sequence encoding the anti-V δ 1 antibody or fragment thereof comprising a sequence having at least 70% sequence identity with SEQ ID NO: 99-110.

Clause 83. A polynucleotide sequence encoding the anti-V δ 1 antibody or fragment thereof consisting of a sequence of SEQ ID NO: 99-110.

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Clause 84. An expression vector comprising the polynucleotide sequence as defined in any one of clauses 81 to 83.

Clause 85. An expression vector comprising the VH region of SEQ ID NO: 99-110.

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Clause 86. An expression vector comprising the VL region of SEQ ID NO: 99-110.

Clause 87. An expression vector comprising the VH region of clause 85 and the VL region of clause 86.

Clause 88. A cell comprising the polynucleotide sequence as defined in any one of clauses 5 81 to 83 or the expression vector as defined in any one of clauses 84 to 87.

Clause 89. A cell comprising a first expression vector as defined in clause 85 and a second expression vector as defined in clause 86.

10 Clause 90. A cell comprising the expression vector as defined in clause 87.

Clause 91. The cell as defined in any one of clauses 88 to 90, wherein the polynucleotide or expression vector encodes a membrane anchor or transmembrane domain fused to the antibody or fragment thereof, wherein the antibody or fragment thereof is presented on an 15 extracellular surface of the cell.

Clause 92. A composition comprising the antibody or fragment thereof as defined in any one of clauses 1 to 80.

20 Clause 93. A pharmaceutical composition comprising the antibody or fragment thereof as defined in any one of clauses 1 to 80, together with a pharmaceutically acceptable diluent or carrier.

Clause 94. An isolated antigen comprising an amino acid sequence having at least 80% 25 sequence identity with SEQ ID NO: 123 for use in generating an anti-V δ 1 antibody or fragment thereof.

Clause 95. A method of generating an anti-V δ 1 antibody or fragment thereof comprising:

- 30 (i) designing a series of antigens comprising a TCR delta variable 1 (TRDV1) amino acid sequence wherein the CDR3 sequence of the TRDV1 is the same for all antigens in the series;
- (ii) exposing a first antigen designed in step (i) to an antibody library;
- (iii) isolating the antibodies or fragments thereof which bind to the antigen;
- (iv) exposing the isolated antibodies or fragments thereof to a second antigen 35 designed in step (i); and
- (v) isolating the antibodies or fragments thereof which bind to both the first and second antigen.

Clause 96. The method as defined in clause 95, which further comprises exposing the isolated antibodies or fragments thereof to a second series of antigens comprising a $\gamma\delta$ TCR with a different delta variable chain, such as TCR delta variable 2 (TRDV2) or TCR delta variable 3 (TRDV3), and then deselecting the antibodies or fragments thereof which also bind to the second series of antigens.

Clause 97. The method as defined in clause 95 or clause 96, wherein the first and/or second series of antigens are presented as a leucine zipper and/or Fc fusion.

Clause 98. The method as defined in any one of clauses 95 to 97, wherein the series of antigens are in a heterodimeric and/or homodimeric format.

Clause 99. An antibody obtained by the method as defined in any one of clauses 95 to 98.

Other features and advantages of the present invention will be apparent from the description provided herein. It should be understood, however, that the description and the specific examples while indicating preferred embodiments of the invention are given by way of illustration only, since various changes and modifications will become apparent to those skilled in the art. The invention will now be described using the following, non-limiting examples:

EXAMPLES

EXAMPLE 1. Materials and Methods

Human Antibody Discovery

Human phage display was employed to generate the human anti-human variable $V\delta 1+$ domain antibodies as described herein. The library was constructed as described in Schofield et al (*Genome biology* 2007, 8(11): R254) and comprised a single chain fragment variable (scFv) displaying library of ~40 billion human clones. This library was screened using antigens, methods, selections, deselection, screening, and characterization strategies as described herein.

Antigen preparation

The design of the soluble $\gamma\delta$ TCR heterodimers comprising the TCR α and TCR β constant regions used in the below Examples were generated according to Xu *et al.* (2011) *PNAS* 108: 2414-2419. $V\gamma$ or $V\delta$ domains were fused in-frame to a TCR α or TCR β constant region lacking

the transmembrane domain, followed by a leucine zipper sequence or an Fc sequence, and a histidine tag/linker.

The expression construct was transiently transfected in mammalian EXPI HEK293 suspension cells (either as single or co-transfections for heterodimer). Secreted recombinant proteins were recovered and purified from culture supernatant by affinity chromatography. To ensure good recovery of monomer antigen, samples were further purified using preparative size exclusion chromatography (SEC). Purified antigens were analysed for purity by SDS-PAGE and aggregation state by analytical SEC.

Antigen functional validation

The specificity of the antigens containing delta variable 1 (V δ 1) chain was confirmed in DELFIA immunoassay (Perkin Elmer) and in flow-based assay in competition with $\gamma\delta$ T cells using REA173-Miltenyi Biotec anti-V δ 1 antibody.

Dissociation-enhanced lanthanide fluorescence immunoassay (DELFLIA)

For the confirmation of antigen's specificity, DELFLIA immunoassay was performed with the antigen directly coated to the plate (3 μ g/mL of antigen in 50 μ L PBS at 4 °C overnight (Nunc #437111) and serial dilution of primary antibodies starting at 300nM. For detection DELFLIA Eu-N1 Anti-Human IgG (Perkin Elmer # 1244-330) was used as secondary antibody at 1/500 dilution in 50 μ L of 3 % of MPBS (PBS + 3 % (w/V) skimmed milk powder). Development was with 50 μ L of DELFLIA enhancement solution (Perkin Elmer #4001-0010).

Affinity ranking of antibody of interest were performed using DELFLIA immunoassay in which antibodies were captured via protein G coated on the plate and soluble biotinylated L1 (DV1-GV4) antigen was added at 5nM in 50 μ L (3MPBS). For detection 50 μ L of streptavidin-Eu (1:500 in assay buffer, Perkin Elmer) was used and signal was developed with DELFLIA enhancement solution. D1.3 hlgG1 (described in England *et al.* (1999) *J. Immunol.* 162: 2129-2136) was used as a negative control.

Phage display selection outputs were subcloned into the scFv expression vector pSANG10 (Martin *et al.* (2006) *BMC Biotechnol.* 6: 46). Soluble scFv were expressed and screened for binding in DELFLIA on directly immobilised targets. Hits were defined as a DELFLIA signal above 3000 fluorescence units.

Antibody preparation

Selected scFvs were subcloned into IgG1 frameworks using commercially available plasmids. expi293F suspension cells were transfected with said plasmids for antibody expression. For convenience, unless otherwise noted, the antibodies characterised in these Examples refer to IgG1 formatted antibodies selected from phage display as scFv. However, the antibodies of the invention may be in any antibody format as previously discussed.

Antibody purification

IgG antibodies were batch purified from supernatants using protein A chromatography. Concentrated protein A eluates were then purified using Size Exclusion Chromatography (SEC). Quality of purified IgG was analysed using ELISA, SDS-PAGE and SEC-HPLC.

$\gamma\delta$ T cell preparation

Populations of enriched $\gamma\delta$ T cells were prepared according to the methods described in WO2016/198480 (i.e. blood-derived $\gamma\delta$ T cells) or WO2020/095059 (i.e. skin-derived $\gamma\delta$ T cells). Briefly, for blood-derived $\gamma\delta$ T cells PBMCs were obtained from blood and subjected to magnetic depletion of $\alpha\beta$ T cells. The $\alpha\beta$ -depleted PBMCs were then cultured in CTS OpTmiser media (ThermoFisher) in the presence of OKT-3 (or respective anti-V δ 1 antibody), IL-4, IFN- γ , IL-21 and IL-1 β for 7 days. At day 7 of culture, the media was supplemented with OKT-3 (or respective anti-V δ 1 antibody), IL-21 and IL-15 for a further 4 days. At day 11 of culture, the media was supplemented with OKT-3 (or respective anti-V δ 1 antibody) and IL-15 for a further 3 days. At day 14 of culture, half of the media was replaced with fresh complete OpTmiser and supplemented with OKT-3 (or respective anti-V δ 1 antibody), IL-15 and IFN- γ . From day 17 of culture onwards, the culture was supplemented with OKT-3 (or respective anti-V δ 1 antibody) and IL-15 every 3 to 4 days; half of the media was replaced with fresh media every 7 days.

For skin-derived $\gamma\delta$ T cells, skin samples are prepared by removing subcutaneous fat and a 3mm biopsy punch is used to make multiple punches. Punches are placed on carbon matrix grids and placed in the well of a G-REX6 (Wilson Wolf). Each well is filled with complete isolation medium containing AIM-V media (Gibco, Life Technologies), CTS Immune Serum Replacement (Life Technologies), IL-2 and IL-15. For the first 7 days of culture, complete isolation medium containing Amphotericin B (Life Technologies) was used ("AMP"). Media was changed every 7 days by gently aspirating the upper media and replacing with 2X complete isolation medium (without AMP), trying not to disturb the cells at the bottom of the plate or bioreactor. Beyond three weeks in culture, the resulting egressed cells are then passaged into fresh tissue culture vessels and fresh media (e.g. AIM-V media or TexMAX

media (Miltenyi)) plus recombinant IL-2, IL-4, IL-15 and IL-21 before harvest. Optionally, $\alpha\beta$ T cells also present within the culture are then removed with aid of $\alpha\beta$ T cell depletion kits and associated protocols, such as those provided by Miltenyi. For further reference see WO2020/095059.

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$\gamma\delta$ T cell binding assay

The binding of antibodies to $\gamma\delta$ T cells was tested by incubating a fixed concentration of purified antibodies with 250000 $\gamma\delta$ T cells. This incubation was performed under blocking conditions to prevent unspecific binding of antibodies via the Fc receptor. Detection was performed by addition of a secondary, fluorescent dye-conjugated antibody against human IgG1. For negative controls, cells were prepared with a) an isotype antibody only (recombinant human IgG), b) the fluorescent dye-conjugated anti-human IgG antibody only and c) a combination of a) and b). A control well of completely unstained cells was also prepared and analysed. As positive controls, a purified murine monoclonal IgG2 anti-human CD3 antibody and a purified murine monoclonal IgG1 anti-human TCR V δ 1 antibody were used in two different concentrations and stained with a fluorescent dye-conjugated goat anti-mouse secondary antibody. The assay was accepted if the lower concentration positive controls' mean fluorescence intensity in the FITC channel was at least tenfold as high as the highest negative control.

20

SPR Analysis

A MASS-2 instrument with an amine high capacity chip (both from Sierra Sensors, Germany) was used to perform SPR analysis. 15 nM IgG were captured via protein G to an amine high capacity chip (100 nM for TS8.2). L1 (DV1-GV4) antigen was flown over the cell at a 1:2 dilution series from 2000 nM to 15.625 nM with the following parameters: 180 s association, 600 s dissociation, flowrate 30 μ L/min, running buffer PBS + 0.02 % Tween 20. All experiments were performed at room temperature on MASS-2 instrument. Steady state fitting was determined according to Langmuir 1:1 binding using software Sierra Analyzer 3.2.

Comparator antibodies

Antibodies of the invention were compared to commercially available antibodies in test assays as described.

Antibody	Source	Catalogue No.
Ultra-LEAF™ Purified anti-human CD3 Antibody (OKT3), functional	Biolegend	317326

Ultra-LEAF™ Purified anti-human IgG2a Antibody (isotype control for OKT3)	Biolegend	400264
Human TCR Vδ1 purified mAb (functional TS8.2)	ThermoFisher	TCR1730
Ultra-LEAF™ Purified Mouse IgG1, κ Isotype Ctrl Antibody for TS8.2	Biolegend	400166
Anti-human CD107a BV421 (clone H4A3)	BD Biosciences	562623
BV421 Mouse IgG1, κ Isotype Control Clone X40 (RUO)	BD Biosciences	562438
Anti-TCR Vδ1-PE-Vio770, human (flow, discontinued)	Miltenyi	130-100-540

γδ TCR downregulation and degranulation assay

THP-1 (TIB-202™, ATCC) target cells loaded or not with test antibodies were labelled with CellTracker™ Orange CMTMR (ThermoFisher, C2927) and incubated with γδ T cells at 2:1 ratio in the presence of CD107a antibody (Anti-human CD107a BV421 (clone H4A3) BD Biosciences 562623). After 2 hours of incubation, the surface expression of γδ TCR (to measure TCR downregulation) and expression of CD107a (to measure degranulation) on γδ T cells was evaluated using flow cytometry.

10 Killing assay

Gamma delta T cell killing activity and effect of test antibodies on the killing activity of γδ T cells was accessed by flow cytometry. After 4 hours of *in vitro* co-culture at 20:1 ratio of γδ T cells and CellTracker™ Orange CMTMR (ThermoFisher, C2927) labelled THP-1 cells (loaded or not with the antibody) were stained with Viability Dye eFluor™ 520 (ThermoFisher, 520 65-0867-14) to distinguish between live and dead target THP-1 cells. During sample acquisition, target cells were gated on the CellTracker™ Orange CMTMR positivity and examined for cell death based on the uptake of Viability Dye. CMTMR and eFluor™ 520 double positive cells were recognized as the dead target cells. The killing activity of γδ T cells was presented as a % of the dead target cells.

Epitope mapping

All protein samples (antigen L1 (DV1-GV4) and antibodies 1245_P01_E07, 1245_P02_G04, 1252_P01_C08, 1251_P02_C05 and 1141_P01_E01) used for epitope mapping were analyzed for protein integrity and aggregation level using a high-mass MALDI.

5

In order to determine the epitope of L1(DV1-GV4)/1245_P01_E07, L1(DV1-GV4)/1245_P02_G04, L1(DV1-GV4)/1252_P01_C08, L1(DV1-GV4)/1251_P02_C05, and L1(DV1-GV4)/1141_P01_E01 complexes with high resolution, the protein complexes were incubated with deuterated cross-linkers and subjected to multi-enzymatic proteolysis using trypsin, chymotrypsin, Asp-N, elastase and thermolysin. After enrichment of the cross-linked peptides, the samples were analyzed by high resolution mass spectrometry (nLC-LTQ-Orbitrap MS) and the data generated were analyzed using XQuest and Stavrox software.

10

EXAMPLE 2. Antigen design

Gamma delta ($\gamma\delta$) T cells are polyclonal with CDR3 polyclonality. In order to avoid a situation where generated antibodies would be selected against the CDR3 sequence (as the CDR3 sequence will differ from TCR clone to TCR clone), the antigen design involved maintaining a consistent CDR3 in different formats. This design aimed to generate antibodies recognising a sequence within the variable domain, which is germline encoded and therefore the same in all clones, thus providing antibodies which recognise a wider subset of $\gamma\delta$ T cells.

20

Another important aspect of the antigen preparation process was to design antigens which are suitable for expression as a protein. The $\gamma\delta$ TCR is a complex protein involving a heterodimer with inter-chain and intra-chain disulphide bonds. A leucine zipper (LZ) format and Fc format were used to generate soluble TCR antigens to be used in the phage display selections. Both the LZ and Fc formats expressed well and successfully displayed the TCR (particularly heterodimeric TCRs, e.g. V δ 1V γ 4).

25

It was found that the CDR3 sequence from a public database entry for the $\gamma\delta$ TCR expressed well as proteins (RCSB Protein Data Bank entries: 3OMZ). This was therefore selected for antigen preparation.

30

Antigens containing the delta variable 1 chain were expressed in LZ formats as a heterodimer (*i.e.* in combination with different gamma variable chains – “L1”, “L2”, “L3”) and in Fc format either as a heterodimer (“F1”, “F2”, “F3”) or as a homodimer (*i.e.* in combination with another delta variable 1 chain – “Fc1/1”). All delta variable 1 chains of the antigens contained the 3OMZ CDR3. Another series of $\gamma\delta$ TCR antigens using similar formats were designed

35

containing different delta variable chains (such as delta variable 2 and delta variable 3) and used to deselect antibodies with non-specific or off target binding ("L4", "F9", "Fc4/4", "Fc8/8"). These antigens were also designed to include the 3OMZ CDR3 to ensure that antibodies binding in the CDR3 region were also deselected.

5

Antigen functional validation was performed to confirm that the designed antigens would be suitable to generate anti-TRDV1 (TCR delta variable 1) antibodies. Detection was seen only with antigens containing the $\delta 1$ domain (**Figure 1**).

10 **EXAMPLE 3. Phage Display**

Phage display selections were performed against libraries of human scFvs using either heterodimeric LZ TCR format in round 1 and 2, with deselections on heterodimeric LZ TCR in both rounds. Or round 1 was performed using homodimeric Fc fusion TCR with deselection on human IgG1 Fc followed by round 2 on heterodimeric LZ TCR with deselection on heterodimeric LZ TCR (see **Table 1**).

15

Table 1. Overview phage display selections

Target	Round 1 selection	Round 1 deselection	Round 2 selection	Round 2 deselection
DV1	bt-L1 (DV1-GV4)	L4 (DV2-GV4)	bt-L3 (DV1-GV8)	L4 (DV2-GV4)
DV1	bt-Fc1/1 (DV1-DV1)	Fc	bt-L1 (DV1-GV4)	L4 (DV2-GV4)

bt = biotin.

20 Selections were performed in solution phase using 100 nM biotinylated proteins. Deselections were performed using 1 μ M non-biotinylated proteins.

Success of the phage display selections was analysed by polyclonal phage ELISA (DELFI A). All DV1 selection outputs showed the desired binding to the targets Fc 1/1, L1, L2, L3, F1 and F3. Varying degrees of binding to non-targets L4, F9, Fc 4/4, Fc 8/8 and Fc were detected (see **Figure 2A and B**).

25

EXAMPLE 4. Antibody selection

Hits obtained in Example 3 were sequenced (using standard methods known in the art). 130 unique clones were identified, which showed a unique combination of VH and VL CDR3. Of these 130 unique clones, 125 showed a unique VH CDR3 and 109 showed a unique VL CDR3.

30

Unique clones were re-arrayed and specificity was analysed by ELISA (DELFI A). A panel of 94 unique human scFv binders which bind TRDV1 (L1, L2, L3, F1, F2, F3) but not TRDV2 (L4), were identified from the selections.

- 5 Affinity ranking of the selected binders was included to aid the choice of clones going forward. A large number of binders showed affinities in the nanomolar range, reacting with 25 to 100 nM biotinylated antigen. A handful of binders showed a strong reaction with 5 nM antigen, indicating possible single digit nanomolar affinities. Some binders showed no reaction with 100 nM antigen, indicating affinities in the micromolar range.

10

For the selection of clones to proceed with to IgG conversion, the aim was to include as many germline lineages and as many different CDR3s as possible. Further, sequence liabilities like glycosylation, integrin binding sites, CD11c/CD18 binding sites, unpaired cysteines were avoided. In addition, a variety of affinities was included.

15

Selected clones were screened for binding to natural, cell-surface expressed $\gamma\delta$ TCR using skin derived $\gamma\delta$ T cells obtained from different donors. The clones chosen to be converted to IgG are shown in **Table 2**.

Table 2. DV1 binders for IgG conversion

Clone ID	Heavy CDR1	SEQ ID NO.	Heavy CDR2	SEQ ID NO.	Heavy CDR3	SEQ ID NO.	Light CDR1	SEQ ID NO.	Light CDR2	SEQ	Light CDR3	SEQ ID NO.	100 nM L1
1245_P01_E07	GFTFSDYY	38	ISSSGSTI	26	VDYADAFDI	2	QSIGTY	50	VAS	A1	QQSYSTLLT	14	162591
1252_P01_C08	GFTVSSNY	39	IYSGGST	27	PIELGAFDI	3	NIGSQS	51	YDS	A2	QVWDSSSDHVV	15	1977
1245_P02_G04	GDSVSSKSAA	40	TYRRSKWST	28	TWSGYVDV	4	QDINDW	52	DAS	A3	QQSYSTPQVT	16	5896
1245_P01_B07	GFTFSDYY	41	ISSSGSTI	29	ENYLNAFDI	5	QSLSNY	53	AAS	A4	QQSYSTPLT	17	64271
1251_P02_C05	GFTFSSYA	42	ISGGGGTT	30	DSGVAFDI	6	QNIRTW	54	DAS	A5	QQFKRYPPT	18	65269
1141_P01_E01	GYSFTSYW	43	IYPGSDT	31	HQVDTRTADY	7	RSDVGGYNY	55	EVS	A6	SSYTSTSLV	19	136780
1139_P01_E04	GDSVSSNSAA	44	TYRRSKWYN	32	SWNDAFDI	8	QSISTW	56	DAS	A7	QQSYSTPLT	20	23786
1245_P02_F07	GDSVSSNSAA	45	TYRRSKWYN	33	DYYYSMVDV	9	QSISSW	57	DAS	A8	QQSHSHPPT	21	10450
1245_P01_G06	GFTFSDYY	46	ISSSGSTI	34	HSWNDAFDV	10	QSISSY	58	AAS	A9	QQSYSTPDT	22	22474
1245_P01_G09	GDSVSSNSAA	47	TYYGSKWYN	35	DYYYSMVDV	11	QSISTW	59	DAS	A10	QQSYSTPVT	23	18430
1138_P01_B09	GFTFSDYY	48	ISSSGSTI	36	HSWSDAFDI	12	QDISNY	60	DAS	A11	QQSYSTPLT	24	29193
1251_P02_G10	GFTFSDYY	49	ISSSGSTI	37	HSWNDAFDI	13	QSISSH	61	AAS	A12	QQSYSTLLT	25	17053

EXAMPLE 5: Antibody SPR analysis

Prepared IgG antibodies were passed through a $\gamma\delta$ cell binding assay, and 5 were selected for further functional and biophysical characterization. SPR analysis was performed to determine the equilibrium dissociation constants (K_D). Sensorgrams of the interaction of the tested antibody with the analyte, along with steady state fits (if available), are presented in **Figure 3**. No binding was detected for TS8.2 with 80 RU of IgG captured on the chip. Results are summarised in **Table 3**.

Table 3. Results of IgG capture

Analyte	Clone ID	K_D (nM)	K_D (M)
L1 (DV1-GV4)	1245_P01_E07	12.4	1.24e-08
L1 (DV1-GV4)	1252_P01_C08	100	1.00e-07
L1 (DV1-GV4)	1245_P02_G04	126	1.26e-07
L1 (DV1-GV4)	1245_P01_B07	341	3.41e-07
L1 (DV1-GV4)	1251_P02_C05	1967*	1.97e-06
L1 (DV1-GV4)	1139_P01_E04	251	2.51e-07
L1 (DV1-GV4)	1245_P02_F07	193	1.93e-07
L1 (DV1-GV4)	1245_P01_G06	264	2.64e-07
L1 (DV1-GV4)	1245_P01_G09	208	2.08e-07
L1 (DV1-GV4)	1138_P01_B09	290	2.90e-07
L1 (DV1-GV4)	1251_P02_G10	829	8.29e-07
L1 (DV1-GV4)	TS8.2 (commercial anti-V δ 1 antibody)	44	4.40e-08

*Binding of 1252_P02_C05 did not reach saturation, therefore data was extrapolated

EXAMPLE 6: TCR engagement assay

The inventors designed several assays to be used for functional characterization of the selected antibodies. The first assay assessed $\gamma\delta$ TCR engagement by measuring downregulation of the $\gamma\delta$ TCR upon antibody binding. Selected antibodies were tested against commercial anti-CD3 and anti-V δ 1 antibodies which were used as positive controls or against 1252_P01_C08 as a positive control (for 1139_P01_E04, 1245_P02_F07, 1245_P01_G06 and 1245_P01_G09). Commercial anti-p $\alpha\gamma\delta$ was used as a negative control because it is a p $\alpha\gamma\delta$ antibody, recognising all $\gamma\delta$ T cells irrespective of variable chain, and therefore is likely to have a different mode of action.

The assay was performed using skin-derived $\gamma\delta$ T cells obtained from three different donor samples (samples with 94%, 80% and 57% purity). Results are shown in **Figure 4**. EC50 values are summarised in **Table 4**, below.

5 **EXAMPLE 7: T cell degranulation assay**

A second assay assessed the degranulation of $\gamma\delta$ T cells. It is thought $\gamma\delta$ T cells may mediate target cell killing by perforin-granzyme-mediated activation of apoptosis. Lytic granules within the cytoplasm of the $\gamma\delta$ T cell may be released toward the target cell upon T cell activation. Therefore, labelling target cells with antibodies to CD107a and measuring the expression by
10 flow cytometry can be used to identify degranulating $\gamma\delta$ T cells.

As for **Example 6**, selected antibodies were tested against commercial anti-CD3 and anti-V δ 1 antibodies as positive controls or against 1252_P01_C08 as a positive control (for 1139_P01_E04, 1245_P02_F07, 1245_P01_G06 and 1245_P01_G09). IgG2a, IgG1 and
15 D1.3 antibodies were used as negative controls. The assay was performed using skin-derived $\gamma\delta$ T cells obtained from three different donor samples (samples with 94%, 80% and 57% purity). Results are shown in **Figure 5**. EC50 values are summarised in **Table 4**, below.

EXAMPLE 8: Killing assay

20 A third assay assessed the ability of $\gamma\delta$ T cells activated with the selected antibodies to kill target cells.

As for **Example 6**, selected antibodies were tested against commercial anti-CD3 and anti-V δ 1 antibodies as positive controls or against 1252_P01_C08 as a positive control (for
25 1139_P01_E04, 1245_P02_F07, 1245_P01_G06 and 1245_P01_G09) and anti-p $\gamma\delta$ as a negative control. IgG2a, IgG1 and D1.3 antibodies were also used as isotype controls. The assay was performed using skin-derived $\gamma\delta$ T cells obtained from two donors (94% and 80% purity) and the results are shown in **Figure 6**.

30 Results from the three functional assays tested in **Examples 6-8** are summarised in **Table 4**.

Table 4. Summary of results obtained from functional assays

Clone ID	TCR downregulation (EC50 μ g/ml – 3 donors)	T cell degranulation (EC50 μ g/ml – 3 donors)	Killing assay (EC50 μ g/ml – 2 or 3 donors)
1245_P01_E07	0.04-0.11	0.007-0.004	0.06

1252_P01_C08	0.02-0.03	0.001-0.0006	0.02
1245_P02_G04	0.01-0.05	0.002	0.10
1245_P01_B07	Positive; 0.35 (1 donor only)	Positive; 0.1 (1 donor only)	0.13
1251_P02_C05	Positive; N/D	Positive; N/D	N/D*
1139_P01_E04	0.027-0.057	0.005	0.005-0.019
1245_P02_F07	0.032-0.043	0.001-0.002	0.006-0.018
1245_P01_G06	0.042-0.055	0.001	0.007-0.051
1245_P01_G09	0.029-0.040	0.001	0.003-0.008
1138_P01_B09	0.078-0.130	N/D	0.055-0.199
1251_P02_G10	0.849; N/D	N/D	N/D**
OKT3 (anti-CD3 antibody)	0.03-0.04	0.001-0.008	0.05
TS8.2 (anti-V δ 1 antibody)	0.48-0.8	0.07-0.16	N/D*

N/D: could not be determined; N/D*: could not be determined, titration curve did not reach plateau; N/D**: Reduced killing profile, EC50 not established

EXAMPLE 9: Epitope mapping

5 In order to determine the epitope of antigen/antibody complexes with high resolution, the protein complexes were incubated with deuterated cross-linkers and subjected to multi-enzymatic cleavage. After enrichment of the cross-linked peptides, the samples were analysed by high resolution mass spectrometry (nLC-LTQ-Orbitrap MS) and the data generated were analysed using XQuest (version 2.0) and Stavrox (version 3.6) software.

10

After trypsin, chymotrypsin, Asp-N, elastase and thermolysin proteolysis of the protein complex L1(DV1-GV4)/1245_P01_E07 with deuterated d0d12, the nLC-orbitrap MS/MS analysis detected 13 cross-linked peptides between L1(DV1-GV4) and the antibody 1245_P01_E07. Results are presented in **Figure 7**.

15

After trypsin, chymotrypsin, Asp-N, elastase and thermolysin proteolysis of the protein complex L1(DV1-GV4)/1252_P01_C08 with deuterated d0d12, the nLC-orbitrap MS/MS analysis detected 5 cross-linked peptides between L1(DV1-GV4) and the antibody 1252_P01_C08. Results are presented in **Figure 8**.

20

After trypsin, chymotrypsin, Asp-N, elastase and thermolysin proteolysis of the protein complex L1(DV1-GV4)/1245_P02_G04 with deuterated d0d12, the nLC-orbitrap MS/MS analysis detected 20 cross-linked peptides between L1(DV1-GV4) and the antibody 1245_P02_G04. Results are presented in **Figure 9**.

5

After trypsin, chymotrypsin, Asp-N, elastase and thermolysin proteolysis of the protein complex L1(DV1-GV4)/1251_P02_C05 with deuterated d0d12, the nLC-orbitrap MS/MS analysis detected 5 cross-linked peptides between L1(DV1-GV4) and the antibody 1251_P02_C05. Results are presented in **Figure 10**.

10

Epitope binding with another antibody, Clone ID 1141_P01_E01, was also tested. After trypsin, chymotrypsin, Asp-N, elastase and thermolysin proteolysis of the protein complex L1(DV1-GV4)/1141_P01_E01 with deuterated d0d12, the nLC-orbitrap MS/MS analysis detected 20 cross-linked peptides between L1(DV1-GV4) and the antibody 1141_P01_E01.

15 Results are presented in **Figure 11**.

A summary of the epitope mapping results is presented in **Table 5**.

Table 5. Results of epitope mapping for antigen/antibody complexes

Clone ID	Epitope mapping, amino acid numbering of SEQ ID NO: 1
1245_P01_E07	5, 9, 16, 20, 62, 64, 72, 77
1252_P01_C08	50, 53, 59, 62, 64
1245_P02_G04	37, 42, 50, 53, 59, 64, 68, 69, 72, 73, 77
1251_P02_C05	59, 60, 68, 72
1141_P01_E01	3, 5, 9, 10, 12, 16, 17, 62, 64, 68, 69

20

CLAIMS

1. A human, isolated anti-TCR delta variable 1 (anti-V δ 1) antibody or fragment thereof, which binds to an epitope of a variable delta 1 (V δ 1) chain of a $\gamma\delta$ T cell receptor (TCR) comprising one or more amino acid residues within amino acid regions:
 - (i) 3-20 of SEQ ID NO: 1; and/or
 - (ii) 37-77 of SEQ ID NO: 1.
2. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in claim 1, wherein the epitope comprises at least one of amino acid residues 3, 5, 9, 10, 12, 16, 17, 20, 37, 42, 50, 53, 59, 62, 64, 68, 69, 72 or 77 of SEQ ID NO: 1.
3. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in claim 1 or claim 2, wherein the epitope comprises one or more amino acid residues within amino acid regions 5-20 and 62-77 of SEQ ID NO: 1.
4. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in claim 1 or claim 2, wherein the epitope comprises one or more amino acid residues within amino acid region 50-64 of SEQ ID NO: 1.
5. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in claim 1 or claim 2, wherein the epitope comprises one or more amino acid residues within amino acid regions 37-53 and 59-77 of SEQ ID NO: 1.
6. The human, isolated anti-V δ 1 antibody or fragment thereof as defined in any one of claims 1 to 5, wherein the epitope is an activating epitope of a $\gamma\delta$ T cell.
7. An isolated anti-V δ 1 antibody or fragment thereof, which comprises one or more of:
 - a CDR3 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 2-25;
 - a CDR2 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 26-37 and SEQUENCES: A1-A12 (of Table 2); and/or
 - a CDR1 comprising a sequence having at least 80% sequence identity with any one of SEQ ID NOs: 38-61.
8. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 7, which comprises a VH region comprising a CDR3 comprising a sequence of SEQ ID NO: 2, a CDR2

comprising a sequence of SEQ ID NO: 26, and a CDR1 comprising a sequence of SEQ ID NO: 38.

9. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 7, which comprises a VH region comprising a CDR3 comprising a sequence of SEQ ID NO: 3, a CDR2 comprising a sequence of SEQ ID NO: 27, and a CDR1 comprising a sequence of SEQ ID NO: 39.

10. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 7, which comprises a VH region comprising a CDR3 comprising a sequence of SEQ ID NO: 4, a CDR2 comprising a sequence of SEQ ID NO: 28, and a CDR1 comprising a sequence of SEQ ID NO: 40.

11. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 7, which comprises a VL region comprising a CDR3 comprising a sequence of SEQ ID NO: 14, a CDR2 comprising a sequence of SEQUENCE: A1, and a CDR1 comprising a sequence of SEQ ID NO: 50.

12. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 7, which comprises a VL region comprising a CDR3 comprising a sequence of SEQ ID NO: 15, a CDR2 comprising a sequence of SEQUENCE: A2, and a CDR1 comprising a sequence of SEQ ID NO: 51.

13. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 7, which comprises a VL region comprising a CDR3 comprising a sequence of SEQ ID NO: 16, a CDR2 comprising a sequence of SEQUENCE: A3, and a CDR1 comprising a sequence of SEQ ID NO: 52.

14. An isolated anti-V δ 1 antibody or fragment thereof, which comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 62-85.

15. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 14, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 62 and a VL region comprising an amino acid sequence of SEQ ID NO: 74.

16. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 14, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 63 and a VL region comprising an amino acid sequence of SEQ ID NO: 75.
17. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 14, which comprises a VH region comprising an amino acid sequence of SEQ ID NO: 64 and a VL region comprising an amino acid sequence of SEQ ID NO: 76.
18. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of claims 7 to 17, wherein the anti-V δ 1 antibody or fragment thereof comprises a VH region and a VL region and wherein the VH and VL region are joined by a linker, such as a polypeptide linker.
19. An isolated anti-V δ 1 antibody or fragment thereof which comprises an amino acid sequence having at least 80% sequence identity with any one of SEQ ID NOs: 86-97.
20. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 19, which comprises SEQ ID NO: 86.
21. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 19, which comprises SEQ ID NO: 87.
22. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 19, which comprises SEQ ID NO: 88.
23. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of claims 1 to 22, which binds a variable delta 1 (V δ 1) chain of a $\gamma\delta$ T cell receptor (TCR) with a binding affinity (KD) as measured by surface plasmon resonance of less than 1.5×10^{-7} M.
24. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of claims 1 to 23, which is an scFv, Fab, Fab', F(ab')₂, Fv, variable domain (e.g. VH or VL), diabody, minibody or full length antibody.
25. The isolated anti-V δ 1 antibody or fragment thereof as defined in claim 24, which is an scFv or a full length antibody, such as IgG1.
26. The isolated anti-V δ 1 antibody as defined in claim 25, which comprises an amino acid sequence having at least 80% sequence identity with of any one of SEQ ID NOs: 111-122.

27. The isolated anti-V δ 1 antibody as defined in claim 26, which comprises SEQ ID NO: 111.
28. The isolated anti-V δ 1 antibody as defined in claim 26, which comprises SEQ ID NO: 112.
29. The isolated anti-V δ 1 antibody as defined in claim 26, which comprises SEQ ID NO: 116.
30. The isolated anti-V δ 1 antibody or fragment thereof as defined in any one of claims 7 to 29, which is human.
31. A polynucleotide sequence encoding the anti-V δ 1 antibody or fragment thereof as defined in any one of claims 1 to 30.
32. A polynucleotide sequence encoding the anti-V δ 1 antibody or fragment thereof comprising a sequence having at least 70% sequence identity with SEQ ID NO: 99-110.
33. An expression vector comprising the polynucleotide sequence as defined in claim 31 or claim 32.
34. A cell comprising the polynucleotide sequence as defined in claim 31 or claim 32 or the expression vector as defined in claim 33.
35. A composition comprising the antibody or fragment thereof as defined in any one of claims 1 to 30.
36. A pharmaceutical composition comprising the antibody or fragment thereof as defined in any one of claims 1 to 30, together with a pharmaceutically acceptable diluent or carrier.
37. A method of generating an anti-V δ 1 antibody or fragment thereof comprising:
- (i) designing a series of antigens comprising a TCR delta variable 1 (TRDV1) amino acid sequence wherein the CDR3 sequence of the TRDV1 is the same for all antigens in the series;
 - (ii) exposing a first antigen designed in step (i) to an antibody library;
 - (iii) isolating the antibodies or fragments thereof which bind to the antigen;

- (iv) exposing the isolated antibodies or fragments thereof to a second antigen designed in step (i); and
- (v) isolating the antibodies or fragments thereof which bind to both the first and second antigen.

38. The method as defined in claim 37, which further comprises exposing the isolated antibodies or fragments thereof to a second series of antigens comprising a $\gamma\delta$ TCR with a different delta variable chain, such as TCR delta variable 2 (TRDV2) or TCR delta variable 3 (TRDV3), and then deselecting the antibodies or fragments thereof which also bind to the second series of antigens.

39. The method as defined in claim 37 or claim 38, wherein the series of antigens are in a heterodimeric and/or homodimeric format.

40. An antibody obtained by the method as defined in any one of claims 37 to 39.

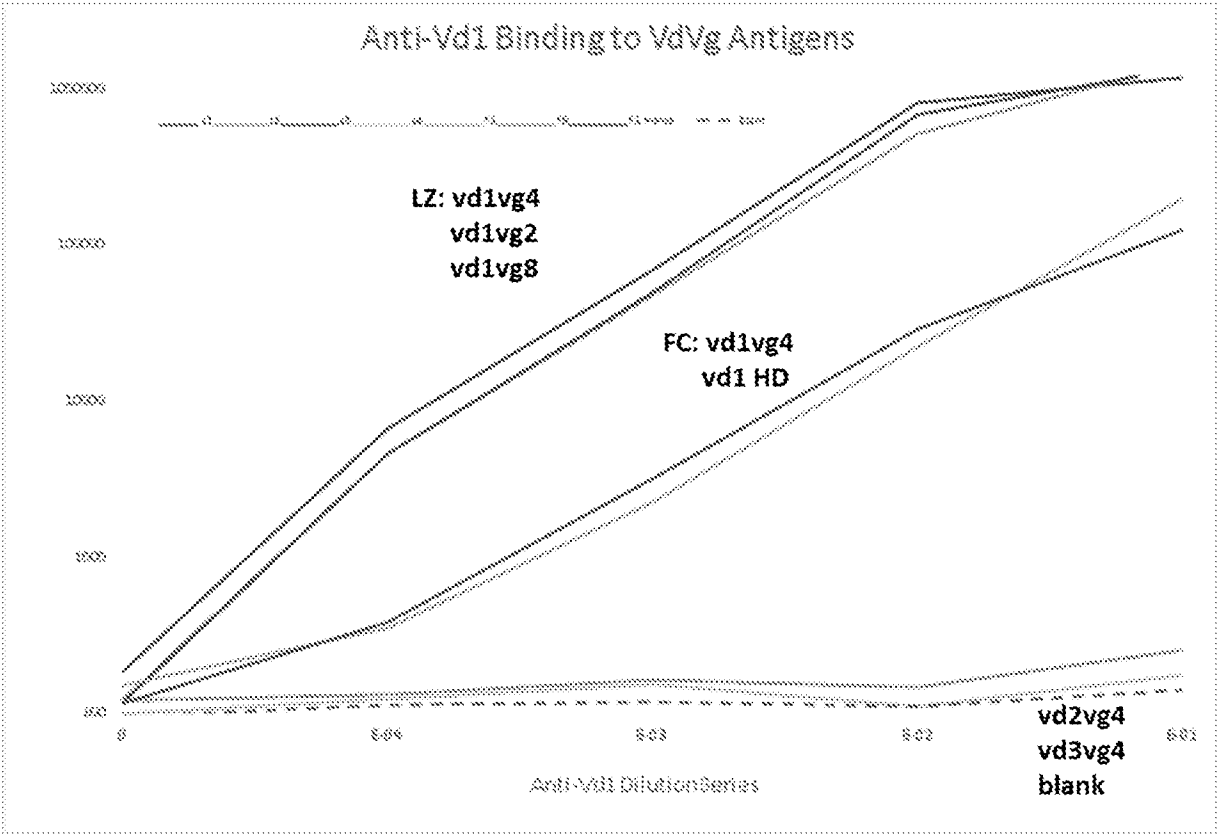
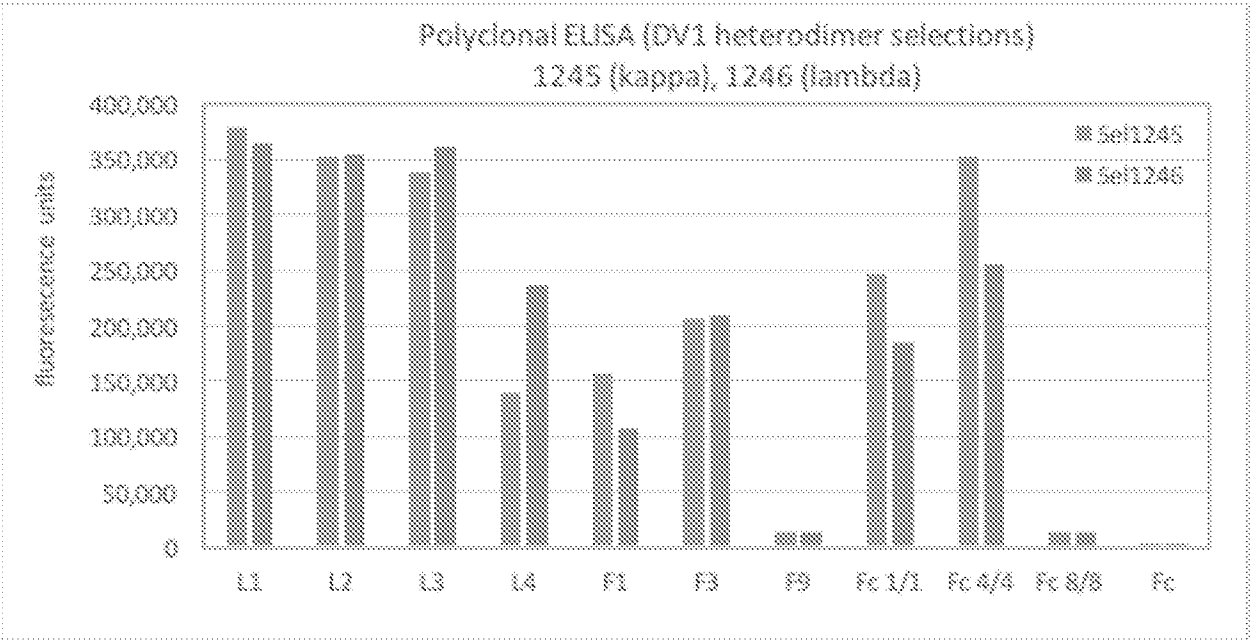


FIGURE 1

A



B

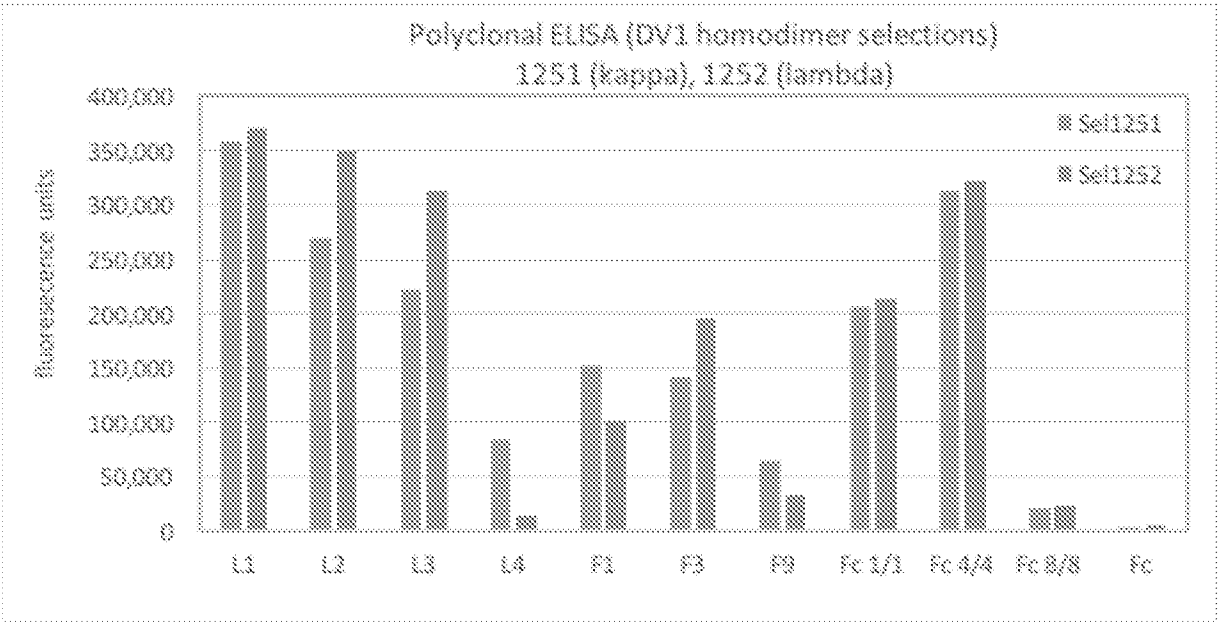
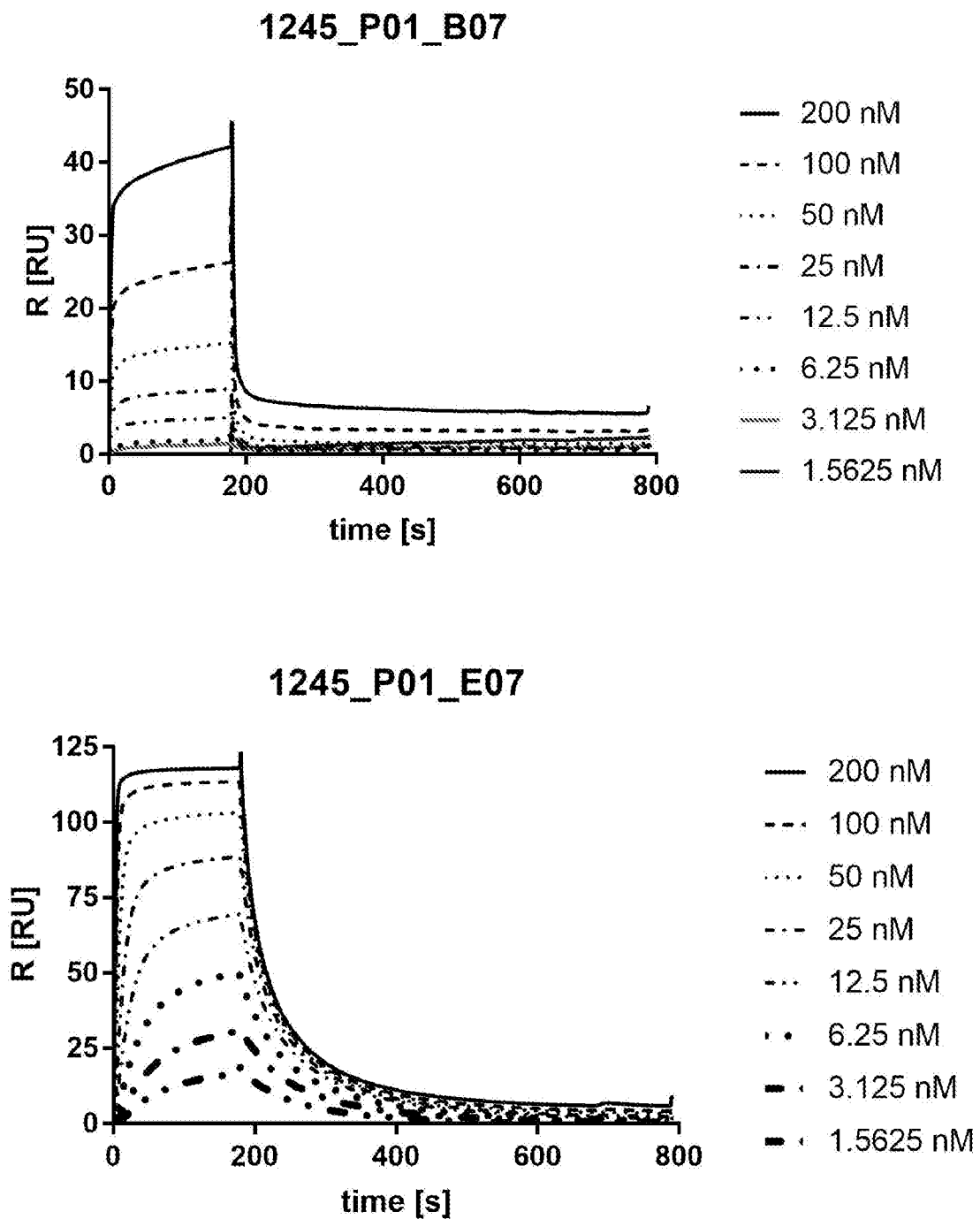


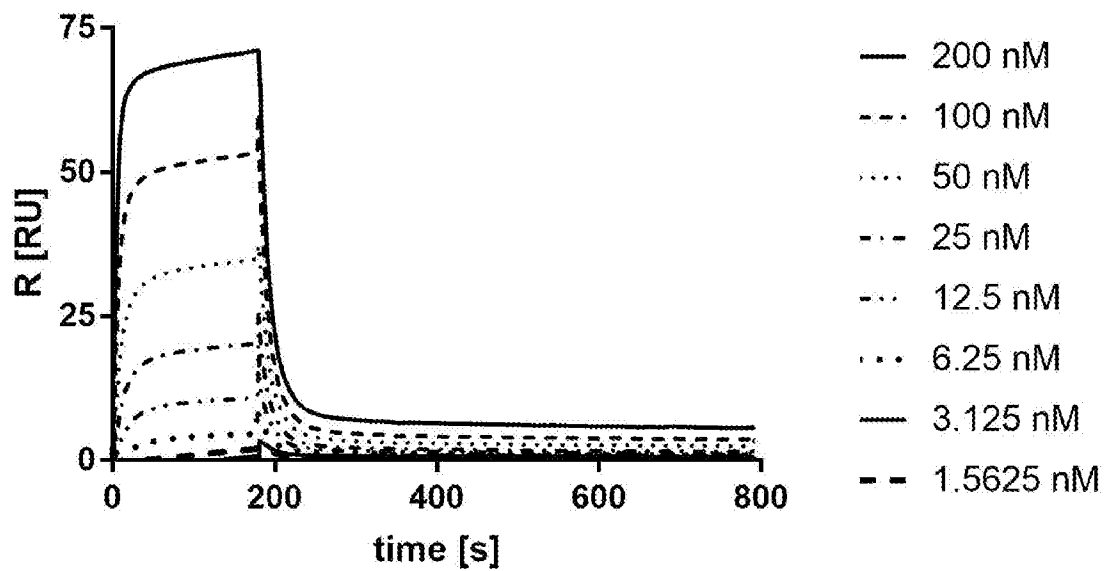
FIGURE 2

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**FIGURE 3**

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1245_P02_G04



1251_P02_C05

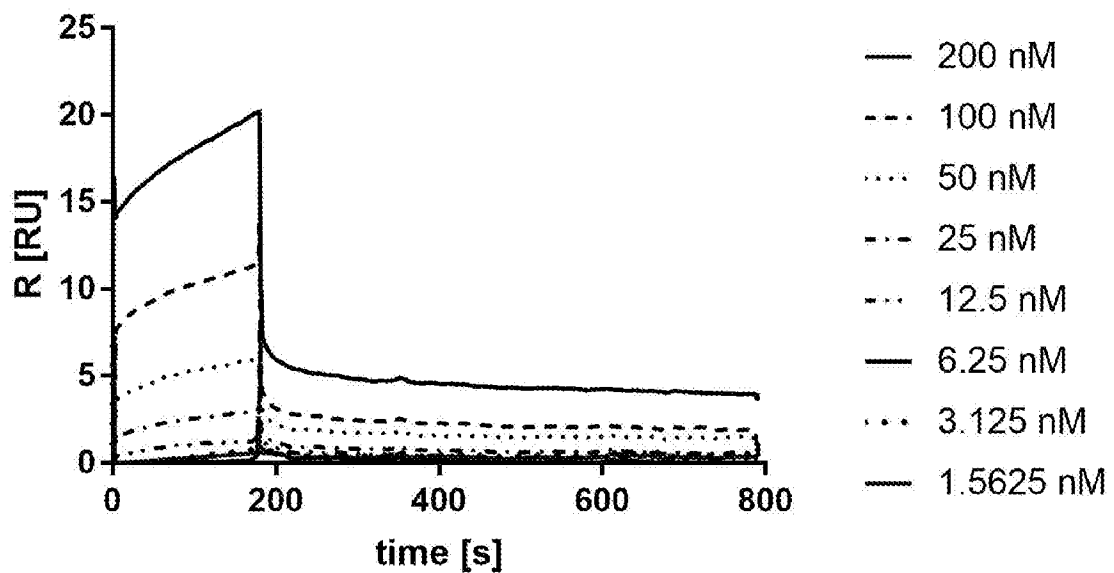
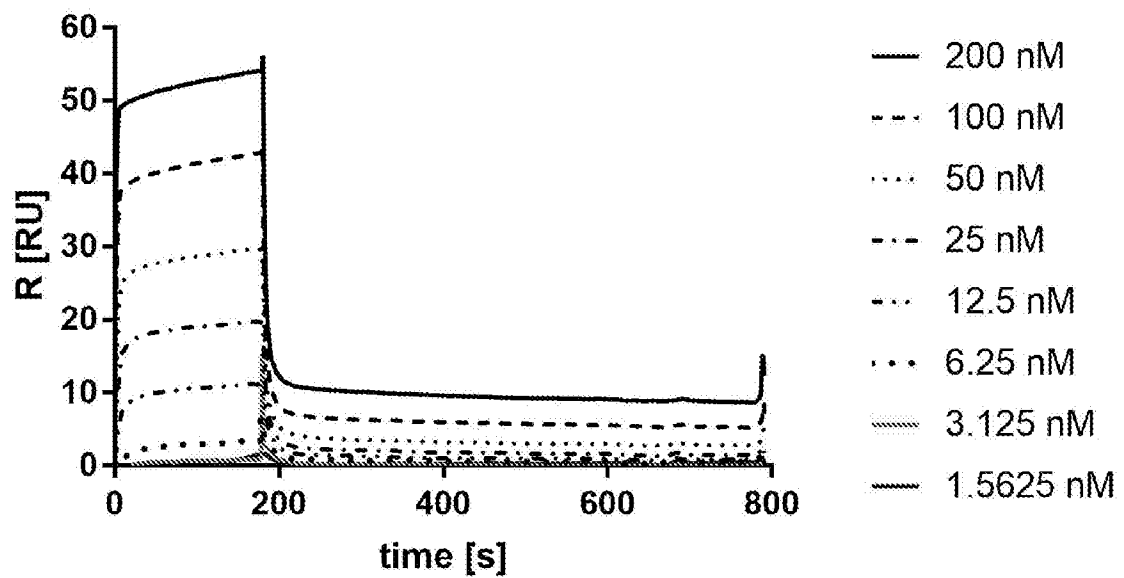


FIGURE 3 (contd.)

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1252_P01_C08



TS8.2_anti-mouse IgG

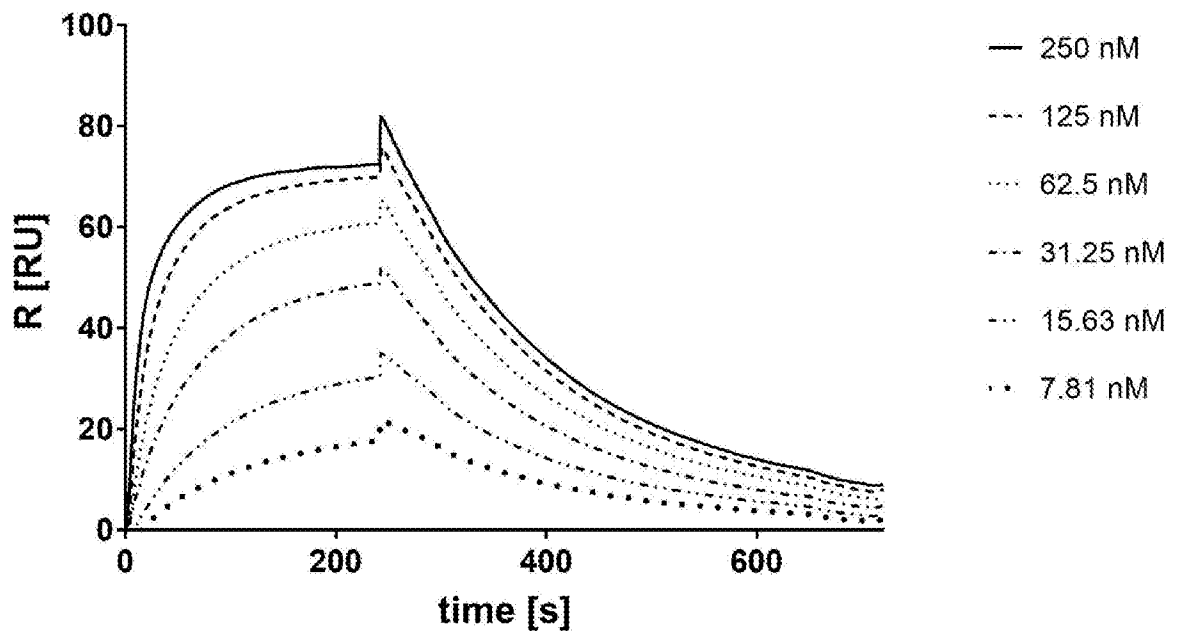
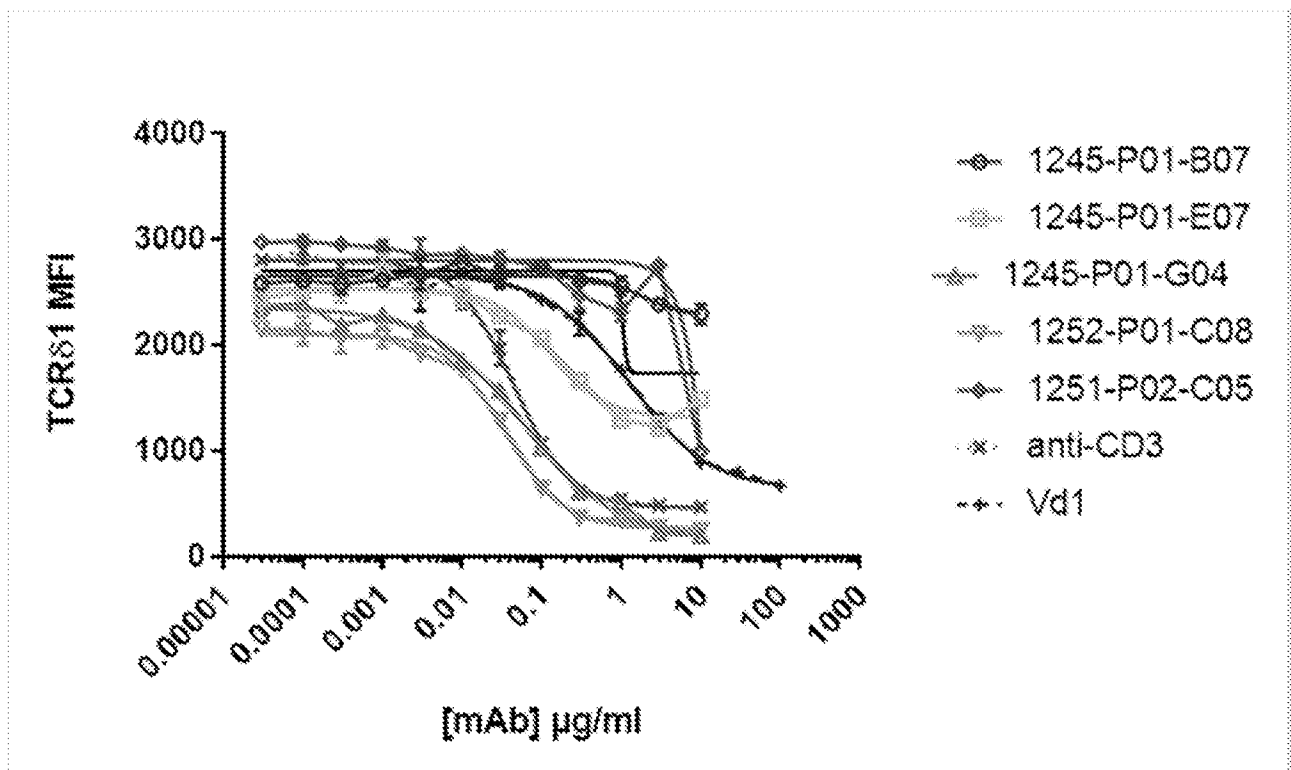


FIGURE 3 (contd.)

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A)



B)

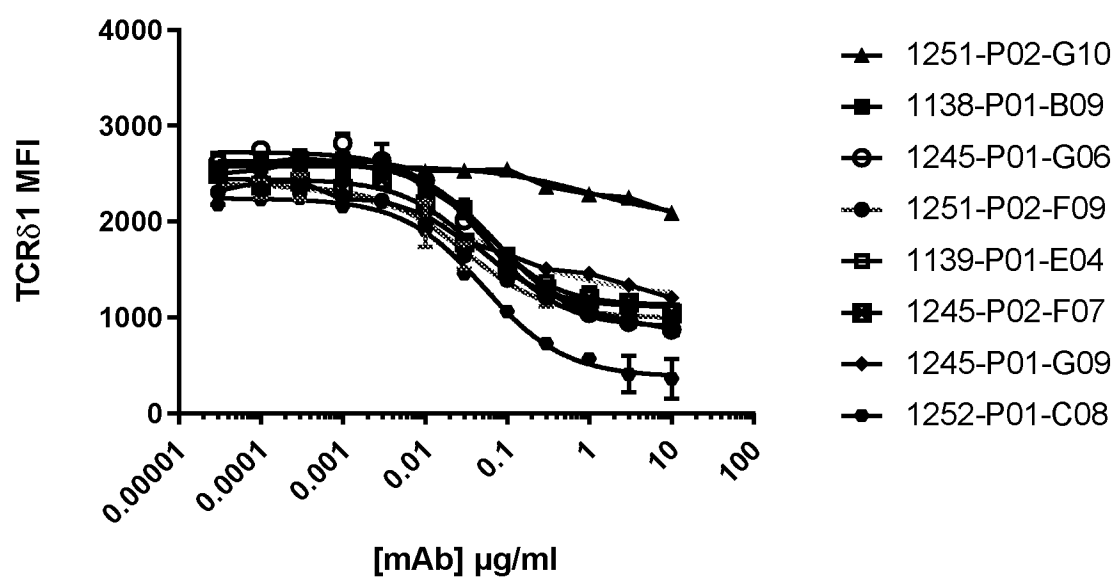
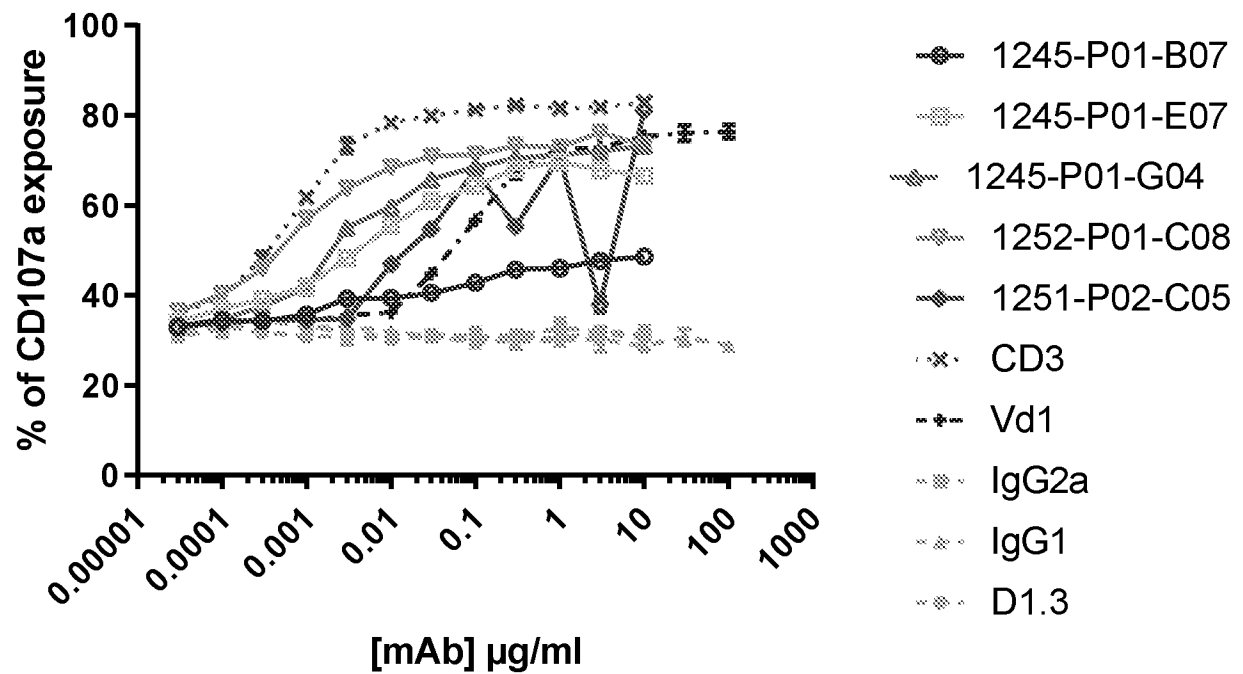


FIGURE 4

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A)



B)

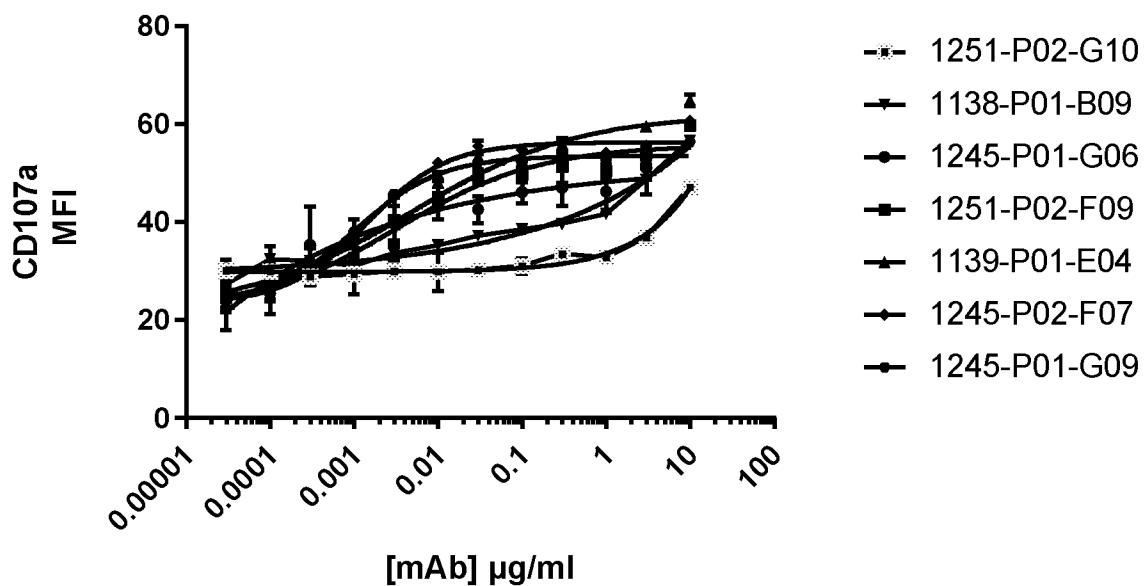
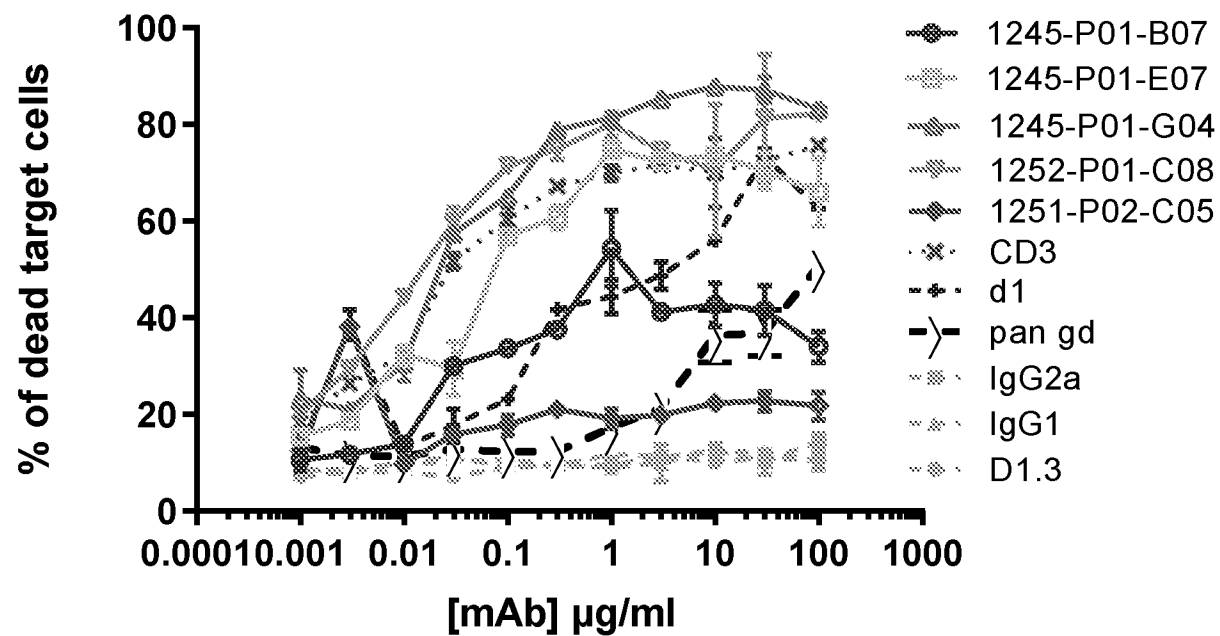


FIGURE 5

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A)



B)

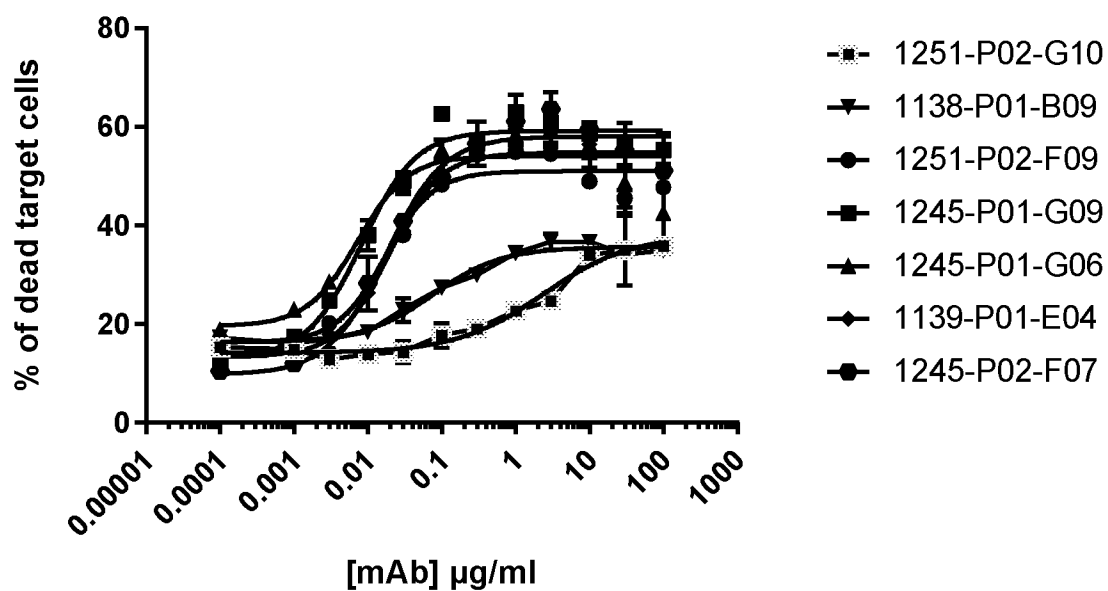


FIGURE 6

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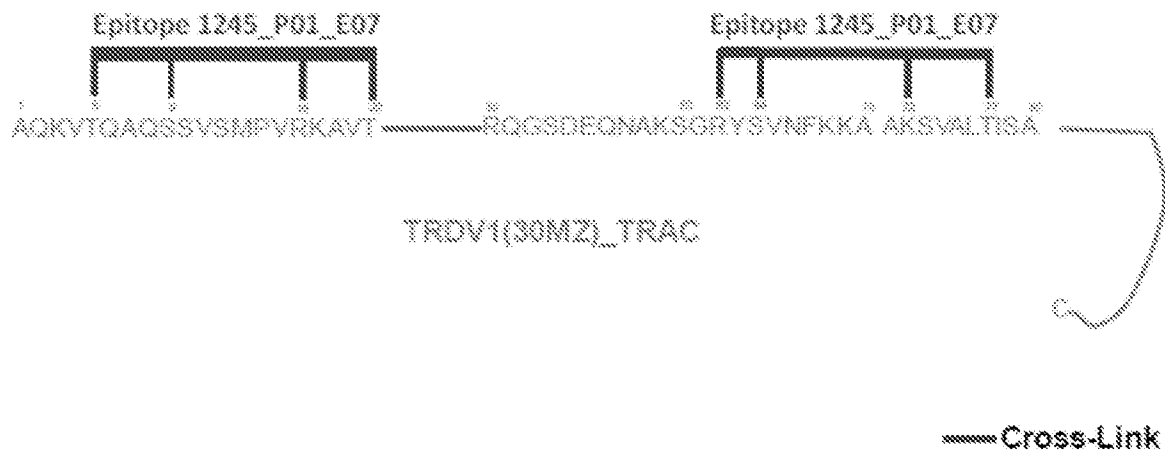


FIGURE 7

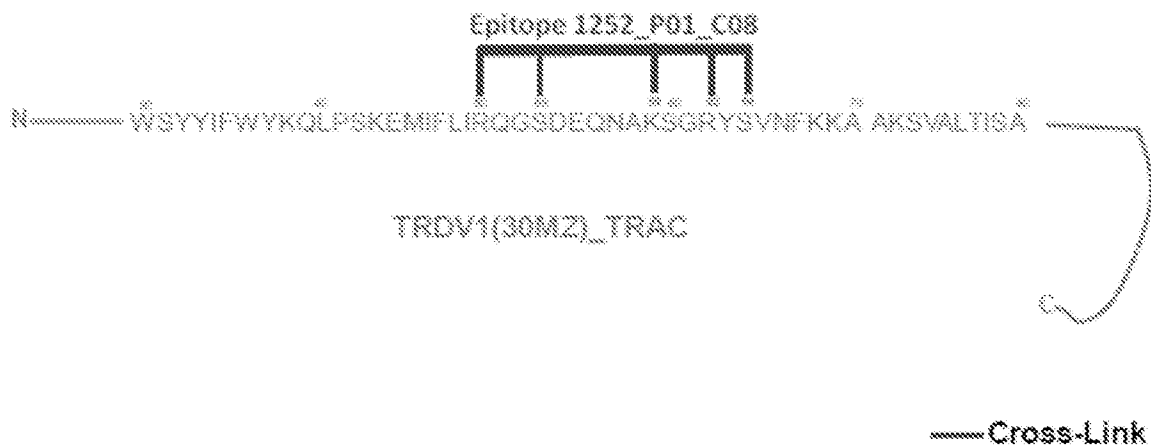


FIGURE 8

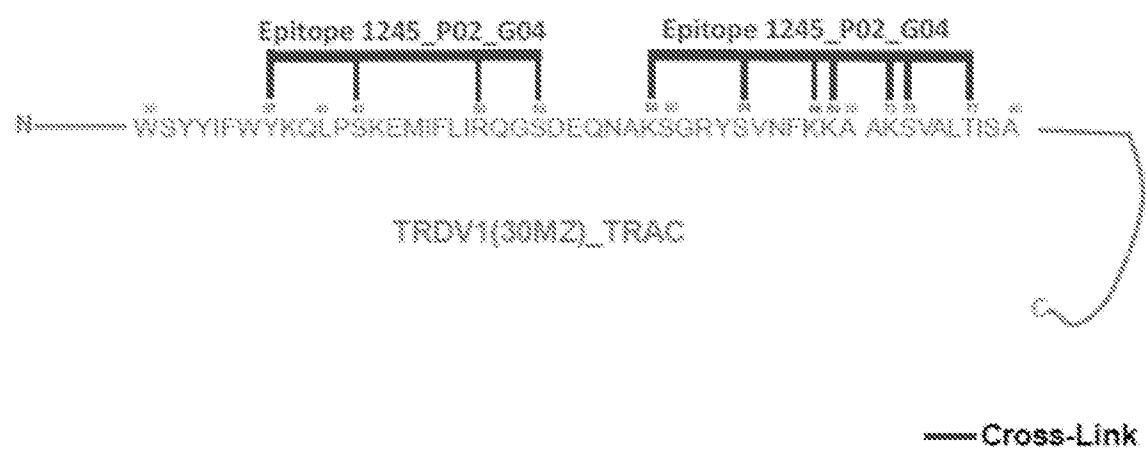


FIGURE 9

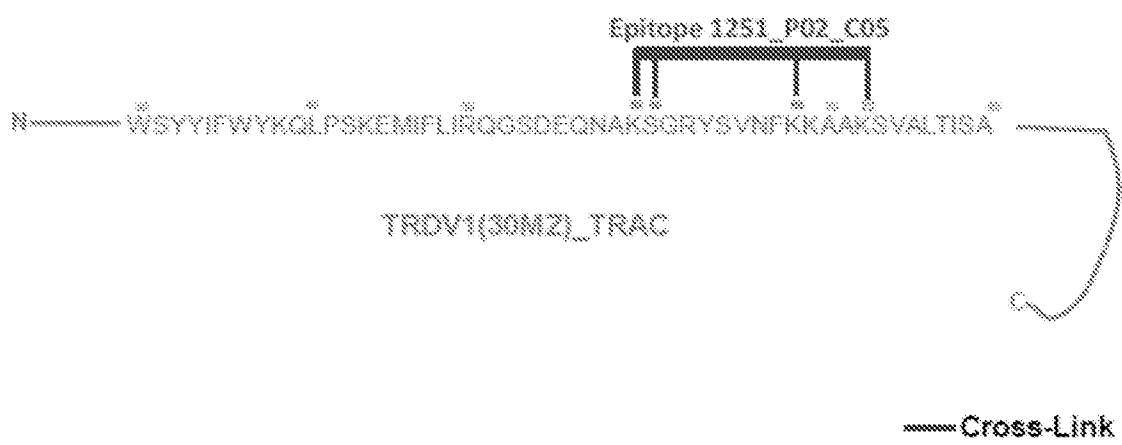


FIGURE 10

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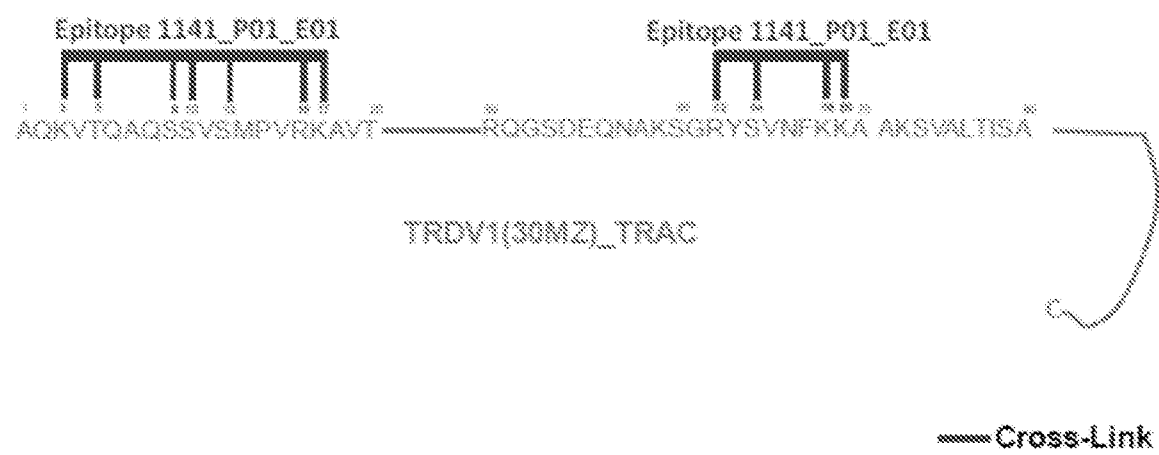


FIGURE 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2020/051955

A. CLASSIFICATION OF SUBJECT MATTER INV. A61P35/00 A61K35/17 C07K16/28 C12N5/0783 ADD.																	
According to International Patent Classification (IPC) or to both national classification and IPC																	
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) A61P C12N A61K C07K																	
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																	
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data, BIOSIS, EMBASE																	
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>WO 2019/147735 A1 (UNIV NEW YORK [US]) 1 August 2019 (2019-08-01)</td> <td>37,40</td> </tr> <tr> <td>Y</td> <td>the whole document</td> <td>1-36,38, 39</td> </tr> <tr> <td>Y</td> <td>----- WO 2017/197347 A1 (ADICET BIO INC [US]) 16 November 2017 (2017-11-16) 100% identity to the epitopes</td> <td>1-40</td> </tr> <tr> <td>Y</td> <td>----- GABRIELLE M SIEGERS ET AL: "Cytotoxic and Regulatory Properties of Circulating V[delta]1+ [gamma][delta] T Cells: A New Player on the Cell Therapy Field?", MOLECULAR THERAPY, vol. 22, no. 8, 4 June 2014 (2014-06-04), pages 1416-1422, XP055159816, ISSN: 1525-0016, DOI: 10.1038/mt.2014.104 the whole document ----- -/-</td> <td>1-40</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	WO 2019/147735 A1 (UNIV NEW YORK [US]) 1 August 2019 (2019-08-01)	37,40	Y	the whole document	1-36,38, 39	Y	----- WO 2017/197347 A1 (ADICET BIO INC [US]) 16 November 2017 (2017-11-16) 100% identity to the epitopes	1-40	Y	----- GABRIELLE M SIEGERS ET AL: "Cytotoxic and Regulatory Properties of Circulating V[delta]1+ [gamma][delta] T Cells: A New Player on the Cell Therapy Field?", MOLECULAR THERAPY, vol. 22, no. 8, 4 June 2014 (2014-06-04), pages 1416-1422, XP055159816, ISSN: 1525-0016, DOI: 10.1038/mt.2014.104 the whole document ----- -/-	1-40
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.															
X	WO 2019/147735 A1 (UNIV NEW YORK [US]) 1 August 2019 (2019-08-01)	37,40															
Y	the whole document	1-36,38, 39															
Y	----- WO 2017/197347 A1 (ADICET BIO INC [US]) 16 November 2017 (2017-11-16) 100% identity to the epitopes	1-40															
Y	----- GABRIELLE M SIEGERS ET AL: "Cytotoxic and Regulatory Properties of Circulating V[delta]1+ [gamma][delta] T Cells: A New Player on the Cell Therapy Field?", MOLECULAR THERAPY, vol. 22, no. 8, 4 June 2014 (2014-06-04), pages 1416-1422, XP055159816, ISSN: 1525-0016, DOI: 10.1038/mt.2014.104 the whole document ----- -/-	1-40															
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.																	
* Special categories of cited documents : <table border="0"> <tr> <td> "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed </td> <td> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family </td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family													
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family																
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21 October 2020		30/10/2020															
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Hix, Rebecca															

INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB2020/051955

Box No. I Nucleotide and/or amino acid sequence(s) (Continuation of item 1.c of the first sheet)

1. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of a sequence listing:
- a. ☒ forming part of the international application as filed:
- ☒ in the form of an Annex C/ST.25 text file.
- ☐ on paper or in the form of an image file.
- b. ☐ furnished together with the international application under PCT Rule 13~~ter~~.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
- c. ☐ furnished subsequent to the international filing date for the purposes of international search only:
- ☐ in the form of an Annex C/ST.25 text file (Rule 13~~ter~~.1(a)).
- ☐ on paper or in the form of an image file (Rule 13~~ter~~.1(b) and Administrative Instructions, Section 713).
2. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
3. Additional comments:

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International application No
PCT/GB2020/051955

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	WO 2016/166544 A1 (TC BIOPHARM LTD [GB]) 20 October 2016 (2016-10-20) the whole document	1-40
Y	DREW C. DENIGER ET AL: "Clinical Applications of Gamma Delta T Cells with Multivalent Immunity", FRONTIERS IN IMMUNOLOGY, vol. 5, 1 December 2014 (2014-12-01), XP055650678, DOI: 10.3389/fimmu.2014.00636 the whole document	1-40
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International application No

PCT/GB2020/051955

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CHITADZE GURANDA ET AL: "The Ambiguous Role of [gamma][delta] T Lymphocytes in Antitumor Immunity", TRENDS IN IMMUNOLOGY, ELSEVIER LTD. * TRENDS JOURNALS, GB, vol. 38, no. 9, 11 July 2017 (2017-07-11), pages 668-678, XP085170623, ISSN: 1471-4906, DOI: 10.1016/J.IT.2017.06.004 the whole document	1-40
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Y,P	GARBER KEN: "[gamma][delta] T cells bring unconventional cancer-targeting to the clinic - again", NATURE BIOTECHNOLOGY, GALE GROUP INC., NEW YORK, US, vol. 38, no. 4, 1 April 2020 (2020-04-01), pages 389-391, XP037096945, ISSN: 1087-0156, DOI: 10.1038/S41587-020-0487-2 [retrieved on 2020-04-07] the whole document	1-40
Y,P	SEBESTYEN ZSOLT ET AL: "Translating gammadelta ([gamma][delta]) T cells and their receptors into cancer cell therapies", NATURE REVIEWS DRUG DISCOVERY, NATURE PUBLISHING GROUP, GB, vol. 19, no. 3, 6 September 2019 (2019-09-06), pages 169-184, XP037049360, ISSN: 1474-1776, DOI: 10.1038/S41573-019-0038-Z [retrieved on 2019-09-06] the whole document	1-40
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International application No
PCT/GB2020/051955

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	HANS-HEINRICH OBERG ET AL: "Bispecific antibodies enhance tumor-infiltrating T cell cytotoxicity against autologous HER-2-expressing high-grade ovarian tumors", JOURNAL OF LEUKOCYTE BIOLOGY, vol. 107, no. 6, 13 December 2019 (2019-12-13), pages 1081-1095, XP055740419, GB ISSN: 0741-5400, DOI: 10.1002/JLB.5MA1119-265R the whole document -----	1-40

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Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2019147735 A1	01-08-2019	US 2019144540 A1 US 2020102388 A1 WO 2019147735 A1	16-05-2019 02-04-2020 01-08-2019
WO 2017197347 A1	16-11-2017	AU 2017261804 A1 CA 3023993 A1 CN 110072533 A EP 3454870 A1 JP 2019519210 A KR 20190016960 A US 2019119634 A1 WO 2017197347 A1	29-11-2018 16-11-2017 30-07-2019 20-03-2019 11-07-2019 19-02-2019 25-04-2019 16-11-2017
WO 2016166544 A1	20-10-2016	AU 2016250211 A1 BR 112017022249 A2 CA 2982523 A1 CN 107810267 A EA 201792041 A1 EP 3283620 A1 HK 1250741 A1 JP 2018512161 A KR 20180012754 A SG 11201708401W A US 2018125889 A1 WO 2016166544 A1	02-11-2017 10-07-2018 20-10-2016 16-03-2018 30-04-2018 21-02-2018 11-01-2019 17-05-2018 06-02-2018 29-11-2017 10-05-2018 20-10-2016