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(71) Applicant: **THE CALIFORNIA INSTITUTE FOR BIOMEDICAL RESEARCH** [US/US]; 11119 North Torrey Pines Road, Suite 100, La Jolla, California 92037 (US).

(72) Inventors: **YOUNG, Travis**; 8012 Paseo del Ocaso, La Jolla, California 92037 (US). **RODGERS, David T.**; 115 W. Montecito Way, San Diego, California 92103 (US). **HARDY, Ian**; 9505 Easter Way #6, San Diego, CA 92121 (US). **KIM, Chanhyuk**; 9434 Twin Trails Drive, Apt. 103, San Diego, California 92129 (US). **SCHULTZ, Peter G.**; 1650 La Jolla Rancho Road, La Jolla, California 92037 (US). **HAMPTON, Eric**; 1433 Chert Drive, San Marcos, California 92078 (US). **LABORDA, Eduardo**; 2609 Pico Place, #233, San Diego, California 92109 (US). **PRESTA, Leonard**; 1900 Gough Street, Apt. 206, San Francisco, California 94109 (US).

(74) Agents: **NUDELMAN, Aaron S.** et al.; Cooley LLP, 1299 Pennsylvania Avenue, NW, Suite 700, Washington, District of Columbia 20004 (US).

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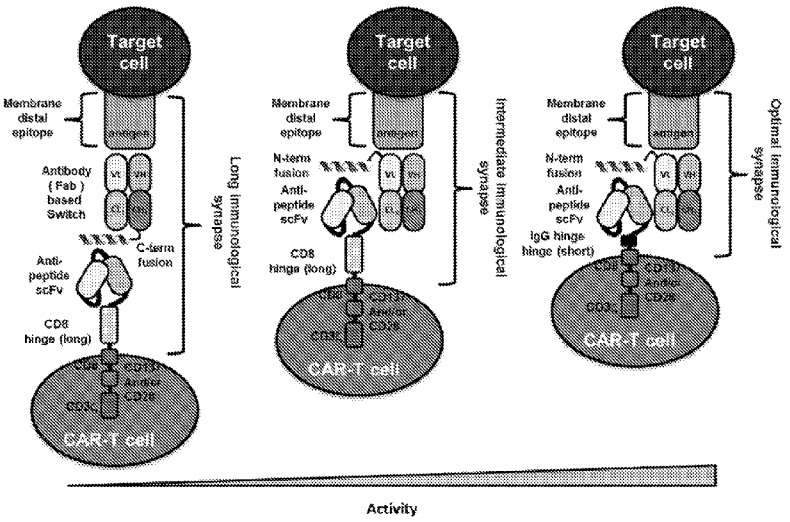
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(54) Title: OPTIMIZED PNE-BASED CHIMERIC RECEPTOR T CELL SWITCHES AND USES THEREOF

FIG. 2



(57) Abstract: Disclosed herein are chimeric antigen receptor effector cells (CAR-ECs) and CAR-EC switches. The switchable CAR-ECs are generally T cells. The one or more chimeric antigen receptors may recognize a peptidic antigen on the CAR-EC switch. The CAR-ECs and switches may be used for the treatment of a condition in a subject in need thereof.

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OPTIMIZED PNE-BASED CHIMERIC RECEPTOR T CELL SWITCHES AND USES THEREOF

CROSS-REFERENCE

[0001] This application claims priority to U.S. Provisional Application No. 62/148,063, filed, April 15, 2015, and U.S. Provisional Application No. 62/253,467, November 10, 2015, each of which application is incorporated by reference herein in its entirety.

STATEMENT REGARDING SEQUENCE LISTING

[0002] The Sequence Listing associated with this application is provided in text format in lieu of a paper copy, and is hereby incorporated by reference into the specification. The name of the text file containing the Sequence Listing is CIBR_008_01WO_ST25.txt. The text file is 534 KB, was created on April 15, 2016, and is being submitted electronically via EFS-Web.

BACKGROUND OF THE INVENTION

[0003] Immunotherapies are becoming attractive alternatives to chemotherapies, including immunotherapies that use adoptive transfer of genetically modified T cells to "reteach" the immune system to recognize and eliminate malignant tumor cells. Genetically modified T cells express chimeric antigen receptors, which generally consist of a signaling endodomain, a CD3-zeta transmembrane domain and an extracellular single-chain variable fragment (scFv) derived from a monoclonal antibody which gives the receptor specificity for a tumor-associated antigen on a target malignant cell. Upon binding the tumor-associated antigen via the chimeric antigen receptor, the chimeric antigen receptor expressing T cell (CAR T-cell) mounts an immune response that is cytotoxic to the malignant cell. Such therapies can circumvent chemotherapy resistance and have been shown to be active against relapsed/refractory disease, resulting in sustained remissions for some chronic lymphocytic leukemia (CLL) and acute lymphoblastic leukemia (ALL) patients. However, these therapies require further investigation and optimization, as they caused undesirable effects such as toxic lymphophenia, chronic hypogammaglobulinemia for hematological targets, fatal off-target cytolysis for solid tumor targets, persistent B cell aplasia with the use of anti-CD19 antibody expressing CAR T-cells, and, in some cases, death.

SUMMARY OF THE INVENTION

[0004] Disclosed herein are chimeric antigen receptors ("CAR") comprising an extracellular domain, a transmembrane domain an intracellular signaling domain, wherein the extracellular

domain comprises: a region that interacts with a chimeric antigen receptor switch; and a hinge domain. The hinge domain may be about one to about twenty amino acids long. The hinge domain may be greater than about 20 amino acids long. The hinge domain may be flexible. The hinge domain may be rigid. A first cysteine of a first chimeric antigen receptor and a second cysteine of a second chimeric antigen receptor may form a disulfide bond, resulting in multimerization of the first chimeric antigen receptor and the second chimeric antigen receptor. The hinge domain may have a sequence selected from SEQ ID NOS: 68-71. The hinge domain may have a sequence that is at least 50% homologous to a sequence selected from SEQ ID NOS: 68-71. The extracellular domain may comprise a humanized anti-GCN4 scFv. The humanized anti-GCN4 scFv may have a sequence selected from SEQ ID NOS: 165-170. The humanized anti-GCN4 scFv may have a sequence that is at least 50% homologous to a sequence selected from SEQ ID NOS: 165-170. The hinge domain may comprise a peptide derived from a protein selected from a CD8, an IgG, portions thereof, and combinations thereof. The region that interacts with a chimeric antigen receptor switch may interact with a chimeric antigen receptor binding peptide of the chimeric antigen receptor switch. The chimeric antigen receptor may have a sequence selected from SEQ ID NOS: 51, 73, 74, and 171-176. The chimeric antigen receptor may have a sequence that is at least 50% homologous to a sequence selected from SEQ ID NOS: 51, 73, 74, and171-176.

[0005] Further disclosed herein are soluble T cell receptor switches comprising: a chimeric antigen receptor binding peptide; and a soluble T cell receptor or portion thereof. The chimeric antigen receptor binding peptide may be fused to a terminus of a domain of the soluble T cell receptor. The chimeric antigen receptor binding peptide may be grafted into an internal site of a domain of the soluble T cell receptor. The domain of the soluble T cell receptor may be selected from an alpha chain and a beta chain. The soluble T cell receptor switch may have a sequence selected from SEQ ID NOS: 62-67. The soluble T cell receptor switch may have a sequence at least 50% homologous to a sequence selected from SEQ ID NOS: 62-67. The soluble T cell receptor switch may further comprise a linker, wherein the linker links the chimeric antigen receptor binding peptide to the soluble T cell receptor or portion thereof. The linker may be flexible. The linker may be rigid. The linker may be selected from SEQ ID NOS: 40-50.

[0006] Disclosed herein are chimeric antigen receptor switches comprising: a chimeric antigen receptor binding peptide; a targeting moiety; and a linker, wherein the linker links the chimeric antigen receptor binding peptide to the targeting moiety. The linker may be rigid. The linker may comprise an alpha helix. The linker may be flexible.

[0007] Further disclosed herein are chimeric antigen receptor switches comprising: a fusion antibody comprising: a chimeric antigen receptor binding peptide; and a light chain of an antibody or antibody fragment, wherein the chimeric antigen receptor binding peptide is connected to the

light chain of the targeting antibody or antibody fragment; and a heavy chain of the targeting antibody or antibody fragment. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 85, 93, 94, 97, 97-99, 151, 153 and 154 and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence selected from SEQ ID NOS. 9, 10 and 150. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 85, 93, 94, 97, 97-99, 151, 153 and 154, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS. 9, 10 and 150. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 103 and 105, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence of SEQ ID NO. 18. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 103 and 105, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO. 18. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 109, 111, 115, 117, 121 and 123, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence selected from SEQ ID NOS: 106, 112 and 118. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 109, 111, 115, 117, 121 and 123, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 106, 112 and 118. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 125, 127, 131, 133, 137 and 139, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence selected from SEQ ID NOS: 14, 128 and 134. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 125, 127, 131, 133, 137 and 139, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 14, 128 and 134. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 141 and 143, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence of SEQ ID NO: 12. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 141 and 143, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 12. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 145 and

146, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence of SEQ ID NO: 144. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 145 and 146, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 144. The fusion antibody may be encoded by a nucleotide sequence of SEQ ID NO: 158, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence of SEQ ID NO: 157. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 158, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 157. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 162 and 164, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence of SEQ ID NO: 20. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 162 and 164, and the heavy chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 20. The fusion antibody and the heavy chain of the targeting antibody or antibody fragment may be encoded by one or more nucleotide sequences in a polynucleotide vector, wherein the polynucleotide vector has a sequence selected from SEQ ID NOS: 100 and 101. The fusion antibody and the heavy chain of the targeting antibody or antibody fragment may be encoded by one or more nucleotide sequences in a vector, wherein the vector has a sequence that is at least 50% homologous to a sequence selected from SEQ ID NOS: 100 and 101. The fusion antibody may have a sequence selected from SEQ ID NOS: 30 and 31, and the heavy chain of the targeting antibody or antibody fragment has a sequence selected from SEQ ID NOS: 28 and 29. The fusion antibody may have a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 30 and 31, and the heavy chain of the targeting antibody or antibody fragment has a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 28 and 29.

[0008] Disclosed herein are chimeric antigen receptor switches comprising: a fusion antibody comprising: a chimeric antigen receptor binding peptide; and a heavy chain of an antibody or antibody fragment, wherein the chimeric antigen receptor binding peptide is connected to the heavy chain of the targeting antibody or antibody fragment; and a light chain of the targeting antibody or antibody fragment. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 86-92, 95, 96, 152, 155 and 156, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence selected from SEQ ID NOS: 8 and

149. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 86-92, 95 , 96, 152, 155 and 156, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 8 and 149. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 102 and 104, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence of SEQ ID NO. 17. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 102 and 104, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO. 17. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 108, 110, 116, 120 and 122, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence selected from SEQ ID NOS: 113 and 119. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 108, 110, 116, 120 and 122 and 104, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 113 and 119. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 124, 126, 130, 132, 136 and 138, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence selected from SEQ ID NOS: 129 and 135. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 124, 126, 130, 132, 136 and 138, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 129 and 135. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 140 and 142, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence of SEQ ID NO: 11. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 140 and 142, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 11. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 147 and 148. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 147 and 148. The fusion antibody may be encoded by a nucleotide sequence of SEQ ID NO: 160, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence of SEQ ID NO: 159. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ

ID NO: 160, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 159. The fusion antibody may be encoded by a nucleotide sequence selected from SEQ ID NOS: 161 and 163, and the light chain of the targeting antibody or antibody fragment may be encoded by a nucleotide sequence of SEQ ID NO: 19. The fusion antibody may be encoded by a nucleotide sequence that is at least about 50% homologous to a nucleotide sequence selected from SEQ ID NOS: 161 and 163, and the light chain of the targeting antibody or antibody fragment may be encoded by a sequence that is at least about 50% homologous to SEQ ID NO: 19. The fusion antibody may have a sequence selected from SEQ ID NOS: 32-25 and the light chain of the targeting antibody or antibody fragment may have a sequence of SEQ ID NO. 27. The fusion antibody may have a sequence at least about 50% homologous to a sequence selected from SEQ ID NOS: 32-25 and the light chain of the targeting antibody or antibody fragment may have a sequence at least about 50% homologous to SEQ ID NO. 27.

[0009] Further disclosed herein are pharmaceutical compositions comprising any one of the chimeric antibody antigen receptor switches disclosed herein. Disclosed herein are methods of administering the chimeric antigen receptor switch and the chimeric antigen receptor effector cell disclosed herein to a subject in need thereof, wherein the chimeric antigen receptor switch and/or chimeric antigen receptor effector cell is administered by a method selected from intraperitoneal injection and intravenous injection. The method may comprise administering the chimeric antigen receptor switch and/or the chimeric antigen receptor effector cell multiple times.

[0010] Disclosed herein are methods of producing an optimal switchable chimeric antigen receptor platform, comprising: incorporating a first chimeric antigen receptor binding peptide to a first site of a targeting moiety that binds a first cell surface molecule on a first target cell to produce a first switch; incorporating a second chimeric antigen receptor binding peptide to a second site of a second targeting moiety that binds a second cell surface molecule on a second target cell to produce a second switch; contacting the first target cell with the first switch and a first chimeric antigen receptor effector cell expressing a first chimeric antigen receptor; contacting the second target cell with the second switch and a second chimeric antigen receptor effector cell expressing a second chimeric antigen receptor; and comparing a first cytotoxic effect of the first switch and the first chimeric antigen receptor effector cell on the first target cell to a second cytotoxic effect of the second switch and the second chimeric antigen receptor effector cell on the second target cell; and selecting the first switch and first chimeric antigen receptor effector cell or the second switch and the second chimeric antigen receptor effector cell as the optimal switchable chimeric antigen receptor platform based on comparing the first cytotoxic effect to the second cytotoxic effect. The first chimeric antigen receptor binding peptide and the second chimeric antigen receptor binding

peptide may be the same. The first targeting moiety and the second targeting moiety may be the same. The first site and the second site may be the same. The first site and the second site may be different. The first and/or second targeting moiety may comprise a peptide or protein. The first site and/or second site may be selected from an N terminus of the peptide or protein, a C terminus of the peptide or protein, and an internal site of the peptide or protein. The first and/or second targeting moiety comprises an antibody or antibody fragment. The first site and/or second site may be selected from an N terminus of the antibody or antibody fragment, a C terminus of the antibody or antibody fragment, and an internal site of the antibody or antibody fragment. The first site and/or second site may be selected from a light chain of the antibody or antibody fragment and a heavy chain of the antibody or antibody fragment. The first site and/or second site may be selected from a variable region of the antibody or antibody fragment and a constant region of the antibody or antibody fragment. The first site and/or second site may be selected from a VL domain, a CL domain, a VH domain, a CH1 domain, a CH2 domain, a CH3 domain, and a hinge domain of the antibody or antibody fragment. Incorporating the first/second chimeric antigen receptor binding peptide may comprise a method selected from fusing, grafting, conjugating, linking, and combinations thereof. The method may further comprise incorporating a first linker to the first site, wherein the first linker links the first chimeric antigen receptor binding peptide to the first targeting moiety. The method may further comprise incorporating a second linker to the second site wherein the second linker links the second chimeric antigen receptor binding peptide to the second targeting moiety. The first linker and the second linker may be the same. The first linker and the second linker may be different. The first linker and the second linker may differ by a feature selected from flexibility, length, amino acid sequence, and combinations thereof. The first and/or second linker may have a sequence selected from SEQ ID NOS: 40-50. The first chimeric antigen receptor and the second chimeric antigen receptor may be the same. The first chimeric antigen receptor and the second chimeric antigen receptor may be different. The first chimeric antigen receptor and the second chimeric antigen receptor may differ by a domain selected from an extracellular domain, a transmembrane domain, an intracellular domain, and a hinge domain (also known as a spacer domain). A first hinge domain of the first chimeric antigen receptor and a second hinge domain of the second chimeric antigen receptor may differ by a feature selected from flexibility, length, amino acid sequence and combinations thereof. The method may further comprise incorporating one or more additional chimeric antigen receptor binding peptides to the first and/or second targeting moiety to produce a first multivalent switch and/or a second multivalent switch. The method may further comprise incorporating a cysteine residue into the first chimeric antigen receptor and/or the second chimeric antigen receptor in order to multimerize the first chimeric antigen receptor and/or the second chimeric antigen receptor through a disulfide bond. Contacting the first target cell

and/or contacting the second target cell may occur *in vitro*. Contacting the first target cell and/or contacting the second target cell may occur *in vivo*. Comparing the first cytotoxic effect to the second cytotoxic effect may comprise comparing a feature selected from viability of target cells, viability of off-target cells, tumor burden, and health of an *in vivo* model.

[0011] Disclosed herein are optimized chimeric antigen receptor–effector cell platforms, comprising: a chimeric antigen receptor–effector cell switch comprising a chimeric antigen receptor binding peptide and a targeting moiety; and a chimeric antigen receptor–effector cell that expresses a chimeric antigen receptor, wherein the chimeric antigen receptor–effector cell platform is derived by a method comprising: incorporating a first chimeric antigen receptor binding peptide to a first site of a targeting moiety that binds a first cell surface molecule on a first target cell to produce a first switch; incorporating a second chimeric antigen receptor binding peptide to a second site of a second targeting moiety that binds a second cell surface molecule on a second target cell to produce a second switch; contacting the first target cell with the first switch and a first chimeric antigen receptor effector cell expressing a first chimeric antigen receptor; contacting the second target cell with the second switch and a second chimeric antigen receptor effector cell expressing a second chimeric antigen receptor; and comparing a first cytotoxic effect of the first switch and the first chimeric antigen receptor effector cell on the first target cell to a second cytotoxic effect of the second switch and the second chimeric antigen receptor effector cell on the second target cell; and selecting the first switch and first chimeric antigen receptor effector cell or the second switch and the second chimeric antigen receptor effector cell as the optimal switchable chimeric antigen receptor platform based on comparing the first cytotoxic effect to the second cytotoxic effect. The chimeric antigen receptor effector cell may be derived from a T cell. The chimeric antigen receptor-binding peptide may comprise a peptide selected from a non-human peptide, a non-mammalian peptide, a synthetic non-naturally occurring peptide, and a peptide that has low immunogenicity in a human subject. The chimeric antigen receptor-binding peptide may comprise a sequence selected from SEQ ID NOS: 2-6. The targeting moiety may be selected from a protein, a peptide, an antibody, an antibody fragment, a small molecule, and a soluble T cell receptor or portion thereof. The targeting moiety may comprise an antibody or antibody fragment that binds a cell surface molecule. The targeting moiety may comprise an antibody or antibody fragment that binds a cell surface molecule selected from CD19, CD20, CD22, CD33, CD123, CEA, CLL1, BCMA, EGFRvIII, EGFR, CS1 and Her2. The targeting moiety may comprise a sequence selected from SEQ ID NOS: 21-38, or a portion thereof, or a homolog thereof. The targeting moiety may be encoded by a sequence selected from SEQ ID NOS: 8-20, or a portion thereof, or a homolog thereof.

[0012] In embodiments, a switch may be constructed by combining any of the heavy or light chain sequences disclosed herein.

[0013] Further disclosed herein are methods of enriching a population of chimeric antigen receptor effector cells comprising contacting the chimeric antigen receptor effector cells with an antigen that binds the chimeric antigen receptor of the chimeric antigen receptor effector cells. The antigen may be located on a chimeric antigen receptor effector cell switch. The contacting may occur multiple times. The antigen may be removed between the multiple times.

[0014] Disclosed herein are model systems for testing a CAR-EC platform, comprising: a chimeric antigen receptor–effector cell switch comprising a chimeric antigen receptor binding peptide and a targeting moiety, wherein the targeting moiety binds a non-human cell surface molecule on a non-human target cell; and a chimeric antigen receptor–effector cell that expresses a chimeric antigen receptor, wherein the chimeric antigen receptor–effector cell is a non-human cell. The non-human target cell may be produced by a cell line. The model system may be an *in vitro* model system. The non-human target cell may be *in vivo*. The model system may be selected from a rat, a mouse, and a monkey. The targeting moiety may comprise an anti-mouse antibody or antibody fragment. The targeting moiety may have a sequence selected from SEQ ID NOS: 52-61. The targeting moiety may have a sequence at least 50% homologous to a sequence selected from SEQ ID NOS: 52-61. The chimeric antigen receptor may be encoded by SEQ ID NO. 51. The chimeric antigen receptor may be encoded by a sequence at least 50% homologous to SEQ ID NO. 51.

[0015] Further disclosed herein are methods of treating cancer in a subject comprising administering a chimeric antigen receptor effector cell and a chimeric antigen receptor switch to the subject. The chimeric antigen receptor effector cell may be administered to the subject prior to administration of the chimeric antigen receptor switch. The chimeric antigen receptor switch may comprise a soluble T cell receptor switch described herein or a chimeric antigen receptor switch described herein. The chimeric antigen receptor switch may be administered in an amount titrated in the subject to optimize the treatment of the cancer. The chimeric antigen receptor switch may be administered at an initial dose, wherein the initial dose is the smallest dose necessary to treat the cancer. The chimeric antigen receptor switch may be administered at a second dose after about 1, 2, 3, 4, 5, 6, 7, 8, or more weeks of treatment at the initial dose, wherein the second dose is larger than the initial dose. Administration of the chimeric antigen receptor switch may be terminated after one or more of a) adverse effects or b) elimination of the cancer. The adverse effects may comprise one or more of tumor lysis syndrome or cytokine release syndrome. Administration of the chimeric antigen receptor switch may be continued after recurrence of the cancer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] **FIG. 1** illustrates a general overview of chimeric antigen receptor-T cell (CAR T-cell) and CAR T-cell switch therapy with switches disclosed herein. Lymphocytes are isolated from a subject and an expression vector encoding a chimeric antigen receptor is subsequently introduced to the lymphocytes to produce chimeric antigen receptor expressing cells. Resulting engineered lymphocytes are administered to the subject, along with a CAR T-cell switch. The CAR T-cell switch comprises a peptide that is bound by the chimeric antigen receptor of the CAR T-cell and a targeting antibody that is selective for a target cell. Binding of the CAR T-cell switch to the CAR T-cell induces an immune response that would be cytotoxic to the malignant cell also bound to the CAR T-cell switch.

[0017] **FIG. 2** exemplifies switch optimization for switchable CAR-T cells by varying the length of the immunological synapse from long (left) to intermediate (middle) to short (right), activity increasing from left to right.

[0018] **FIG. 3** exemplifies switch optimization for switchable CAR-T cells by varying the length of the immunological from intermediate (left) to short (middle) to very short (right), switch activity optimal with a short synapse, relative to switch activity produced with the intermediate synapse or very short synapse.

[0019] **FIG. 4A-D** exemplifies CAR hinge and CAR switch optimization. **FIG. 4A** shows an example of switchable CAR-T cell and formation of a monovalent immunological synapse from a monovalent switch and a monovalent CAR. **FIG. 4B** shows an example of switchable CAR-T cell and formation of a bivalent immunological synapse from a bivalent switch and a monovalent CAR. **FIG. 4C** shows an example of switchable CAR-T cell and formation of a bivalent immunological synapse from a monovalent switch and a bivalent CAR. **FIG. 4D** shows an example of switchable CAR-T cell and formation of a bivalent immunological synapse from a bivalent switch and a bivalent CAR. Relative activity of switchable CAR-T cells is shown by (+) signs below each of **FIGS. 4A-D**.

[0020] **FIG. 5** shows xenograft and surrogate models in liquid and solid tumors in immunodeficient and immunocompetent mice that allow optimization of sCAR-T cell efficacy.

[0021] **FIG. 6** shows alanine scanning of the GCN4 peptide. Alanine residues were systematically introduced into the N- and C-terminals of the GCN4 peptide (**SEQ ID: 75-82**). Cells harboring the anti-GCN4 scFv were incubated with 1nM of GCN4 peptide labelled with Alexa Fluor® 488 (AF488) and increasing concentrations of un-labelled mutated GCN4 peptides. Un-labelled peptide binding efficiency was indirectly shown by measuring the mean fluorescence intensity (MFI) staining with the labelled peptide.

[0022] FIG. 7A-B shows sCAR hinge modifications. **FIG. 7A** shows data from sCAR-T cells containing the short (IgG4; **SEQ ID: 70**) or short-dimeric (IgG4m; **SEQ ID: 71**) hinges, which were stained with the APC-conjugated goat-anti mouse IgG (H&L) (top) or the HiLyte 488-conjugated PNE (bottom) for 30 minutes at 4°C and then analyzed by flow cytometry: the reduced binding of the goat-anti mouse IgG (H&L) polyclonal antibody to the IgG4 and IgG4m sCAR-T cells compared with the long sCAR and CART19 is likely due to there being less binding epitopes with the shortened sCAR and indeed binding of the HiLyte 488-PNE is normal. **FIG. 7B** shows a Western blot showing the dimerization of the chimeric antigen receptors of the sCAR-T cells and CART19 cultured with RS4;11 (R) or K562 (K) cells, anti-human CD3ζ (green) was used to detect endogenous CD3ζ (~20 KDal) and the CD3ζ present in the CAR signaling domain (monomers = 50-60 KDal; dimers (white arrow) = 100-125KDal): non-reduced samples are shown on the left and reduced samples on the right. GAPDH (band labeled at ~37 KDa) was used as an endogenous control.

[0023] FIG. 8A-B shows the structure and molecular weight of a switch peptide. **FIG. 8A** depicts a PDB 1P4B crystal structure of an affinity matured scFv (light and medium gray represent light chain and heavy chain) bound to a peptide derived from the yeast transcription factor GCN4 (7P-14P) (dark grey represents the GCN4 peptide; **SEQ ID: 2**). **FIG. 8B** shows mass spectrometry of a CAR-EC switch comprising an anti-CD19-Fab with a GCN4 graft in the CL1 loop (**SEQ ID: 30 & 29**). Calculated: 49533, found: 49537.09.

[0024] FIG. 9 shows relative orientations of non-limiting examples of switches including a cartoon depicting the immunological synapse between the sCAR, switch, and antigen (top row, left). Switches described in the text shown in Fab format (top row right and down) are isosteric in IgG format. The cartoons are oriented such that the antigen binding interface is at top.

[0025] FIG. 10A-B shows results of shortening the hinge, and incorporating a dimerization motif between the scFv and the membrane of the CAR. **FIG. 10A** shows that potency increases when CAR-T cells with shorter hinges are incubated with the anti-CD19 Fab LCNT switch (**SEQ ID: 29 & 36**) and RS4;11 (CD19-positive) cells. sCAR-T effector cells were cultured with RS4;11 (CD19+) target cells at a ratio of 10:1 for 24 hours with the anti-CD19 Fab LCNT switch (**SEQ ID: 29 & 36**) before cytotoxicity was determined by the amount of LDH released into the assay supernatant. **FIG. 10B** shows that the increased activity associated with shortening the hinge design does not result in an increase in non-specific lysis of K562 (CD19-negative) cells. **FIG. 10C** shows potency is increased for all grafted switches used with the short hinge CAR. **FIG. 10D** shows that cytokine production by sCAR-T cells is enhanced with the IgG4 or IgG4m hinges, compared with the CD8 hinge.

[0026] FIG. 11 A-C shows activity of sCAR-T cells with anti-CD19 switch. **FIG. 11A** shows cytotoxicity of sCAR-T cells against $CD19^+$ RS4;11 cells with titration of anti-CD19 Fab switch designs. **FIG. 11B** shows cytotoxicity of sCAR-T cells against $CD19^-$ K562 cells with titration of the anti-CD19 Fab switch designs. **FIG. 11C** shows IL-2 released from sCAR-T cells cultured with RS4;11 or K562 and 1 nM anti-CD19 Fab switches. Gray asterisk denote significance compared to WT switch and black asterisks denote significance between switches. All assays were performed with E:T = 10:1 and 24 h incubation. Cytotoxicity was assessed by LDH release. Data are represented as mean ± SD. Values listed next to switches show EC_{50} of cytotoxicity. Significance was calculated using the student's t-test where **=$p<0.01$ and ***=$p<0.001$.

[0027] FIG. 12A-B exemplifies distance and orientation considerations as they pertain to the peptide grafting position on the Fab. **FIG. 12A** shows distance and orientations by dashed lines of target cell binding and CAR-T binding to the switch. **FIG. 12B** shows the target cell binding region domains of the switch. Arrow points to VH beta turn on the VH N term.

[0028] FIG. 13A-B shows biochemical assessment of switches. **FIG. 13A** shows a denaturing SDS-page gel depicting the anti-CD19 IgG, anti-CD19 Fab switches derived from the FMC63 clone under non-reducing (top) and reducing (bottom) conditions. In some grafting positions the heavy and light chains resolve into two bands on the reduced gel, while in other cases they overlap and appear as one band. **FIG.13B** shows an SDS-page gel showing the anti-CD20 Fab switches derived from the Ofatumumab clone under non-reducing (top) and reducing (bottom) conditions.

[0029] FIG. 14 shows a liquid chromatography and mass spectrometry analysis of a peptide switch indicating no proteolysis occurs in mouse serum.

[0030] FIG. 15 shows the activity of a peptide-based switch incubated in mouse serum for 2 hours at 37 degrees celcius vs 37 degrees celcius in PBS. No treatment was incubated 2 hours at 4 degrees in PBS. This indicates there is no appreciable loss of activity in mouse serum.

[0031] FIG. 16 shows ternary complex formation of "A" and "B" monovalent switches and A+B bivalent switches with target and CAR-T cells by flow cytometry. Fusion/grafting locations: A=LCC1 (**SEQ ID: 29 & 30**), B=HCCT (**SEQ ID: 27 & 34**), A:B=LCC1:HCCT (**SEQ ID: 30 & 34**).

[0032] FIG. 17 exemplifies CAR hinges, with varying lengths, derived from CD8 (**SEQ ID: 69**), IgG4 (**SEQ ID: 70**), or IgG4m (**SEQ ID: 71**).

[0033] FIG. 18 shows localization of anti-CD19 switch "B" labeled infrared 750 (IR) fluorophore (using the Thermo Fisher Scientific SAIVI kit) with tumor burden in NSG mice harboring subcutaneous NALM-6 CD19+ tumors, 48h after dosing, using luciferized tumor luminescence and switch dosed 1 mg/kg I.V.

[0034] FIG. 19 shows time-dependent localization of the IR-labeled switch at tumor site.

[0035] FIG. 20A-B shows a schematic of direct versus switchable CAR-T cells. **FIG. 20A** shows conventional CAR-T cells (left) utilize an scFv that directly targets tumor associated cell surface antigens. Upon binding, signaling through the CAR drives an effector response that leads to the killing of target cells and propagation of the anti-tumor immune response. The same response is achieved with switchable CAR-T cells (right), however, antigen recognition is uncoupled from T cell signaling by the introduction of an antibody based "switch" that targets tumor associated antigens. The switch is then recognized by the switchable CAR-T cell (sCAR-T) through an scFv that binds to, with high affinity, a peptide neo-epitope (PNE) that is engrafted onto the switch. Thus sCAR-T cells only target antigens in the presence of a switch and offer controlled activation, deactivation and re-targeting of CAR-T cell therapy. The LCCT switch is shown as an example. **FIG. 20B** shows the relative immunogenicity of PNE engrafted Herceptin heavy or light chains (HCNT and LCNT respectively), which was measured in silico by EpiVax and showed minimal increases compared with the wild type heavy and light chains (HCWT and LCWT respectively). Using this analysis, scores of >20 are considered to be potentially immunogenic.

[0036] FIG. 21A-C show thermal stability and antigen binding of switches. **FIG. 21A** shows representative thermal stability analysis for the anti-CD19 Fab and IgG switches with accompanying table showing the melt temperatures of the WT, LCNT, HCNT, NTBV, LCC1, HCC1, C1BV, LCCT, HCCT and CTBV switches, in both IgG and Fab formats, using the Protein Thermal Shift™ kit (Thermo). The first melt temperature indicates the Fab melt where all PNE grafting resided. The second melt temperature indicates the Fc region and is only present for full length IgG constructs. **FIG. 21B** shows the indicated switches binding to $CD19^+$ RS4;11 cells and **FIG. 21C** shows the lack of switch binding to $CD19^-$ K562 cells with both Fab and IgG based switches. Data for **FIGS. 21B-C** was acquired by incubating the cells with each switch for 30 minutes at 4°C in FACS buffer (PBS, 1% FCS, 1mM EDTA) followed by incubating with a PE-conjugated goat-anti-human-kappa chain antibody for 30 minutes at 4°C and analyzing by flow cytometry. The EC_{50} of binding for each switch is indicated in the legend in **FIG. 21B**.

[0037] FIG. 22A-C show expression of CAR and binding to switch. **FIG. 22A** shows an AF647-conjugated goat-anti-mouse IgG (H&L) antibody (Thermo) was used to show surface expression of CART19 and the sCAR by flow cytometry; alternatively, a AF488-conjugated PNE (Anaspec) was used to detect surface expression of the sCAR by flow cytometry. **FIG. 22B** shows switch binding to sCAR-T cells. The EC_{50} of binding for each switch is indicated in the legend. **FIG. 22C** shows lack of switch binding in mock transduced PBMC (sCAR negative). Data for **FIGS 22A-C** were acquired for each switch using the method described in **FIG. 21B**.

[0038] FIG. 23A-E shows activity of sCAR hinge designs. **FIG. 23A** shows cytotoxicity of sCAR-T cells with CD8, IgG4, or IgG4m hinges, or non-transduced T cells (mock) against RS4;11

cells with titration of the anti-CD19 LCNT Fab switch (**SEQ ID: 29 & 36**). **FIG. 23B** shows cytotoxicity as described in (A) against K562 cells. **FIG 23C** shows activation of sCAR-T cells with short-dimeric hinge or mock cells in the presence of RS4;11 cells with or without 1 nM LCNT anti-CD19 Fab switch (**SEQ ID: 29 & 36**) was measured by flow cytometry with staining for CD25 and CD69. **FIG. 23D** shows IL-2 released from sCAR-T cells cultured with RS4;11 cells and 1 nM of the indicated anti-CD19 Fab switches. **FIG. 23E** top panel shows quantification of the flow cytometry assay shown in (C) in the presence of 1 nM of the indicated anti-CD19 Fab switch design. **FIG. 23E** bottom panel shows the IL-2 release from sCAR-T cells when cultured with the different switches and K562 cells. In (D) and (E) gray asterisks denote significance between CART-19 and sCAR-T cells and black asterisks denote significance between sCAR-T cell hinges. Mean values for CART-19 is indicated by dotted horizontal line. Values listed next to switch show EC_{50} of cytotoxicity. All cytotoxicity and cytokine assays were performed with E:T = 10:1 and 24 h incubation. Cytotoxicity was assessed by LDH release. Data are represented as mean ± SD, and statistical significance was calculated using the 1-way ANOVA with Tukey's post-test (B & D) where *=$p<0.05$, **=$p<0.01$ and ***=$p<0.001$.

[0039] FIG. 24A-B shows *in vitro* sCART cell activity, wherein sCAR-T cells that were cultured with RS4;11 (**A**) or K562 (**B**) cells along with a serial dilution of the IgG anti-CD19 switches for 20-24h before the supernatants were assayed to detect LDH release as a proxy for target cell lysis. **FIG. 24A** shows data for the Fab switches and **FIG. 24B** shows data for the CD8 hinge, IgG4m hinge, and the IgG4 hinge sCAR-T cells when cultured with K562 and the switches denoted in the figure key. EC_{50} values, where calculatable, for each switch are denoted within parentheses. Unless otherwise stated, all *in vitro* cytotoxicity assays were conducted at a ratio of 10 effector cells to 1 target cell. **FIG. 24C** shows the proportion of T cells that are activated following a 24-hour cytotoxicity assay whereby sCAR-T cells are incubated with the specific switches listed in the figure key, T cell activation is measured by flow cytometry and defined as being CD25 positive and CD69 positive.

[0040] FIG. 25A-B shows activity of sCAR-T cells with anti-CD20 switch. **FIG. 25A** shows cytotoxicity of CD8 hinge sCAR-T cells against $CD20^+$ Raji cells with titrations of anti-CD20 Fab switch designs. **FIG. 25B** shows IL-2 released from sCAR-T cells cultured with Raji cells and 1 nM anti-CD20 Fab switches against. All assays were performed with E:T = 10:1 and 24 h incubation. Cytotoxicity was assessed by LDH release. Data are represented as mean ± SD. Values listed next to switches show EC_{50} of cytotoxicity. Significance was calculated using the student's t-test where **=$p<0.01$ and ***=$p<0.001$.

[0041] FIG. 26A-F shows sCAR modifications enhance activity and activity can be controlled using free PNE. **FIG. 26A-F** shows that switch-induced activity of short-dimeric sCAR-T cells can

be controlled by the addition of free PNE. **FIG. 26A**shows LDH cytotoxicity assay, which utilized a dose titration of the LCNT Fab switch in the presence of various concentrations of free PNE or a non-binding alanine mutatant of the PNE (PNE-X; grey line) as a control. **FIG. 26B** shows cytokine release induced by 1nM LCNT switch in the presence of various concentrations of free PNE or the PNE-X control mentioned above, as measured by CBA. **FIG. 26C** shows upregulation of T cell activation markers induced by 1nM LCNT switch in the presence of various concentrations of free PNE or the PNE-X control mentioned above. The non-binding mutated version of the PNE (PNE-X; bar farthest to the right) was, again, used as a control. **FIG. 26D** shows that a peptide based CAR is highly specific. Alanine mutated free peptide (PepX) has no effect. Only the cognate free peptide epitope inhibits cytotoxicity (see **FIGS. 26D-F)**. **FIG. 26E-F** show live cell imaging (Incucyte, Essen). **FIG. 26E** shows quantification of the killing of RS4;11 cells in the presences of the Cell Tox Green® cell viability dye. **FIG. 26F** shows clustering of $Nalm6^{GFP/Luc}$ (green) cells ± LCNT switch or mock transduced cells with the LCNT switch (the reduction of GFP^+ cluster size indicates target cell lysis).

[0042] FIG. 27A-B shows cytotoxicity assay. **FIG. 27A** shows cytotoxicity assay whereby IgG4 sCAR-T cells were cultured with RS4;11 cells and a panel of anti-CD19 Fab switches. **FIG. 27B** shows cytotoxicity assay whereby IgG4m sCAR-T cells were cultured with RS4;11 cells and a panel of anti-CD19 Fab switches. EC_{50} values are denoted within parentheses.

[0043] FIGS. 28A-28L. **FIG. 28A** shows cytotoxicity of IgG4m sCAR-T cells against Raji cells with titration of anti-CD20 Fab switch designs. Values listed next to switch show EC_{50} of cytotoxicity. All cytotoxicity and cytokine assays were performed with E:T = 10:1 and 24 h incubation. Cytotoxicity was assessed by LDH release. Data are represented as mean ± SD. **FIG. 28B** shows flow cytometry based cytotoxicity assay whereby sCAR-T cells were cultured with Raji cells (CD22+) and the anti-CD22 (clone hLL2) WT or GCN4-based Fab switches. **FIG. 28C** shows flow cytometry based cytotoxicity assay whereby sCAR-T cells were cultured with Raji cells (CD22+) and the anti-CD22 (clone m971) WT or GCN4-based Fab switches. **FIG. 28D** shows SDS gel images of anti-CD22 (clone hLL2)-Fab CTBV1 (SEQ ID NO: 189 & 191), CTBV2 (SEQ ID NO: 192 & 194) or CTBV3 (SEQ ID NO: 193 & 195). M represents protein marker. **FIG. 28E** shows mass spectrometry of anti-CD22 (clone hLL2)- Fab-CTBVs. **FIG. 28F** shows flow cytometry based cytotoxicity assay whereby sCAR-T cells (SEQ ID NO: 74) were cultured with Raji cells (CD22+) and the anti-CD22 CTBV1, CTBV2 and CTBV3 switches. **FIG. 28G** shows position of GCN4 tag in IgG format switches. **FIG. 28H** shows SDS gel images of anti-CD22 IgG (clone M971 and clone hLL2)-LCCT, HCCT, and CTBV switches. Samples were treated with10 mM DTT before running the gel to reduce the protein. **FIG. 28I** shows Mass spectrometry of anti-CD22-IgG (clone m971)-LCCT, HCCT, and CTBV. Samples were treated with PNGase F for

deglycosylation and 10 mM DTT for reduction. **FIG. 28J** shows flow cytometry based cytotoxicity assay whereby sCAR-T cells (SEQ ID NO: 74) were cultured with Raji cells (CD22+) and the switch concentrations indicated on the x axis of the figure. **FIG. 28K** shows mass spectrometry of anti-CD22-IgG (clone hLL2)-LCCT, HCCT, and CTBV. Samples were treated with PNGase F for deglycosylation and 10 mM DTT for reduction. **FIG. 28L** shows cytotoxicity of sCAR-T cells (determined using the Flow cytometry-based cytotoxicity assay) with short-dimeric hinge against Raji cells (CD22+) with anti-CD22 IgG (clone hLL2) IgG switches: Switch concentrations indicated on the x axis of the figure.

[0044] FIG. 29A-F shows *in vivo* activity of switch and hinge designs in Nalm-6$^{GFP/Luc}$ xenograft model. NSG mice were inoculated with CD19^{+} Nalm-6$^{GFP/Luc}$ cells. Six days later, 40x10^{6} sCAR-T cells were delivered *I.V.* and switch dosing commenced every other day at 0.5 mg/kg for 10 days. Tumor burden was followed by luminescence after injection of luciferin and imaged on an *in vivo* imaging system (IVIS; PerkinElmer, Waltham, MA, USA). **FIG. 29A** shows representative IVIS images depicting long, short, or short-dimeric sCAR-T cells dosed with the LCNT Fab switch. **FIG 29B** shows quantified tumor burden (as average radiance from luciferase activity from each mouse) from (A) during switch dosing period (n=5). **FIG. 29C** shows enumeration of T cells in peripheral blood from (A) at day 17 by flow cytometry. **FIG. 29D** shows representative IVIS images depicting short-dimeric sCAR-T cells dosed with anti-CD19 Fab switch designs. **FIG. 29E** shows quantified tumor burden from (D) during switch dosing period (n=5). **FIG. 29F** shows enumeration of T cells in peripheral blood from (A) at day 17 by flow cytometry. Asterisks indicate significance from LCNT Fab group. Data are represented as means ± SEM, and statistical significance was calculated using the 2-way ANOVA with Bonferroni's post-test (B & E; shown for final time-point only) or by one-tailed student's t-test (C & F) where *=$p<0.05$, **=$p<0.01$ and ***=$p<0.001$.

[0045] FIG. 30A-D shows sCAR-T cell expansion and localization during tumor clearance. NSG mice were inoculated with Nalm-6$^{GFP/Luc}$ as described in **Fig 28**. **FIG. 30A** shows results after six days, 5 cohorts (n=3) of mice were randomized into 3 groups and injected *I.V.* with 40x10^{6} CART-19, sCAR-T cells with (+) LCNT Fab switch, or no T cells (PBS group). A fourth group consisted of two cohorts (n=3) of mice injected *I.V.* with sCAR-T cells without (-) LCNT Fab switch. LCNT Fab dosing in the indicated group was carried out daily at 0.5 mg/kg after the initial T cell infusion. Luminescence was measured at 6 h and subsequently every 24 h as indicated. Cohorts were sacrificed for analysis immediately following IVIS imaging. **FIG. 30B** shows quantified tumor burden (radiance, left axis) and quantified human IL-2 (pg/mL, right axis) in peripheral blood from each cohort shown in (A) at time indicated. Gray lines indicate tumor burden in PBS and sCAR-T cell - LCNT Fab controls. **FIG. 30C** shows the proportion of leukocytes that were human

$CD3^+CD4/8^+$ in the blood, spleen, lungs and liver at 96 h in the + LCNT Fab and - LCNT Fab groups quantified by flow cytometry **FIG. 30D** shows relative proliferation of T cells in the spleen, lung, and liver at 96 h in + and – LCNT Fab groups, determined by dye dilution. Data are represented as means ± SEM, and statistical significance was calculated using the one-tailed student's t-test (C & D) where *=$p<0.05$, **=$p<0.01$ and ***=$p<0.001$.

[0046] FIG. 31A-C shows T cell analysis in the peripheral blood. **FIG. 31A** shows representative IVIS images from **FIG. 33A**. **FIG 31B** shows $CD3^+CD4/8^+$ T cells were enumerated in the blood of NSG mice treated with sCAR-T cells over 70 days using count bright absolute counting beads (BD); switch was dosed from day 6-21 using either the q.d., q.a.d., or q.5.d. strategies as described in **FIG 33A**. **FIG. 31C** shows a flow cytometry gating strategy to identify $CD3^+$ T cells that expressed CD4, CD8, CD45RA or CD62-L as presented in **FIG. 33D**.

[0047] FIG. 32A-D shows *in vivo* kinetics of LCNT Fab clearance of tumor compared to CART19. **FIG. 32A** shows the spleen, lungs, liver and blood of NGS mice that were engrafted with $Nalm6^{GFP/Luc}$ cells were homogenized to produce a single cell suspension (lungs were digested using 1mg/ml Liberase LT (Roche) and 50μg/ml DNaseI (Sigma) for 45min at 37°C prior to homogenization) and analyzed by flow cytometry: by day 5 $Nalm6^{Luc/GFP}$ cells were detected in the lung and liver but not in the spleens or blood. **FIG. 32B** shows the proportion of lymphocytes that are $Nalm6^{GFP/Luc}$ over the first 96 hours of the NSG model, these data were generated using the gating strategy presented in FIG. 32A. **FIG. 32C** shows CART19 or sCAR-T cells were infused into $Nalm6^{GFP/Luc}$ engrafted NSG mice at day 6 and dosed q.d. with the LCNT switch (0.5mg/kg). Prior to infusion, the T cells were labelled with the E450 proliferation tracker dye (eBiosciences; 0.5μM per 10^6 cells) which enabled cell proliferation to be analyzed by flow cytometry *ex vivo* as shown in this representative histogram. **FIG. 32D** shows an E450 dilution in CART19 and IgG4m sCAR-T cells + LCNT switch over 5 days in the spleen, lung and liver as measured by flow cytometry; data are presented as mean fluorescence intensity (MFI) of the proliferation dye.

[0048] FIG. 33A-E shows the influence of switch dosing regimen on sCAR-T cell activation and efficacy. NSG mice were inoculated with $Nalm6^{GFP/Luc}$ and six days later engrafted with short-dimeric sCAR-T cells as described in **FIG. 29**. **FIG. 33A** shows quantified tumor burden from groups dosed every day (q.d.) every other day (q.a.d.) or every fifth day (q.5.d) with 0.5 mg/kg LNCT Fab. Dosing was carried out for 15 d starting at day 6 (corresponding with sCAR-T cell infusion) as indicated by gray shading. Control groups CART-19 and PBS received no switch. The NS group received sCAR-T cells but no switch. Open circles denote the death of individual mice without evidence of tumor burden and may reflect GVHD. Triangles in PBS, NS and q.a.d. group indicate death due to increasing tumor burden. (n=3) **FIG. 33B** shows quantified IL-2, INFγ, and TNFα at 24 h after first dose of switch, from groups dosed every day with 0, 0.05, 0.5, or 2.5

mg/kg of LNCT Fab. (19) indicates CART-19. **FIG. 33C** shows quantified tumor burden by IVIS from groups in (B) after 10 d. (19) indicates CART-19. **FIG. 33D** shows quantified tumor burden from mice dosed with 0.05 mg/kg LCNT Fab for 10 d indicated by gray box. Dosing was resumed at 0.5 mg/kg when the average tumor burden in group became significantly higher than CART-19 control at day 33, indicated by asterisk and second gray box. Triangles indicate the death of individual mice with significant tumor burden. The single mouse death in the 0.05 mg/kg group occurred while tumor burden was decreasing. (n=5) **FIG. 33E** shows the phenotype of T cells in the peripheral blood from (B) after 21 days as the proportion of $CD3^{+}CD4/CD8^{+}$ by flow cytometry with staining for CD62-L and CD45RA using the gating strategy presented in FIG. 31C. Statistical significance was calculated using the one-tailed student's t-test (B, C & E) where *=$p<0.05$, **=$p<0.01$ and ***=$p<0.001$.

[0049] FIGS. 34A-B show antigen re-challenge models. **FIG. 34A** shows data from a dual targeting experiment. Mice with CD19+/CD20+ Raji xenograft tumors are cleared initially using a CD19 switch, rechallenged with the same CD19+/CD20+ Raji, and cleared using a CD20 switch. **FIG. 34B** shows data from a dual targeting experiment that is similar to **FIG. 34A**, except the rechallenge group was CD19 negative: mice with CD19+/CD20+ Raji xenograft tumors are cleared initially using a CD19 switch, rechallenged with $CD19^{-}$/CD20+ Raji, and cleared using a CD20 switch.

[0050] FIG. 35 shows murine surrogate anti-CD19 switch activity. Peptide based CAR-T cells are also efficacious in murine platform, using retrovirus in murine B6 cells and a CD28 costimulatory domain with hamster anti-mouse CD19 antibody and murine Myc5-CD19 target cells. Potency increases as graft moves towards N-terminus. (Fusion/grafting locations: A=LCNT1 (light chain N terminus version 1) and B= CL1 (constant region light chain 1).

[0051] FIG. 36A-B shows cytokine production in a murine surrogate model by sCAR T-cells treated with switches. **FIG. 36A** shows murine anti-peptide CAR-T cell cytokine production. **FIG.36B** shows cytokine production from co-culture of MYC5-GFP-CD19 target cells with CAR-T cells and 10^{-1} nM switch.

[0052] FIG. 37 shows cytotoxicity of an anti-GCN4 CAR T-cell and CAR T-cell switch (anti-BCMA antibody -GCN4 peptide grafted into the light chain constant domain) against BCMA-positive cells (OPM2).

[0053] FIG. 38A-D shows an anti-CLL1 switch and its activity. **FIG. 38A** illustrates multiple fusion/grafting locations: A=LCNT1 (light chain N terminus version 1), B= HCNT3 (heavy chain N terminus version 3), C= heavy chain C terminus, and D= light chain C terminus). **FIG. 38B** shows cytotoxic activity against U9347 (CLL1+) cells of the CLL1 switch with a long (CD8) hinge CAR. **FIG. 38C** shows cytotoxic activity against U9347 (CLL1+) cells of the CLL1 switch with a

short, dimeric (IgG4m) hinge CAR. **FIG. 38D** shows cytokine production by the various anti-CLL1 switches. **FIG. 38E** shows *in vivo* cytotoxicity of sCAR-T cells against CLL1+ U937 cells with the NTBV anti-CLL1 Fab switch in a sub-cutaneous AML model. **FIG. 38F** shows SDS page analysis of multiple anti-CD33 (hP67.6) switches that were expressed. **FIG. 38G** shows cytotoxicity assay data for monovalent and bivalent combinations of various anti-CD33 (hP67.6) switches tested as a dose titration within the range of 0.4 nM to 0.0001nM. in CD33+ MOLM14 cells. **FIG. 38H** shows measurement of indicated cytokines in supernatant from each sCAR-T/switch combination in cytotoxicity assay in MOLM14 cell lineby CBA. Data shown are an average of duplicate samples, and error bars represent SD. Only the NT switches plus the BvCT and Bv CH1CL1 as references are depicted. **FIG. 38I** shows SDS gel images of anti-CD123 Fab-GCN4 (clones 26292 and 32716) in non-reducing conditions. **FIG. 38J** shows cytotoxicity of sCAR-T cells against CD 123+ MOLM14 cells with titration of anti-CD 123 26292 Fab switch designs. **FIG. 38K** shows cytotoxicity of sCAR-T cells against CD 123+ MOLM14 cells with titration of anti-CD 123 32716 Fab switch designs.

[0054] FIG. 39 shows expression and purification of 1G4c113 TCR with peptide graft. 1G4c113 TCR alpha and beta chains were expressed and refolded as described. Following the refolding samples were purified by loading onto MonoQ with 20mM Tris (pH 8.1) and 50 mM NaCl. The refolded 1G4c113 TCR was eluted by a gradient to 20 mM Tris (pH 8.1) and 1M NaCl. Pre column and the eluted protein are shown on a Coomassie stained 10% Tris-Glycine gel. Left Panel. Native, refolded 1G4c113 TCR with GCN4-CTerm peptide grafted to the beta chain. Right panel, reduced 1G4c113 TCR alpha chain and 1G4c113-TCR beta chain with grafted GCN4-Cterm.

[0055] FIG 40A-C shows mass spectrometry of purified 1G4c113 TCR with peptide graft. Samples from the post-MonoQ elutions were identified via mass spectrometry. **FIG. 40A** shows non-reduced peaks correlating to the non-reduced 1G4c113-TCR with GCN4-Cterm peptide graft. **FIG. 40B** shows reduced 1G4c113 TCR beta chain with grafted GCN4-Cterm. **FIG. 40C** shows reduced 1G4c113 TCR alpha chain.

[0056] FIG. 41A-F shows data from the soluble based TCR (sTCR) switch. **FIG. 41A** shows a schematic depiction of the soluble based TCR (sTCR) interacting with a peptide presenting HLA molecule. **FIG. 41B** shows a sTCR specific for HLA molecules bound to the cancer associated NY-ESO-1 peptide. The sTCR was expressed with a C-terminal GCN4 and a 6x HIS tag on the beta chain and was used to stain T2 cells expressing HLA molecules loaded with the NY-ESO-1 peptide as determined by flow cytometry. **FIG. 41C** shows results from 10^5 T2 cells loaded with 10^0-10^{-8}nM of the NY-ESO-1 of a HIV peptide for 2 hours at 37°C in 200µl of DMEM medium with no serum protein added. The cells were then labelled with the NY-ESO-1 specific sTCR as described in **FIG. 41B**. The data are presented as MFI of the switch binding against the

concentration of the peptide used to load the cells. These data indicated that 1nM of peptide loaded onto the T2 HLA molecules was sufficient for the sTCR to bind to the T2 cells and therefore was used for subsequent experiments. **FIG. 41D** shows that short-dimeric (IgG4m: **SEQ ID: 71**) sCAR-T cells can kill T2 cells pulsed with NY-ESO-1 peptide but not HIV peptide. **FIG. 41E** shows that sTCR switches activate T cells in *in vitro* cytotoxicity assays. **FIG. 41F** shows elicited cytokines from the activated T cells in **FIG. 41D**.

[0057] FIG. 42A-F shows data from treating solid tumors with sCAR-T cells and Herceptin-based CTBV switch. **FIG. 42A** shows cytotoxicity of sCAR-T cells against Her2 3+ SKBR3 cells with titrations of anti-HER2 Fab switch designs. **FIG. 42B** shows cytotoxicity of sCAR-T cells against Her2 2+ MDA MB453 cells with titrations of anti-HER2 Fab switch designs. **FIG. 42C** shows cytotoxicity of sCAR-T cells against Her2 1+ MB435 cells with titrations of anti-HER2 Fab switch designs. **FIG. 42D** shows cytotoxicity of sCAR-T cells against Her2$^-$ MB468 cells with titrations of anti-HER2 Fab switch designs. **FIG. 42E** shows *in vivo* cytotoxicity of sCAR-T cells against Her2 2+ MDA MB453 cells with the CTBV anti-HER2 Fab switch. **FIG. 42F** shows *in vivo* cytotoxicity of sCAR-T cells against Her2 3+ HCC1954 cells with the CTBV anti-HER2 Fab switch.

[0058] FIG. 43A-B shows production of GCN4-based anti-Her2 Fab switches. **FIG. 43A** shows SDS-PAGE analysis of switches before and after anti-Her2 Fab fusion with GCN4 (B) under non-reducing and reducing conditions. **FIG. 43B**shows mass spectrometric analysis of anti-Her2-GCN4 fusions obtained on an Agilent Quadruple Time-of-Flight (QTOF) mass spectrometer. Deconvoluted masses were obtained using Agilent Qualitative Analysis software.

[0059] FIG. 44A-D shows construction and testing of various PNE (GCN4) anti-Her2 Fab switches and different short and long hinged anti-GCN4 CAR-T cells. **FIG. 44A** shows the crystal structure of the anti-Her2 Fab 4D5 bound to Her2. The location of the two N-terminal and two C-terminal positions that were grafted with the PNE (GCN4) are indicated by P1, P3 (N-terminal) and P2, P4 (C-terminal). **FIG. 44B** shows a schematic representation of anti-GCN4 sCARs containing the CD8 signaling sequence, corresponding scFv, extracellular hinge region (CD8 or IgG4m), CD8 transmembrane domain, 4-1BB costimulatory domain and CD3ζ signaling domain. **FIG. 44C** show the relative distances between bivalent sites on the CTBV switch, as modeled over the 4D5 Fab structure (Protein Data Bank ID 1N8Z). Distance were calculated with UCSF Chimera 1.10.2. The LCCT and HCCT grafting positions for the PNE are only 11.6 Å apart. **FIG. 44D** shows Binding of different GCN4 switches to GCN4 specific CAR-T cells (both CD8 and IgG4m). Cells were incubated with indicated switches and detected with Alexa Fluor647 conjugated anti-human kappa chain antibody. The EC50 value was calculated with Graphpad Prism software.

[0060] FIG. 45 shows flow cytometry analysis of GCN4-based switches and wild type 4D5 Fab bound to breast cancer cells with a range of Her2 expression levels. Bound switches were detected with an Alexa Fluor647 conjugated anti-human IgG (H+L) secondary antibody.

[0061] FIG. 46A-C shows binding of different GCN4 switches to GCN4 specific CAR-T cells (both CD8 and IgG4m). **FIG. 46A** shows switch binding to GCN4 specific CAR-T cells with CD8 hinge. **FIG. 46B** shows switch binding to GCN4 specific CAR-T cells with IgG4m hinge. **FIG. 46C** shows validation of binding specificity of GCN4 specific CAR-T cells with irrelevant tag-based antibody switches. Cells were incubated with indicated switches and detected with Alexa Fluor647 conjugated anti-human kappa chain antibody. No cross binding was observed to occur between GCN4-based sCAR-T cells and irrelevant tag-based switches.

[0062] FIG. 47 shows GCN4 switch-mediated redirection of various anti-GCN4 sCAR-T cells with different hinge lengths against different Her2 expressing cancer cells, as evaluated by flow cytometry with staining for CD69 and CD25. ***= $p<0.005$, **=$p<0.05$ and NS=$p>0.05$ were calculated using the Student's t-test, and a p value < 0.05 was considered significant.

[0063] FIG. 48A-C shows sCAR-T activation by combinations of various switches and hinge length anti-GCN4 sCAR-T cells against different Her2 expressing cancer cells. **FIG. 48A** shows ELISA detection of IL-2. **FIG. 48B** shows ELISA detection of IFN-γ. **FIG. 48C** shows ELISA detection of TNF-α. ***= $p<0.005$, **=$p<0.05$ and NS=$p>0.05$ were calculated using the Student's t-test, and a p value < 0.05 was considered significant.

[0064] FIG. 49 shows *in vitro* cytotoxicity of GCN4-specific sCAR-T cells harboring the CD8 or IgG4m hinges and bivalent switches. sCAR-T cells were incubated with SKBR3 (Her2 3+), MDA MB453 (Her2 2+), MDA MB435 (Her2 1+) or MDA MB468 (Her2 0) cancer cells at an E: T = 10: 1 ratio with serial dilution of GCN4 switch CTBV. Cytotoxicity was assayed after 24h by measuring the amount of lactate dehydrogenase (LDH) released into cultured media. The EC50 values (mean ± SD) were determined and listed in parenthesis in the figure legend inserts.

[0065] FIG. 50A-B shows *in vitro* cytotoxicity. FIG. 50A shows *in vitro* cytotoxicity of sCAR-T cells with different hinge lengths on Her2 1+ BT20 and MDA MB231 cancer cells. Different concentrations of GCN4 CTBV switch was used to induce the corresponding CAR-T activity on target cells. **FIG. 50B** shows *in vitro* cytotoxicity comparison of different GCN4 switches redirected anti-GCN4 CAR-T (IgG4m hinge) cells against different Her2 1+ cancer cells..Cytotoxicity was determined by measuring the amount of LDH released into cultured medium.

[0066] FIG. 51 shows evaluation of the binding of the anti-FLAG antibody (5B3 monoclonal antibody) to an anti-Her2-FLAG switch and wild type anti-Her2 Fab (without the FLAG tag) by ELISA.

[0067] FIG 52A-B shows FLAG-based switchable CAR-T cells by combination of CTBV and different hinge length sCAR-T cells against different Her2 expressing cancer cells. **FIG. 52A** shows The FLAG specific sCAR-T cells containing different hinges were incubated with SKBR3, MDA MB453, MDA MB435 and MDA MB468 cancer cells at an E: T = 10: 1 ratio with serial dilution of FLAG switch CTBV. **FIG. 52B** shows ELISA measurement of T cell activation, which was evaluated by CD69/CD25 staining and cytokine release (IL-2, IFN-γ and TNF-α) in media.

[0068] FIG. 53 shows *in vitro* comparison of anti-Her2 CAR-T cells with optimized anti-GCN4 and anti-FLAG sCAR-T cells. The anti-Her2 CAR-T or sCAR-T cells were co-cultured with Her2 expressing cancer cells at indicated E: T ratios with 50pM of the corresponding bivalent switches, and target cell lysis was determined by LDH release.

[0069] FIG. 54 shows *in vitro* comparison of anti-Her2 CAR-T cells with optimized anti-GCN4 and anti-FLAG sCAR-T cells. T cell activation was evaluated by CD69/CD25 staining and the cytokine release (IL-2, IFN-γ and TNF-α) in media was measured by ELISA. Error bars represent SD. ***= $p<0.005$, **=$p<0.05$ and NS=$p>0.05$ were calculated using the Student's t-test.

[0070] FIG. 55A-C shows *in vivo* antitumor efficacy of conventional anti-Her2 CAR-T and sCAR-T cell approaches in xenograft models. **FIG. 55A** shows HCC1954 xenograft model. **FIG. 55B** shows MDA MB453 xenograft model. **FIG. 55C** shows MDA MB231 xenograft model. Ten days after cancer cell implantation in NSG mice, mice were i.v. injected with 30×10^6 CAR-T cells, followed by a dose of switch or wild type 4D5 Fab at 0.5mg/kg every other day for 14 days. The control group received saline instead of switch and did not receive any T cells. Tumor volume was calculated by W×L×H. Each data point represents tumor volume of five mice in each group. Error bars represent SD. Arrows indicate time of CAR-T cell injection or of treatment with specific antibodies.

[0071] FIG. 56 shows *in vitro* LDH release cytotoxicity assay results using various sCAR-T cells made with sCARs incorporating humanized murine anti-GCN4 scFv (52SR4). The switch peptide comprised a LCNT graft of the GCN4 peptide to the murine FMC63 anti-CD19 FAB.

DETAILED DESCRIPTION OF THE INVENTION

[0072] Current chimeric antigen receptor T cell (CAR T-cell) therapies can be unreliable due to lack of means to control CAR T-cell activity. Disclosed herein are compositions and methods for selectively activating and deactivating chimeric antigen receptor T cells, which may provide for safer and more versatile immunotherapies than those currently being tested and administered. Disclosed herein are switchable chimeric antigen receptor effector cells (CAR-ECs) and chimeric antigen receptor effector cell (CAR-EC) switches ("switch," or "CAR EC switch," interchangeably), wherein the switch is a polypeptide fusion comprising a first region that is bound

by a CAR-EC and a second region that binds a cell surface molecule on target cell. The switches may comprise a peptide neo-eptiope (PNE) that is bound by a chimeric antigen receptor on the CAR-EC and an antibody or antibody fragment that binds a cell surface molecule on a target cell, bringing the target cell in proximity of the CAR-EC and thereby stimulating an immune response from the CAR-EC that is cytotoxic to the bound target cell. In general, the CAR-EC is a T cell, and the CAR-EC is referred to as a switchable CAR-T cell (sCAR-T cell). In this way, the CAR-EC switch may act as an "on-switch" for CAR-EC activity. Activity may be "turned off" or reduced by reducing or ceasing administration of the switch or adding a switch component that competes with the switch. These CAR-EC switches may be used with CAR-ECs disclosed herein, as well as existing CAR T-cells for the treatment of a disease or condition, such as cancer, wherein the target cell is a malignant cell. Such treatment may be referred to herein as switchable immunotherapy, for which an exemplary schematic overview is depicted in FIG.1.

[0073] Major advantages of the switchable CAR platforms disclosed herein include control, safety, titratability, and universality. Switchable CARs can be turned on and off with addition and cessation or competition of the switch. In addition, CAR-EC switches can be titrated to a desired response. For example, solid tumors may be targeted by titration of therapy to achieve suitable therapeutic index. The response may be titrated "on" to avoid CRS (cytokine release syndrome) and TLS (tumor lysis syndrome) events, providing for personalized therapy. Furthermore, administration of a switch can be terminated or reduced in case of an adverse event. The switchable CAR-T cell can be designed to target a non-endogenous antigen with a switch that can be reduced at any time. In contrast, a canonical CAR-T cell is always "on" as long as a target exists. This always "on" can lead to T cell anergy. A switchable CAR-T cell can be stimulated and rested. This is more analogous to the natural stimulation of a T cell responding to an infection. Iterative stimulations in this nature, if timed correctly, may be able to better recapitulate the natural stimulation and resting cycles of T cells that would be encountered, for example, with an acute infection. This type of natural life expansion and contraction of T cells may off-set anergy (or T cell dysfunction) and promote the formation of long-lived memory cells. Long-lived memory cells are known to be advantageous in CAR-T cells. Therefore, a switchable approach to CAR-T cells may be advantageous in that it can promote more favorable T cell responses and phenotypes/lineage commitments than canonical CAR-T cells.

[0074] Another advantage of the sCAR-EC system is that it is easier and faster to design multiple switches for each CAR-EC rather than empirically building and testing CAR hinge designs. This is because the switches are biologics which may be easier, less expensive, and faster to build multiple variants than the CAR which requires cell engineering and cell handling. Further, previously approved monoclonal antibody biologics with known safety profiles can be adapted into switches.

Thus a universal CAR has a significant advantage in design of the optimal immunological synapse. In addition, CAR-EC switches make it possible for a single CAR-T cell to be redirected to multiple therapeutic targets. Redirection during therapy, by variation of switches, can combat antigen-loss escape mutants with a single CAR. Treatment of heterologous tumors with multiple switches is more straightforward than with multiple CARs. Switches also enable standardized treatment protocols which may provide safety and lower up front treatment costs.

[0075] Each target antigen and epitope requires empirical design of a canonical CAR in order to find the optimal CAR-T cell activation, but a switch enables more geometric options than a canonical CAR, allowing for optimal geometry and/or distance of the immunological synapse. An advantage to switchable CAR-ECs is the additional flexibility in geometric orientations that can be provided by a switch that cannot be provided by modifying the CAR-EC hinge. The additional geometric orientations may be useful in forming optimal immunological synapses. Switch designs that provide maximal ternary complex formation may correlate with increased sCAR-T cell activity. On the other hand, improper balancing of kinetics, as a result of sub-optimal design, can result in auto-inhibition of the ternary complex formation, translating to a decrease in the number of immunological synapses that can form between the CAR-EC and target cell, which may be detrimental to activity. States of auto-inhibition may result in increased activation induced cell death (AICD) through sub-optimal signaling. Recursive CAR signaling can also result in AICD. Other sCAR-T cell platforms with non-specific labeling of antibodies or constrained site labeling are unable to comprehensively explore these design considerations.

[0076] Mathematical models related to binary binding equilibria and concentration (which is related to antigen density) of each component to the formation of the ternary complex as a function of switch concentration are considered in optimizing the sCAR-T immunological synapse. These models take into account auto-inhibition of the ternary complex by high concentrations of the switch or disproportionately high affinities of the binary interactions, which may reduce the cytotoxic capacity of the sCAR-EC cells. In order to apply these models, sCARs and switches with varied affinities are produced by specific mutations, grafting/fusion sites, and quantitative flow cytometry is used to establish sCAR density. The increased avidity of the IgG based switch, relative to a Fab switch, enables a larger range of off-rates to study. Target cells with a range of cell surface antigen density are also employed. Candidate designs are tested for cytotoxicity, cytokine release, AICD and up-regulation of activation markers on sCAR-EC cells. Optimal ternary complex and immunological synapse formation may be achieved when the affinity of the sCAR is far lower than the concentration of sCAR on the surface of the T cell. Alternatively, optimal ternary complex and immunological synapse formation may be achieved when the affinity of the sCAR is relatively high and the concentration of sCAR on the surface of the T cell is relatively low.

[0077] The examples disclosed herein demonstrate that changes in the length of the hinge region of the sCAR could be matched with compensatory switch modifications (*e.g.*, geometry) to yields switch-sCAR pairs that exhibit robust cytotoxicity, upregulation of activation markers, and production of cytokines. For example, optimal configurations of switches and sCAR hinges afforded high potency on breast cancer cells expressing high (3+) mid (2+) and low (1+) levels of Her2 expression with no activity on Her2 negative (0) cell lines. We have shown this with at least two switches that differ by their CAR binding region. These platforms eliminated established Her2 3+, 2+ and 1+ solid and orthotopic tumor xenografts with comparable efficacy to the conventional anti-Her2 CAR-T cells. This controllable nature of sCAR-T cells is expected to provide increased safety in the translation of CAR-T cell strategies for solid tumors, especially in the treatment of patients with Her2-low malignancies for which trastuzumab is not approved.

[0078] The CAR-EC switches disclosed herein comprise a first region that binds a cell surface molecule on a target cell, and a second region that is bound by a chimeric antigen receptor. In general the first region is a targeting polypeptide. The targeting polypeptide may be a targeting antibody or antibody fragment that binds an antigen on the target cell. Alternatively or additionally, the first region may comprise a non-peptide small molecule (*e.g.*, vitamin, metabolite). The second region, referred to herein as a chimeric antigen binding peptidic antigen (CAR-BP) or peptide neo-epitope (PNE), comprises a peptide. For simplicity, the term chimeric antigen binding peptidic antigen may simply be referred to herein as a peptidic antigen. In general, the CAR-BP is fused to a terminus of the targeting polypeptide or grafted within the targeting polypeptide. Fusing or grafting the CAR-BP to the targeting polypeptide may be carried out by cloning one or more polynucleotides encoding the first region and the second region into a polynucleotide expression vector, in a desired order or combination.

[0079] Methods of treating a disease or condition comprising administering the CAR-EC switches, disclosed herein, may provide for a titratable response, improved safety and/or cessation of CAR-EC activity by reducing or ceasing administration of the CAR-EC switch. In contrast to other approaches of controlling CAR-EC activity, which "turn off" CAR-EC activity by competing with the target cell surface molecule for binding the CAR, the CAR-EC switches disclosed herein, generally function as CAR-EC activators or "on" switches.

[0080] Further disclosed herein are CAR-EC platforms including CAR-EC switches and effector cells comprising universal chimeric antigen receptors (CAR) that can bind multiple CAR-EC switches, providing for sequential targeting of one or more types of target cells (*e.g.*, treatment of heterogeneous tumors). The CAR may comprise an ultra-high affinity antibody or antibody fragment (*e.g.*, scFv) to the switch. Methods of producing the CAR-EC switches disclosed herein may advantageously provide for control of CAR-EC cell activity, titration of off-target reactivity,

abrogation of tumor lysis syndrome (TLS), attenuation of cytokine release syndrome (CRS), and/or optimization of CAR-EC switch binding by affinity, valency, geometry, length and/or chemistry through site-specific grafting/fusing of CAR-EC switch peptides/antibodies. Methods also may advantageously provide for titrating the dose of the switch over the course of treatment of the subject in order to maximize targeting of the target cells while minimizing adverse effects such as TLS and CRS.

[0081] Unless otherwise specified, the terms "switch" and "CAR-EC switch", as used herein, are used interchangeably and may refer to a peptide switch. The antibody portion of the peptide antibody switch may comprise at least a portion of an antibody or an entire antibody. For example, the antibody portion of the peptide antibody switch may comprise at least a portion of a heavy chain, a portion of a light chain, a portion of a variable region, a portion of a constant region, a portion of a complementarity determining region (CDR), or a combination thereof. The antibody portion of the peptide antibody switch and/or hapten antibody switch may comprise at least a portion of the Fc (fragment, crystallizable) region. The antibody portion of the peptide antibody switch may comprise at least a portion of the complementarity determining region (*e.g.*, CDR1, CDR2, CDR3). The antibody portion of the peptide antibody switch may comprise at least a portion of the Fab (fragment, antigen-binding) region. The peptide switch may be a peptide-Fab switch.

[0082] Before the present methods, kits and compositions are described in greater detail, it is to be understood that this invention is not limited to particular method, kit or composition described, as such may, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting, since the scope of the present invention will be limited only by the appended claims. Examples are put forth so as to provide those of ordinary skill in the art with a complete disclosure and description of how to make and use the present invention, and are not intended to limit the scope of what the inventors regard as their invention nor are they intended to represent that the experiments below are all or the only experiments performed. Efforts have been made to ensure accuracy with respect to numbers used (*e.g.,* amounts, temperature, etc.) but some experimental errors and deviations should be accounted for. Unless indicated otherwise, parts are parts by weight, molecular weight is average molecular weight, temperature is in degrees Centigrade, and pressure is at or near atmospheric.

[0083] Where a range of values is provided, it is understood that each intervening value, to the tenth of the unit of the lower limit unless the context clearly dictates otherwise, between the upper and lower limits of that range is also specifically disclosed. Each smaller range between any stated value or intervening value in a stated range and any other stated or intervening value in that stated range is encompassed within the invention. The upper and lower limits of these smaller ranges may

independently be included or excluded in the range, and each range where either, neither or both limits are included in the smaller ranges is also encompassed within the invention, subject to any specifically excluded limit in the stated range. Where the stated range includes one or both of the limits, ranges excluding either or both of those included limits are also included in the invention.

[0084] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, some potential and preferred methods and materials are now described. All publications mentioned herein are incorporated herein by reference to disclose and describe the methods and/or materials in connection with which the publications are cited. It is understood that the present disclosure supersedes any disclosure of an incorporated publication to the extent there is a contradiction.

[0085] As will be apparent to those of skill in the art upon reading this disclosure, each of the individual embodiments described and illustrated herein has discrete components and features which may be readily separated from or combined with the features of any of the other several embodiments without departing from the scope or spirit of the present invention. Any recited method can be carried out in the order of events recited or in any other order which is logically possible.

[0086] It must be noted that as used herein and in the appended claims, the singular forms "a", "an", and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a cell" includes a plurality of such cells and reference to "the peptide" includes reference to one or more peptides and equivalents thereof, *e.g.,* polypeptides, known to those skilled in the art, and so forth.

[0087] The publications discussed herein are provided solely for their disclosure prior to the filing date of the present application. Nothing herein is to be construed as an admission that the present invention is not entitled to antedate such publication by virtue of prior invention. Further, the dates of publication provided may be different from the actual publication dates which may need to be independently confirmed.

[0088] Methods, kits and compositions are provided for producing CAR-EC platforms and CAR-EC switches used to bring an effector cell together with a target in a subject. These methods, kits and compositions find therapeutic use in a number of diseases. For example, heterogeneous tumors and blood cell malignancies (*e.g.,* acute lymphoblastic leukemia and chronic lymphocytic leukemia) may be more effectively treated with a CAR-EC platform when the length, valency and orientation of the CAR-EC switch linkage as well as the CAR-EC switch cell targeting moiety is optimized. Heterogeneous tumors may be more effectively treated with multiple CAR-EC switches

that target more than one tumor antigens. Advantages, and features of the invention will become apparent to those persons skilled in the art upon reading the details of the compositions and methods as more fully described below.

[0089] While preferred embodiments of the present invention have been shown and described herein, it will be obvious to those skilled in the art that such embodiments are provided by way of example only. Numerous variations, changes, and substitutions will now occur to those skilled in the art without departing from the invention. It should be understood that various alternatives to the embodiments of the invention described herein may be employed in practicing the invention. It is intended that the following claims define the scope of the invention and that methods and structures within the scope of these claims and their equivalents be covered thereby.

IA. Peptide switch

[0090] Disclosed herein are chimeric antigen receptor–effector cell switches comprising: a peptidic antigen or peptide neo-epitope (PNE) that binds a chimeric antigen receptor on an effector cell; and a targeting moiety that binds a cell surface molecule on a target. The targeting moiety may be a targeting polypeptide, comprising a targeting peptide that binds the cell surface molecule. The targeting moiety may be a targeting antibody or antibody fragment comprising the targeting peptide, wherein the targeting peptide is an antigen binding site of the targeting antibody or antibody fragment. The targeting peptide may be at least a portion of an antibody fragment and the cell surface molecule may be an antigen. The targeting moiety may comprise one or more peptides that recognize and/or bind one or more antigens. The targeting moiety may comprise one or more peptides that recognize and/or bind only one antigen. The peptidic antigen may not comprise an antibody or antibody fragment that recognizes and/or binds an antigen.

[0091] The design of the switch (*e.g.*, grafting position, linker length) is critical to the cytotoxicity, activation, and cytokine release of the peptide switchable CAR-EC cells. The switch grafting position may be empirically designed for each unique target based on the epitope location of each antibody on each antigen in order to find an optimal distance and geometry (immunological synapse) between the CAR-EC and the target cell. For example, for antibodies that bind to epitopes of an antigen that are far from the membrane (membrane distal), switch designs that provide an overall short immunological synapse through the use of an N-terminal fusion improve the activity (**FIG. 2** (middle)). Designs which provide too much distance between the CAR-EC and target cell through the use of a C-terminal fusion result in suboptimal activity (**FIG. 2** (left)). The CAR can also be modified to shorten the hinge region. This can bring the CAR-T cell and target cell closer together (**FIG. 2** (right)) which is further advantageous. Also, by way of a non-limiting example, for antibodies that bind to epitopes of an antigen that are close the membrane (membrane proximal), switch designs that provides sufficient distance (through the use of a C-

terminal fusion) for the immunological synapse to form are optimal (**FIG. 3** (middle)). Designs which do not provide enough distance between the CAR-EC and the target cell through the use of N-terminal fusions result in suboptimal or no activity due to steric hindrance (**FIG. 3** (right)). Designs which provide too much distance between the CAR-EC and target cell (through a longer hinge region) result in suboptimal activity (**FIG. 3** (left)).

[0092] Further disclosed herein are CAR-EC switches comprising: a peptidic antigen that binds a CAR (CAR-BP) on an effector cell, wherein the CAR-BP; and a targeting polypeptide that binds a cell surface molecule on a target cell. The peptidic antigen may be fused to a terminus of the targeting polypeptide. The peptidic antigen may be grafted into the targeting polypeptide (*e.g.*, between chosen amino acids of the targeting polypeptide). The targeting polypeptide may be fused to a terminus of the peptidic antigen. The targeting polypeptide may be grafted into the peptidic antigen (*e.g.*, between chosen amino acids of the peptidic antigen).

[0093] Disclosed herein are CAR-EC switches comprising: a peptidic antigen that binds a CAR (CAR-BP) on an effector cell; and a targeting antibody or antibody fragment that binds an antigen on a target. The targeting antibody or antibody fragment may be selected from an immunoglobulin, a Fab, a Fab', a $F(ab')_2$ and an scFv. The targeting antibody or antibody fragment may comprise a light chain. The targeting antibody or antibody fragment may comprise a heavy chain.

[0094] The peptidic antigen may be fused to an N terminus of the light chain of the targeting antibody or antibody fragment. The peptidic antigen may be fused to a C terminus of the light chain of the targeting antibody or antibody fragment. The peptidic antigen may be fused to an N terminus of the heavy chain of the targeting antibody or antibody fragment. The peptidic antigen may be fused to a C terminus of the heavy chain of the targeting antibody or antibody fragment. The peptidic antigen may be fused to an N terminus of a VL domain of the targeting antibody or antibody fragment. The peptidic antigen may be fused to an N terminus of a VH domain of the targeting antibody or antibody fragment. The peptidic antigen may be fused to a C terminus of a CL domain of the targeting antibody or antibody fragment. The peptidic antigen may be fused to a C terminus of an Fc domain of the targeting antibody or antibody fragment. The peptidic antigen may be fused to an N terminus of a VL domain of an IgG. The peptidic antigen may be fused to an N terminus of a VH domain of an IgG. The peptidic antigen may be fused to a C terminus of a CL domain of an IgG. The peptidic antigen may be fused to a C terminus of an Fc domain of an IgG. The peptidic antigen may be fused to an N terminus of a VL domain of a Fab. The peptidic antigen may be fused to an N terminus of a VH domain of a Fab. The peptidic antigen may be fused to a C terminus of a CL domain of a Fab. The peptidic antigen may be fused to a C terminus of a CH_1 domain of the Fab.

[0095] The peptidic antigen may be grafted into an internal site of a targeting antibody or antibody fragment (*e.g.*, between chosen amino acids of the targeting antibody or antibody fragment). The peptidic antigen may be grafted into a heavy chain of a targeting antibody or antibody fragment. The peptidic antigen may be grafted into a light chain of a targeting antibody or antibody fragment. The peptidic antigen may be grafted into a constant domain/region of a targeting antibody or antibody fragment. The peptidic antigen may be grafted into a variable domain/region of a targeting antibody or antibody fragment. The peptidic antigen may be grafted into an internal site of a Fab. The peptidic antigen may be grafted into an internal site of an immunoglobulin (*e.g.*, IgG). The peptidic antigen may be grafted into a domain of the targeting antibody or fragment thereof selected from a CL domain, a CH_1 domain, a CH_2 domain, a CH_3 domain, a VL domain, a VH domain and a hinge domain. The peptidic antigen may be grafted between two domains of the antibody or fragment thereof selected from a CL domain, a CH_1 domain, a CH_2 domain, a CH_3 domain, a VL domain, a VH domain and a hinge domain, wherein the two domains are adjacent. The peptidic antigen may be grafted into a CL domain of the antibody or fragment thereof. The peptidic antigen may be grafted into a CH_1 domain of the antibody or fragment thereof. The peptidic antigen may be grafted into a hinge domain of the antibody or fragment thereof. The peptidic antigen may be grafted into a loop of the antibody or fragment thereof. The peptidic antigen may be grafted into a CL domain loop of the antibody or fragment thereof.

[0096] The CAR-BP may be grafted into the C terminus of the antibody or antibody fragment and therefore the distance between the chimeric antigen receptor and the target may differ substantially depending on the size of CAR-EC switch (approximately 40 Å for scFv, 70 Å for Fab, and 120 Å for IgG). While a larger distance may negatively impact efficacy *in vitro*, the increased residence time of the full length antibody may be superior *in vivo*.

[0097] The CAR-EC switch may further comprise a linker, wherein the linker links the CAR-BP and the targeting moiety. The linker may be flexible. The linker may be rigid. Flexible and rigid linkers are understood by a person of skill in the art and are described in Chen et al. (Adv Drug Deliv Rev. 2013 65: 1357-1369). Switch linker design may be critical to the expression yields and the potency of the switch. The linker may connect the CAR-BP to the targeting antibody sequence by fusion and grafting. Design of the linker may directly impact the stability (*e.g.*, thermal stability, proteolytic stability) of the switch. The linker may further dictate how the peptide is presented to the CAR, especially in the distance and relative orientation to the switch. For example a flexible linker may present many different orientations, while a rigid linker may form an alpha helix and present only one orientation of the peptide epitope relative to the antibody. The linker may be flexible such as GGGGS (SEQ ID NO. 40, n=1), or the linker may be rigid such as EAAAKEAAAKEAAAKA (SEQ ID NO. 47). The linker may provide the CAR-EC switch

flexibility, length or geometry optimal for facilitating an interaction or effect of the CAR-EC on the target cell. The CAR-BP may further comprise one or more linkers. The CAR-BP may comprise two linkers. The linker may comprise a peptide. The linker may be at least about 1, at least about 2, at least about 3, at least about 4, at least about 5, at least about 6, at least about 7, at least about 8, at least about 9 or at least about 10 amino acids in length. The one or more linkers may comprise about 5, about 10, about 15, about 20, about 25, about 30, about 35, about 40, about 45, about 50, about 55, about 60, about 70, about 80, about 90 or about 100 amino acids. The linker may be located at the N terminus or the C terminus of the CAR-BP to graft the CAR-BP to the targeting polypeptide. A first linker may be fused to the N terminus of the CAR-BP and a second linker may be fused to the C terminus of the CAR-BP. The linker may be comprised of the sequence $(GGGGS)_n$, (SEQ ID NO.40), wherein n may be 1, 2, 3, 4, 5 or more. The linker may be comprised of the sequence $(GGS)_n$, (SEQ ID NO.40), wherein n may be 1, 2, 3, 4, 5 or more. The CAR-BP may be grafted into an internal site of the targeting polypeptide with a linker on either end of the CAR-BP. The linker may comprise a sequence selected from SEQ ID NOS: 40-50.

The peptidic antigen

[0098] Unless otherwise specified, the terms "peptidic antigen," "peptide neo-epitope (PNE)," and "chimeric antigen binding peptidic antigen (CAR-BP)," as used herein, are used interchangeably. The peptidic antigen may be a peptide that is bound by a chimeric antigen receptor (CAR). The peptidic antigen may have high proteolytic stability and low immunogenicity in humans relative to peptides in general. The CAR-BP may be selected from a hormone, a cytokine, a chemokine, a growth factor, a cell adhesion molecule, a signaling peptide, a receptor, a cell surface peptide and fragments thereof. The CAR-BP may be a peptoid. The CAR-BP may be a peptide nucleic acid (PNA). The CAR-BP may be a ligand or a fragment thereof. The ligand may be a hormonal ligand. The ligand may be a peptide ligand. The CAR-BP may be a cyclic peptide. The CAR-BP may be a linear peptide. The CAR-BP may have a length of between about 2 and about 10, about 10 and about 20, about 20 and about 30, about 30 and about 40, about 40 and about 50, about 50 and about 60, about 60 and about 70, about 70 and about 80, and about 80 and about 90 amino acids. The CAR-BP may be an antigen. The CAR-BP may be an epitope. The CAR-BP may be a nonlinear epitope. The CAR-BP may further comprise a second peptide.

[0099] The peptidic antigen may not comprise an antibody or antibody fragment. The peptidic antigen may comprise less than 10 amino acids of an antibody or antibody fragment. The peptidic antigen may comprise less than 12 amino acids of an antibody or antibody fragment. The peptidic antigen may comprise less than 15 amino acids of an antibody or antibody fragment. The peptidic antigen may comprise less than 20 amino acids of an antibody or antibody fragment. The peptidic antigen may comprise less than 22 amino acids of an antibody or antibody fragment. The peptidic

antigen may comprise less than 30 amino acids of an antibody or antibody fragment. The peptidic antigen may not comprise a paratope of an antibody or antibody fragment.

[0100] Disclosed herein are chimeric antigen receptor effector cell switches comprising a targeting moiety and a peptidic antigen, wherein the targeting moiety is a targeting polypeptide. The targeting polypeptide may comprise a targeting antibody or antibody fragment. The targeting antibody or antibody fragment may comprise a variable domain. The variable domain may be selected from a VH domain and a VL domain. The peptidic antigen may be located at or near the N terminus of the VH domain. The peptidic antigen may be located at or near the N terminus of the VL domain.

[0101] The peptidic antigen may comprise a non-naturally occurring peptide. The peptidic antigen may comprise a synthetic peptide. The peptidic antigen may comprise a non-animal peptide (*e.g.*, a peptide not expressed in an animal). The peptidic antigen may comprise a non-mammalian peptide. The peptidic antigen may comprise a non-human peptide. The peptide may comprise a peptide derived from a plant, a yeast, a bacteria, a reptile, a bird or an insect.

[0102] The peptidic antigen may comprise a myc-tag. The peptidic antigen may comprise His-tag. The peptidic antigen may comprise an HA-tag. The peptidic antigen may comprise peridinin chlorophyll protein complex. The peptidic antigen may comprise green fluorescent protein (GFP). The peptidic antigen may comprise red fluorescent protein (RFP). The peptidic antigen may comprise phycoerythrin (PE). The peptidic antigen may comprise streptavidin. The peptidic antigen may comprise avidin. The peptidic antigen may comprise horseradish peroxidase (HRP). The peptidic antigen may comprise alkaline phosphatase. The peptidic antigen may comprise glucose oxidase. The peptidic antigen may comprise glutathione-S-transferase (GST). The peptidic antigen may comprise maltose binding protein. The peptidic antigen, by non-limiting example, may be a c-myc tag, polyhistidine tag, V5, VSVG, softag 1, softag 3, express tag, S tag, palmitoylation, nitrosylation, SUMO tag, thioredoxin, poly(NANP), poly-Arg, calmodulin binding protein, PurF fragment, ketosteroid isomerase, PaP3.30, TAF12 histone fold domain, FKBP-tag, SNAP tag, Halo-tag, peptides from RNAse I. The peptidic antigen may comprise a protease cleavage site. The protease cleavage site may be recognized by thrombin, factor Xa, TEV protease or enterokinase.

[0103] The peptidic antigen may be a small linear hydrophilic peptide. The small linear hydrophilic peptide may comprise a linker. The small linear hydrophilic peptide may be a hydrophilic target peptide (HTP). The small linear hydrophilic peptide may comprise the sequence GGGGSDYKDDDDK (SEQ ID NO: 5). The small linear hydrophilic peptide may comprise the sequence GGGGSDYKDDDDKP (SEQ ID NO: 6). The small linear hydrophilic peptide may consist essentially of the sequence GGGGSDYKDDDDK (SEQ ID NO: 5). The small linear hydrophilic peptide may consist essentially of the sequence GGGGSDYKDDDDKP (SEQ ID NO:

6). The small linear hydrophilic peptide may be at least about 50% homologous to SEQ ID NOs: 5 or 6. The small linear hydrophilic peptide may be at least about 60% homologous to SEQ ID NOs: 5 or 6. The small linear hydrophilic peptide may be at least about 70% homologous to SEQ ID NOs: 5 or 6. The small linear hydrophilic peptide may be at least about 80% homologous to SEQ ID NOs: 5 or 6. The small linear hydrophilic peptide may be at least about 85% homologous to SEQ ID NOs: 5 or 6. The small linear hydrophilic peptide may be at least about 90% homologous to SEQ ID NOs: 5 or 6. The small linear hydrophilic peptide may have reduced non-specific binding relative to other peptides known in the art. The small linear hydrophilic peptide may have reduced non-specific binding and reduced fusion protein instability relative to other peptides disclosed herein. The peptidic antigen may comprise a FLAG® tag (SEQ ID NO: 7) or a derivative or a homolog thereof.

[0104] The peptidic antigen may be based on or derived from a naturally occurring peptide. The peptide may be based on or derived from a human peptide. The peptidic antigen may be a non-endogenous peptide or a non-native peptide, as opposed to an endogenous peptide or native peptide. An endogenous peptide may be something that is naturally or normally present in the human body (*e.g.*, biotin, Fc of monoclonal antibody) or that the human body typically encounters. Thus, a non-endogenous peptide would be something foreign or not naturally present in the human body. For example, switches disclosed herein may employ GCN4 peptides as CAR-BPs, which are not normally encountered *in vivo*. In some embodiments, such non-natural peptides maintain orthogonality of the sCAR-switch interaction. The peptidic antigen may be a non-immunogenic peptide (*e.g.*, a peptide known to cause no immune response or a negligible immune response in the human body).

[0105] The peptidic antigen may be based on or derived from a peptide expressed in animal selected from a chimpanzee, a monkey, a rat, a mouse, a bird, a fish, a pig, a horse, a cow, a goat, a chicken, a rabbit and a guinea pig. The peptidic antigen may be based on or derived from a mammalian peptide. The peptidic antigen may be based on or derived from a non-mammalian peptide. The peptidic antigen may be based on or derived from a peptide expressed in a plant. The peptidic antigen may be based on or derived from a peptide expressed in a bacterium. The peptidic antigen may be based on or derived from a prokaryotic peptide. The peptidic antigen may be based on or derived from a eukaryotic peptide. The peptidic antigen may be based on or derived from a peptide expressed by a yeast. The peptidic antigen may comprise a yeast transcription factor GCN4 peptide or a derivative or a homolog thereof. The yeast transcription factor GCN4 peptide may comprise the sequence RMKQLEPKVEELLPKNYHLENEVARLKKLVGER (SEQ ID NO: 2). The yeast transcription factor GCN4 peptide may comprise the sequence NYHLENEVARLKKL (SEQ ID NO: 3). The yeast transcription factor GCN4 peptide may consist essentially of the

sequence RMKQLEPKVEELLPKNYHLENEVARLKKLVGER (SEQ ID NO: 2). The yeast transcription factor GCN4 peptide may consist essentially of the sequence NYHLENEVARLKKL (SEQ ID NO: 3). The yeast transcription factor GCN4 peptide may comprise a portion of SEQ ID NO. 2. The portion of SEQ ID NO. 2 may be at least 4 amino acids long. The portion of SEQ ID NO. 2 may be about 4, about 5, about 6, about 7, about 8, about 9, about 10, about 11, about 12 or about 13 amino acids long. The yeast transcription factor GCN4 peptide may be at least about 50% homologous to SEQ ID NOs: 2 or 3. The yeast transcription factor GCN4 peptide may be at least about 60% homologous to SEQ ID NOs: 2 or 3. The yeast transcription factor GCN4 peptide may be at least about 70% homologous to SEQ ID NOs: 2 or 3. The yeast transcription factor GCN4 peptide may be at least about 80% homologous to SEQ ID NOs: 2 or 3. The yeast transcription factor GCN4 peptide may be at least about 85% homologous to SEQ ID NOs: 2 or 3. The yeast transcription factor GCN4 peptide may be at least about 90% homologous to SEQ ID NOs: 2 or 3. The CAR-EC switch may comprise a yeast GCN4 peptide and one or more linkers. The CAR-EC switch may comprise SEQ ID NO. 4.

The targeting moiety

[0106] The targeting moiety may bind to a cell surface molecule on a target. The cell surface molecule may comprise an antigen. The cell surface molecule may be selected from a protein, a lipid moiety, a glycoprotein, a glycolipid, a carbohydrate, a polysaccharide, a nucleic acid, an MHC-bound peptide, or a combination thereof. The cell surface molecule may comprise parts (*e.g.*, coats, capsules, cell walls, flagella, fimbrae, and toxins) of bacteria, viruses, and other microorganisms. The cell surface molecule may be expressed by the target cell. The cell surface molecule may not be expressed by the target cell. By way of non-limiting example, the cell surface molecule may be a ligand expressed by a cell that is not the target cell and that is bound to the target cell or a cell surface molecule of the target cell. Also, by non-limiting example, the cell surface molecule may be a toxin, exogenous molecule or viral protein that is bound to a cell surface or cell surface receptor of the target cell.

[0107] The targeting polypeptide may be a targeting antibody or antibody fragment. The targeting antibody or antibody fragment may be an immunoglobulin (Ig). The immunoglobulin may selected from an IgG, an IgA, an IgD, an IgE, an IgM, a fragment thereof or a modification thereof. The immunoglobulin may be IgG. The IgG may be IgG1. The IgG may be IgG2. The IgG may have one or more Fc mutations for modulating endogenous T cell FcR binding to the CAR-EC switch. The IgG may have one or more Fc mutations for removing the Fc binding capacity to the FcR of FcR-positive cells. Removal of the Fc binding capacity may reduce the opportunity for crosslinking of the CAR-EC to FcR positive cells, wherein crosslinking of the CAR-EC to FcR positive cells would activate the CAR-EC in the absence of the target cell. As such, modulating the endogenous

T cell FcR binding to the CAR-EC switch may reduce an ineffective or undesirable immune response. The one or more Fc mutations may remove a glycosylation site. The one or more Fc mutations may be selected from E233P, L234V, L235A, delG236, A327G, A330S, P331S, N297Q and any combination thereof. The one or more Fc mutations may be in IgG1. The one or more Fc mutations in the IgG1 may be L234A, L235A, or both. Alternatively, or additionally, the one or more Fc mutations in the IgG1 may be L234A, L235E, or both. Alternatively, or additionally, the one or more Fc mutations in the IgG1 may be N297A. Alternatively, or additionally, the one or more mutations may be in IgG2. The one or more Fc mutations in the IgG2 may be V234A, V237A, or both.

[0108] The targeting antibody or antibody fragment may be an Fc null immunoglobulin or a fragment thereof.

[0109] As used herein, the term "antibody fragment" refers to any form of an antibody other than the full-length form. Antibody fragments herein include antibodies that are smaller components that exist within full-length antibodies, and antibodies that have been engineered. Antibody fragments include, but are not limited to, Fv, Fc, Fab, and (Fab')2, single chain Fv (scFv), diabodies, triabodies, tetrabodies, bifunctional hybrid antibodies, a CDRl, a CDR2, a CDR3, combinations of CDRs, variable regions, framework regions, constant regions, heavy chains, light chains, alternative scaffold non-antibody molecules, and bispecific antibodies. Unless specifically noted otherwise, statements and claims that use the term "antibody" or "antibodies" may specifically include "antibody fragment" and "antibody fragments."

[0110] The targeting antibody or antibody fragment may be a Fab. A central tenant of the sCAR-T cells described herein is the orthogonality of PNE-grafted switches in that they only interact with the target cell and sCAR and no other immune receptors or cell types. Lack of orthogonality has the potential to cause off-target effects. For example, while IgG-based switches described herein were potent in *in vitro* cytotoxicity assays, they could fail to have significant impact on disease burden in the xenograft model. However, the Fc of IgG may also bind to other cell types in mouse and human. Thus, in some embodiments, Fabs may be desirable because their lack of an Fc domain removes the possibility of an Fc receptor-mediated off target binding. In some embodiments, their smaller size and shorter half-life (approximately 1-5 h for Fab vs 10-20 d for IgG provides better tumor penetration and greater temporal control over sCAR-T cell activation, in clinical translation. In addition, the Fab may differ from the IgG in valency, off-rate, or tissue distribution.

[0111] The targeting antibody fragment may be human, fully human, humanized, human engineered, non-human, and/or chimeric antibody. The non-human antibody may be humanized to reduce immunogenicity to humans, while retaining the specificity and affinity of the parental non-

human antibody. Chimeric antibodies may refer to antibodies created through the joining of two or more antibody genes which originally encoded for separate antibodies. A chimeric antibody may comprise at least one amino acid from a first antibody and at least one amino acid from a second antibody, wherein the first and second antibodies are different. At least a portion of the antibody or antibody fragment may be from a bovine species, a human species, or a murine species. At least a portion of the antibody or antibody fragment may be from a rat, a goat, a guinea pig or a rabbit. At least a portion of the antibody or antibody fragment may be from a human. At least a portion of the antibody or antibody fragment antibody may be from cynomolgus monkey.

[0112] The targeting antibody or antibody fragment may be based on or derived from an antibody or antibody fragment from a mammal, bird, fish, amphibian, or reptile. Mammals include, but are not limited to, carnivores, rodents, elephants, marsupials, rabbits, bats, primates, seals, anteaters, cetaceans, odd-toed ungulates and even-toed ungulates. The mammal may be a human, non-human primate, mouse, sheep, cat, dog, cow, horse, goat, or pig.

[0113] The targeting antibody or an antibody fragment may target an antigen selected from, by non-limiting example, CD19, Her2, CLL1, CD33, CD123, EGFT, EGFRvIII, CD20, CD22, CS1, BCMA, CEA or a fragment thereof. The antigen may comprise a wildtype antigen. The antigen may comprise one or more mutations. The targeting antibody or antibody fragment may be a B cell targeting moiety. The targeting antibody or antibody fragment may be an anti-CD19 antibody or antibody fragment. The anti-CD19 antibody or antibody fragment may be selected from antibody clone huB4 (*see, e.g.,* SEQ ID NOS: 150-157) and FMC63 (*see, e.g.,* SEQ ID NOS.: 85-102). The targeting antibody or antibody fragment may be an anti-CLL1 antibody or antibody fragment. The anti-CLL1 antibody or antibody fragment may be antibody clone 1075.7 (*see, e.g.,* SEQ ID NOS: 103-106). The targeting antibody or antibody fragment may be an anti-CD22 antibody or antibody fragment. The anti-CD22 antibody or antibody fragment may be selected from antibody clone m972 (*see, e.g.,* SEQ ID NOS: 113-118) and m971 (*see, e.g.,* SEQ ID NOS: 107-112). The targeting antibody or antibody fragment may be an anti-CD20 antibody or antibody fragment. The anti-CD20 antibody or antibody fragment may be selected from antibody clone OFA (*see, e.g.,* SEQ ID NOS: 135-140), RTX (*see, e.g.*, SEQ ID NOS: 125-128), and GA101 (*see, e.g.,* SEQ ID NOS: 129-134). The targeting antibody or antibody fragment may be an anti-BCMA antibody or antibody fragment. The anti-BCMA antibody or antibody fragment may be antibody clone BCMA-98 (*see, e.g.,* SEQ ID NOS: 145-149). The targeting antibody or antibody fragment may be an anti-Her2 antibody or antibody fragment. The anti-Her2 antibody or antibody fragment may be selected from antibody clone trastuzumab (*see, e.g.,* SEQ ID NOS: 11, 12, 141-144). The targeting antibody or antibody fragment may be an anti-CS1 antibody or antibody fragment. The anti-CS1 antibody or antibody fragment may be antibody clone elotuzumab (*see, e.g.,* SEQ ID NOS: 21-22). The

targeting antibody or antibody fragment may be an anti-CD33 antibody or antibody fragment. The anti-CD33 antibody or antibody fragment may be antibody clone hM195 (*see, e.g.,* SEQ ID NOS: 53-56, 162-165). The targeting antibody or antibody fragment may be an anti-CEA antibody or antibody fragment. The anti-CEA antibody or antibody fragment may be antibody clone A5B7 (*see, e.g.,* SEQ ID NOS: 158-161). The expression of each switch requires a heavy chain and light chain gene to be co-transfected into one or more expression cells (*e.g.,* HEK). The CAR-BP may be located in only the heavy chain to provide a monovalent switch. The CAR-BP may be located in only the light chain to provide a monovalent switch. The CAR-BP may be located in both the heavy chain and the light chain to provide a bivalent switch. The CAR-BP may be located in both the heavy chain and the light chain to provide a multivalent switch.

[0114]

[0115] The targeting antibody or antibody fragment may be an anti-CD19 antibody or a fragment thereof. The targeting polypeptide may be an anti-CD22 antibody. The targeting polypeptide may be an anti-BCMA antibody or a fragment thereof. The targeting polypeptide may be an anti-CS1 antibody or a fragment thereof. The targeting polypeptide may be an anti-EGFRvIII antibody or a fragment thereof. The targeting polypeptide may be an anti-Her2 antibody or a fragment thereof. The targeting polypeptide may comprise an anti-CD20 antibody or antibody fragment. The targeting polypeptide may comprise rituximab. The targeting polypeptide may comprise an anti-EGFR antibody or antibody fragment. The targeting polypeptide may comprise an anti-CEA antibody or antibody fragment. The targeting polypeptide may comprise an anti-CLL1 antibody or antibody fragment. The targeting polypeptide may comprise an anti-CD33 antibody or antibody fragment. The targeting polypeptide may not comprise an anti-EpCAM antibody or fragment thereof.

[0116] The targeting antibody or antibody fragment may be selected any commercially available antibody. The targeting antibody or antibody fragment may be selected from ado-trastuzumab emtansine, alemtuzumab, bevacizumab, brentuximab, vedotin, gemtuzumab, ozogamicin, ipilimumab, ibritumomab, tiuxetan, panitumumab, cetuximab, erbitux, rituximab, trastuzumab and fragments thereof.

[0117] The targeting antibody or antibody fragment may comprise an anti-CD19 antibody or fragment thereof. The targeting antibody or fragment thereof may comprise a light chain of the anti-CD19 antibody or fragment thereof. The light chain of the anti-CD19 antibody or fragment thereof may be encoded by a nucleotide sequence based on or derived from SEQ ID NO. 8. The nucleotide sequence may be about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about

15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 8. The targeting antibody or fragment thereof may comprise a heavy chain of the anti-CD19 antibody or fragment thereof. The heavy chain of the anti-CD19 antibody or fragment thereof may be encoded by a sequence based on or derived from SEQ ID NO. 9. The nucleotide sequence may be about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 9.

[0118] The targeting antibody or antibody fragment may comprise an anti-CD19 antibody or fragment thereof. The targeting antibody or fragment thereof may comprise a light chain of the anti-CD19 antibody or fragment thereof. The light chain of the anti-CD19 antibody or fragment may comprise an amino acid sequence based on or derived from SEQ ID NO. 27. The amino acid sequence may be about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 27. The targeting antibody or fragment thereof may comprise a heavy chain of the anti-CD19 or fragment thereof. The targeting antibody or fragment thereof may comprise a heavy chain of an anti-CD19 IgG. The heavy chain of the anti-CD19 IgG may comprise a sequence based on or derived from SEQ ID NO. 28. The amino acid sequence may be about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 28. The targeting antibody or fragment thereof may comprise a heavy chain of an anti-CD19 Fab. The heavy chain of the anti-CD19 Fab may comprise a sequence based on or derived from SEQ ID NO. 29. The amino acid sequence may be about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 29.

[0119] The targeting antibody or fragment thereof may comprise a light chain of the anti-CLL1 antibody or fragment thereof. The light chain of the anti-CLL1 antibody or fragment thereof may be encoded by SEQ ID NO. 17. The light chain of the anti-CLL1 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about

15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 17. The targeting antibody or fragment thereof may comprise a heavy chain of the anti-CLL1 antibody or fragment thereof. The heavy chain of the anti-CLL1 antibody or fragment thereof may be encoded by SEQ ID NO. 18. The heavy chain of the anti-CLL1 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 18.

[0120] The targeting antibody or fragment thereof may comprise a light chain of the anti-CD22 antibody or fragment thereof. The light chain of the anti- CD22 antibody or fragment thereof may be encoded by a sequence selected from SEQ ID NOS: 108, 114 and 120. The light chain of the anti- CD22 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to a sequence selected from SEQ ID NOS: 108, 114 and 120. The targeting antibody or fragment thereof may comprise a heavy chain of the anti- CD22 antibody or fragment thereof. The heavy chain of the anti- CD22 antibody or fragment thereof may be a sequence selected from SEQ ID NOS:107, 113 and 119. The heavy chain of the anti- CD22 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to a sequence selected from SEQ ID NOS: 107, 113 and 119.

[0121] The targeting antibody or fragment thereof may comprise a light chain of the anti-CD20 antibody or fragment thereof. The light chain of the anti- CD20 antibody or fragment thereof may be encoded by a sequence selected from SEQ ID NOS: 13, 130 and 136. The light chain of the anti-CD20 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to a sequence selected from SEQ ID NOS: 13, 130 and 136. The targeting antibody or fragment thereof may comprise a heavy chain of the anti- CD20 antibody or fragment thereof. The heavy chain of the anti- CD20 antibody or fragment thereof may be a sequence selected from SEQ ID NOS: 14, 129 and 135. The heavy chain of the anti-CD20 antibody or fragment thereof may be encoded by a

sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to a sequence selected from SEQ ID NOS: 14, 129 and 135. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NOS: 13, 129 or 135 and a light chain of SEQ ID NOS: 13, 130 or 136, or homologs thereof or fragments thereof.

[0122] The targeting antibody or fragment thereof may comprise a light chain of the anti-Her2 antibody or fragment thereof. The light chain of the anti- Her2 antibody or fragment thereof may be encoded by SEQ ID NO. 11. The light chain of the anti- Her2 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 11. The targeting antibody or fragment thereof may comprise a heavy chain of the anti- Her2 antibody or fragment thereof. The heavy chain of the anti- Her2 antibody or fragment thereof may be encoded by SEQ ID NO. 12. The heavy chain of the anti- Her2 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 12. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 12 and a light chain of SEQ ID NO. 11, or homologs thereof, or fragments thereof.

[0123] The targeting antibody or fragment thereof may comprise a light chain of the anti-BCMA antibody or fragment thereof. The light chain of the anti- BCMA antibody or fragment thereof may be encoded by SEQ ID NO. 25. The light chain of the anti- BCMA antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 25. The targeting antibody or fragment thereof may comprise a heavy chain of the anti-BCMA antibody or fragment thereof. The heavy chain of the anti- BCMA antibody or fragment thereof may be encoded by a sequence selected from SEQ ID NOS: 26 and 38. The heavy chain of the anti-BCMA antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about

65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to a sequence selected from SEQ ID NOS: 26 and 38. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NOS: 26 or 38 and a light chain of SEQ ID NO. 25, or homologs thereof, or fragments thereof.

[0124] The targeting antibody or fragment thereof may comprise a light chain of the anti-CEA antibody or fragment thereof. The light chain of the anti-CEA antibody or fragment thereof may be encoded by SEQ ID NO. 160. The light chain of the anti-CEA antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 160. The targeting antibody or fragment thereof may comprise a heavy chain of the anti-CEA antibody or fragment thereof. The heavy chain of the anti-CEA antibody or fragment thereof may be encoded by SEQ ID NO. 158. The heavy chain of the anti-CEA antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 158. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 158 and a light chain of SEQ ID NO. 160, or homologs thereof, or fragments thereof.

[0125] The targeting antibody or fragment thereof may comprise a light chain of the anti-CS1 antibody or fragment thereof. The light chain of the anti-CS1 antibody or fragment thereof may be encoded by SEQ ID NO. 21. The light chain of the anti-CS1 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 21. The targeting antibody or fragment thereof may comprise a heavy chain of the anti-CS1 antibody or fragment thereof. The heavy chain of the anti-CS1 antibody or fragment thereof may be encoded by SEQ ID NO. 22. The heavy chain of the anti-CS1 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 22. The chimeric antigen receptor–effector cell switch may

comprise a heavy chain of SEQ ID NO. 22 and a light chain of SEQ ID NO. 21, or homologs thereof, or fragments thereof.

[0126] The targeting antibody or fragment thereof may comprise a light chain of the anti-CD33 antibody or fragment thereof. The light chain of the anti-CD33 antibody or fragment thereof may be encoded by SEQ ID NO. 19. The light chain of the anti-CD33 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 19. The targeting antibody or fragment thereof may comprise a heavy chain of the anti-CD33 antibody or fragment thereof. The heavy chain of the anti-CD33 antibody or fragment thereof may be encoded by SEQ ID NO. 20. The heavy chain of the anti-CD33 antibody or fragment thereof may be encoded by a sequence at least about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous to SEQ ID NO. 20. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 20 and a light chain of SEQ ID NO. 19, or homologs thereof, or fragments thereof.

[0127] The targeting antibody or antibody fragment may comprise a nucleotide sequence selected from SEQ ID NOs: 8-20. The targeting polypeptide may be based on or derived from a nucleotide selected from SEQ ID NOs: 8-20. The targeting antibody or antibody fragment may comprise an amino acid sequence selected from SEQ ID NOs: 21-29. The targeting polypeptide may be based on or derived from an amino acid sequence selected from SEQ ID NOs: 21-29.

[0128] Disclosed herein are chimeric antigen receptor effector cell (CAR-EC) switches comprising a peptidic antigen and a targeting moiety that binds a cell surface molecule on a target cell. Generally, binding of the effector cell and the target cell to the CAR-EC switch construct brings the target cell into proximity with the effector cell sufficiently close for an activity of the effector cell to have an effect on the target cell. For example, when the T cell and the target cell are bound to the CAR-EC switch, the T cell may produce an immune response that has a cytotoxic effect on the target cell.

[0129] The CAR-EC switches may interact with a plurality of target cells. The target cell may be an infected cell. The target cell may be a pathogenically infected cell. The target cell may be a diseased cell. The target cell may be a genetically-modified cell. The target cell may not be a host cell. The target cell may come from an invading organism (*e.g.*, yeast, worm, bacteria, fungus). Further disclosed herein are CAR-EC switches that interact with a molecule on a non-cell target.

The non-cell target may be a virus or a portion thereof. The non-cell target may be a fragment of a cell. The non-cell target may be an extracellular matrix component or protein.

[0130] The target cell may be derived from a tissue. The tissue may be selected from brain, esophagus, breast, colon, lung, glia, ovary, uterus, testes, prostate, gastrointestinal tract, bladder, liver, thymus, bone and skin. The target cell may be derived from one or more endocrine glands. Alternatively, or additionally, the target cell may be derived from one or more endocrine glands. The endocrine gland may be a lymph gland, pituitary gland, thyroid gland, parathyroid gland, pancreas, gonad or pineal gland.

[0131] The target cell may be selected from a stem cell, a pluripotent cell, a hematopoietic stem cell or a progenitor cell. The target cell may a circulating cell. The target cell may be an immune cell.

[0132] The target cell may be a cancer stem cell. The target cell may be a cancer cell. The cancer cell may be derived from a tissue. The tissue may be selected from, by way of non-limiting example, a brain, an esophagus, a breast, a colon, a lung, a glia, an ovary, a uterus, a testicle, a prostate, a gastrointestinal tract, a bladder, a liver, a thyroid and skin. The cancer cell may be derived from bone. The cancer cell may be derived from blood. The cancer cell may be derived from a B cell, a T cell, a monocyte, a thrombocyte, a leukocyte, a neutrophil, an eosinophil, a basophil, a lymphocyte, a hematopoietic stem cell or an endothelial cell progenitor. The cancer cell may be derived from a CD19-positive B lymphocyte. The cancer cell may be derived from a stem cell. The cancer cell may be derived from a pluripotent cell. The cancer cell may be derived from one or more endocrine glands. The endocrine gland may be a lymph gland, pituitary gland, thyroid gland, parathyroid gland, pancreas, gonad or pineal gland.

[0133] The cancer cell may be a CD19-positive cell. The cancer cell may be a CD19-positive B lymphocyte. The cancer cell may be a Her2-positive cell. The Her2-positive cell may be a Her2-positive breast cancer cell. The target cell may be a BCMA-positive cell. The cancer cell may be a BCMA-positive multiple myeloma cell. The cancer cell may be a CS1-positive cell. The CS1-positive cell may be a multiple myeloma cell. The cancer cell may be a EGFRvIII-positive cell. The cancer cell may be a EGFRvIII-positive glioblastoma cell. The cancer cell may be a CD20-positive cell. The cancer cell may be a CD22-positive cell.

[0134] The cell surface molecule may be an antigen. The antigen may be at least a portion of a surface antigen or a cell surface marker on a cell. The antigen may be a receptor or a co-receptor on a cell. The antigen may refer to a molecule or molecular fragment that may be bound by a major histocompatibility complex (MHC) and presented to a T-cell receptor. The term “antigen” may also refer to an immunogen. The immunogen may provoke an adaptive immune response if injected on its own into a subject. The immunogen may induce an immune response by itself. The antigen may

be a superantigen, T-dependent antigen or a T-independent antigen. The antigen may be an exogenous antigen. Exogenous antigens are typically antigens that have entered the body from the outside, for example by inhalation, ingestion, or injection. Some antigens may start out as exogenous antigens, and later become endogenous (for example, intracellular viruses). The antigen may be an endogenous antigen. The endogenous antigen may be an antigen that has been generated within cells as a result of normal cell metabolism, or because of pathogenic infections (*e.g.*, viral, bacterial, fungal, parasitic). The antigen may be an autoantigen. The autoantigen may be a normal protein or complex of proteins (and sometimes DNA or RNA) that is recognized by the immune system of patients suffering from a specific autoimmune disease. These antigens should, under normal conditions, not be the target of the immune system, but, due to genetic and/or environmental factors, the normal immunological tolerance for such an antigen is not present in these patients. The antigen may be present or over-expressed due to a condition or disease. The condition or disease may be a cancer or a leukemia. The condition may be an inflammatory disease or condition. The condition or disease may be a metabolic disease. The condition may be a genetic disorder.

[0135] The cell surface molecule may be an antigen that has been designated as a tumor antigen. Tumor antigens or neoantigens may be antigens that are presented by MHC I or MHC II molecules on the surface of tumor cells. These antigens may sometimes be presented by tumor cells and never by the normal ones. In this case, they are called tumor-specific antigens (TSAs) and, in general, result from a tumor-specific mutation. More common are antigens that are presented by tumor cells and normal cells, and they are called tumor-associated antigens (TAAs). Cytotoxic T lymphocytes that recognize these antigens may be able to destroy the tumor cells before they proliferate or metastasize. Tumor antigens may also be on the surface of the tumor in the form of, for example, a mutated receptor, in which case they may be recognized by B cells. Unless otherwise specified, the terms "tumor antigen," "tumor specific antigen" and "tumor associated antigen," are used interchangeably herein.

[0136] The cell surface molecule may be a receptor. The receptor may be an extracellular receptor. The receptor may be a cell surface receptor. By way of non-limiting example, the receptor may bind a hormone, a neurotransmitter, a cytokine, a growth factor or a cell recognition molecule. The receptor may be a transmembrane receptor. The receptor may be an enzyme-linked receptor. The receptor may be a G-protein couple receptor (GPCR). The receptor may be a growth factor receptor. By way of non-limiting example, the growth factor receptor may be selected from an epidermal growth factor receptor, a fibroblast growth factor receptor, a platelet derived growth factor receptor, a nerve growth factor receptor, a transforming growth factor receptor, a bone morphogenic protein growth factor receptor, a hepatocyte growth factor receptor, a vascular

endothelial growth factor receptor, a stem cell factor receptor, an insulin growth factor receptor, a somatomedin receptor, an erythropoietin receptor and homologs and fragments thereof. The receptor may be a hormone receptor. The receptor may be an insulin receptor. By way of non-limiting example, the receptor may selected from an eicosanoid receptor, a prostaglandin receptor, an estrogen receptor, a follicle stimulating hormone receptor, a progesterone receptor, a growth hormone receptor, a gonadotropin-releasing hormone receptor, homologs thereof and fragments thereof. The receptor may be an adrenergic receptor. The receptor may be an integrin. The receptor may be an Eph receptor. The receptor may be a luteinizing hormone receptor. The cell surface molecule may be at least about 50% homologous to a luteinizing hormone receptor. The receptor may be an immune receptor. By way of non-limiting example, the immune receptor may be selected from a pattern recognition receptor, a toll-like receptor, a NOD like receptor, a killer activated receptor, a killer inhibitor receptor, an Fc receptor, a B cell receptor, a complement receptor, a chemokines receptor and a cytokine receptor. By way of non-limiting example, the cytokine receptor may be selected from an interleukin receptor, an interferon receptor, a transforming growth factor receptor, a tumor necrosis factor receptor, a colony stimulating factor receptor, homologs thereof and fragments thereof. The receptor may be a receptor kinase. The receptor kinase may be a tyrosine kinase receptor. The receptor kinase may be a serine kinase receptor. The receptor kinase may be a threonine kinase receptor. By way of non-limiting example, the receptor kinase may activate a signaling protein selected from a Ras, a Raf, a PI3K, a protein kinase A, a protein kinase B, a protein kinase C, an AKT, an AMPK, a phospholipase, homologs thereof and fragments thereof. The receptor kinase may activate a MAPK/ERK signaling pathway. The receptor kinase may activate Jak, Stat or Smad.

[0137] The cell surface molecule may be a non-receptor cell surface protein. The cell surface molecule may be a cluster of differentiation proteins. By way of non-limiting example, the cell surface molecule may be selected from CD34, CD31, CD117, CD45, CD11b, CD15, CD24, CD114, CD182, CD14, CD11a, CD91, CD16, CD3, CD4, CD25, CD8, CD38, CD22, CD61, CD56, CD30, CD13, CD33, CD123, CD19, CD20, fragments thereof, and homologs thereof.

[0138] The cell surface molecule may be a molecule that does not comprise a peptide. The cell surface molecule may comprise a lipid. The cell surface molecule may comprise a lipid moiety or a lipid group. The lipid moiety may comprise a sterol. The lipid moiety may comprise a fatty acid. The antigen may comprise a glycolipid. The cell surface molecule may comprise a carbohydrate.

[0139] Disclosed herein are CAR-EC switches comprising (a) a chimeric antigen receptor binding peptidic antigen comprising a peptide from a yeast transcription factor peptide; and (b) a targeting polypeptide. The yeast transcription factor peptide may be a GCN4 peptide. The targeting polypeptide may comprise a targeting antibody or antibody fragment. The targeting antibody or

antibody fragment may comprise a heavy chain of an antibody. The targeting antibody or antibody fragment may comprise a light chain of an antibody. The targeting antibody or antibody fragment may comprise a Fab of an antibody. The targeting antibody or antibody fragment may comprise an anti-CD19 antibody or a fragment thereof. The targeting antibody or antibody fragment may comprise an anti-Her2 antibody or a fragment thereof. The targeting antibody or antibody fragment may be selected from an anti-CS1 antibody, an anti-BCMA antibody, an anti-EGFRvIII antibody, an anti-CD20 antibody, an anti-EGFR antibody, an anti-CEA antibody, an anti-CLL1 antibody, an anti-CD33 antibody and fragments thereof.

[0140] Further disclosed herein are CAR-EC switches comprising (a) a CAR binding region comprising a hydrophilic target peptide (HTP) tag; and (b) a targeting polypeptide. The targeting polypeptide may comprise a targeting antibody or antibody fragment. The targeting antibody or antibody fragment may comprise a heavy chain of an antibody. The targeting antibody or antibody fragment may comprise a light chain of an antibody. The targeting antibody or antibody fragment may comprise a Fab of an antibody. The targeting antibody or antibody fragment may comprise an anti-CD19 antibody or a fragment thereof. The targeting antibody or antibody fragment may comprise an anti-Her2 antibody or a fragment thereof. The targeting antibody or antibody fragment may be selected from an anti-CS1 antibody, an anti-BCMA antibody, an anti-EGFRvIII antibody, an anti-CD20 antibody, an anti-EGFR antibody, an anti-CEA antibody, an anti-CLL1 antibody, an anti-CD33 antibody and fragments thereof.

[0141] The chimeric antigen receptor–effector cell switch may comprise a heavy chain selected from SEQ ID NO. 32, SEQ ID NO. 33, SEQ ID NO. 34, SEQ ID NO. 35 and SEQ ID NO. 38. The chimeric antigen receptor–effector cell switch may comprise a heavy chain that is at least 50% homologous to a sequence selected from SEQ ID NO. 32, SEQ ID NO. 33, SEQ ID NO. 34, SEQ ID NO. 35 and SEQ ID NO. 38. The chimeric antigen receptor–effector cell switch may comprise a heavy chain that is at least 60% homologous to a sequence selected from SEQ ID NO. 32, SEQ ID NO. 33, SEQ ID NO. 34, SEQ ID NO. 35 and SEQ ID NO. 38. The chimeric antigen receptor–effector cell switch may comprise a heavy chain that is at least 70% homologous to a sequence selected from SEQ ID NO. 32, SEQ ID NO. 33, SEQ ID NO. 34, SEQ ID NO. 35 and SEQ ID NO. 38. The chimeric antigen receptor–effector cell switch may comprise a heavy chain that is at least 80% homologous to a sequence selected from SEQ ID NO. 32, SEQ ID NO. 33, SEQ ID NO. 34, SEQ ID NO. 35 and SEQ ID NO. 38. The chimeric antigen receptor–effector cell switch may comprise a heavy chain that is at least 90% homologous to a sequence selected from SEQ ID NO. 32, SEQ ID NO. 33, SEQ ID NO. 34, SEQ ID NO. 35 and SEQ ID NO. 38.

[0142] The chimeric antigen receptor–effector cell switch may comprise a light chain selected from SEQ ID NO. 30, SEQ ID NO. 31, SEQ ID NO. 36 and SEQ ID NO. 37. The chimeric antigen

receptor–effector cell switch may comprise a light chain that is at least 50% homologous to a sequence selected from SEQ ID NO. 30, SEQ ID NO. 31, SEQ ID NO. 36 and SEQ ID NO. 37. The chimeric antigen receptor–effector cell switch may comprise a light chain that is at least 60% homologous to a sequence selected from SEQ ID NO. 30, SEQ ID NO. 31, SEQ ID NO. 36 and SEQ ID NO. 37. The chimeric antigen receptor–effector cell switch may comprise a light chain that is at least 70% homologous to a sequence selected from SEQ ID NO. 30, SEQ ID NO. 31, SEQ ID NO. 36 and SEQ ID NO. 37. The chimeric antigen receptor–effector cell switch may comprise a light chain that is at least 80% homologous to a sequence selected from SEQ ID NO. 30, SEQ ID NO. 31, SEQ ID NO. 36 and SEQ ID NO. 37. The chimeric antigen receptor–effector cell switch may comprise a light chain that is at least 90% homologous to a sequence selected from SEQ ID NO. 30, SEQ ID NO. 31, SEQ ID NO. 36 and SEQ ID NO. 37.

[0143] The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 29 and a light chain of SEQ ID NO. 30. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 29 and a light chain of SEQ ID NO. 36. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 28 and a light chain of SEQ ID NO. 31. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 32 and a light chain of SEQ ID NO. 27. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 33 and a light chain of SEQ ID NO. 27. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 34 and a light chain of SEQ ID NO. 27. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 35 and a light chain of SEQ ID NO. 27. The chimeric antigen receptor–effector cell switch may comprise a heavy chain of SEQ ID NO. 38 and a light chain of SEQ ID NO. 37.

Multivalent CAR-EC Switches

[0144] Exemplified herein are CAR-EC switches comprising a chimeric antigen receptor binding peptidic antigen (CAR-BP) and a targeting polypeptide. However, one skilled in the art would understand that these switches could further comprise additional targeting polypeptides and/or additional CAR-BPs. One or more CAR-BPs may be grafted into one or more grafting sites of the targeting polypeptide. One or more CAR-BPs may be fused to one or more termini of the targeting polypeptide. Such switches are referred to herein as a "multivalent switch."

[0145] Multivalent switches are advantageous in CAR-T cell activation for at least the reason that multiple CARs are recruited for every one switch (and correspondingly one antigen) (**FIG. 4B**). This is expected to increase the signal transduction, CAR-T cell activation, and target cell lysis. The multivalent switch may bind to a CAR with a longer hinge region than that of canonical CARs in order for the CAR to access multiple peptides of the switch. However, the multivalent switch

may, alternatively or additionally, have an optimal geometry and/or length for efficient activity with the CAR, including a canonical CARs or CARs with short hinges.

[0146] A first CAR-BP may be grafted into a first domain of the targeting polypeptide and a second CAR-BP may be grafted into a second domain of the targeting polypeptide. The first domain and the second domain may be the same. The first domain and the second domain may be different. By way of non-limiting example, the first CAR-BP may be grafted into a light chain of a targeting antibody or antibody fragment and a second CAR-BP may be grafted into heavy chain of the targeting antibody or antibody fragment. The first CAR-BP may be fused to a first terminus of the targeting polypeptide and a second CAR-BP may be fused to a second terminus of the targeting polypeptide. By way of non-limiting example, the first CAR-BP may be fused to a C terminus of a light chain of a targeting antibody or antibody fragment and a second CAR-BP may be fused to an N terminus of a heavy chain of the targeting antibody or antibody fragment. The first CAR-BP may be fused to a terminus of the targeting polypeptide and a second CAR-BP may be grafted within a domain of the targeting polypeptide. The first CAR-BP and the second CAR-BP may be the same or similar, such that the CAR-EC switch may be used with a CAR-EC cell that expresses one CAR. The first CAR-BP and the second CAR-BP may be different, such that the CAR-EC switch may be used with a CAR-EC cell that expresses one or more CARs or multiple CAR-EC cells that express different CARs.

[0147] The peptide switches disclosed herein may comprise one or more CAR-BPs. The peptide switches disclosed herein may comprise two or more CAR-BPs. The peptide switches disclosed herein may comprise three or more CAR-BPs. The peptide switches disclosed herein may comprise 1, 2, 3, 4, 5, 6, 7 or more CAR-BPs. The one or more CAR-BPs may be fused or grafted to the targeting polypeptide via one or more linkers. Thus, the peptide switches disclosed herein may comprise one or more linkers (*e.g.*, L1, L2). The peptide switches disclosed herein may comprise two or more linkers. The peptide switches disclosed herein may comprise three or more linkers. The peptide switches disclosed herein may comprise 1, 2, 3, 4, 5, 6, 7 or more linkers. The linker may comprise a sequence selected from SEQ ID NOS: 40-50. The linker may comprise a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 40-50. The linker may comprise a sequence selected from SEQ ID NOS: 68-71. The linker may comprise a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 68-71.

[0148] The distance between the first CAR-BP and the second CAR-BP may be any suitable distance such that the CAR-BPs are able to bind to their target CAR-EC domains. For example, the distance may be between about 0 Å and about 200 Å or between about 0 Å and about 150 Å, or about 0 Å and about 100 Å, including all integers (e.g., 121 Å, 122 Å, 123 Å, 124 Å) and ranges (e.g., about 25 Å to about 125 Å, about 50 Å to about 125 Å, about 70 Å to about 115 Å) in

between. The distance between the first CAR-BP and the second CAR-BP may be about 12 Å. The distance between the first CAR-BP and the second CAR-BP may be about 24 Å.

IB. Peptide-small molecule switch

[0149] Further disclosed herein are CAR-EC switches comprising a CAR binding region and a targeting moiety, wherein the CAR binding region is a CAR-binding peptidic antigen and the targeting moiety is a non-peptidic small molecule. The non-peptidic small molecule may be a cell-targeting molecule, a chemical ligand, a nucleic acid, a vitamin, a substrate or a substrate analog. The non-peptidic small molecule may not comprise two amino acids, wherein the two amino acids are connected by an amide bond. The CAR-EC switch may further comprise a linker. The CAR-binding peptidic antigen (CAR-BP) and the small molecule may be site-specifically linked. The CAR-binding peptidic antigen may comprise an unnatural amino acid. The CAR-binding peptidic antigen and the small molecule may be site-specifically linked by the unnatural amino acid. The small molecule may bind a cell surface molecule on a target cell. The cell surface molecule may be selected from an antigen, a protein, a peptide, a lipid, a sterol, a glycolipid and a cell surface marker. The CAR-binding peptidic antigen may be selected from FLAG® tag, yeast transcription factor GCN4 and a hydrophilic target peptide (HTP). The small molecule may be 2-[3-(1,3-dicarboxypropyl)ureido]pentanedioic acid. The small molecule may be folate. The CAR-EC switch may further comprise a linker.

[0150] Disclosed herein are methods of producing CAR-EC switches comprising conjugating the CAR binding region to the targeting moiety, wherein the CAR-EC switches comprise a CAR binding region and a targeting moiety, wherein the CAR binding region is a CAR-binding peptidic antigen and the targeting moiety is a small molecule. The method may further comprise conjugating the small molecule to the linker to create a small molecule-linker intermediate. The small molecule or the small molecule-linker intermediate may comprise one or more reactive functional groups that may react with a complementary reactive functional group on the CAR-BP, previous to incorporation into the CAR-EC switch. The linker or the small molecule-linker intermediate may be bifunctional. The linker or the small molecule-linker intermediate may be heterobifunctional.

[0151] The small molecule-linker intermediate or the CAR-EC switch may be the product of a bioorthogonal reaction, non-limiting examples of which are reviewed in Kim *et al.*, Curr Opin Chem Bio 17:412-419 (2013). The small molecule-linker intermediate, linker or the CAR-EC switch may comprise an oxime, a tetrazole, a Diels Alder adduct, a hetero Diels Alder adduct, an aromatic substitution reaction product, a nucleophilic substitution reaction product, an ester, an amide, a carbamate, an ether, a thioether, or a Michael reaction product. The small molecule-linker

intermediate, linker or the CAR-EC switch be a cycloaddition product, a metathesis reaction product, a metal-mediated cross-coupling reaction product, a radical polymerization product, an oxidative coupling product, an acyl-transfer reaction product, or a photo click reaction product. The cycloaddition may be a Huisgen-cycloaddition. The cycloaddition may be a copper-free [3+2] Huisgen-cycloaddition. The cycloaddition may be a Diels-Alder reaction. The cycloaddition may be a hetero Diels-Alder reaction. The small molecule-linker intermediate may be the product of an enzyme-mediated reaction. The small molecule-linker intermediate may be a product of a transglutaminase-mediated reaction, non-limiting examples of which are described in Lin *et al.*, J. Am. Chem. Soc. 128:4542-4543 (2006) and WO 2013/093809. The small molecule-linker intermediate, linker or the CAR-EC switch may comprise a disulfide bridge that connects two cysteine residues, such as ThioBridge™ technology by PolyTherics. The small molecule-linker intermediate, linker or the CAR-EC switch may comprise a maleimide bridge that connects two amino acid residues. The small molecule-linker intermediate, linker or the CAR-EC switch may comprise a maleimide bridge that connects two cysteine residues.

[0152] The small molecule-linker intermediate or linker may comprise an alkoxy-amine (or aminooxy) group, azide group and/or cyclooctyne group at one or more termini. The small molecule-linker intermediate or linker may comprise an alkoxy-amine at one terminus and an azide group at the other terminus. The small molecule-linker intermediate or linker may comprise an alkoxy-amine at one terminus and a cyclooctyne group at the other terminus. The alkoxy-amine may form a stable oxime with a ketone group on an amino acid. The alkoxy-amine may form a stable oxime with a ketone group on an unnatural amino acid. The ketone group may be on a *p*-acetyl phenylalanine (pAcF).

IC. Soluble T Cell Receptors Switches

[0153] TCR and biologics derived from TCRs, such as affinity matured soluble TCR (sTCR) and single chain TCR (scTCR) can also be used as a moiety for peptide-switch targeting. These reagents allow detection of intracellular proteins displayed on the cell surface in the context of MHC. An example of this targeting strategy is the affinity matured sTCR 1G4c113 which recognizes a peptide derived from the cancer/testes antigen NYESO-1 in the context of HLA-A201. Grafting peptides onto TCR-derived products like 1G4c113 enables the expansion of CAR-EC targeting to intracellular antigens not normally accessible by conventional antibody-derived switches. An example of grafting strategies for TCR-derived switches can be seen in (SEQ ID NOS: 62-67).

[0154] A major limitation of antibody-based targeting is the restriction to cell surface targets; however many tumor associated antigens are intracellular, non-membrane bound proteins. One way to target intracellular proteins is by immunologic targeting using T cell receptors (TCRs). This

exploits the mechanism in which a T cell naturally surveys the intracellular proteome, represented as peptides displayed by human leukocyte antigen (HLA, MHC). Affinity matured, tumor-specific TCRs transduced into adoptively transferred T cells have the potential to lose specificity and have caused serious adverse effects in the clinic due to off-target reactivity. For example, adoptive transfer of engineered T cells harboring a high avidity TCR against MAGE-A3 for melanoma and myeloma resulted in two deaths in the clinic due to off-target reactivity with the protein Titin in cardiac tissue. On-target, off-tumor toxicity has also been reported. An affinity matured TCR against CEA caused severe inflammatory colitis even at doses of T cells 100 fold lower than those typically given with autologous tumor infiltrating lymphocyte (TIL) therapy. Surprisingly, these serious safety concerns have not stopped researchers from initiating clinical trials for more than a dozen targets. Therefore, using a soluble TCR as a CAR-EC switch may be highly advantageous.

[0155] The use of soluble mTCRs as switches for sCAR-T will allow dose titratable sCAR-T cell targeting of intracellular tumor associated antigens that may be turned off in the case of an adverse event.

[0156] The heterologous expression of mTCRs and their use as soluble therapeutics is well established. Because natural TCRs have weak affinity (1-100 uM) for their targets (naturally tuned for cooperative binding of CD8), directed evolution strategies have used phage display to produce mTCRs with affinities strong as 1 pM. Soluble TCRs have additional advantages over mAbs including the ability to target intracellular proteins, small size and improved tumor penetration, detection of very low cell surface antigen densities, are fully human, and are inexpensively expressed in *E. coli*.

[0157] The soluble TCR switch may comprise a fusion of the CAR-BP to the soluble TCR. The soluble TCR switch may comprise the CAR-BP, wherein the CAR-BP is grafted within the soluble TCR. Soluble TCR switches may comprise a fusion of the CAR-BP to the N-terminus of the TCR alpha chain, the N-terminus of the TCR beta-chain, the C-terminus of the TCR alpha chain or the C-terminus of the TCR beta chain. Alternatively, additional structure based design may be employed to fuse the CAR-BP to additional chains/regions of the TCR that are permissive to mutation. The CAR-BP may be grafted within a chain/region of the soluble TCR. The soluble TCR switch may recognize and bind to a target cell antigen bound to MHC.

[0158] The potential to target intracellular antigens opens the door to sCAR-T cells that can remodel the tumor microenvironment. For example, naturally occurring CD8 T cells have been recently identified that recognize FoxP3 or indoleamine-pyrrole 2,3-dioxygenase (IDO) expressing regulatory T cells (Treg) and myeloid-derived suppressor cells (MDSC), respectively. The cloning and heterologous expression of mTCRs from these cells as switches may enable a sCAR-T cell to

deplete immunosuppressive cells within the tumor microenvironment. This may be a novel route to overcoming disease-mediated immunosuppression.

II. Chimeric Antigen Receptor (CAR)

[0159] Disclosed herein are CAR-EC switches that regulate the activities of a cell expressing a chimeric antigen receptor (CAR). The chimeric antigen receptor may comprise an extracellular domain, transmembrane domain and intracellular domain. The extracellular domain may bind to the peptidic antigen (*e.g.*, CAR-BP) of the CAR-EC switch. The extracellular domain may comprise an antibody or antibody fragment that binds to the CAR-BP of the CAR-EC switch (a CAR-antibody). The CAR-antibody may comprise at least a portion of an antibody. In some instances, the CAR-antibody is not a full-length antibody. The CAR-antibody may comprise at least a portion of an immunoglobulin or fragment thereof. The immunoglobulin or fragment thereof may be selected from the group consisting of an scFv, a di-scFv, a bi-scFv, a Fab, an Fc, an $F(ab')_2$, a pFc', a nanobody, an affibody, a DARPin, a diabody, a camelid, an engineered T cell receptor and a monobody. The immunoglobulin may be selected from the group consisting of an IgA1, an IgA2, an IgD, an IgM, an IgE, an IgG1, an IgG2, an IgG3, and an IgG4. The CAR-antibody may comprise at least a portion of a single chain variable fragment (scFv). The CAR-antibody may be human, fully human, humanized, human engineered, non-human, and/or chimeric antibody. The extracellular domain may comprise a humanized anti-GCN4 scFv (*e.g.*, clone 52SR4). The humanized anti-GCN4 scFV may be encoded by a sequence selected from SEQ ID NOS: 165-170.

[0160] The CAR-antibody may have a binding affinity for the CAR-BP of less than about 0.01 pM, about 0.02 pM, about 0.03 pM, about 0.04 pM, 0.05 pM, about 0.06 pM, about 0.07 pM, about 0.08 pM, about 0.09 pM, about 0.1 pM, about 0.2 pM, 0.3 pM, about 0.4 pM, about 0.5 pM, about 0.6 pM, about 0.7 pM, about 0.8 pM, about 0.9 pM or about 1 pM, about 2 pM, about 3 pM, about 4 pM, about 5 pM, about 6 pM, about 7 pM, about 8 pM, about 9 pM, about 10 pM, about 0.01 nM, about 0.02 nM, about 0.03 nM, about 0.04 nM, about 0.05 nM, about 0.06 nM, about 0.07 nM, about 0.08 nM, about 0.09 nM, about 0.1 nM, about 0.2 nM, about 0.3 nM, about 0.4 nM, about 0.5 nM, about 0.6 nM, about 0.7 nM, about 0.8 nM, about 0.9 nM, about 1 nM, about 2 nM, about 2.5 nM, about 3 nM, about 4 nM, about 5 nM, about 6 nM, about 7 nM, about 8 nM, about 9 nM, about 10 nM, about 12nM, about 14 nM, about 16 nM, about 18 nM, about 20 nM, about 22 nM, about 24 nM, about 26 nM, about 28 nM or about 30 nM.

[0161] The CAR-antibody may recognize a synthetic (non-naturally-occurring) peptide. The CAR-antibody may comprise an antibody or antibody fragment that recognizes a FLAG® tag or a fragment thereof. The CAR-antibody may comprise an antibody or antibody fragment that recognizes a yeast transcription factor GCN4 or a fragment thereof. The CAR-antibody may comprise an anti-HTP antibody or a fragment thereof.

[0162] The transmembrane domain and/or the intracellular domain of the CAR may comprise at least a portion of a cytoplasmic signaling domain. The intracellular domain may comprise at least a portion of a signaling molecule selected from the group comprising CD3zeta, CD28, and 4-1BB. The intracellular domain may comprise an Fc receptor or a portion thereof. The Fc receptor or portion thereof may be CD16 or a portion thereof. The signaling molecule may comprise CD3zeta. The signaling molecule may comprise CD28. The signaling molecule may comprise 4-1BB. The intracellular domain may comprise at least a portion of CD3zeta. The intracellular domain may comprise at least a portion of CD28, The intracellular domain may comprise at least a portion of 4-1BB, The intracellular domain may comprise at least a portion of OX-40, The intracellular domain may comprise at least a portion of CD30, The intracellular domain may comprise at least a portion of CD40, The intracellular domain may comprise at least a portion of CD2. The intracellular domain may comprise at least a portion of CD27. The intracellular domain may comprise at least a portion of PD-1. The intracellular domain may comprise at least a portion of ICOS. The intracellular domain may comprise at least a portion of lymphocyte function-associated antigen-1 (LFA-1). The intracellular domain may comprise at least a portion of CD7. The intracellular domain may comprise at least a portion of LIGHT. The intracellular domain may comprise at least a portion of NKG2C. The intracellular domain may comprise at least a portion of B7-H3. The intracellular domain may comprise at least a portion of a cytoplasmic signaling domain from one or more signaling molecules. The intracellular domain may comprise at least a portion of two or more cytoplasmic signaling domains. The two or more cytoplasmic signaling domains may be from two or more different signaling molecules. The intracellular domain may comprise at least a portion of three or more cytoplasmic signaling domains. The intracellular domain may comprise at least a portion of four or more cytoplasmic signaling domains. The intracellular domain may comprise at least a portion of a ligand that binds to one or more signaling molecules. The intracellular domain may comprise at least a portion of a ligand that binds to CD83.

[0163] The CAR may comprise a hinge. The hinge may be located between the transmembrane domain and the extracellular domain. The hinge may comprise a portion of the transmembrane domain. The hinge may comprise a portion of the extracellular domain. The hinge may provide a length, orientation, geometry or flexibility to the CAR that is necessary for an optimal immunological synapse. The optimal immunological synapse may provide for an optimal distance and/or orientation between the CAR-EC and the target cell. The optimal immunological synapse may provide for optimal and/or maximal cytotoxicity against the target cell. The hinge may be derived from the extracellular domain of an endogenous transmembrane protein specific to T cell such as CD28 or 4-1BB, or components of CD3. The hinge may be derived from a synthetically derived sequence (such as the ones listed for linkers relevant to switch design). The hinge may be

derived from a human protein. The hinge may be contiguous with the transmembrane domain. This hinge may comprise part of the heavy chain constant region 1 of the scFv). This hinge may comprise part of the light chain constant region 1 of the scFv).

[0164] The hinge length may be between about 1 amino acid and about 10 amino acids. The hinge length may be between 1 amino acid and about 20 amino acids. The hinge length may be between about 1 amino acid and about 50 amino acids. The hinge length may be between about 1 amino acid and about 100 amino acids. The hinge length may be between 10 amino acids and about 50 amino acids. The hinge lenght may be about 12 amino acids. The hinge may length may be about 45 amino acids.

[0165] The hinge may be a long hinge. The long hinge may have a length of about 20 to about 200 amino acids, about 20 to about 100 amino acids, about 30 to about 100 amino acids, about 40 to about 100 amino acids, or about 45 to about 100 amino acids.

[0166] The hinge may be a short hinge. The short hinge may have a length of about 1 to about 20 amino acids, about 5 to about 20 amino acids, or about 10 to about 20 amino acids.

[0167] The hinge may comprise a portion of a CD8 protein. The portion of the CD8 protein may be between about 4 amino acids and about 100 amino acids. The portion of the CD8 protein may be about 45 amino acids. The hinge may comprise a portion of an immunoglobulin. The immunoglobulin may be an IgG. The immunoglobulin may be an IgG4. The IgG4 may be mutated (referred to herein as IgG4m). The portion of the immunoglobulin may be between about 1 amino acid and about 20 amino acids. The portion of the immunoglobulin may be about 12 amino acids.

[0168] The hinge may be flexible. The hinge may be structured.

[0169] As used herein in reference to a peptide sequence (e.g. a hinge or linker disclosed herein), the term "flexible" means a peptide sequence that comprises a linear sequence of amino acids with little or no known secondary structure. Such flexible sequences may comprise linear sequences of amino acids in which the torsion angles or rotation around the bonds of the polypeptide backbone have freedom to occupy many different orientations. In some embodiments, reference to a "flexible hinge" means that a hinge comprises a flexible peptide sequence that allows a CAR to bind CAR-BPs via various binging orientations, thus, alleviating steric hindrance that would otherwise have been detrimental to the CAR-BP binding the CAR extracellular domain.

[0170] As used herein in reference to a peptide sequence (e.g. a hinge or linker disclosed herein), the term "structured" means a peptide sequence that comprises a linear sequence of amino acids that forms a defined secondary structure. Such structured sequences may comprise a linear sequence of amino acids in which the torsion angles or rotation around the bonds of the polypeptide backbone have defined preferences to occupy a limited number of orientations. In some embodiments, a structured hinge may comprise a peptide sequence that defines the immunological

synapse and reduces entropic costs of finding more productice orientation. Said another way, a structured hinge is, in some embodiments, a hinge that is not flexible. In various embodiments, the terms "rigid" and "structured," are are used interchangeably in reference to a peptide sequence (e.g., a hinge or linker disclosed herein).

[0171] The hinge may comprise a sequence selected from SEQ ID NOS: 40-50. The hinge may comprise a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 40-50. The hinge may comprise a sequence selected from SEQ ID NOS: 68-71. The hinge may comprise a sequence that is at least about 50% homologous to a sequence selected from 68-71. The CAR having a hinge region may be encoded by a sequence selected from SEQ ID NOS: 72-74. The CAR having a hinge region may be encoded by a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 72-74.

[0172] The CAR may be expressed at relatively low levels on the CAR-EC. The CAR may be expressed at relatively high levels on the CAR-EC. The CAR may be expressed at a cell density of less than about $2x10^6$ receptors per cell. The CAR may be expressed at a cell density of about $0.5x10^6$ receptors per cell. The CAR may be expressed at a cell density of more than about $0.05x10^6$ per cell The CAR may be expressed under the control of a promoter selected from EF1a, IL-2, CMV, and synthetic promoters designed to increase or decrease CAR expression. The promoter may be constitutive. The promoter may be inducible.

Multivalent CARS

[0173] Valency can also be engineered into a CAR hinge (**FIG. 4C**). By way of non-limiting example, a monovalent switches may recruit two CARs through a disulfide that forms in the hinge region of the CAR. The hinge may be a CD8-derived hinge (**SEQ ID NO. 68**) which is expected to be monovalent. The hinge may be derived from the hinge region of an IgG molecule. The IgG molecule may be selected from IgG1, IgG4 or IgG4m (mutated). The IgG4 hinge (**SEQ ID NO. 70**) may not participate in interchain disulfides but instead has intrachain disulfide bonds which do not dimerize the CAR. The hinge may be considered functionally monovalent. The IgG1 and IgG4m hinge (**SEQ ID NO. 71**) may contain a serine to proline mutation which enables it to participate in interchain disulfide bonds which covalently dimerizes the hinge region (**FIG. 4**). These hinges may be used to study both the distance constraints of an immunological synapse (by testing the long CD8-derived hinge vs the short IgG4 derived hinge) and the valency effect (by testing the short IgG4 derived hinge vs an IgG4m derived CAR) of the CAR and/or switch. Other hinges may comprise CH2 and/or CH3 of IgG1, IgG2, IgG3, or IgG4 molecules, or portions thereof, or combinations thereof. The hinge may be derived from CD28. The hinge may dimerize.

coCARS/iCARs

[0174] The switchable CARs and switches disclosed herein may encompass inhibitory chimeric antigen receptor (iCAR)-T cell switches and switchable iCAR-T cells for targeting an immune response to specific cells (*e.g.*, diseased cells) and minimizing an immune attack on healthy cells. The switchable CARs and switches disclosed herein may also encompass co-stimulatory chimeric antigen receptor (coCAR)-T cell switches for use with switchable coCAR-T cells for targeting an immune response to target cells (*e.g.*, diseased cells) and maximizing an immune attack on these cells. iCAR-T cell switches and coCAR-T cell switches comprise a CAR-binding domain and a target binding domain. Compositions disclosed herein may comprise a plurality of switches for modulating a chimeric antigen receptor-effector cell (CAR-EC), wherein a first switch that interacts with a first antigen on a first target cell and a first chimeric antigen receptor (CAR) on the CAR-EC; and a second switch that interacts with a second antigen on a second target cell and a second chimeric antigen receptor (CAR) on the CAR-EC. The plurality of switches may be used with existing CAR-T cells and with CAR-ECs that express a canonical CAR and/or an inhibitory CAR (iCAR). The plurality of switches may be used with existing CAR-T cells and with CAR-ECs that express a canonical CAR and/or a co-stimulatory CAR (coCAR).

[0175] The switchable CAR-EC cells disclosed herein may comprise a first switchable CAR and a second switchable CAR. The first switchable CAR may be a canonical CAR and the second switchable CAR may be an iCAR. The first switchable CAR may be a canonical CAR and the second switchable CAR may be a co-CAR.

[0176] The iCAR may comprise a chimeric receptor which provides an inhibitory signal to CAR-T cells. The iCAR may comprise a cytoplasmic domain selected from PD-1 or CTLA-4. The iCAR may be expressed by the same cell as a canonical (activating) CAR. Activation of the iCAR may tune down a canonical CAR signal and/or activity. The specificity of the iCAR can be used to protect tissues in which CAR-T cell activity is not desirable. iCAR activity may be controlled by a switch, referred to as an "iCAR switch" herein. Similarly, canonical CAR activity may be controlled by the first and/or second switch, referred to as an "aCAR switch" herein. A switchable iCAR-T cell enables targeting of antigens that may be unsafe to target with a canonical or CAR-T cell.

[0177] To mount an immune response, the aCAR switch binds a positive, or "A" antigen on a target cell that is to be attacked (e.g. cancer cell) and the canonical CAR, stimulating cytotoxic activity towards the target cell through activation of the canonical CAR. To protect normal tissue, the iCAR switch binds a negative, or "B", antigen on a cell that is to be avoided by T cells (*e.g.*, a healthy cell) and the iCAR, inhibiting immune activity through signaling of the iCAR. The "B" antigen may be ubiquitously expressed on normal tissue but down-regulated in most malignant

cells. The "A" antigen may be over-expressed in malignant cells relative to normal tissue. The B antigen may be opioid binding protein/cell adhesion molecule-like gene (OPCML). The B antigen may be selected from hyaluronidase 2 (HYAL2), deleted in colorectal cancer (DCC), and SMAR1.

[0178] The coCAR may comprise a chimeric receptor which provides a co-stimulatory signal to CAR-T cells. The coCAR may comprise a cytoplasmic domain selected from CD137 and/or CD28. The coCAR may be expressed by the same cell as a canonical (activating) CAR. Activation of the coCAR may enhance and/or synergize a canonical CAR signal and/or activity. The coCAR may increase cytotoxicity towards a target cell relative to the cytotoxicity towards a target cell generated by a CAR-T cell that only expresses a canonical CAR-T cell. coCAR activity may be controlled by a switch, referred to as an "coCAR switch" herein. Similarly, canonical CAR activity may be controlled by the first and/or second switch, referred to as an "aCAR switch" herein.

Non-Antibody CARs

[0179] In contrast to conventional CARS, the chimeric antigen receptors disclosed herein may comprise a non-antibody extracellular domain that interacts with the CAR-BP. That is, the extracellular domain may comprise a non-antibody protein or a non-antibody peptide that interacts with the CAR-BP. Thus, the chimeric antigen receptor may not actually recognize an antigen on a target in the traditional sense of an antibody or antibody fragment recognizing an antigen, but interact with the target in ways that a non-antibody protein or peptide would. In these cases, the chimeric antigen receptor may be referred to more accurately as a "chimeric receptor." A person of skill in the art would understand that in many examples and descriptions throughout this disclosure, the chimeric antigen receptor may be a chimeric receptor. The chimeric receptor binding partner of the switch may be non-antibody protein or peptide. Thus, the chimeric receptor and the switch may have a protein-protein interaction or a protein-peptide interaction.

Epsilon CAR

[0180] Further disclosed herein are chimeric antigen receptors comprising: an extracellular domain that interacts with an anti-CD3 antibody or fragment thereof on the switch; a transmembrane domain; and an intracellular domain, wherein at least a portion of the transmembrane domain or at least a portion of the intracellular domain is not based on or derived from a CD3 protein. The extracellular domain may comprise a CD3 extracellular domain or portion thereof. The extracellular domain may comprise a CD3 epsilon extracellular domain or portion thereof. The extracellular domain may comprise a CD3 delta extracellular domain or portion thereof. The extracellular domain may comprise a CD3 gamma extracellular domain or portion thereof. The extracellular domain may comprise a CD3 zeta extracellular domain or portion thereof. The extracellular domain may comprise an alpha chain of TCR extracellular domain or portion thereof. The extracellular domain may comprise a pre-alpha chain of TCR extracellular domain or portion

thereof. The extracellular domain may comprise a beta chain of TCR extracellular domain or portion thereof.

III. Chimeric Antigen Receptor Effector Cells (CAR-EC)

[0181] The methods, platforms and kits disclosed herein may comprise one or more chimeric antigen receptor effector cells (CAR-EC) or uses thereof. The chimeric antigen receptor effector cells disclosed herein express a chimeric antigen receptor. The chimeric antigen receptor (CAR) may be any CAR disclosed herein. Wherein the methods, platforms or kits comprise two or more effector cells, the two or more effector cells may be of the same cell type. The two or more effector cells may be of a different cell type. The two or more effector cells may be of the same cell lineage. The two or more effector cells may be of different cell lineages. The two or more effector cells may comprise two or more identical CARs. The two or more effector cells may comprise two or more different CARs. The two or more effector cells may comprise two or more similar CARs.

[0182] The effector cell may be a T cell. The effector cell may be a cell of a T cell lineage. The effector cell may be a mature T cell. The effector cell may be a precursor T cell. The effector cell may be a cytotoxic T cell. The effector cell may be a naive T cell. The effector cell may be a memory stem cell T cell (T_{MSC}). The effector cell may be a central memory T cell (T_{CM}). The effector cell may be an effector T cell (TE). The effector cell may be a CD4+ T cell. The T cell may be a CD8+ T cell. The effector cell may be a CD4+ and CD8+ cell. The effector cell may be an alpha-beta T cell. The effector cell may be a gamma-beta T cell. The effector cell may be a natural killer T cell. The effector cell may be a helper T cell.

[0183] While preferred embodiments of the present disclosure describe methods, kits and platforms comprising T cells, one skilled in the art may also understand that other cell types may be used in place of a T cell. The effector cell may be an effector cell that has an effect on a target or target cell when brought into proximity of the target or target cell. The effector cell may be a cell that has a cytotoxic effect on a target or target cell when brought into proximity of the target or target cell. The effector cell may be an immune cell. The effector cell may be selected from a B cell, a monocyte, a thrombocyte, a leukocyte, a neutrophil, an eosinophil, a basophil, or a lymphocyte. The effector cell may be a lymphocyte. The effector cell may be a macrophage. The effector cell may be a phagocytic cell. The effector cell may be an effector B cell. The effector cell may be a natural killer cell. The effector cell may isolated or derived from a subject suffering from a disease or condition. The effector cell may be a cell derived from a subject to be treated with a CAR-EC switch or CAR-EC platform disclosed herein.

[0184] The T cell may express a chimeric antigen receptor encoded by one or more polynucleotides based on or derived from SEQ ID NO: 1. The polynucleotide may be at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90% or 95%

identical to one or more polynucleotides based on or derived from SEQ ID NO: 1. The polynucleotide may be at least about 70% identical to one or more polynucleotides based on or derived from SEQ ID NO: 1. The polypeptide encoded by one or more polynucleotides may be based on or derived from SEQ ID NO: 1. The polypeptide may be encoded by a polynucleotide that is at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90% or 95% identical to one or more polynucleotides based on or derived from SEQ ID NO: 1. The polynucleotide may be constitutively expressed. The polynucleotide may be conditionally expressed.

[0185] Disclosed herein are methods of producing a chimeric antigen receptor effector cell (CAR-EC), the methods comprising introducing one or more polynucleotides encoding a chimeric antigen receptor or a chimeric antigen receptor complex into an effector cell. The effector cell may be a T cell. Introducing one or more polynucleotides encoding a chimeric antigen receptor or a chimeric antigen receptor complex into an effector cell may comprise transfecting the effector cell with the one or more polynucleotides. Introducing one or more polynucleotides encoding a chimeric antigen receptor or a chimeric antigen receptor complex into an effector cell may comprise virally infecting the effector cell with one or more viruses comprising the one or more polynucleotides encoding a chimeric antigen receptor disclosed herein. The virus may be a lentivirus. The virus may be an adenovirus. The virus may be a retrovirus. The virus may be an adeno-associated virus. The virus may be a self-complementary adeno-associated virus (scAAV). The virus may be a modified human immunodeficiency (HIV) virus. The virus may be a modified herpes simplex virus (HSV) virus. Other methods of producing the CAR-EC may comprise a method of transferring one or more polynucleotides encoding a chimeric antigen receptor into a cell, wherein the methods comprise adding a transposon, a zinc finger nuclease, a TALEN or a CRISPR to the cell. The transposon may be a sleeping beauty transposon. The one or more polynucleotides may be based on or derived from SEQ ID NO: 1.

Tumor infiltrating lymphocytes (TILs)

[0186] The effector cell may be a tumor-infiltrating lymphocyte (TIL). TILs are a type of white blood cell found in tumors. TILs are implicated in killing tumor cells, and the presence of lymphocytes in tumors is often associated with better clinical outcomes. To obtain TILs, autologous lymphocytes may be isolated from patients' tumors and grown to very large numbers of cells *in vitro*. Prior to TIL treatment, the subject may be given nonmyeloablative chemotherapy to deplete native lymphocytes ("lymphodepletion") that can suppress tumor killing. Once lymphodepletion is complete, the subject may be infused with the TILs. TILs may be administered in combination with interleukin 2 (IL-2).

[0187] The present application provides for TILs that are modified to express a CAR and applications thereof (*e.g.,* CAR-TIL therapy). Disclosed herein are T cells (*e.g.,* TILs) modified to express a chimeric antigen receptor. Further disclosed herein are methods for treating a condition in a subject in need thereof, comprising administering a TIL, wherein the TIL expresses a CAR. The CAR may be a co-receptor of a T cell receptor (TCR) expressed by the TIL. The CAR may associate with a TCR of the TIL. The CAR may enhance TCR activation. The CAR may have intracellular signaling domains that are activated upon association and/or interaction with a TCR, wherein the TCR is bound to an antigen on a target cell. These methods may be referred to as chimeric antigen receptor tumor infiltrating lymphocyte therapy (CAR-TIL therapy). An advantage of this application is to utilize the specificity of endogenous T cell receptors (TCRs) of the engineered T cells (*e.g.,* antigen specific MHC), circumventing the need to introduce artificial tumor targeting moieties (*e.g.,* antibody-based switches) used in conventional CAR-T approaches, for the recognition of the target tumor cells. The endogenous TCRs expressed on tumor specific T cells are heterogeneous, but may be pre-selected for specifically targeting tumor-associated peptide antigens bound to major histocompatibility complexes (MHCs) on tumor cells. Moreover, the diverse repertoire of the endogenous, tumor specific TCRs are suitable to target heterogeneous tumors.

IV. CAR-EC platform

[0188] Disclosed herein are chimeric antigen receptor effector cell (CAR-EC) platforms comprising (i) an effector cell, wherein the effector cell comprises a polynucleotide encoding a chimeric antigen receptor (CAR); and (ii) a chimeric antigen receptor effector cell (CAR-EC) switch, wherein the CAR-EC switch comprises a CAR binding peptidic antigen and a targeting polypeptide and wherein the CAR-EC switch binds a cell surface molecule on a target cell. The CAR-EC switch may be selected from any CAR-EC switches disclosed herein. As used herein, the terms "switchable CAR platform", "CAR-EC platform", "sCAR-T platform", "sCAR-T cell platform", "switchable chimeric antigen receptor platform", "chimeric antigen receptor-effector cell platform", "CAR-T switch platform", "sCAR platform", "switch platform", and "switchable platform" are used interchangeably.

[0189] The CAR-EC platforms may comprise two or more CAR-EC switches. The CAR-EC platforms may comprise 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 or more CAR-EC switches. The CAR-EC platforms may comprise may comprise more than 20, more than 25, more than 30, more than 35, more than 40, more than 45 or more than 50 CAR-EC switches. The two or more switches may be selected from one or more CAR-EC switches disclosed herein or a combination thereof.

[0190] The CAR-EC platforms disclosed herein may further comprise a first CAR-EC switch and a second CAR-EC switch, wherein the first CAR-EC switch comprises a first CAR-BP and a first targeting polypeptide and the second CAR-EC switch comprises a second CAR-BP and a second targeting polypeptide. The first CAR-BP and the second CAR-BP may be the same. The first CAR-BP and the second CAR-BP may be different. The first CAR-BP and the second CAR-BP may be about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous. The first targeting polypeptide and the second targeting polypeptide may be the same. The first targeting polypeptide and the second targeting polypeptide may be different. The first targeting polypeptide and the second targeting polypeptide may be about 99%, about 98%, about 97%, about 96%, about 95%, about 92%, about 90%, about 85%, about 80%, about 75%, about 70%, about 65%, about 60%, about 55%, about 50%, about 45%, about 40%, about 35%, about 30%, about 25%, about 20%, about 15%, about 10%, about 5% or about 2% homologous.

[0191] V. Kits, Vectors and Polynucleotides

[0192] Disclosed herein are kits comprising one or more CAR-EC switches disclosed herein. The kit may further comprise two or more CAR-EC switches. The kit may comprise three CAR-EC switches. The kit may comprise about 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 24, 30, 35, 48, 50, 55, 60, 65, 70, 75, 80, 85, 90, 96, 100, 120, 150, 200, 300, 384, 400, 500, 600, 700, 800, 900 or 1000 CAR-EC switches. The kit may be employed for biological research. The kit may be used for diagnosing a disease or a condition. The kit may be used for treating a disease or condition. The CAR-EC switches of the kit may be used with CAR-EC cells disclosed herein or existing CAR T-cells clinically used or tested. The kit may further comprise one or more effector cells. The kit may further comprise one or more CAR-EC cells. The CAR-EC cell may be a T cell. The T cell may express one or more CARs. The kit may further comprise a polynucleotide encoding one or more CARs. The kit may further comprise a vector comprising a polynucleotide encoding one or more CARs. The CAR may be selected from any of the CARs disclosed herein.. The kit may comprise one or more polynucleotide encoding a CAR-EC switch disclosed herein or a portion thereof (*e.g.*, antibody, antibody fragment, peptide).

[0193] Further disclosed herein are and vectors and polynucleotides encoding CAR-EC switches or portions thereof, wherein the CAR-EC switch comprises a chimeric antigen receptor binding peptidic antigen and a targeting polypeptide, wherein the targeting peptide binds a cell surface molecule on a target cell. The polynucleotides may be DNA. The polynucleotides may be RNA. Unless otherwise specified, the terms "polynucleotide" and "vector," as used herein, are used interchangeably. The targeting polypeptide may be an antibody or antibody fragment. The vector

may comprise a sequence encoding a heavy chain of the antibody or antibody fragment. The vectors may comprise a sequence encoding a light chain of the antibody or antibody fragment. The vectors may comprise the sequence encoding the light chain of the antibody or antibody fragment and the sequence encoding the heavy chain of the antibody or antibody fragment. The light chain and the heavy chain may be expressed from the same vector. The light chain and the heavy chain may be expressed from two separate vectors.

[0194] Disclosed herein are vectors and polynucleotides encoding chimeric antigen receptors, wherein the chimeric antigen receptors comprise an extracellular domain that binds to a peptide of a chimeric antigen receptor effector cell switch. The extracellular domain may comprise an antibody or antibody fragment. The antibody or antibody fragment may bind a peptidic antigen of a chimeric antigen receptor effector cell switch . The peptidic antigen may be a yeast peptide. The yeast peptide may be GCN4. f a or portions thereof may be encoded by one or more polynucleotides based on or derived from SEQ ID NO: 1. CARs or portions thereof may be encoded by a polynucleotide at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90% or 95% identical to one or more polynucleotides based on or derived from SEQ ID NO: 1. CARs or portions thereof encoded by a polynucleotide may be at least about 70% identical to one or more polynucleotides based on or derived from SEQ ID NO: 1. Disclosed herein are vectors comprising one or more polynucleotides based on or derived from SEQ ID NO: 1.

[0195] Vectors comprising sequences encoding chimeric antigen receptors and/or chimeric antigen receptor effector cell switches and portions thereof, disclosed herein, may be selected from any commercially available expression vector. The expression vector may be a prokaryotic expression vector. The expression vector may be a eukaryotic expression vector. The expression vector may be a mammalian expression vector. The expression vector may be a viral expression vector. The expression vector may have a constitutive promoter for constitutive expression of the CAR and/or CAR-EC switch encoding sequences. The expression vector may have an inducible promoter for conditional expression of the CAR and/or CAR-EC switch encoding sequences.

VI. Therapeutic Use

[0196] Disclosed herein are methods, platforms and kits for treating a disease or condition in a subject in need thereof, the method comprising administering a chimeric antigen receptor effector cell (CAR-EC) switch to the subject, wherein the CAR-EC switch comprises: a CAR-binding peptidic antigen; and a targeting moiety. Disclosed herein are methods of treating a disease or condition in a subject in need thereof, the method comprising administering any one of the CAR-EC switches disclosed herein. The disease or condition may be cancer.

[0197] The methods may comprise administering a CAR-EC cell and one or more CAR-EC switches. The methods may comprise administering about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 24, 30, 35, 48, 50, 55, 60, 65, 70, 75, 80, 85, 90, 96, 100, 120, 150, 200, 300, 384, 400, 500, 600, 700, 800, 900, 1000 or more CAR-EC switches. The methods may comprise administering two or more CAR-EC switches. The two or more CAR-EC switches may comprise the same CAR-binding peptidic antigen. The two more CAR-EC switches may comprise the same cell targeting polypeptide. The two or more CAR-EC switches may comprise one or more different CAR-binding peptidic antigens. The two more CAR-EC switches may comprise one or more different cell targeting polypeptides. The methods may comprising a plurality of CAR-EC cells and one or more CAR-EC switches. Administering the CAR-EC cell may comprise intravenous CAR-EC delivery. Administering the CAR-EC cell may comprise intraperitoneal CAR-EC delivery. Administering the CAR-EC cell may comprise intravenous CAR-EC delivery and intraperitoneal CAR-EC delivery. Administering the CAR-EC cell may occur once. Administering the CAR-EC cell may occur more than once (*e.g.,* repeat injection). The CAR-ECs may be sorted to enrich a memory population of CAR-ECs before administering the CAR-ECs. The CAR-ECs may be subjected to iterative stimulation to enrich the memory population, as opposed to recursive stimulation which promotes exhaustion, provide for a long-lived, persistent phenotype. This rationale is based on natural acute infections with enrich long-lived memory cells through a 1-2 week long contraction phase that occurs after the challenge has been cleared. Similarly, the sCAR-T cell system in which adoptively transferred cells are rested following stimulation may more closely recapitulate a physiological duration of T cell activation.

[0198] Disclosed herein are methods of treating a disease or condition in a subject in need thereof, the method comprising administering a chimeric antigen receptor effector cell (CAR-EC) switch to the subject, wherein the CAR-EC switch comprises: a chimeric antigen receptor binding peptidic antigen (CAR-BP); and a targeting moiety that binds an antigen on a target. The CAR-BP, by non-limiting example, may be selected from a FLAG® tag, a yeast transcription factor GCN4 and a hydrophilic target peptide (HTP). The targeting moiety, by non-limiting example may be selected from an anti-CD19 antibody, an anti-CD20 antibody, an anti-CD22 antibody, an anti-EGFR antibody, an anti-EGFRvIII antibody, an anti-Her2 antibody, an anti-CS1 antibody, an anti-BCMA antibody, an anti-CEA antibody, an anti-CLL1 antibody and an anti-CD33 antibody.

[0199] The methods may comprise administering one or more chimeric antigen receptor effector cells to a subject in need thereof and then administering one or CAR-EC switches to a subject in need thereof. The amount or dose of CAR-EC switch may affect the magnitude of the chimeric antigen receptor effector cells toward the target cells, therefore the amount or dose of the CAR-EC switch may be titrated for a desired effect. For example, tumors may be targeted by titration of

CAR-EC switch to achieve suitable therapeutic index. The response may be titrated "on" to avoid CRS (cytokine release syndrome) and TLS (tumor lysis syndrome) events, providing for personalized therapy. Furthermore, administration of a switch can be terminated in case of an adverse event, control of CAR-EC cell activity, titration of off-target reactivity, abrogation of tumor lysis syndrome (TLS), or attenuation of cytokine release syndrome (CRS). The amount or dose may start at one level for a specified time period and then the amount or dose may be increased or decreased to a second level for a second specified time period. For example, the initial amount or dose of the CAR-EC switch may be the lowest dose necessary to eliminate the tumor. The amount or dose of the CAR-EC switch may then be increased to a larger dose in order to eliminate any remaining tumor cells. The methods may comprise terminating the administration of the CAR-EC switch once the tumor cells are eliminated. The methods may comprise re-administering the CAR-EC switch if the tumor cells re-occur in the patient or if the patient relapses.

[0200] The methods may comprise titrating the CAR-EC switch for a desired effect. Titrating the CAR-EC switch may enable antigen density discrimination. For example, the fatal on-target, off-tumor reactivity for Her2 targeted CAR-T cells to low levels of Her2 expression in the lung has tempered the application of CAR-T cells to solid tumors in the clinic. The use of a Fab-based switch that is expected to have a half-life of approximately 10h in human allows a more rapid decrease in activity than long-live IgG-based molecules. The methods described herein may comprise titrating a switch to an optimal level wherein the switch activity may be affected by the density of Her2, thereby discriminating or distinguishing Her2 (and switch activity) on cancer cells from Her2 on healthy tissue. In the clinic this may be used to titrate therapy to an appropriate therapeutic index. Additionally, it may be possible in patients to decouple infusion of sCAR-T cells from activation by administering the switch only after adoptively transferred sCAR-T cells have cleared a tissue (*e.g.*, the lungs in the case of Her2), thus mitigating potential toxicities to the tissue. For example, studies have shown that transferred cytotoxic T cells immediately accumulate in the lung, but the accumulation clears over 72 hours. One advantage of sCAR-T cells is that they can be transferred and the switch dose can be delayed until the sCAR-T cells have cleared the lung, during which time, the sCAR-T cells are inert. Once cleared, switch may be administered to activate the sCAR-T upon binding of the switch to the CAR and the target antigen. One skilled in the art would readily understand how this concept would apply to other antigens besides Her2 that are expressed on cells at varying denisities.

[0201] The methods may comprise administering one or more chimeric antigen receptor effector cells. The methods may comprise administering one or more T cells. The one or more effector cells may be selected from T cell is selected from a naive T cell, a memory stem cell T cell, a central

memory T cell, an effector memory T cell, a helper T cell, a CD4+ T cell, a CD8+ T cell, a CD8/CD4+ T cell, an αβ T cell, a γδ T cell, a cytotoxic T cell, a natural killer T cell, a natural killer cell, a macrophage.

[0202] The CAR-EC switch may have a therapeutic effect that is at least partially dependent on bringing an effector cell in proximity of a target cell. The therapeutic effect on the intended indication of the CAR-EC switch may be at least partially due to the CAR-EC switch recruiting an effector cell to the target cell. The therapeutic effect on the intended indication of the CAR-EC switch may be predominantly due to the CAR-EC switch recruiting an effector cell to the target cell. The therapeutic effect of the CAR-EC switch may be at least partially dependent on stimulating an immune response in the CAR-EC cell.

[0203] Administering the CAR-EC switch may not have any therapeutic effect without further administering an effector cell. The CAR-EC switch may not have a significant, desirable and/or intended therapeutic effect without further administering an effector cell. The CAR-EC switch may not have any therapeutic effect towards an intended indication of the CAR-EC platform without further administering an effector cell. A portion or component of the CAR-EC switch (*e.g.,* CAR-BP or targeting moiety) may not have a therapeutic effect towards the intended indication of the CAR-EC switch without being conjugated to a second portion or component of the CAR-EC switch (*e.g.,* CAR-BP or targeting moiety). The dose of a portion or component of the CAR-EC switch (*e.g.,* CAR-BP or targeting moiety) when administered as part of the CAR-EC platform to provide a therapeutic effect may not have a therapeutic effect when the portion or component of the CAR-EC switch is administered alone at that dose. The portion or component of the CAR-EC switch may not be intended to have any therapeutic effect besides recruiting the T cell to the target cell. Administering the portion or component of the CAR-EC switch alone may have a therapeutic effect on the target cell, wherein the therapeutic effect is negligible relative to the therapeutic effect of administering the CAR-EC switch and the CAR-EC cell. Administering the portion or component of the CAR-EC switch may have a therapeutic effect on the target cell, wherein the therapeutic effect is less than the therapeutic effect of administering the CAR-EC switch and the CAR-EC cell.

[0204] Disclosed herein are uses of CAR-EC switches disclosed herein to treat a disease or condition in a subject in need thereof. Further disclosed herein are uses of CAR-EC switches disclosed herein in the manufacture of a medicament for the treatment of a disease.

[0205] Disclosed herein is use of a switch comprising a peptidic antigen that binds a CAR (CAR-BP) on an effector cell; and a targeting polypeptide that binds an antigen on a target to treat a disease or condition in a subject in need thereof. Further disclosed herein is use of a switch comprising a peptidic antigen (CAR-BP) that binds a CAR on an effector cell, wherein the CAR-

BP; and a targeting polypeptide that binds an antigen on a target in the manufacture of a medicament for the treatment of a disease.

[0206] Disclosed herein is use of a CAR-EC switch comprising a CAR-BP, wherein the CAR-BP comprises a low immunogenicity peptide (*e.g.,* FLAG) or derivative thereof and a targeting polypeptide, wherein the targeting polypeptide comprises an anti-CD19 antibody or fragment thereof; and an effector cell comprising a CAR, wherein the CAR comprises an anti-low immunogenicity peptide antibody, wherein the anti-CD19 antibody or fragment thereof binds CD19 on a B cell to treat a multiple myeloma. Notably, no previously reported antibody-based control system has reported targeting of CD19 *in vivo*. As reported herein, sCAR-T cell platforms were able to eliminate Nalm-$6^{Luc/GFP}$ *in vivo* with comparable efficacy to conventional CART-19. Efficacy was reliant on optimal target cell engagement. More specifically, differences in the *in vitro* lytic activity of switch/hinge designs which were generally less than 10 fold in EC_{50} were decisive for *in vivo* tumor elimination.

[0207] Disclosed herein is use of a CAR-EC switch comprising a CAR-BP, wherein the CAR-BP comprises a yeast transcription factor GCN4 or derivative thereof and a targeting polypeptide, wherein the targeting polypeptide comprises an anti-CD19 antibody or fragment thereof; and an effector cell comprising a CAR, wherein the CAR comprises an anti-GCN4 antibody, wherein the anti-CD19 antibody or fragment thereof binds CD19 on a lymphoblast, lymphocyte or B cell, to treat an acute lymphoblastic leukemia, a chronic lymphocytic leukemia or a B-cell lymphoma.

[0208] The disease or condition may be a cell proliferative disorder. The cell proliferative disorder may be selected from a solid tumor, a lymphoma, a leukemia and a liposarcoma. The cell proliferative disorder may be acute, chronic, recurrent, refractory, accelerated, in remission, stage I, stage II, stage III, stage IV, juvenile or adult. The cell proliferative disorder may be selected from myelogenous leukemia, lymphoblastic leukemia, myeloid leukemia, an acute myeloid leukemia, myelomonocytic leukemia, neutrophilic leukemia, myelodysplastic syndrome, B-cell lymphoma, burkitt lymphoma, large cell lymphoma, mixed cell lymphoma, follicular lymphoma, mantle cell lymphoma, hodgkin lymphoma, recurrent small lymphocytic lymphoma, hairy cell leukemia, multiple myeloma, basophilic leukemia, eosinophilic leukemia, megakaryoblastic leukemia, monoblastic leukemia, monocytic leukemia, erythroleukemia, erythroid leukemia and hepatocellular carcinoma. The cell proliferative disorder may comprise a hematological malignancy. The hematological malignancy may comprise a B cell malignancy. The cell proliferative disorder may comprise a chronic lymphocytic leukemia. The cell proliferative disorder may comprise an acute lymphoblastic leukemia. The cell proliferative disorder may comprise a CD19-positive Burkitt's lymphoma.

[0209] The disease or condition may be a cancer, a pathogenic infection, autoimmune disease, inflammatory disease, or genetic disorder.

[0210] In some instances, the one or more diseases comprise a cancer. The cancer may comprise a recurrent and/or refractory cancer. Examples of cancers include, but are not limited to, sarcomas, carcinomas, lymphomas or leukemias.

[0211] The cancer may comprise a neuroendocrine cancer. The cancer may comprise a pancreatic cancer. The cancer may comprise an exocrine pancreatic cancer. The cancer may comprise a thyroid cancer. The thyroid cancer may comprise a medullary thyroid cancer. The cancer may comprise a prostate cancer.

[0212] The cancer may comprise an epithelial cancer. The cancer may comprise a breast cancer. The cancer may comprise an endometrial cancer. The cancer may comprise an ovarian cancer. The ovarian cancer may comprise a stromal ovarian cancer. The cancer may comprise a cervical cancer.

[0213] The cancer may comprise a skin cancer. The skin cancer may comprise a neo-angiogenic skin cancer. The skin cancer may comprise a melanoma.

[0214] The cancer may comprise a kidney cancer.

[0215] The cancer may comprise a lung cancer. The lung cancer may comprise a small cell lung cancer. The lung cancer may comprise a non-small cell lung cancer.

[0216] The cancer may comprise a colorectal cancer. The cancer may comprise a gastric cancer. The cancer may comprise a colon cancer.

[0217] The cancer may comprise a brain cancer. The brain cancer may comprise a brain tumor. The cancer may comprise a glioblastoma. The cancer may comprise an astrocytoma.

[0218] The cancer may comprise a blood cancer. The blood cancer may comprise a leukemia. The leukemia may comprise a myeloid leukemia. The cancer may comprise a lymphoma. The lymphoma may comprise a non-Hodgkin's lymphoma.

[0219] The cancer may comprise a sarcoma. The sarcoma may comprise an Ewing's sarcoma.

[0220] Sarcomas are cancers of the bone, cartilage, fat, muscle, blood vessels, or other connective or supportive tissue. Sarcomas include, but are not limited to, bone cancer, fibrosarcoma, chondrosarcoma, Ewing's sarcoma, malignant hemangioendothelioma, malignant schwannoma, bilateral vestibular schwannoma, osteosarcoma, soft tissue sarcomas (*e.g.*, alveolar soft part sarcoma, angiosarcoma, cystosarcoma phylloides, dermatofibrosarcoma, desmoid tumor, epithelioid sarcoma, extraskeletal osteosarcoma, fibrosarcoma, hemangiopericytoma, hemangiosarcoma, Kaposi's sarcoma, leiomyosarcoma, liposarcoma, lymphangiosarcoma, lymphosarcoma, malignant fibrous histiocytoma, neurofibrosarcoma, rhabdomyosarcoma, and synovial sarcoma).

[0221] Carcinomas are cancers that begin in the epithelial cells, which are cells that cover the surface of the body, produce hormones, and make up glands. By way of non-limiting example, carcinomas include breast cancer, pancreatic cancer, lung cancer, colon cancer, colorectal cancer, rectal cancer, kidney cancer, bladder cancer, stomach cancer, prostate cancer, liver cancer, ovarian cancer, brain cancer, vaginal cancer, vulvar cancer, uterine cancer, oral cancer, penile cancer, testicular cancer, esophageal cancer, skin cancer, cancer of the fallopian tubes, head and neck cancer, gastrointestinal stromal cancer, adenocarcinoma, cutaneous or intraocular melanoma, cancer of the anal region, cancer of the small intestine, cancer of the endocrine system, cancer of the thyroid gland, cancer of the parathyroid gland, cancer of the adrenal gland, cancer of the urethra, cancer of the renal pelvis, cancer of the ureter, cancer of the endometrium, cancer of the cervix, cancer of the pituitary gland, neoplasms of the central nervous system (CNS), primary CNS lymphoma, brain stem glioma, and spinal axis tumors. In some instances, the cancer is a skin cancer, such as a basal cell carcinoma, squamous, melanoma, nonmelanoma, or actinic (solar) keratosis.

[0222] In some instances, the cancer is a lung cancer. Lung cancer may start in the airways that branch off the trachea to supply the lungs (bronchi) or the small air sacs of the lung (the alveoli). Lung cancers include non-small cell lung carcinoma (NSCLC), small cell lung carcinoma, and mesotheliomia. Examples of NSCLC include squamous cell carcinoma, adenocarcinoma, and large cell carcinoma. The mesothelioma may be a cancerous tumor of the lining of the lung and chest cavity (pleura) or lining of the abdomen (peritoneum). The mesothelioma may be due to asbestos exposure. The cancer may be a brain cancer, such as a glioblastoma.

[0223] Alternatively, the cancer may be a central nervous system (CNS) tumor. CNS tumors may be classified as gliomas or nongliomas. The glioma may be malignant glioma, high grade glioma, diffuse intrinsic pontine glioma. Examples of gliomas include astrocytomas, oligodendrogliomas (or mixtures of oligodendroglioma and astocytoma elements), and ependymomas. Astrocytomas include, but are not limited to, low-grade astrocytomas, anaplastic astrocytomas, glioblastoma multiforme, pilocytic astrocytoma, pleomorphic xanthoastrocytoma, and subependymal giant cell astrocytoma. Oligodendrogliomas include low-grade oligodendrogliomas (or oligoastrocytomas) and anaplastic oligodendriogliomas. Nongliomas include meningiomas, pituitary adenomas, primary CNS lymphomas, and medulloblastomas. In some instances, the cancer is a meningioma.

[0224] The leukemia may be an acute lymphocytic leukemia, acute myelocytic leukemia, chronic lymphocytic leukemia, or chronic myelocytic leukemia. Additional types of leukemias include hairy cell leukemia, chronic myelomonocytic leukemia, and juvenile myelomonocytic leukemia.

[0225] Lymphomas are cancers of the lymphocytes and may develop from either B or T lymphocytes. The two major types of lymphoma are Hodgkin's lymphoma, previously known as

Hodgkin's disease, and non-Hodgkin's lymphoma. Hodgkin's lymphoma is marked by the presence of the Reed-Sternberg cell. Non-Hodgkin's lymphomas are all lymphomas which are not Hodgkin's lymphoma. Non-Hodgkin lymphomas may be indolent lymphomas and aggressive lymphomas. Non-Hodgkin's lymphomas include, but are not limited to, diffuse large B cell lymphoma, follicular lymphoma, mucosa-associated lymphatic tissue lymphoma (MALT), small cell lymphocytic lymphoma, mantle cell lymphoma, Burkitt's lymphoma, mediastinal large B cell lymphoma, Waldenström macroglobulinemia, nodal marginal zone B cell lymphoma (NMZL), splenic marginal zone lymphoma (SMZL), extranodal marginal zone B cell lymphoma, intravascular large B cell lymphoma, primary effusion lymphoma, and lymphomatoid granulomatosis.

[0226] The cancer may comprise a solid tumor. The cancer may comprise a sarcoma. The cancer may be selected from a group consisting of a bladder cancer, a breast cancer, a colon cancer, a rectal cancer, an endometrial cancer, a kidney cancer, a lung cancer, melanoma, a myeloma, a thyroid cancer, a pancreatic cancer, a glioma, a malignant glioma of the brain, a glioblastoma, an ovarian cancer, and a prostate cancer. The cancer may have non-uniform antigen expression. The cancer may have modulated antigen expression. The antigen may be a surface antigen. The cancer may not comprise a myeloma. The cancer may not comprise a melanoma. The cancer may not comprise a colon cancer. The cancer may be acute lymphoblastic leukemia (ALL). The cancer may be relapsed ALL. The cancer may be refractory ALL. The cancer may be relapsed, refractory ALL. The cancer may be chronic lymphocytic leukemia (CLL). The cancer may be relapsed CLL. The cancer may be refractory CLL. The cancer may be relapsed, refractory CLL.

[0227] The cancer may comprise a breast cancer. The breast cancer may be triple positive breast cancer (estrogen receptor, progesterone receptor and Her2 positive). The breast cancer may be triple negative breast cancer (estrogen receptor, progesterone receptor and Her2 negative). The breast cancer may be estrogen receptor positive. The breast cancer may be estrogen receptor negative. The breast cancer may be progesterone receptor positive. The breast cancer may be progesterone receptor negative. The breast cancer may comprise a Her2 negative breast cancer. The breast cancer may comprise a low-expressing Her2 breast cancer. The breast cancer may comprise a Her2 positive breast cancer. Cell lines expressing Her2 have been well-characterized for antigen density, reflecting clinical immunohistochemistry characterization which classifies malignancies as 0 (<20,000 Her2 antigens per cell), 1+ (100,000 Her2 antigens per cell), 2+ (500,000 Her2 antigens per cell), and 3+ (>2,000,000 Her2 antigens per cell). The present invention provides for methods of treating breast cancers of these classifications. The breast cancer may comprise a breast cancer classified as Her2 0. The breast cancer may comprise a breast cancer

classified as Her2 1+. The breast cancer may comprise a breast cancer classified as Her2 2+. The breast cancer may comprise a breast cancer classified as a Her2 3+.

[0228] The disease or condition may be a pathogenic infection. Pathogenic infections may be caused by one or more pathogens. In some instances, the pathogen is a bacterium, fungi, virus, or protozoan.

[0229] Exemplary pathogens include but are not limited to: Bordetella, Borrelia, Brucella, Campylobacter, Chlamydia, Chlamydophila, Clostridium, Corynebacterium, Enterococcus, Escherichia, Francisella, Haemophilus, Helicobacter, Legionella, Leptospira, Listeria, Mycobacterium, Mycoplasma, Neisseria, Pseudomonas, Rickettsia, Salmonella, Shigella, Staphylococcus, Streptococcus, Treponema, Vibrio, or Yersinia. In some cases, the disease or condition caused by the pathogen is tuberculosis and the heterogeneous sample comprises foreign molecules derived from the bacterium Mycobacterium tuberculosis and molecules derived from the subject. In some instances, the disease or condition is caused by a bacterium is tuberculosis, pneumonia, which may be caused by bacteria such as Streptococcus and Pseudomonas, a foodborne illness, which may be caused by bacteria such as Shigella, Campylobacter and Salmonella, and an infection such as tetanus, typhoid fever, diphtheria, syphilis and leprosy. The disease or condition may be bacterial vaginosis, a disease of the vagina caused by an imbalance of naturally occurring bacterial flora. Alternatively, the disease or condition is a bacterial meningitis, a bacterial inflammation of the meninges (*e.g.*, the protective membranes covering the brain and spinal cord). Other diseases or conditions caused by bacteria include, but are not limited to, bacterial pneumonia, a urinary tract infection, bacterial gastroenteritis, and bacterial skin infection. Examples of bacterial skin infections include, but are not limited to, impetigo which may be caused by Staphylococcus aureus or Streptococcus pyogenes; erysipelas which may be caused by a streptococcus bacterial infection of the deep epidermis with lymphatic spread; and cellulitis which may be caused by normal skin flora or by exogenous bacteria.

[0230] The pathogen may be a fungus, such as, *Candida, Aspergillus, Cryptococcus, Histoplasma, Pneumocystis,* and *Stachybotrys.* Examples of diseases or conditions caused by a fungus include, but are not limited to, jock itch, yeast infection, ringworm, and athlete's foot.

[0231] The pathogen may be a virus. Examples of viruses include, but are not limited to, adenovirus, coxsackievirus, Epstein-Barr virus, Hepatitis virus (*e.g.*, Hepatitis A, B, and C), herpes simplex virus (type 1 and 2), cytomegalovirus, herpes virus, HIV, influenza virus, measles virus, mumps virus, papillomavirus, parainfluenza virus, poliovirus, respiratory syncytial virus, rubella virus, and varicella-zoster virus. Examples of diseases or conditions caused by viruses include, but are not limited to, cold, flu, hepatitis, AIDS, chicken pox, rubella, mumps, measles, warts, and poliomyelitis.

[0232] The pathogen may be a protozoan, such as Acanthamoeba (*e.g.*, A. astronyxis, A. castellanii, A. culbertsoni, A. hatchetti, A. polyphaga, A. rhysodes, A. healyi, A. divionensis), Brachiola (*e.g.*, B connori, B. vesicularum), Cryptosporidium (*e.g.*, C. parvum), Cyclospora (*e.g.*, C. cayetanensis), Encephalitozoon (*e.g.*, E. cuniculi, E. hellem, E. intestinalis), Entamoeba (*e.g.*, E. histolytica), Enterocytozoon (*e.g.*, E. bieneusi), Giardia (*e.g.*, G. lamblia), Isospora (e.g, I. belli), Microsporidium (*e.g.*, M. africanum, M. ceylonensis), Naegleria (*e.g.*, N. fowleri), Nosema (*e.g.*, N. algerae, N. ocularum), Pleistophora, Trachipleistophora (*e.g.*, T. anthropophthera, T. hominis), and Vittaforma (*e.g.*, V. corneae).

[0233] The disease or condition may be an autoimmune disease or autoimmune related disease. An autoimmune disorder may be a malfunction of the body's immune system that causes the body to attack its own tissues. Examples of autoimmune diseases and autoimmune related diseases include, but are not limited to, Addison's disease, alopecia areata, ankylosing spondylitis, antiphospholipid syndrome (APS), autoimmune aplastic anemia, autoimmune hemolytic anemia, autoimmune hepatitis, autoimmune myocarditis, Behcet's disease, celiac sprue, Crohn's disease, dermatomyositis, eosinophilic fasciitis, erythema nodosum, giant cell arteritis (temporal arteritis), Goodpasture's syndrome, Graves' disease, Hashimoto's disease, idiopathic thrombocytopenic purpura (ITP), IgA nephropathy, juvenile arthritis, diabetes, juvenile diabetes, Kawasaki syndrome, Lambert-Eaton syndrome, lupus (SLE), mixed connective tissue disease (MCTD), multiple sclerosis, myasthenia gravis, pemphigus, polyarteritis nodosa, type I, II, & III autoimmune polyglandular syndromes, polymyalgia rheumatica, polymyositis, psoriasis, psoriatic arthritis, Reiter's syndrome, relapsing polychondritis, rheumatoid arthritis, sarcoidosis, scleroderma, Sjogren's syndrome, sperm & testicular autoimmunity, stiff person syndrome, Takayasu's arteritis, temporal arteritis/giant cell arteritis, ulcerative colitis, uveitis, vasculitis, vitiligo, and Wegener's granulomatosis.

[0234] The disease or condition may be an inflammatory disease. Examples of inflammatory diseases include, but are not limited to, alveolitis, amyloidosis, angiitis, ankylosing spondylitis, avascular necrosis, Basedow's disease, Bell's palsy, bursitis, carpal tunnel syndrome, celiac disease, cholangitis, chondromalacia patella, chronic active hepatitis, chronic fatigue syndrome, Cogan's syndrome, congenital hip dysplasia, costochondritis, Crohn's Disease, cystic fibrosis, De Quervain's tendinitis, diabetes associated arthritis, diffuse idiopathic skeletal hyperostosis, discoid lupus, Ehlers-Danlos syndrome, familial mediterranean fever, fascitis, fibrositis/fibromyalgia, frozen shoulder, ganglion cysts, giant cell arteritis, gout, Graves' Disease, HIV-associated rheumatic disease syndromes, hyperparathyroid associated arthritis, infectious arthritis, inflammatory bowel syndrome/ irritable bowel syndrome, juvenile rheumatoid arthritis, lyme disease, Marfan's Syndrome, Mikulicz's Disease, mixed connective tissue disease, multiple

sclerosis, myofascial pain syndrome, osteoarthritis, osteomalacia, osteoporosis and corticosteroid-induced osteoporosis, Paget's Disease, palindromic rheumatism, Parkinson's Disease, Plummer's Disease, polymyalgia rheumatica, polymyositis, pseudogout, psoriatic arthritis, Raynaud's Phenomenon/Syndrome, Reiter's Syndrome, rheumatic fever, rheumatoid arthritis, sarcoidosis, sciatica (lumbar radiculopathy), scleroderma, scurvy, sickle cell arthritis, Sjogren's Syndrome, spinal stenosis, spondyloisthesis, Still's Disease, systemic lupus erythematosis, Takayasu's (Pulseless) Disease, Tendinitis, tennis elbow/golf elbow, thyroid associated arthritis, trigger finger, ulcerative colitis, Wegener's Granulomatosis, and Whipple's Disease.

[0235] Methods of treatment disclosed herein may comprise off-target activity as measured by cytokine levels. The method may reduce the off-target activity, as measured by cytokine levels, when compared to other CAR-EC therapies. The method may reduce the off-target activity as measured by interferon gamma levels. Other off-target activities that may be reduced include toxic lymphophenia, fatal cytolysis of solid tumor targets and chronic hypogammaglobulinemia for hematological targets. Methods of treatment and compositions disclosed herein may be used to treat a cancer comprising CD19-mediated B cell aplasia. The methods and compositions may minimize the CD19-mediated B cell aplasia. The method may avoid long-term B-cell aplasia.

[0236] The CAR-EC platforms, methods and compositions disclosed herein may be used to treat a heterogeneous tumor or a heterogeneous blood cell malignancy in a subject in need thereof. The "pan-B cell" marker CD20 is the most prevalently targeted antigen for B cell neoplasms and the FDA-approved antibody rituximab is a vital component in the treatment of many leukemias and lymphomas. However, resistance mechanisms related to modulation of CD20 antigen expression occurs in a significant number of patients. It is clear that targeting with either CD19 or CD20 antigen alone is insufficient for a curative therapy. The methods disclosed herein provide for construction and administration of two or more switches with different specificities (*e.g.*, an anti-CD19 antibody CAR-EC switch and an anti-CD20 antibody CAR-EC switch). The methods disclosed herein provide for construction and administration of two or more switches with different specificities (*e.g.*, an anti-CD19 antibody CAR-EC switch and an anti-CD22 antibody CAR-EC switch). This methodology may offer a significant advantage against the propensity for relapse in the clinic while avoiding persistent loss of B cells. A heterogeneous tumor or heterogeneous blood cell malignancy may also be treated with an anti-CD19 antibody CAR-EC switch and an anti-CD22 antibody CAR-EC switch. One or more CAR-EC switches may be administered sequentially or simultaneously. A second switch targeting a second cell surface molecule on the target cell may be administered after down regulation of a first cell surface molecule on the target cell that is targeted by a first switch.

[0237] The CAR-EC switch may be administered with one or more additional therapeutic agents. The one or more additional therapeutic agents may be selected from a group consisting of an immunotherapy, a chemotherapy and a steroid. The one or more additional therapeutic agents may be a chemotherapy drug. The chemotherapy drug may be an alkylating agent, an antimetabolite, an anthracycline, a topoisomerase inhibitor, a mitotic inhibitor, a corticosteroid or a differentiating agent. The chemotherapy drug may be selected from actinomycin-D, bleomycin, altretamine, bortezomib, busulfan, carboplatin, capecitabine, carmustine, chlorambucil, cisplatin, cladribine, clofarabine, cyclophosphamide, cytarabine, dacarbazine, daunorubicin, docetaxel, doxorubicin, epirubicin, etoposide, estramustine, floxuridine, fludarabine, fluorouracil, gemcitbine (Gemzar), hydroxyurea, idarubicin, ifosfamide, irinotecan (Camptosar), ixabepilone, L-asparaginase, lomustine, mechlorethamine, melphalan, 6-mercaptopurine, methotrexate, mitomycin-C, paclitaxel (Taxol), pemetrexed, pentostatin, streptozocin, temozolomide, teniposide, thioguanine, thiotepa, topotecan (Hycamtin), vincristine, vinblastine, vinorelbine, retinoids, tretinoin (ATRA or Atralin®), bexarotene (Targretin®) and arsenic trioxide (Arsenox®). The chemotherapy may be administered as a pill to swallow, as an injection into the muscle or fat tissue, intravenously, topically or directly into a body cavity.

[0238] The one or more additional therapeutic agents may comprise an angiogenesis inhibitor. The angiogenesis inhibitor may be selected from bevacizumab, itraconazole, carboxyamidotriazole, TNP-470, CM101, IFN alpha, IL-12, platelet factor 4, suramin, SU5416, thrombospondin, a VEGFR antagonist, an angiostatic steroid with heparin, CAR-ECilage-derived angiogenesis inhibitory factor, matrix metalloprotease inhibitors, angiostatin, endostatin, sorafenib, sunitinib, pazopanib, everolimus, 2-methoxyestradiol, tecogalan, tetrathiomolybdate, thalidomide, prolactin, $\alpha v\beta_3$ inhibitor, linomide, tasquinimod, soluble VEGFR-1, soluble NRP-1, angiopoietin 2, vasostatin, calreticulin, TIMP, CDAI, Meth-1, Meth-2, interferon-alpha, interferon-beta, interferon-gamma, CXCL10, IL-4, IL-12, IL-18, prothrombin, antithrombin III fragment, prolactin, VEGI, SPARC, osteopontin, maspin, canstatin, proliferin-related protein and restin.

[0239] The one or more additional therapeutic agents may comprise a hormone therapy. The hormone therapy may be selected from an anti-estrogen (*e.g.,* fulvestrant (Faslodex®), tamoxifen, toremifene (Fareston®)); an aromatase inhibitor (*e.g.,* anastrozole (Arimidex®), exemestane (Aromasin®), letrozole (Femara®)); a progestin (*e.g.,* megestrol acetate (Megace®)); an estrogen; an anti-androgen (*e.g.,* bicalutamide (Casodex®), flutamide (Eulexin®), nilutamide (Nilandron®)); a gonadotropin-releasing hormone (GnRH) or luteinizing hormone-releasing hormone (LHRH) agonist or analog (*e.g.,* leuprolide (Lupron®), goserelin (Zoladex®)).

[0240] The one or more additional therapeutic agents may comprise a steroid. The steroid may be a corticosteroid. The steroid may be cortisol or a derivative thereof. The steroid may be selected from prednisone, methylprednisolone (Solumedrol®) or dexamethasone.

[0241] The CAR-EC switch may be administered with one or more additional therapies. The one or more additional therapies may comprise laser therapy. The one or more additional therapies may comprise radiation therapy. The one or more additional therapies may comprise surgery.

[0242] Disclosed herein are platforms, kits and methods for treating a disease or condition in a subject. The subject may be a healthy subject. The subject may be suffering from a disease or condition. The subject may be suffering from more than one disease or condition. The subject may be suffering from chronic lymphocytic leukemia. The subject may be suffering from acute lymphoblastic leukemia. The subject may be an animal. The subject may be a mammal. The mammal may be a human, a chimpanzee, a gorilla, a monkey, a bovine, a horse, a donkey, a mule, a dog, a cat, a pig, a rabbit, a goat, a sheep, a rat, a hamster, a guinea pig or a mouse. The subject may be a bird or a chicken. The subject may be a human. The subject may be a child. The child may be suffering from acute lymphoblastic leukemia. The subject may be less than 6 months old. The subject may be about 1 year old, about 2 years old, about 3 years old, about 4 years old, about 5 years old, about 6 years old, about 7 years old, about 8 years old, about 9 years old, about 10 years old, about 11 years old, about 12 years old, about 13 years old, about 14 years old, about 15 years old, about 18 years old, about 20 years old, about 25 years old, about 30 years old, about 35 years old, about 40 years old, about 45 years old, about 50 years old, about 55 years old, about 60 years old, about 65 years old, about 70 years old, about 75 years old, about 80 years old, about 85 years old, about 90 years old, about 95 years old, about 100 years old or about 105 years old.

VII. Method of Clearing Effector cells

[0243] Further disclosed herein are methods of clearing CAR-EC cells in a subject, comprising administering a CAR-EC off switch. The CAR-EC off switch may comprise an antibody or antibody fragment that targets a cell surface marker on the effector cell. The CAR-EC off switch may comprise a peptide that is bound by the CAR of the CAR-EC. The CAR-EC off switch may comprise a CAR-BP that is bound by the CAR of the CAR-EC.

[0244] The antibody, antibody fragment or peptide of the CAR-EC off switch may be conjugated to a drug or a toxin. The drug or toxin may be selected from maytasine (*e.g.*, DM1, DM4), monomethylauristatin E, monomethylauristatin F, Ki-4.dgA, dolastatin 10, calicheamicin, SN-38, duocarmycin, irinotecan, ricin, saporin, gelonin, poke weed antiviral protein, *pseudomonas aeruginosa* exotoxin A or diphtheria toxin. The toxin may comprise a poison, a bacterial toxin (*e.g.*, bacterial toxins causing tetanus, diphtheria), a plant toxin or animal toxin. The toxin may be a snake venom. The toxin may comprise vinblastine. The toxin may comprise auristatin. The toxin

may be contained in a liposome membrane-coated vesicle. Wherein the toxin is contained in a liposome membrane-coated vesicle, the antibody is attached to the vesicle.

[0245] The cell surface marker may be a viral protein or fragment thereof. Alternatively or additionally, the effector cell expresses a viral protein or fragment thereof that is not a cell surface marker. The effector cell expressing a viral protein or fragment thereof may be targeted with a drug. Wherein the effector cell comprises a viral protein or fragment thereof, the drug may be selected from a group comprising abacavir, acyclovir, acyclovir, adefovir, amantadine, amprenavir, ampligen, arbidol, atazanavir, atripla, balavir, boceprevirertet, cidofovir, combivir, darunavir, delavirdine, didanosine, docosanol, edoxudine, efavirenz, emtricitabine, enfuvirtide, entecavir, an entry inhibitor, famciclovir, a fixed dose combination antiretroviral drug, fomivirsen, fosamprenavir, foscarnet, fosfonet, a fusion inhibitor, ganciclovir, ibacitabine, imunovir, idoxuridine, imiquimod, indinavir, inosine, integrase inhibitor, interferon type III, interferon type II, interferon type I, interferon, lamivudine, lopinavir, loviride, maraviroc, moroxydine, methisazone, nelfinavir, nevirapine, nexavir, nucleoside analogue, oseltamivir, peginterferon alfa-2a, penciclovir, peramivir, pleconaril, podophyllotoxin, protease inhibiro, raltegravir, a reverse transcriptase inhibitor, ribavirin, rimantadine, ritonavir, pyramidine, saquinavir, sofosbuvir, stavudine, a synergistic enhancer retroviral durg, tea tree oil, telaprevir, tenofovir, tenofovir disoproxil, tipranavir, trifluridine, trizivir, tromantadine, truvada, valaciclovir, vicriviroc, vidarabine, viramidine, zacitabine, zanamivir or zidovudine. The drug may be ganciclovir. The drug may be acyclovir.

VIII. Pharmaceutical Compositions

[0246] Disclosed herein is a pharmaceutical composition comprising one or more of the CAR-EC switches disclosed herein. The compositions may further comprise one or more pharmaceutically acceptable salts, excipients or vehicles. Pharmaceutically acceptable salts, excipients, or vehicles for use in the present pharmaceutical compositions include carriers, excipients, diluents, antioxidants, preservatives, coloring, flavoring and diluting agents, emulsifying agents, suspending agents, solvents, fillers, bulking agents, buffers, delivery vehicles, tonicity agents, cosolvents, wetting agents, complexing agents, buffering agents, antimicrobials, and surfactants.

[0247] Neutral buffered saline or saline mixed with serum albumin are exemplary appropriate carriers. The pharmaceutical compositions may include antioxidants such as ascorbic acid; low molecular weight polypeptides; proteins, such as serum albumin, gelatin, or immunoglobulins; hydrophilic polymers such as polyvinylpyrrolidone; amino acids such as glycine, glutamine, asparagine, arginine or lysine; monosaccharides, disaccharides, and other carbohydrates including glucose, mannose, or dextrins; chelating agents such as EDTA; sugar alcohols such as mannitol or sorbitol; salt-forming counterions such as sodium; and/or nonionic surfactants such as Tween,

pluronics, or polyethylene glycol (PEG). Also by way of example, suitable tonicity enhancing agents include alkali metal halides (preferably sodium or potassium chloride), mannitol, sorbitol, and the like. Suitable preservatives include benzalkonium chloride, thimerosal, phenethyl alcohol, methylparaben, propylparaben, chlorhexidine, sorbic acid and the like. Hydrogen peroxide also may be used as preservative. Suitable cosolvents include glycerin, propylene glycol, and PEG. Suitable complexing agents include caffeine, polyvinylpyrrolidone, beta-cyclodextrin or hydroxy-propyl-beta-cyclodextrin. Suitable surfactants or wetting agents include sorbitan esters, polysorbates such as polysorbate 80, tromethamine, lecithin, cholesterol, tyloxapal, and the like. The buffers may be conventional buffers such as acetate, borate, citrate, phosphate, bicarbonate, or Tris-HCl. Acetate buffer may be about pH 4-5.5, and Tris buffer may be about pH 7-8.5. Additional pharmaceutical agents are set forth in Remington's Pharmaceutical Sciences, 18th Edition, A. R. Gennaro, ed., Mack Publishing Company, 1990.

[0248] The composition may be in liquid form or in a lyophilized or freeze-dried form and may include one or more lyoprotectants, excipients, surfactants, high molecular weight structural additives and/or bulking agents (see, for example, U.S. Patent Nos. 6,685,940, 6,566,329, and 6,372,716). In one embodiment, a lyoprotectant is included, which is a non-reducing sugar such as sucrose, lactose or trehalose. The amount of lyoprotectant generally included is such that, upon reconstitution, the resulting formulation will be isotonic, although hypertonic or slightly hypotonic formulations also may be suitable. In addition, the amount of lyoprotectant should be sufficient to prevent an unacceptable amount of degradation and/or aggregation of the protein upon lyophilization. Exemplary lyoprotectant concentrations for sugars (*e.g.,* sucrose, lactose, trehalose) in the pre-lyophilized formulation are from about 10 mM to about 400 mM. In another embodiment, a surfactant is included, such as for example, nonionic surfactants and ionic surfactants such as polysorbates (*e.g.,* polysorbate 20, polysorbate 80); poloxamers (*e.g.,* poloxamer 188); poly(ethylene glycol) phenyl ethers (*e.g.*, Triton); sodium dodecyl sulfate (SDS); sodium laurel sulfate; sodium octyl glycoside; lauryl-, myristyl-, linoleyl-, or stearyl-sulfobetaine; lauryl-, myristyl-, linoleyl-or stearyl-sarcosine; linoleyl, myristyl-, or cetyl-betaine; lauroamidopropyl-, cocamidopropyl-, linoleamidopropyl-, myristamidopropyl-, palmidopropyl-, or isostearamidopropyl-betaine (*e.g.,* lauroamidopropyl); myristamidopropyl-, palmidopropyl-, or isostearamidopropyl-dimethylamine; sodium methyl cocoyl-, or disodium methyl ofeyl-taurate; and the MONAQUAT™. series (Mona Industries, Inc., Paterson, N.J.), polyethyl glycol, polypropyl glycol, and copolymers of ethylene and propylene glycol (*e.g.,* Pluronics, PF68 etc). Exemplary amounts of surfactant that may be present in the pre-lyophilized formulation are from about 0.001-0.5%. High molecular weight structural additives (*e.g.,* fillers, binders) may include for example, acacia, albumin, alginic acid, calcium phosphate (dibasic), cellulose, carboxymethylcellulose,

carboxymethylcellulose sodium, hydroxyethylcellulose, hydroxypropylcellulose, hydroxypropylmethylcellulose, microcrystalline cellulose, dextran, dextrin, dextrates, sucrose, tylose, pregelatinized starch, calcium sulfate, amylose, glycine, bentonite, maltose, sorbitol, ethylcellulose, disodium hydrogen phosphate, disodium phosphate, disodium pyrosulfite, polyvinyl alcohol, gelatin, glucose, guar gum, liquid glucose, compressible sugar, magnesium aluminum silicate, maltodextrin, polyethylene oxide, polymethacrylates, povidone, sodium alginate, tragacanth microcrystalline cellulose, starch, and zein. Exemplary concentrations of high molecular weight structural additives are from 0.1% to 10% by weight. In other embodiments, a bulking agent (*e.g.,* mannitol, glycine) may be included.

[0249] Compositions may be suitable for parenteral administration. Exemplary compositions are suitable for injection or infusion into an animal by any route available to the skilled worker, such as intraarticular, subcutaneous, intravenous, intramuscular, intraperitoneal, intracerebral (intraparenchymal), intracerebroventricular, intramuscular, intraocular, intraarterial, or intralesional routes. A parenteral formulation typically will be a sterile, pyrogen-free, isotonic aqueous solution, optionally containing pharmaceutically acceptable preservatives.

[0250] Examples of non-aqueous solvents are propylene glycol, polyethylene glycol, vegetable oils such as olive oil, and injectable organic esters such as ethyl oleate. Aqueous carriers include water, alcoholic/aqueous solutions, emulsions or suspensions, including saline and buffered media. Parenteral vehicles include sodium chloride solution, Ringers' dextrose, dextrose and sodium chloride, lactated Ringer's, or fixed oils. Intravenous vehicles include fluid and nutrient replenishers, electrolyte replenishers, such as those based on Ringer's dextrose, and the like. Preservatives and other additives may also be present, such as, for example, anti-microbials, anti-oxidants, chelating agents, inert gases and the like. See generally, Remington's Pharmaceutical Science, 16th Ed., Mack Eds., 1980.

[0251] Pharmaceutical compositions described herein may be formulated for controlled or sustained delivery in a manner that provides local concentration of the product (*e.g.,* bolus, depot effect) and/or increased stability or half-life in a particular local environment. The compositions may comprise the formulation of CAR-EC switches, polypeptides, nucleic acids, or vectors disclosed herein with particulate preparations of polymeric compounds such as polylactic acid, polyglycolic acid, *etc.*, as well as agents such as a biodegradable matrix, injectable microspheres, microcapsular particles, microcapsules, bioerodible particles beads, liposomes, and implantable delivery devices that provide for the controlled or sustained release of the active agent which then may be delivered as a depot injection. Techniques for formulating such sustained-or controlled-delivery means are known and a variety of polymers have been developed and used for the controlled release and delivery of drugs. Such polymers are typically biodegradable and

biocompatible. Polymer hydrogels, including those formed by complexation of enantiomeric polymer or polypeptide segments, and hydrogels with temperature or pH sensitive properties, may be desirable for providing drug depot effect because of the mild and aqueous conditions involved in trapping bioactive protein agents (*e.g.,* antibodies comprising an ultralong CDR3). See, for example, the description of controlled release porous polymeric microparticles for the delivery of pharmaceutical compositions in WO 93/15722. Suitable materials for this purpose include polylactides (see, *e.g.,* U.S. Patent No. 3,773,919), polymers of poly-(a-hydroxycarboxylic acids), such as poly-D-(-)-3-hydroxybutyric acid (EP 133,988A), copolymers of L-glutamic acid and gamma ethyl-L-glutamate (Sidman *et al.*, Biopolymers, 22: 547-556 (1983)), poly(2-hydroxyethyl-methacrylate) (Langer *et al.*, J. Biomed. Mater. Res., 15: 167-277 (1981), and Langer, Chem. Tech., 12: 98-105 (1982)), ethylene vinyl acetate, or poly-D(-)-3-hydroxybutyric acid. Other biodegradable polymers include poly(lactones), poly(acetals), poly(orthoesters), and poly(orthocarbonates). Sustained-release compositions also may include liposomes, which may be prepared by any of several methods known in the art (see, *e.g.,* Eppstein *et al.*, Proc. Natl. Acad. Sci. USA, 82: 3688-92 (1985)). The carrier itself, or its degradation products, should be nontoxic in the target tissue and should not further aggravate the condition. This may be determined by routine screening in animal models of the target disorder or, if such models are unavailable, in normal animals. Microencapsulation of recombinant proteins for sustained release has been performed successfully with human growth hormone (rhGH), interferon-(rhIFN-), interleukin-2, and MN rgp120. Johnson *et al.*, Nat. Med., 2:795-799 (1996); Yasuda, Biomed. Ther., 27:1221-1223 (1993); Hora *et al.*, Bio/Technology. 8:755-758 (1990); Cleland, "Design and Production of Single Immunization Vaccines Using Polylactide Polyglycolide Microsphere Systems," in Vaccine Design: The Subunit and Adjuvant Approach, Powell and Newman, eds, (Plenum Press: New York, 1995), pp. 439-462; WO 97/03692, WO 96/40072, WO 96/07399; and U.S. Patent No. 5,654,010. The sustained-release formulations of these proteins were developed using poly-lactic-coglycolic acid (PLGA) polymer due to its biocompatibility and wide range of biodegradable properties. The degradation products of PLGA, lactic and glycolic acids may be cleared quickly within the human body. Moreover, the degradability of this polymer may be depending on its molecular weight and composition. Lewis, "Controlled release of bioactive agents from lactide/glycolide polymer," in: M. Chasin and R. Langer (Eds.), Biodegradable Polymers as Drug Delivery Systems (Marcel Dekker: New York, 1990), pp. 1-41. Additional examples of sustained release compositions include, for example, EP 58,481A, U.S. Patent No. 3,887,699, EP 158,277A, Canadian Patent No. 1176565, U. Sidman *et al.*, Biopolymers 22, 547 [1983], R. Langer *et al.*, Chem. Tech. 12, 98 [1982], Sinha *et al.*, J. Control. Release 90, 261 [2003], Zhu *et al.*, Nat. Biotechnol. 18, 24 [2000], and Dai *et al.*, Colloids Surf B Biointerfaces 41, 117 [2005].

[0252] Bioadhesive polymers are also contemplated for use in or with compositions of the present disclosure. Bioadhesives are synthetic and naturally occurring materials able to adhere to biological substrates for extended time periods. For example, Carbopol and polycarbophil are both synthetic cross-linked derivatives of poly(acrylic acid). Bioadhesive delivery systems based on naturally occurring substances include for example hyaluronic acid, also known as hyaluronan. Hyaluronic acid is a naturally occurring mucopolysaccharide consisting of residues of D-glucuronic and N-acetyl-D-glucosamine. Hyaluronic acid is found in the extracellular tissue matrix of vertebrates, including in connective tissues, as well as in synovial fluid and in the vitreous and aqueous humor of the eye. Esterified derivatives of hyaluronic acid have been used to produce microspheres for use in delivery that are biocompatible and biodegradable (see, for example, Cortivo *et al.*, Biomaterials (1991) 12:727-730; EP 517,565; WO 96/29998; Illum *et al.*, J. Controlled Rel. (1994) 29:133-141).

[0253] Both biodegradable and non-biodegradable polymeric matrices may be used to deliver compositions of the present disclosure, and such polymeric matrices may comprise natural or synthetic polymers. Biodegradable matrices are preferred. The period of time over which release occurs is based on selection of the polymer. Typically, release over a period ranging from between a few hours and three to twelve months is most desirable. Exemplary synthetic polymers which may be used to form the biodegradable delivery system include: polymers of lactic acid and glycolic acid, polyamides, polycarbonates, polyalkylenes, polyalkylene glycols, polyalkylene oxides, polyalkylene terepthalates, polyvinyl alcohols, polyvinyl ethers, polyvinyl esters, poly-vinyl halides, polyvinylpyrrolidone, polyglycolides, polysiloxanes, polyanhydrides, polyurethanes and co-polymers thereof, poly(butic acid), poly(valeric acid), alkyl cellulose, hydroxyalkyl celluloses, cellulose ethers, cellulose esters, nitro celluloses, polymers of acrylic and methacrylic esters, methyl cellulose, ethyl cellulose, hydroxypropyl cellulose, hydroxypropyl methyl cellulose, hydroxybutyl methyl cellulose, cellulose acetate, cellulose propionate, cellulose acetate butyrate, cellulose acetate phthalate, carboxylethyl cellulose, cellulose triacetate, cellulose sulphate sodium salt, poly(methyl methacrylate), poly(ethyl methacrylate), poly(butylmethacrylate), poly(isobutyl methacrylate), poly(hexylmethacrylate), poly(isodecyl methacrylate), poly(lauryl methacrylate), poly(phenyl methacrylate), poly(methyl acrylate), poly(isopropyl acrylate), poly(isobutyl acrylate), poly(octadecyl acrylate), polyethylene, polypropylene, poly(ethylene glycol), poly(ethylene oxide), poly(ethylene terephthalate), poly(vinyl alcohols), polyvinyl acetate, poly vinyl chloride, polystyrene and polyvinylpyrrolidone. Exemplary natural polymers include alginate and other polysaccharides including dextran and cellulose, collagen, chemical derivatives thereof (substitutions, additions of chemical groups, for example, alkyl, alkylene, hydroxylations, oxidations, and other modifications routinely made by those skilled in the art), albumin and other hydrophilic proteins, zein and other prolamines and hydrophobic proteins, copolymers and

mixtures thereof. In general, these materials degrade either by enzymatic hydrolysis or exposure to water *in vivo*, by surface or bulk erosion. The polymer optionally is in the form of a hydrogel (see, for example, WO 04/009664, WO 05/087201, Sawhney, *et al.*, Macromolecules, 1993, 26, 581-587) that can absorb up to about 90% of its weight in water and further, optionally is cross-linked with multi-valent ions or other polymers.

[0254] Delivery systems also include non-polymer systems that are lipids including sterols such as cholesterol, cholesterol esters and fatty acids or neutral fats such as mono-di-and tri-glycerides; hydrogel release systems; silastic systems; peptide based systems; wax coatings; compressed tablets using conventional binders and excipients; partially fused implants; and the like. Specific examples include, but are not limited to: (a) erosional systems in which the product is contained in a form within a matrix such as those described in U.S. Patent Nos. 4,452,775, 4,675,189 and 5,736,152 and (b) diffusional systems in which a product permeates at a controlled rate from a polymer such as described in U.S. Patent Nos. 3,854,480, 5,133,974 and 5,407,686. Liposomes containing the product may be prepared by methods known methods, such as for example (DE 3,218,121; Epstein *et al.*, Proc. Natl. Acad. Sci. USA, 82: 3688-3692 (1985); Hwang *et al.*, Proc. Natl. Acad. Sci. USA, 77: 4030-4034 (1980); EP 52,322; EP 36,676; EP 88,046; EP 143,949; EP 142,641; JP 83-118008; U.S. Patent Nos. 4,485,045 and 4,544,545; and EP 102,324).

[0255] Alternatively or additionally, the compositions may be administered locally via implantation into the affected area of a membrane, sponge, or other appropriate material on to which a CAR-EC switch disclosed herein has been absorbed or encapsulated. Where an implantation device is used, the device may be implanted into any suitable tissue or organ, and delivery of a CAR-EC switch, nucleic acid, or vector disclosed herein may be directly through the device via bolus, or via continuous administration, or via catheter using continuous infusion.

[0256] A pharmaceutical composition comprising a CAR-EC switch disclosed herein may be formulated for inhalation, such as for example, as a dry powder. Inhalation solutions also may be formulated in a liquefied propellant for aerosol delivery. In yet another formulation, solutions may be nebulized. Additional pharmaceutical composition for pulmonary administration include, those described, for example, in WO 94/20069, which discloses pulmonary delivery of chemically modified proteins. For pulmonary delivery, the particle size should be suitable for delivery to the distal lung. For example, the particle size may be from 1 μm to 5 μm; however, larger particles may be used, for example, if each particle is fairly porous.

[0257] Certain formulations containing CAR-EC switches disclosed herein may be administered orally. Formulations administered in this fashion may be formulated with or without those carriers customarily used in the compounding of solid dosage forms such as tablets and capsules. For example, a capsule may be designed to release the active portion of the formulation at the point in

the gastrointestinal tract when bioavailability is maximized and pre-systemic degradation is minimized. Additional agents may be included to facilitate absorption of a selective binding agent. Diluents, flavorings, low melting point waxes, vegetable oils, lubricants, suspending agents, tablet disintegrating agents, and binders also may be employed.

[0258] Another preparation may involve an effective quantity of a CAR-EC switch disclosed herein in a mixture with non-toxic excipients which are suitable for the manufacture of tablets. By dissolving the tablets in sterile water, or another appropriate vehicle, solutions may be prepared in unit dose form. Suitable excipients include, but are not limited to, inert diluents, such as calcium carbonate, sodium carbonate or bicarbonate, lactose, or calcium phosphate; or binding agents, such as starch, gelatin, or acacia; or lubricating agents such as magnesium stearate, stearic acid, or talc.

[0259] Suitable and/or preferred pharmaceutical formulations may be determined in view of the present disclosure and general knowledge of formulation technology, depending upon the intended route of administration, delivery format, and desired dosage. Regardless of the manner of administration, an effective dose may be calculated according to patient body weight, body surface area, or organ size. Further refinement of the calculations for determining the appropriate dosage for treatment involving each of the formulations described herein are routinely made in the art and is within the ambit of tasks routinely performed in the art. Appropriate dosages may be ascertained through use of appropriate dose-response data.

IX. CAR-EC Switch Production Methods

[0260] Disclosed herein are methods of producing CAR-EC switches comprising expressing one or more polypeptides from one or more vectors comprising one or more polynucleotide having one or more sequences that encode a chimeric antigen receptor–effector cell switch or a portion thereof, wherein the chimeric antigen receptor–effector cell switch comprises a peptidic antigen (CAR-BP) and a targeting polypeptide. The targeting moiety may comprise a targeting polypeptide. In general, the methods comprise fusing or grafting a polynucleotide encoding the CAR-BP to a polynucleotide encoding the targeting polypeptide. Fusing or grafting may be carried out by any standard cloning method known to one skilled in the art. Fusing or grafting the polynucleotides encoding the CAR-BP and targeting polypeptide may comprise enzymatic digestion of the polynucleotides, ligation of the polynucleotides and/or amplification of the polynucleotides.

[0261] The peptidic antigen may be fused to an N terminus of the targeting polypeptide. The peptidic antigen may be fused to a C terminus of the targeting polypeptide. The peptidic antigen may be grafted within the targeting polypeptide. The targeting polypeptide may comprise a targeting antibody or antibody fragment. The peptidic antigen may be fused to an N terminus of the targeting antibody or antibody fragment. The peptidic antigen may be fused to a C terminus of the targeting antibody or antibody fragment.

[0262] As used herein, the term "fused" may refer to adjoining a terminus of the CAR-BP with a terminus of the targeting polypeptide. The CAR-BP may be fused to the terminus of the targeting polypeptide without replacing or removing any amino acids of the targeting polypeptide. Fusing the CAR-BP to the terminus of the targeting polypeptide may comprise removing or replacing amino acids at the terminus of the targeting polypeptide. Removing or replacing amino acids at the terminus of the targeting polypeptide may comprise removing or replacing about 1 to about 20 amino acids at the terminus of the targeting polypeptide. The CAR-BP may be fused to the terminus of the targeting polypeptide via a linker. The linker may be fused to the CAR-BP to produce a CAR-BP-linker intermediate. The linker may be fused to a CAR-BP N terminus to produce the CAR-BP-linker intermediate. The linker may be fused to a CAR-BP C terminus to produce the CAR-BP-linker intermediate. The CAR-BP-linker intermediate may be fused to the targeting polypeptide. The CAR-BP-linker intermediate may be fused to the N terminus of the targeting polypeptide. The CAR-BP-linker intermediate may be fused to the C terminus of the targeting polypeptide. A first CAR-BP linker intermediate may be fused to the N terminus of the targeting polypeptide and a second CAR-BP linker intermediate may be fused to the C terminus of the targeting polypeptide. The CAR-BP of the first CAR-BP linker intermediate may be the same or similar to the CAR-BP of the second CAR-BP linker intermediate. The CAR-BP of the first CAR-BP linker intermediate may be different from the CAR-BP of the second CAR-BP linker intermediate.

[0263] As used herein, light chain grafts on the N-terminus may be refered to as LCNT. Light chain grafts on the C-terminus may be refered to as LCCT. Light chain grafts in the C1 domain may be refered to as LCC1. Heavy chain grafts on the N-terminus may be refered to as HCNT. Heavy chain grafts on the C-terminus may be refered to as HCCT. Heavy chain grafts in the C1 domain may be refered to as HCC1. Switches expressed with N-terminal grafts on the light and heavy chain may be refered to as NTBV. Switches expressed with C-terminal grafts on the light and heavy chain may be refered to as CTBV. Switches expressed with grafts in the C1 domain of the light and heavy chain may be refered to as C1BV.

[0264] As used herein, the term "grafted" may refer to inserting a CAR-BP within a targeting polypeptide (*e.g.,* between two amino acids of the targeting polypeptide). The CAR-BP may be grafted within the targeting polypeptide without replacing or removing any amino acids of the targeting polypeptide. Grafting the CAR-BP within the targeting polypeptide may comprise removing or replacing amino acids within the targeting polypeptide. Removing or replacing amino acids within the targeting polypeptide may comprise removing or replacing about 1 to about 20 amino acids within the targeting polypeptide. The CAR-BP may be grafted within the targeting polypeptide via one linker. The CAR-BP may be grafted within the targeting polypeptide via two

linkers. The linker may be fused to the CAR-BP N terminus to produce a CAR-BP-linker intermediate. The linker may be fused to the CAR-BP C terminus to produce a CAR-BP-linker intermediate. A first linker may be fused to the CAR-BP N terminus and a second linker may be fused to the CAR-BP C terminus to produce a CAR-BP-linker intermediate. The CAR-BP linker intermediate may be grafted with in the targeting polypeptide. A first CAR-BP linker intermediate may be grafted within the targeting polypeptide and a second CAR-BP linker intermediate may be grafted within the targeting polypeptide. The first CAR-BP linker intermediate may be grafted within a first domain of the targeting polypeptide and a second CAR-BP linker intermediate may be grafted within a second domain of the targeting polypeptide. The first domain of the targeting polypeptide may be the same as the second domain of the targeting polypeptide. The first domain of the targeting polypeptide may be different from the second domain of the targeting polypeptide. The CAR-BP of the first CAR-BP linker intermediate may be the same or similar to the CAR-BP of the second CAR-BP linker intermediate. The CAR-BP of the first CAR-BP linker intermediate may be different from the CAR-BP of the second CAR-BP linker intermediate. Unless otherwise specified, the terms "graft" and "insert", as used herein, are used interchangeably.

[0265] The targeting moiety may comprise an antibody or antibody fragment. The antibody or antibody fragment may comprise a heavy chain and a light chain or fragments thereof. The methods may comprise expressing a heavy chain wherein the peptidic antigen is fused to a terminus of the heavy chain. The methods may comprise expressing a heavy chain wherein the peptidic antigen is grafted within the heavy chain. The methods may comprise expressing a light chain wherein the peptidic antigen is fused to a terminus of the light chain. The methods may comprise expressing a light chain wherein the peptidic antigen is grafted within the light chain.

[0266] The methods may further comprise cloning one or more polynucleotides encoding the targeting polypeptide and/or the peptidic antigen into an expression vector. The methods may further comprise ligation of the one or more polynucleotides encoding the targeting polypeptide and/or peptidic antigen into an expression vector. The expression vector may be a prokaryotic expression vector. The expression vector may be a eukaryotic expression vector. The expression vector may be a mammalian expression vector. The expression vector may be a viral expression vector. The expression vector may be a pFUSE vector. The methods may further comprise validating the cloning of the one or more polynucleotides encoding the targeting polypeptide and/or peptidic antigen into the expression vector comprising sequencing the expression vector, running gel electrophoresis of the vector and/or viewing the targeting polypeptide and/or peptidic antigen on an SDS page gel.

[0267] The methods may further comprise amplifying a polynucleotide encoding the targeting polypeptide and/or peptidic antigen and cloning the targeting polypeptide and/or peptidic antigen

into the expression vector. Amplifying the polynucleotide encoding the targeting polypeptide and/or the peptidic antigen may comprise synthesizing oligonucleotides at least partially complementary to the gene. The oligonucleotides may be sufficiently complementary to the gene to anneal to the polynucleotide. The oligonucleotides may comprise linker sequences. The linker sequences may be selected from SEQ ID NOs: 40-50 & 214.

[0268] The methods may further comprise transfecting or infecting a cell with the expression vector. The methods may further comprise expressing the targeting polypeptide and/or peptidic antigen in the cell. The methods may further comprise expressing the targeting polypeptide and/or peptidic antigen in a cell free system. The methods may further comprise producing a virus comprising the expression vector. The methods may further comprise propagating the virus. The methods may further comprise infecting a cell with the virus comprising the expression vector. The methods may further comprise propagating the cell.

[0269] The switch may be expressed as two vectors, one of the heavy chain of the antibody and one for the light chain of the antibody. The two vectors may be co-transfected into an expression cell. The expression cell may be selected from a prokaryotic cell and a eukaryotic cell. The expression cell may be selected from a HEK cell and a CHO cell. Expression may be carried out in HEK cells over 7 or more days with routine harvesting of media to collect and isolate the antibody switch of interest. Expression may be carried out in less than 7 days. The switch may also be expressed from CHO cells in analogous fashion using the same plasmids. The media may or may not be harvested at intervals or may be harvested at the end of the expression. Harvesting at intervals may be preferable to preventing proteolytic degradation of the switch.

[0270] The switch may be expressed in *E. coli* . The switch may be expressed in *E. coli* from a vector, such as the pBAD vector, by way of non-limiting example. The pBAD vector may harbor both the light chain and the heavy chain of the antibody. This may require transformation of *E. coli* with only one plasmid. This may be advantageous as expression in *E. coli* is generally less expensive and faster than expression in mammalian cells (*e.g.*, HEK cells). To express the switch in *E. coli*, careful attention must be paid to the genotype of the strain used. Preferable genotypes include, but are not limited to, those with the *ompT* gene (an outer membrane protein protease VII which may proteolyze the expressed protein) disrupted. This includes BL21 (E. coli B F- dcm ompT hsdS(rB- mB-) gal [malB+]K-12(λS)), OverExpress(tm)C41(DE3) (Lucigen) (F– ompT gal dcm hsdSB(rB- mB-)(DE3)), and others. The non-preferable strains for expression include DH10B (F- endA1 recA1 galE15 galK16 nupG rpsL ΔlacX74 Φ80lacZΔM15 araD139 Δ(ara,leu)7697 mcrA Δ(mrr-hsdRMS-mcrBC) λ-), DH5alpha (F- endA1 glnV44 thi-1 recA1 relA1 gyrA96 deoR nupG Φ80dlacZΔM15 Δ(lacZYA-argF)U169, hsdR17(rK- mK+), λ–) or other strains which do not include the *ompT* knockout. Strains such as DH10B and DH5alpha may be made preferable by

disruption of the *ompT* gene. To express the LCNT1 switch from *E. coli*, the pBAD plasmid may be used (TSY-3-53_pBAD_aCD19(FMC63)-GCN4-LCNT1, (SEQ ID NO. 81)). Even more preferable is the LCNT1 switch sequence which has been codon optimized for expression in *E. coli* (TSY-3-97_pBAD_aCD19(FMC63)_LCNT1(opt), (SEQ ID NO. 82)).

[0271] Disclosed herein are methods of grafting the antibody or antibody fragment, the peptidic antigen or the targeting peptide to produce a CAR-EC switch. The method may comprise grafting the CAR-BP to the antibody or antibody fragment. The method may comprise grafting the CAR-BP to an N terminus, C terminus or internal site of the antibody or antibody fragment. The CAR-BP may be grafted to a CL domain of the antibody or antibody fragment. The CAR-BP may be grafted to a loop of the CL domain of the antibody or antibody fragment. The method may comprise grafting the antibody or antibody fragment to the CAR-BP. The method may comprise grafting the antibody or antibody fragment to an N terminus, C terminus or internal site of the CAR-BP. The method may comprise grafting the CAR-BP to the targeting peptide. The method may comprise grafting the CAR-BP to an N terminus, C terminus or internal site of the targeting peptide. The method may comprise grafting the targeting peptide to the CAR-BP. The method may comprise grafting the targeting peptide to an N terminus, C terminus or internal site of the CAR-BP.

[0272] The CAR-BP, targeting peptide, antibody or antibody fragment may comprise one or more linkers, wherein the linker is located at the N terminus and/or C terminus of the CAR-BP, targeting peptide, antibody or antibody fragment. The method may comprise grafting the antibody or antibody fragment, the CAR-BP or the targeting peptide through the linker. The linker may comprise $(GSSSS)_n$. The linker may comprise a sequence selected from SEQ ID NOS: 40-50. The linker may comprise a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 40-50. The linker may comprise a sequence selected from SEQ ID NOS: 68-71. The linker may comprise a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 68-71.

[0273] Grafting may comprise producing a CAR-EC switch encoding nucleic acid. Producing the CAR-EC switch encoding nucleic acid may comprise one or more polymerase chain reactions. Producing the CAR-EC switch encoding nucleic acid may comprise one or more nucleic acid enzymatic digestions. The enzymatic digestion may be site specific. Producing the CAR-EC switch encoding nucleic acid may comprise one or more ligations. The methods of producing the CAR-EC switch may comprise incorporating the CAR-EC switch encoding nucleic acid into a CAR-EC switch vector. The vector may be an expression vector. The expression vector may comprise a constitutive promoter, an inducible promoter and/or a conditional promoter. The CAR-EC switch encoding nucleic acid or CAR-EC switch vector may be expressed in a cell and the resulting CAR-EC switch isolated and purified. The cell may be a prokaryotic cell. The cell may be an *E.coli*. The

cell may be a eukaryotic cell. The cell may be a mammalian cell. The CAR-EC switch encoding nucleic acid or CAR-EC switch vector may be expressed in a cell-free system. Alternatively or additionally the CAR-EC switch may be synthesized from free amino acids.

Purification of CAR-EC switches and portions thereof

[0274] Disclosed herein are methods of purifying CAR-EC switches disclosed herein, comprising separating the CAR-EC switches disclosed herein from components of a CAR-EC switch production system (*e.g.,* cellular debris, free amino acids). Purifying the CAR-EC switch may comprise use of one or more concentrator columns, electrophoresis, filtration, centrifugation, chromatography or a combination thereof. Chromatography may comprise size-exclusion chromatography. Additional chromatography methods include, but are not limited to, hydrophobic interaction chromatography, ion exchange chromatography, affinity chromatography, metal binding, immunoaffinity chromatography, and high performance liquid chromatography or high pressure liquid chromatography. Electrophoresis may comprise denaturing electrophoresis or non-denaturing electrophoresis.

[0275] The CAR-EC switches may comprise one or more peptide tags. The methods of purifying CAR-EC switches may comprise binding one or more peptide tags of the CAR-EC switches to a capturing agent. The capturing agent may be selected from an antibody, a column, a bead and a combination thereof. The one or more tags may be cleaved by one or more proteases. Examples of tags include, but are not limited to, polyhistidine, FLAG® tag, HA, c-myc, V5, chitin binding protein (CBP), maltose binding protein (MBP), and glutathione-S-transferase (GST). The peptide tag may be the CAR-BP. The peptide tag may be HTP. The peptide tag may be yeast transcription factor GCN4.

[0276] The methods may further comprise lyophilization or ultracentrifugation of the CAR-BPs, targeting polypeptides and/or the CAR-EC switches.

[0277] The purity of the CAR-BPs, targeting polypeptides and/or the CAR-EC switches may be equal to or greater than 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99% or more. The purity of the CAR-BPs, targeting polypeptides and/or the CAR-EC switches may be equal to or greater than 85%. The purity of the CAR-BPs, targeting polypeptides and/or the CAR-EC switches may be equal to or greater than 90%. The purity of the CAR-BPs, targeting polypeptides and/or the CAR-EC switches may be equal to or greater than 95%. The purity of the CAR-BPs, targeting polypeptides and/or the CAR-EC switches may be equal to or greater than 97%.

[0278] The methods of producing CAR-EC switches disclosed herein may comprise producing CAR-EC switches that are structurally homogeneous. The method of producing the CAR-EC switch from a polynucleotide may result in one or more CAR-EC switches that have the same or

similar form, features, binding affinities (*e.g.,* for the CAR or the target), geometry and/or size. The homogeneity of the CAR-EC switches may be equal to or greater than 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99% or more. The homogeneity of the CAR-EC switches may be equal to or greater than 85%. The homogeneity CAR-EC switches may be equal to or greater than 90%. The homogeneity of the CAR-EC switches may be equal to or greater than 95%. The homogeneity of the CAR-EC switches may be equal to or greater than 97%. The homogeneity may be a structural homogeneity. The homogeneity may be a structural homogeneity prior to administering the cell to a subject. The homogeneity may be a structural homogeneity prior to modifications to the CAR-EC switch by cellular activities (methylation, acetylation, glycosylation, etc.). These high percentages of homogeneity may provide a more predictable effect of the CAR-EC switch. These high percentages of homogeneity may provide for less off-target effects of the CAR-EC switch, when combined with a CAR-EC to treat a condition in a subject.

X. Methods of Optimization

[0279] Disclosed herein are methods of optimizing a chimeric antigen receptor switch for maximum safety and efficacy in a subject. Further disclosed herein are methods of optimizing treatment of a condition in a subject comprising optimizing a chimeric antigen receptor switch. Also, disclosed herein are methods of optimizing a switchable chimeric antigen receptor platform. Also, disclosed herein are methods of optimizing a switchable chimeric antigen receptor platform for maximum safety and efficacy in a subject. Further disclosed herein are methods of optimizing treatment of a condition in a subject comprising optimizing a switchable chimeric antigen receptor platform.

Optimizing CAR-EC Activation

[0280] Disclosed herein are methods of producing an optimal switchable chimeric antigen receptor platform, comprising: incorporating a first chimeric antigen receptor binding peptide to a first site of a targeting moiety that binds a first cell surface molecule on a first target cell to produce a first switch; incorporating a second chimeric antigen receptor binding peptide to a second site of a second targeting moiety that binds a second cell surface molecule on a second target cell to produce a second switch; contacting the first target cell with the first switch and a first chimeric antigen receptor effector cell expressing a first chimeric antigen receptor; contacting the second target cell with the second switch and a second chimeric antigen receptor effector cell expressing a second chimeric antigen receptor; and comparing a first cytotoxic effect of the first switch and the first chimeric antigen receptor effector cell on the first target cell to a second cytotoxic effect of the second switch and the second chimeric antigen receptor effector cell on the second target cell; and selecting the first switch and first chimeric antigen receptor effector cell or the second switch and

the second chimeric antigen receptor effector cell as the optimal switchable chimeric antigen receptor platform based on comparing the first cytotoxic effect to the second cytotoxic effect.

[0281] Further disclosed herein are methods of producing an optimal switchable chimeric antigen receptor platform, comprising: incorporating a first chimeric antigen receptor binding peptide to a first site of a targeting moiety that binds a first cell surface molecule on a first target cell to produce a first switch; incorporating a second chimeric antigen receptor binding peptide to a second site of a second targeting moiety that binds a second cell surface molecule on a second target cell to produce a second switch; contacting the first target cell with the first switch and a first chimeric antigen receptor effector cell expressing a first chimeric antigen receptor; contacting the second target cell with the second switch and a second chimeric antigen receptor effector cell expressing a second chimeric antigen receptor; and comparing a first effect of the first switch and the first chimeric antigen receptor effector cell on the first chimeric antigen receptor effector cell to a second effect of the second switch and the second chimeric antigen receptor effector cell on the second second chimeric antigen receptor effector cell; and selecting the first switch and first chimeric antigen receptor effector cell or the second switch and the second chimeric antigen receptor effector cell as the optimal switchable chimeric antigen receptor platform based on comparing the first cytotoxic effect to the second cytotoxic effect.

[0282] The first chimeric antigen receptor binding peptide and the second chimeric antigen receptor binding peptide may be the same. The first targeting moiety and the second targeting moiety may be the same. The first site and the second site may be the same. The first site and the second site may be different. The methods may further comprise incorporating one or more additional chimeric antigen receptor binding peptides to the first and/or second targeting moiety to produce a first multivalent switch and/or a second multivalent switch.

[0283] The first chimeric antigen receptor and the second chimeric antigen receptor may be the same. The first chimeric antigen receptor and the second chimeric antigen receptor may be different. The first chimeric antigen receptor and the second chimeric antigen receptor may differ by a domain selected from an extracellular domain, a transmembrane domain, an intracellular domain and a hinge domain. A first hinge domain of the first chimeric antigen receptor and a second hinge domain of the second chimeric antigen receptor may differ by a feature selected from flexibility, length, amino acid sequence and combinations thereof.

[0284] Contacting the first target cell and/or contacting the second target cell may occur *in vitro*. Contacting the first target cell and/or contacting the second target cell may occur *in vivo*. By way of non-limiting example, contacting the first target cell and/or contacting the second target cell may occur in an *in vivo* model, such as a mouse. The *in vivo* model may have a condition or disease. The condition or disease may be a tumor or a cancer. Comparing the first cytotoxic effect to the second

cytotoxic effect may comprise comparing a feature selected from viability of target cells, expression/production of activation markers (*e.g.,* production of cytokines) by the first CAR-EC and/or second CAR-EC, viability of off-target cells, tumor burden, and health of an *in vivo* model. The method may further comprise comparing the first cytotoxic effect and or the second cytotoxic effect to that of a canonical CAR cytotoxic effect, wherein the canonical CAR is a non-switchable CAR (*e.g.,* not controlled by a CAR switch).

[0285] The first target cell and the second target cell may express the same cell surface molecule. The first target cell and the second target cell may express different levels of the same cell surface molecule, resulting in different cell surface molecule (*e.g.,* antigen) densities. The method may comprise comparing the first cytotoxic effect on the first target cell to the first cytotoxic effect on the second target cell. The method may comprise comparing the first cytotoxic effect on the first target cell to the second cytotoxic effect on the second target cell. The method may comprise comparing the first cytotoxic effect on the first target cell to the second cytotoxic effect on the first target cell.

[0286] The methods of optimizing may comprise modulating the distance and geometry of the immunological synapse, chimeric receptor binding affinity for the switch, the valency and location of the peptidic antigen(s) on the switch, and the density of chimeric receptors on the CAR-EC surface. The optimizing may result in activating the CAR-EC to an activation level that results in a desired CAR-EC fate or phenotype. Demonstrated herein are methods of PNE-grafting to create switches with a range of geometries, lengths, and valences which can be used to systematically optimize the sCAR immunological synapse (*see, e.g.,* Example 29).

Optimizing the Immunological Synapse- Length and Geometry

[0287] The methods disclosed herein comprise developing sCAR-T cell systems with switch-mediated control over the immunological synapse formed by the switch between the sCAR and target cell, wherein the immunological synapse may be defined as the junction between the CAR-EC and the target cell.

[0288] The methods may comprise modulating the length of the immunological synapse or the distance between the CAR-EC and the target cell. The methods may comprise modulating the length or size of the switch. The methods may comprise modulating the length or size of the CAR extracellular domain. Modulating the length or size of the CAR extracellular domain may comprise modulating the length of the CAR hinge.

[0289] The methods may comprise modulating the length of the immunological synapse by modulating the location of the peptidic antigen(s) on the switch. In some cases, the methods comprise designing switches with the CAR-BP placed distal to an antigen binding domain of the targeting moiety. In some cases, the methods comprise designing switches with the CAR-BP placed

distal to an antigen binding domain of the targeting antibody or antibody fragment. Distal may be the C terminus of the targeting antibody or antibody fragment. Distal may be the constant region of the targeting antibody or antibody fragment. In some cases, the methods comprise designing switches with the CAR-BP placed proximal to the antigen binding domain of the targeting moiety. Proximal may be the N terminus of the targeting antibody or antibody fragment. Proximal may be the variable region of the targeting antibody or antibody fragment. In some cases, the methods comprise designing a switch such that the CAR-BP is located at the C-terminus of the targeting moiety (e.g Fab) to enable sufficient length to display the CAR-BP to the sCAR-T while avoiding steric hindrance from a relatively large cell surface molecule. Thus, modulating the length of the switch and/or CAR extracellular domain may afford varying levels of sCAR-T cell activation. In some cases, switches with the CAR-BP proximal to the antigen binding domain may stimulate less CAR-EC activation than switches with the CAR-BP distal to the antigen binding domain. In other cases, switches with the CAR-BP distal to the antigen binding domain may stimulate less CAR-EC activation than switches with the CAR-BP proximal to the antigen binding domain. This underscores the necessity to empirically design switches with defined structures and valencies enabled by site specific fusing/grafting methodologies described herein. This is a significant advantage compared with previous reports that use non-specific conjugation to create switches which produce heterogeneous mixtures of conjugates. These reports do not provide methods of optimizing the sCAR immunological synapse for any antigen.

[0290] As shown in Examples 10-14, in some embodiments, CD19 targeting switches with the PNE grafted at the N-terminus of the (heavy chain, light chain or both), proximal to the antigen binding interface of the FMC63 Fab, may be superior to switches with the PNE grafted at C-terminus. Although the epitope of anti-CD19 antibody FMC63 and corresponding structure of the CD19 antigen are not known, this may be due to a decreased distance between target cell and sCAR-T cell. In the physiological immunological synapse formed by the native T cell receptor (TCR), the distance between the T cell and antigen presenting cell is approximately 150 Å. This distance is critical to sterically exclude inhibitory phosphatases such as CD45 and CD148 from the synapse which act to dephosphorylate signaling molecules and down regulate T cell activation. Without being limited by conjecture, it is likely that the longer synapse contributed by the C-terminal switches (65 Å longer than the N-terminal switches by length of Fab) is unable to sterically exclude these inhibitory molecules, resulting in less productive sCAR signaling. The increase in sCAR-T cell activity observed when the sCAR hinge was shortened from 45 amino acids to 12 amino acids supports this notion. In addition, similar switch SAR was demonstrated for the FMC63 antibody in a parallel work which used site-specific conjugation of the Fab with FITC in order to redirect the activity anti-FITC CAR-T cells. With this method, FITC conjugation sites

near the antigen binding interface afforded better activity than sites distal from the binding interface (data not shown). This further confirms that the impact of switch size on the immunological synapse is an important factor in sCAR-T cell activity and not an artifact of the PNE-grafting methodology. Thus, the methods disclosed herein may comprise modulating the distance of the immunological synapse by modulating the length of the switch and/or CAR extracellular domain such that the distance of the immunological synapse is not greater than about 150 Å, about 175 Å, or about 200 Å.

[0291] In some cases, the methods comprise modulating the length of the CAR hinge. The methods may comprise activating a first CAR-EC comprising a first CAR with a first hinge and activating a second CAR-EC comprising a second CAR with a second hinge and comparing an activity of the first CAR-EC to that of the second CAR-EC. The activity, by way of non-limiting example, may be selected from cytokine release, expression of a phenotypic marker, proliferation, senescence, and migration/trafficking. The first CAR hinge may be a long hinge and the second CAR hinge may be a short hinge. In some cases, the switch may provide greater sCAR-T activity when paired with a CAR that has a long hinge versus a short hinge. In some cases, the switch may provide lesser sCAR-T activity when paired with a CAR that has a long hinge versus a short hinge. The long hinge may be a flexible hinge. The long hinge may be a rigid or structured hinge. The long hinge may have a length of about 20 to about 200 amino acids, about 20 to about 100 amino acids, about 30 to about 100 amino acids, about 40 to about 100 amino acids, or about 45 to about 100 amino acids. The long hinge may comprise a portion of a CD8 protein. The portion of the CD8 protein may be between about 4 amino acids and about 100 amino acids. The portion of the CD8 protein may be about 45 amino acids. The short hinge may be a flexible hinge. The short hinge may be a rigid or structured hinge. The short hinge may have a length of about 1 to about 20 amino acids, about 5 to about 20 amino acids, or about 10 to about 20 amino acids. The short hinge may comprise a portion of an immunoglobulin. The immunoglobulin may be an IgG. The immunoglobulin may be an IgG4. The IgG4 may be mutated (refered to herein as IgG4m). The portion of the immunoglobulin may be between about 1 amino acid and about 20 amino acids. The portion of the immunoglobulin may be about 12 amino acids.

[0292] The methods of optimizing may further comprise accounting for the size and structure of the cell surface molecule (*e.g.*, antigen) on the target cell. In some embodiments, switches developed from an OFA antibody scaffold to target CD20 exhibited a SAR trend which was similar to the FMC63 antibody when paired with sCAR-T cells harboring the long, CD8-based hinge. Interestingly, when the sCAR hinge was shortened to 12 amino acids the SAR trend for OFA switches was reversed and C-terminally grafted switches afforded better activity than N-terminally grafted switches. While the structure of CD20 antibody is also unknown, the OFA antibody is

reported to bind a small, membrane proximal loop of the multi-pass transmembrane CD20 antigen. Thus, without being limited by conjecture, in this case, it is likely that the distance of the synapse created by the N-terminally grafted OFA switches with the short-dimeric sCAR is too short to enable efficient binding of the switch to the sCAR and CD20 simultaneously. Alternatively, without being limited by conjecture, the large adjacent loop domain of the CD20 antigen may create a steric hindrance for the short-dimeric sCAR, which prefers a longer switch length in order to bind. A similar effect was observed which supports this theory in parallel work with site-specific FITC conjugation on the anti-CD22 antibody m971 (data not shown). In this case, the m971 antibody has a membrane proximal epitope on CD22 and several large modular domains which may sterically preclude binding. Correspondingly, the m971 switches were optimal with FITC placed at sites distal from the antigen binding interface (data not shown). Thus, in some embodiments, the distance of the immunological synapse is a key parameter to consider when designing switches and highlights the requirement for empirical design as described herein.

[0293] The methods disclosed herein may comprise varying the geometry of the immunological synapse. The geometry may be defined or referred to herein as the orientation of the bio-orthogonal immunological synapse The methods disclosed herein comprise optimizing geometry of the switch. The methods disclosed herein comprise optimizing geometry of the switch to be compatible with a CAR. The CAR may be a universal CAR. The first site and/or second site may be selected from an N terminus of the antibody or antibody fragment, a C terminus of the antibody or antibody fragment, and an internal site of the antibody or antibody fragment. The first site and/or second site may be selected from a light chain of the antibody or antibody fragment and a heavy chain of the antibody or antibody fragment. The first site and/or second site may be selected from a variable region of the antibody or antibody fragment and a constant region of the antibody or antibody fragment. The first site and/or second site may be selected from a VL domain, a CL domain, a VH domain, a CH1 domain, a CH2 domain, a CH3 domain, and a hinge domain of the antibody or antibody fragment. Incorporating the first/second chimeric antigen receptor binding peptide may comprise a method selected from fusing, grafting, conjugating, linking, and combinations thereof.

[0294] Optimizing the geometry of the switch may further comprise incorporating one or more linkers in the switch. Optimizing the geometry of the switch may further comprise comparing two or more linkers. The two or more linkers may differ by a feature selected from flexibility, length, amino acid sequence, and combinations thereof. The method may comprise incorporating a first linker to the first site, wherein the first linker links the first chimeric antigen receptor binding peptide to the first targeting moiety. The method may further comprise incorporating a second linker to the second site wherein the second linker links the second chimeric antigen receptor binding peptide to the second targeting moiety. The first linker and the second linker may be the

same. The first linker and the second linker may be different. The first linker and the second linker may differ by a feature selected from flexibility, length, amino acid sequence, and combinations thereof. The first and/or second linker may have a sequence selected from SEQ ID NOS: 40-50, and 214. The first and/or second linker may have a sequence that is at least about 50%, about 60%, about 70%, about 80% or about 90% homologous to a sequence selected from SEQ ID NOS: 40-50.

Optimizing CAR-EC phenotype, activation, fate and progeny

[0295] CAR-T cell expansion and trafficking in humans has been shown to be predictive of clinical responses in clinical trials. The methods disclosed herein may comprise optimizing CAR-EC phenotype, activation, fate and progeny. Optimizing CAR-EC activation may compise optimizing the switch dose. The methods may comprise administering a first dose of a switch to a subject and a second dose of the switch to the subject and comparing CAR-EC cytokine release, CAR-EC expansion/fate, CAR-EC trafficking to disease sites, CAR-EC proliferation, and any combination thereof. The method may further comprise continuing administering the first dose or the second dose in the subject or administering a third dose to the subject, after the comparing. For example, as presented herein, it was shown that switch dose may be used to control CAR-EC cytokine release in the Nalm-$6^{Luc/GFP}$ xenograft model. Because the Nalm-6 tumor lacks CD80 and CD86 co-receptors, it is difficult to treat and has become a standard for CAR-T therapy adjudication. *In vivo* expansion and trafficking of sCAR-T cells to sites of disease was demonstrated to be reliant on switch dosing. Importantly, serum levels of human cytokines IL-2, TNFα, and IFNγ were tightly controlled by LCNT Fab switch dose (see FIG. 33B). A key finding of these studies was that sCAR-T cells treated with lower doses of switch (0.05 mg/kg) could provide complete clearance of Nalm-$6^{Luc/GFP}$ at a slower rate and with lower levels of cytokine release (see FIG. 33C). This indicates that low dose switch treatment may be an effective method of mitigating CRS and TLS in the treatment of patients with high tumor burdens. When tumors relapsed at day 30, mice were retreated with a higher dose of 0.5 mg/kg to ensure clearance (see FIG. 33D. Due to the lower tumor burden at this stage, excessive cytokine release would not be expected. Thus, the methods may comprise administering a first dose of switch before a relapse in the subject and a second dose after the relapse. The second dose may be higher than the first dose. The method may also comprise terminating the dosing of the first or the second switch due to the occurrence of an adverse effect. The adverse effect may be cellular aplasia. The cellular aplasia may be B cell aplasia. The adverse effect may be cytokine storm.

[0296] The methods may comprise administering a first dose of a switch to a subject and a second dose of the switch to the subject and comparing CAR-EC phenotype after the first dose to CAR-EC phenotype after the second dose. Also demonstrated herein was the sCAR-T cell phenotype

dependence on switch dose. This experiment again demonstrated an advantage to low dose (0.05 mg/kg) switch treatment in its ability to produce a larger central memory compartment compared with high dose (2.5 mg/kg) treatment which produced more effector memory T (TEMRA) cells at day 21 (15 days after the start of treatment). Central and stem cell memory CAR-T cells have a more naïve phenotype and provide prolonged persistence compared with relatively short-lived TEMRA cells. In the sCAR-T cell system persistence is critical to enable re-dosing strategies in the case of relapse. Persistence of sCAR-T cells may also be promoted through rest phases in which switch dosing is withheld to prevent exhaustion related to persistent T cell signaling (see FIG. 33E). Thus, the methods may further comprise comparing TEMRA cell quantity in the subject before administering the first/second switch to the subject to after administering the first/second switch to the subject. The methods may additionally or alternatively comprise comparing other populations of interest shown to correlate with good prognosis in CAR-T cell therapy before administering the first/second switch to the subject to after administering the first/second switch to the subject.

[0297] The methods may comprise optimizing the switch or sCAR-T platform to control CAR-EC fate. The methods may comprise optimizing the switch or sCAR-T platform to optimally activate the CAR-EC, thereby optimizing CAR-EC fate. For example, optimally activating the CAR-EC may cause it to become an effector memory T cell, as opposed to partially activating or over-activating, which can lead to death, senescence or anergy of the CAR-EC. The methods may comprise activating a CAR with a first switch and activating the CAR with a second switch and comparing CAR-EC fate after the first switch to CAR-EC fate after the second switch. The methods may comprise administering a first switch to a subject and a second switch to the subject and comparing CAR-EC fate after the first switch to CAR-EC fate after the second switch. The methods may comprise administering a first dose of a switch to a subject and a second dose of the switch to the subject and comparing CAR-EC fate after the first dose to CAR-EC fate after the second dose.

Optimizing Switch Valency

[0298] In various embodiments, using methods of optimizing sCAR-T configurations, sCAR-T systems disclosed herein show similar *in vitro* T cell activation, functional cytokine release and cell-killing sensitivity and specificity, and *in vivo* tumor elimination with comparable efficacy as conventional CARs. The examples disclosed herein demonstrate that in some embodiments, the methods of optimization may be highly dependent on switch and CAR hinge design, and less dependent on the targeting modality. Disclosed herein is the development of binary sCAR-T cells which function on multiple inputs (*e.g.*, multiple orthogonal pairs) that enable precise control over sCAR-T cell function.

[0299] Methods of optimizing the CAR-EC platform or CAR-EC switch may comprise incorporating more than one peptidic antigen in to the switch to produce a multivalent switch. In some cases, a bivalent switch may be preferable to a monovalent switch. In some cases, the monovalent switch may be preferable to the bivalent switch. The methods of optimizing may comprise comparing a first effect of a CAR-EC on a target cell wherein the first CAR-BP is a first distance from the second CAR-BP to a second effect of the CAR-EC on the target cell wherein the first CAR-BP is a second distance from the second CAR-BP. The first or second distance may be between about 5 Å and about 100 Å. The first or second distance may be between about 8 Å and about 80 Å. The first or second distance may be between about 10 Å and about 50 Å. The first or second distance may be between about 10 Å and about 50 Å. The first or second distance may be between about 10 Å and about 40 Å. The first or second distance may be between about 10 Å and about 30 Å. The first or second distance may be about 12 Å. The first or second distance may be about 24 Å.

Optimizing the CAR and CAR-EC

[0300] The methods of optimizing may comprise optimizing CAR density on the membranes of the CAR-ECs. Optimizing CAR density on the membranes of the CAR-ECs may comprise modulating the expression of the CAR. This can be done, for example, by engineering cells that express a CAR under a high or low expression promoter. Alternatively, or additionally, CARs may be designed to multimerize on the CAR-EC membrane, creating "rafts" of CARs that stimulate a greater effect (*e.g.,* cytotoxic effect) in the CAR-EC than a single CAR, or even two CARs, alone. This may be acheived, by way of non-limiting example, by incorporating a cysteine residue into the first chimeric antigen receptor and/or the second chimeric antigen receptor in order to multimerize the first chimeric antigen receptor and/or the second chimeric antigen receptor through a disulfide bond.

[0301] The first/second CAR-ECs may be derived from a T cell (*e.g.*, genetically modified T cell or differentiated from a T cell). The CAR-EC may be a T cell. The CAR-EC may be a cell of a T cell lineage. The CAR-EC may be a mature T cell. The CAR-EC may be a precursor T cell. The CAR-EC may be a cytotoxic T cell. The CAR-EC may be a naive T cell. The CAR-EC may be a memory stem cell T cell (T_{MSC}). The CAR-EC may be a central memory T cell (T_{CM}). The CAR-EC may be an effector T cell (TE). The CAR-EC may be a CD4+ T cell. The CAR-EC may be a CD8+ T cell. The CAR-EC may be a CD4+ and CD8+ cell. The CAR-EC may be an alpha-beta T cell. The CAR-EC may be a gamma-beta T cell. The CAR-EC may be a natural killer T cell. The CAR-EC may be a helper T cell. The CAR-EC may be a neutrophil. The neutrophil may be a CD34+ neutrophil. The neutrophil may be engineered or genetically modified to have greater cytoxic capacity than a naturally-occurring neutrophil.

[0302] The methods may further comprise consideration for switch compatiblity with the cell surface molecule and the CAR. The methods may comprise testing compensatory mutations in switches and CARs in the development of a single, universal sCAR.

[0303] Further disclosed herein are optimized chimeric antigen receptor–effector cell platforms, comprising: a chimeric antigen receptor–effector cell switch comprising a chimeric antigen receptor binding peptide and a targeting moiety; and a chimeric antigen receptor–effector cell that expresses a chimeric antigen receptor, wherein the chimeric antigen receptor–effector cell platform is produced/derived by methods of producing an optimal switchable chimeric antigen receptor platform disclosed herein.

XI. Models for Testing CAR-ECs & Switches

[0304] Although xenograft models in immunodeficient mice allow optimization of sCAR-T cell efficacy, in some cases, such models may not be optimal to assess safety (exemplary surrogate models shown in **FIG. 5**). Disclosed herein are model systems for evaluating the efficacy and/or safety of CAR-ECs and corresponding CAR switches. The model system may be selected from an *in vitro* model, an *in vivo* model, and combinations thereof. The model system may be a non-human *in vivo* model. The model system may be a rodent model. The model system may be a murine model. The model system may be a simian model. The model system may be a syngeneic model. The model system may comprise an immunocompetent animal. The immunocompetent animal may be an immunocompetent mouse. For example, immunocompetent mice have endogenous lymphocytes (i.e. T_{reg} cells), as compared to immunodeficient (*e.g.,* NSG) mice, that may affect CAR-EC activity, thus providing a clinically relevant host. The *in vivo* model may be a surrogate model that allows off-targeted cells to re-populate after cessation of the switch. The model system may comprise a murine surrogate CAR-EC cell. The murine surrogate CAR-EC cell may be produced by cloning a sequence encoding an anti-CAR-BP scFv into a viral vector for transduction into murine lymphocytes or splenocytes. The sequence may also comprise sequences encoding murine-derived signaling domains. The murine-derived signaling domains may be selected from CD28, a CD3 domain (*e.g.,* zeta), and combinations thereof.

[0305] The model system may comprise a model system switch. The model system switch may comprise an antibody that targets a non-human antigen on a non-human target cell. The antibody that targets a non-human antigen on a non-human target cell may be an anti-rodent antibody. The antibody that targets a non-human antigen on a non-human target cell may be an anti-mouse antibody. The anti-mouse antibody may be selected from an anti-mouse CD19 antibody, an anti-mouse CLL1 antibody, an anti-mouse CD33 antibody, an anti-mouse BCMA antibody, an anti-mouse CD22 antibody, and an anti-mouse Her2 antibody. The anti-mouse antibody may be a rat anti-mouse CD19 clone 1D3. The anti-mouse CD19 antibody may have a sequence selected from

SEQ ID NOS: 193-203. The model system switch may comprise a CAR-BP. The CAR-BP may be a synthetic (non-naturally occurring) peptide. The CAR-BP may be a non-human peptide. The CAR-BP may have low immunogenicity in a human subject. The CAR-BP may be the yeast transcription factor GCN4.

[0306] *In vitro* cytotoxicity may be tested in the *in vitro* model. The *in vitro* model may comprise a cell line. The cell line may be a mammalian cell line. The cell line may be a cancer cell line. The cancer cell line may be a B cell lymphoma cell line. The B cell lymphoma cell line may be CD19 positive. The B cell lymphoma cell line may be a Myc5-CD19 cell line.

[0307] Model CAR-ECs and switches may be administered with dosing schedules based on xenograft studies. Two or more different CAR-ECs and switches may be compared in these model systems. For example, efficacy and/safety of a Fab switch may be compared to a similar IgG switch.

XII. Libraries

[0308] Disclosed herein are libraries of CAR-EC switches. The libraries of CAR-EC switches may comprise a first switch comprising a first targeting moiety and a universal CAR-BP and a second switch comprising a second targeting moiety and the universal CAR-BP. The libraries of CAR-EC switches may be used with a universal CAR that binds the CAR-BP. The first/second switch may be any CAR-EC switch disclosed herein. The first targeting moiety and the second targeting moeity may be different. The first targeting moiety and the second targeting moeity may be the same.

[0309] Further disclosed herein are pluralities of libraries of CAR-EC switches, comprising a first library comprising a plurality of switches, wherein each switch of the plurality of switches comprises a first universal CAR-BP; and a second library comprising a plurality of switches, wherein each switch of the plurality of switches comprises a second universal CAR-BP. The first universal CAR-BP may interact with a first universal CAR and the second universal CAR-BP may interact with a second universal CAR. The first universal CAR and second universal CAR may differ by a characteristic selected from amino acid sequence, size, length (*e.g.*, extracellular domain length, hinge length), hinge flexibility, and multimerization potential (*e.g.* ability to multimerize when expressed on the CAR-EC). A switch from the first library of switches may be administered to a subject at a different dose than that of a switch from the second library of switches. A switch from the first library of switches may comprise a first targeting moiety and a switch from the second library of switches may comprise a second targeting moiety. The first targeting moiety and the second targeting moiety may be the same. The first targeting moiety and the second targeting moiety may be different.

[0310] The universal CAR-BP may be connected to a first site on the first targeting moiety of the first switch and the universal CAR-BP may be connected to a second site on the second targeting

moeity. The first site and the second site may be the same. The first site and the second site may be different. The first and/or second switch may further comprise a first/second linker. The first linker may be connected to a first site on the first targeting moiety of the first switch and the second linker may be connected to a second site on the second targeting moeity. The first site and the second site may be the same. The first site and the second site may be different.

[0311] The first/second targeting moiety may be an antibody or antibody fragment. The antibody fragment may be a Fab. The antibody or antibody fragment may be an anti-CD19 antibody or anti-CD19 antibody fragment. The antibody or antibody fragment may be an anti-CD20 antibody or anti-CD20 antibody fragment. The antibody or antibody fragment may be an anti-CD22 antibody or anti- CD22 antibody fragment. The antibody or antibody fragment may be an anti-CD33 antibody or anti- CD33 antibody fragment. The antibody or antibody fragment may be an anti-CD123 antibody or anti- CD123 antibody fragment.The antibody or antibody fragment may be an anti-CLL1 antibody or anti-CLL1 antibody fragment. The antibody or antibody fragment may be an anti-CEA antibody or anti-CEA antibody fragment. The antibody or antibody fragment may be an anti-Her2 antibody or anti-Her2 antibody fragment. The antibody or antibody fragment may be an anti-BCMA antibody or anti-BCMA antibody fragment. The antibody or antibody fragment may be an anti-CS1 antibody or anti-CS1 antibody fragment. The targeting moiety may be a T cell receptor. The targeting moiety may be a soluble T cell receptor. The soluble T cell receptor may bind an MHC-restricted NY-ESO-1 peptide.

EXAMPLES

[0312] The following illustrative examples are representative of embodiments of the software applications, systems, and methods described herein and are not meant to be limiting in any way.

***Example 1* – Production and evaluation of a switchable CAR-T platforms**

Switch Production

[0313] The solubility, stability, affinity, and potential for cross reactive epitopes in the human proteome of developed antibodies were considered in choosing a CAR-EC switch peptidic antigen. Based on these criteria, a linear amino acid epitope from the yeast transcription factor GCN4 (7P14P) was chosen. Single chain antibodies with affinities varying from 2.6 nM to 5.2 pM enable optimization of the CAR-EC through binding kinetics. Additionally, these antibodies are among the highest affinity anti-peptide single chain antibodies for linear epitopes. The dissociation constant (Kd) for the chosen GCN4 epitope (7P14P) having a sequence of NYHLENEVARLKKL (SEQ ID NO. 3) and GCN4 binding scFv (52SR4) is 5.2 pM.

[0314] GCN4 peptide eptitope alanine scanning: To determine the residues of the GCN4 epitope NYHLENEVARLKKL (SEQ ID NO. 3) that are important, residues from the N-terminus and from

the C-terminus were replaced with alanines. Peptides (SEQ ID NOS: 75-82) were synthesized by solid phase peptide synthesis. Flow cytometry was used to assess binding to the CAR-T cell harboring the GCN4 CAR (SEQ ID NO. 74) using a fluorophore labeled GCN4 epitope (SEQ ID NO. 3 labeled with HyLyte488 dye). Cells were incubated with a saturating concentration of the GCN4 epitope (1nM) and increasing concentrations of each mutated GCN4 peptide (10pM – 1μM) for 30 minutes in PBS at 4°C. Cells were then washed twice with cold PBS to remove the free labelled peptide before being analyzed using the BD Accuri flow cytometer. The mean fluorescence intensity (MFI) of the AF488 labelled GCN4 peptide was plotted against the concentration of mutated peptide to show that the first 4 residues of the GCN4 polypeptide sequence were important for binding to the anti-GCN4 scFv (**FIG. 6**).

[0315] A small hydrophilic target peptide (HTP), based on the commonly used FLAG® tag, was developed. FLAG® has low antigenicity, is highly soluble, and has been fused to numerous proteins with little impact on protein folding or stability. In modifying FLAG to HTP, a proline residue was incorporated after the terminal lysine in an effort to increase proteolytic stability. Antibodies to this epitope are developed by traditional mouse immunization and subsequent humanization or by phage panning of a human library. Binding kinetics of evolved scFv's are fully characterized and peptide-CAR-ECs are created and tested for off-target specificity as described.

CAR construction

[0316] The CARs were constructed as follows:

[0317] LV-EF1a-GCN4-BBZ (**SEQ ID: 1**) was designed to target the 7P14P epitope of the yeast transcription factor GCN4 (sequence RMKQLEPKVEELLPKNYHLENEVARLKKLVGER (SEQ ID NO. 2) where the underlined amino acids have been shown to bind to the c11L32Ser scFv in the 1P4B crystal structure from PDB. The scFv was constructed from the 52SR4 (high affinity mutant with similar sequence to c11L32Ser) antibody scFv from reference: Zahnd, C., Spinelli, S., Luginbuhl, B., Amstutz, P., Cambillau, C., and Pluckthun, A. (2004) Directed *in vitro* evolution and crystallographic analysis of a peptide-binding single chain antibody fragment (scFv) with low picomolar affinity, *The Journal of Biological Chemistry 279*, 18870-18877.

Example 2. **Evaluation of a switchable CAR-T platform in a xenograft model**

[0318] To evaluate efficacy, mouse xenograft models are used to compare these switchable platforms to previously developed by CAR-T switch platforms. Towards this end, RS4;11, NALM-6, Raji or other CD19 positive cell lines are used to establish tumor models in non-obese diabetic–severe combined immunodeficiency (NOD-SCID-$\gamma^{-/-}$, NSG) mice. CAR-Ts are delivered by intravenous administration. Dose-range finding is carried out for the peptide anti-CD19 switch, and is compared to a wild type CD19 Fab control. Efficacy is judged based on tumor burden and overall survival. Mice are monitored with weekly blood draws to monitor proliferation of CAR-ECs in

peripheral blood. Detailed immunophenotypic characterization of CAR-ECs focus on effector, memory, senescent (terminally differentiated), or anergized phenotypes are defined according to standard phenotypic parameters using multi-channel flow cytometry.

[0319] Primary patient-derived ALL or CLL samples are obtained and for generating xenograft models in NSG mice. Primary samples are characterized for CD19 expression by flow cytometry. Leukemia is established in mice for 2-3 weeks prior to administration of therapy. Efficacy versus CAR-T-19 is judged by monitoring $CD19^+$ ALL blast counts in peripheral blood. In the event that leukemia is not controlled or eliminated, proliferated blasts are immunophenotyped (specifically looking for loss of CD19 antigen expression, *vida infra* for further study). Persistence of CAR-ECs is also monitored (although the latter is not expected to differ substantially from RS4;11-based xenografts).

Example 3. **Production of anti-CD19-Fab/IgG-GCN4 Switches with Varying Positions of Peptide**

[0320] Peptide CAR-EC switches were created by fusing 14 amino acids of the GCN4 yeast transcription factor peptide sequence 7P14P (defined in Zahnd et al. (2004). Directed *in vitro* evolution and crystallographic analysis of a peptide-binding single chain antibody fragment (scFv) with low picomolar affinity, *The Journal of Biological Chemistry 279*, 18870-18877). The 14 amino acids were chosen based on those defined in crystal structure 1P4B of GCN4 peptide 7P14P with scFv c11L32Ser. The switches were constructed by either fusing the GCN4 peptide sequence to the C-terminus of the heavy chain of the Fab antibody or by fusing the GCN4 peptide sequence in the CL loop of the light chain of the Fab or IgG antibody. All expressions were carried out in CHO or HEK cells.

[0321] To create a grafted GCN4 peptide based anti-CD19 CAR-T switch (SEQ ID NO: 30), the peptide NYHLENEVARLKKL (SEQ ID NO: 3), suggested to be the minimal binding epitope according to the crystal structure (PDB: 1P4B) (see **FIG. 8A**) from the yeast transcription factor GCN4 peptide (7P14P) RMKQLEPKVEELLPKNYHLENEVARLKKLVGER (SEQ ID NO: 2), was grafted to the mouse anti-human CD19 Fab clone FMC63. The graft was carried out by replacing K63 (as counted from the N terminus of the constant region, which would be K169 when counting from the N terminus of the mature protein) of the light chain with the sequence GGGGSNYHLENEVARLKKLGGGGS (SEQ ID NO. 4), *i.e.*, the GCN4 epitope flanked by GGGGS linkers (SEQ ID NO: 40, wherein n=1**)**. The mass spec of anti-CD19 Fab LCC1 is provided in **FIG. 8B**. Alternatively, the peptide is grafted to the heavy chain (SEQ ID NO: 29).

[0322] Cloning: Mammalian expression vector of CD19 IgG or Fab heavy/light chains was generated by ligation of amplified CD19 IgG or Fab heavy/light chain to pFuse-hIgG1-Fc backbone vector (InvivoGen, CA) with (IgG) or without (Fab) Fc fragment. A polynucleotide

encoding GCN4 (NYHLENEVARLKKL (SEQ ID NO: 3)) was synthesized with oligonucleotides and grafted into the CD19 IgG or Fab at select positions (HC1 S135, hinge C223, CL1 K169) or fused to the C and N termini of the CD19 IgG or Fab. The resulting mammalian expression vectors were confirmed by DNA sequencing. Switches were expressed through transient transfection of FreeStyle HEK 293 cells with vector pairs of light and heavy chain sequences, according to the manufacturer's protocol. The light heavy/chain pairs are shown below in Table 1. Proteins were purified by Protein G chromatography and then they were analyzed by SDS-PAGE gels. FIG. 13Ashows SDS gel images of the following switches shown in Table 1.

Table 1.Anti-CD19 Fab and IgG Switch peptide chain pairs

Name	Format	Light chain SEQ ID	Heavy chain SEQ ID
WT	Fab	27	29
LCNT	Fab	36	29
HCNT	Fab	27	88
NTBV	Fab	36	88
LCC1	Fab	30	29
HCCT	Fab	27	34
LCCT	Fab	97	29
HCC1	Fab	27	32
C1BV	Fab	30	32
CTBV	Fab	97	32
WT	IgG	27	28
LCNT	IgG	36	28
HCNT	IgG	27	259
NTBV	IgG	36	259
LCC1	IgG	31	28
HCCT	IgG	33	35
LCCT	IgG	97	28
HCC1	IgG	27	33
C1BV	IgG	31	33
CTBV	IgG	97	35

Example 4. **Cytotoxicity of anti-CD19 Fab LCC1, anti-CD19 IgG LCC1 and anti-CD19 Fab-HCCT CAR-EC switches**

[0323] The cytotoxic activity of the anti-CD19 Fab LCC1 switch was assessed with human PBMCs transduced with LV-EF1a-GCN4(52SR4) (**SEQ ID: 1**) to create CAR-T-GCN4 at E:T ratios of 10:1 and 24 hour incubation. Activity was assessed against NALM-6 ($CD19^+$), RS4;11 ($CD19^+$), or RPMI-8226 ($CD19^-$) (**Table 2**). The activity of the IgG (FcNull) switch was assessed against RS4;11 ($CD19^+$), or K562 ($CD19^-$) (**Table 2**). The activity of the C-terminal switch was assessed against RS4;11 ($CD19^+$), or K562 ($CD19^-$) (**Table 4**).

Table 2. Cytotoxicity of the anti-CD19 Fab LCC1 switch (**SEQ ID: 30 & 29**).

	%Cytotoxicity		
Concentration (pM)	NALM-6 (CD19 positive)	RS4;11 (CD19 positive)	RPMI-8226 (CD19 negative)
10	86.74405	104.0488	15.20283
1	82.23607	90.00308	8.149928
0.1	77.28449	84.11992	3.819127
0.01	47.15363	45.37116	2.656606
0.001	-5.794394	-2.258805	-4.993927
0.0001	-7.191706	-8.02902	-7.662813
0.00001	-4.779683	-2.792706	-1.318068

Table 3. Cytotoxicity of anti-CD19 IgG LCC1 switch (**SEQ ID: 31 & 28**).

	%Cytotoxicity	
Concentration (pM)	RS4;11 (CD19 positive)	K562 (CD19 negative)
1	53.56274	6.218475
0.1	48.75237	1.844815
0.01	38.21278	-2.777584
0.001	12.10702	-2.964143
0.0001	0.1621473	-6.301391
0.00001	-0.9188344	-4.891867

Table 4. Cytotoxicity of anti-CD19 Fab HCCT switch (**SEQ ID: 27 & 32**).

	%Cytotoxicity	
Concentration (nM)	RS4;11 (CD19 positive)	K562 (CD19 negative)
10	92.10811	1.44819
1	76.75676	-3.445695
0.1	66.59459	-2.197255
0.01	60.97298	-1.348315
0.001	8.216215	-2.147315
0.0001	-2.162161	-3.046195
0.00001	1.945946	-0.299624

Example 5. **Cytotoxicity of various anti-CD19 switches with peptide grafted/fused to varying and multiple regions of an anti-CD19 antibody or antibody fragment**

[0324] The cytotoxic activities of various anti-CD19-GCN4 CAR-EC switches grafted/fused to different regions of anti-CD19 FMC63 antibodies or antibody fragments were assessed with human PBMCs transduced with the LV-EF1a-GCN4(52SR4) (**SEQ ID: 1**) to create the anti-GCN4 sCAR-T cell (**SEQ ID: 180**), these cells were incubated with RS4;11 (CD19 positive) target cells, at an E:T ratio of 10:1, for 24 hours (**FIG. 11A**). The anti-CD19 Fab switches used in this example are listed in Table 1, and are as follows: anti-CD19 Fab with no grafted peptide (WT; **SEQ ID: 27 & 29**), anti-CD19 Fab with the peptide grafted on the N-terminus of the light chain (LCNT; **SEQ ID: 36 & 29**), anti-CD19 Fab with the peptide grafted on the N-terminus of the heavy chain (HCNT; **SEQ ID: 27 & 88**), anti-CD19 Fab with the peptide grafted on the C-terminus of the light chain (LCCT; **SEQ ID: 97 & 29**), anti-CD19 Fab with the peptide grafted on the N-terminus of the heavy chain (HCCT; **SEQ ID: 27 & 34**), anti-CD19 Fab with the peptide grafted on the C1 domain of the light chain (LCC1; **SEQ ID: 30 & 29**), anti-CD19 Fab with the peptide grafted on the C1 domain of the heavy chain (HCC1; **SEQ ID: 27 & 32**), anti-CD19 Fab with the peptide grafted on the N-terminus of the light chain and heavy chain (NTBV; **SEQ ID: 36 & 88**), anti-CD19 Fab with the peptide grafted on the C-terminus of the light chain and heavy chain (CTBV; **SEQ ID: 97 & 34**), anti-CD19 Fab with the peptide grafted on the C1 domain of the light chain and heavy chain (C1BV; **SEQ ID: 30 & 32**).

[0325] The cytotoxic activities of various anti-CD19-GCN4 CAR-EC switches grafted/fused to different regions of anti-CD19 FMC63 antibodies or antibody fragments were assessed with human PBMCs transduced with the LV-EF1a-GCN4(52SR4) (**SEQ ID: 1**) to create the anti-GCN4 sCAR-T cell (**SEQ ID: 180**), these cells were incubated with RS4;11 (CD19 positive) target cells, at an E:T ratio of 10:1, for 24 hours (**FIG. 24A**). The anti-CD19 IgG switches used in this example are listed in Table 1, and are as follows: anti-CD19 IgG with no grafted peptide (WT; **SEQ ID: 27 & 28**), anti-CD19 IgG with the peptide grafted on the N-terminus of the light chain (LCNT; **SEQ ID: 36 & 28**), anti-CD19 IgG with the peptide grafted on the N-terminus of the heavy chain (HCNT; **SEQ ID: 27 & 259**), anti-CD19 IgG with the peptide grafted on the C-terminus of the light chain (LCCT; **SEQ ID:97 & 28**), anti-CD19 IgG with the peptide grafted on the N-terminus of the heavy chain (HCCT; **SEQ ID: 33 & 35**), anti-CD19 IgG with the peptide grafted on the C1 domain of the light chain (LCC1; **SEQ ID: 31 & 28**), anti-CD19 IgG with the peptide grafted on the C1 domain of the heavy chain (HCC1; **SEQ ID: 27 & 33**), anti-CD19 IgG with the peptide grafted on the N-terminus of the light chain and heavy chain (NTBV; **SEQ ID: 36 & 259**), anti-CD19 IgG with the peptide grafted on the C-terminus of the light chain and heavy chain (CTBV; **SEQ ID: 97 & 35**),

anti-CD19 IgG with the peptide grafted on the C1 domain of the light chain and heavy chain (C1BV; **SEQ ID: 31 & 33**).

[0326] FIG. 9 depicts certain non-limiting examples of the grafting positions of some of the switches described in this example. All formats were expressed in the Fab or IgG format. The N-terminus grafting is shown as grafted to the light chain, however N-terminal grafting is not restricted to the light chain or Fab and may also be grafted to the heavy chain as well as the IgG format. The C-term position on the Fab is isosteric with the hinge IgG. In this context all Fab constructs are monovalent and all IgG constructs are bivalent.

Example 6. **Anti-CD19 sCAR-T cell and switch structural activity relationship (SAR)**

[0327] General LDH release cytotoxicity assay method

[0328] sCAR-T cells were co-cultured (96-well plate round bottom; 20-24h; 37°C; 5% CO_2) with RS4;11 ($CD19^+$) or K562 ($CD19^-$) cells at a ratio of 10 sCAR-T cells to 1 RS4;11/K562 cell (110,000 cells in total) in 100uL of RPMI-1640 supplemented with 5% heat inactivated fetal calf serum (Thermo), 1% penicillin-streptomycin (Gibco), 1% L-Glutamine (Gibco), 1mM sodium pyruvate (Gibco) and 1% non-essential amino acids (Gibco). After 24 hours, each plate was centrifuged at 400xg for 5 minutes at 4°C. To measure target cell lysis, the intracellular protein lactate dehydrogenase (LDH) was measured in the cytotoxicity assay supernatants from the co-cultured cells using the CytoTox 96® Non-Radioactive Cytotoxicity Assay kit (Promega). To measure the effector responses of the sCART cells in vitro, cytokine levels were measured in the cytotoxicity assay supernatants using the Cytometric Bead Array (CBA) Human Th1/Th2 Cytokine Kit II (BD). To measure the activation state of the sCART cells *in vitro*, the cells from the cytotoxicity assay were washed in PBS containing 1% BSA and 1mM EDTA, stained with anti-CD25 (BC96; PE; BioLegend), anti-CD69 (FN50; PerCP; BioLegend) and anti CD3 (APC; OKT3; BioLegend), and analyzed using the BD Accuri flow cytometer; $CD3^+CD25^+CD69^+$ were classified as activated T cells.

[0329] General flow cytometry based cytotoxicity assay

[0330] The flow cytometry based cytotoxicity assay were performed in RPMI-1640 media supplemented with 5% heat inactivated FBS, 1% Pen/Strep, 1% glutamine, and 1% Sodium pyruvate. Target cells (2x104 cells) were pre-labeled with CellVue Claret Far Red Fluorescent Cell linker (Sigma-Aldrich) and co-cultured with 1x105 sCAR-T cells. Variable concentration of switch was added to asses *in vitro* activity. This assay was conducted in a volume of 100 ul in 96-well U bottom plate for 24 hours, after which the cells were stained with 7-AAD viability dye (1:100; BD Biosciences) in FACs staining buffer (PBS with 2mM EDTA and 1% FCS) and acquired on BD Accuri C6 flow cytometer. The viability was calculated as following formula:

% viability = [(no switch viable target cells-experimental viable target cells)/no switch viable target cells]*100

[0331] Hinge development

[0332] The length of the CAR determines the distance between the CART cell and target cell. In the case of a canonical CAR this distance is fixed however with the switchable CART cell system this can be modified to provide optimal cell-cell contact conditions for cytotoxicity. Introducing a switch to the immunological increases the distance between target and effector cells, in some scenarios this added length may be beneficial or detrimental to cytotoxicity.

Hinge development

[0333] The GCN4 CAR design was therefore modified to contain the CD8 hinge region (used in CART-19), which has an extracellular CAR domain of approximately 80Å, and an IgG4 hinge with an extracellular CAR domain of approximately 15-30Å. An additional construct was developed where a mutation was introduced into the IgG4 hinge that allows for spontaneous disulphide bridge formation between receptor molecules (IgG4m). These three CAR designs were compared using a monovalent anti-CD19 LCNT switch (**SEQ ID: 36 & 29**) against the RS4;11 ($CD19^+$) cell line. Briefly, activated PBMC were transduced with lentivirus (**SEQ ID: 1**) containing the anti-PNE CAR construct (**SEQ ID: 180**) with the CD8 (**SEQ ID: 68**), IgG4 (**SEQ ID: 70**) and IgG4m (**SEQ ID: 71**) hinge domains. These cells were cultured for 12 days before *in vitro* activity with the anti-CD19 Fab LCNT switch (**SEQ ID: 29 & 36**) was determined. **FIG. 10A** shows the switch activity as assessed by analyzing the levels of LDH (*see,* General LDH release cytotoxicity assay **[0323]**). **FIG. 27B** shows switch acitivity as assessed by measuring proinflammatory cytokines released into the culture supernatants, and as shown in **FIG. 10A**, potency for cytoxicity increases with shorter hinge anti-peptide CARs (LDH, E:T 10:1, 24hr). No non-specific lysis of K562 cells was observed (**FIG. 10B**). Further, CARs with IgG4 hinge domains have lower EC_{50} values in cytotoxicity LDH assays (**FIG. 10C**).

Switch structural activity relationship (SAR)

[0334] The location of peptide engraftment onto the Fab switches determines the relative orientation of CART cell to target cell which greatly influences cytotoxicity. The position of the epitope that each switch binds to, be it membrane distal (far from the membrane) or membrane proximal (close to the membrane), occupies a space in the extracellular matrix that may be optimal or suboptimal for sCART cell killing. With the switchable CART cell system the peptide can be engrafted into different domains of the Fab switch to alter the overall orientation of the immunological synapse.

[0335] An example of switch SAR is demonstrated with an anti-CD19 switch derived from the anti-CD19 antibody Fmc63. GCN4 peptide was engrafted N-terminally, or C-terminally on each of

the heavy and light chain of the Fmc63 anti-CD19 Fab molecule, or to the constant region of the light chain (CL1)(SEQ ID NOS: 30, 34, 36, 88, 97). Monovalent and bivalent combinations of these switches were expressed in mammalian protein expression systems (HEK293 or CHO cells) and purified using protein-G columns. Switches were used in cytotoxicity assays at a dose titration within the range of 10nM to 0.0001nM. The activity of each switch combination was tested *in vitro* in the General cytotoxicity assays where LDH release, cytokine production and sCART cell activation were compared (**FIGS. 11A-11C**). In terms of LDH release, N-terminal engraftment positions on both the light (LCNT) and heavy chains (HCNT) showed the highest levels of cytotoxity against $CD19^+$ RS4;11 cells which correlated with elevated levels of IFNγ and IL-2 along with increased T cell activation (see **FIGS. 11A-11B**). Switch positions in the CL1 loop and C-terminal positions had lower cytotoxicity levels (**FIG. 11A**) which correlated with reduced cytokine production and sCART cell activation (**FIG. 11C**).

[0336] A second example of a switch SAR is demonstrated with an anti CD22 switch.

[0337] CD22 is a 135-kDa glycoprotein that is expressed in most B cell lineage and is therefore an option for the targeting of malignant B cells in non-Hodgkin's lymphomas (NHL), follicular lymphoma (FL), diffuse large B-cell lymphoma (DLBCL), and systemic lupus erythematosus. Several CD22 targeting antibodies have been published in the literature. Several of these were expressed in switch format and empirically tested in combination with the sCAR-T cells. Previously we have found that the epitope location of the antibody has a significant impact on the activity of the switchable CAR-T cell (Rodgers et al., PNAS 2016, 113:E459-68, Ma et al., PNAS 2016, 113:E450-8).

[0338] The first set of anti CD22 switches in this example were derived from the anti-CD22 antibody clone hLL2 (SEQ ID NOS: 186 and 187), which binds the membrane distal domain of CD22 with high affinity (KD = ~0.7 nM). hLL2 switches with N-terminal (SEQ ID NO: 188) or C-terminal (SEQ ID NO: 189) grafts of GCN4 (SEQ ID NO: 3) on the light chain were designed. hLL2 switches with N-terminal (SEQ ID NO: 190) or C-terminal (SEQ ID NO: 191) grafts of GCN4 (SEQ ID NO: 3) on the heavy chain were designed. . Switches were expressed in mammalian protein expression systems (HEK293 or CHO cells), purified using protein-G columns, and their ability to induce cytotoxicity of Raji cells (CD22+) was tested using the general flow cytometry based cytotoxicity assay described herein.

[0339] Switches were tested using a dose titration within the range of 10nM to 0.00001nM. **FIG. 28b** and Tables 5 and 6 show flow cytometry based cytotoxicity assay whereby sCAR-T cells (SEQ ID NO: 74) were cultured with Raji cells (CD22+) and the anti-CD22 (clone hLL2) WT (SEQ ID NO: 186 and 187), LCCT (SEQ ID NO: 189 and 187), HCCT (SEQ ID NO: 186 & 191), CTBV (SEQ ID NO: 189 & 191), LCNT (SEQ ID NO: 188 and 187) and NTBV (SEQ ID NO: 188 &

190) Fab switches. These data show that hLL2 based anti-CD22 switches with the GCN4 peptide (SEQ ID NO: 3) engrafted at the C-terminus of the FAB switch have optimal activity.

Table 5. EC50 from **FIG. 28B**

	WT	**LCCT**	**HCCT**	**CTBV**	**LCNT**	**NTBV**
EC50 (pM)	N/A	131.9	1343	69.11	6557	135.1

Table 6. Raw data of cytotoxicity from **FIG. 28B**

Conc. (pM)	**hLL2-WT**	**hLL2-LCCT**	**hLL2-HCCT**	**hLL2-LCNT**	**hLL2-CTBV**	**hLL2-NTBV**
0.01	2.81	-2.13	1.30	2.50	1.34	1.52
0.1	2.64	-0.84	6.05	2.21	0.18	2.19
1	4.59	-0.01	7.67	0.33	1.38	4.20
10	5.12	4.80	8.27	3.91	4.10	2.07
100	5.40	23.84	7.35	3.09	28.19	2.52
1000	5.72	49.64	24.96	5.19	46.91	-2.07
10000	3.46	56.47	45.11	15.81	44.17	1.50

[0340] A third example of a switch SAR is demonstrated with an second set of anti CD22 switches, which were derived from the anti-CD22 antibody clone m971 (SEQ ID NOS: 106, 107). M971 binds the membrane proximal domain of CD22 with low affinity (KD = ~25 nM). m971 switches with N-terminal (SEQ ID NO: 109) or C-terminal (SEQ ID NO: 111) grafts of GCN4 peptide (SEQ ID NO: 3) on the light chain were designed. m971 switches with N-terminal (SEQ ID NO: 108) or C-terminal (SEQ ID NO: 110) grafts of GCN4 peptide (SEQ ID NO: 3) on the heavy chain were also designed. Switches were expressed in mammalian protein expression systems (HEK293 or CHO cells), purified using protein-G columns, and their ability to induce cytotoxicity of Raji cells (CD22+) was tested using the general flow cytometry based cytotoxicity assay described herein.

[0341] FIG. 28C and Tables [xx and xx] show results from the cytotoxicity assay, whereby sCAR-T cells (SEQ ID NO: 74) were cultured with Raji cells (CD22+) and the anti-CD22 (clone m971) WT (SEQ ID NOS: 106, 107), LCCT (SEQ ID NOS: 106, 111), HCCT (SEQ ID NOS: 107,110), CTBV (SEQ ID NOS: 110, 111), LCNT (SEQ ID NOS: 106, 109), HCNT (SEQ ID NOS: 107, 108) or NTBV (SEQ ID NOS: 108, 109) Fab switches. These data show that m971 based anti-CD22 switches with the GCN4 peptide (SEQ ID NO: 3) engrafted at the C-terminus of the FAB switch have optimal activity.

TABLE 7. EC50 from **FIG.28C**

	WT	LCCT	HCCT	CTBV	LCNT	HCNT	NTBV
EC50	N/A	N/A	N/A	3.846	395.6	398.0	3.505

(pM)							

TABLE 8. Raw data of cytotoxicity from **FIG.28C**

Conc. (pM)	WT	LCCT	HCCT	LCNT	HCNT	CTBV	NTBV
0.1	13.60544	17.18721	18.36735	14.62585	17.68708	14.96599	12.92517
1	18.36735	15.1464	15.64626	18.70748	19.04762	14.96599	13.26531
10	15.64626	13.44572	12.92517	14.96599	15.9864	18.36735	18.70749
100	18.02721	15.1464	11.90477	17.0068	20.7483	16.66667	21.08844
1000	15.64626	15.1464	15.9864	13.94558	43.87755	18.70748	19.38776
10000	16.66667	30.45252	29.2517	14.62585	48.29932	20.40816	20.06803

[0342] We tested whether we could increase activity by further increasing the distance between sCAR-T and target cells. This can be achieved by adding a linker, e.g., by extra GGGGS linkers (SEQ ID: 40) between the peptide (SEQ ID: 3) and the anti-CD22 switch. To test this, hLL2 derived anti-CD22 switches were created with 1 GGGGS linker (CTBV1; SEQ ID: 189 & 191), 2 GGGGS linker (CTBV2; SEQ ID: 192 & 194) or 3 GGGGS linker (CTBV3; SEQ ID: 193 & 195). **FIG. 28D** shows SDS gel images of these constructs, which are labled "hLL2-CTBV 1" for anti-CD22 (clone hLL2)-Fab CTBV1 (SEQ ID: 189 & 191), "hLL2-CTBV 2" for CTBV2 (SEQ ID: 192 & 194) , and "hLL2-CTBV 3" for CTBV3 (SEQ ID: 193 & 195). M represents protein marker.

[0343] The molecular weights of hLL2 Fab with GCN4 tag was determined by Q-TOF LC/MS (FIG. 28E and Table 9. **FIG. 28E** shows spectrometry of these anti-CD22 (clone hLL2)- Fab-CTBVs and Table 9 shows the difference in expected and observed masses, listed as Da error, which is attributable to an N-terminal glutamine to pyroglutamate conversion.

Table 9. Data from **FIG. 28E**: Q-TOF LC/MS determined molecular weights of hLL2 Fab with GCN4 tag determined by.

hLL2-Fab	Expected	Observed	Da error
CTBV1	51861.87	51845.98	-15.89
CTBV2	52492.44	52476.64	-15.80
CTBV3	53123.02	53107.15	-15.87

We tested the ability of these hLL2-CTBV switches to induce cytotoxicity of sCAR-T cells using a flow cytometry based cytotoxicity assay, as discussed above, whereby sCAR-T cells (SEQ ID: 74) were cultured with Raji cells (CD22+) and either one of the anti-CD22 CTBV1, CTBV2 and CTBV3 switches. As shown in **FIG. 28F** and Tables [XX and XX], cytotoxicity of sCAR-T cells with short-dimeric hinge against Raji cells (CD22+) was not significantly different between the groups treated with the CTBV1 (SEQ ID: 189 & 191), CTBV2 (SEQ ID: 192 & 194) or CTBV3 (SEQ ID: 193 & 195) switches. Importantly, these data demonstrate that, although activity was not

improved significantly by the extension of the linker, the linkers separating the peptide from the FAB can be manipulated without loosing activity. The raw data used to generate **FIG. 28F** is shown below in Table 10, and EC50 values calculated from this data are shown in Table 11.

Table 10. Raw data of **FIG. 28F** cytotoxicity by anti-CD22 CTBV1, CTBV2 and CTBV3 switches.

Conc. (pM)	hLL2-CTBV1	hLL2-CTBV2	hLL2-CTBV3
0.01	4.60	7.08	2.54
0.1	3.60	2.90	7.90
1	2.68	13.37	12.95
10	10.39	22.10	16.99
100	42.20	45.81	51.27
1000	47.38	45.77	45.27
10000	44.85	45.99	41.54

Table. 11. EC50 values from **FIG. 28F** showing cytotoxicity induced by anti-CD22 CTBV1, CTBV2 and CTBV3 switches.

	hLL2-CTBV1	hLL2-CTBV2	hLL2-CTBV3
EC50 (pM)	28.77	12.65	14.89

Example 7. Use of IgG based switches to improve anti-CD22 switch efficacy

[0344] We tested whether the efficacy of anti-CD22 switches against Raji cells may be improved by using IgG based switches, which would provide higher affinities than the FAB based switches. Increasing the affinity of the switch to the target cell, through use of a IgG vs Fab, may increase activity of the sCAR-T cells. An IgG format will also increase the valency of the molecule to 2 in the case of LCCT and HCCT, or 4 in the case of CTBV.

[0345] Anti-CD22-IgG switches were generated for both the m971 and hLL2 clones, each of which demonstrated *in vitro* activity in the FAB format. The GCN4 peptide (SEQ ID NO: 40) was engrafted onto the LCCT (SEQ ID NOS: 189, 196) or the IgG HCCT (SEQ ID NOS: 186, 197) of the hLL2 clone (**FIG. 28G**), and the GCN4 peptide (SEQ ID NO: 40) was also engrafted onto the LCCT (SEQ ID NOS: 111, 198) or the IgG HCCT (SEQ ID NOS: 107, 199) of the m971 clone (**FIG. 28G**). **FIG. 28H** shows SDS gel images of these constructs after expression and purification as described in the above examples.

[0346] **FIG. 28I** and Table 12 show the molecular weights of anti-CD22-IgG (clone m971)-LCCT, HCCT, and CTBV, as determined by Q-TOF LC/MS. Samples were treated with PNGase F for deglycosylation and 10 mM DTT for reduction. Da error in heavy chain of LCCT caused by

cleavage of lysine at C-terminus of heavy chain. Da erroring heavy chains of HCCT and CTBV came from the N-terminal glutamine to pyroglutamate conversion.

Table 12. Data from **FIG. 28I**: Q-TOF LC/MS-determined molecular weights of m971-IgG switches with GCN4 tag.

	expected		observed		Da error	
m971-IgG	LC	HC	LC	HC	LC	HC
LCCT	25514.39	49697.93	25511.57	49547.69	-2.82	-150.24
HCCT	23490.13	51722.19	23487.21	51700.26	-2.92	-21.93
CTBV	25514.39	51722.19	25511.52	51700.08	-2.87	-22.11

[0347] FIG. 28K and Table 13 show the molecular weights of anti-CD22-IgG (clone hLL2)-LCCT, HCCT, and CTBV, as determined by Q-TOF LC/MS. Samples were treated with PNGase F for deglycosylation and 10 mM DTT for reduction. Da error in heavy chain of LCCT caused by cleavage of lysine at C-terminus of heavy chain. Da erroring heavy chains of HCCT and CTBV came from the N-terminal glutamine to pyroglutamate conversion.

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Table 13. Data from **FIG. 28K**: Q-TOF LC/MS-determined molecular weights of hLL2-IgG switches with GCN4 tag.

	expected		observed		difference	
hLL2-IgG	LC	HC	LC	HC	LC	HC
LCCT	26087.03	49137.32	26084.12	48986.78	-2.91	-150.54
HCCT	24062.77	51161.58	24059.67	51139.46	-3.1	-22.12
CTBV	26087.03	51161.58	26084.1	51139.43	-2.93	-22.15

[0348] The activity of each of these m971-IgG and hLL2-IgG switches, as compared to respective bivalent m971-FAB and hLL2-FAB switches, was assessed in a flow cytometry based cytotoxicity assay, as described above. sCAR-T cells (**SEQ ID: 74**) were cultured with Raji cells (CD22+) and with various concentrations of the switches, which concentrations are indicated on the x axis of the figure (**FIG. 28J** and **FIG. 28L**). The raw data used to generate **FIG. 28J** is shown below in Table 15, and EC50 values calculated from this data are shown in Table 14; the raw data used to generate **FIG. 28L** is shown below in Table 17, and EC50 values calculated from this data are shown in Table 16.

[0349] As shown in **FIG. 28J** and **FIG. 28L,** for both the m971-FAB and hLL2-FAB switches, the highest efficacy was observed with the HCCT switches.. Thus, in these examples, use of IgG-based switches led to increased efficacy for cytotoxicity.

[0350]

Table. 14. m971-IgG switch EC50 values from **FIG. 28J** for inducing cytotoxicity

	m971 IgG LCCT	**m971 IgG HCCT**	**m971 IgG CTBV**	**m971 Fab CTBV**
EC50 (pM)	194.2	18.13	83.15	777.5

Table. 15. Raw data of **FIG. 28J** m971-IgG cytotoxicity

Conc. (pM)	**m971 IgG LCCT**	**m971 IgG HCCT**	**m971 IgG CTBV**	**m971 Fab CTBV**
0.06	1.51	5.33	3.93	-1.20
0.30	0.42	5.65	4.93	2.20
1.52	-3.01	8.14	2.68	-2.05
7.62	-1.47	18.32	6.31	0.47
38.10	2.52	31.68	13.48	-1.00
190.48	8.43	40.50	16.16	1.78
952.40	13.12	45.89	23.27	-2.47
4762.00	16.64	45.16	26.32	-1.02

Table. 16. hLL2-IgG switch EC50 values from **FIG. 28L** for inducing cytotoxicity

	hLL2 Fab CTBV	**hLL2 IgG LCCT**	**hLL2 IgG HCCT**	**hLL2 IgG CTBV**
EC50 (pM)	55.55	26.93	15.32	34.69

Table. 17. Raw data of **FIG. 28L** hLL2-IgG cytotoxicity

Conc. (pM)	**hLL2 Fab CTBV**	**hLL2 IgG LCCT**	**hLL2 IgG HCCT**	**hLL2 IgG CTBV**
0.06	-3.84	-2.80	0.25	4.45
0.30	-0.28	-7.88	-1.05	-3.82
1.52	-4.59	-6.59	-4.45	5.34
7.62	0.02	0.95	8.18	7.92
38.10	6.77	14.07	20.88	18.33
190.48	20.72	24.40	31.78	29.82
952.40	21.70	25.43	31.70	28.61
4762.00	24.28	28.46	24.14	38.05

Example 8. Optimization of CAR platform- Modulating the Immunological Synapse with compensatory modifications of switch peptide positionand CAR hinge length

[0351] To understand the relationship between peptide grafting positions and switchable CAR T (sCART) cell activity, several switch designs were generated with varied peptide engraftment positions.The expression of these were confirmed by protein gel (**FIG. 13A**) and QTOF mass spectrometry (**Table 18**) and switches showed good serum stability (**FIGS. 14-15**).

Table 18

FMC63	Protein mass (Da)		Error	
Protein	Expected	Found	ppm	Da
WT	47321.99	47323.03	-21.98	1.04
LCNT	49346.25	49346.93	-13.78	0.68
HCNT	50312.44	50314.54	-41.74	2.10
NTBV	52336.70	52339.41	-51.78	2.71
LCC1	49533.36	49534.46	-22.21	1.10
HCC1	49517.41	49518.86	-29.28	1.45
C1BV	51728.78	51730.26	-28.61	1.48
LCCT	49160.00	49161.32	-26.85	1.32
HCCT	49346.25	49347.13	-17.83	0.88
CTBV	51184.26	51185.83	-30.67	1.57

[0352] Switches with GCN4 peptide at different grafting positions (**FIG. 9**) on the anti-CD19 antibody FMC63 were used in a LDH release cytotoxicity assay and cytokine production was also measured. These data indicate a clear structure activity relationship between the different peptide grafting positions (**Table 19**). None of the switches had off-target effects when tested against the $CD19^-$ K562 cell line. The optimal peptide engraftment position for *in vitro* killing of RS4;11 ($CD19^+$) cells was at the N-terminal of the switch. Furthermore, the N-terminal bivalent construct had a low EC_{50} of cytotoxicity and enhanced cytokine production indicating that bivalent switches may have enhanced activity.

Table 19. Potency on CD19-positive cells

Switch	Valency	EC_{50} (nM)
WT	N/A	N/A
LCNT	Mono	0.0011
HCNT	Mono	0.0027
NTBV	Bi	0.0047
LCC1	Mono	0.0104
HCCT	Mono	0.0263

[0353] To assess ternary complex formation, flow cytometry (FACS) was used to measure the number of double positive cell doublets that formed with increasing concentration of the switch. sCAR-T cells and RS4;11 cells were labeled with different cell stains (CFSE, FITC) and Cellvue Claret(APC)) prior to assay to enable read-out. FITC/APC double positive cell doublets were used as a surrogate read-out for the number of synapses between CAR-T cells and target cells. More synapses correlate with more double positives. In this assay the E:T was 10:1 making the theoretical maximum ternary complex percentage approximately 10%. An increased number of double positives were found with increasing concentrations of the switch. The bivalent switch A+B1 had a more potent EC50 of complex formation compared with the monovalent switches A or

B1 (**FIG. 16**). However, the bivalent switch had a lower maximum ternary complex formation which is hypothesized to relate to the concepts of auto-inhibition.

Anti-CD19 CAR hinge optimization

[0354] The addition of the switch to the sCART cell system means that there is a greater distance between the surface of the effector and target cell when compared to a conventional CART19 cell. It is possible that this has an effect on sCART cell activity. To test this, switchable and conventional anti-CD19 CAR-T platforms were compared with long and short CAR hinges. To reduce the length of the sCAR and immunological synapse, the CD8 hinge, which was initially selected due to its inclusion in the CART19 construct, was replaced with a shorter hinge derived from IgG4 (**FIG. 17**). Furthermore, as the bivalent switch generated enhanced cytokine responses the IgG4 hinge was mutated (IgG4m) so to form intra-chain disulphide bridges; thus enhancing sCAR dimerization. The max kill (highest cytotoxicity %) and EC_{50} was improved by the inclusion of the IgG4 and IgG4m hinges indicating that the shorter immunological synapse created by the shorter sCAR and N-terminal switches improves cytotoxicity (see **FIGS. 10A-C** and **Table 20**).

Table 20. Potency on CD19-positive cells

Switch	Valency	EC_{50} (nM)
WT	N/A	N/A
A	Mono	0.0020
A1	Mono	0.0008
A+A1	Bi	0.0028
B1	Mono	0.0014
C1	Mono	0.0011

Testing CAR hinge variants with anti-CD19 switch variants in vivo

[0355] The different sCAR designs were tested in a xenograft model harboring luciferized NALM-6 (CD19+, CD80-, CD86-) cells. 1 mg/kg monovalent switch "A" was administered along with sCAR cells. The short-dimeric sCAR with a switch "A" was most comparable to conventional anti-CD19 CART in tumor regression. Optimized hinge improved response. Short hinge CARs have faster clearance. Short, dimeric hinge CARs have improved persistence. Tumor burden was visualized with IVIS imaging. Experiments are repeated with a humanized scFv and bivalent switches.

Example 9.* Anti-CD19 Fab switch tumor penetration and residence, *in vivo

[0356] Fab switches were able to penetrate tumors, *in vivo*, as demonstrated by labelling the anti-CD19 Fab switch molecules with a near-infrared dye (Alexa Fluor 700), which were detected using an IVIS machine. **FIG. 18** shows localization of switches with tumor burden (NALM-6-luc subcutaneous tumor). Tumor residence kinetics are shown in **FIG. 19**, with residence peaking at 2hr. These data show that the Fab switches have a good half-life in solid tumors and.

Example 10. **Development of an orthogonal anti-CD19 sCAR-T cell**

[0357] A 14 amino acid peptide neo-epitope (PNE) sequence was the target of the sCAR. This sequence has no instance in the human proteome and thereby provides an exclusive orthogonal interaction between the sCAR-T cell and switch. As the PNE is derived from a protein naturally found in yeast, the risk of immunogenicity was assessed *in silico* (EpiVax, RI) which predicted the PNE to have a low risk of immunogenicity in humans **(FIG. 20B)**. To generate switches, the PNE was grafted at defined sites in the anti-CD19 antibody FMC63. The antigen binding region of the antibody switch relative to the scFV on the T cell surface was systematically varied with respect to valency and orientation (**FIG. 9** & **FIG. 20A**). Four fusions of the PNE were generated by linking the PNE to the N- or C-terminus (NT, CT, respectively) of the heavy and/or light chains (HC, LC, respectively) of the antigen binding fragment (Fab) with short peptide linkers. The GGGGS linker was suitable in all positions except for fusion to the N-terminus of the heavy chain (HCNT) which gave increased yields with a rigid, helical linker sequence. In addition, the PNE was grafted directly into loops of the constant region 1 (C1) of the heavy and light chains. These constructs provided distinct binding orientation of the sCAR relative to the target antigen which in some embodiments is preferable for binding to certain antibody epitopes on target antigens. Furthermore, the PNE was engrafted into both the heavy and light chains to create bivalent switches, thus doubling the number of sCAR's that engage with each antigen. PNE-grafted switches were efficiently expressed in transient transfections using HEK cells with yields 50%-100% compared to yields of the wild type FMC63 antibody. Engraftment of the PNE to the Fab at all sites had minimal impact on protein stability and antigen binding as determined by thermal melt assay (**FIG. 21A** and **Table 21**) and flow cytometry (**FIGS. 21B, 21C**), respectively.

Table 21

Switch	Sample	T_m 1 (Fab)	St. Error	T_m 2 (Fc)	St. Error
Fab	WT	84.77	0.19	--	--
	LCNT	83.93	0.16	--	--
	HCNT	83.86	0.22	--	--
	NTBV	82.68	0.16	--	--
	LCC1	76.75	0.25	--	--
	HCCT	84.33	0.19	--	--
	LCCT	73.96	0.08	--	--
	CTBV	73.29	0.1	--	--
	HCC1	82.98	0.19	--	--
	C1BV	75.25	0.12	--	--
IgG	WT	85	0.09	67.78	0.09
	LCNT	84.26	0.09	66.85	0.18
	HCNT	84.45	0.09	67.87	0
	NTBV	83.34	0.23	67.87	0
	LCC1	77.13	0	67.97	0.09
	HCCT	85.1	0.19	67.5	0
	LCCT	73.42	0	70.92	2.89
	CTBV	73.51	0.19	67.68	0.21
	HCC1	83.6	0.21	67.68	0.21
	C1BV	72.21	0.06	68.23	0

[0358] An sCAR-T cell that recognizes the switch was created using the high affinity scFv (52SR4; K_d = 5.2 pM) specific for the PNE, incorporated into a second generation CAR harboring human CD8 hinge, CD8 transmembrane, 4-1BB costimulatory, and CD3ζ activation domains (SEQ ID NO: 1). Lentiviral transduction of this construct into freshly isolated human PBMCs demonstrated efficient surface expression with transduction efficiencies of 50-70% (**FIG. 22A**). The switches bound to $CD19^+$ RS4;11 (EC_{50} ±S.D. = 5.6nM ± 6.3) cells but not $CD19^-$ K562 cells (**FIGS. 21B** and **21C**). The switches also bound to sCAR-T cells and not to un-transduced T cells (**FIGS. 22B, 22C**), demonstrating that the sCAR-T cell-switch interaction is highly specific.

Example 11. **PNE grafting position controls sCAR-T cell potency *in vitro***

[0359] The optimal switch design for CD19 was determined empirically. The effect of switch design on activity was determined by assaying the potential of each switch to induce target cell cytotoxicity, T cell activation, and cytokine production. All switches elicited dose-dependent lysis of RS4;11 cells in the presence of sCAR-T cells at picomolar (pM) concentrations (**FIG. 23 A, D** and **FIG. 24A-B**). There was a clear structure activity relationship (SAR) between cytotoxicity and the location of the PNE in the antibody: Switches with both PNE engrafted proximal to the antigen binding site of the Fab (LCNT, HCNT, NTBV) were more potent than switches with the PNE at the center (LCC1, HCC1, C1BV) or C-terminus (LCCT, HCCT, CTBV) of the Fab region (**FIG. 11A and Table 22**). No significant lysis of $CD19^-$ K562 cells was observed for any Fab or IgG switch design, even at concentrations 10^3 fold higher than the EC_{50} (**FIG. 11B**). In addition, wild type

anti-CD19 Fab and IgG lacking the PNE peptide did not induce significant cytotoxicity, demonstrating the strictrequirement for PNE-mediated immunological synapse formation.

Table 22

Chain	Position	Location	EC_{50} (pM)
LC	NT	proximal	2.1 ± 1.3
HC	NT	proximal	2.1 ± 1.6
BV	NT	proximal	9.3 ± 1.8
LC	C1	central	2.5 ± 2.4
HC	C1	central	2.4 ± 1.9
BV	C1	central	10.3 ± 3.6
LC	CT	distal	14.8 ± 1.1
HC	CT	distal	20 ± 0.9
BV	CT	distal	9.3 ± 2.2

[0360] Consistent with the cytotoxicity results, all switches induced robust multi-cytokine release (IL-2, IFNγ, TNFα; **FIG. 11C**) with the N-terminally grafted switches providing greater cytokine levels than the constant region or C-terminally positioned switches. Notably, the bivalent NTBV switch induced the greatest cytokine production against RS4;11 cells, indicating a benefit to the recruitment of two sCAR with one switch. Again, no switch stimulated cytokine release against $CD19^-$ K562 cells in the presence of the sCAR-T cells confirming that switch binding alone was not responsible for sCAR-T cell activation (**FIG. 11C**). In addition, markers of T cell activation ($CD25^+$, $CD69^+$) were upregulated by the sCAR-T cells in response to RS4;11 cells only in the presence of switch and $CD19^+$ cells. These results demonstrate that sCAR-T cell effector function in terms of activation, cytokine production, and target cell killing is dependent on the presence of both a target antigen and switch.

[0361] A similar panel of switches was constructed to target CD20 expressing cancers based on the anti-CD20 antibody Ofatumumab (OFA) (**FIG. 13B, Table 23**). Along with CD19, CD20 is an important pan-B cell antigen, and it is widely targeted therapeutically by monoclonal antibodies in clinical usage. Consistent with the SAR trend for FMC63, N-terminally grafted switches were found to be more potently cytotoxic than C-terminally grafted switches against $CD20^+$ Raji cells (**FIG. 25A**). In addition, N-terminally grafted switches stimulated higher levels of cytokine release at 1 nM (**FIG. 25B**).

Table 23

OFA	Protein mass (Da)		Error	
Protein	Expected	Found	ppm	Da
WT	47447.42	47448.52	-29.51	1.4
LCNT	49471.38	49473.84	-49.73	2.46
HCNT	50437.57	50439.74	-43.02	2.17
NTBV	52461.83	52465.00	-60.42	3.17
LCCT	49471.38	49472.77	-28.10	1.39
HCCT	49471.38	49473.05	-33.76	1.67
CTBV	51495.64	51497.13	-28.93	1.49

Example 12. **Optimization of the anti-CD19 sCAR platform design**

[0362] In some embodiments, increased activity of switches observed when the PNE is grafted proximal to the antigen binding domain results from the decreased overall distance between the sCAR-T cell and target cell. To test whether this same notion applies to the design of the sCAR itself, the hinge region which connects the scFv to the transmembrane domain was modified by replacing the 45 amino acid CD8 hinge (labeled as "long") with a 12 amino acid hinge derived from IgG4 ("short", **FIG. 22A**). This substitution increased the potency of cytotoxicity against RS4;11 cells with the LCNT switch by 2.8 fold (**FIG. 23A**) while not causing lysis of K562 cells (**FIG. 23B** & **FIG. 24A**).

[0363] In some embodiments, the increased cytokine induction of the NTBV switch indicates a favorable effect of bivalency on sCAR activation, through the simultaneous recruitment of two sCARs by one switch. To investigate the effect of sCAR valence on activity, a second IgG4-based hinge was designed with a serine to proline mutation (S228P mutation relevant to the IgG molecule) which facilitates inter-chain disulfide formation ("short-dimeric", **FIG. 7A**). Analysis of hinge designs by western blot showed the long CD8-based hinge in the sCAR and CART-19 constructs formed spontaneous disulfide-mediated dimers in the absence of CAR stimulation (**FIG. 7B**). Dimer formation of the IgG4-based hinge designs only occurred with the S228P mutation in the short-dimeric hinge and not in the short IgG4-based hinge lacking this mutation. Correspondingly, cytotoxicity of the short-dimeric sCAR against RS4;11 cells with the LCNT Fab switch was further improved to EC_{50} = 0.9 pM, and maximum target cell lysis increased by > 80%, compared with the original CD8-based long hinge (**FIG. 23A**).

[0364] Specificity of sCAR-T cell activation is essential to switch-based control. Therefore, to confirm the improved activity of the short-dimeric sCAR did not sacrifice specificity, off-target cytotoxicity, upregulation of activation markers, and cytokine release were interrogated. The short-dimeric sCAR was unable to cause significant lysis of K562 cells with up to 10 nM of any switch (**FIG. 23B** & **FIG. 24B**) and did not produce cytokines in the presence of any switch and K562 cells (**FIG. 23F**). The short-dimeric sCAR-T cells also did not exhibit significant upregulation of activation markers compared with non-transduced (mock) cells in the absence of PNE-grafted

switch and target antigen, confirming that the short-dimeric sCAR did not cause antigen-independent activation (**FIG. 23C**). Finally, the activity of sCAR-T cells on RS4;11 cells could be fully inhibited by the addition of an excess of soluble, synthetic PNE peptide, demonstrating the requirement for switch-mediated target cell cross-linking for activity (**FIG. 26A-H**).

[0365] The additive effect of switch and hinge design on activity and compared sCAR activation was determined with conventional CART-19. Each switch design was combinatorially tested in dose titration with each hinge design and assayed for cytotoxicity, cytokine release, and upregulation of activation markers in the presence of RS4;11 cells. Cytotoxicity increased as the PNE grafting position moved from C-terminus to N-terminus and as the hinge design was shortened and made dimeric (**FIGS. 27A, 27B**). Correspondingly, the cytokine release at 1 nM switch on RS4;11 cells was greatest with the N-terminally grafted switches (HCNT, LCNT, NTBV) with the short or short-dimeric hinges (**FIG. 23D**). The level of cytokine production with these optimal switch/hinge combinations was significantly greater than conventional CART-19 (which was not treated with a switch) and represented a 14-fold improvement in IL-2 secretion over the least effective combination of long hinge with the HCCT switch. The upregulation of activation makers in the presence of 1 nM switch and RS4;11 cells exhibited a similar trend in switch SAR; however, sCAR hinge design had little impact on activation markers (**FIG. 23E**). The potential of 1 nM LCNT switch to upregulate activation markers on sCAR-T cells was found to be significantly greater than the activation of conventional CART-19 (without switch) on RS4;11 cells.

[0366] To test whether the increased potency of the short-dimeric hinge design could extend to another antigen, the cytotoxicity of anti-CD20 switches on $CD20^+$ Raji cells was assayed. The potency of cytotoxicity was increased for all switches (**FIG. 28A**). Unexpectedly, however, the trend in cytotoxicity as a function of switch design was opposite what was observed for anti-CD20 switches with the long hinge sCAR design (**FIG. 25B**). For the short-dimeric hinge design, C-terminally grafted switches were 10-100-fold more potent than N-terminally grafted switches. Collectively, this indicates that the activity of sCAR-T cells could be significantly enhanced through hinge design, but requires empirical switch design to attain optimal efficacy.

Example 13. **Switch and hinge design effects on tumor clearance *in vivo***

[0367] Activity of the switchable CAR-T cell platform *in vivo* was evaluated via tumor regression in a Nalm-$6^{Luc/GFP}$ leukemia xenograft model in immunodeficient NOD scid gamma (NSG) mice. These mice without treatment succumb to disease within 21 days. The impact of CAR hinge design on *in vivo* efficacy was determined using mice inoculated with Nalm-$6^{Luc/GFP}$, followed by I.V. injection of long, short, or short-dimeric sCAR-T cells 6 days later. The LCNT Fab was dosed I.V. (0.5 mg/kg) every other day for 10 days and tumor regression was followed by

in vivo imaging (IVIS) of the luciferase signal from Nalm-6$^{Luc/GFP}$ cells (**FIG. 29A**). Both short (IgG4), and short-dimeric (IgG4m) sCAR-T cells provided a significant decrease in tumor burden; whereas long hinge sCAR-T cells (CD8) had minimal impact on disease compared with untreated control (**FIG. 29B**). Increased T cells counts in the peripheral blood at day 17 corresponded with reduction of tumor burden and revealed that the short-dimeric sCAR-T cells provided significantly greater T cell expansion compared with the short or long hinge designs (**FIG. 29C**). Based on this result, the short-dimeric sCAR construct was chosen for further *in vivo* studies.

[0368] The effect of switch grafting position on the control of tumor burden was determined. As with the previous model, short-dimeric CAR-T cells were injected 6 days after tumor inoculation and mice were treated every other day (starting at day 6) with 0.5 mg/kg LCNT, HCNT, NTBV, LCC1, or HCCT Fab switches (**FIG. 29D**). Corresponding with the *in vitro* data, N-terminally grafted switches (LCNT, HCNT, and NTBV) provided the greatest reduction in tumor burden, while switches with the PNE grafted at the middle (LCC1) or C-terminus (HCCT) provided little control (**FIG. 29E**). T cell counts at day 17 again correlated with reduction of tumor burden and indicated the LCNT Fab switch provided the greatest T cell expansion (**FIG 29F**). To determine if the LCNT switch was efficacious in IgG format the Nalm-6$^{Luc/GFP}$ model was repeated with 0.5 mg/kg LCNT IgG switch delivered *I.V.* every 5 days for 15 days (3 doses) to compensate for the longer pharmacokinetic half-life of IgG compared with Fab. Surprisingly, the LCNT IgG switch was unable to significantly control tumor burden compared with 0.5 mg/kg LCNT Fab switch and CART-19. Increased LCNT IgG switch dosage to 1 mg/kg every day for 10 d resulted was similarly unable to control tumor growth, indicating switch dosing was not responsible for the lack of activity with the IgG format. From this data it was apparent that the combination of the LCNT Fab switch with the short-dimeric sCAR offered the most optimal therapy *in vivo* and thus was used in further studies of the sCAR platform.

[0369] Clearance of Nalm-6$^{Luc/GFP}$ with the short-dimeric sCAR-T cell and LCNT Fab in the above model was observed to rapidly occur during the first 96 hours of treatment. To determine the proliferation and localization of sCAR-T cell cytotoxicity during this time interval, mice were sorted into 5 cohorts per treatment regimen and analyzed at 8, 24, 48, 72, and 96 h after treatment with short-dimeric sCAR-T cells + LCNT Fab switch or with conventional CART-19 and no switch. Using daily 0.5 mg/kg LCNT Fab, tumor reduction was first observed at the 24 h time point and continue to shrink to the limit of luminescence detection within 96 hours of treatment (**FIG. 30A**). The rate of clearance during this time was insignificantly different from CART-19 (**FIG. 30B**). Human IL-2 in peripheral blood peaked at similar levels at 24 h for CART-19 and at 48 h for sCAR-T cells and decreased as tumor was cleared (**FIG. 30B**). As expected, sCAR-T cells

not treated with switch had no effect on disease progression in this model, confirming requirement for switch dosing.

[0370] To further understand the effect of switch treatment on T cell trafficking, short-dimeric sCAR-T cells were tracked in the spleen, lungs, liver, and peripheral blood by flow cytometry over the first 96 h. During this time interval Nalm-6$^{Luc/GFP}$ cells were only detectable in the lung and liver (**FIG. 32B**). Correspondingly, significantly increased numbers of sCAR-T cells were found in the lung and liver at 96 h in mice dosed with LCNT Fab switch compared mice not treated with switch (**FIG. 30C**). Switch dosing did not increase sCAR-T recruitment to the spleen where tumor burden was not detectable. In the organs assessed, sCAR-T cells had proliferated significantly more (by dye dilution) in the mice treated with LCNT Fab switch compared to no switch treatment, again demonstrating the requirement for the switch for sCAR-T cell expansion (**FIG. 30D** & **FIG. 32D**). The magnitude of sCAR-T cell proliferation dosed with LCNT Fab switch was comparable to that of CART-19 in both liver and lung. Together, these results indicate the short-dimeric sCAR-T cells with the LCNT Fab switch can expand and eliminate tumor burden comparably to conventional CART-19.

Example 14. **Dose-dependent control of sCAR-T cell activity *in vivo***

[0371] To determine the minimal dosing regimen required for a sustained response with short-dimeric sCAR-T cells, every day, every other day, or every fifth day dosing of 0.5 mg/kg LCNT Fab switch was tested for 15 days in the Nalm-6$^{Luc/GFP}$ model. Every day and every other day dosing yielded comparable rates of tumor regression which was sustained for >100 days after dosing had stopped (**FIG. 33A** and **FIG. 32A**). Mice that died between days 40 and 100 (open circles) had no evidence of disease; expiration in these cases was attributed to xenogeneic graft versus host disease caused by human T cells in the NSG mouse. Dosing every fifth day (3 total dosages) greatly decreased and stabilized disease burden at a low level, but did not completely clear disease by luciferase signal (**FIG. 33A**). Residual disease in this group relapsed when dosing was discontinued indicating the activity of the sCAR-T cells towards Nalm-6$^{Luc/GFP}$ had been turned "off" in the absence of the switch even though sCAR-T cells were still detectable in blood up to 64 days after injection (**FIG. 32B**).

[0372] Control of cytokine release *in vivo* is important to prevent CRS in clinical translational. Therefore, switch dosage was correlated with short-dimeric sCAR-T cell cytokine release in the Nalm-6$^{Luc/GFP}$ model. Mice dosed everyday with 0.05, 0.5, or 2.5 mg/kg LCNT Fab switch every day showed a dose-dependent increase in serum IL-2, INFγ, and TNFα at 24 h (**FIG. 33B**) which correlated with dose dependent reductions in tumor burden by day 10 (**FIG. 33C**). Cytokine production in the 0.5 and 2.5 mg/kg groups was not significantly different from CART-19 at 24 h for all cytokines, except for serum TNFα which was decreased in the 2.5 mg/kg group compared

with CART-19. However, all cytokines in the 0.05 mg/kg group were significantly lower than CART-19.

[0373] To determine if treatment with the lower dose of 0.05 mg/kg could be efficacious, despite lower levels of cytokine production, dosing of LCNT Fab switch was carried out every day for 10 d in the Nalm-$6^{Luc/GFP}$ model and tumor burden followed by IVIS. At this low dosage, tumor clearance was correspondingly slower compared with CART-19 and previous models, but still reached the limit of detection by day 16, final day of dosing (**FIG. 33D** & **FIG. 32D**). Fifteen days after the final dose, at day 30, tumor burden rose significantly higher than the CART-19 control and therefore mice were retreated with 0.5 mg/kg LCNT Fab switch for 10 days. This treatment paradigm effectively decreased tumor signal to equivalent levels as CART-19 within 5 days. Mice remained tumor-free for >35 days after the final dose of the second dosing period. Thus sCAR-T cells can control cytokine release while still providing efficacy which is an effective strategy to avoiding CRS in patients receiving therapy.

[0374] Persistent memory phenotypes have been correlated with efficacy in CAR-T cell therapy clinical trials. To understand whether switch dosage could influence sCAR-T cell phenotype, mice in the Nalm-$6^{Luc/GFP}$ model were dosed with 0.05, 0.5, or 2.5 mg/kg LCNT Fab switch and analyzed the expression of CD45RA and CD62L on $CD4^+$ and $CD8^+$ T cells in peripheral blood after 20 days (5 days after the final dose). The 2.5 mg/kg group demonstrated significant expansion of the $CD45RA^+CD62L^-$ effector memory RA (TEMRA) compartment in both $CD4^+$ and $CD8^+$ T cells compared with the lower dose groups (**FIG. 33E**). Conversely, the lower dose groups of 0.05 and 0.5 mg/kg had significantly larger populations of $CD45RA^-CD62L^+$ central memory cells compared with 2.5 mg/kg group which may be a result of decreased stimulation during the dosing period. Central memory CAR-T cells are favorable for their persistence and indicate a benefit to low dose treatment of sCAR-T cells during the initial stages of tumor clearance. Collectively these results demonstrate that the efficacy, tissue-tracking, cytokine release, and phenotype of sCAR-T cells is fully dose titratable and can be tuned to provide efficacy comparable to the corresponding conventional CART-19, but with lower levels of cytokines and increased expansion of central memory subsets.

Example 15. **Dual Targeting of CD19 and CD20 *in vivo***

[0375] Ten percent of all ALL patients treated with CART19 T-cells relapse due to the expansion of CD19- tumor cells, which cannot be targeted by conventional CAR-T cells because their antigen specificity is fixed against the CD19 antigen. Switchable CAR-T cells can target such tumors by utilizing two or more switches with different antigen specificities capable of targeting the tumor cells.

[0376] In one experiment, illustrated in **FIG. 34A**, NSG mice were injected (i.v.) with $5x10^5$ RAJI-Luc cells ($CD19^+$ $CD20^+$) (RAJI-Luc cvells are luciferase-expressing Raji cells) on day 0. On day 3, $40x10^6$ sCAR-T cells were infused intravenously. Mice that received the sCAR-T cells were dosed 8 times (q.a.d.) with the Fmc63 anti-CD19 LCNT switch or OFA anti-CD20 LCCT switch from day 3-17. 13 days after the initial round of switch dosing, day 30, the mice originally treated with the Fmc63 anti-CD19 LCNT switch were re-challenged with RAJI-Luc cells ($CD19^+$ $CD20^+$) and, following the 3 day engraftment period, were retreated with the OFA anti-CD20 LCCT switch. An additional group was incorporated into this study to show that sCAR-T cells were still active even after 30 days in the mice with no additional stimuli: these mice received sCAR-T cells on day 3 and were challenged, for the first time, with Raji cells on day 30 and dosed with the OFA anti-CD20 LCCT switch from day 33-47. This data show that sCAR-T cells can be reactivated *in vivo* to target a different cancer associated antigen using a second switch.

[0377] In a similar experiment, illustrated in **FIG. 34B**, we tested whether the use of a second switch can eliminate tumors that lack the CD19 antigen. Simlar to the prior experiment, NSG mice were injected (i.v.) with $5x10^5$ RAJI-Luc cells (CD19+CD20+). Three days later $40x10^6$ CART19 (SEQ ID NO: 181), CART20 (SEQ ID NO: 182; this construct used the 4-1BB and CD3 co-stimulatory domains as used with CART19) or sCAR-T (SEQ ID NO: 74) cells were injected (i.v.). The sCAR-T cell treated groups received anti-CD19 switch (LCNT graft; SEQ ID NOS: 9 and 36) q.a.d. from day 3 to day 18 (indicated by dotted lines in shaded area in figure 43B). The CD19+CD20+ Raji cell tumor was cleared in all groups. On day 30, the mice were re-challenged with RAJI-Luc cells (CD19-CD20+) (note, unlike the data shown in **FIG.34A**, these RAJI-Luc cells are CD19 negative). Three days later, one of the sCAR-T cell groups was re-dosed with an anti-CD20 switch (CTBV graft; SEQ ID NOS: 138 and 139) q.a.d. from day 33 to day 48 (indicated by dotted lines in shaded area in **FIG. 34B**). The CD19-CD20+ Raji cell tumor was cleared in the groups treated with CART20 or the sCAR-T cells with the anti-CD20 switch; however, CART19 was not able to clear the rechallenged CD19-negative tumor. These data highlight one major benefit of the switchable CAR-T system, *i.e.*, the ability of the switchable CAR-T cells to be re-directed *in vivo* to target different antigen specificities; thus, demonstrating a potential utility of sCAR-T cells in targeting multiple cancer associated antigens. Further, these data demonstrate the potential to treat antigen escape mutants such as, *e.g.*, the CD19-negative tumor cells that are commonly expanded in ALL relapse patients.

Example 16. **Evaluation of a switchable CAR-T platform in a heterogeneous cancer model**

[0378] A first switch containing an anti-CD19 targeting antibody and a second switch containing the anti-CD20 targeting antibody rituximab are used sequentially or simultaneously to target

different antigens in the same patient using a single adoptively transferred CAR-T in an effort to combat ALL relapse attributed to a CD19 escape variant during CAR-T-19 therapy.

[0379] An anti-CD20 switch is created in analogous fashion to the anti-CD19 switch using the optimal characteristics determined in Example 3. A CAR-T-20 based on rituximab is constructed for comparison. Efficacy is tested *in vitro* against CD20-positive IM-9 and Daudi cells lines. To create a heterogeneous B-cell lymphoblast, the chronic myelogenous leukemia-derived K562 cell line (which is negative for CD20 and CD19) is stably transduced with the CD19 antigen using a lentiviral vector. Single cell clones are obtained via flow-sorting to obtain a population with homogenous CD19 expression. This cell line is then be transduced with CD20 and sorted by high ($CD20^{hi}$) or low ($CD20^{low}$) level of antigen expression. The activation and cytotoxicity of the switchable CAR-T on mixtures of $CD19^{+}CD20^{-}$ and $CD19^{+}CD20^{hi}$ or $CD19^{+}CD20^{low}$ are assessed *in vitro* using the CD19 and CD20 switches (simultaneous or sequential administration). The method provides an opportunity to study the lowest percentage of $CD20^{hi}$ or $CD20^{low}$ cells in a population that are necessary to stimulate the CAR-T with the rituximab switch. This may be more physiologically relevant than a homogeneous population. This system is then tested in a xenograft mouse model. A mixture of $CD19^{+}CD20^{-}$ and $CD19^{+}CD20^{+}$ is used to establish the xenograft. Alternatively, primary patient derived ALL samples are used for this experiment if found to be heterogeneous for CD19 or CD20 expression in our initial xenograft study. Switchable CAR-ECs with the anti-CD20 switch are administered to eliminate the $CD19^{+}CD20^{+}$ population and allow outgrowth of $CD19^{+}CD20^{-}$ cells. To demonstrate the feasibility of retargeting the same CAR-T, the anti-CD19 switch is subsequently dosed and growth of remaining xenograft monitored. Tumors are evaluated for antigen expression in cohorts of sacrificed mice or in primary blasts. Simultaneous targeting is also assessed. Treatment is compared with CAR-T-19, CAR-T-20, or both simultaneously.

Example 17. **sCAR-T surrogate mouse model**

[0380] B cell aplasia is a significant side effect reported in clinical trials with CART19 therapy. With the switch platform, switch dosing may be discontinued after sCAR-T cells have had the opportunity to target CD19+ tumors, thus, allowing the B cell pool to reconstitute.

[0381] A murine surrogate model was developed in immunocompetent mice to test the abilitiy of a sCART system to alleviate the long-term B cell aplasia associated with canonical CART-19 therapy. The surrogate model was established using the murine Myc5 ($CD19^{+}$) cell line in which various peptide engrafted anti-murine CD19 switches were designed and expressed.

[0382] To create the switches, the antibody fragment (Fab) from the hamster anti-mouse CD19 (1D3) antibody clone was expressed with the GCN4 peptide grafted with a linker to the N-terminus of the light chain (LCNT; **SEQ ID NOS: 54 & 58**) or to the N-terminus of the heavy chain

(HCNT; **SEQ ID NOS: 53 & 60**) or to the C-terminus of the light chain (LCCT; **SEQ ID NOS: 54 & 57**). Alternately, switch constructs were expressed in which each of the light and heavy chains were grafted at their N-terminus with the GCN4 peptide (NTBV; **SEQ ID NOS: 58 & 60**).

[0383] To create the murine surrogate sCAR-T cell, we used a Moloney murine leukemia-based retroviral vector (MSGV, murine stem cell virus-based splice-gag vector) for transduction into murine splenocytes as previously described Kochenderfer, J.N., et al., Blood, 116(19): p. 3875-86 (2010), incorporated herein by reference in its entirety. The original murine construct, 1D3 CART19, was created as previously described, *id,* with the rat anti-mouse CD19 clone 1D3 scFv, murine CD28 hinge, transmembrane and cytoplasmic domain, and murine CD3ζ molecule where the first and third ITAMs (immunoreceptor tyrosine-based activation motif) were inactivated (referred to as CD3ζ(1-3)) (**SEQ ID NO: 200**). The sCAR construct was developed with the same design using the anti-GCN4 scFv in place of the 1D3 scFv (**SEQ ID NO: 201**).These switches were shown to be active against murine Myc5-CD19^{+} target cells, *in vitro*, as demonstrated by LDH release cytotoxicity assay and cytokine responses (**FIG. 35** and **FIG. 36A**). Potency increased as graft moved towards N-terminus as in human system.

[0384] This cell line is subsequently used to establish B cell lymphoma in wild type C57BL/6 mice. sCAR-T cells and switches are administered with dosing schedules based on xenograft studies. Of particular interest in this model is to compare Fab, and IgG based switches on the rate of Myc5-CD19 elimination and B cell ablation. As with xenografts studies, sCAR-T proliferation is monitored and immunophenotypic characterization is carried out *ex vivo*. The primary goals of this study are to demonstrate elimination of disease and repopulation of B cells on cessation of switch administration. Both the surrogate CART-19 and the surrogate sCAR-T cells eliminate disease, but only the switchable platform enables repopulation of B cells. Long-term persistence of sCAR-T cells after dosing has stopped is checked by re-dosing switch after a rest period and assessing B cell re-depletion. This is important to developing sCAR-T cells that can be reactivated to in the case of disease relapse.Other factors studied in this system are the effect of Tregs, macrophages, and myeloid cells on the switchable CAR-T cells; the ability of the switchable CAR-T cells to differentiate into memory subsets including effector memory, central memory, and stem cell memory; the natural ability for T cells to home to the lymph nodes, thymus, spleen or peripheral organs; and the effect of the switchable CAR-T cells on the immune system, including depletion of B cells.

[0385] Human signaling moieties included in CAR-T cells have been demonstrated to be function in murine T cells. To further explore the potency of sCAR-T cells in the surrogate system, additional CAR constructs containing human elements were created and transfected into and expressed by murine T cells.

[0386] An anti-GCN4 52SR4 sCAR construct was made using the 52SR4 scFv, human IgG4m hinge domain, murine CD8 transmembrane domain, murine 4-1BB costimulatory domain, and a mutated murine CD3zeta (**SEQ ID NO: 202**). An anti-GCN4 52SR4 sCAR construct was made using the 52SR4 scFv, human IgG4m hinge domain, murine CD8 transmembrane domain, murine 4-1BB costimulatory domain, and a intact murine CD3zeta (**SEQ ID NO: 203**). An anti-GCN4 52SR4 sCAR construct was made using the 52SR4 scFv, murine CD8 hinge domain, murine CD8 transmembrane domain, murine 4-1BB costimulatory domain, and a mutated murine CD3zeta (**SEQ ID NO: 204**). An anti-GCN4 52SR4 sCAR construct was made using the 52SR4 scFv, murine CD8 hinge domain, murine CD8 transmembrane domain, murine 4-1BB costimulatory domain, and a intact murine CD3zeta (**SEQ ID NO: 205**). An anti-CD19 1D3 sCAR construct was made using the 52SR4 scFv, human IgG4m hinge domain, murine CD8 transmembrane domain, murine 4-1BB costimulatory domain, and a mutated murine CD3zeta (**SEQ ID NO: 206**). An anti-CD19 1D3 sCAR construct was made using the 52SR4 scFv, human IgG4m hinge domain, murine CD8 transmembrane domain, murine 4-1BB costimulatory domain, and a intact murine CD3zeta (**SEQ ID NO: 207**). An anti-CD19 1D3 sCAR construct was made using the 52SR4 scFv, murine CD8 hinge domain, murine CD8 transmembrane domain, murine 4-1BB costimulatory domain, and a mutated murine CD3zeta (**SEQ ID NO: 208**). An anti-CD19 1D3 sCAR construct was made using the 52SR4 scFv, murine CD8 hinge domain, murine CD8 transmembrane domain, murine 4-1BB costimulatory domain, and a intact murine CD3zeta (**SEQ ID NO: 209**). An anti-GCN4 52SR4 sCAR construct was made using the 52SR4 scFv, human IgG4m hinge domain, murine CD28 transmembrane domain, murine CD28 costimulatory domain, and a mutated murine CD3zeta (**SEQ ID NO: 210**). An anti-GCN4 52SR4 sCAR construct was made using the 52SR4 scFv in the opposite orientation (HC then LC) than (**SEQ ID NO: 210**), human IgG4m hinge domain, murine CD28 transmembrane domain, murine CD28 costimulatory domain, and a mutated murine CD3zeta (**SEQ ID NO: 211**). An anti-GCN4 52SR4 sCAR construct was made using the 52SR4 scFv, human IgG4m hinge domain, human CD8 transmembrane domain, human 4-1BB costimulatory domain, and a human CD3zeta (**SEQ ID NO: 212**). An anti-CD19 1D3 sCAR construct was made using the 52SR4 scFv, human IgG4m hinge domain, human CD8 transmembrane domain, human 4-1BB costimulatory domain, and a human CD3zeta (**SEQ ID NO: 213**).

Example 19. **Anti-CD19 sCAR-T *in vitro* model with mouse surrogate CARTs**

[0387] Activated mouse splenocytes were transduced with gammaretrovirus containing GCN4-mCAR construct (SEQ ID NO: 203). **FIG. 35** and **FIG. 36** show *in vitro* cytotoxicity of mouse surrogate CARTs. **FIG. 35** shows cytotoxicity of transduced mouse GCN4-mCAR T cells against CD19+ tumor line MYC5-GFP-CD19 with various 1D3-derived switches with wild-type heavy and light chains (Fab-LCWT) or bearing GCN4-peptide insertions in the light chain N-terminus (Fab-

LCNT1) or in the constant region of the light chain (Fab-LCCL1). **FIG. 36** shows cytokines released during the cytotoxicity co-culture of the transduced mouse GCN4-mCAR T cells.

[0388] The *in vitro* model is ideal for evaluating CAR-T cell activity that would otherwise be greatly affected by other immune cells *in vivo* and therefore cannot be accurately assessed in the xenograft models.

[0389] To further explore the geometry of the ternary complex formed by the switch between the effector and target cells, anti-CD19 switches were created with shorter linkers between the FAB and GCN4 peptide. As the N-terminal grafted switches provided the best activity in vitro, it may be possible to further increase this by shortening the linker. For these switches the GGGGS linker (**SEQ ID NO: 40**) was replaced with a GG linker (**SEQ ID NO: 214**). A switch was created containing a peptide and short linker on the N terminus (**SEQ ID NO: 215**) and on the heavy terminus (**SEQ ID NO: 216**) of the anti-CD19 1D3 switch. LCNT (**SEQ ID NOS: 215, 54**), HCNT (**SEQ ID NOS: 216, 53**) and NTBV (**SEQ ID NOS: 215, 216**) constructs were made.

[0390] , **FIG. 36B** shows activity data for several of these constructs, as assessed by an *in vitro* cytotoxicity assay, in which IFNy production (measured by CBA assay) was the read out.

[0391] Cytokine levels produced were higher in the presence of LCNT (**SEQ ID NOS: 54, 58**) switch than in the presence of LCCT (**SEQ ID NOS: 54, 57**) switch. Cytokine levels were also higher for **SEQ ID NO: 202**, **SEQ ID NO: 203** and **SEQ ID NO: 205** in comparison with **SEQ ID NO: 201**. **SEQ ID NO: 202** CAR-T cells secrete the same amount of IFNγ as **SEQ ID NO: 200** cells. The same trends were also observed for IL-2 and TNFα cytokine production (data not shown).

[0392] General method for cytotoxicity assay with murine T cells

[0393] Cytotoxicity assays were performed in R5 medium (RPMI 1640 (Gibco, #A10491) + 10% FBS + 1% Penicillin-streptomycin, 0.1% 2-Mercaptoethanol) at a 10 effectors:1 target ratio. LCNT switch dilutions are prepared in a standard 96-well plate in R5. Switches are diluted to 500 nM in 200 µl R5 then filter sterilized. Serial 10-fold dilutions are made transferring 10ul of switch into 90 µl R5. Target cells (MYC5-GFP-CD19, $mCD19^+$) are collected and re-suspended in R5 at a density of $4x10^5$ cells/ml. Target cells are then added to all wells of a U-bottom 96-well plate except medium-only and CAR-T cells-only controls. CAR-T cells are collected and re-suspended in R5 at a density of $4x10^6$ cells/ml. CAR-T cells (effector cells) (50 µl) are added to all wells except medium-only control, maximum kill, and spontaneous kill wells. Switch dilutions (2 µl) are added to cytotoxicity wells. Plate is incubated at 37°C, 5% CO_2 for 6h. LDH release assays are performed using the Promega CytoTox 96® Non-Radioactive Cytotoxicity Assay (Promega). Forty five minutes before the end of incubation, 10X lysis solution is added to maximum kill wells containing only target cells (1X final). Wells are mixed well to lyse cells and plate is returned to the incubator

for 45 minutes. After 45 minutes incubation, plate is centrifuged at 400xg for 5 minutes to pellet cells. Supernatants (30 µl) are transferred to a 96-flat bottom well plate and 30 µl of CytoTox 96® Reagent is added and plate is incubated in the dark at room temperature for 30 minutes. Stop Solution (30 µl) is added and absorbance is measured at 490nm on a plate reader. Cytotoxicity is calculated using the following formula: 100 x ((Sample OD490 – medium OD490 – target cells only OD490 – effector cells only OD490) / (maximum kill OD490 – spontaneous kill OD490)).

Example 20. **Cloning, expression and purification of anti-BCMA-IgG-LCC1**

[0394] Cloning: Mammalian expression vector of CD19 IgG heavy chain was generated by in-frame ligation of amplified anti-BCMA IgG heavy chain (VH and CH1) to pFuse-hIgG1-Fc backbone vector (InvivoGen, CA). A gene encoding antibody BCMA light chain was amplified and cloned into the pFuse vector without hIgG1 Fc fragment. A gene encoding GCN4 (NYHLENEVARLKKL = SEQ ID NO: 3) with GGGGS (SEQ ID NO: 40, wherein n=1) linker at both ends was synthesized as oligonucleotides. Subsequently, anti-BCMA-IgG LCC1 fusion proteins were created by grafting GCN4 with linker sequences at both ends into the CL region of the anti-BCMA light chain. The resulting mammalian expression vectors were confirmed by DNA sequencing.

[0395] Expression and Purification: anti-BCMA-IgG LCC1 was expressed through transient transfection of FreeStyle HEK 293 cells with expression vectors of BCMA-IgG heavy chain and GCN4-BCMA LCC1 light chain, according to the manufacturer's protocol. Briefly, 28 mL FreeStyle HEK 293 cells containing 3×10^7 cells were seeded in a 125 mL shaking flask. 15 µg light chain plasmid and 15 µg heavy chain plasmid diluted in 1 mL Opti-MEM medium were added in 1 mL Opti-MEM containing 60 µL 293fectin (Invitrogen, Inc.). After the plasmids were incubated with 293fectin for 30 min, the lipoplex mixture was added to the cell suspension. Cells were then shaken at 125 rpm in a 5% CO_2 environment at 37 ºC. Culture medium containing secreted proteins was harvested at 48 and 96 hours after transfection. anti-BCMA-IgG LCC1 was purified by Protein G chromatography (Thermo Fisher Scientific, IL).

Example 21. **Cytotoxicity of anti-BCMA-IgG LCC1 CAR-EC switch with GCN4 grafted to the light chain of an anti-BCMA antibody or antibody fragment**

[0396] The cytotoxic activity of the anti-BCMA-IgG LCC1 CAR-EC switch was assessed with the human PBMCs transduced with LV-EF1a-GCN4(52SR4) to create CAR-T-GCN4 at E:T ratios of 10:1 and 24 hour incubation. Transduction efficiency of PBMCs was approximately 50%. Activities were assessed against OPM2 ($BCMA^+$), by quantifying lactate dehydrogenase due to cytolysis of target cells (**FIG. 37, Table 24**).

Table 24. Cytotoxicity of anti-BCMA-IgG LCC1 CAR-EC switch and anti-GCN4 CAR-T cell

anti-BCMA-IgG LCC1 switch concentration [pM]	% cytotoxicity
10000.000	35.52758
1000.000	35.06853
100.000	41.44725
10.000	31.59707
1.000	5.575391
0.100	1.13803
0.010	0.812881

Example 22. **Anti-CLL1 switches**

[0397] Despite current therapeutic advances, Acute Myeloid Leukemia (AML) survival rate after 5 years is below 50%, being the second most common leukemia in children. AML is a highly immune-phenotypically heterogeneous disease. Relapse is frequent in AML patients. A common event in relapsed disease, as it happens for B-cell leukemia and CD19, is the down regulation or loss of antigen expression. Therefore, conventional CAR-T treatment of AML patients will be highly susceptible to immune scape of different immune-phenotypical variants.

[0398] The switchable CAR-T (sCAR-T) approach not only will be able to overcome the immune escaping process targeting multiple antigens, but also a personalized medicine can be performed, selectively targeting specific antigens according to the immune-phenotype of each AML patient in a dose-controllable format and reducing therefore the side effects linked to each off-tumor on-target antigen which will likely cause severe chronic myelosuppression and different types of cytopenia in patients. (i.e. CD33 or CD123 are expressed in myeloid and hematopoietic precursors).

[0399] Initially, we targeted CLL1 antigen for AML, with in vitro and in vivo efficacy data supporting CLL1 as a valid target for AML. To expand the antigenic targets for AML, CD33 (hP67.6 antibody) and CD123 (26292 and 32716 antibodies) will be included in our switchable CAR-T platform.

[0400] By utilizing the “universal” anti-peptide sCART cell, multiple switches targeting multiple cancer associated antigens can be rapidly developed. An example of this is the generation of peptide engrafted switches against the AML associated antigen CLL1. A series of 6 plasmids were designed into which commercially synthesized gene-blocks encoding scFv sequences were inserted by gibson phase assembly to generate: Light chain wild type, light chain N-terminal, light chain C-terminal, heavy chain wild type, heavy chain N-terminal and heavy chain C-terminal plasmid constructs. These constructs were expressed in HEK cells to generate: light chain N-terminal, light

chain C-terminal, heavy chain N-terminal, heavy chain C-terminal and N- or C-terminal bivalent switches. The 6 anti-CLL1 switches were then used in cytotoxicity assays with the long, short and short-dimeric sCART cells to give a spread of data that could be used to predict the optimal immunological synapse required to kill U937 ($CLL1^+$) cells (**FIG. 38A-C, Tables 25 and 26).**

Table 25. Potency on CLL1+ cells, Long Hinge CAR

Switch	Valency	EC_{50} (nM)
C	Mono	0.0033
D	Mono	0.0022
C+D	Bi	0.0031
A	Mono	0.0041
B	Mono	0.0013
A+B	Bi	0.0006

Table 26. Potency on CLL1+ cells, Short Hinge CAR

Switch	Valency	EC_{50} (nM)
C	Mono	0.0049
D	Mono	0.0051
C+D	Bi	0.0012
A	Mono	0.0015
B	Mono	0.0006
A+B	Bi	0.0005

***Example 23.* Anti-CLL1 sCAR-T cell and switch structural activity relationship (SAR)**

[0401] Another example (see Example 7) of switch SAR was shown with the anti-CLL1 switch derived from the anti-CLL1 antibody clone. In this example 6 generic pFuze plasmids which were wild type (without peptide) or had the GCN4 peptide positioned at the N-terminal or C-terminal of the heavy and light chains were developed. Using synthesized gene blocks containing the anti-CLL1 Fab sequence and the Gibson assembly method of cloning 6 switch constructs that could be expressed in mammalian cells to produce 7 different switches were rapidly generated: wild type, light chain N-terminal (LCNT), light chain C-terminal (LCCT), heavy chain N-terminal (HCNT), heavy chain C-terminal (HCCT), N-terminal bivalent (LCNT & HCNT; NTBv) and C-terminal bivalent (LCCT & HCCT; NTBv). Using these switches in combination with the three different CAR constructs (long, short and short dimeric) in cytotoxicity assays with the $CLL1^+$ U937 cell line it was determined that N-terminal bivalent switches with the short-dimeric CAR was the most optimal for immunological synapse for the *in vitro* killing of U937 cells (**FIG. 38D**). This process is repeated for other target antigens and is one of the major advantages of the switchable system.

***Example 24.* Treatment of CLL1+ solid AML tumors with switchable CAR-T cells**

[0402] To test whether an anti-CLL1 switch could treat tumors, *in vivo*, 6-8-week old female NSG mice were injected with $2x10^6$ U937 (CLL1+) AML cells subcutaneously in the right flank. Seven

days after tumor implantation, mice received $30x10^6$ sCAR-T cells or PBS via intra venous injection. Mice were dosed intravenously with PBS or anti-CLL1 NTBV (SEQ ID: 102 & 103) 1mg/Kg q.d. from day 0-10. Tumors were measured twice weekly using calipers. Tumor volume was calculated based on width x length x height. **FIG. 38E** shows *in vivo* cytotoxicity of sCAR-T cells against CLL1+ U937 cells with the NTBV anti-CLL1 Fab switch, as determined by tumor mean size in (mm^3), and Table X shows the raw data from **FIG. 38E**.

Example 25. **Treatment of CD33+ solid AML tumors with switchable CAR-T cells**

[0403] Rational:

[0404] To target $CD33^+$ tumor cells, GCN4 engrafted switches were generated using the VL and VH sequences from Mylotarg (SEQ ID: 231 & 232), a cytotoxic antibiotic linked to a recombinant monoclonal antibody directed against the CD33 antigen used in clinic; described in *Vol. 7, 1490–1496, June 2001, Clinical Cancer Research* and in U.S. Pat. No. 5,773,001; each of which is incorporated herein by reference in its entirety. This antibody clone has also been validated in preclinical *in vitro* and *in vivo* assays for conventional CAR-T generation described in Kenderian, *et al*; Leukemia; Aug; 29(8):1637-47 (2015), incorporated herein by reference in its entirety.

[0405] Experiment:

[0406] The cloning, expression, and purification of GCN4 peptide-engrafted switches in hP67.6 was performed as described in Example 3 for CD19 switches. Extra engraftment positions were used in order to optimize the anti-CD33 hP67.6 clone. For this purpose, flexible or rigid linkers composed by a linker listed in SEQ ID 40-50 were used to engraft GCN4 peptide (SEQ ID NO: 3) at N-terminal or C-terminal or in internal loops of the Anti-CD33 hP67.6 clone light or heavy chain. (SEQ Light Chain of anti-CD33 hP67.6 Fab, Heavy Chain of anti-CD33 hP67.6 Fab). Several switch designs were generated for both clones with varied peptide engraftment positions. In one instance the peptide was engrafted on the N-terminus of the light chain of anti- CD33 hP67.6 using 1 of linker (SEQ ID NO: 40) to make (SEQ ID NO: 217). In one instance the peptide was engrafted on the N-terminus of the light chain of anti- CD33 hP67.6 using 2 of linker (SEQ ID NO: 40) to make (SEQ ID NO: 218). In one instance the peptide was engrafted on the N-terminus of the light chain of anti- CD33 hP67.6 using 3 of linker (SEQ ID NO: 40) to make (SEQ ID NO: 219). In one instance the peptide was engrafted on the N-terminus of the heavy chain of anti- CD33 hP67.6 using 1 of linker (SEQ ID NO: 45) to make (SEQ ID NO: 220). In one instance the peptide was engrafted on the N-terminus of the heavy chain of anti- CD33 hP67.6 using 2 of linker (SEQ ID NO: 47) to make (SEQ ID NO: 221). In one instance the peptide was engrafted on the C-terminus of the light chain of anti- CD33 hP67.6 using 1 of linker (SEQ ID NO: 40) to make (SEQ ID NO: 222). In one instance the peptide was engrafted on the C-terminus of the light chain of anti- CD33 hP67.6 using 2 of linker (SEQ ID NO: 40) to make (SEQ ID NO: 223). In one instance the peptide

was engrafted on the C-terminus of the light chain of anti- CD33 hP67.6 using 3 of linker (SEQ ID NO: 40) to make (SEQ ID NO: 224). In one instance the peptide was engrafted on the C-terminus of the heavy chain of anti- CD33 hP67.6 using 1 of linker (SEQ ID NO: 40) to make (SEQ ID NO: 225). In one instance the peptide was engrafted on the C-terminus of the heavy chain of anti- CD33 hP67.6 using 2 of linker (SEQ ID NO: 40) to make (SEQ ID NO: 226). In one instance the peptide was engrafted on the C-terminus of the heavy chain of anti- CD33 hP67.6 using 3 of linker (SEQ ID NO: 40) to make (SEQ ID NO: 227). In one instance the peptide was engrafted in the CH1 loop of the heavy chain of anti- CD33 hP67.6 with no linker (SEQ ID NO: 228). In one instance the peptide was engrafted in the CH1 loop of the heavy chain of anti- CD33 hP67.6 with 1 linker (SEQ ID NO: 40) on either side of the peptide to make (SEQ ID NO: 229), in this construct the GCN4 peptide (SEQ ID NO: 3) was engrafted with linkers at both sites replacing S70 and G71 of the heavy chain. In one instance the peptide was engrafted in the CH1 loop of the light chain of anti-CD33 hP67.6 with 1 linker (SEQ ID NO: 40) on either side of the peptide to make (SEQ ID NO: 230). Any of these constructs could be used to express mono-valent or bivalent switches by combining an engrafted chain with a corresponding WT 'ungrafted' chain. See **FIG. 38F** for gel images of these switches and Table 27 for high resolution anti-CD33 (clone hP67.6) Fab switch masses obtained on an Agilent Qadruple Time-of-Flight (QTOF) mass spectrometer attached to an Agilent liquid chromatography stack. Masses were deconvoluted from charge envelopes using Agilent Qualitative Analysis software with Bioconfirm plugin. In general accuracy was ± 2 Da.

TABLE 27. QTOF analysis of the anti-CD33 (clone hP67.6) Fab switches in FIG. 16F.

Protein	Expected Mass	Observed Mass	ppm	Da
1	47188.7	47189.5	-16.9532	0.8
2	50179.15	50180.72	-31.2879	1.57
3	49212.96	49213.93	-19.7102	0.97
4	49212.96	49214.49	-31.0894	1.53
5	49212.96	49213.41	-9.14393	0.45
6	52203.41	52205.82	-46.1656	2.41
7	51237.22	51237.65	-8.39234	0.43
8	49384.12	49385.37	-25.3118	1.25
9	49528.25	49529.32	-21.6038	1.07
10	49843.53	49844.71	-23.6741	1.18
11	50380.32	50382.36	-40.492	2.04
12	49400.08	49401.3	-24.6963	1.22
13	49528.25	49529.55	-26.2476	1.3
14	49843.54	49844.76	-24.4766	1.22
15	49528.25	49530.25	-40.381	2
16	49843.54	49845.8	-45.3419	2.26

17	47188.7	47190.64	-41.1115	1.94
18	50792.7	50794.7	-39.3757	2
19	51595.5	X		
20	51867.8	51869.4	-30.8477	1.6
21	52498.37	52499.8	-27.2389	1.43
22	52719.87	52723.39	-66.768	3.52
23	53035.16	53038.68	-66.3711	3.52

[0407] Monovalent and bivalent combinations of these switches were expressed and tested in cytotoxicity assays at a dose titration within the range of 0.4 nM to 0.0001nM. Results of this experiment are shown in **FIG. 38G** and **Table 28.** Additionally, **FIG. 38H and Table 29** shows measurement of indicated cytokines in supernatant from each sCAR-T/switch combination in cytotoxicity assay in MOLM14 cell line using BD Cytometric Bead Array (CBA) Human Th1/Th2 II Kit according to manufacturer's protocol. Data shown are an average of duplicate samples, and error bars represent SD. Only the NT switches plus the BvCT and Bv CH1CL1 as references are depicted.cytokine secretion was measured.

[0408] In terms of EC50, maximum killing, and cytokine release, N- terminal engraftment positions on both the light (LCNT; SEQ ID NO: 232 with SEQ ID NO: 217, 218 or 219) and heavy chains (HCNT; SEQ ID NO: 231 with SEQ ID NO: 220 or 221) showed the highest levels of cytotoxicity against CD33+ MOLM14 cells. Positions in the C-terminal or internal sites (ie.CL1, CH1 loop; SEQ ID NO: 222, 223, 224, 225, 226, 227, 228, 229 or 230) had lower cytotoxicity. Furthermore, all bivalent constructs had a low EC50 of cytotoxicity compared to their monovalent counterparts, indicating that bivalent switches may have enhanced activity, among them the NTBV (SEQ ID NOS: 217 & 220) HCNT (SEQ ID NOS: 231 & 220; N-terminal fusion to the heavy chain using rigid linker design SEQ ID NO: 45) and [CD33 (hP67.6) LCNT (N-terminal fusion to the light chain using flexible linker GGGGS) SEQ ID NOS: 217 & 232] showed the best profile.

Table 28: Table of data presented in **FIG. 38G.**

pM	HCNT		LCNT		NTBV		HCCT		LCCT		CTBV		HCC1	
400	69.4	70.2	59.5	60.9	69.3	69.5	44.2	46.3	48.3	49.7	56.9	58.3	47.5	46.7
80	65	64.4	66	66.5	69.7	69.2	44.3	42.9	49.4	48.3	51.4	49.4	57.3	55.6
16	47.8	45.5	58.7	59.2	55.4	57.1	20	13.4	26	26.3	48.2	51.5	40.2	40.2
3.2	10.3	8.3	36.9	35.9	23.6	28.4	0.6	1.3	1	2.9	17.2	16.4	7	4.4
0.64	1.5	0.5	5.9	4.6	0.9	0.8	-0.3	-0.2	-0.1	-0.3	2.6	1	0.5	0.5
0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pM	**HCCH1.2**		**HCCT2**		**HCCT3**		**HCNT2**		**LCC1**		**LCCT2**		**LCCT3**	
400	50.6	50.8	44.3	43.7	45.1	43.8	69.2	64.7	62.5	62.7	46.2	45.3	46.4	47.4
80	58.9	60.9	52.6	49.5	49.8	46.9	64.1	66.6	65.8	66.1	54.9	54.2	53.3	54.6
16	49.9	51.3	30.3	29.7	28.5	26	51.5	50.5	50.8	52.5	40.9	40.8	44.4	44.5
3.2	24.8	23.6	2.3	2.7	2	2.1	19.9	16.7	16	15.5	4.5	5.3	11.9	8.4

0.64	3.1	0.9	0.2	-0.1	0.5	-0.6	0.7	0.9	1.6	0.1	0.8	0.3	1	0.6
0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

pM	**LCNT2**		**LCNT3**		**C1BV**		**CTBV1**		**CTBV3**		**NTBV2**		**NTBV3**	
400	58.4	57.7	55.4	57.5	61.7	64.7	51.9	51.4	49.3	49.4	62.9	64.6	67.1	66
80	69	65.3	62.1	63.5	58.7	61.9	54.8	55.6	55.1	55.3	70.4	67.8	65.1	67.4
16	60.3	57.5	54.3	54	37.6	36.7	23.5	28.5	28.2	26.9	55.3	54	56.9	58.7
3.2	33.1	30.4	31.8	31.4	2.4	4.9	4	2.7	3.4	2.8	20.9	19.7	25.3	26.7
0.64	2.4	2.6	3.8	1.4	-0.8	0.7	-0.1	1.4	-0.2	0.6	2	2.1	2.8	2.8
0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 29: Table of data presented in **FIG. 38H.**

	HCNT		**LCNT**		**NTBv**		**CTBv**		**HCNT2**	
IFNg	1037.59	876.36	448.47	374.76	957.81	958.26	526.49	520.07	733.49	678.54
TNFa	114.13	87.74	53.4	44.84	98.48	97.95	43.06	42.54	69.7	63.85
Il-2	861.13	653	328.62	234	936.57	898.28	410.48	397.66	589.59	495.39

	LCNT2		**LCNT3**		**BvCH1CL1**		**NTBv2**		**NTBv3**	
IFNg	448.43	436.29	494.2	406.99	703.22	641.9	817.31	769.19	852.49	843.46
TNFa	48.69	54.82	54.25	43.69	63.66	60.22	73.22	64.02	84.81	88.51
Il-2	273.1	276.22	301.05	250.79	335.69	296.06	666.7	621.66	760.22	774.07

Example 26. **Treatment of CD123$^+$ solid AML tumors with switchable CAR-T cells**

[0409] CD123 has been described previously as a marker for AML (Jordan et al. Leukemia (2000) 14, 1777–1784 and Testa et al. Biomarker Research (2014), 2:4). Moreover, recently single chain Fragment Variable (scFv) targeting CD123 have been used in the design of conventional CAR-T cells. (Gill et al. Blood 2014) volume 123, number 15, and W02014130635). Two anti-CD123 Fab clones were used to design CAR-T: Clone 32716 (**SEQ ID NOS: 233 & 234**) and Clone 26292 (**SEQ ID NOS: 235 & 236**). Anti CD123 32716 (**SEQ ID NOS: 233 & 234**) clone had increased cytokine release compared to Anti-C123 clone 26292 (**SEQ ID NOS: 235 & 236**) and showed in vivo efficacy in previous reports. However, complete myeloablation was observed due to the expression of CD123 in myeloid and hematopoietic precursors what makes CD123 conventional CAR-T highly toxic for clinic use.

[0410] As suggested previously, our sCAR-T platform can overcome this problem due to our ability of switch titration, targeting and activation of our switchable CAR-Ts through different switch dosing regimen. Several switch designs were generated for both clones (as described for CD19 switches) with varied peptide engraftment positions.

[0411] In one instance the peptide was engrafted on the N-terminus of the light chain of anti-CD123 26292 using 1 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 237**). In one instance the peptide was engrafted on the N-terminus of the light chain of anti-CD123 32716 using 1 of linker

(**SEQ ID NO: 40**) to make (**SEQ ID NO: 238**). In one instance the peptide was engrafted on the N-terminus of the light chain of anti-CD123 32716 using 3 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 239**). In one instance the peptide was engrafted on the N-terminus of the light chain of anti-CD123 32716 using 2 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 240**). In one instance the peptide was engrafted on the N-terminus of the heavy chain of anti-CD123 26292 using 1 of linker (**SEQ ID NO: 45**) to make (**SEQ ID NO: 241**). In one instance the peptide was engrafted on the N-terminus of the heavy chain of anti-CD123 32716 using 1 of linker (**SEQ ID NO: 45**) to make (**SEQ ID NO: 242**). In one instance the peptide was engrafted on the N-terminus of the heavy chain of anti-CD123 32716 using 2 of linker (**SEQ ID NO: 47**) to make (**SEQ ID NO: 243**). In one instance the peptide was engrafted on the C-terminus of the light chain of anti-CD123 26292 using 1 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 244**). In one instance the peptide was engrafted on the C-terminus of the light chain of anti-CD123 32716 using 1 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 245**). In one instance the peptide was engrafted on the C-terminus of the light chain of anti-CD123 32716 using 2 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 246**). In one instance the peptide was engrafted on the C-terminus of the light chain of anti-CD123 32716 using 3 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 247**). In one instance the peptide was engrafted on the C-terminus of the heavy chain of anti-CD123 26292 using 1 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 248**). In one instance the peptide was engrafted on the C-terminus of the heavy chain of anti-CD123 32716 using 1 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 249**). In one instance the peptide was engrafted on the C-terminus of the heavy chain of anti-CD123 32716 using 2 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 250**). In one instance the peptide was engrafted on the C-terminus of the heavy chain of anti-CD123 32716 using 3 of linker (**SEQ ID NO: 40**) to make (**SEQ ID NO: 251**). In one instance the peptide was engrafted on the CH1 loop of the heavy chain of anti-CD123 32716 using no linkers to make (**SEQ ID NO: 252**). In one instance the peptide was engrafted on the CH1 loop of the heavy chain of anti-CD123 32716 using 1 of linker (**SEQ ID NO: 40**) either side of the peptide to make (**SEQ ID NO: 253**); in this construct the GCN4 peptide (**SEQ ID:3**) was engrafted with linkers at both sites replacing S74 and G75 of the heavy chain. In one instance the peptide was engrafted on the CH1 loop of the light chain of anti-CD123 32716 using 1 of linker (**SEQ ID NO: 40**) either side of the peptide to make (**SEQ ID NO: 254**). These switches were expressed and several are demonstrated by SDS-Page (**FIG. 38I**) and switch masses are shown in Table 30, as determined by high resolution QTOF mass spectrometry.

TABLE 30. QTOF analysis of the anti-CD123 Fab-GCN4 switches in **FIG. 38F**.

Protein	Expected Mass	Observed Mass	ppm	Da

26292 WT	46955.44	46939.3	343.7301	-16.14
26292 HCNT	49945.89	49947.61	-34.4373	1.72
26292 HCCT	48979.7	48963.21	336.670	-16.49
26292 LCNT	48979.7	48963.81	324.4201	-15.89
26292 LCCT	48979.7	48962.96	341.7742	-16.74
26292 NTBV	51970.15	51972.21	-39.6381	2.06
26292 CTBV	51003.96	50987.07	331.1508	-16.89
32716 WT	47423.98	47406.89	360.3662	-17.09
32716 HCNT	50414.43	50415.35	-18.2487	0.92
32716 HCCT	49448.24	49431.02	348.2429	-17.22
32716 LCNT	49448.25	49431.82	332.2666	-16.43
32716 LCCT	49448.25	49431.17	345.4116	-17.08
32716 NTBV	52438.7	52440.43	-32.9909	1.73
32716 CTBV	51472.51	51455.49	330.6619	-17.02

[0412] Activity was confirmed by flow cytometry based cytotoxicity assay (**FIG. 38J & FIG. 38K**). **FIG. 38J** and **Table 31.** Shows cytotoxicity of sCAR-T cells against CD 123+ MOLM14 cells with titration of anti-CD 123 26292 Fab switch designs. **FIG. 38K** and **Table 32.** Shows cytotoxicity of sCAR-T cells against CD 123+ MOLM14 cells with titration of anti-CD 123 32738 Fab switch designs.

Table 31: Percent of cytotoxicity in target cells (data in **FIG. 38J)** (duplicate for each switch).

pM	LCCT		HCCT		CTBv		LCNT		HCNT		NTBv	
10000	61	65.3	64.2	67.9	61.6	60.7	66.9	67.2	66.8	70	55.3	57.4
2000	65.9	68.8	67.2	67.3	69	68.2	66.9	69.9	69.4	69.6	64.2	62.1
400	68.9	67.5	66.5	68.7	66.9	68.6	67.6	69.1	65.5	64.9	57.5	55.5
80	59.5	60.9	53.2	55.3	55	59.2	52.7	54	35.6	35.8	31.4	33.2
16	25.8	30.4	26.4	24	32.9	39.1	24.2	27.5	11.9	14.3	16.5	19.3
3.2	10.4	12.6	9	3.8	15.6	21.6	4.5	9.7	4.7	5.3	9.8	4.1
0.64	3.5	5.1	2.6	9.5	10.2	6.9	0.7	4.1	1.3	7.8	7.4	6.4
0.128	2.4	-1	1.6	2.9	6.4	4.6	-0.8	0.4	-1.1	4	2	3.4
0.01	0	0	0	0	0	0	0	0	0	0	0	0

Table 32. Percent of cytotoxicity in target cells (data in **FIG. 38K)** (duplicate for each switch).

pM	LCCT		HCCT		CTBv		LCNT		HCNT		NTBv	
10000	73	75.5	71	73.6	65.1	67.8	52	50.6	77.1	74.9	58.3	51
2000	68.6	68.1	66.7	70.2	61.9	66.1	52.1	47.5	74.9	76.6	60.9	55.7
400	64.7	66.8	64	68.8	50	56.5	33.7	31.3	69.5	68.3	50.9	44.5
80	57.2	55.3	54.7	61.3	40.5	48.1	13.1	11.2	51.3	49.3	27	28.5
16	32.5	26.5	28.3	35.4	16.4	29.1	6.2	0.3	25.9	24	13.7	12.6
3.2	12.7	10.5	8.2	13.8	-9.8	15.9	2	2.6	14.9	11.1	6.4	0.2
0.64	-2.1	-2.3	2.5	4.6	-39.7	-4.6	0.5	-0.2	7.3	2.9	1.6	-6.4
0.128	-0.9	-5.6	-1.8	5.9	-33.3	-16.2	1.1	2.6	6.2	1.7	2.2	3.1
0.01	0	0	0	0	0	0	0	0	0	0	0	0

Example 27. **Soluble TCR (sTCR) switch targeting**

[0413] NY-ESO-1 is a cancer-testis antigen: expression is restricted to the testes and no other normal tissue. NY-ESO-1 expression is found in a surprisingly large range of tumors and may be particularly useful in targeting melanoma and multiple myeloma.

[0414] An NY-ESO-1 switch was produced by fusion of the GCN4 epitope to the C-terminal of the TCR β chain. This construct was expressed and purified in high yields from *E. coli*. The switch is tested for its ability to recruit sCAR-T cells using *in vitro* cytotoxicity assays against A375 (melanoma). Additional constructs are tested with grafting positions identified by structure-based design to assess the geometric constraints of TCR targeting in the context of sCAR-T cells. Notably, all sTCRs bind with the same relative orientation. Therefore, one optimal switch design works equally for any sTCR.

[0415] sTCR switches were expressed as follows:

[0416] TCR chains were expressed separately as inclusion bodies in the E.coli strain BL21-DE3(pLysS) by induction in mid-log phase with 0.5 mM IPTG. Inclusion bodies were isolated by sonication, followed by successive wash and centrifugation steps using 0.5% Triton X-100. Finally, the inclusion bodies were dissolved in 6 M guanidine, 10 mM dithiothreitol (DTT), 10 mM ethylenediaminetetra-acetate (EDTA), buffered with 50 mM Tris pH 8.1 and stored at ±80°C. Soluble TCR was refolded by rapid dilution of a mixture of the dissolved a- and b-chain inclusion bodies into 5 M urea, 0.4 M L-arginine, 100 mM Tris pH 8.1, 3.7 mM cystamine, 6.6 mM b-mercapoethylamine (4°C) to a final concentration of 60 mg/l.

[0417] sTCR switches were purified as follows:

[0418] The refold mixture was dialysed for 24 h against 10 volumes of demineralized water, then against 10 volumes of 10 mM Tris pH 8.1 at 4°C. The refolded protein was then filtered and loaded onto a POROS 50HQ column (Applied Biosystems). The column was washed with 10 mM Tris pH 8.1 prior to elution with a 0±500 mM NaCl gradient in the same buffer. Fractions were analysed by Coomassie-stained sodium docecyl sulphate (SDS)±10% NuPAGE (Novagen, WI), and TCR-containing fractions were pooled and further purified by gel filtration on a Superdex 75PG 26/60 column (Amersham Biosciences, Uppsala, Sweden) pre-equilibrated in phosphate-buffered saline. Fractions comprising the main peak were pooled and analysed further. The ®nal puri®ed 1G4 dsTCR was analysed by Coomassie-stained SDS±10% NuPAGE under reducing and non-reducing conditions, and an aliquot of protein was buffer exchanged into HBSE (HEPES pH 7.4, 150 mM NaCl, 3 mM EDTA) and concentrated prior to activity determination by BIAcore SPR.

[0419] Alternatively, TCR zipper chains were overexpressed in *E. coli* and purified as follows. GFG020, GFG021, JMB002, GFG089, and GFG092, the pGMT7 expression plasmids encoding the JM22a-Jun, JM22b-Fos, JM22b-Fosbt, F5a-Jun, and F5b-Fos proteins, respectively, were

transformed separately into E. *coli* strain BL21pLysS ~DE3!, and single colonies were grown at 37 C in TYP ~ampicillin 100 µg/mL medium to OD600 of 0.4 before inducing protein expression with 0.5 mM IPTG. Cells were harvested 3 h postinduction by centrifugation for 30 min at 4000 rpm in a Beckman J-6B. Cell pellets were resuspended in a buffer containing 50 mM Tris-HCl, 25% ~w/v sucrose, 1 mM EDTA, 0.1% w/v sodium azide, 10 mM DTT, pH 8.0. After an overnight freeze–thaw step, resuspended cells were sonicated in 1 min bursts for a total of around 10 min in a Milsonix XL2020 sonicator using a standard 12 mm diameter probe. Inclusion body pellets were recovered by centrifugation for 30 min at 13,000 rpm in a Beckman J2-21 centrifuge. Three detergent washes were then carried out to remove cell debris and membrane components. Each time the inclusion body pellet was homogenized in a Triton buffer ~50 mM Tris-HCl, 0.5% Triton X-100, 200 mM NaCl, 10 mM EDTA, 0.1% ~w/v sodium azide, 2 mM DTT, pH 8.0 before being pelleted by centrifugation for 15 min at 13,000 rpm in a Beckman J2-21. Detergent and salt were then removed by a similar wash in the following buffer: 50 mM Tris-HCl, 1 mM EDTA, 0.1% ~w/v sodium azide, 2 mM DTT, pH 8.0. Finally, the inclusion bodies were solubilized in denaturant for 3–4 h at 48C. JM22a-Jun, JM22b-Fos, JM22b-Fosbt, and F5a-Jun pellets were dissolved separately in a urea solution ~50 mM MES, 8 M urea, 10 mM EDTA, 2 mM DTT, pH 6.5, whereas F5b-Fos pellets were dissolved in a guanidine solution containing 50 mM MES, 6 M guanidine, 10 mM EDTA, 2 mM DTT, pH 6.5. Insoluble material was then pelleted by centrifugation for 30 min at 13,000 rpm in a Beckman J2-21, and the supernatant was divided into 1 mL aliquots and frozen at 270 8C. Solubilized, purified inclusion bodies were quantitated using a Bradford dye-binding assay (Biorad, Richmond, California). For each chain a yield of around 100 mg of purified inclusion body was obtained from 1 L of culture. From SDS-PAGE analysis, the purity of each inclusion body was estimated to be around 90%.

Example 28. **Expression of TCR chains**

[0420] TCR chains were expressed separately according to the following protocol:

[0421] 1. Pick colony for 50ml starter culture o/n at 37 with Amp

[0422] 2. Seed large culture at 0.07 OD(600). Induce at 0.4 OD(600) with 0.5 mM IPTG (0.5-1.0 L 2xYT+Amp)

[0423] 3. Spin down at 6k for 20' at 4C

[0424] 4. Freeze O/N at -80 C

[0425] 5. Resuspend with 25ml to 50ml of buffer (50mM Tris-HCL [8.0], 25% w/v sucrose, 1mM EDTA, 0.1% w/v NaN3, 10mM DTT) + 0.5 mg/ml of lysozyme + 1 pellet of protease inhibitors (crushed)/tube. Keep on ice.

[0426] 6. Sonicate 20s on, 30s off for 15 minutes total experimental time. Keep on ice.

[0427] 7. Pellet (13k/15') and wash 3x with detergent/salt buffer (50mM Tris-HCL [8.0], 0.5% Triton X-100, 200mM NaCl, 10mM EDTA, 0.1% w/v NaN3, 2mM DTT).

[0428] 8. Pellet (13k/15') and wash 2x with (50mM Tris-HCL [8.0], 1mM EDTA, 0.1% w/v NaN3, 2mM DTT).

[0429] 9. Dissolve inclusion bodies in (6M guanidine, 10 mM DTT, 10 mM EDTA, 50mM Tris [8.1] stored at -80 C

[0430] To analyze protein in the lysed cells collect 100 ul before spinning down the sonicated cells and 100 uL after spinning down the cells. Get the ABS280 of the post spun cells (cleared lysate) and calculate the appropriate volume for 5ug of protein (assume 1 mg/mL = 1 ABS). Load this amount of cleared lysate on the gel. Load ½ of this amount for each of the noncleared samples.

[0431] For the remainder of the protocol:

[0432] 1. Solubilize pellets in 5 mL 6 M guanidine, 10 mM dithiothreitol (DTT), 10 mM ethylenediaminetetra-acetate (EDTA), buffered with 50 mM Tris pH 8.1 . (This is a 100x concentration from initial culture volume). Pellets are incubated at 48 degrees for 3-4 hours to solubilize. Alternatively, pellets are shaken at 37°C for 4 hrs.

[0433] 2. Spin to remove insoluble proteins.

[0434] 3. Use supernatant to obtain protein concentration with BCA assay. Note the tolerance for guanidine in BCA (or Bradford) assay is 4M so dilute the analyte to 4M (confirm this with your assay kit). You'll likely need an additional at least 3, 10x dilutions to get in the measurable range. These should all be in 4M guanidine (water may cause crashing out of protein).

[0435] 4. Load 1-2 ug of all samples on gel for analysis.

[0436] 5. For test refolding, combine 300 ug of each alpha and beta protein/guanidine solution and dilute to 10 mL with 5 M urea, 0.4 M L-arginine, 100 mM Tris pH 8.1, 3.7 mM cystamine (note not cysteamine, do not need the un-induced control expressions for these refolding steps), 6.6 mM b-mercapoethylamine (4°C) to a (final concentration of 60 mg/l). If we do not have cystamine and mecaptoethylamine in the lab use 2 mM DTT instead. Aliquot and freeze remaining unused guanidine/protein solutions.

[0437] 6. Add this solution to 10 KDa MWCO snakeskin tubing or a 12 mL pierce dialysis cassette.

[0438] 7. Dialyze in 100 mL of water for 6-8 hours at 4 degrees (or overnight)

[0439] 8. Change buffer to 10 mM Tris pH 8.1 at 4 degrees, dialyze overnight.

[0440] 9. Protein should be refolded. Remove dialyzed solution, spin to clear

[0441] 10. Run gel, native and denaturing. To assess. If sufficient soluble, refolded protein can proceed with His column or anion exchange to clean up and return to frozen aliquots to scale up refolding. Note scale up will require Pierce dialysis snakeskin tubing 10 kDa MWCO.

[0442] 1G4c113 TCR alpha and beta chains were expressed and refolded as described. Following the refolding samples were purified by loading onto MonoQ with 20mM Tris (pH 8.1) and 50 mM NaCl. The refolded 1G4c113 TCR was eluted by a gradient to 20 mM Tris (pH 8.1) and 1M NaCl. Pre column and the eluted protein are shown on a Coomassie stained 10% Tris-Glycine gel. Left Panel. Native, refolded 1G4c113 TCR with GCN4-CTerm peptide grafted to the beta chain. Right panel, reduced 1G4c113 TCR alpha chain and 1G4c113-TCR beta chain with grafted GCN4-Cterm. See **FIG. 39** for expressed and purified 1G4c113 TCR with peptide graft.

[0443] Samples from the post-MonoQ elutions as shown in **FIG. 39** were identified via mass spectrometry. **FIG. 40A** shows non-reduced and **FIGS. 40B-C** show reduced peaks correlating to the non-reduced 1G4c113-TCR with GCN4-Cterm peptide graft. Table 33 shows summary of mass spectrometry data as shown in **FIG. 40A-C**.

Table 33.

Protein	Theoretic	Found	Dif. (d)	p.p.m.
NYESO1(1G4c113)-TCRa/TCRb-GCN4-Cterm	53528.71	53540.13	11.42	-213.343
NYESO1(1G4c113)-TCRa	22937.59	22937.05	-0.54	23.54214
NYESO1(1G4c113)-TCRb-GCN4-Cterm	30601.12	30599.13	-1.99	65.0303

Example 29. Soluble Based TCR (sTCR) Switches

[0444] A schematic depiction of the soluble based TCR (sTCR) interacting with a peptide presenting HLA molecule. In some embodiments, the sTCR is engrafted with a peptide that could be recognized by a sCAR T cell (**FIG. 41A**).

[0445] A sTCR specific for HLA molecules expressing the cancer associated NY-ESO-1 peptide was expressed with a C-terminal GCN4 peptide and a His-tag. The ability of this NY-ESO-1 sTCR switch to bind to T2 cells expressing HLA molecules loaded with the NY-ESO-1 peptide was determined by flow cytometry. 10^5 T2 cells were loaded with 10 nM of either the NY-ESO-1 or a HIV peptide for 2 hours at 37°C in 200 µl of DMEM medium with no serum protein added. The cells were then washed with cold PBS two times before being incubated with 1 nM of the NY-ESO-1 sTCR for 30 minutes at 4°C in 100 µL of FACS buffer (PBS, 1% FCS, 2 mM EDTA). The cells were then washed with cold PBS two times before being incubated with a Biotin-conjugated anti-HIS antibody (Sigma; 5 µg/ml) for 30 minutes at 4°C in 100 µL of FACS buffer. The cells were then washed with cold PBS two times before being incubated with a streptavidin conjugated phycoerythrin (svPE; Biolegend; 1:200 dilution) for 30 minutes at 4°C in 100 µL of FACS buffer. Cells were then washed a final two times and the cells were analyzed using a BD Accuri C6 flow

cytometer. The sTCR bound to the T2 cells loaded with the NY-ESO-1 peptide but not the HIV peptide (**FIG. 41B**).

[0446] 10^5 T2 cells were loaded with 10^0-10^{-8} nM of the NY-ESO-1 or HIV peptide for 2 hours at 37°C in 200 µl of DMEM medium with no serum protein added. The cells were then labelled with the NY-ESO-1 specific sTCR as described above. The data are presented as MFI of the switch binding against the concentration of the peptide used to load the cells. These data indicated that 1 nM of peptide loaded onto the T2 HLA molecules was sufficient for the sTCR to bind to the T2 cells, therefore 1 nM of the NY-ESO-1 peptide was used for subsequent experiments (**FIG. 41C**).

[0447] Short-dimeric sCAR-T cells (also known as IgG4m sCAR-T)can kill T2 cells pulsed with NY-ESO-1 peptide but not HIV peptide. In this experiment, the short-dimeric sCAR-T cells were cultured with T2 cells that had been pulsed with 1 nM of the NY-ESO-1 or HIV peptide as described above. This assay was conducted at an effector: target cell ratio of 10: 1. A serial dilution (100,000-0.01 pM) of the sTCR_GCN4 switch was added to the cells. The cells were incubated for 20-24 hours, after which the supernatants were assayed to detect LDH release as a proxy for target cell lysis. EC50 values are shown in parentheses. This data show that only T2 cells that had been pulsed with the NY-ESO-1 peptide were susceptible to killing mediated by the short-dimeric sCAR-T cells (**FIG. 41D**).

[0448] sTCR switches activate T cells in *in vitro* cytotoxicity assays. The cells from the assay described above were stained with PE-conjugated anti-human CD25 and PerCP-conjugated anti-human-CD69 for 30 minutes in FACs buffer at 4°C. These cells were then washed twice and acquired using an Accuri C6 (BD). The $CD25^+CD69^+$ T cells were considered as being activated and the proportion of these cells is plotted against the concentration of switch used in the original assay. This data shows how at sTCR switch concentrations of >1 pM the T cells become activated and express the T cell activation markers CD25 and CD69 (**FIG. 41E**).

[0449] sTCR switches can induce pro-inflammatory cytokine production from short-dimeric sCAR-T cells. Cytokine levels were measured in the supernatants from the assay described above by cytometric bead array (CBA, BD) as per the manufacturer's instructions. These data show how at sTCR switch concentrations of >10 pM the T cells become express the pro-inflammatory cytokines IFNγ, IL-2 and TNFα (**FIG. 41F**).

[0450] Collectively this data shows that soluble TCR based switches can direct sCAR-T cells to kill target cells presenting the target HLA:peptide complex and sTCR switches can activate sCAR-T cells to produce pro-inflammatory cytokines.

Example 30. **Off-switch: Peptide-based CAR-T disruption**

[0451] One of the great advantages of the sCART cell system is that the activity can be controlled. This can be achieved by either dose escalation of the switches or by stopping switch dosing. In the

event that the cessation of switch dosing is not an acute enough response to halt sCART cell activity, immunological synapses are disrupted by the administration of free peptide. To demonstrate this, **FIGS. 26A-F** shows increasing the concentration of free peptide blocks sCART cell activation and activity *in vitro*. **FIG. 26D** shows that only the cognate free peptide epitope inhibited cytotoxicity, and alanine mutated free peptides (PepX) had no effect).

Example 31. **Titrated Treatment of Solid Tumors with Switchable CAR T Cells**

[0452] FIGS. 42A-D show *in vitro* activity of sCAR-T cells with anti-HER2 switch. FIG. 42A shows cytotoxicity of sCAR-T cells against Her2 3+ SKBR3 cells with titrations of anti-HER2 Fab switch designs. **FIG. 42B** shows cytotoxicity of sCAR-T cells against Her2 2+ MDA MB453 cells with titrations of anti-HER2 Fab switch designs. **FIG. 42C** shows cytotoxicity of sCAR-T cells against Her2 1+ MB435 cells with titrations of anti-HER2 Fab switch designs. **FIG. 42D** shows cytotoxicity of sCAR-T cells against Her2$^-$ MB468 cells with titrations of anti-HER2 Fab switch designs. In the experiments shown in **Fig 42A&B**, sCAR-T cells were cultured with target cells at a ratio of 10:1, LDH levels were measured in the supernatant following 24h incubation with the anti-HER2 switch. Percent cytotoxicity was calculated by: % cytotoxicity = [(absorbance experimental – absorbance spontaneous average)/(absorbance maximum killing average – absorbance spontaneous average)] x 100. This data show that sCAR-T cells have activity against HER2 3+, 2+ and 1+ but not HER2$^-$ cells.

[0453] FIGS. 42E-F show *in vivo* activity of sCAR-T cells with anti-HER2 switch. FIG. 42E shows *in vivo* cytotoxicity of sCAR-T cells against Her2 2+ MDA MB453 cells with the CTBV anti-HER2 Fab switch. FIG. 42F shows *in vivo* cytotoxicity of sCAR-T cells against Her2 3+ HCC1954 cells with the CTBV anti-HER2 Fab switch. The experiments shown in Fig 42E&F were conducted with 6 to 8-week-old female NSG mice. $5x10^6$ of HCC1954 (HER2 3+) or MDA MB453 (HER2 2+) the human breast cancer cell lines in 50% Matrigel (BD Bioscience) were subcutaneously implanted into the right flank of mice. Ten days after tumor implantation, mice received $30x10^6$ sCAR-T cells or the direct HER2 CAR-T cells (both with a transduction efficiency of 45-55%) via intra venous injection. Mice were dosed intravenously with PBS, WT anti-HER2 (no peptide engraft) or the CTBV anti-HER2 q.a.d. from day 10-24 as indicated by the grey shaded area of the data. Tumors were measured twice weekly using calipers. Tumor volume was calculated based on width x length x height.

Example 32. **Design Optimization of Multiple sCAR T Cells Targeting Breast Cancers**

[0454] The standard of care for patients with Her2 positive cancer, trastuzumab, is not approved in patients with low levels of Her2 expression (Her2 1+), which occurs in ~35% of breast cancer patients and represents a major unmet medical need. This example demonstrates that optimal sCAR-T cell-switch combinations potently lysed Her2 positive tumors, including Her2 1+ tumors,

both *in vitro* and *in vivo* with efficacy that is comparable to the conventional anti-Her2 CAR-T cells. Activity of these switches depended strongly on the orientation of the bio-orthogonal immunological synapse, which was determined by location of the tag incorporation in the switch.

[0455] To develop switches that redirect the activity of sCAR-T cells to Her2 expressing cancer cells, anti-Her2 (4D5 Fab) switches conjugated to GCN4 peptide at defined sites in the variable or constant regions of antibody antigen binding fragment (Fab). These tag positions were chosen to provide switches that formed the ternary complex between the sCAR-T cell, switch, and the target cell with a diverse range of distance and orientation, thus allowing the empirical optimization of immunological synapse.

To develop GCN4 switches, we grafted the GCN4 peptide sequence to the N- or C-terminus of the 4D5 Fab heavy chain or light chains to create the light chain N-terminus (LCNT), light chain C-terminus (LCCT), heavy chain N-terminus (HCNT) or heavy chain C-terminus (HCCT) engrafted switches. A GGGGS peptide linker was used to separate the peptide tag from the Fab. To create bivalent switches, the GCN4 peptide was grafted onto either the N- or C-terminus of the heavy and light chain to create NTBV or CTBV respectively (**FIG. 44A**). Mass spectrometric analysis of anti-Her2-GCN4 fusions obtained on an Agilent Quadruple Time-of-Flight (QTOF) mass spectrometer. Deconvoluted masses were obtained using Agilent Qualitative Analysis software (**FIG. 43B**, **Table 34**).

Table 34. QTOF-MS characterization of different anti-Her2 Fab and the GCN4 fusions

Constructs	Non-reducing condition (-DTT) Expected/Observed Mass	Reducing condition (+DTT) Expected/Observed Mass
Wild type	47762/ 47755	23457/ 23454 (light chain) 24305/ 24302 (heavy chain)
LCNT	49786/ 49780	25481/ 25479 (LC-NT light chain) 24305/ 24302 (heavy chain)
LCCT	49786/ 49779	25481/ 25479 (LC-CT light chain) 24305/ 24302 (heavy chain)
HCNT	49787/ 49779	23457/ 23454 (light chain) 26330/ 26327 (HC-NT heavy chain)
HCCT	49787/ 49779	23457/ 23454 (light chain) 26330/ 26327 (HC-CT heavy chain)
NTBV	51811/ 51806	25481/ 25479 (LC-NT light chain) 26330/ 26327 (HC-NT heavy chain)
CTBV	51811/ 51804	25481/ 25478 (LC-NT light chain) 26330/ 26326 (HC-NT heavy chain)

[0456] GCN4-based switches bound Her2 expressing cancer cells to a similar extent as wild type 4D5 Fab (**Table 35**, **FIG. 45**) and did not bind to MDA MB468 cancer cells lacking Her2 expression. Replacing the long 45 amino acid CD8 hinge CAR region with a shorter 12 amino acid hinge derived from a dimeric mutant of the IgG4 hinge (IgG4m) improved anti-GCN4 sCAR-T cell

activity in the context of targeting CD19 and CD20, putatively by reducing the overall distance between the sCAR-T cell and target cell (**FIG. 44B**). However, it is unknown if the increased activity of the IgG4m hinge can be extended to the Her2 antigen.

Table 35. Comparison of binding activity of different GCN4 tagged anti-Her2 fusions on breast cancer cells

		MFI[a] / Relative Binding Index[b]							
Cell line	Her2 Level	anti-CD19 Fab	anti-Her2 Fab	LCNT	LCCT	HCNT	HCCT	NTBV	CTBV
SKBR3	Her2 3+	151	14306/95	18068/120	14977/99	17535/116	17381/115	19253/128	22931/152
MDA MB453	Her2 2+	147	8081/55	7342/50	7041/48	7309/50	7947/54	8195/56	6910/47
MDA MB231	Her2 1+	87	424/5	475/5	334/4	414/5	418/5	458/5	406/5
MDA MB435	Her2 1+	94	245/3	213/2	188/2	191/2	206/2	210/2	216/2
MDA MB468	Her2 0	80	86/1	84/1	89/1	84/1	90/1	92/1	86/1

[a]MFI: mean fluorescence intensity calculated by software FlowJo X10.0.6
[b]Relative Binding index represent MFI of indicated antibody / MFI of anti-CD19 Fab

[0457] Next, the capacity of sCAR-T cells with CD8 or IgG4m hinges to bind their corresponding anti-Her2 switches was tested. The GCN4 switches were used to stain anti-GCN4 sCAR-T cells, and detected with an APC-labeled anti-human kappa-chain antibody specific for the constant region at the Fab. As shown in **FIGS. 46A and 46B**, all the switches bound to their corresponding sCAR-T cells with similar EC_{50} (1.4 to 3.8 nM for GCN4-based sCAR-T cells). The wild type 4D5 Fab failed to bind any sCAR-T cells, demonstrating the specificity of the sCAR to their specific tags. Together with the target cell binding assay, we confirmed that PNE grafted fusions reserved the binding specificity to the target cells as well as the tag recognition of 4D5-based switch by the sCAR-T cells.

[0458] As shown in **FIG. 44C** and **Table 36**, switches with the GCN4 distal to the antigen binding interface formed ternary complex more effectively than switches where the tags were proximal to the antigen binding interface. Conversely, switches with the GCN4 tag placed distal from the antigen binding domain allow for efficient ternary complex formation as they display the tag for efficient sCAR binding. Bivalent switches were observed to form more efficient ternary complexes compared with their monovalent counterparts, presumably due to increased avidity, with the greatest complex formation observed for the distal, bivalent switch (CTBV) **(FIG. 44C)**.

Table 36. Comparison of crosslinking ability between anti-GCN4 CAR-T cells and Her2 ECD by different GCN4 tagged anti-Her2 fusions.

EC_{50} (nM)/Maximal binding (MFI × 100)		
	Anti GCN4 CAR-EC with CD8 hinge	**Anti-GCN4 CAR-EC with IgG4m hinge**
Anti-Her2 Fab	N.D./2.9±0.5	N.D./1.6±1.0
LCNT	5.1±0.2/45.3±1.6	3.3±0.2/41.2±3.5
LCCT	1. 8±0.1/49.2±3.5	2.2±0.2/54.6±4.4
HCNT	6.3±0.4/50.6±2.4	2.9±0.2/46.6±2.1
HCCT	1.9±0.2/44.7±3.1	1.9±0.1/57.4±1.2
NTBV	N.D./12.2±1.1	N.D./31.4±0.3
CTBV	0.3±0.0/72.1±3.1	0.5±0.1/110.1±2.5

Abbreviations: EC_{50}, half-maximal binding concentration; N.D., not determined.
Data shown are a mean of duplicate samples ± SD.

[0459] *Influence of hinge design on sCAR-T cell activity.*

[0460] To test if the results of ternary complex assay correlated with sCAR-T activity, we combinatorially tested sCAR-T cell activation with representative monovalent (HCNT and LCCT GCN4) and bivalent (NTBV and CTBV GCN4) switches at 100pM against each Her2 expressing cancer cell.

[0461] For GCN4-based switches, the same hinge was not optimal for all representative switches tested (**FIG. 47**, **FIGS. 48 A-C**). The anti-GCN4 sCAR harboring the CD8 hinge showed the greatest T cell activation and cytokine release when redirected by the switches grafted with GCN4 on the N-terminal (HCNT), but when GCN4 was grafted on the C-terminal (LCCT), the IgG4m hinge-based anti-GCN4 sCAR was optimal. Conversely, the IgG4m hinge-based anti-GCN4 sCAR had superior activation and cytokine release with C-terminal grafted switches. This suggested that the compensatory design of the sCAR hinge and switch labeling sites was required to find the optimal distance and orientation for sCAR-T cell cytotoxicity for the GCN4-based sCAR-T cells.

[0462] To further understand the differences observed for CD8 and IgG4m hinge designs for GCN4 sCARs, *in vitro* cytotoxicity was measured against a panel of breast cancer cells with different Her2 antigen densities. The CTBV GCN4 switch was used to redirect anti-GCN4 sCAR-T cells. This switch provided the greatest ternary complex formation and sCAR-T cell activation against Her2-positive cells. In agreement with this result, anti-GCN4 sCAR-T cells afforded greater potency of cytotoxicity harboring the IgG4m hinge compared with the CD8 hinge (**FIG. 49**). Differences in the EC_{50} of cytotoxicity for different hinges were nominal against cells with high levels of Her2 expression (SKBR3, Her2 3+; MDA MB453, Her2 2+); however, the effect of

hinge design afforded a marked difference on cells at low levels of Her2 expression (MDA MB435, Her2 1+). These findings were reproducible on Her2 1+ cancer cells BT20 and MDA MB231 (**FIG. 50**), providing further confirmation of the correlation with antigen density. This may be due to the limited number of immunological synapses that may be formed by the low antigen density cells which increases the relative contribution of each synapse, thus placing a greater emphasis on optimal complex formation.

[0463] *Novel PNE FLAG-based switchable CAR strategy*

[0464] To understand the generalizability of the switchable approach, another sCAR system based on the 9 amino acid FLAG sequence (SDYKDDDK ; SEQ ID NO: 258) was developed. This short, hydrophilic PNE is reported to be non-immunogenic, and consequently is an ideal target for the sCAR. To create an anti-FLAG scFv, we immunized BALB/c mice with the FLAG peptide grafted to a prototypical Fab to obtain high affinity (apparent affinity of 2.2×10^{-10} M, (**FIG. 51)** monoclonal antibody (clone: 5B3) from hybridoma screens. The heavy and light chain variable regions were subcloned subcloned in scFv format in the second generation CAR vector harboring the CD8 or IgG4m hinge as described above.

[0465] Based on the switch design optimization for GCN4 switches, a bivalent FLAG switch was made by fusing the FLAG peptide to the C-terminus of both heavy and light chains (CTBV) of anti-Her2 Fab. A $(GGGGS)_2$ linker was used to link the FLAG peptide to the Fab which corresponded to the linker used in the immunization strategy to develop the 5B3 scFv. Following expression from *E.coli*, FLAG switches were purified to > 95%, and homogeneity was confirmed by SDS-PAGE and MS analysis. To test the activity of the CTBV Flag switch with the CD8 or IgG4m-based sCAR-T cell, the functional activities of this switch with these CARs against Her2 positive cancer cells was compared. Corresponding with the GCN4 CTBV switch, the FLAG CTBV switch demonstrated enhanced activity with FLAG sCAR-T harboring IgG4m hinge compared to the CD8 hinge (**FIG. 52A**). This correlated with significantly greater T cell activation and cytokine release (IL-2, IFN-γ and TNF-α) with the IgG4m-based hinge FLAG sCAR-T cells, especially on Her2 1+ cells. (**FIG. 52B**).

[0466] To compare the activity of the optimal switch/sCAR pair with conventional anti-Her2 CAR, *in vitro* cytotoxicity assays were carried out at a range of E: T ratios against the representative Her2 3+, 2+, 1+ and 0 cancer cells. The optimal sCAR-T combinations: GCN4 (CTBV with IgG4m hinge CAR) and FLAG (CTBV with IgG4m hinge CAR) were selected. For sCAR-T cells, 50pM of each switch was used. As shown in **FIG. 53** sCAR-T cells lysed Her2 cancer cells with comparable efficacy to the conventional CAR-Her2 across all E: T ratios. Both sCAR-T cells and conventional CAR-T cells showed good selectivity for Her2 cells with little lysis on Her2 negative MDA MB468 cells. Furthermore, T cell activation and cytokines at the E: T ratio

of 5: 1 demonstrated that the optimized sCAR-T cells afforded comparable induction of T cell function to the conventional anti-Her2 CAR-T cells (**FIG. 54)**.

[0467] *Comparison of conventional CAR-T with sCAR-T strategies.*

[0468] To compare the *in vivo* antitumor ability of each optimized sCAR-T, their *in vivo* efficacies were evaluated in mouse xenograft models using Her2 3+ (HCC1954) and Her2 2+ (MDA MB453) breast tumors. Tumor cells were s.c. inoculated in the right flank of NSG mice and solid tumors grown until palpable (~300 mm^3). On day 10, mice were infused i.v. with 30×10^6 anti-GCN4 or anti-FLAG sCAR-T cells, followed by i.v. injection of the corresponding switches every other day at 0.5mg/kg for 14 days based on our earlier publications. To confirm the requirement for switch-mediated sCAR-T cell-target cell crosslinking for activity, each sCAR-T cell was dosed with wild type 4D5 Fab in control group. Tumor growth was monitored for 50 days. As shown in **FIG. 55A and FIG. 55B**, both conventional and sCAR-T cells showed comparable tumor regression kinetics and completely eliminated both Her2 3+ and 2+ tumors by day 25. The treatment of sCAR-T cells with wild type 4D5 Fab had no effect on tumor growth. No relapse events were observed during the course of the study.

[0469] To test activity in a more stringent model, a Her2 1+ orthotopic xenograft model using MDA MB231 cells was selected. In this model, MDA MB231 (Her2 1+) cells are implanted into the right fourth mammary fat pad of female NSG mice to generate tumors. Treatment with the same dosing and schedule as the Her2 3+/2+ models above was begun ten days after tumor inoculation. As shown in **FIG. 55C**, sCAR-T cells induced complete eradication of Her2 1+ tumors by day 30, and no tumor relapse occurred during the 50 days of observation. The kinetics of tumor removal were comparable to conventional anti-Her2 CAR-T cells. Collectively, these *in vivo* findings confirmed the methodology of optimization of sCAR-T platforms. Further, this study demonstrated sCAR-T cells constructed from multiple targeting modalities and can specifically target and destroy Her2 expressing tumors with comparable efficacy to conventional CAR-T.

Example 33. **Humanization of sCAR-T cells**

[0470] To reduce immunogenicity in human patients, it is important for murine antibody constructs to be humanized. Humanization of murine antibodies involves the engraftment of the murine CDR regions onto the amino acid framework of a human antibody.

[0471] In this example, the CDRs of the murine anti-GCN4 scFv (52SR4) were engrafted onto a human framework (4D5). Several other mutations were made in the framework regions of both the heavy and light chains. The potency of the humanized sCAR-T cell constructs was tested in an *in vitro* LDH release cytotoxicity assay. The humanized CAR-T cells were co-cultured with RS4;11 ($CD19^+$) cells at an effector : target ratio of 10:1. The murine FMC63 anti-CD19 switch (LCNT

graft; SEQ ID NOS: 36 & 9) was added at concentrations ranging from 1000-0.1 pM. After a 24-hour incubation at 37°C, LDH levels were measured in the supernatant and the percentage cytotoxicity was calculated. In this example (**FIG. 56** and **Table 37**), the parent antibody FMC63 anti-CD19 switch (LCNT graft; **SEQ ID NO: 36 & 9**), L5 H6 (**SEQ ID NO: 183**), L6 H6 (**SEQ ID NO: 257**), L5 H4b (**SEQ ID NO: 256**), L5 H6b (**SEQ ID NO: 185**), L6b H4 (**SEQ ID NO: 255**) and L5b H4b (**SEQ ID NO: 256**) switches were used. Importantly, these data demonstrate that single modifications can be made to the scFv construct without a loss in *in vitro* activity.

Table 37. Raw data of cytotoxicity from **FIG. 56**

Switch [pM]	Murine LCHC		L5 H6		L6 H6		L5 H4b		L5 H6b		L6b H4		L5b H4b	
1000	36.84	38.41	28.44	31.13	28.86	35.79	34.51	38.4	31.52	30.31	37.25	36.67	36.04	33.74
100	34.76	37.86	31.73	37.29	23.48	28.7	33.82	33.59	34.63	32.28	40.03	42.69	35.68	36.06
10	29.48	30.81	22.72	33.36	25.94	27.16	25.91	28.37	27.08	25.02	31.43	31.03	31.1	27.68
1	26.58	24.16	25.38	27.01	22.76	24.15	22.79	22.15	21.71	18.7	26.85	27.25	26.95	25.8
0.1	5.74	6.67	11.21	-0.17	11.34	4.6	5.86	6.41	8.21	8.73	8.9	9.66	4.68	7.54
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Example 34. ***Methods of Making and Using CAR T Cell Switches***

Mice and cell lines

[0472] Female NOD scid gamma (NSG) mice, 9-11 weeks of age, were purchased from Jackson Laboratories and maintained in a vivarium on a 12hr light cycle access to food and water ad libitum. RS4;11 and K562 cells were purchased from ATCC and cultured in RPMI supplemented with 10% heat inactivated FCS (Thermo), 0.1mM MEM non-essential amino acids, 2mM L-glutamine, 1mM MEM sodium pyruvate and 1% penicillin/streptomycin (all from Life Technologies); Nalm-6$^{GFP/Luc}$ cells were also cultured in complete RPMI media. CAR-T cells were cultured in Aim-V media supplemented with 5% penicillin/streptomycin (both from Life Technologies) and 5% heat inactivated human serum (Valley Biomedical Inc.).

Switch binding and cytotoxicity assays

[0473] CAR-T or target cells were incubated with 1 pM to 1.5 μM of switch in FACS buffer (PBS, 1% FCS, 2 mM EDTA) for 30 minutes at 4°C before being washed twice and then incubated with the PE-conjugated goat-anti-human kappa antibody (1:100). Cells were washed two times and analyzed using the Accuri flow cytometer (BD). CAR-T cell activity was determined using the CytoTox 96® Non-Radioactive Cytotoxicity Assay (Promega). CAR-T cells were incubated with target cells in the presence of switch for 20-24 hours at 37°C in complete RPMI with 5% FCS. At the end of the assay, 30 μL of cell free supernatant was added to 30 μL of the LDH assay reagent in a 96-well plate and incubated for 30 minutes at room temperature in the dark; 30 μL of stop solution was added before the plate was read at OD_{495}. To calculate cytotoxicity, 45 minutes before the end of the assay, target cells alone were lysed using the 10x lysis solution (Promega): this

OD_{495} value was subtracted from that of target cells alone, reflecting spontaneous lysis, and used as 100% cytotoxicity. Cytokines were analyzed in the cytotoxicity assay supernatants using the Human Th1/Th2 Cytokine Bead Array kit II (CBA; BD). Cells from the cytotoxicity assay were stained with anti-human CD3 (APC), anti-human CD25 (PE) and anti-human CD69 (PerCP), all from BioLegend, and analyzed by flow cytometry to determine the proportion of T cells that were activated ($CD25^+$ $CD69^+$).

Xenograft Mouse models

[0474] NSG mice were inoculated with $5x10^5$ Nalm-$6^{GFP/Luc}$ i.v. (day 0). On day 6, $4x10^7$ CAR-T cells (50-70% CAR^+) were infused i.v.; unless otherwise stated switches were added 6 hours later. Body weight was monitored and mice were sacrificed upon losing more that 15% of body weight or 10% body weight loss with the development of hind limb paralysis. Tumor burden was measured by IVIS and was quantified as radiance in the region of interest (ROI) which was generally the area of 1 mouse. Mouse blood was drawn at 24 hours and every 10 days after T cell infusion (maximum of 5 times) and cytokine concentrations were determined by CBA. T cells were analyzed in the blood of these mice at the stated time points by flow cytometry using: anti-CD3 (APC or PerCP), anti-CD4 (PerCP or PE/Cy7), anti-CD8 (PE), CD45RA (PE) or CD62-L (APC) (all from BioLegend), and were enumerated using the count bright beads (BD). T cells were defined as $CD3^+$ and either $CD4^+$ or $CD8^+$. Cells were analyzed using the Accuri or LSR-II flow cytometers (BD).

Statistical analysis

[0475] Statistical significance and EC_{50} values were calculated using GraphPad software. Unless otherwise stated, *in vitro* data were analyzed using the one-tailed student's t-test and *in vivo* data were analyzed by one-way ANOVA with Tukey's post-test. Data acquired from *in vitro* assays using experimental replicates are presented ± standard deviation and data acquired *in vitro* or *in vivo* using biological replicates are presented ± standard error of the mean. *=$p<0.5$, **=$p<0.01$ and ***=$p<0.001$.

Switch cloning and expression

[0476] Gene fragments encoding the Fmc63 (anti-CD19) or Ofatumumab (OFA, antiCD20) heavy or light chains, with or without the peptide neo-epitope (PNE) engraftment shown in FIG. 37, were synthesized (IDT) and subcloned into the pFUSE vector (InvivoGen, CA). Switches were expressed by transient transfection in the FreeStyle 293 Expression System (Thermo Fisher Scientific, CA). Heavy chain Fab constructs were expressed in vectors in which the Fc region was removed and a stop codon included after the first cysteine of the hinge region. Full length IgG heavy chain constructs were expressed in vectors harboring the IgG1 sequence with the following mutations: E233P/L234V/L235A/ΔG236 + A327G/A330S/P331S to reduce the ADCC and CDC

effector capacity of the Fc region. Expression was carried out as follows: Briefly, HEK293F cells were transfected at a density of 1 x 10^6 cells/ml with a 1:2 plasmid DNA to 293fectin ratio. Small scale expressions (30-50ml) had a 1:1 ratio of heavy chain to light chain, whereas larger scale expressions (≥100ml) required a 3:2 ratio of heavy chain to light chain. Expression medium containing the secreted proteins was harvested 72 hours post-transfection by centrifugation at 400 x *g*. Fab or IgG switches were purified by Protein G or Protein A (GE Healthcare Life Sciences, CA) respectively. Switches were eluted with 0.1 M glycine pH 2.8 and neutralized by the addition of 10% v/v 1M Tris-HCl pH 8. Switches were then buffer exchanged into phosphate buffered saline with PD10 desalting columns (GE Healthcare Life Sciences, CA) for subsequent assays. Switch integrity was confirmed by SDS page (Life Tech) and QTOF analysis (Agilent).

Lentivirus generation and transduction of human PBMC

[0477] To create the sCAR lentiviral construct, the 52SR4 scFv specific for GCN4(7P14P) was subcloned into a lentiviral vector behind an EF1a promoter and CD8 leader sequence and in front of CD8 hinge, CD8 transmembrane, CD137(4-1BB) costimulatory, and CD3ς domains. Conventional CART-19 was constructed in similar fashion using the scFv from anti-CD19 antibody FMC63. For the short and short, dimeric constructs of the sCAR the 45 amino acid CD8 hinge region was replaced with peptide sequences from IgG4 or IgG4m (below). For virus production, HEK293FT cells (ATCC) were sub-cultured in DMEM supplemented with 10% heat inactivated FCS, 0.1mM MEM non-essential amino acids, 6mM L-glutamine, 1mM MEM sodium pyruvate, 1% penicillin/streptomycin and 1mg/ml Geneticin (all from Life Technologies). 5x10^6 HEK293FT cells were transferred to a biocoat (Corning) 90mm petri dish in antibiotic free media and transfected with pMDL (6μg), pRev (6μg), pMDG (2μg) and the CAR containing lentiviral vector (7.5μg) using the Lipofectamin-2000 transfection reagent as per manufacturers instruction (Life Technologies). Cells were incubated with the DNA-lipofectamine complexes for 6 hours before the media was replaced and the cells cultured for 48 hours, at which point lentivirus containing supernatant was removed, clarified of cell debris by centrifugation (3000RPM at 4°C) and stored at -80°C. PBMC were isolated from healthy donor blood using Ficoll-Plaque PLUS and were rested for 1 hour before the non-adherent fraction were activated with anti-CD3/CD28 human T cell activation and expansion beads (Life Technologies; 3;1 bead to PBMC ratio) and IL-2 (300IU/ml) for 24 hours. Activated PBMC were then transduced with lentivirus containing serum mixed with protamine sulphate (Sigma; 10μg/ml) by spinfection (1000xg for 90 minutes). Following spinfection, cells were incubated for 24 hours with the virus before the media was replaced with AimV. Between 50-70% of the PBMC expressed the CAR by day 12, and cells were maintained at a concentration of 0.5-2x10^6/ml at all times. CAR expression on CART19 cells was detected using

the AF647-conjugated goat-anti-mouse IgG (H&L; Life Technologies) and CAR expression on sCAR-T cells was detected using the same antibody or an soluble AF488-conjugated synthetic PNE peptide (Anaspec).

Western blot

[0478] CAR-T cells were incubated with RS4;11 or K562 cells with the LCNT switch for 30 minutes before being washed and lysed in ice cold RIPA buffer (supplemented with protease and phosphatase inhibitors; Sigma) for 15 minutes on ice, this was followed by a 15 minute centrifuge (12,000xg at 4°C). Reduced or non-reduced whole cell lysates (15μg) were boiled in SDS for 10 minutes and then resolved on a 4-12% Bis-Tris pre-cast gel (Life Technologies). Proteins were transferred onto a nitrocellulose membrane using the iBlot system (Life Technologies), which were then incubated in Odyssey blocking buffer (LiCor) for 1 hour at room temperature followed by incubation with anti-CD3ζ (BD; 1mg/ml) or anti-GAPDH over night at 4°C. The membrane was then washed using PBS (0.01% Tween-20; Sigma) and incubated with the IRDye-688-conjugated donkey anti-mouse or IRDye-800-conjugated donkey-anti-rabbit antibodies (LiCor) for 1 hour at room temperature before being washed several times and imaged using the LiCor scanner.

Live cell imaging

[0479] Live cell imaging was performed using the IncuCyte ZOOM® microscope (Essen BioScience). Basic cytotoxicity assays were set up using CAR-T cells with RS4;11 or Nalm6$^{GFP/Luc}$ cells in flat bottomed 96-well plates and were imaged every 30 minutes at 10x magnification for 16-24 hours. The Nalm6$^{GFP/Luc}$ cells were used for clustering analysis and the RS4;11 cells were used to detect cytotoxicity using the Cell Tox Green® (Promega) which was added at a 1:4000 dilution. T cells were labelled with the CellVue Claret® Far Red fluorescence stain (Sigma; Red). Images were analyzed using software provided by the manufacturer and using the following settings for cluster formation: Top-hat (500μm and 2.0 GCU) with edge sensitivity of -59 and filters of 500μm^2 area, 5.0 mean intensity and 5E4 integrated intensity; and for Cell Tox Green® staining: Top-hat (400μm and 2.0 GCU) with edge sensitivity of -38 and filters of 2000μm^2 area, 70.0 mean intensity and 2E5 integrated intensity.

Mass spectrometry

[0480] Mass spectrometry of samples was acquired on an Agilent 6520 Accurate-Mass Quadrupole-Time-of-Flight (Q-TOF) mass spectrometer equipped with an electrospray (ESI) ionization source and liquid chromatography stack (Agilent). Ionization settings were: capillary voltage 3500 kV; positive mode; fragmentor voltage 200 V; drying nebulizer gas, 350 °C. Instrument was configured to standard 2 GHz, extended dynamic range and deconvolution was performed by Agilent MassHunter Qualitative Analysis software using the maximum entropy

setting. To separate antibodies a 2.1x150 mm, C8 reverse phase, wide pore (5 μm, 300 Å, Phenomenex) column was used. The gradient was: water (A)/acetonitrile (B) (0.1% formic acid) gradient (2% B for 3 min, followed by a 2-95% B gradient over 15 min, and 95% B for 7 min). Results from mass spectrometry can be found tabulated in **FIG. 32B**.

Example 35. ***Design of an orthogonal sCAR-T cell***

[0481] A 14 amino acid PNE sequence from the yeast transcription factor GCN4 (SEQ ID: 2) was chosen as the target of the sCAR. This sequence does not occur in the human proteome and thereby provides an orthogonal interaction between the sCAR-T cell and switch. Moreover, high affinity antibodies against this peptide have been previously developed by directed evolution (19-21). To determine the risk of immunogenicity associated with engraftment of this non-human sequence into an antibody fragment (Fab) to create a switch, we performed an *in silico* immunogenicity analysis of the PNE linked to the N-terminus of the light or heavy chains of a model, therapeutically approved antibody (Herceptin) (**SEQ ID: 11 & 12**) (**FIG. 20B**). This analysis predicted the PNE graft to have a low probability of inducing an antibody response in the context of a prototypical antibody and supported its use in generating switches. To generate switch molecules specific for the CD19 antigen, the PNE was introduced at defined sites in the anti-CD19 antibody FMC63 (**SEQ ID: 8 & 9**) (22). This antibody clone is used in the most widely studied conventional CART-19 construct in clinical trials and thus provides a direct comparison for the sCAR-T cell system (23). By varying the stoichiometry and site of PNE engraftment in FMC63, we could systematically vary the valency and orientation of the antigen binding region of the antibody switch relative to the scFv on the T cell surface (**FIG. 9** & **FIG. 20A**). Two fusions of the PNE were generated by linking the PNE to the N-terminus (NT; **SEQ ID: 36**) or C-terminus (CT; **SEQ ID: 97**) of the light chains (LC) of the antigen binding fragment (Fab) with short peptide linkers (**SEQ ID: 40**). Two fusions of the PNE were generated by linking the PNE to the N-terminus (NT; **SEQ ID: 87**) or C-terminus (CT; **SEQ ID: 34**) of the heavy chains (HC) of the antigen binding fragment (Fab) with short peptide linkers (**SEQ ID: 40** for HCCT and **SEQ ID: 45** for HCNT). We found that a GGGGS linker (**SEQ ID: 40**) was suitable in all positions except for fusion to the N-terminus of the heavy chain (HCNT; **SEQ ID 87**), which afforded increased yields with a putative helical forming EAAAK sequence (24) (**SEQ ID: 45**). In addition, we inserted the PNE directly into loops of the constant region 1 (C1) in the center of the heavy (HCC1; **SEQ ID: 32**) and light (LCC1; **SEQ ID: 30**) chains using a strategy similar to one we had previously developed for direct peptide-antibody loop fusions (25-27). These C1 constructs provide yet another distinct binding orientation of the sCAR relative to the target antigen, which could be preferable for certain antibody epitopes on target antigens. Finally, the PNE was engrafted into both

the heavy and light chains to create the bivalent switches NTBV (**SEQ ID: 36 & 87**), CTBV (**SEQ ID: 97 & 34**) and C1BV (**SEQ ID: 32 & 30**). The PNE-engrafted switch molecules were efficiently expressed in Fab and IgG format using transient transfections in HEK cells with yields 50-100% that of wild type FMC63 antibody (**FIG. 13A & Table 18**). Engraftment of the PNE at all sites in the Fab had minimal impact on protein stability and antigen binding as determined by thermal melt assays (**FIG. 21A & Table 21**) and flow cytometry based binding to $CD19^+$ RS4;11 (EC_{50} = 5.6 nM ± 6.3, **FIG. 21B**), respectively.

[0482] To create a sCAR-T cell that recognizes the switch, a sCAR was developed using the 52SR4 antibody, which selectively binds the PNE with high affinity (K_d = 5.2 pM, (21)). The 52SR4 scFv was incorporated into a second generation CAR construct harboring the human CD8 hinge, CD8 transmembrane, 4-1BB costimulatory, and CD3ζ activation domains. This design is identical to the second generation CAR used by June and coworkers in CART-19 (28). Lentiviral transduction of this construct into freshly isolated human PBMCs demonstrated efficient surface expression with transduction efficiencies of 50-75%, which were comparable to the FMC63-based CART-19 (29) (**FIG. 22A**). Switches bound to sCAR-T cells and not to un-transduced T cells (**FIG. 22B**), demonstrating that the sCAR-T cell-switch interaction is highly specific.

Site and valency of PNE engraftment affects sCAR-T cell potency *in vitro*

[0483] To empirically determine the optimal switch design for CD19, we tested the potency of each switch *in vitro*. All switches elicited dose-dependent lysis of $CD19^+$ RS4;11 cells in the presence of sCAR-T cells at picomolar (pM) concentrations (**FIG. 11A & Table 22 & FIG. 24A**). There was a clear structure activity relationship between cytotoxicity and the location of the PNE in the antibody. Switches with the PNE engrafted proximal to the antigen binding site (LCNT, HCNT, NTBV) were generally more potent than switches with the PNE engrafted at the C1 (LCC1, HCC1, C1BV) or C-terminus (LCCT, HCCT, CTBV) of the Fab region. No significant lysis of $CD19^-$ K562 cells was observed for any Fab or IgG switch design, even at concentrations 10^3 fold higher than the EC_{50} (**FIG. 11B & FIG. 24B**). In addition, wild type anti-CD19 Fab and IgG lacking the PNE peptide did not induce significant cytotoxicity, demonstrating a strict requirement for PNE-mediated immunological synapse formation. We chose to further pursue switches in the Fab format rather than IgG because the Fab has a shorter pharmacokinetic half-life, which we predicted would enable greater temporal control over the response *in vivo*.

[0484] Consistent with the cytotoxicity results, all switches induced robust IL-2 release (**FIG. 11C**) with the N-terminal PNE switches providing greater IL-2 responses than the constant region or C-terminal PNE switch molecules. Notably, the bivalent N-terminal NTBV (**SEQ ID: 36 & 87**)

switch induced the greatest IL-2 production against RS4;11 cells, indicating a potential benefit of engagement of 2 sCARs with 1 switch. Again, addition of the switches stimulated no cytokine release in the presence of sCAR-T cells and $CD19^-$ K562 cells, confirming that switch binding to the sCAR-T cell alone is not sufficient for activation (**FIG. 11C**). Consistent with the cytokine release data, markers of T cell activation ($CD25^+$, $CD69^+$) on sCAR-T cells were only upregulated by the switches in the presence of $CD19^+$ RS4;11 cells and not $CD19^-$ K562 cells (**FIG. 24C**). These results clearly demonstrate that sCAR-T cell effector function, as measured by activation, cytokine production, and target cell killing, is dependent on the presence of both a target antigen and switch.

[0485] To determine whether the same sCAR-T cell could be used to target other antigens relevant to B cell malignancies, a similar panel of switches was constructed to bind CD20-expressing cancers based on the anti-CD20 antibody Ofatumumab (OFA) (**FIG. 13B & Table 23**) (30). Along with CD19, CD20 is an important pan-B cell marker and the most widely targeted B cell antigen in the clinic. To develop the anti-CD20 switch, the OFA antibody was chosen because it binds a membrane proximal epitope (31) which might lead to enhanced activity due to the close association of the T cell and cancer cell. Switches were generated in a fashion similar to the CD19 switches. Consistent with the trend for FMC63, N-terminal PNE switches were found to be more cytotoxic than C-terminal PNE switches (EC_{50} = 1.1 - 6.8 pM vs 4.7 - 15 pM, respectively) against $CD20^+$ Raji cells (**FIG. 25A**). In addition, anti-CD20 N-terminal PNE switches stimulated higher levels of cytokine release than C-terminus PNE switches (**FIG. 25B**).

Optimization of the sCAR design improves activity *in vitro*

[0486] We hypothesized that the increased activity of switches with the PNE engrafted proximal to the antigen binding domain was the result of a decreased overall distance between the sCAR-T cell and target cell (32). To determine whether the distance could be further shortened to increase activity we modified the hinge region of the sCAR itself (also referred to as the spacer domain), which connects the anti-PNE scFv to the transmembrane domain of the sCAR. The initial sCAR design used a 45 amino acid CD8-based hinge identical to that of conventional CART-19. To test a shorter hinge, this region of the sCAR was replaced with a 12 amino acid sequence derived from the hinge of IgG4 (**FIG. 7A**). As expected, the IgG4-hinge-based sCAR-T cells had increased cytotoxicity in the presence of the LCNT switch against RS4;11 cells compared with CD98-hinge based sCAR-T cells (**FIG. 10A**) while retaining antigen specificity for $CD19^+$ cells (**FIG. 10B**).

[0487] We also hypothesized that the increased cytokine induction observed with the bivalent NTBV switch reflected an effect of increased valency on sCAR-T cell activation. To test whether this notion could be translated to the IgG4 sCAR design, a serine to proline mutation (S228P relative to the IgG4 molecule (33)) was incorporated in the IgG4 hinge to enhance inter-chain sCAR disulfide formation (IgG4m, **FIG. 7A**). Consistent with previous reports, western blot analysis confirmed that the sCAR and CART-19 CD8-based hinges formed spontaneous disulfide dimers in the absence of CAR stimulation (**FIG. 7B**) (34). Dimers also formed for the IgG4m-based sCAR hinge containing the S228P mutation, but not for the IgG4 hinge lacking this mutation. As expected, the maximum cell lysis and EC_{50} of cytotoxicity of the IgG4m sCAR against RS4;11 cells with the LCNT switch were increased compared with the IgG4 sCAR lacking the S228P mutation (**FIG. 10A**). This result is consistent with Riddell and coworkers in which the same IgG4m hinge design increased the activity of anti-ROR1 conventional CAR-T cell compared with other hinge designs in their study (35, 36). However, no corresponding monomeric IgG4 hinge was compared in that study. Thus, our result supports that the S228P mutation in the IgG4 hinge confers increased sCAR-T cell activation through dimerization of the sCAR.

[0488] We next determined the additive effect of switch and hinge design on sCAR activity, and compared this with conventional CART-19. Each switch design was empirically tested in combination with each hinge design in dose response for cytotoxicity, cytokine release, and upregulation of activation markers in the presence of RS4;11 cells. As expected, the observed trend was that cytotoxicity increased as the PNE engraftment site moved from the C-to N-terminus: and as the hinge design was shortened from the 45 amino acid CD8 design to the 12 amino acid IgG4 design; this was further increased with the IgG4m design (**FIG. 10F**). Correspondingly, IL-2 release with 1 nM switch was greater with the N-terminal PNE switches (HCNT, LCNT, NTBV) and the IgG4 and IgG4m hinges than with the C-terminal PNE switches (HCCT, LCCT, NTCT) and CD8 hinge (**FIG. 23D**). The bivalent NTBV switch increased IL-2 production from CD8 sCAR-T cells by 50% but did not have a significant impact on sCAR-T cells harboring the IgG4 or IgG4m hinges. We expect this may be due to steric clashes with the shorter IgG4 and IgG4m hinges which prevent binding of 2 sCARs to 2 N-terminal PNEs on the same switch molecule. The trend in switch design on the upregulation of T cell activation markers was similar to that observed for cytotoxicity and cytokine production with the greatest activation observed in response to the LCNT switch (**FIG. 23E**). Collectively, the LCNT switch with the IgG4m sCAR-T cell demonstrated the greatest cytotoxicity compared with other switch/hinge designs and afforded cytokine release and upregulation of T cell activation markers that were significantly greater against $CD19^+$ RS4;11 cells.

[0489] Specificity of sCAR-T cell activation is a critical design consideration for switch-based control. Therefore, to confirm that the improved activity of the IgG4m sCAR did not sacrifice specificity, we repeated the assays above on $CD19^-$ K562 cells. The IgG4m sCAR did not cause significant lysis of K562 cells with up to 10 nM of any switch molecule (**FIG. 23B, FIG. 26A, FIG 26B**), nor did the IgG4m sCAR produce IL-2 in the presence of K562 cells and any of the switches (**FIG. 26C**). Furthermore, the IgG4m sCAR-T cells did not exhibit significant upregulation of activation markers compared with non-transduced (mock) cells in the absence of the PNE-engrafted switch and target antigen (**FIG. 23C**). Together, these data confirmed that the improved activity of the IgG4m sCAR did not result in antigen-independent activation. Finally, the activity of sCAR-T cells on RS4;11 cells could be fully inhibited by the addition of an excess of soluble, synthetic PNE peptide, further demonstrating the requirement of a switch for activity (**FIG. 26A, 26B, 26C, 26D and 26E**).

[0490] To test whether the improved IgG4m hinge design extends to our anti-CD20 OFA switches, we tested the anti-CD20 switches with IgG4m sCAR-T cells on $CD20^+$ Raji cells. As expected, cytotoxicity was increased with the IgG4m sCAR for all CD20 switches compared with CD8 sCAR-T cells (**FIG. 28A**). Unexpectedly, however, the trend in anti-CD20 switch design with the IgG4m sCAR was opposite to what was observed with the CD8 sCAR (**Fig. 1G**). In this case the C-terminal PNE switches were 10-100-fold more potent than the N-terminal PNE switches. We hypothesized that this is due to the membrane proximal epitope of the OFA on CD20 which may require additional distance between the PNE and antigen binding interface of the Fab when the hinge region of the sCAR is short in order to alleviate steric clashes at the immunological synapse. Collectively the above studies demonstrate that the activity of sCAR-T cells can be significantly enhanced through both sCAR hinge and switch design and underscore the advantages of being able to optimized each.

Switch and hinge design effects on tumor clearance *in vivo*

[0491] To investigate the activity of sCAR-T cells *in vivo*, we evaluated tumor regression in a xenograft model of B cell leukemia using luciferized human B-ALL Nalm-6 cells in immunodeficient NOD.Cg-*Prkdc*^{scid} *Il2rg*^{tm1Wjl}/SzJ (NSG) mice. In this model, mice without treatment succumb to disease within 21 days. First, to understand the impact of CAR hinge design on *in vivo* efficacy, mice were inoculated with Nalm-6, followed by *I.V.* injection of CD8, IgG4, or IgG4m sCAR-T cells 6 days later (**FIG. 32A & 32B**). Based on our *in vitro* results we chose the anti-CD19 LCNT switch to test in this model. This switch was dosed *I.V.* (0.5 mg/kg) every other day for 10 days and tumor regression was followed by *in vivo* imaging (IVIS) of the luciferase signal from Nalm-6 cells (**FIG. 29A**). In line with the *in vitro* data, both IgG4 and IgG4m sCAR-T

cells afforded a significant decrease in tumor burden; whereas CD8 sCAR-T cells had minimal impact on disease compared with untreated controls (**FIG. 29B**). Increased T cell counts in the peripheral blood at day 17 corresponded with reduced tumor burden and revealed that the IgG4m sCAR-T cells provided significantly greater T cell expansion compared with the IgG4 or CD8 hinge designs (**FIG. 29C**). Based on this result, the IgG4m sCAR construct was chosen for further *in vivo* analysis.

[0492] Next, we determined the effect of switch graft position and valency on *in vivo* efficacy. As with the previous model, IgG4m CAR-T cells were injected 6 days after tumor inoculation and mice were treated every other day (starting at day 6) with the LCNT, HCNT, NTBV, LCC1, or HCCT switches (0.5 mg/kg, **FIG. 29D**). Analogous to the *in vitro* data, the N-terminally grafted switches (LCNT, HCNT, and NTBV) afforded the greatest reduction in tumor burden, while switches with the PNE at the middle (LCC1) or C-terminus (HCCT) provided little control (**FIG. 29E**). T cell counts at day 20 correlated with reduction of tumor burden and indicated the LCNT switch provided the greatest T cell expansion (**FIG. 29F**). In agreement with our *in vitro* data, the combination of the LCNT switch with the IgG4m sCAR resulted in the greatest efficacy *in vivo* and thus was used in subsequent studies to explore the effect of switch dosing regimen.

[0493] Clearance of Nalm-6 with the IgG4m sCAR-T cell and the LCNT switch in the above model was observed to occur rapidly during the first 96 hours of treatment. To further investigate IgG4m sCAR T cell proliferation and localization during this time interval, Nalm-6 engrafted NSG mice were sorted into 4 groups that received IgG4m sCAR-T cells (with or without the LCNT switch), conventional CART-19 (with no switch) or no cells. Each group was divided into 5 cohorts per treatment regimen, which were analyzed at 8, 24, 48, 72, and 96 hours after T cell infusion. Daily dosing of the LCNT switch (0.5 mg/kg) reduced tumor burden within the 24 hours and continued to shrink the tumor to the limit of luminescence detection (approximately 10^3-10^4 p/s/cm^2/sr) within 96 hours with daily treatment (**FIG. 30A**). The rate of clearance during this time was not significantly different from CART-19 (**FIG. 30B**). Human IL-2 in peripheral blood peaked at similar levels at 24 hours for CART-19 and at 48 hours for sCAR-T cells and decreased as tumor was cleared (**FIG. 30B**). As expected, IgG4m sCAR-T cells had no effect on disease progression in this model in the absence of switch, confirming requirement of switch dosing for *in vivo* anti-tumor effect. We also tracked IgG4m sCAR-T cells and tumor in the spleen, lungs, liver, and peripheral blood by flow cytometry over the 96 hours. During this time, Nalm-6 cells were only detectable in the lung and liver (**FIG. 32A & 32B**). Correspondingly, significantly increased numbers of sCAR-T cells were found in the lung and liver at 96 hours in mice dosed with the LCNT switch compared mice not treated with switch (**FIG. 30C**). Switch dosing did not increase sCAR-T cell recruitment to the spleen where tumor burden was not detectable. In the organs

assessed, sCAR-T cells had proliferated significantly more in the mice treated with LCNT switch (by dye dilution experiments) compared to no switch treatment, again demonstrating the requirement for the switch for sCAR-T cell expansion (**FIG. 30D & 32C**). The magnitude of sCAR-T cell proliferation when dosed with the LCNT switch was comparable to that of CART-19 in both the liver and lung (**FIG. 32D**). Together, these results indicate that the IgG4m sCAR-T cells dosed with the LCNT switch can expand and eliminate tumor burden with comparable efficacy to conventional CART-19.

Dose-dependent control of sCAR-T cell activity *in vivo*

[0494] To determine the minimal dose frequency required for a sustained response with the IgG4m sCAR-T cells, we tested every day, every other day, or every fifth day dosing of the LCNT switch (0.5 mg/kg) for 15 days in the Nalm-6 model. Every day and every other day dosing yielded comparable rates of tumor regression which was sustained for >100 days after dosing was discontinued (**FIG. 33A**). Mice that died between days 40 and 100 (open circles) had no evidence of disease; expiration in these cases was attributed to xenogeneic graft versus host disease caused by human T cells in the NSG mouse as previously described (37). Dosing every fifth day (3 total dosages) greatly decreased and stabilized disease burden at a low level, but did not completely clear disease based on luciferase signal. This corresponds with the expected short half-life for the Fab-based switch in the mouse. Residual disease in this group relapsed when dosing was discontinued indicating that the activity of the sCAR-T cells towards the Nalm-6 cells had been turned "off" in the absence of the switch; nevertheless sCAR-T cells were still detectable in blood up to 64 days after injection (**FIG.31B**).

[0495] Control of cytokine production *in vivo* is important to prevent CRS in patients receiving CAR-T cell therapy. To investigate the potential of switch-regulated IgG4m sCAR-T cells to achieve reduced cytokine release *in vivo*, we correlated switch dosage with cytokine release by the IgG4m sCAR-T cells in the Nalm-6 model. Mice dosed everyday with 0.05, 0.5, or 2.5 mg/kg of the LCNT switch showed a dose-dependent increase in serum IL-2, IFNγ, and TNFα at 24hours (**FIG. 33B**) that correlated with dose dependent reductions in tumor burden by day 10 (**FIG. 33C**). Cytokine production in the 0.5 and 2.5 mg/kg groups was not significantly different from CART-19 at 24hours for all cytokines, except for serum TNFα which was decreased in the 2.5 mg/kg group compared with CART-19. However, all cytokines in the 0.05 mg/kg group were significantly lower than CART-19.

[0496] To determine if treatment with the lower dose of 0.05 mg/kg could be efficacious, despite lower levels of cytokine production, dosing of the LCNT switch was carried out every day for 10 days in the Nalm-6 model. At this low dose, tumor clearance was correspondingly slower compared to the conventional CART-19 previous models, but still reached the limit of detection by

the final day of dosing (day 16; **FIG. 33D**). The Nalm-6 tumor relapsed at in the 0.05mg/kg treatment group at day 30 (fifteen days after the final dose) at which time the luciferase signal was significantly higher than for CART-19 treatment. These mice were retreated with a higher dose of the LCNT switch (0.5 mg/kg) for an additional 10 days. This retreatment regimen effectively decreased tumor signal to equivalent levels as CART-19 within 5 days and the mice remained tumor-free for >35 days after the final dose of the second treatment period. Thus IgG4m sCAR-T cells in combination with an escalating switch dose regimen can control cytokine release while still providing efficacy comparable to conventional CART-19. This titration approach to reducing tumor burden with a reduced initial dose of switch followed by increasing sCAR T cell activity by escalating the switch dose may be an effective strategy for avoiding CRS in the clinic.

[0497] Persistent memory phenotypes have been correlated with complete remissions in CAR-T cell therapy clinical trials for leukemia (38). To understand whether the switch dose can influence IgG4m sCAR-T cell populations, we dosed NSG mice bearing the Nalm-6 tumor xenograft with 0.05, 0.5, or 2.5 mg/kg LCNT switch and analyzed the expression of CD45RA and CD62-L on $CD4^+$ and $CD8^+$ T cells in peripheral blood after 21 days (5 days after the final dose). The 2.5 mg/kg group demonstrated significant expansion of the $CD45RA^+CD62L^-$ terminal effector memory expressing CD45RA (TEMRA) compartment in both $CD4^+$ and $CD8^+$ T cells compared with the lower dose groups (**FIG. 33E**). Conventional CART-19 exhibited the greatest increase in TEMRA population consistent with strong activation through the direct CAR design. Conversely, the lower dose groups that received 0.05 and 0.5 mg/kg of switch had significantly larger populations of $CD45RA^-CD62L^+$ central memory cells compared with 2.5 mg/kg group, which we hypothesize is a result of lower levels of stimulation during the initial dosing period. Thus this result may indicate a potential benefit derived from low dose treatment of sCAR-T cells during the initial stages of tumor clearance. Collectively these results demonstrate that switch dose can control the activity, tissue-localization, cytokine release, and phenotype of sCAR-T cells in the Nalm-6 xenograft model with efficacy comparable to the corresponding conventional CART-19.

Discussion

[0498] We have demonstrated that protein engineering can be used to create antibody-based switches that redirect the activity of bio-orthogonal anti-PNE sCAR-T cells to tumors. Moreover, we show this methodology allows one to systematically optimize the activity of the sCAR by varying the geometry and valency of the switch molecule. Similar approaches have been described using antibodies that are non-specifically or enzymatically labeled with small molecule haptens to redirect the activity anti-hapten CARs (16, 17). However these systems do not easily allow for optimization of the immunological synapse between the CAR-T cell, antibody and target cell. The importance of the spatial orientation between the T cell and target cell demonstrated in our studies

is in agreement with several recent studies using conventional CAR, which showed that variation in the epitope location of different targeting scFv's require compensatory CAR hinge designs for good CAR-T cell activity (35, 36, 39, 40).

[0499] In the context of CD19 targeting, switches with the PNE engrafted at the N-terminus (HCNT, LCNT, NTBV), proximal to the antigen binding interface of the FMC63, were found to be superior to switches with the PNE grafted at the C-terminus (HCCT, LCCT, CTBV). Although the epitope of FMC63 and corresponding structure of the CD19 antigen are not known (41), we hypothesized that this trend was due to a decreased distance between target cell and sCAR-T cell. In the case of the immunological synapse formed by the native T cell receptor (TCR), the distance between the T cell and antigen presenting cell is reported to be approximately 130 - 150 Å (42, 43). This distance is important to sterically exclude inhibitory phosphatases such as CD45 and CD148 from the synapse, which act to dephosphorylate signaling molecules and down regulate T cell activation (44). It is likely that the longer synapse resulting from the C-terminal switches (approximately 70 Å longer than the N-terminal switches) is unable to sterically exclude these inhibitory molecules, resulting in less productive sCAR signaling. The increase in sCAR-T cell activity observed when the sCAR hinge was shortened from 45 amino acids to 12 amino acids supports this hypothesis. A similar relationship was observed in the accompanying publication which reports a sCAR-T cell specific for FITC and a FMC63-based switch molecule that is site-specifically modified with FITC (45). FITC conjugation sites near the antigen binding interface afforded better activity than sites distal to the binding interface. Moreover, we have shown, in that study, that non-specific conjugation of switches with FITC did not provide sufficient *in vivo* activity to clear Nalm-6 tumor (45). Collectively, these studies underscore the importance of switch structure on optimizing immunological synapse geometry, which directly impacts sCAR-T cell activity.

[0500] Switches based on the OFA antibody scaffold that target CD20 exhibited a trend similar to the FMC63 antibody when paired with sCAR-T cells harboring the CD8-based hinge. Interestingly, when the sCAR hinge was shortened to the 12 amino acid IgG4m hinge the trend for OFA switches was reversed and C-terminal PNE switches afforded better activity than N-terminal switches. While the structure of CD20 antibody is also unknown, the OFA antibody is reported to bind a small, membrane proximal loop of the multi-pass transmembrane CD20 antigen (31). In this case, it is likely that the distance created by the N-terminal OFA switches with the IgG4m sCAR is too short to enable efficient synapse formation between the sCAR and CD20. Alternatively, the large adjacent loop domain of the CD20 antigen may create a steric hindrance for binding of the IgG4m sCAR. We observed a similar effect supporting this hypothesis in our work with site-specific FITC conjugation on the anti-CD22 antibody m971 (45). In this case, the m971

antibody has a membrane proximal epitope on CD22 (39) and several large modular domains that may sterically preclude binding. Correspondingly, the m971 switches were optimal with FITC placed at sites distal from the antigen binding interface. Thus the geometry of the immunological synapse is a key parameter to consider when designing switches and highlights the requirement for precise control over switch structure which cannot be accomplished with previously reported platforms.

[0501] A central tenant of the sCAR-T cells described here is the orthogonality of PNE-engrafted switches in that they only interact with the target cell and sCAR and no other immune receptors or cell types. Recently, Campana and coworkers reported a CD16 (Fc receptor)-based CAR-T cell for use in combination with therapeutic monoclonal antibodies (46). However, CD16 indiscriminately binds to therapeutic and naturally occurring antibodies, which yields the potential for any endogenous antibody to activate the CD16-CAR. This lack of orthogonality has the potential to cause off-target effects. Thus, in the development of orthogonal switches, Fab's may be desirable because their lack of an Fc domain removes the possibility of an Fc receptor-mediated off target binding. In addition, the smaller size and shorter half-life of Fab molecules (approximately 12-20 hours for Fab (47) vs 10 days for IgG (48)) is also expected to provide better tumor penetration and greater temporal control over sCAR-T cell activation in clinical translation. We expect this will correlate with a dosage of every other day or twice a week dosing in the clinic.

[0502] To assess the efficacy of the sCAR-T cell approach *in vivo*, we chose the Nalm-6 xenograft model. Because the Nalm-6 tumor lacks CD80 and CD86 co-receptors, it is difficult to treat and has become a standard for CAR-T therapy adjudication (49). Our sCAR-T cell platform was able to eliminate Nalm-6 with comparable efficacy to conventional CART-19 T cells. Interestingly, differences in the *in vitro* lytic activity of switch/hinge designs that were generally less than 10 fold by EC_{50}, were highly amplified for *in vivo* tumor elimination, reinforcing the need for careful *in vitro* design to provide robust *in vivo* activity. In addition to eliminating the tumor, *in vivo* expansion and trafficking of sCAR-T cells to sites of disease was demonstrated to be reliant on switch dosing. CAR-T cell expansion and trafficking in human trials have been shown to be predictive of clinical responses (50). Importantly, serum levels of human cytokines IL-2, TNFα, and IFNγ were tightly controlled by LCNT switch dose. The exception was TNFα which was not increased in the 2.5 mg/kg group compared with the 0.5 mg/kg group suggesting a potential maximum induction of this cytokine with 0.5 mg/kg LCNT; however it is also possible that TNFα in the 2.5 mg/kg group peaked earlier than 24hours which was not captured in this experiment.

[0503] A key finding of this study was that sCAR-T cells treated with lower levels of LCNT switch (0.05 mg/kg) provided complete clearance of Nalm-6 at a slower rate and with lower levels of cytokine release. This suggests that low dose switch treatment could be an effective method of

mitigating CRS and TLS in the treatment of patients with high tumor burdens. When tumor relapsed at day 30, mice were retreated with a higher dose of 0.5 mg/kg to ensure clearance. Due to the lower tumor burden at this stage, excessive cytokine release would not be expected. The titration of sCAR-T cell "on" activity to prevent CRS and TLS in the clinic would be a significant paradigm shift from proposed use of kill switches which can only turn "off" the CAR-T cell response in the case of an adverse event (14).

[0504] Another key finding of the dose titration study was the impact of switch dose on sCAR-T cell phenotype. This experiment demonstrated a potential advantage to low dose (0.05 mg/kg) switch treatment in its ability to maintain a larger CD62-L^+ central memory compartment compared with high dose (2.5 mg/kg) treatment which produced more TEMRA cells at day 21 (15 days after T cell infusion). The formation of central memory CAR-T cells has been shown to provide prolonged persistence in clinical trials, where persistence has been correlated with sustained remissions for ALL and CLL patients (51, 52). In the sCAR-T cell system, clinical persistence will also be critical to enable re-dosing strategies in the case of relapse. Thus, the ability to affect CAR-T cell phenotype through dosing paradigms may be advantageous in the clinic. We are currently exploring the impact of sCAR-T cell phenotype on persistence in surrogate, syngeneic mouse models.

[0505] Towards translating sCAR-T cells to the clinic we have initiated humanization and in silico prediction of T cell epitopes for the murine 52SR4-based sCAR and FMC63-based switch to reduce the risk of development of human anti-mouse (HAMA) antibodies. We expect this will be important to ensure orthogonality of the sCAR-T cell/switch interaction is not compromised by a HAMA response and to prevent immunological clearance of sCAR-T cells. Although the PNE sequence does not occur in the human proteome, it cannot be excluded that antigenic mimicry could lead to off-target activation. Towards understanding this risk we have initiated tissue cross-reactivity studies with the 52SR4 scFv.

[0506] In summary, sCAR-T cells represent a promising new paradigm in cell therapy that have the potential for improved safety and versatility compared to current T cell therapies. We are currently testing sCAR-T cells in solid tumor models where the ability to titrate therapy to minimize organ toxicity due to shared antigen expression and bystander cellular toxicity may be critical (53). In addition, this added control over sCAR-T cell activity may allow engineered cells to be turned off after tumor elimination to allow healthy B cells to repopulate in leukemia and lymphoma patients who are in remission. Indeed, in the accompanying publication we show that switch discontinuation can lead to the restoration of the peripheral blood B cells in a surrogate mouse model using anti-FITC CAR-T cells and FITC labeled anti-murine CD19 switches (45). Finally, we are also evaluating the ability of sCAR-T cells to target more than one antigen *in vivo*

by co-delivery of CD19 and CD20 switches, which may be an effective method to prevent relapse due to antigen-loss escape mutations in patients (11), and may provide improved efficacy in the treatment of cancers with heterogeneous antigen expression. Furthermore, the development of a single, universal sCAR-T cell is expected to obviate the development of a new CAR for each target and off-set the cost of cell therapy by standardizing vector design, cell manufacture, and treatment protocols across multiple indications.

Table 38. Chimeric Antigen Receptor –Nucleotide Sequence

SEQ ID NO	SEQUENCE
1	CAGGTGGCACTTTTCGGGGAAATGTGCGCGGAACCCCTATTTGTTTATTTTTCTAAATACA TTCAAATATGTATCCGCTCATGAGACAATAACCCTGATAAATGCTTCAATAATATTGAAA AAGGAAGAGTATGAGTATTCAACATTTCCGTGTCGCCCTTATTCCCTTTTTTGCGGCATTT TGCCTTCCTGTTTTTGCTCACCCAGAAACGCTGGTGAAAGTAAAAGATGCTGAAGATCAG TTGGGTGCACGAGTGGGTTACATCGAACTGGATCTCAACAGCGGTAAGATCCTTGAGAGT TTTCGCCCCGAAGAACGTTTTCCAATGATGAGCACTTTTAAAGTTCTGCTATGTGGCGCG GTATTATCCCGTATTGACGCCGGGCAAGAGCAACTCGGTCGCCGCATACACTATTCTCAG AATGACTTGGTTGAGTACTCACCAGTCACAGAAAAGCATCTTACGGATGGCATGACAGTA AGAGAATTATGCAGTGCTGCCATAACCATGAGTGATAACACTGCGGCCAACTTACTTCTG ACAACGATCGGAGGACCGAAGGAGCTAACCGCTTTTTTGCACAACATGGGGGATCATGT AACTCGCCTTGATCGTTGGGAACCGGAGCTGAATGAAGCCATACCAAACGACGAGCGTG ACACCACGATGCCTGTAGCAATGGCAACAACGTTGCGCAAACTATTAACTGGCGAACTA CTTACTCTAGCTTCCCGGCAACAATTAATAGACTGGATGGAGGCGGATAAAGTTGCAGGA CCACTTCTGCGCTCGGCCCTTCCGGCTGGCTGGTTTATTGCTGATAAATCTGGAGCCGGTG AGCGTGGGTCTCGCGGTATCATTGCAGCACTGGGGCCAGATGGTAAGCCCTCCCGTATCG TAGTTATCTACACGACGGGGAGTCAGGCAACTATGGATGAACGAAATAGACAGATCGCT GAGATAGGTGCCTCACTGATTAAGCATTGGTAACTGTCAGACCAAGTTTACTCATATATA CTTTAGATTGATTTAAAACTTCATTTTTAATTTAAAAGGATCTAGGTGAAGATCCTTTTTG ATAATCTCATGACCAAAATCCCTTAACGTGAGTTTTCGTTCCACTGAGCGTCAGACCCCG TAGAAAAGATCAAAGGATCTTCTTGAGATCCTTTTTTTCTGCGCGTAATCTGCTGCTTGCA AACAAAAAAACCACCGCTACCAGCGGTGGTTTGTTTGCCGGATCAAGAGCTACCAACTCT TTTTCCGAAGGTAACTGGCTTCAGCAGAGCGCAGATACCAAATACTGTCCTTCTAGTGTA GCCGTAGTTAGGCCACCACTTCAAGAACTCTGTAGCACCGCCTACATACCTCGCTCTGCT AATCCTGTTACCAGTGGCTGCTGCCAGTGGCGATAAGTCGTGTCTTACCGGGTTGGACTC AAGACGATAGTTACCGGATAAGGCGCAGCGGTCGGGCTGAACGGGGGGTTCGTGCACAC AGCCCAGCTTGGAGCGAACGACCTACACCGAACTGAGATACCTACAGCGTGAGCTATGA GAAAGCGCCACGCTTCCCGAAGGGAGAAAGGCGGACAGGTATCCGGTAAGCGGCAGGG TCGGAACAGGAGAGCGCACGAGGGAGCTTCCAGGGGGAAACGCCTGGTATCTTTATAGT CCTGTCGGGTTTCGCCACCTCTGACTTGAGCGTCGATTTTTGTGATGCTCGTCAGGGGGGC GGAGCCTATGGAAAAACGCCAGCAACGCGGCCTTTTTACGGTTCCTGGCCTTTTGCTGGC CTTTTGCTCACATGTTCTTTCCTGCGTTATCCCCTGATTCTGTGGATAACCGTATTACCGCC TTTGAGTGAGCTGATACCGCTCGCCGCAGCCGAACGACCGAGCGCAGCGAGTCAGTGAG CGAGGAAGCGGAAGAGCGCCCAATACGCAAACCGCCTCTCCCCGCGCGTTGGCCGATTC ATTAATGCAGCTGGCACGACAGGTTTCCCGACTGGAAAGCGGGCAGTGAGCGCAACGCA ATTAATGTGAGTTAGCTCACTCATTAGGCACCCCAGGCTTTACACTTTATGCTTCCGGCTC GTATGTTGTGTGGAATTGTGAGCGGATAACAATTTCACACAGGAAACAGCTATGACCATG ATTACGCCAAGCGCGCAATTAACCCTCACTAAAGGGAACAAAAGCTGGAGCTGCAAGCT TAATGTAGTCTTATGCAATACTCTTGTAGTCTTGCAACATGGTAACGATGAGTTAGCAAC ATGCCTTACAAGGAGAGAAAAAGCACCGTGCATGCCGATTGGTGGAAGTAAGGTGGTAC GATCGTGCCTTATTAGGAAGGCAACAGACGGGTCTGACATGGATTGGACGAACCACTGA ATTGCCGCATTGCAGAGATATTGTATTTAAGTGCCTAGCTCGATACAATAAACGGGTCTC TCTGGTTAGACCAGATCTGAGCCTGGGAGCTCTCTGGCTAACTAGGGAACCCACTGCTTA AGCCTCAATAAAGCTTGCCTTGAGTGCTTCAAGTAGTGTGTGCCCGTCTGTTGTGTGACTC TGGTAACTAGAGATCCCTCAGACCCTTTTAGTCAGTGTGGAAAATCTCTAGCAGTGGCGC CCGAACAGGGACCTGAAAGCGAAAGGGAAACCAGAGCTCTCTCGACGCAGGACTCGGCT

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SEQ ID NO	SEQUENCE
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	GAGAATTAGATCGCGATGGGAAAAAATTCGGTTAAGGCCAGGGGGAAAGAAAAAATAT
	AAATTAAAACATATAGTATGGGCAAGCAGGGAGCTAGAACGATTCGCAGTTAATCCTGG
	CCTGTTAGAAACATCAGAAGGCTGTAGACAAATACTGGGACAGCTACAACCATCCCTTC
	AGACAGGATCAGAAGAACTTAGATCATTATATAATACAGTAGCAACCCTCTATTGTGTGC
	ATCAAAGGATAGAGATAAAAGACACCAAGGAAGCTTTAGACAAGATAGAGGAAGAGCA
	AAACAAAAGTAAGACCACCGCACAGCAAGCGGCCGCTGATCTTCAGACCTGGAGGAGGA
	GATATGAGGGACAATTGGAGAAGTGAATTATATAAATATAAAGTAGTAAAAATTGAACC
	ATTAGGAGTAGCACCCACCAAGGCAAAGAGAAGAGTGGTGCAGAGAGAAAAAAGAGCA
	GTGGGAATAGGAGCTTTGTTCCTTGGGTTCTTGGGAGCAGCAGGAAGCACTATGGGCGCA
	GCCTCAATGACGCTGACGGTACAGGCCAGACAATTATTGTCTGGTATAGTGCAGCAGCA
	GAACAATTTGCTGAGGGCTATTGAGGCGCAACAGCATCTGTTGCAACTCACAGTCTGGGG
	CATCAAGCAGCTCCAGGCAAGAATCCTGGCTGTGGAAAGATACCTAAAGGATCAACAGC
	TCCTGGGGATTTGGGGTTGCTCTGGAAAACTCATTTGCACCACTGCTGTGCCTTGGAATG
	CTAGTTGGAGTAATAAATCTCTGGAACAGATTGGAATCACACGACCTGGATGGAGTGGG
	ACAGAGAAATTAACAATTACACAAGCTTAATACACTCCTTAATTGAAGAATCGCAAAAC
	CAGCAAGAAAAGAATGAACAAGAATTATTGGAATTAGATAAATGGGCAAGTTTGTGGAA
	TTGGTTTAACATAACAAATTGGCTGTGGTATATAAAATTATTCATAATGATAGTAGGAGG
	CTTGGTAGGTTTAAGAATAGTTTTTGCTGTACTTTCTATAGTGAATAGAGTTAGGCAGGG
	ATATTCACCATTATCGTTTCAGACCCACCTCCCAACCCCGAGGGGACCCGACAGGCCCGA
	AGGAATAGAAGAAGAAGGTGGAGAGAGAGACAGAGACAGATCCATTCGATTAGTGAAC
	GGATCTCGACGGTTAACTTTTAAAAGAAAAGGGGGGATTGGGGGGTACAGTGCAGGGGA
	AAGAATAGTAGACATAATAGCAACAGACATACAAACTAAAGAATTACAAAAACAAATTA
	CAAAAATTCAAAATTTTATCGAGCTTTGCAAAGATGGATAAAGTTTTAAACAGAGAGGA
	ATCTTTGCAGCTAATGGACCTTCTAGGTCTTGAAAGGAGTGCCTCGTGAGGCTCCGGTGC
	CCGTCAGTGGGCAGAGCGCACATCGCCCACAGTCCCCGAGAAGTTGGGGGGAGGGGTCG
	GCAATTGAACCGGTGCCTAGAGAAGGTGGCGCGGGGTAAACTGGGAAAGTGATGTCGTG
	TACTGGCTCCGCCTTTTTCCCGAGGGTGGGGGAGAACCGTATATAAGTGCAGTAGTCGCC
	GTGAACGTTCTTTTTCGCAACGGGTTTGCCGCCAGAACACAGGTAAGTGCCGTGTGTGGT
	TCCCGCGGGCCTGGCCTCTTTACGGGTTATGGCCCTTGCGTGCCTTGAATTACTTCCACCT
	GGCTGCAGTACGTGATTCTTGATCCCGAGCTTCGGGTTGGAAGTGGGTGGGAGAGTTCGA
	GGCCTTGCGCTTAAGGAGCCCCTTCGCCTCGTGCTTGAGTTGAGGCCTGGCCTGGGCGCT
	GGGGCCGCCGCGTGCGAATCTGGTGGCACCTTCGCGCCTGTCTCGCTGCTTTCGATAAGT
	CTCTAGCCATTTAAAATTTTTGATGACCTGCTGCGACGCTTTTTTTCTGGCAAGATAGTCT
	TGTAAATGCGGGCCAAGATCTGCACACTGGTATTTCGGTTTTTGGGGCCGCGGGCGGCGA
	CGGGGCCCGTGCGTCCCAGCGCACATGTTCGGCGAGGCGGGGCCTGCGAGCGCGGCCAC
	CGAGAATCGGACGGGGGTAGTCTCAAGCTGGCCGGCCTGCTCTGGTGCCTGGCCTCGCGC
	CGCCGTGTATCGCCCCGCCCTGGGCGGCAAGGCTGGCCCGGTCGGCACCAGTTGCGTGA
	GCGGAAAGATGGCCGCTTCCCGGCCCTGCTGCAGGGAGCTCAAAATGGAGGACGCGGCG
	CTCGGGAGAGCGGGCGGGTGAGTCACCCACACAAAGGAAAAGGGCCTTTCCGTCCTCAG
	CCGTCGCTTCATGTGACTCCACGGAGTACCGGGCGCCGTCCAGGCACCTCGATTAGTTCT
	CGAGCTTTTGGAGTACGTCGTCTTTAGGTTGGGGGGAGGGGTTTTATGCGATGGAGTTTC
	CCCACACTGAGTGGGTGGAGACTGAAGTTAGGCCAGCTTGGCACTTGATGTAATTCTCCT
	TGGAATTTGCCCTTTTTGAGTTTGGATCTTGGTTCATTCTCAAGCCTCAGACAGTGGTTCA
	AAGTTTTTTTCTTCCATTTCAGGTGTCGTGAGGAATTCGGTACCGCGGCCGCCCGGGGATC
	CATGGCCTTACCAGTGACCGCCTTGCTCCTGCCGCTGGCCTTGCTGCTCCACGCCGCCAG
	GCCGGACGCCGTTGTGACCCAGGAATCCGCTCTGACCTCTTCTCCAGGCGAAACCGTGAC
	TCTGACTTGCCGTAGTAGCACCGGGGCTGTGACCACATCTAACTATGCCAGTTGGGTCCA
	GGAAAAACCGGATCACCTGTTTACTGGCCTGATTGGCGGCACCAACAATCGCGCACCGG
	GTGTGCCCGCTCGTTTCAGCGGTTCCCTGATTGGGGACAAGGCAGCACTGACTATCACCG
	GCGCCCAGACCGAAGATGAGGCGATCTATTTTTGCGTCCTGTGGTACAGCGACCATTGGG
	TGTTCGGGGGAGGCACCAAACTGACAGTGCTGGGCGGAGGAGGAGGTTCAGGAGGAGG
	AGGTAGCGGGGGAGGCGGTTCCGGGGGAGGCGGTTCTGATGTGCAGCTGCAAGAATCCG
	GGCCAGGACTGGTTGCGCCTTCTCAGAGTCTGTCAATTACATGTACTGTTAGTGGCTTTCT
	GCTGACCGACTATGGTGTGAACTGGGTTCGTCAGAGCCCAGGCAAGGGTCTGGAGTGGC
	TGGGAGTGATTTGGGGGGATGGAATCACAGACTACAATAGCGCACTGAAATCTCGGCTG
	AGTGTTACCAAAGATAACAGCAAGTCCCAGGTCTTCCTGAAGATGAACAGCCTGCAAAG
	CGGCGACTCCGCTCGCTATTACTGCGTTACCGGACTGTTTGATTATTGGGGGCAGGGGAC
	AACTCTGACTGTTTCCTCCACCACGACGCCAGCGCCGCGACCACCAACACCGGCGCCCAC

Table 38. Chimeric Antigen Receptor –Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	CATCGCGTCGCAGCCCCTGTCCCTGCGCCCAGAGGCGTGCCGGCCAGCGGCGGGGGGCG CAGTGCACACGAGGGGGCTGGACTTCGCCTGTGATATCTACATCTGGGCGCCCTTGGCCG GGACTTGTGGGGTCCTTCTCCTGTCACTGGTTATCACCCTTTACTGCAAACGGGGCAGAA AGAAACTCCTGTATATATTCAAACAACCATTTATGAGACCAGTACAAACTACTCAAGAGG AAGATGGCTGTAGCTGCCGATTTCCAGAAGAAGAAGAAGGAGGATGTGAACTGAGAGTG AAGTTCAGCAGGAGCGCAGACGCCCCCGCGTACAAGCAGGGCCAGAACCAGCTCTATAA CGAGCTCAATCTAGGACGAAGAGAGGAGTACGATGTTTTGGACAAGAGACGTGGCCGGG ACCCTGAGATGGGGGGAAAGCCGAGAAGGAAGAACCCTCAGGAAGGCCTGTACAATGA ACTGCAGAAAGATAAGATGGCGGAGGCCTACAGTGAGATTGGGATGAAAGGCGAGCGC CGGAGGGGCAAGGGGCACGATGGCCTTTACCAGGGTCTCAGTACAGCCACCAAGGACAC CTACGACGCCCTTCACATGCAGGCCCTGCCCCCTCGCTAAGTCGACAATCAACCTCTGGA TTACAAAATTTGTGAAAGATTGACTGGTATTCTTAACTATGTTGCTCCTTTTACGCTATGT GGATACGCTGCTTTAATGCCTTTGTATCATGCTATTGCTTCCCGTATGGCTTTCATTTTCTC CTCCTTGTATAAATCCTGGTTGCTGTCTCTTTATGAGGAGTTGTGGCCCGTTGTCAGGCAA CGTGGCGTGGTGTGCACTGTGTTTGCTGACGCAACCCCCACTGGTTGGGGCATTGCCACC ACCTGTCAGCTCCTTTCCGGGACTTTCGCTTTCCCCCTCCCTATTGCCACGGCGGAACTCA TCGCCGCCTGCCTTGCCCGCTGCTGGACAGGGGCTCGGCTGTTGGGCACTGACAATTCCG TGGTGTTGTCGGGGAAGCTGACGTCCTTTCCATGGCTGCTCGCCTGTGTTGCCACCTGGAT TCTGCGCGGGACGTCCTTCTGCTACGTCCCTTCGGCCCTCAATCCAGCGGACCTTCCTTCC CGCGGCCTGCTGCCGGCTCTGCGGCCTCTTCCGCGTCTTCGCCTTCGCCCTCAGACGAGTC GGATCTCCCTTTGGGCCGCCTCCCCGCCTGGAATTCGAGCTCGGTACCTTTAAGACCAAT GACTTACAAGGCAGCTGTAGATCTTAGCCACTTTTTAAAAGAAAAGGGGGGACTGGAAG GGCTAATTCACTCCCAACGAAGACAAGATCTGCTTTTTGCTTGTACTGGGTCTCTCTGGTT AGACCAGATCTGAGCCTGGGAGCTCTCTGGCTAACTAGGGAACCCACTGCTTAAGCCTCA ATAAAGCTTGCCTTGAGTGCTTCAAGTAGTGTGTGCCCGTCTGTTGTGTGACTCTGGTAAC TAGAGATCCCTCAGACCCTTTTAGTCAGTGTGGAAAATCTCTAGCAGTAGTAGTTCATGT CATCTTATTATTCAGTATTTATAACTTGCAAAGAAATGAATATCAGAGAGTGAGAGGAAC TTGTTTATTGCAGCTTATAATGGTTACAAATAAAGCAATAGCATCACAAATTTCACAAAT AAAGCATTTTTTTCACTGCATTCTAGTTGTGGTTTGTCCAAACTCATCAATGTATCTTATC ATGTCTGGCTCTAGCTATCCCGCCCCTAACTCCGCCCAGTTCCGCCCATTCTCCGCCCCAT GGCTGACTAATTTTTTTTATTTATGCAGAGGCCGAGGCCGCCTCGGCCTCTGAGCTATTCC AGAAGTAGTGAGGAGGCTTTTTTGGAGGCCTAGGCTTTTGCGTCGAGACGTACCCAATTC GCCCTATAGTGAGTCGTATTACGCGCGCTCACTGGCCGTCGTTTTACAACGTCGTGACTG GGAAAACCCTGGCGTTACCCAACTTAATCGCCTTGCAGCACATCCCCCTTTCGCCAGCTG GCGTAATAGCGAAGAGGCCCGCACCGATCGCCCTTCCCAACAGTTGCGCAGCCTGAATG GCGAATGGCGCGACGCGCCCTGTAGCGGCGCATTAAGCGCGGCGGGTGTGGTGGTTACG CGCAGCGTGACCGCTACACTTGCCAGCGCCCTAGCGCCCGCTCCTTTCGCTTTCTTCCCTT CCTTTCTCGCCACGTTCGCCGGCTTTCCCCGTCAAGCTCTAAATCGGGGGCTCCCTTTAGG GTTCCGATTTAGTGCTTTACGGCACCTCGACCCCAAAAAACTTGATTAGGGTGATGGTTC ACGTAGTGGGCCATCGCCCTGATAGACGGTTTTTCGCCCTTTGACGTTGGAGTCCACGTT CTTTAATAGTGGACTCTTGTTCCAAACTGGAACAACACTCAACCCTATCTCGGTCTATTCT TTTGATTTATAAGGGATTTTGCCGATTTCGGCCTATTGGTTAAAAAATGAGCTGATTTAAC AAAAATTTAACGCGAATTTTAACAAAATATTAACGTTTACAATTTCC

Table 39. CAR Binding Region –Nucleotide & Amino Acid Sequences	
SEQ ID NO	SEQUENCE
2	RMKQLEPKVEELLPKNYHLENEVARLKKLVGER
3	NYHLENEVARLKKL
4	GGGGSNYHLENEVARLKKLGGGGS
5	GGGGSDYKDDDDK
6	GGGGSDYKDDDDKP
7	DYKDDDDK

Table 40. CAR-T switch targeting polypeptides–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
8	GACATCCAGATGACACAGACTACATCCTCCCTGTCTGCCTCTCTGGGAGACAGAGTCACC

Table 40. CAR-T switch targeting polypeptides–Nucleotide Sequence	
SEQ ID NO	**SEQUENCE**
	ATCAGTTGCAGGGCAAGTCAGGACATTAGTAAATATTTAAATTGGTATCAGCAGAAACC AGATGGAACTGTTAAACTCCTGATCTACCATACATCAAGATTACACTCAGGAGTCCCATC AAGGTTCAGTGGCAGTGGGTCTGGAACAGATTATTCTCTCACCATTAGCAACCTGGAGCA AGAAGATATTGCCACTTACTTTTGCCAACAGGGTAATACGCTTCCGTACACGTTCGGAGG GGGGACCAAGCTTGAGATCAAACGAACTGTGGCTGCACCATCTGTCTTCATCTTCCCGCC ATCTGATGAGCAGTTGAAATCTGGAACTGCCTCTGTCGTGTGCCTGCTGAATAACTTCTAT CCCAGAGAGGCCAAAGTACAGTGGAAGGTGGATAACGCCCTCCAATCGGGTAACTCCCA GGAGAGTGTCACAGAGCAGGACAGCAAGGACAGCACCTACAGCCTCAGCAGCACCCTGA CGCTGAGCAAAGCAGACTACGAGAAACACAAAGTCTACGCCTGCGAAGTCACCCATCAG GGCCTGTCCTCGCCCGTCACAAAGAGCTTCAACAGGGGAGAGTGT
9	GAGGTGAAACTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGT CACATGCACTGTCTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCC TCCACGAAAGGGTCTGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATA ATTCAGCTCTCAAATCCAGACTGACCATCATCAAGGACAACTCCAAGAGCCAAGTTTTCT TAAAAATGAACAGTCTGCAAACTGATGACACAGCCATTTACTACTGTGCCAAACATTATT ACTACGGTGGTAGCTATGCTATGGACTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCT CAGCCTCCACCAAGGGCCCATCGGTCTTCCCCCTGGCACCCTCCTCCAAGAGCACCTCTG GGGGCACAGCGGCCCTGGGCTGCCTGGTCAAGGACTACTTCCCCGAACCGGTGACGGTG TCGTGGAACTCAGGCGCCCTGACCAGCGGCGTGCACACCTTCCCGGCTGTCCTACAGTCC TCAGGACTCTACTCCCTCAGCAGCGTGGTGACTGTGCCCTCTAGCAGCTTGGGCACCCAG ACCTACATCTGCAACGTGAATCACAAGCCCAGCAACACCAAGGTGGACAAGAAAGTTGA GCCCAAATCTTGT
10	GAGGTGAAACTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGT CACATGCACTGTCTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCC TCCACGAAAGGGTCTGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATA ATTCAGCTCTCAAATCCAGACTGACCATCATCAAGGACAACTCCAAGAGCCAAGTTTTCT TAAAAATGAACAGTCTGCAAACTGATGACACAGCCATTTACTACTGTGCCAAACATTATT ACTACGGTGGTAGCTATGCTATGGACTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCT CAGCCTCCACCAAGGGCCCATCGGTCTTCCCCCTGGCACCCTCCTCCAAGAGCACCTCTG GGGGCACAGCGGCCCTGGGCTGCCTGGTCAAGGACTACTTCCCCGAACCGGTGACGGTG TCGTGGAACTCAGGCGCCCTGACCAGCGGCGTGCACACCTTCCCGGCTGTCCTACAGTCC TCAGGACTCTACTCCCTCAGCAGCGTGGTGACTGTGCCCTCTAGCAGCTTGGGCACCCAG ACCTACATCTGCAACGTGAATCACAAGCCCAGCAACACCAAGGTGGACAAGAAAGTTGA GCCCAAATCTTGTGACAAAACTCACACATGCCCACCGTGCCCAGCACCTCCAGTCGCCGG ACCGTCAGTCTTCCTCTTCCCTCCAAAACCCAAGGACACCCTCATGATCTCCCGGACCCCT GAGGTCACATGCGTGGTGGTGGACGTGAGCCACGAAGACCCTGAGGTCAAGTTCAACTG GTACGTGGACGGCGTGGAGGTGCATAATGCCAAGACAAAGCCGCGGGAGGAGCAGTAC AACAGCACGTACCGTGTGGTCAGCGTCCTCACCGTCCTGCACCAGGACTGGCTGAATGGC AAGGAGTACAAGTGCAAGGTCTCCAACAAAGGCCTCCCAAGCTCCATCGAGAAAACCAT CTCCAAAGCCAAAGGGCAGCCCCGAGAACCACAGGTGTACACCCTGCCTCCATCCCGGG ATGAGCTGACCAAGAACCAGGTCAGCCTGACCTGCCTGGTCAAAGGCTTCTATCCCAGCG ACATCGCCGTGGAGTGGGAGAGCAATGGGCAGCCGGAGAACAACTACAAGACCACGCCT CCCGTGCTGGACTCCGACGGCTCCTTCTTCCTCTACAGCAAGCTCACCGTGGACAAGAGC AGGTGGCAGCAGGGGAACGTCTTCTCATGCTCCGTGATGCATGAGGCTCTGCACAACCAC TACACGCAGAAGAGCCTCTCCCTGTCTCCGGGTAAA
11	ATGAAAAAGAATATCGCATTTCTTCTTGCTAGCATGTTCGTTTTTTCTATTGCTACAAACG CATACGCTGACATCCAGATGACCCAGTCTCCATCCTCCCTGTCTGCATCTGTAGGAGACA GAGTCACCATCACTTGCCGGGCAAGTCAGGATGTGAATACCGCGGTCGCATGGTATCAG CAGAAACCAGGGAAAGCCCCTAAGCTCCTGATCTATTCTGCATCCTTCTTGTATAGTGGG GTCCCATCAAGGTTCAGTGGCAGTAGATCTGGGACAGATTTCACTCTCACCATCAGCAGT CTGCAACCTGAAGATTTTGCAACTTACTACTGTCAACAGCATTACACTACCCCTCCGACG TTCGGCCAAGGTACCAAGCTTGAGATCAAACGAACTGTGGCTGCACCATCTGTCTTCATC TTCCCGCCATCTGATGAGCAGTTGAAATCTGGAACTGCCTCTGTCGTGTGCCTGCTGAAT AACTTCTATCCCAGAGAGGCCAAAGTACAGTGGAAGGTGGATAACGCCCTCCAATCGGG TAACTCCCAGGAGAGTGTCACAGAGCAGGACAGCAAGGACAGCACCTACAGCCTCAGCA GCACCCTGACGCTGAGCAAAGCAGACTACGAGAAACACAAAGTCTACGCCTGCGAAGTC ACCCATCAGGGCCTGTCCTCGCCCGTCACAAAGAGCTTCAACAGGGGAGAGTGT
12	ATGAAAAAGAATATCGCATTTCTTCTTGCATCTATGTTCGTTTTTTCTATTGCTACAAACG CGTACGCTGAGGTGCAGCTGGTGGAGTCTGGAGGAGGCTTGGTCCAGCCTGGGGGGTCC

Table 40. CAR-T switch targeting polypeptides–Nucleotide Sequence	
SEQ ID NO	**SEQUENCE**
	CTGAGACTCTCCTGTGCAGCCTCTGGGTTCAATATTAAGGACACTTACATCCACTGGGTC CGCCAGGCTCCAGGGAAGGGGCTGGAGTGGGTCGCACGTATTTATCCTACCAATGGTTAC ACACGCTACGCAGACTCCGTGAAGGGCCGATTCACCATCTCCGCAGACACTTCCAAGAA CACGGCGTATCTTCAAATGAACAGCCTGAGAGCCGAGGACACGGCCGTGTATTACTGTTC GAGATGGGGCGGTGACGGCTTCTATGCCATGGACTACTGGGGCCAAGGAACCCTGGTCA CCGTCTCCTCAGCCTCCACCAAGGGCCCATCGGTCTTCCCCCTGGCACCCTCCTCCAAGA GCACCTCTGGGGGCACAGCGGCCCTGGGCTGCCTGGTCAAGGACTACTTCCCCGAACCG GTGACGGTGTCGTGGAACTCAGGCGCCCTGACCAGCGGCGTGCACACCTTCCCGGCTGTC CTACAGTCCTCAGGACTCTACTCCCTCAGCAGCGTGGTGACTGTGCCCTCTAGCAGCTTG GGCACCCAGACCTACATCTGCAACGTGAATCACAAGCCCAGCAACACCAAGGTGGACAA GAAAGTTGAGCCCAAATCTTGTGACAAAACTCACACA
13	ATGAAAAAGAATATCGCATTTCTTCTTGCTAGCATGTTCGTTTTTTCTATTGCTACAAACG CATACGCTCAGATTGTGCTGAGCCAGAGCCCGGCGATTCTGAGCGCGAGCCCGGGCGAA AAAGTGACCATGACCTGCCGCGCGAGCAGCAGCGTGAGCTATATTCATTGGTTTCAGCAG AAACCGGGCAGCAGCCCGAAACCGTGGATTTATGCGACCAGCAACCTGGCGAGCGGCGT GCCGGTGCGCTTTAGCGGCAGCGGCAGCGGCACCAGCTATAGCCTGACCATTAGCCGCG TGGAAGCGGAAGATGCGGCGACCTATTATTGCCAGCAGTGGACCAGCAACCCGCCGACC TTTGGCGGCGGCACCAAGCTTGAGATCAAACGAACTGTGGCTGCACCATCTGTCTTCATC TTCCCGCCATCTGATGAGCAGTTGAAATCTGGAACTGCCTCTGTCGTGTGCCTGCTGAAT AACTTCTATCCCAGAGAGGCCAAAGTACAGTGGAAGGTGGATAACGCCCTCCAATCGGG TAACTCCCAGGAGAGTGTCACAGAGCAGGACAGCAAGGACAGCACCTACAGCCTCAGCA GCACCCTGACGCTGAGCAAAGCAGACTACGAGAAACACAAAGTCTACGCCTGCGAAGTC ACCCATCAGGGCCTGTCCTCGCCCGTCACAAAGAGCTTCAACAGGGGAGAGTGT
14	ATGAAAAAGAATATCGCATTTCTTCTTGCATCTATGTTCGTTTTTTCTATTGCTACAAACG CGTACGCTCAGGTGCAGCTGCAGCAGCCGGGCGCGGAACTGGTGAAACCGGGCGCGAGC GTGAAAATGAGCTGCAAAGCGAGCGGCTATACCTTTACCAGCTATAACATGCATTGGGTG AAACAGACCCCGGGCCGCGGCCTGGAATGGATTGGCGCGATTTATCCGGGCAACGGCGA TACCAGCTATAACCAGAAATTTAAAGGCAAAGCGACCCTGACCGCGGATAAAAGCAGCA GCACCGCGTATATGCAGCTGAGCAGCCTGACCAGCGAAGATAGCGCGGTGTATTATTGC GCGCGCAGCACCTATTATGGCGGCGATTGGTATTTTAACGTGTGGGGCGCGGGCACCACC GTGACCGTGAGCGCGGCGAGCACCAAGGGCCCATCGGTCTTCCCCCTGGCACCCTCCTCC AAGAGCACCTCTGGGGGCACAGCGGCCCTGGGCTGCCTGGTCAAGGACTACTTCCCCGA ACCGGTGACGGTGTCGTGGAACTCAGGCGCCCTGACCAGCGGCGTGCACACCTTCCCGG CTGTCCTACAGTCCTCAGGACTCTACTCCCTCAGCAGCGTGGTGACTGTGCCCTCTAGCA GCTTGGGCACCCAGACCTACATCTGCAACGTGAATCACAAGCCCAGCAACACCAAGGTG GACAAGAAAGTTGAGCCCAAATCTTGTGACAAAACTCACACA
15	ATGAGGGTCCCCGCTCAGCTCCTGGGGCTCCTGCTGCTCTGGCTCCCAGGTGCACGATGT GACATCCTGCTGACCCAGTCCCCCGTGATCCTGTCCGTGTCCCCTGGCGAGCGGGTGTCC TTCTCCTGCCGGGCCTCCCAGTCCATCGGCACCAACATCCACTGGTATCAGCAGCGGACC AACGGCTCCCCTCGGCTGCTGATCAAGTACGCCTCCGAGTCTATCTCCGGCATCCCTTCCC GGTTCTCCGGCTCCGGCTCTGGCACCGACTTCACCCTGTCCATCAACTCCGTGGAGTCCG AGGATATCGCCGACTACTACTGCCAGCAGAACAACAACTGGCCTACCACCTTCGGCGCTG GAACCAAGCTGGAGCTGAAGCGTACGGTGGCTGCACCATCTGTCTTCATCTTCCCGCCAT CTGATGAGCAGTTGAAATCTGGAACTGCCTCTGTTGTGTGCCTGCTGAATAACTTCTATCC CAGAGAGGCCAAAGTACAGTGGAAGGTGGATAACGCCCTCCAATCGGGTAACTCCCAGG AGAGTGTCACAGAGCAGGACAGCAAGGACAGCACCTACAGCCTCAGCAGCACCCTGACG CTGAGCAAAGCAGACTACGAGAAACACAAAGTCTACGCCTGCGAAGTCACCCATCAGGG CCTGAGCTCGCCCGTCACAAAGAGCTTCAACAGGGGAGAGTGTTGATGA
16	ATGGGTTGGAGCCTCATCTTGCTCTTCCTTGTCGCTGTTGCTACGCGTGTCCACTCCCAGG TGCAGCTGAAGCAGTCCGGCCCTGGCCTGGTGCAGCCTTCCCAGTCCCTGTCCATCACCT GCACCGTGTCCGGCTTCTCCCTGACCAACTACGGCGTGCACTGGGTGCGCCAGTCCCCCG GCAAGGGCCTGGAGTGGCTGGGCGTGATCTGGTCCGGCGGCAACACCGACTACAACACC CCTTTCACCTCCCGGCTGTCCATCAACAAGGACAACTCCAAGTCCCAGGTGTTCTTCAAG ATGAACTCCCTGCAGTCCAACGACACCGCCATCTACTACTGCGCCAGAGCCCTGACCTAC TATGACTACGAGTTCGCCTACTGGGGCCAGGGCACCCTGGTGACCGTGTCCGCCGCTAGC ACCAAGGGCCCATCGGTCTTCCCCCTGGCACCCTCCTCCAAGAGCACCTCTGGGGGCACA GCGGCCCTGGGCTGCCTGGTCAAGGACTACTTCCCCGAACCGGTGACGGTGTCGTGGAAC TCAGGCGCCCTGACCAGCGGCGTGCACACCTTCCCGGCTGTCCTACAGTCCTCAGGACTC TACTCCCTCAGCAGCGTGGTGACCGTGCCCTCCAGCAGCTTGGGCACCCAGACCTACATC

Table 40. CAR-T switch targeting polypeptides–Nucleotide Sequence	
SEQ ID NO	**SEQUENCE**
	TGCAACGTGAATCACAAGCCCAGCAACACCAAGGTGGACAAGAAAGTTGAGCCCAAATC TTGTGACAAAACTCACACATGCCCACCGTGCCCA
17	GAGAACGTGCTCACCCAATCCCCCGCCATTATGTCCGCCTCCCCAGGCGAAAAGGTGACA ATGACCTGCAGGGCCAGCTCCAACGTGATCAGCTCTTACGTGCACTGGTACCAGCAACGG TCCGGCGCCTCCCCTAAGCTGTGGATCTATAGCACAAGCAACCTGGCTTCCGGCGTGCCT GCACGGTTCAGCGGAAGCGGAAGCGGAACAAGTTACTCCCTCACCATTTCTAGCGTTGA AGCCGAGGATGCCGCTACATACTATTGTCAACAGTACAGCGGATACCCCCTGACCTTCGG AGCCGGCACAAAACTGGAGCTCAAGAGAGCAGCTGCAGCTCCCAGCGTGTTCATTTTTCC TCCCTCCGACGAACAACTGAAAAGCGGAACAGCCTCTGTCGTTTGCCTGTTGAACAATTT CTACCCTAGGGAGGCCAAGGTCCAGTGGAAAGTGGATAACGCTCTGCAAAGCGGAAATT CTCAGGAAAGCGTTACCGAACAGGATTCTAAGGACTCTACATACTCTCTGTCTAGCACAC TCACGCTGAGCAAAGCAGACTACGAGAAACACAAAGTCTACGCCTGCGAAGTCACCCAT CAGGGCCTGTCCTCGCCCGTCACAAAGAGCTTCAACAGGGGAGAGTGT
18	GACATCCAGCTGCAGGAGAGCGGCCCCGGCCTGGTGAAGCCCAGCCAGAGCCTGAGCCT GACCTGCAGCGTGACCGGCTACAGCATCACCAGCGCCTATTACTGGAACTGGATCCGGC AGTTCCCCGGCAACAAGCTGGAGTGGATGGGCTACATCAGCTACGACGGCCGGAACAAC TACAACCCAAGCCTGAAGAACCGGATCAGCATCACCCGGGACACCAGCAAGAACCAGTT TTTCCTGAAGCTGAACAGCGTGACCACAGAGGACACCGCCACCTATTACTGCGCCAAGG AGGGAGACTACGACGTGGGCAACTACTACGCCATGGACTACTGGGGCCAGGGCACCAGC GTGACCGTGTCTAGCGCCCGGACCAAGGGCCCCAGCGTGTTCCCCCTGGCCCCCAGCTCT AAGAGCACCAGCGGCGGAACCGCCGCTCTGGGCTGCCTGGTGAAGGACTACTTCCCCGA GCCCGTGACCGTGAGCTGGAACAGCGGCGCCCTGACCAGCGGCGTGCACACCTTCCCCG CCGTGCTGCAGAGCTCTGGCCTGTACAGCCTGAGCAGCGTGGTTACCGTGCCCAGTTCTT CCCTGGGCACCCAGACCTACATCTGCAACGTGAACCACAAGCCCAGCAACACCAAGGTG GACAAGAAAGTGGAGCCCAAGAGCTGC
19	GATATTCAGATGACCCAGAGCCCGAGCAGCCTGAGCGCGAGCGTGGGCGATCGCGTGAC CATTACCTGCCGCGCGAGCGAAAGCGTGGATAACTATGGCATTAGCTTTATGAACTGGTT TCAGCAGAAACCGGGCAAAGCGCCGAAACTGCTGATTTATGCGGCGAGCAACCAGGGCA GCGGCGTGCCGAGCCGCTTTAGCGGCAGCGGCAGCGGCACCGATTTTACCCTGAACATTA GCAGCCTGCAGCCGGATGATTTTGCGACCTATTATTGCCAGCAGAGCAAAGAAGTGCCGT GGACCTTTGGCCAGGGCACCAAAGTGGAAATTAAACGAACTGTGGCTGCACCATCTGTCT TCATCTTCCCGCCATCTGATGAGCAGTTGAAATCTGGAACTGCCTCTGTTGTGTGCCTGCT GAATAACTTCTATCCCAGAGAGGCCAAAGTACAGTGGAAGGTGGATAACGCCCTCCAAT CGGGTAACTCCCAGGAGAGTGTCACAGAGCAGGACAGCAAGGACAGCACCTACAGCCTC AGCAGCACCCTGACGCTGAGCAAAGCAGACTACGAGAAACACAAAGTCTACGCCTGCGA AGTCACCCATCAGGGCCTGAGCTCGCCCGTCACAAAGAGCTTCAACAGGGGAGAGTGT
20	CAGGTGCAGCTGGTGCAGAGCGGCGCGGAAGTGAAAAAACCGGGCAGCAGCGTGAAAG TGAGCTGCAAAGCGAGCGGCTATACCTTTACCGATTATAACATGCATTGGGTGCGCCAGG CGCCGGGCCAGGGCCTGGAATGGATTGGCTATATTTATCCGTATAACGGCGGCACCGGCT ATAACCAGAAATTTAAAAGCAAAGCGACCATTACCGCGGATGAAAGCACCAACACCGCG TATATGGAACTGAGCAGCCTGCGCAGCGAAGATACCGCGGTGTATTATTGCGCGCGCGG CCGCCCGGCGATGGATTATTGGGGCCAGGGCACCCTGGTGACCGTGAGCAGCGCCTCCA CCAAGGGCCCATCGGTCTTCCCCCTGGCACCCTCCTCCTAGAGCACCTCTGGGGGCACAG CGGCCCTGGGCTGCCTGGTCAAGGACTACTTCCCCGAACCGGTGACGGTGTCGTGGAACT CAGGCGCCCTGACCAGCGGCGTGCACACCTTCCCGGCTGTCCTACAGTCCTCAGGACTCT ACTCCCTCAGCAGCGTGGTGACCGTGCCCTCCAGCAGCTTGGGCACCCAGACCTACATCT GCAACGTGAATCACAAGCCCAGCAACACCAAGGTCGACAAGAAAGTTGAGCCCAAATCT TGTGGTGGCGGTCACCATCACCATCATCACCACCAC

Table 41. CAR-T switch targeting polypeptides- Amino Acid Sequence	
SEQ ID NO	**SEQUENCE**
21	DIQMTQSPSSLSASVGDRVTITCKASQDVGIAVAWYQQKPGKVPKLLIYWASTRHTGVPDRFSG SGSGTDFTLTISSLQPEDVATYYCQQYSSYPYTFGQGTKLEIK
22	EVQLVESGGGLVQPGGSLRLSCAASGFDFSRYWMSWVRQAPGKGLEWIGEINPDSSTINYAPS LKDKFIISRDNAKNSLYLQMNSLRAEDTAVYYCARPDGNYWYFDVWGQGTLVTVSSASTKGP SVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVT VPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC

Table 41. CAR-T switch targeting polypeptides- Amino Acid Sequence	
SEQ ID NO	**SEQUENCE**
23	DIQMTQSPSSMSVSVGDRVTITCHSSQDINSNIGWLQQKPGKSFKGLIYHGTNLDDGVPSRFSGS GSGTDYTLTISSLQPEDFATYYCVQYAQFPWTFGGGTKLEIKRTVAAPSVFIFPPSDEQLKSGTA SVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVY ACEVTHQGLSSPVTKSFNRGEC
24	QLQESGPGLVKPSQTLSLTCTVSGYSISSDFAWNWIRQPPGKGLEWMGYISYSGNTRYQPSLKS RITISRDTSKNQFFLKLNSVTAADTATYYCVTAGRGFPYWGQGTLVTVSSASTKGPSVFPLAPSS KSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQ TYICNVNHKPSNTKVDKKVEPKSC
25	DIQMTQSPSSLSASVGDRVTITCRANQGISNNLNWYQQKPGKAPKPLIYYTSNLQSGVPSRFSGS GSGTDYTLTISSLQPEDFATYYCQQFTSLPYTFGQGTKLEIKRTVAAPSVFIFPPSDEQLKSGTAS VVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYA CEVTHQGLSSPVTKSFNRGEC
26	EVQLVESGGGLVQPGGSLRLSCAASGFTFSNFDMAWVRQAPGKGLVWVSSITTGGGDTYYAD SVKGRFTISRDNAKSTLYLQMDSLRSEDTAVYYCVRHGYYDGYHLFDYWGQGTLVTVSSAST KGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSV VTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC
27	DIQMTQTTSSLSASLGDRVTISCRASQDISKYLNWYQQKPDGTVKLLIYHTSRLHSGVPSRFSGS GSGTDYSLTISNLEQEDIATYFCQQGNTLPYTFGGGTKLEIKRTVAAPSVFIFPPSDEQLKSGTAS VVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYA CEVTHQGLSSPVTKSFNRGEC
28	EVKLQESGPGLVAPSQSLSVTCTVSGVSLPDYGVSWIRQPPRKGLEWLGVIWGSETTYYNSALK SRLTIIKDNSKSQVFLKMNSLQTDDTAIYYCAKHYYYGGSYAMDYWGQGTSVTVSSASTKGPS VFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTV PSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPPVAGPSVFLFPPKPKDTLMIS RTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLN GKEYKCKVSNKGLPSSIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVE WESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLS LSPGK
29	EVKLQESGPGLVAPSQSLSVTCTVSGVSLPDYGVSWIRQPPRKGLEWLGVIWGSETTYYNSALK SRLTIIKDNSKSQVFLKMNSLQTDDTAIYYCAKHYYYGGSYAMDYWGQGTSVTVSSASTKGPS VFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTV PSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC

Table 42. CAR-T switches- Amino Acid Sequence	
SEQ ID NO	**SEQUENCE**
30	DIQMTQTTSSLSASLGDRVTISCRASQDISKYLNWYQQKPDGTVKLLIYHTSRLHSGVPSRFSGSG SGTDYSLTISNLEQEDIATYFCQQGNTLPYTFGGGTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVV CLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDS**GGGGS<u>NYHLENEVARLKKL</u>GGGGS**DS TYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
31	DIQMTQTTSSLSASLGDRVTISCRASQDISKYLNWYQQKPDGTVKLLIYHTSRLHSGVPSRFSGSG SGTDYSLTISNLEQEDIATYFCQQGNTLPYTFGGGTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVV CLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDS**GGGGS<u>NYHLENEVARLKKL</u>GGGGS**DS TYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
32	EVKLQESGPGLVAPSQSLSVTCTVSGVSLPDYGVSWIRQPPRKGLEWLGVIWGSETTYYNSALK SRLTIIKDNSKSQVFLKMNSLQTDDTAIYYCAKHYYYGGSYAMDYWGQGTSVTVSSASTKGPS VFPLAPSS**<u>NYHLENEVARLKKL</u>**SGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQS SGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC
33	EVKLQESGPGLVAPSQSLSVTCTVSGVSLPDYGVSWIRQPPRKGLEWLGVIWGSETTYYNSALK SRLTIIKDNSKSQVFLKMNSLQTDDTAIYYCAKHYYYGGSYAMDYWGQGTSVTVSSASTKGPS VFPLAPSS**<u>NYHLENEVARLKKL</u>**SGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQS SGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPPVAGPSVFLF PPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVL TVLHQDWLNGKEYKCKVSNKGLPSSIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVK GFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHN HYTQKSLSLSPGK

Table 42. CAR-T switches- Amino Acid Sequence	
SEQ ID NO	**SEQUENCE**
34	EVKLQESGPGLVAPSQSLSVTCTVSGVSLPDYGVSWIRQPPRKGLEWLGVIWGSETTYYNSALK SRLTIIKDNSKSQVFLKMNSLQTDDTAIYYCAKHYYYGGSYAMDYWGQGTSVTVSSASTKGPS VFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVP SSSLGTQTYICNVNHKPSNTKVDKKVEPKSC**GGGGSNYHLENEVARLKKL**
35	EVKLQESGPGLVAPSQSLSVTCTVSGVSLPDYGVSWIRQPPRKGLEWLGVIWGSETTYYNSALK SRLTIIKDNSKSQVFLKMNSLQTDDTAIYYCAKHYYYGGSYAMDYWGQGTSVTVSSASTKGPS VFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVP SSSLGTQTYICNVNHKPSNTKVDKKVEPKSC**GGGGSNYHLENEVARLKKLGGS**DKTHTCPPCP APPVAGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQ YNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKGLPSSIEKTISKAKGQPREPQVYTLPPSRDELT KNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVF SCSVMHEALHNHYTQKSLSLSPGK
36	**NYHLENEVARLKKLGGGGS**DIQMTQTTSSLSASLGDRVTISCRASQDISKYLNWYQQKPDGTV KLLIYHTSRLHSGVPSRFSGSGSGTDYSLTISNLEQEDIATYFCQQGNTLPYTFGGGTKLEIKRTVA APSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLS STLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
37	DIQMTQSPSSLSASVGDRVTITCRANQGISNNLNWYQQKPGKAPKPLIYYTSNLQSGVPSRFSGS GSGTDYTLTISSLQPEDFATYYCQQFTSLPYTFGQGTKLEIKRTVAAPSVFIFPPSDEQLKSGTASV VCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDS**GGGGSNYHLENEVARLKKLGGGGS**D STYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
38	EVQLVESGGGLVQPGGSLRLSCAASGFTFSNFDMAWVRQAPGKGLVWVSSITTGGGDTYYADS VKGRFTISRDNAKSTLYLQMDSLRSEDTAVYYCVRHGYYDGYHLFDYWGQGTLVTVSSASTKG PSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVT VPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPPVAGPSVFLFPPKPKDTLMIS RTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNG KEYKCKVSNKGLPSSIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEW ESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSP GK

Table 43. pBAD vector with CAR-T targeting moiety- Nucleotide Sequence	
SEQ ID NO	**SEQUENCE**
39	AAGAAACCAATTGTCCATATTGCATCAGACATTGCCGTCACTGCGTCTTTTACTGGCTCTTCT CGCTAACCAAACCGGTAACCCTGATTATTTGCACGGAGTCACACTTTGCTATGCCATAGCAT TTTTATCCATAAGATTAGCGGATCCTACCTGACGCTTTTTATCGCAACTCTCTACTGTTTCTCC ATACCCGTTTTTTTGGGCTAGAAATAATTTTGTTTAACTTTAAGAAGGAGAATACATCAACT AGTACGCAAGTTCACGTAAAAAGGGTATCTAGAGGTTGAGGTGATTTTATGAAAAAGAATA TCGCATTTCTTCTTGCTAGCATGTTCGTTTTTTCTATTGCTACAAACGCATACGCTGACATCC AGATGACACAGACTACATCCTCCCTGTCTGCCTCTCTGGGAGACAGAGTCACCATCAGTTGC AGGGCAAGTCAGGACATTAGTAAATATTTAAATTGGTATCAGCAGAAACCAGATGGAACTG TTAAACTCCTGATCTACCATACATCAAGATTACACTCAGGAGTCCCATCAAGGTTCAGTGGC AGTGGGTCTGGAACAGATTATTCTCTCACCATTAGCAACCTGGAGCAAGAAGATATTGCCAC TTACTTTTGCCAACAGGGTAATACGCTTCCGTACACGTTCGGAGGGGGGACCAAGCTTGAGA TCAAACGAACTGTGGCTGCACCATCTGTCTTCATCTTCCCGCCATCTGATGAGCAGTTGAAA TCTGGAACTGCCTCTGTCGTGTGCCTGCTGAATAACTTCTATCCCAGAGAGGCCAAAGTACA GTGGAAGGTGGATAACGCCCTCCAATCGGGTAACTCCCAGGAGAGTGTCACAGAGCAGGAC AGCAAGGACAGCACCTACAGCCTCAGCAGCACCCTGACGCTGAGCAAAGCAGACTACGAGA AACACAAAGTCTACGCCTGCGAAGTCACCCATCAGGGCCTGTCCTCGCCCGTCACAAAGAG CTTCAACAGGGGAGAGTGTTAAGCTGGGGATCCTCTAGAGGTTGAGGTGATTTTATGAAAA AGAATATCGCATTTCTTCTTGCATCTATGTTCGTTTTTTCTATTGCTACAAACGCGTACGCTG AGGTGAAACTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGTCAC ATGCACTGTCTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCCTCCAC GAAAGGGTCTGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATAATTCAGC TCTCAAATCCAGACTGACCATCATCAAGGACAACTCCAAGAGCCAAGTTTTCTTAAAAATGA ACAGTCTGCAAACTGATGACACAGCCATTTACTACTGTGCCAAACATTATTACTACGGTGGT AGCTATGCTATGGACTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCTCAGCCTCCACCAA

Table 43. pBAD vector with CAR-T targeting moiety- Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	GGGCCCATCGGTCTTCCCCCTGGCACCCTCCTCCAAGAGCACCTCTGGGGGCACAGCGGCCC
	TGGGCTGCCTGGTCAAGGACTACTTCCCCGAACCGGTGACGGTGTCGTGGAACTCAGGCGCC
	CTGACCAGCGGCGTGCACACCTTCCCGGCTGTCCTACAGTCCTCAGGACTCTACTCCCTCAG
	CAGCGTGGTGACTGTGCCCTCTAGCAGCTTGGGCACCCAGACCTACATCTGCAACGTGAATC
	ACAAGCCCAGCAACACCAAGGTGGACAAGAAAGTTGAGCCCAAATCTTGTGACAAAACTCA
	CACATAATAAGTCGACCGATGCCCTTGAGAGCCTTCAACCCAGTCAGCTCCTTCCGGTGGGC
	GCGGGGCATGACTATCGTCGCCGCACTTATGACTGTCTTCTTTATCATGCAACTCGTAGGAC
	AGGTGCCAAACGGTCTCCAGCTTGGCTGTTTTGGCGGATGAGAGAAGATTTTCAGCCTGATA
	CAGATTAAATCAGAACGCAGAAGCGGTCTGATAAAACAGAATTTGCCTGGCGGCAGTAGCG
	CGGTGGTCCCACCTGACCCCATGCCGAACTCAGAAGTGAAACGCCGTAGCGCCGATGGTAG
	TGTGGGGTCTCCCCATGCGAGAGTAGGGAACTGCCAGGCATCAAATAAAACGAAAGGCTCA
	GTCGAAAGACTGGGCCTTTCGTTTTATCTGTTGTTTGTCGGTGAACGCTCTCCTGAGTAGGAC
	AAATCCGCCGGGAGCGGATTTGAACGTTGCGAAGCAACGGCCCGGAGGGTGGCGGGCAGG
	ACGCCCGCCATAAACTGCCAGGCATCAAATTAAGCAGAAGGCCATCCTGACGGATGGCCTT
	TTTGCGTTTCTACAAACTCTTTTTGTTTATTTTTCTAAATACATTCAAATATGTATCCGCTCAT
	GAGACAATAACCCTGATAAATGCTTCAATAATATTGAAAAAGGAAGAGTATGAGTATTCAA
	CATTTCCGTGTCGCCCTTATTCCCTTTTTTGCGGCATTTTGCCTTCCTGTTTTTGCTCACCCAG
	AAACGCTGGTGAAAGTAAAAGATGCTGAAGATCAGTTGGGTGCACGAGTGGGTTACATCGA
	ACTGGATCTCAACAGCGGTAAGATCCTTGAGAGTTTTCGCCCCGAAGAACGTTTTCCAATGA
	TGAGCACTTTTAAAGTTCTGCTATGTGGCGCGGTATTATCCCGTGTTGACGCCGGGCAAGAG
	CAACTCGGTCGCCGCATACACTATTCTCAGAATGACTTGGTTGAGTACTCACCAGTCACAGA
	AAAGCATCTTACGGATGGCATGACAGTAAGAGAATTATGCAGTGCTGCCATAACCATGAGT
	GATAACACTGCGGCCAACTTACTTCTGACAACGATCGGAGGACCGAAGGAGCTAACCGCTT
	TTTTGCACAACATGGGGGATCATGTAACTCGCCTTGATCGTTGGGAACCGGAGCTGAATGAA
	GCCATACCAAACGACGAGCGTGACACCACGATGCCTGTAGCAATGGCAACAACGTTGCGCA
	AACTATTAACTGGCGAACTACTTACTCTAGCTTCCCGGCAACAATTAATAGACTGGATGGAG
	GCGGATAAAGTTGCAGGACCACTTCTGCGCTCGGCCCTTCCGGCTGGCTGGTTTATTGCTGA
	TAAATCTGGAGCCGGTGAGCGTGGGTCTCGCGGTATCATTGCAGCACTGGGGCCAGATGGT
	AAGCCCTCCCGTATCGTAGTTATCTACACGACGGGGAGTCAGGCAACTATGGATGAACGAA
	ATAGACAGATCGCTGAGATAGGTGCCTCACTGATTAAGCATTGGTAACTGTCAGACCAAGTT
	TACTCATATATACTTTAGATTGATTTAAAACTTCATTTTTAATTTAAAAGGATCTAGGTGAAG
	ATCCTTTTTGATAATCTCATGACCAAAATCCCTTAACGTGAGTTTTCGTTCCACTGAGCGTCA
	GACCCCGTAGAAAAGATCAAAGGATCTTCTTGAGATCCTTTTTTTCTGCGCGTAATCTGCTGC
	TTGCAAACAAAAAAACCACCGCTACCAGCGGTGGTTTGTTTGCCGGATCAAGAGCTACCAA
	CTCTTTTTCCGAAGGTAACTGGCTTCAGCAGAGCGCAGATACCAAATACTGTCCTTCTAGTG
	TAGCCGTAGTTAGGCCACCACTTCAAGAACTCTGTAGCACCGCCTACATACCTCGCTCTGCT
	AATCCTGTTACCAGTGGCTGCTGCCAGTGGCGATAAGTCGTGTCTTACCGGGTTGGACTCAA
	GACGATAGTTACCGGATAAGGCGCAGCGGTCGGGCTGAACGGGGGGTTCGTGCACACAGCC
	CAGCTTGGAGCGAACGACCTACACCGAACTGAGATACCTACAGCGTGAGCTATGAGAAAGC
	GCCACGCTTCCCGAAGGGAGAAAGGCGGACAGGTATCCGGTAAGCGGCAGGGTCGGAACA
	GGAGAGCGCACGAGGGAGCTTCCAGGGGGAAACGCCTGGTATCTTTATAGTCCTGTCGGGT
	TTCGCCACCTCTGACTTGAGCGTCGATTTTTGTGATGCTCGTCAGGGGGGCGGAGCCTATGG
	AAAAACGCCAGCAACGCGGCCTTTTTACGGTTCCTGGCCTTTTGCTGGCCTTTTGCTCACATG
	TTCTTTCCTGCGTTATCCCCTGATTCTGTGGATAACCGTATTACCGCCTTTGAGTGAGCTGAT
	ACCGCTCGCCGCAGCCGAACGACCGAGCGCAGCGAGTCAGTGAGCGAGGAAGCGGAAGAG
	CGCCTGATGCGGTATTTTCTCCTTACGCATCTGTGCGGTATTTCACACCGCATATGGTGCACT
	CTCAGTACAATCTGCTCTGATGCCGCATAGTTAAGCCAGTATACACTCCGCTATCGCTACGT
	GACTGGGTCATGGCTGCGCCCCGACACCCGCCAACACCCGCTGACGCGCCCTGACGGGCTTG
	TCTGCTCCCGGCATCCGCTTACAGACAAGCTGTGACCGTCTCCGGGAGCTGCATGTGTCAGA
	GGTTTTCACCGTCATCACCGAAACGCGCGAGGCAGCAGATCAATTCGCGCGCGAAGGCGAA
	GCGGCATGCATAATGTGCCTGTCAAATGGACGAAGCAGGGATTCTGCAAACCCTATGCTACT
	CCGTCAAGCCGTCAATTGTCTGATTCGTTACCAATTATGACAACTTGACGGCTACATCATTCA
	CTTTTTCTTCACAACCGGCACGGAACTCGCTCGGGCTGGCCCCGGTGCATTTTTTAAATACCC
	GCGAGAAATAGAGTTGATCGTCAAAACCAACATTGCGACCGACGGTGGCGATAGGCATCCG
	GGTGGTGCTCAAAAGCAGCTTCGCCTGGCTGATACGTTGGTCCTCGCGCCAGCTTAAGACGC
	TAATCCCTAACTGCTGGCGGAAAAGATGTGACAGACGCGACGGCGACAAGCAAACATGCTG
	TGCGACGCTGGCGATATCAAAATTGCTGTCTGCCAGGTGATCGCTGATGTACTGACAAGCCT
	CGCGTACCCGATTATCCATCGGTGGATGGAGCGACTCGTTAATCGCTTCCATGCGCCGCAGT
	AACAATTGCTCAAGCAGATTTATCGCCAGCAGCTCCGAATAGCGCCCTTCCCCTTGCCCGGC

Table 43. pBAD vector with CAR-T targeting moiety- Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	GTTAATGATTTGCCCAAACAGGTCGCTGAAATGCGGCTGGTGCGCTTCATCCGGGCGAAAGA ACCCCGTATTGGCAAATATTGACGGCCAGTTAAGCCATTCATGCCAGTAGGCGCGCGGACG AAAGTAAACCCACTGGTGATACCATTCGCGAGCCTCCGGATGACGACCGTAGTGATGAATCT CTCCTGGCGGGAACAGCAAAATATCACCCGGTCGGCAAACAAATTCTCGTCCCTGATTTTTC ACCACCCCCTGACCGCGAATGGTGAGATTGAGAATATAACCTTTCATTCCCAGCGGTCGGTC GATAAAAAAATCGAGATAACCGTTGGCCTCAATCGGCGTTAAACCCGCCACCAGATGGGCA TTAAACGAGTATCCCGGCAGCAGGGGATCATTTTGCGCTTCAGCCATACTTTTCATACTCCC GCCATTCAGAG

Table 44. Linker–Amino Acid Sequence	
SEQ ID NO	SEQUENCE
40	$(GGGGS)_n$, n is at least 1
41	$(GGGS)_n$, n is at least 1
42	$(GGS)_n$, n is at least 1
43	$(G_mS)_n$, n is at least 1, m is at least 1
44	$(X_mS)_n$, n is at least 1, m is at least 1 and X is an amino acid
45	LVGEAAAKEAAAKA
46	AEAAAKEAAAKA
47	EAAAKEAAAKEAAAKA
48	EGKSSGSGSESKST
49	GSAGSAAGSGEF
50	APAPAPAPAPAPAP

Table 45. direct GCN4-CAR with mouse signaling domains–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
51	tcgagaagcttgccaccatgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcGACGCCGTTGTGAC CCAGGAATCCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCA CCGGGGCTGTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTT ACTGGCCTGATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTTC CCTGATTGGGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGCGATC TATTTTTGCGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAACTGACAGT GCTGGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTCCGGGGGAGG CGGTTCTGATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTTCTCAGAGTCTGT CAATTACATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGAACTGGGTTCGTCAG AGCCCAGGCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGATGGAATCACAGACTACA ATAGCGCACTGAAATCTCGGCTGAGTGTTACCAAAGATAACAGCAAGTCCCAGGTCTTCCTG AAGATGAACAGCCTGCAAAGCGGCGACTCCGCTCGCTATTACTGCGTTACCGGACTGTTTGA TTATTGGGGGCAGGGGACAACTCTGACTGTTTCCTCCatcgagttcatgtacccccctccctacctggacaacgagag aagcaacggcaccatcatccacatcaaagaaaagcacctgtgccacacccagagcagccccaagctgttctgggccctggtggtggtggccggcgtg ctgttctgttacggcctgctggtcacagtggccctgtgcgtgatctggaccaacagcagaagaaacagaggcggccagagcgactacatgaacatgac ccccagaaggccaggcctgaccagaaagccctaccagccctacgcccctgccagagacttcgccgcctacagacccagagccaagttcagcagatc cgccgagacagccgccaacctgcaggatcccaaccagctgttcaacgagctgaacctgggcagacgggaggaattcgacgtgctggaaaagaaga gagccagggaccccgagatgggcggcaagcagcagagaagaagaaaccctcaggaaggcgtctacaacgccctgcagaaagacaagatggccg aggcctacagcgagatcggcaccaagggcgagagaagaaggggcaagggccacgatggcctgttccagggcctgtccaccgccaccaaggacac cttcgacgccctgcacatgcagaccctggccccagatgagtcgacggtaccgcgggcccgggatccgataaaataaaagattttatttagtctccagaa aaaggggggaatgaaagaccccacctgtaggtttggcaagctagcttaagtaacgccattttgcaaggcatggaaaatacataactgagaatagagaag ttcagatcaaggttaggaacagagagacagcagaatatgggccaaacaggatatctgtggtaagcagttcctgccccggctcagggccaagaacagat ggtccccagatgcggtcccgccctcagcagtttctagagaaccatcagatgtttccagggtgccccaaggacctgaaaatgaccctgtgccttatttgaac taaccaatcagttcgcttctcgcttctgttcgcgcgcttctgctcccgagctcaataaaagagcccacaacccctcactcggcgcgccagtcctccgata gactgcgtcgcccgggtacccgtgtatccaataaaccctcttgcagttgcatccgacttgtggtctcgctgttccttgggagggtctcctctgagtgattgac tacccgtcagcgggggtctttcatgggtaacagtttcttgaagttggagaacaacattctgagggtaggagtcgaatattaagtaatcctgactcaattagcc

Table 45. direct GCN4-CAR with mouse signaling domains–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	actgttttgaatccacatactccaatactcctgaaatccatcgatggagttcattatggacagcgcagaaagagctggggagaattgtgaaattgttatccgc tcacaattccacacaacatacgagccggaagcataaagtgtaaagcctggggtgcctaatgagtgagctaactcacattaattgcgttgcgctcactgccc gctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggcggtttgcgtattgggcgctcttccgcttcctcgc tcactgactcgctgcgctcggtcgttcggctgcggcgagcggtatcagctcactcaaaggcggtaatacggttatccacagaatcaggggataacgcag gaaagaacatgtgagcaaaaggccagcaaaaggccaggaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgcccccctgacgagca tcacaaaaatcgacgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttccccctggaagctccctcgtgcgctctcctgtt ccgaccctgccgcttaccggatacctgtccgcctttctcccttcgggaagcgtggcgctttctcatagctcacgctgtaggtatctcagttcggtgtaggtcg ttcgctccaagctgggctgtgtgcacgaacccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacga cttatcgccactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaactacggcta cactagaaggacagtatttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggta gcggtggttttttttgtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaacg aaaactcacgttaagggattttggtcatgagattatcaaaaaggatcttcacctagatccttttaaattaaaaatgaagttttaaatcaatctaaagtatatatga gtaaacttggtctgacagttaccaatgcttaatcagtgaggcacctatctcagcgatctgtctatttcgttcatccatagttgcctgactccccgtcgtgtagat aactacgatacgggagggcttaccatctggccccagtgctgcaatgataccgcgagacccacgctcaccggctccagatttatcagcaataaaccagcc agccggaagggccgagcgcagaagtggtcctgcaactttatccgcctccatccagtctattaattgttgccgggaagctagagtaagtagttcgccagtta atagtttgcgcaacgttgttgccattgctacaggcatcgtggtgtcacgctcgtcgtttggtatggcttcattcagctccggttcccaacgatcaaggcgagtt acatgatccccatgttgtgcaaaaaagcggttagctccttcggtcctccgatcgttgtcagaagtaagttggccgcagtgttatcactcatggttatggcag cactgcataattctcttactgtcatgccatccgtaagatgcttttctgtgactggtgagtactcaaccaagtcattctgagaatagtgtatgcggcgaccgagtt gctcttgcccggcgtcaatacgggataataccgcgccacatagcagaactttaaaagtgctcatcattggaaaacgttcttcggggcgaaaactctcaag gatcttaccgctgttgagatccagttcgatgtaacccactcgtgcacccaactgatcttcagcatcttttactttcaccagcgtttctgggtgagcaaaaacag gaaggcaaaatgccgcaaaaaagggaataagggcgacacggaaatgttgaatactcatactcttcctttttcaatattattgaagcatttatcagggttattgt ctcatgagcggatacatatttgaatgtatttagaaaaataaacaaatagggggttccgcgcacatttccccgaaaagtgccacctgacgtctaagaaaccatt attatcatgacattaacctataaaaatagggcgtatcacgaggccctttcgtctcgcgcgtttcggtgatgacggtgaaaacctctgacacatgcagctcccg gagacggtcacagcttgtctgtaagcggatgccgggagcagacaagcccgtcagggcgcgtcagcgggtgttggcgggtgtcggggctggcttaact atgcggcatcagagcagattgtactgagagtgcaccatatgcggtgtgaaataccgcacagatgcgtaaggagaaaataccgcatcaggcgccattcg ccattcaggctgcgcaactgttgggaagggcgatcggtgcgggcctcttcgctattacgccagctggcgaaaggggatgtgctgcaaggcgattaag ttgggtaacgccagggttttcccagtcacgacgttgtaaaacgacggccagtgccacgctctcccttatgcgactcctgcattaggaagcagcccagtag taggttgaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtccccggccacggggcctgccaccatacc cacgccgaaacaagcgctcatgagcccgaagtggcgagcccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcg ccggtgatgccggccacgatgcgtccggcgtagaggcgatttaaagacaggatatcagtggtccaggctctagttttgactcaacaatatcaccagctga agcctatagagtacgagccatagataaaataaaagattttatttagtctccagaaaaaggggggaatgaaagaccccacctgtaggtttggcaagctagct taagtaacgccattttgcaaggcatggaaaatacataactgagaatagagaagttcagatcaaggttaggaacagagagacagcagaatatgggccaaa caggatatctgtggtaagcagttcctgccccggctcagggccaagaacagatggtccccagatgcggtcccgccctcagcagtttctagagaaccatca gatgtttccagggtgccccaaggacctgaaaatgaccctgtgccttatttgaactaaccaatcagttcgcttctcgcttctgttcgcgcgcttctgctcccga gctcaataaaagagcccacaacccctcactcggcgcgccagtcctccgatagactgcgtcgcccgggtacccgtattcccaataaagcctcttgctgttt gcatccgaatcgtggactcgctgatccttgggagggtctcctcagattgattgactgcccacctcgggggtctttcatttggaggttccaccgagatttgga gacccctgcctagggaccaccgacccccccgccgggaggtaagctggccagcggtcgtttcgtgtctgtctctgtctttgtgcgtgtttgtgccggcatct aatgtttgcgcctgcgtctgtactagttagctaactagctctgtatctggcggacccgtggtggaactgacgagttcggaacacccggccgcaaccctgg gagacgtcccagggacttcgggggccgtttttgtggcccgacctgagtccaaaaatcccgatcgttttggactctttggtgcacccccctagaggaggg atatgtggttctggtaggagacgagaacctaaaacagttcccgcctccgtctgaatttttgctttcggtttgggaccgaagccgcgccgcgcgtcttgtctg ctgcagcatcgttctgtgttgtctctgtctgactgtgtttctgtatttgtctgagaatatgggcccgggctagcctgttaccactcccttaagtttgaccttaggtc actggaaagatgtcgagcggatcgctcacaaccagtcggtagatgtcaagaagagacgttgggttaccttctgctctgcagaatggccaaccttttaacgt cggatggccgcgagacggcacctttaaccgagacctcatcacccaggttaagatcaaggtcttttcacctggcccgcatggacacccagaccaggtcc cctacatcgtgacctgggaagccttggcttttgaccccctcccctgggtcaagcccttgtacaccctaagcctccgcctcctcttcctccatccgccccgtc tctccccctgaacctcctcgttcgaccccgcctcgatcctccctttatccagccctcactccttctctaggcgccccatatggccatatgagatcttatatg gggcaccccgccccttgtaaacttccctgaccctgacatgacaagagttactaacagcccctctctccaagctcacttacaggctctctacttagtccagc acgaagtctggagacctctggcggcagcctaccaagaacaactggaccgaccggtggtacctcaccctaccgagtcggcgacacagtgtgggtccg ccgacaccagactaagaacctagaacctcgctggaaaggaccttacacagtcctgctgaccacccccaccgccctcaaagtagacggcatcgcagctt ggatacacgccgcccacgtgaaggctgccgaccccgggggtggaccatcctctagactgc

Table 46. anti-mouse CD19 switch antibody chains–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
52	ggatctgcgatcgctccggtgcccgtcagtgggcagagcgcacatcgcccacagtccccgagaagttgggggggagggtcggcaattgaacgggtg cctagagaaggtggcgcggggtaaactgggaaagtgatgtcgtgtactggctccgccttttcccgagggtgggggagaaccgtatataagtgcagtag tcgccgtgaacgttcttttcgcaacgggtttgccgccagaacacagctgaagcttcgaggggctcgcatctctccttcacgcgcccgccgccctacctga

Table 46. anti-mouse CD19 switch antibody chains–Nucleotide Sequence

SEQ ID NO	SEQUENCE
	ggccgccatccacgccggttgagtcgcgttctgccgcctcccgcctgtggtgcctcctgaactgcgtccgccgtctaggtaagtttaaagctcaggtcga gaccgggcctttgtccggcgctcccttggagcctacctagactcagccggctctccacgctttgcctgaccctgcttgctcaactctacgtctttgtttcgtttt ctgttctgcgccgttacagatccaagctgtgaccggcgcctacctgagatcaccggcgaaggagggccaccatgtacaggatgcaactcctgtcttgcat tgcactaagtcttgcacttgtcacgaattcgGACATTCAGCTGACCCAGTCTCCAGCTTCCCTGTCTACATCTCT GGGAGAAACTGTCACCATCCAATGTCAAGCAAGTGAGGACATTTACAGTGGTTTAGCGTGG TATCAGCAGAAGCCAGGGAAATCTCCTCAGCTCCTGATCTATGGTGCAAGTGACTTACAAGA CGGCGTCCCATCACGATTCAGTGGCAGTGGATCTGGCACACAGTATTCTCTCAAGATCACCA GCATGCAAACTGAAGATGAAGGGGTTTATTTCTGTCAACAGGGTTTAACGTATCCTCGGACG TTCGGTGGCGGCACCAAGCTGGAAATCaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttga aatctggaactgcctctgtcgtgtgcctgctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcc caggagagtgtcacagagcaggacagcGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactcGGT GGCGGAGGCAGCgacagcacctacagcctcagcagcaccctgacgcttagcaaagcagactacgagaaacacaaagtctacgcctgcga agtcacccatcagggcctgtcctcgcccgtcacaaagagcttcaacaggggagagtgttgataagtgctagctggccagacatgataagatacattgatg agtttggacaaaccacaactagaatgcagtgaaaaaaatgctttatttgtgaaatttgtgatgctattgctttatttgtaaccattataagctgcaataaacaagt taacaacaacaattgcattcattttatgtttcaggttcagggggaggtgtgggaggttttttaaagcaagtaaaacctctacaaatgtggtatggaattaattct aaaatacagcatagcaaaacttaacctccaaatcaagcctctacttgaatccttttctgagggatgaataggcataggcatcaggggctgttgccaatgt gcattagctgtttgcagcctcaccttctttcatggagtttaagatatagtgtattttcccaaggtttgaactagctcttcatttctttatgttttaaatgcactgacctc ccacattccctttttagtaaaatattcagaaataatttaaatacatcattgcaatgaaaataaatgtttttttattaggcagaatccagatgctcaaggcccttcata atatcccccagtttagtagttggacttagggaacaaaggaaccttttaatagaaattggacagcaagaaagcgagcttctagcttatcctcagtcctgctcctc tgccacaaagtgcacgcagttgccggccgggtcgcgcagggcgaactcccgcccccacggctgctcgccgatctcggtcatggccggcccggagg cgtcccggaagttcgtggacacgacctccgaccactcggcgtacagctcgtccaggccgcgcacccacacccaggccagggtgttgtccggcaccac ctggtcctggaccgcgctgatgaacagggtcacgtcgtcccggaccacaccggcgaagtcgtcctccacgaagtcccgggagaacccgagccggtc ggtccagaactcgaccgctccggcgacgtcgcgcgcggtgagcaccggaacggcactggtcaacttggccatgatggctcctcctgtcaggagagga aagagaagaaggttagtacaattgctatagtgagttgtattatactatgcagatatactatgccaatgattaattgtcaaactagggctgcagggttcatagtg ccacttttcctgcactgccccatctcctgcccaccctttcccaggcatagacagtcagtgacttaccaaactcacaggagggagaaggcagaagcttgag acagacccgcgggaccgccgaactgcgaggggacgtggctagggcggcttcttttatggtgcgccggcctcggaggcagggcgctcggggaggc ctagcggccaatctgcggtggcaggaggcggggccgaaggccgtgcctgaccaatccggagcacataggagtctcagccccccgccccaaagcaa ggggaagtcacgcgcctgtagcgccagcgtgttgtgaaatgggggcttgggggggttggggccctgactagtcaaaacaaactcccattgacgtcaat ggggtggagacttggaaatccccgtgagtcaaaccgctatccacgcccattgatgtactgccaaaaccgcatcatcatggtaatagcgatgactaatacg tagatgtactgccaagtaggaaagtcccataaggtcatgtactgggcataatgccaggcgggccatttaccgtcattgacgtcaatagggggcgtacttg gcatatgatacacttgatgtactgccaagtgggcagtttaccgtaaatactccacccattgacgtcaatggaaagtccctattggcgttactatgggaacata cgtcattattgacgtcaatgggcgggggtcgttgggcggtcagccaggcgggccatttaccgtaagttatgtaacgcctgcaggttaattaagaacatgtg agcaaaaggccagcaaaaggccaggaaccgtaaaaggccgcgttgctggcgtttttccataggctccgccccctgacgagcatcacaaaaatcga cgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttcccccctggaagctccctcgtgcgctctcctgttccgaccctgccg cttaccggatacctgtccgcctttctcccttcgggaagcgtggcgctttctcatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctccaagct gggctgtgtgcacgaaccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgacttatcgccactg gcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaactacggctacactagaagaac agtatttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggtagcggtggttttttt gtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaacgaaaactcacgtta agggattttggtcatggctagttaattaacatttaaatcagcggccgcaataaaatatctttatttcattacatctgtgtgttggttttttgtgtgaatcgtaactaa catacgctctccatcaaaacaaaacgaaacaaaacaaactagcaaaataggctgtccccagtgcaagtgcaggtgccagaacatttctctatcgaa
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Table 46. anti-mouse CD19 switch antibody chains–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	tggaattaattctaaaatacagcatagcaaaactttaacctccaaatcaagcctctacttgaatccttttctgagggatgaataaggcataggcatcaggggc tgttgccaatgtgcattagctgtttgcagcctcaccttctttcatggagtttaagatatagtgtattttcccaaggtttgaactagctcttcatttctttatgttttaaat gcactgacctcccacattccctttttagtaaaatattcagaaataatttaaatacatcattgcaatgaaaataaatgttttttattaggcagaatccagatgctcaa ggcccttcataatatccccccagtttagtagttggacttagggaacaaaggaaccttttaatagaaattggacagcaagaaagcgagcttctagcttatcctca gtcctgctcctctgccacaaagtgcacgcagttgccggccgggtcgcgcagggcgaactcccgcccccacggctgctcgccgatctcggtcatggcc ggcccggaggcgtcccggaagttcgtggacacgacctccgaccactcggcgtacagctcgtccaggccgcgcacccacacccaggccagggtgttg tccggcaccacctggtcctggaccgcgctgatgaacagggtcacgtcgtcccggaccacaccggcgaagtcgtcctccacgaagtcccgggagaac ccgagccggtcggtccagaactcgaccgctccggcgacgtcgcgcgcggtgagcaccggaacggcactggtcaacttggccatgatggctcctcctg tcaggagaggaaagagaagaaggttagtacaattgctatagtgagttgtattatactatgcagatatactatgccaatgattaattgtcaaactagggctgca gggttcatagtgccacttttcctgcactgccccatctcctgcccacccttccaggcatagacagtcagtgacttaccaaactcacaggagggagaaggc agaagcttgagacagacccgcgggaccgccgaactgcgaggggacgtggctagggcggcttcttttatggtgcgccggccctcggaggcagggcg ctcggggaggcctagcggccaatctgcggtggcaggaggcggggccgaaggccgtgcctgaccaatccggagcacataggagtctcagccccccg ccccaaagcaaggggaagtcacgcgcctgtagcgccagcgtgttgtgaaatgggggcttgggggggttggggccctgactagtcaaaacaaactccc attgacgtcaatggggtggagacttggaaatccccgtgagtcaaaccgctatccacgcccattgatgtactgccaaaaccgcatcatcatggtaatagcg atgactaatacgtagatgtactgccaagtaggaaagtcccataaggtcatgtactgggcataatgccaggcgggccatttaccgtcattgacgtcaatagg gggcgtacttggcatatgatacacttgatgtactgccaagtgggcagtttaccgtaaatactccacccattgacgtcaatggaaagtccctattggcgttact atgggaacatacgtcattattgacgtcaatgggcgggggtcgttgggcggtcagccaggcgggccatttaccgtaagttatgtaacgcctgcaggttaatt aagaacatgtgagcaaaaggccagcaaaaggccaggaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgcccccctgacgagcatc acaaaaatcgacgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttcccccctggaagctccctcgtgcgctctcctgttc cgaccctgccgcttaccggatacctgtccgcctttctcccttcgggaagcgtggcgctttctcatagctcacgctgtaggtatctcagttcggtgtaggtcgt tcgctccaagctgggctgtgtgcacgaacccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgac ttatcgccactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaactacggctac actagaagaacagtatttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggtag cggtggtttttttgtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaacgaa aactcacgttaagggattttggtcatggctagttaattaacatttaaatcagcggccgcaataaaatatctttatttttcattacatctgtgtgttggttttttgtgtga atcgtaactaacatacgctctccatcaaaacaaaacgaaacaaaacaaactagcaaaataggctgtccccagtgcaagtgcaggtgccagaacatttctc tatcgaa
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Table 46. anti-mouse CD19 switch antibody chains–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	atgtactgccaaaaccgcatcatcatggtaatagcgatgactaatacgtagatgtactgccaagtaggaaagtcccataaggtcatgtactgggcataatg ccaggcgggccatttaccgtcattgacgtcaataggggggcgtacttggcatatgatacacttgatgtactgccaagtgggcagtttaccgtaaatactccac ccattgacgtcaatggaaagtccctattggcgttactatgggaacatacgtcattattgacgtcaatgggcgggggtcgttgggcggtcagccaggcggg ccatttaccgtaagttatgtaacgcctgcaggttaattaagaacatgtgagcaaaaggccagcaaaaggccaggaaccgtaaaaaggccgcgttgctgg cgtttttccataggctccgcccccctgacgagcatcacaaaaatcgacgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgt ttcccccctggaagctccctcgtgcgctctcctgttccgaccctgccgcttaccggatacctgtccgcctttctcccttcgggaagcgtggcgctttctcatag ctcacgctgtaggtatctcagttcggtgtaggtcgttcgctccaagctgggctgtgtgcacgaaccccccgttcagcccgaccgctgcgccttatccggta actatcgtcttgagtccaacccggtaagacacgacttatcgccactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgcta cagagttcttgaagtggtggcctaactacggctacactagaagaacagtatttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggta gctcttgatccggcaaacaaaccaccgctggtagcggtggtttttttgtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttg atcttttctacggggtctgacgctcagtggaacgaaaactcacgttaagggattttggtcatggctagttaattaacatttaaatcagcggccgcaataaaat atctttatttttcattacatctgtgtgttggttttttgtgtgaatcgtaactaacatacgctctccatcaaaacaaaacgaaacaaaacaaactagcaaaataggct gtccccagtgcaagtgcaggtgccagaacatttctctatcgaa
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Table 46. anti-mouse CD19 switch antibody chains–Nucleotide Sequence

SEQ ID NO	SEQUENCE
56	ggatctgcgatcgctccggtgcccgtcagtgggcagagcgcacatcgcccacagtccccgagaagttgggggggagggtcggcaattgaacgggtg cctagagaaggtggcgcggggtaaactgggaaagtgatgtcgtgtactggctccgccttttcccgagggtgggggagaaccgtatataagtgcagtag tcgccgtgaacgttcttttcgcaacgggtttgccgccagaacacagctgaagcttcgaggggctcgcatctctccttcacgcgcccgccgccctacctga ggccgccatccacgccggttgagtcgcgttctgccgcctcccgcctgtggtgcctcctgaactgcgtccgccgtctaggtaagtttaaagctcaggtcga gaccgggcctttgtccggcgctcccttggagcctacctagactcagccggctctccacgctttgcctgaccctgcttgctcaactctacgtctttgtttcgtttt ctgttctgcgccgttacagatccaagctgtgaccggcgcctacctgagatcaccggcgaaggagggccaccatgtacaggatgcaactcctgtcttgcat tgcactaagtcttgcacttgtcacgaattcgCAAGTGCAGCTGGTGCAGTCTGGGGCTGAGCTTGTGAGACCTG GGACCTCTGTGAAGTTATCTTGCAAAGTTTCTGGCGATACCATTACATTTTACTACATGCACT TTGTGAAGCAAAGGCCTGGACAGGGTCTGGAATGGATAGGAAGGATTGATCCTGAGGATGA AAGTACTAAATATTCTGAGAAGTTCAAAAACAAGGCGACACTCACTGCAGATACATCTTCCA ACACAGCCTACCTGAAGCTCAGCAGCCTGACCTCTGAGGACACTGCAACCTATTTTTGTATC TACGGAGGATACTACTTTGATTACTGGGGCCCAGGAACCATGGTCACCGTGTCCTCAgcctccac caagggcccatcggtcttcccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaac cggtgacggtgtcgtggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtgg tgactgtgccctctagcagcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaa tcttgtggcgggggaggctcaaactaccacctggagaatgaagtcgccagactgaagaaactgtgataagtgctagctggccagacatgataagataca ttgatgagtttggacaaaccacaactagaatgcagtgaaaaaaatgctttatttgtgaaatttgtgatgctattgctttatttgtaaccattataagctgcaataaa caagttaacaacaacaattgcattcattttatgtttcaggttcaggggggaggtgtgggaggttttttaaagcaagtaaaacctctacaaatgtggtatggaatt aattctaaaatacagcatagcaaaactttaacctccaaatcaagcctctacttgaatccttttctgagggatgaataaggcataggcatcaggggctgttgcc aatgtgcattagctgtttgcagcctcaccttctttcatggagtttaagatatagtgtattttcccaaggtttgaactagctcttcatttctttatgttttaaatgcactg acctcccacattcccttttagtaaaatattcagaaataatttaaatacatcattgcaatgaaaataaatgtttttttattaggcagaatccagatgctcaaggccct tcataatatcccccagtttagtagttggacttagggaacaaaggaaccctttaatagaaattggacagcaagaaagcgagcttctagcttatcctcagtcctgc tcctctgccacaaagtgcacgcagttgccggccgggtcgcgcagggcgaactcccgcccccacggctgctcgccgatctcggtcatggccggcccg gaggcgtcccggaagttcgtggacacgacctccgaccactcggcgtacagctcgtccaggccgcgcacccacacccaggccagggtgttgtccggc accacctggtcctggaccgcgctgatgaacagggtcacgtcgtcccggaccacaccggcgaagtcgtcctccacgaagtcccgggagaacccgagc cggtcggtccagaactcgaccgctccggcgacgtcgcgcgcggtgagcaccggaacggcactggtcaacttggccatgatggctcctcctgtcagga gaggaaagagaagaaggttagtacaattgctatagtgagttgtattatactatgcagatatactatgccaatgattaattgtcaaactagggctgcagggttc atagtgccacttttcctgcactgccccatctcctgcccaccctttcccaggcatagacagtcagtgacttaccaaactcacaggagggagaaggcagaag cttgagacagacccgcgggaccgccgaactgcgaggggacgtggctagggcggcttcttttatggtgcgccggccctcggaggcagggcgctcggg gaggcctagcggccaatctgcggtggcaggaggcggggccgaaggccgtgcctgaccaatccggagcacataggagtctcagccccccgccccaa agcaaggggaagtcacgcgcctgtagcgccagcgtgttgtgaaatgggggcttgggggggttggggccctgactagtcaaaacaaactcccattgac gtcaatggggtggagacttggaaatccccgtgagtcaaaccgctatccacgcccattgatgtactgccaaaaccgcatcatcatggtaatagcgatgact aatacgtagatgtactgccaagtaggaaagtcccataaggtcatgtactgggcataatgccaggcgggccatttaccgtcattgacgtcaataggggcg tacttggcatatgatacacttgatgtactgccaagtgggcagtttaccgtaaatactccacccattgacgtcaatggaaagtccctattggcgttactatggg aacatacgtcattattgacgtcaatgggcgggggtcgttgggcggtcagccaggcgggccatttaccgtaagttatgtaacgcctgcaggttaattaagaa catgtgagcaaaaggccagcaaaaggccaggaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgccccccctgacgagcatcacaaaa atcgacgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttcccccctggaagctccctcgtgcgctctcctgttccgaccct gccgcttaccggatacctgtccgcctttctcccttcgggaagcgtggcgctttctcatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctcc aagctgggctgtgtgcacgaaccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgacttatcgc cactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaactacggctacactagaa gaacagtatttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggtagcggtggt ttttttgtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaacgaaaactcac gttaagggattttggtcatggctagttaattaacatttaaatcagcggccgcaataaaatatctttatttttcattacatctgtgtgttggttttttgtgtgaatcgtaa ctaacatacgctctccatcaaaacaaaacgaaacaaaacaaactagcaaaataggctgtccccagtgcaagtgcaggtgccagaacatttctctatcgaa
57	ggatctgcgatcgctccggtgcccgtcagtgggcagagcgcacatcgcccacagtccccgagaagttgggggggagggtcggcaattgaacgggtg cctagagaaggtggcgcggggtaaactgggaaagtgatgtcgtgtactggctccgccttttcccgagggtgggggagaaccgtatataagtgcagtag tcgccgtgaacgttcttttcgcaacgggtttgccgccagaacacagctgaagcttcgaggggctcgcatctctccttcacgcgcccgccgccctacctga ggccgccatccacgccggttgagtcgcgttctgccgcctcccgcctgtggtgcctcctgaactgcgtccgccgtctaggtaagtttaaagctcaggtcga gaccgggcctttgtccggcgctcccttggagcctacctagactcagccggctctccacgctttgcctgaccctgcttgctcaactctacgtctttgtttcgtttt ctgttctgcgccgttacagatccaagctgtgaccggcgcctacctgagatcaccggcgaaggagggccaccatgtacaggatgcaactcctgtcttgcat tgcactaagtcttgcacttgtcacgaattcgGACATTCAGCTGACCCAGTCTCCAGCTTCCCTGTCTACATCTCT GGGAGAAACTGTCACCATCCAATGTCAAGCAAGTGAGGACATTTACAGTGGTTTAGCGTGG TATCAGCAGAAGCCAGGGAAATCTCCTCAGCTCCTGATCTATGGTGCAAGTGACTTACAAGA CGGCGTCCCATCACGATTCAGTGGCAGTGGATCTGGCACACAGTATTCTCTCAAGATCACCA GCATGCAAACTGAAGATGAAGGGGTTTATTTCTGTCAACAGGGTTTAACGTATCCTCGGACG TTCGGTGGCGGCACCAAGCTgGAaATCaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaa atctggaactgcctctgtcgtgtgcctgctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactccc aggagagtgtcacagagcaggacagcaaggacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtc

Table 46. anti-mouse CD19 switch antibody chains–Nucleotide Sequence

SEQ ID NO	SEQUENCE
	tacgcctgcgaagtcacccatcagggcctgtcctcgcccgtcacaaagagcttcaacaggggagagtgtggcgggggaggctcaaactaccacctgg agaatgaagtcgccagactgaagaaactgtgataagtgctagctggccagacatgataagatacattgatgagtttggacaaaccacaactagaatgca gtgaaaaaaatgctttatttgtgaaatttgtgatgctattgctttatttgtaaccattataagctgcaataaacaagttaacaacaacaattgcattcattttatgttt caggttcaggggaggtgtgggaggttttttaaagcaagtaaaacctctacaaatgtggtatggaattaattctaaaatacagcatagcaaaactttaacctc caaatcaagcctctacttgaatccttttctgagggatgaataaggcataggcatcaggggctgttgccaatgtgcattagctgtttgcagcctcaccttctttc atggagtttaagatatagtgtattttcccaaggtttgaactagctcttcatttctttatgttttaaatgcactgacctcccacattccctttttagtaaaatattcagaa ataatttaaatacatcattgcaatgaaaataaatgtttttttattaggcagaatccagatgctcaaggcccttcataatatcccccagtttagtagttggacttagg gaacaaaggaacctttaatagaaattggacagcaagaaagcgagcttctagcttatcctcagtcctgctcctctgccacaaagtgcacgcagttgccggc cgggtcgcgcagggcgaactcccgcccccacggctgctcgccgatctcggtcatggccggcccggaggcgtcccggaagttcgtggacacgacctc cgaccactcggcgtacagctcgtccaggccgcgcacccacacccaggccagggtgttgtccggcaccacctggtcctggaccgcgctgatgaacag ggtcacgtcgtcccggaccacaccggcgaagtcgtcctccacgaagtcccgggagaacccgagccggtcggtccagaactcgaccgctccggcgac gtcgcgcgcggtgagcaccggaacggcactggtcaacttggccatgatggctcctcctgtcaggagaggaaagagaagaaggttagtacaattgctat agtgagttgtattatactatgcagatatactatgccaatgattaattgtcaaactagggctgcagggttcatagtgccacttttcctgcactgccccatctcctg cccacccttttcccaggcatagacagtcagtgacttaccaaactcacaggagggagaaggcagaagcttgagacagacccgcgggaccgccgaactg cgaggggacgtggctagggcggcttcttttatggtgcgccggccctcggaggcagggcgctcggggaggcctagcggccaatctgcggtggcagga ggcggggccgaaggccgtgcctgaccaatccggagcacataggagtctcagccccccgccccaaagcaaggggaagtcacgcgcctgtagcgcca gcgtgttgtgaaatgggggcttgggggggttggggccctgactagtcaaaacaaactcccattgacgtcaatggggtggagacttggaaatccccgtga gtcaaaccgctatccacgcccattgatgtactgccaaaaccgcatcatcatggtaatagcgatgactaatacgtagatgtactgccaagtaggaaagtccc ataaggtcatgtactgggcataatgccaggcgggccatttaccgtcattgacgtcaataggggcgtacttggcatatgatacacttgatgtactgccaagt gggcagtttaccgtaaatactccacccattgacgtcaatggaaagtccctattggcgttactatgggaacatacgtcattattgacgtcaatgggcgggggt cgttgggcggtcagccaggcgggccatttaccgtaagttatgtaacgcctgcaggttaattaagaacatgtgagcaaaaggccagcaaaaggccagga accgtaaaaaggccgcgttgctggcgtttttccataggctccgccccccctgacgagcatcacaaaaatcgacgctcaagtcagaggtggcgaaacccg acaggactataaagataccaggcgtttcccccctggaagctccctcgtgcgctctcctgttccgaccctgccgcttaccggatacctgtccgcctttctcccctt cgggaagcgtggcgctttctatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctccaagctgggctgtgtgcacgaacccccccgttcag cccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgacttatcgccactggcagcagccactggtaacaggattagca gagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaactacggctacactagaagaacagtatttggtatctgcgctctgctgaagcca gttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggtagcggtggttttttgtttgcaagcagcagattacgcgcagaaa aaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaacgaaaactcacgttaagggattttggtcatggctagttaattaacat ttaaatcagcggccgcaataaaatatctttatttcattacatctgtgtgttggttttttgtgtgaatcgtaactaacatacgctctccatcaaaacaaaacgaaac aaaacaaactagcaaaataggctgtccccagtgcaagtgcaggtgccagaacatttctctatcgaa
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Table 46. anti-mouse CD19 switch antibody chains–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	gcgaggggacgtggctagggcggcttcttttatggtgcgccggccctcggaggcagggcgctcggggaggcctagcggccaatctgcggtggcagg aggcggggccgaaggccgtgcctgaccaatccggagcacataggagtctcagccccccgccccaaagcaaggggaagtcacgcgcctgtagcgcc agcgtgttgtgaaatgggggcttgggggggttggggccctgactagtcaaaacaaactcccattgacgtcaatggggtggagacttggaaatccccgtg agtcaaaccgctatccacgcccattgatgtactgccaaaaccgcatcatcatggtaatagcgatgactaatacgtagatgtactgccaagtaggaaagtcc cataaggtcatgtactgggcataatgccaggcgggccatttaccgtcattgacgtcaataggggggcgtacttggcatatgatacacttgatgtactgccaa gtgggcagtttaccgtaaatactccacccattgacgtcaatggaaagtccctattggcgttactatgggaacatacgtcattattgacgtcaatgggcgggg gtcgttgggcggtcagccaggcgggccatttaccgtaagttatgtaacgcctgcaggttaattaagaacatgtgagcaaaaggccagcaaaaggccag gaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgcccccctgacgagcatcacaaaaatcgacgctcaagtcagaggtggcgaaacc cgacaggactataaagataccaggcgtttcccccctggaagctccctcgtgcgctctcctgttccgaccctgccgcttaccggatacctgtccgcctttctcc cttcgggaagcgtggcgctttctatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctccaagctgggctgtgtgcacgaacccccgttc agcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgacttatcgccactggcagcagccactggtaacaggattag cagagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaactacggctacactagaagaacagtatttggtatctgcgctctgctgaagc cagttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggtagcggtggttttttgtttgcaagcagcagattacgcgcaga aaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaacgaaaactcacgttaagggattttggtcatggctagttaattaa catttaaatcagcggccgcaataaaatatctttatttttcattacatctgtgtgttggttttttgtgtgaatcgtaactaacatacgctctccatcaaaacaaaacga aacaaaacaaactagcaaaataggctgtccccagtgcaagtgcaggtgccagaacatttctctatcgaa
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Table 46. anti-mouse CD19 switch antibody chains–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
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Table 46. anti-mouse CD19 switch antibody chains–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	CTTTGATTACTGGGGACCAGGAACCATGGTCACCGTGTCCTCAgcctccaccaagggcccatcggtcttccccc tggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactca ggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgg gcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgttgataagtgctagctggcc agacatgataagatacattgatgagtttggacaaaccacaactagaatgcagtgaaaaaaatgctttatttgtgaaatttgtgatgctattgctttatttgtaacc attataagctgcaataaacaagttaacaacaacaattgcattcatttttatgtttcaggttcaggggaggtgtgggaggttttttaaagcaagtaaaacctcta caaatgtggtatggaattaattctaaaatacagcatagcaaaactttaacctccaaatcaagcctctacttgaatccttttctgagggatgaataaggcatagg catcaggggctgttgccaatgtgcattagctgtttgcagcctcaccttctttcatggagtttaagatatagtgtattttcccaaggtttgaactagctcttcatttct ttatgttttaaatgcactgacctcccacattcccttttagtaaaatattcagaaataatttaaatacatcattgcaatgaaaataaatgtttttttattaggcagaatc cagatgctcaaggcccttcataatatccccccagtttagtagttggacttagggaacaaaggaaccttttaatagaaattggacagcaagaaagcgagcttct agcttatcctcagtcctgctcctctgccacaaagtgcacgcagttgccggccgggtcgcgcagggcgaactcccgcccccacggctgctcgccgatctc ggtcatggccggcccggaggcgtcccggaagttcgtggacacgacctccgaccactcggcgtacagctcgtccaggccgcgcacccacacccagg ccagggtgttgtccggcaccacctggtcctggaccgcgctgatgaacagggtcacgtcgtcccggaccacaccggcgaagtcgtcctccacgaagtc ccgggagaacccgagccggtcggtccagaactcgaccgctccggcgacgtcgcgcgcggtgagcaccggaacggcactggtcaacttggccatga tggctcctcctgtcaggagaggaaagagaagaaggttagtacaattgctatagtgagttgtattatactatgcagatatactatgccaatgattaattgtcaaa ctagggctgcagggttcatagtgccactttcctgcactgccccatctcctgcccacccttcccaggcatagacagtcagtgacttaccaaactcacagga gggagaaggcagaagcttgagacagacccgcgggaccgccgaactgcgaggggacgtggctagggcggcttcttttatggtgcgccggccctcgg aggcagggcgctcggggaggcctagcggccaatctgcggtggcaggaggcggggccgaaggccgtgcctgaccaatccggagcacataggagtc tcagccccccgccccaaagcaaggggaagtcacgcgcctgtagcgccagcgtgttgtgaaatgggggcttgggggggttggggccctgactagtcaa aacaaactcccattgacgtcaatggggtggagacttggaaatccccgtgagtcaaaccgctatccacgcccattgatgtactgccaaaaccgcatcatca tggtaatagcgatgactaatacgtagatgtactgccaagtaggaaagtcccataaggtcatgtactgggcataatgccaggcgggccatttaccgtcattg acgtcaataggggggcgtacttggcatatgatacacttgatgtactgccaagtgggcagtttaccgtaaatactccacccattgacgtcaatggaaagtccct attggcgttactatgggaacatacgtcattattgacgtcaatgggcgggggtcgttgggcggtcagccaggcgggccatttaccgtaagttatgtaacgcc tgcaggttaattaagaacatgtgagcaaaaggccagcaaaaggccaggaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgcccccct gacgagcatcacaaaaatcgacgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttcccccctggaagctccctcgtgcg ctctcctgttccgaccctgccgcttaccggatacctgtccgcctttctcccttcgggaagcgtggcgctttctcatagctcacgctgtaggtatctcagttcgg tgtaggtcgttcgctccaagctgggctgtgtgcacgaaccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggta agacacgacttatcgccactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaac tacggctacactagaagaacagtatttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccac cgctggtagcggtggttttttttgtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcag tggaacgaaaactcacgttaagggattttggtcatggctagttaattaacatttaaatcagcggccgcaataaaatatctttatttttcattacatctgtgtgttggt tttttgtgtgaatcgtaactaacatacgctctccatcaaaacaaaacgaaacaaaacaaactagcaaaataggctgtccccagtgcaagtgcaggtgccag aacatttctctatcgaa

Table 47. Soluble T cell receptors–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
62	atccggatatagttcctccttttcagcaaaaaaccccctcaagacccgtttagaggccccaaggggttatgctagttattgctcagcggtggcagcagccaac tcagcttcctttcgggctttgttagcagccggatctcagtggtggtggtggtggtgctcgagTTAGTCAGCACGACCCCACGCTTCT GCACTGACAATTTGCGTAACCGGTTTTGCACGGTCCTGGGTCCATTCATCATTTTCGCTCAGG CCGTAGAATTGAACCTGACAGCGAAAATGGTTACGCGGGTCCTGCCAGAAGGTGGCAGACA CGCGCAGACGGGAACTCAGGGCATAACGGCTGTCATTCAGCGCCGGTTGTTCTTTCAGCGGC TGCGGATCGGTACACACACCCGAGTGGACTTCTTTGCCGTTCACCCACCATGACAGTTCGAC ATGGTCCGGATAAAAGCCGGTGGCCAGGCACACCAGCGTCGCTTTCTGGGTATGGGAGATTT CAGCTTCACTCGGTTCGAAAACTGCCACTTCCGGCGGAAAGACATTTTTCAGATCTTCCAGA ACCGTCAGACGAGAACCTTCGCCGAAAAACAGTTCACCGGTGTTGCCCAGGTAAGAGCTTG CGCAGAAATAAACAGACGTTTGGCTCGGTGCTGCGCTCAGCAGACGCAGCGGAAAGTCTTC AATGGTCGAACGTGAAACATTGTAACCGTTCGGCACTTCGCCTTGATCCGTGGTCTGGATGG CGACCGAATAGTGAATCAGACGCAGACCCATACCCGGGTCCTGACGGTACCATGACATATA TTCATGGTTCATATCTTGGGCACATTGCAGCGTCATGGATTGGCCCGTTTTCAGGACTTGGAA TTTCGGCGTTTGGGTCACACCAGCGTTCATatgtatatctccttcttaaagttaaacaaaattatttctagaggggaattgttatcc gctcacaattcccctatagtgagtcgtattaatttcgcgggatcgagatctcgatcctctacgccggacgcatcgtggccggcatcaccggcgccacagg tgcggttgctggcgcctatatcgccgacatcaccgatggggaagatcgggctcgccacttcgggctcatgagcgcttgtttcggcgtgggtatggtggca ggccccgtggccgggggactgttgggcgccatctccttgcatgcaccattccttgcggcggcggtgctcaacggcctcaacctactactgggctgcttc ctaatgcaggagtcgcataagggagagcgtcgagatcccggacaccatcgaatggcgcaaaaccttcgcggtatggcatgatagcgcccggaagag agtcaattcagggtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtgaaccaggc

Table 47. Soluble T cell receptors–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
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Table 47. Soluble T cell receptors–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	CGACCGAATAGTGAATCAGACGCAGACCCATACCCGGGTCCTGACGGTACCATGACATATA TTCATGGTTCATATCTTGGGCACATTGCAGCGTCATGGATTGGCCCGTTTTCAGGACTTGGAA TTTCGGCGTTTGGGTCACACCAGCGTTGCTACCGCCACCGCCCAGTTTTTTCAGGCGCGCAA CTTCATTTTCCAGGTGGTAGTTCATatgtatatctccttcttaaagttaaacaaaattatttctagaggggaattgttatccgctcacaat tcccctatagtgagtcgtattaatttcgcgggatcgagatctcgatcctctacgccggacgcatcgtggccggcatcaccggcgccacaggtgcggttgc tggcgcctatatcgccgacatcaccgatggggaagatcgggctcgccacttcgggctcatgagcgcttgtttcggcgtgggtatggtggcaggccccgt ggccgggggactgttgggcgccatctccttgcatgcaccattccttgcggcggcggtgctcaacggcctcaacctactactgggctgcttcctaatgcag gagtcgcataagggagagcgtcgagatcccggacaccatcgaatggcgcaaaaccttcgcggtatggcatgatagcgcccggaagagagtcaattc agggtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtgaaccaggccagccacg tttctgcgaaaacgcgggaaaaagtggaagcggcgatggcggagctgaattacattcccaaccgcgtggcacaacaactggcgggcaaacagtcgtt gctgattggcgttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgattaaatctcgcgccgatcaactgggtgccagcgtggt 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gcggggcatgactatcgtcgccgcacttatgactgtcttctttatcatgcaactcgtaggacaggtgccggcagcgctctgggtcattttcggcgaggacc gctttcgctggagcgcgacgatgatcggcctgtcgcttgcggtattcggaatcttgcacgccctcgctcaagccttcgtcactggtcccgccaccaaacgt ttcggcgagaagcaggccattatcgccggcatggcggccccacgggtgcgcatgatcgtgctcctgtcgttgaggacccggctaggctggcggggtt gccttactggttagcagaatgaatcaccgatacgcgagcgaacgtgaagcgactgctgctgcaaaacgtctgcgacctgagcaacaacatgaatggtct tcggtttccgtgtttcgtaaagtctggaaacgcggaagtcagcgccctgcaccattatgttccggatctgcatcgcaggatgctgctggctaccctgtggaa cacctacatctgtattaacgaagcgctggcattgaccctgagtgatttttctctggtcccgccgcatccataccgccagttgtttaccctcacaacgttccagt aaccgggcatgttcatcatcagtaacccgtatcgtgagcatcctctctcgtttcatcggtatcattacccccatgaacagaaatcccccttacacggaggcat cagtgaccaaacaggaaaaaaccgcccttaacatggcccgctttatcagaagccagacattaacgcttctggagaaactcaacgagctggacgcggat gaacaggcagacatctgtgaatcgcttcacgaccacgctgatgagctttaccgcagctgcctcgcgcgtttcggtgatgacggtgaaaacctctgacaca tgcagctcccggagacggtcacagcttgtctgtaagcggatgccgggagcagacaagcccgtcagggcgcgtcagcgggtgttggcgggtgtcggg gcgcagccatgacccagtcacgtagcgatagcggagtgtatactggcttaactatgcggcatcagagcagattgtactgagagtgcaccatatatgcggt gtgaaataccgcacagatgcgtaaggagaaaataccgcatcaggcgctcttccgcttcctcgctcactgactcgctgcgctcggtcgttcggctgcggc gagcggtatcagctcactcaaaggcggtaatacggttatccacagaatcaggggataacgcaggaaagaacatgtgagcaaaaggccagcaaaagg ccaggaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgcccccctgacgagcatcacaaaaatcgacgctcaagtcagaggtggcga aacccgacaggactataaagataccaggcgtttcccccctggaagctccctcgtgcgctctcctgttccgaccctgccgcttaccggatacctgtccgcctt tctcccttcgggaagcgtggcgctttctatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctccaagctgggctgtgtgcacgaaccccc cgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgacttatcgccactggcagcagccactggtaacagg attagcagagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaactacggctacactagaaggacagtatttggtatctgcgctctgct 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64	atccggatatagttcctccttttcagcaaaaaaccctcaagacccgtttagaggccccaaggggttatgctagttattgctcagcggtggcagcagccaac tcagcttcctttcgggctttgttagcagccggatctcagtggtggtggtggtggtgctcgagTTAAGAGCTTTCCGGGCTCGGGAA

Table 47. Soluble T cell receptors–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	AAACGTATCTTCCGGGATAATACTATTGTTGAATGCGTTGGCGCACGCAAAGTCAGATTTAT TGCTCCAAGCAACTGCCGAGTTTGATTTGAAATCCATAGAGCGCATGTCCAGAACACATTTA TCGGTAATATACACGTCGGAATCTTTGGATTGACTGACATTCGTCTGACTGTCGAAATCGGT AAACAGGCACACGCTTTTGTCCGATGATTTGCTATCACGCAGTTGGTACACCGCCGGGTCCG GGTTCTGGATATACGGATGGACAATCAGGCTGGTACCGCGGCCAAACGTCGGGATATAGGT ACCATCCAGCAGCGGACGCACCGCACACAGGTACGTAGCGGAGTCACCCGGCTGACTTGCT GCAATATACAGGGTGGAACTACCAGAGCTTTTATCCAGCGATGCATTCAGGCGGCCTGAGGT TTGTTCACGCTGCCACGGCGTGATCAGCAGCAGGCTGGTCAGACCTTTGCCCGGATCTTGAC GAAACCACTGCAGGTTGTAAATGGCGCTATCCGTAAAGGAGCAATTCAGCACCAGATTTTCA CCTTCCGGGACCGACAGAGCAGCCGGGATTTGGGTAACTTCTTGTTTGCTACCGCCACCGCC CAGTTTTTTCAGGCGCGCAACTTCATTTTCCAGGTGGTAGTTCATatgtatatctccttcttaaagttaaacaaaat tatttctagaggggaattgttatccgctcacaattcccctatagtgagtcgtattaatttcgcgggatcgagatctcgatcctctacgccggacgcatcgtggc cggcatcaccggcgccacaggtgcggttgctggcgcctatatcgccgacatcaccgatggggaagatcgggctcgccacttcgggctcatgagcgctt gtttcggcgtgggtatggtggcaggccccgtggccgggggactgttgggcgccatctccttgcatgcaccattccttgcggcggcggtgctcaacggcc tcaacctactactgggctgcttcctaatgcaggagtcgcataagggagagcgtcgagatcccggacaccatcgaatggcgcaaaaccttcgcggtatg gcatgatagcgcccggaagagagtcaattcagggtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtgtctcttatcagaccg tttcccgcgtggtgaaccaggccagccacgtttctgcgaaaacgcgggaaaaagtggaagcggcgatggcggagctgaattacattcccaaccgcgtg gcacaacaactggcgggcaaacagtcgttgctgattggcgttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgattaaatctc gcgccgatcaactgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaagcctgtaaagcggcggtgcacaatcttctcgcgcaacg cgtcagtgggctgatcattaactatccgctggatgaccaggatgccattgctgtggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgacc agacacccatcaacagtattatttttctcccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtcaccagcaaatcgcgctgttagc gggcccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaatatctcactcgcaatcaaattcagccgatagcggaacgggaaggcgac 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cgggagggcttaccatctggccccagtgctgcaatgataccgcgagacccacgctcaccggctccagatttatcagcaataaaccagccagccggaag ggccgagcgcagaagtggtcctgcaactttatccgcctccatccagtctattaattgttgccgggaagctagagtaagtagttcgccagttaatagtttgcg caacgttgttgccattgctgcaggcatcgtggtgtcacgctcgtcgtttggtatggcttcattcagctccggttcccaacgatcaaggcgagttacatgatcc cccatgttgtgcaaaaaagcggttagctccttcggtcctccgatcgttgtcagaagtaagttggccgcagtgttatcactcatggttatggcagcactgcata attctcttactgtcatgccatccgtaagatgcttttctgtgactggtgagtactcaaccaagtcattctgagaatagtgtatgcggcgaccgagttgctcttgcc cggcgtcaatacgggataataccgcgccacatagcagaactttaaaagtgctcatcattggaaaacgttcttcggggcgaaaactctcaaggatcttacc gctgttgagatccagttcgatgtaacccactcgtgcacccaactgatcttcagcatcttttactttcaccagcgtttctgggtgagcaaaaacaggaaggca aaatgccgcaaaaaagggaataagggcgacacggaaatgttgaatactcatactcttcctttttcaatattattgaagcatttatcagggttattgtctcatga gcggatacatatttgaatgtatttagaaaaataaacaaatagggttccgcgcacatttccccgaaaagtgccacctgaaattgtaaacgttaatatttttgtta aaattcgcgttaaatttttgttaaatcagctcatttttttaaccaataggccgaaatcggcaaaatcccttataaatcaaaagaatagaccgagatagggttgag

Table 47. Soluble T cell receptors–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	tgttgttccagtttggaacaagagtccactattaaagaacgtggactccaacgtcaaagggcgaaaaaccgtctatcagggcgatggcccactacgtgaa ccatcaccctaatcaagtttttttggggtcgaggtgccgtaaagcactaaatcggaaccctaaagggagcccccgatttagagcttgacggggaaagccg gcgaacgtggcgagaaaggaagggaagaaagcgaaaggagcgggcgctagggcgctggcaagtgtagcggtcacgctgcgcgtaaccaccaca cccgccgcgcttaatgcgccgctacagggcgcgtcccattcgcca
65	atccggatatagttcctccttttcagcaaaaaaccccctcaagacccgtttagaggccccaaggggttatgctagttattgctcagcggtggcagcagccaac tcagcttcctttcgggctttgttagcagccggatctcagtggtggtggtggtggtgctcgagTTAAGAGCTTTCCGGGCTCGGGAA AAACGTATCTTCCGGGATAATACTATTGTTGAATGCGTTGGCGCACGCAAAGTCAGATTTAT TGCTCCAAGCAACTGCCGAGTTTGATTTGAAATCCATAGAGCGCATGTCCAGAACACATTTA TCGGTAATATACACGTCGGAATCTTTGGATTGACTGACATTCGTCTGACTGTCGAAATCGGT AAACAGGCACACGCTTTTGTCCGATGATTTGCTATCACGCAGTTGGTACACCGCCGGGTCCG GGTTCTGGATATACGGATGGACAATCAGGCTGGTACCGCGGCCAAACGTCGGGATATAGGT ACCATCCAGCAGCGGACGCACCGCACACAGGTACGTAGCGGAGTCACCCGGCTGACTTGCT GCAATATACAGGGTGGAACTACCAGAGCTTTTATCCAGCGATGCATTCAGGCGGCCTGAGGT TTGTTCACGCTGCCACGGCGTGATCAGCAGCAGGCTGGTCAGACCTTTGCCCGGATCTTGAC GAAACCACTGCAGGTTGTAAATGGCGCTATCCGTAAAGGAGCAATTCAGCACCAGATTTTCA CCTTCCGGGACCGACAGAGCAGCCGGGATTTGGGTAACTTCTTGTTTCATatgtatatctccttcttaaagtt aaacaaaattatttctagaggggaattgttatccgctcacaattcccctatagtgagtcgtattaatttcgcgggatcgagatctcgatcctctacgccggacg 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Table 47. Soluble T cell receptors–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	atggcagcactgcataattctcttactgtcatgccatccgtaagatgcttttctgtgactggtgagtactcaaccaagtcattctgagaatagtgtatgcggcg accgagttgctcttgcccggcgtcaatacgggataataccgcgccacatagcagaactttaaaagtgctcatcattggaaaacgttcttcggggcgaaaa ctctcaaggatcttaccgctgttgagatccagttcgatgtaacccactcgtgcacccaactgatcttcagcatcttttactttcaccagcgtttctgggtgagca aaaacaggaaggcaaaatgccgcaaaaaagggaataagggcgacacggaaatgttgaatactcatactcttcctttttcaatattattgaagcatttatcag ggttattgtctcatgagcggatacatatttgaatgtatttagaaaaataaacaaataggggttccgcgcacatttccccgaaaagtgccacctgaaattgtaa acgttaatattttgttaaaattcgcgttaaattttttgttaaatcagctcatttttttaaccaataggccgaaatcggcaaaatcccttataaatcaaaagaatagacc gagatagggttgagtgttgttccagtttggaacaagagtccactattaaagaacgtggactccaacgtcaaagggcgaaaaaccgtctatcagggcgatg gcccactacgtgaaccatcaccctaatcaagttttttggggtcgaggtgccgtaaagcactaaatcggaaccctaaagggagcccccgatttagagcttg acggggaaagccggcgaacgtggcgagaaaggaagggaagaaagcgaaaggagcgggcgctagggcgctggcaagtgtagcggtcacgctgc gcgtaaccaccacacccgccgcgcttaatgcgccgctacagggcgcgtcccattcgcca
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Table 47. Soluble T cell receptors–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	ccaacccggtaagacacgacttatcgccactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaagt ggtggcctaactacggctacactagaaggacagtatttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggc aaacaaaccaccgctggtagcggtggttttttgtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttgatcttttctacgggg tctgacgctcagtggaacgaaaactcacgttaagggattttggtcatgagattatcaaaaggatcttcacctagatccttttaaattaaaaatgaagttttaaa tcaatctaaagtatatatgagtaaacttggtctgacagttaccaatgcttaatcagtgaggcacctatctcagcgatctgtctatttcgttcatccatagttgcct gactccccgtcgtgtagataactacgatacgggagggcttaccatctggccccagtgctgcaatgataccgcgagacccacgctcaccggctccagatt tatcagcaataaaccagccagccggaagggccgagcgcagaagtggtcctgcaactttatccgcctccatccagtctattaattgttgccgggaagctag agtaagtagttcgccagttaatagtttgcgcaacgttgttgccattgctgcaggcatcgtggtgtcacgctcgtcgtttggtatggcttcattcagctccggttc ccaacgatcaaggcgagttacatgatcccccatgttgtgcaaaaaagcggttagctccttcggtcctccgatcgttgtcagaagtaagttggccgcagtgtt atcactcatggttatggcagcactgcataattctcttactgtcatgccatccgtaagatgcttttctgtgactggtgagtactcaaccaagtcattctgagaata gtgtatgcggcgaccgagttgctcttgcccggcgtcaatacgggataataccgcgccacatagcagaactttaaaagtgctcatcattggaaaacgttctt cggggcgaaaactctcaaggatcttaccgctgttgagatccagttcgatgtaacccactcgtgcacccaactgatcttcagcatcttttactttcaccagcgt ttctgggtgagcaaaaacaggaaggcaaaatgccgcaaaaaagggaataagggcgacacggaaatgttgaatactcatactcttcctttttcaatattattg aagcatttatcagggttattgtctcatgagcggatacatatttgaatgtatttagaaaaataaacaaatagggggttccgcgcacatttccccgaaaagtgcca cctgaaattgtaaacgttaatattttgttaaaattcgcgttaaatttttgttaaatcagctcatttttttaaccaataggccgaaatcggcaaaatcccttataaatca aaagaatagaccgagatagggttgagtgttgttccagtttggaacaagagtccactattaaagaacgtggactccaacgtcaaagggcgaaaaaccgtct atcagggcgatggcccactacgtgaaccatcaccctaatcaagttttttggggtcgaggtgccgtaaagcactaaatcggaaccctaaagggagccccc gatttagagcttgacggggaaagccggcgaacgtggcgagaaaggaagggaagaaagcgaaaggagcgggcgctagggcgctggcaagtgtagc ggtcacgctgcgcgtaaccaccacacccgccgcgcttaatgcgccgctacagggcgcgtcccattcgcca
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Table 47. Soluble T cell receptors–Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	gcgtcagcgggtgttggcgggtgtcggggcgcagccatgacccagtcacgtagcgatagcggagtgtatactggcttaactatgcggcatcagagcag attgtactgagagtgcaccatatatgcggtgtgaaataccgcacagatgcgtaaggagaaaataccgcatcaggcgctcttccgcttcctcgctcactgac tcgctgcgctcggtcgttcggctgcggcgagcggtatcagctcactcaaaggcggtaatacggttatccacagaatcaggggataacgcaggaaagaa catgtgagcaaaaggccagcaaaaggccaggaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgccccccctgacgagcatcacaaaa atcgacgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttcccccctggaagctccctcgtgcgctctcctgttccgaccct gccgcttaccggatacctgtccgcctttctcccttcgggaagcgtggcgctttctcatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctcc aagctgggctgtgtgcacgaaccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgacttatcgc cactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaactacggctacactagaa ggacagtatttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggtagcggtggt ttttttgtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaacgaaaactcac gttaagggattttggtcatgagattatcaaaaaggatcttcacctagatccttttaaattaaaaatgaagttttaaatcaatctaaagtatatatgagtaaacttgg tctgacagttaccaatgcttaatcagtgaggcacctatctcagcgatctgtctatttcgttcatccatagttgcctgactccccgtcgtgtagataactacgata cgggagggcttaccatctggccccagtgctgcaatgataccgcgagacccacgctcaccggctccagatttatcagcaataaaccagccagccggaag ggccgagcgcagaagtggtcctgcaactttatccgcctccatccagtctattaattgttgccgggaagctagagtaagtagttcgccagttaatagtttgcg caacgttgttgccattgctgcaggcatcgtggtgtcacgctcgtcgtttggtatggcttcattcagctccggttcccaacgatcaaggcgagttacatgatcc cccatgttgtgcaaaaaagcggttagctccttcggtcctccgatcgttgtcagaagtaagttggccgcagtgttatcactcatggttatggcagcactgcata attctcttactgtcatgccatccgtaagatgcttttctgtgactggtgagtactcaaccaagtcattctgagaatagtgtatgcggcgaccgagttgctcttgcc cggcgtcaatacgggataataccgcgccacatagcagaactttaaaagtgctcatcattggaaaacgttcttcggggcgaaaactctcaaggatcttacc gctgttgagatccagttcgatgtaacccactcgtgcacccaactgatcttcagcatcttttactttcaccagcgtttctgggtgagcaaaaacaggaaggca aaatgccgcaaaaaagggaataagggcgacacggaaatgttgaatactcatactcttccttttcaatattattgaagcatttatcagggttattgtctcatga gcggatacatatttgaatgtatttagaaaaataaacaaataggggttccgcgcacatttccccgaaaagtgccacctgaaattgtaaacgttaatattttgtta aaattcgcgttaaatttttgttaaatcagctcatttttttaaccaataggccgaaatcggcaaaatcccttataaatcaaaagaatagaccgagatagggttgag tgttgttccagtttggaacaagagtccactattaaagaacgtggactccaacgtcaaagggcgaaaaaccgtctatcagggcgatggcccactacgtgaa ccatcaccctaatcaagttttttggggtcgaggtgccgtaaagcactaaatcggaaccctaaagggagcccccgatttagagcttgacggggaaagccg gcgaacgtggcgagaaaggaagggaagaaagcgaaaggagcgggcgctagggcgctggcaagtgtagcggtcacgctgcgcgtaaccaccaca cccgccgcgcttaatgcgccgctacagggcgcgtcccattcgcca

Table 48. CAR Hinge–Amino Acid Sequence	
SEQ ID NO	SEQUENCE
68	TTTPAPRPPTPAPTIASQPLSLRPEACRPAAGGAVHTRGLDFACD
69	D
70	ESKYGPPCPSCP
71	ESKYGPPCPPCP

Table 49. CAR containing hinge variant –Nucleotide Sequence	
SEQ ID NO	SEQUENCE
72	atggccttaccagtgaccgccttgctcctgccgctggccttgctgctccacgccgccaggccgGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGGGCT GTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTACTGGCCT GATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTTCCCTGATTG GGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGCGATCTATTTTTG CGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAACTGACAGTGCTGGGC GGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTCCGGGGGAGGCGGTTCT GATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTTCTCAGAGTCTGTCAATTAC ATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGAACTGGGTTCGTCAGAGCCCAG GCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGATGGAATCACAGACTACAATAGCGC ACTGAAATCTCGGCTGAGTGTTACCAAAGATAACAGCAAGTCCCAGGTCTTCCTGAAGATGA ACAGCCTGCAAAGCGGCGACTCCGCTCGCTATTACTGCGTTACCGGACTGTTTGATTATTGG GGGCAGGGGACAACTCTGACTGTTTCCTCCgatatctacatctgggcgcccttggccgggacttgtggggtccttctcctgtc actggttatcaccctttactgcaaacggggcagaaagaaactcctgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatg gctgtagctgccgatttccagaagaagaagaaggaggatgtgaactgagagtgaagttcagcaggagcgcagacgccccgcgtacaagcagggcc

Table 49. CAR containing hinge variant –Nucleotide Sequence	
SEQ ID NO	SEQUENCE
	agaaccagctctataacgagctcaatctaggacgaagagaggagtacgatgttttggacaagagacgtggccgggaccctgagatgggggaaagcc gagaaggaagaaccctcaggaaggcctgtacaatgaactgcagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgcc ggaggggcaaggggcacgatggcctttaccagggtctcagtacagccaccaaggacacctacgacgcccttcacatgcaggccctgccccctcgc
73	atggccttaccagtgaccgccttgctcctgccgctggccttgctgctccacgccgccaggccgGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGGGCT GTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTACTGGCCT GATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTTCCCTGATTG GGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGCGATCTATTTTTG CGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAACTGACAGTGCTGGGC GGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTCCGGGGGAGGCGGTTCT GATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTTCTCAGAGTCTGTCAATTAC ATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGAACTGGGTTCGTCAGAGCCCAG GCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGATGGAATCACAGACTACAATAGCGC ACTGAAATCTCGGCTGAGTGTTACCAAAGATAACAGCAAGTCCCAGGTCTTCCTGAAGATGA ACAGCCTGCAAAGCGGCGACTCCGCTCGCTATTACTGCGTTACCGGACTGTTTGATTATTGG GGGCAGGGGACAACTCTGACTGTTTCCTCCGAAAGCAAGTATGGCCCaCCTTGTCCAagcTGT CCCgatatctacatctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaactcc tgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaaggaggatgtga actgagagtgaagttcagcaggagcgcagacgcccccgcgtacaagcagggccagaaccagctctataacgagctcaatctaggacgaagagagga gtacgatgttttggacaagagacgtggccgggaccctgagatgggggaaagccgagaaggaagaaccctcaggaaggcctgtacaatgaactgca gaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccggaggggcaaggggcacgatggcctttaccagggtctcagtac agccaccaaggacacctacgacgcccttcacatgcaggccctgccccctcgc
74	atggccttaccagtgaccgccttgctcctgccgctggccttgctgctccacgccgccaggccgGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGGGCT GTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTACTGGCCT GATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTTCCCTGATTG GGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGCGATCTATTTTTG CGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAACTGACAGTGCTGGGC GGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTCCGGGGGAGGCGGTTCT GATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTTCTCAGAGTCTGTCAATTAC ATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGAACTGGGTTCGTCAGAGCCCAG GCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGATGGAATCACAGACTACAATAGCGC ACTGAAATCTCGGCTGAGTGTTACCAAAGATAACAGCAAGTCCCAGGTCTTCCTGAAGATGA ACAGCCTGCAAAGCGGCGACTCCGCTCGCTATTACTGCGTTACCGGACTGTTTGATTATTGG GGGCAGGGGACAACTCTGACTGTTTCCTCCGAAAGCAAGTATGGCCCaCCTTGTCCACCTTG TCCCgatatctacatctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaact cctgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaaggaggatgt gaactgagagtgaagttcagcaggagcgcagacgcccccgcgtacaagcagggccagaaccagctctataacgagctcaatctaggacgaagagag gagtacgatgttttggacaagagacgtggccgggaccctgagatgggggaaagccgagaaggaagaaccctcaggaaggcctgtacaatgaactg cagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccggaggggcaaggggcacgatggcctttaccagggtctcagt acagccaccaaggacacctacgacgcccttcacatgcaggccctgccccctcgc

Table 50. GCN4 epitope–Amino Acid Sequence	
SEQ ID NO	SEQUENCE
75	AYHLENEVARLKKL
76	AAHLENEVARLKKL
77	AAALENEVARLKKL
78	AAAAENEVARLKKL
79	NYHLENEVARLKKA
80	NYHLENEVARLKAA
81	NYHLENEVARLAAA
82	NYHLENEVARAAAA
83	LLPKNYHLENEVARLKKL
84	DLPQKYHLENEVARLKKL

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
85	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcGGCGGAGGCGGGAGCGGCGGAGGCGGGAGCGACAT CCAGATGACACAGACTACATCCTCCCTGTCTGCCTCTCTGGGAGACAGAGTCACCATCAGTT GCAGGGCAAGTCAGGACATTAGTAAATATTTAAATTGGTATCAGCAGAAACCAGATGGAAC TGTTAAACTCCTGATCTACCATACATCAAGATTACACTCAGGAGTCCCATCAAGGTTCAGTG GCAGTGGGTCTGGAACAGATTATTCTCTCACCATTAGCAACCTGGAGCAAGAAGATATTGCC ACTTACTTTTGCCAACAGGGTAATACGCTTCCGTACACGTTCGGAGGGGGGACCAAGCTTGA GATCaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcctgctgaataact tctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcAAGgac agcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcagggcctgtcct cgcccgtcacaaagagcttcaacaggggagagtgt
86	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcGGCGGAGGCGGGAGCGAGGTGAAACTGCAGGAGTCA GGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGTCACATGCACTGTCTCAGGGGTCTC ATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCCTCCACGAAAGGGTCTGGAGTGGCTGG GAGTAATATGGGGTAGTGAAACCACATACTATAATTCAGCTCTCAAATCCAGACTGACCATC ATCAAGGACAACTCCAAGAGCCAAGTTTTCTTAAAAATGAACAGTCTGCAAACTGATGACA CAGCCATTTACTACTGTGCCAAACATTATTACTACGGTGGTAGCTATGCTATGGACTACTGG GGCCAAGGAACCTCAGTCACCGTCTCCTCAgcctccaccaagggcccatcggtcttcccctggcaccctcctccaagagc acctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctgaccagcggc gtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcacccagacctacatctg caacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
87	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcGGCGGAGGCGGGAGCGGCGGAGGCGGGAGCGAGGT GAAACTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGTCACATGC ACTGTCTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCCTCCACGAAA GGGTCTGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATAATTCAGCTCTCA AATCCAGACTGACCATCATCAAGGACAACTCCAAGAGCCAAGTTTTCTTAAAAATGAACAG TCTGCAAACTGATGACACAGCCATTTACTACTGTGCCAAACATTATTACTACGGTGGTAGCT ATGCTATGGACTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCTCAgcctccaccaagggcccatcggt cttcccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgt ggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctcta gcagcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
88	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagccGAGGTGAAA CTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGTCACATGCACTGT CTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCCTCCACGAAAGGGTC TGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATAATTCAGCTCTCAAATCC AGACTGACCATCATCAAGGACAACTCCAAGAGCCAAGTTTTCTTAAAAATGAACAGTCTGC AAACTGATGACACAGCCATTTACTACTGTGCCAAACATTATTACTACGGTGGTAGCTATGCT ATGGACTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCTCAgcctccaccaagggcccatcggtcttcccct ggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactca ggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgg gcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
89	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcgccgaggccgccgcaaaggaagctgctgccaaggctGAGGTGAAACTGC AGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGTCACATGCACTGTCTCA GGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCCTCCACGAAAGGGTCTGGA GTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATAATTCAGCTCTCAAATCCAGAC TGACCATCATCAAGGACAACTCCAAGAGCCAAGTTTTCTTAAAAATGAACAGTCTGCAAACT GATGACACAGCCATTTACTACTGTGCCAAACATTATTACTACGGTGGTAGCTATGCTATGGA CTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCTCAgcctccaccaagggcccatcggtcttcccctggcaccct cctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccct gaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcaccca gacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
90	GAGGTGAAACTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGTCA CATGCACTGTCTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCCTCCA CGAAAGGGTCTGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATAATTCAG CTCTCAAATCCAGACTGACCATCATCAAGGACAACTCCAAGAGCCAAGTTTTCTTAAAAATG AACAGTCTGCAAACTGATGACACAGCCATTTACTACTGTGCCAAACATTATTACTACGGTGG TAGCTATGCTATGGACTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCTCAgcctccaccaagggc

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	ccatcggtcttcccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgac ggtgtcgtggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtccGGCGGGGGAGGCTCAAACTAC CACCTGGAGAATGAAGTCGCCAGACTGAAGAAACTGGGGGGAGGCGGGTCActctactccctcagca gcgtggtgactgtgccctctagcagcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgag cccaaatcttgt
91	GAGGTGAAACTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGTCA CATGCACTGTCTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCCTCCA CGAAAGGGTCTGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATAATTCAG CTCTCAAATCCAGACTGACCATCATCAAGGACAACTCCGGCGGAGGCGGGAGCaactatcacctgga aaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtAAGAGCCAAGTTTTCTTAAAAATGAACAGTCTG CAAACTGATGACACAGCCATTTACTACTGTGCCAAACATTATTACTACGGTGGTAGCTATGC TATGGACTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCTCAgcctccaccaagggcccatcggtcttcccc ctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactc aggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttg ggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
92	GAGGTGAAACTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGTCA CATGCACTGTCTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCCTCCA CGAAAGGGTCTGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATAATTCAG CTCTCAAATCCAGACTGACCATCATCAAGGACAACGGCGGAGGCGGGAGCaactatcacctggaaaac gaagtggcaaggctgaaaaaactgggcgggggcggaagtAGCCAAGTTTTCTTAAAAATGAACAGTCTGCAAACT GATGACACAGCCATTTACTACTGTGCCAAACATTATTACTACGGTGGTAGCTATGCTATGGA CTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCTCAgcctccaccaagggcccatcggtcttcccccctggcaccct cctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccct gaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcaccca gacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
93	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgGAGGCCGCCGCAAAGGAAGCAGCCGCCAAAGAGG CTGCCGCGAAAGCGGACATCCAGATGACACAGACTACATCCTCCCTGTCTGCCTCTCTGGGA GACAGAGTCACCATCAGTTGCAGGGCAAGTCAGGACATTAGTAAATATTTAAATTGGTATCA GCAGAAACCAGATGGAACTGTTAAACTCCTGATCTACCATACATCAAGATTACACTCAGGA GTCCCATCAAGGTTCAGTGGCAGTGGGTCTGGAACAGATTATTCTCTCACCATTAGCAACCT GGAGCAAGAAGATATTGCCACTTACTTTTGCCAACAGGGTAATACGCTTCCGTACACGTTCG GAGGGGGGACCAAGCTTGAGATCaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctg gaactgcctctgtcgtgtgcctgctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccagga gagtgtcacagagcaggacagcAAGgacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctac gcctgcgaagtcacccatcagggcctgtcctcgcccgtcacaaagagcttcaacaggggagagtgt
94	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgGGTTCCGCCGGTTCCGCAGCCGGCTCCGGAGAATT CGACATCCAGATGACACAGACTACATCCTCCCTGTCTGCCTCTCTGGGAGACAGAGTCACCA TCAGTTGCAGGGCAAGTCAGGACATTAGTAAATATTTAAATTGGTATCAGCAGAAACCAGA TGGAACTGTTAAACTCCTGATCTACCATACATCAAGATTACACTCAGGAGTCCCATCAAGGT TCAGTGGCAGTGGGTCTGGAACAGATTATTCTCTCACCATTAGCAACCTGGAGCAAGAAGAT ATTGCCACTTACTTTTGCCAACAGGGTAATACGCTTCCGTACACGTTCGGAGGGGGGACCAA GCTTGAGATCaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcctg ctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacag cAAGgacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcag ggcctgtcctcgcccgtcacaaagagcttcaacaggggagagtgt
95	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcGAGGCCGCCGCAAAGGAAGCAGCCGCCAAAGAGGCT GCCGCGAAAGCGGAGGTGAAACTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGA GCCTGTCCGTCACATGCACTGTCTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATT CGCCAGCCTCCACGAAAGGGTCTGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACAT ACTATAATTCAGCTCTCAAATCCAGACTGACCATCATCAAGGACAACTCCAAGAGCCAAGTT TTCTTAAAAATGAACAGTCTGCAAACTGATGACACAGCCATTTACTACTGTGCCAAACATTA TTACTACGGTGGTAGCTATGCTATGGACTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCT CAgcctccaccaagggcccatcggtcttcccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggact acttccccgaaccggtgacggtgtcgtggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccc tcagcagcgtggtgactgtgccctctagcagcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaa gttgagcccaaatcttgt
96	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcGGTTCCGCCGGTTCCGCAGCCGGCTCCGGAGAATTCG AGGTGAAACTGCAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCCTGTCCGTCAC

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	ATGCACTGTCTCAGGGGTCTCATTACCCGACTATGGTGTAAGCTGGATTCGCCAGCCTCCAC GAAAGGGTCTGGAGTGGCTGGGAGTAATATGGGGTAGTGAAACCACATACTATAATTCAGC TCTCAAATCCAGACTGACCATCATCAAGGACAACTCCAAGAGCCAAGTTTTCTTAAAAATGA ACAGTCTGCAAACTGATGACACAGCCATTTACTACTGTGCCAAACATTATTACTACGGTGGT AGCTATGCTATGGACTACTGGGGCCAAGGAACCTCAGTCACCGTCTCCTCAgcctccaccaagggccc atcggtcttcccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacgg tgtcgtggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgcc ctctagcagcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
97	GACATCCAGATGACACAGACTACATCCTCCCTGTCTGCCTCTCTGGGAGACAGAGTCACCAT CAGTTGCAGGGCAAGTCAGGACATTAGTAAATATTTAAATTGGTATCAGCAGAAACCAGAT GGAACTGTTAAACTCCTGATCTACCATACATCAAGATTACACTCAGGAGTCCCATCAAGGTT CAGTGGCAGTGGGTCTGGAACAGATTATTCTCTCACCATTAGCAACCTGGAGCAAGAAGAT ATTGCCACTTACTTTTGCCAACAGGGTAATACGCTTCCGTACACGTTCGGAGGGGGGACCAA GCTTGAGATCaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcctg ctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacag cAAGgacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcag ggcctgtcctcgcccgtcacaaagagcttcaacaggggagagtgtGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgt ctcaagaaactc
98	CTGCTGCCGAAAaattatcatcttgaaaatgaggtcgctcgtctcaagaaactcGGCGGAGGCGGGAGCGACATCCAG ATGACACAGACTACATCCTCCCTGTCTGCCTCTCTGGGAGACAGAGTCACCATCAGTTGCAG GGCAAGTCAGGACATTAGTAAATATTTAAATTGGTATCAGCAGAAACCAGATGGAACTGTT AAACTCCTGATCTACCATACATCAAGATTACACTCAGGAGTCCCATCAAGGTTCAGTGGCAG TGGGTCTGGAACAGATTATTCTCTCACCATTAGCAACCTGGAGCAAGAAGATATTGCCACTT ACTTTTGCCAACAGGGTAATACGCTTCCGTACACGTTCGGAGGGGGGACCAAGCTTGAGATC aaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcctgctgaataacttctatcc cagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcAAGgacagcac ctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcagggcctgtcctcgccc gtcacaaagagcttcaacaggggagagtgt
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Table 51. Switch Antibody Chains

SEQ ID NO	SEQUENCE
	accctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggc gccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggca cccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgtgacaaaactcacacataataag tcgaccgatgcccttgagagccttcaacccagtcagctccttccggtgggcgcggggcatgactatcgtcgccgcacttatgactgtcttctttatcatgca actcgtaggacaggtgccaaacggtctccagcttggctgttttggcggatgagagaagattttcagcctgatacagattaaatcagaacgcagaagcggt ctgataaaacagaatttgcctggcggcagtagcgcggtggtcccacctgaccccatgccgaactcagaagtgaaacgccgtagcgccgatggtagtgt ggggtctccccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatctgttgtttgtcggtg aacgctctcctgagtaggacaaatccgccgggagcggatttgaacgttgcgaagcaacggcccggagggtggcgggcaggacgcccgccataaact gccaggcatcaaattaagcagaaggccatcctgacggatggccttttgcgtttctacaaactctttttgtttatttttctaaatacattcaaatatgtatccgctc atgagacaataaccctgataaatgcttcaataatattgaaaaaggaagagtatgagtattcaacatttccgtgtcgcccttattcccttttttgcggcattttgcc ttcctgtttttgctcacccagaaacgctggtgaaagtaaaagatgctgaagatcagttgggtgcacgagtgggttacatcgaactggatctcaacagcggt aagatccttgagagttttcgccccgaagaacgttttccaatgatgagcacttttaaagttctgctatgtggcgcggtattatcccgtgttgacgccgggcaag agcaactcggtcgccgcatacactattctcagaatgacttggttgagtactcaccagtcacagaaaagcatcttacggatggcatgacagtaagagaatta tgcagtgctgccataaccatgagtgataacactgcggccaacttacttctgacaacgatcggaggaccgaaggagctaaccgcttttttgcacaacatgg gggatcatgtaactcgccttgatcgttgggaaccggagctgaatgaagccataccaaacgacgagcgtgacaccacgatgcctgtagcaatggcaaca acgttgcgcaaactattaactggcgaactacttactctagcttcccggcaacaattaatagactggatggaggcggataaagttgcaggaccacttctgcg ctcggcccttccggctggctggtttattgctgataaatctggagccggtgagcgtgggtctcgcggtatcattgcagcactggggccagatggtaagccct cccgtatcgtagttatctacacgacggggagtcaggcaactatggatgaacgaaatagacagatcgctgagataggtgcctcactgattaagcattggta actgtcagaccaagtttactcatatatactttagattgatttaaaacttcatttttaatttaaaaggatctaggtgaagatccttttgataatctcatgaccaaaatc ccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaaggatcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaaaca aaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgcagataccaaatac tgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgctgccagt ggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcggtcgggctgaacgggggttcgtgcacacagccca gcttggagcgaacgacctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatc cggtaagcggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctga cttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggcctttttacggttcctggccttttgctggccttttg ctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgca gcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtaca atctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgc gccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaa cgcgcgaggcagcagatcaattcgcgcgcgaaggcgaagcggcatgcataatgtgcctgtcaaatggacgaagcagggattctgcaaaccctatgct actccgtcaagccgtcaattgtctgattcgttaccaattatgacaacttgacggctacatcattcacttttttcttcacaaccggcacggaactcgctcgggctg gccccggtgcatttttttaaataccgcgagaaatagagttgatcgtcaaaaccaacattgcgaccgacggtggcgataggcatccgggtggtgctcaaaa gcagcttcgcctggctgatacgttggtcctcgcgccagcttaagacgctaatccctaactgctggcggaaaagatgtgacagacgcgacggcgacaag caaacatgctgtgcgacgctggcgatatcaaaattgctgtctgccaggtgatcgctgatgtactgacaagcctcgcgtacccgattatccatcggtggatg gagcgactcgttaatcgcttccatgcgccgcagtaacaattgctcaagcagatttatcgccagcagctccgaatagcgcccttcccccttgcccggcgttaa tgatttgcccaaacaggtcgctgaaatgcggctggtgcgcttcatccgggcgaaagaaccccgtattggcaaatattgacggccagttaagccattcatg ccagtaggcgcgcggacgaaagtaaacccactggtgataccattcgcgagcctccggatgacgaccgtagtgatgaatctctcctggcgggaacagc aaaatatcacccggtcggcaaacaaattctcgtccctgatttttcaccaccccctgaccgcgaatggtgagattgagaatataacctttcattcccagcggtc ggtcgataaaaaaatcgagataaccgttggcctcaatcggcgttaaacccgccaccagatgggcattaaacgagtatcccggcagcaggggatcatttt gcgcttcagccatacttttcatactcccgccattcagag
101	aagaaaccaattgtccatattgcatcagacattgccgtcactgcgtctttactggctcttctcgctaaccaaaccggtaaccctgattatttgcacggagtca cactttgctatgccatagcatttttatccataagattagcggatcctacctgacgcttttttatcgcaactctctactgtttctccatacccgtttttttgggctagaa ataatttttgtttaactttaagaaggagaatacatcaactagtacgcaagttcacgtaaaaagggtatctagaggttgaggtgattttatgaaaaagaatatcgc atttcttcttgctagcatgttcgtttttttctattgctacaaacgcatacgctAACTACCATCTGGAAAACGAAGTTGCGCGCCTG AAAAAACTGGGTGGCGGTGGCAGCGATATTCAGATGACGCAGACCACCTCATCTCTCAGCG CGTCCTTAGGTGATCGCGTAACAATTTCCTGTCGTGCCTCTCAGGATATTAGCAAGTACCTG AATTGGTATCAGCAGAAGCCTGATGGGACCGTTAAACTTCTCATTTATCACACTAGTCGTCT GCATTCGGGCGTTCCATCCCGGTTCTCCGGTTCTGGTTCGGGCACTGACTACTCGTTAACCAT CTCGAATCTGGAACAGGAGGATATTGCAACCTATTTTTGTCAGCAAGGTAATACGCTGCCGT ACACGTTCGGCGGAGGTACGaagcttGAAATCAAACGCACCGTCGCGGCGCCGAGCGTGTTTAT CTTCCCGCCGAGTGATGAACAGCTCAAAAGCGGTACTGCCAGCGTTGTTTGCTTACTCAACA ATTTTTATCCACGGGAGGCCAAAGTTCAATGGAAAGTTGACAACGCACTGCAGAGCGGTAA CAGTCAAGAATCTGTCACGGAGCAAGACTCGAAAGACAGCACCTACAGCTTATCCAGCACC CTGACGCTTTCGAAAGCGGACTACGAAAAGCACAAAGTTTATGCATGTGAAGTGACCCATC AGGGCCTTTCCTCACCGGTGACCAAATCATTTAACCGTGGCGAGTGCtaagctggggatcctctagaggttg aggtgattttatgaaaaagaatatcgcatttcttcttgcatctatgttcgtttttctattgctacaaacgcgtacgctGAGGTTAAGTTGCAGGA GTCAGGCCCGGGTTTAGTGGCACCTTCTCAGTCCTTGTCAGTGACATGCACGGTTAGCGGCG

Table 51. Switch Antibody Chains

SEQ ID NO	SEQUENCE
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102	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagccGATATCCAG CTGCAGGAGTCCGGACCAGGTCTGGTGAAGCCCAGCCAGTCCCTGTCTCTGACCTGCAGCGT CACTGGCTATTCCATCACCAGTGCATACTATTGGAACTGGATCAGACAGTTCCCTGGAAACA AACTGGAGTGGATGGGGTACATCTCTTACGACGGTAGAAACAACTACAACCCCAGCCTCAA AAACAGGATTAGCATTACCCGCGACACTAGTAAGAACCAGTTTTTCCTGAAGCTCAACAGTG TGACAACTGAGGACACTGCTACTTATTATTGTGCCAAGGAGGGCGACTATGATGTCGGCAAT TATTACGCTATGGACTATTGGGGTCAGGGGACTAGCGTGACCGTCAGTTCTGCCAGGACCAA AGGACCGTCCGTCTTTCCTCTGGCCCCTTCCTCTAAGTCCACAAGCGGTGGGACCGCAGCAC TGGGATGCCTGGTGAAGGATTACTTCCCTGAGCCGGTGACCGTGTCCTGGAACTCCGGAGCT CTCACCTCCGGTGTCCATACCTTTCCTGCCGTCCTGCAGTCCTCCGGCCTGTACAGCCTCTCT

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	AGCGTCGTGACTGTGCCCTCCAGCTCCCTGGGCACCCAAACTTATATCTGCAATGTTAACCA CAAGCCTTCTAATACCAAGGTCGACAAGAAAGTGGAGCCGAAGAGCTGT
103	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtGAAAACGTGCTCACCCAGAGTCCC GCCATCATGAGCGCCAGTCCCGGCGAGAAGGTGACCATGACCTGTAGGGCCTCTTCCAATGT GATCTCTAGCTACGTGCATTGGTACCAGCAGCGTAGTGGGGCCAGCCCTAAGCTCTGGATTT ACTCCACCTCCAACCTGGCCTCCGGGGTCCCCGCCCGTTTCTCTGGCAGTGGCTCTGGTACCT CTTACTCCCTGACTATCAGCAGCGTCGAGGCCGAGGATGCCGCTACATACTACTGTCAGCAG TACAGTGGATACCCTCTGACCTTCGGGGCTGGCACCAAGCTGGAGCTGAAGCGCGCTGCCGC CGCCCCCAGTGTCTTCATTTTCCCCCCTTCCGATGAGCAGCTGAAGAGCGGTACAGCCTCTGT TGTTTGTCTGCTGAACAACTTCTATCCACGCGAGGCCAAGGTGCAGTGGAAAGTTGATAACG CGCTGCAGAGTGGCAACTCCCAGGAGTCTGTGACAGAGCAGGACAGTAAAGACAGCACATA TTCCCTGTCTAGCACACTGACTCTGTCCAAGGCTGACTATGAGAAGCACAAGGTGTACGCTT GCGAGGTCACCCACCAGGGACTGAGTTCTCCTGTGACCAAGTCCTTCAATCGCGGCGAGTGT
104	GATATCCAGCTGCAGGAGTCCGGACCAGGTCTGGTGAAGCCCAGCCAGTCCCTGTCTCTGAC CTGCAGCGTCACTGGCTATTCCATCACCAGTGCATACTATTGGAACTGGATCAGACAGTTCC CTGGAAACAAACTGGAGTGGATGGGGTACATCTCTTACGACGGTAGAAACAACTACAACCC CAGCCTCAAAAACAGGATTAGCATTACCCGCGACACTAGTAAGAACCAGTTTTTCCTGAAGC TCAACAGTGTGACAACTGAGGACACTGCTACTTATTATTGTGCCAAGGAGGGCGACTATGAT GTCGGCAATTATTACGCTATGGACTATTGGGGTCAGGGGACTAGCGTGACCGTCAGTTCTGC CAGGACCAAAGGACCGTCCGTCTTTCCTCTGGCCCCTTCCTCTAAGTCCACAAGCGGTGGGA CCGCAGCACTGGGATGCCTGGTGAAGGATTACTTCCCTGAGCCGGTGACCGTGTCCTGGAAC TCCGGAGCTCTCACCTCCGGTGTCCATACCTTTCCTGCCGTCCTGCAGTCCTCCGGCCTGTAC AGCCTCTCTAGCGTCGTGACTGTGCCCTCCAGCTCCCTGGGCACCCAAACTTATATCTGCAAT GTTAACCACAAGCCTTCTAATACCAAGGTCGACAAGAAAGTGGAGCCGAAGAGCTGTGGCG GAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactc
105	GAAAACGTGCTCACCCAGAGTCCCGCCATCATGAGCGCCAGTCCCGGCGAGAAGGTGACCA TGACCTGTAGGGCCTCTTCCAATGTGATCTCTAGCTACGTGCATTGGTACCAGCAGCGTAGT GGGGCCAGCCCTAAGCTCTGGATTTACTCCACCTCCAACCTGGCCTCCGGGGTCCCCGCCCG TTTCTCTGGCAGTGGCTCTGGTACCTCTTACTCCCTGACTATCAGCAGCGTCGAGGCCGAGG ATGCCGCTACATACTACTGTCAGCAGTACAGTGGATACCCTCTGACCTTCGGGGCTGGCACC AAGCTGGAGCTGAAGCGCGCTGCCGCCGCCCCCAGTGTCTTCATTTTCCCCCCTTCCGATGA GCAGCTGAAGAGCGGTACAGCCTCTGTTGTTTGTCTGCTGAACAACTTCTATCCACGCGAGG CCAAGGTGCAGTGGAAAGTTGATAACGCGCTGCAGAGTGGCAACTCCCAGGAGTCTGTGAC AGAGCAGGACAGTAAAGACAGCACATATTCCCTGTCTAGCACACTGACTCTGTCCAAGGCT GACTATGAGAAGCACAAGGTGTACGCTTGCGAGGTCACCCACCAGGGACTGAGTTCTCCTGT GACCAAGTCCTTCAATCGCGGCGAGTGTGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtc tcaagaaactc
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107	gacatccagatgacccagtctccatcgtccctgtctgcatctgtaggagacagagtcaccatcacttgccgggcaagccagaccatttggagctacttaaa ttggtatcagcagagaccagggaaagccccctaacctcctgatctatgctgcatccagtttgcaaagtggggtcccatcaaggttcagtggcaggggatct gggacagatttcactctcaccatcagcagtctgcaagctgaagattttgcaacttactactgtcaacagagttacagtatccctcagacttttggccagggg accaagctggagatcaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcctg ctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacag caaggacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcaggg cctgtcctcgcccgtcacaaagagcttcaacaggggagagtgt
108	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagcccaggtacagctgcag cagtcaggtccaggactggtgaagccctcgcagaccctctcactcacctgtgccatctccggggacagtgtctctagcaacagtgctgcttggaactgga tcaggcagtccccatcgagaggccttgagtggctgggaaggacatactacaggtccaagtggtataatgattatgcagtatctgtgaaaagtcgaataac catcaacccagacacatccaagaaccagttctccctgcagctgaactctgtgactcccgaggacacggctgtgtattactgtgcaagagaagtgactggg gatctcgaggatgcttttgatatctggggccaagggacaatggtcaccgtctcctcagcctccaccaagggcccatcggtcttcccctggcaccctcctc caagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctgacc agcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcacccagacct

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	acatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
109	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtgacatccagatgacccagtctccatcgtccctgtctgcatc tgtaggagacagagtcaccatcacttgccgggcaagccagaccatttggagctacttaaattggtatcagcagagaccagggaaagcccctaacctcct gatctatgctgcatccagtttgcaaagtggggtcccatcaaggttcagtggcaggggatctgggacagatttcactctcaccatcagcagtctgcaagctg aagattttgcaacttactactgtcaacagagttacagtatccctcagacttttggccaggggaccaagctggagatcaaacgaactgtggctgcaccatctg tcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcctgctgaataacttctatcccagagaggccaaagtacagtggaa ggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcaaggacagcacctacagcctcagcagcaccctgacgct gagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcagggcctgtcctcgcccgtcacaaagagcttcaacaggggaga gtgt
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112	GAGGTGCAACTCGTTCAGAGCGGGGGCGGCGTCGTCAGGCCTGGCGGCTCCCTCCGTCTGCC TTGTGCTGCCTCCGGCTTTACCTTCGACGATTACGGAATGTCCTGGGTTCGCCAGGCTCCTGG CAAGGGTCTGGAGTGGGTCTCTGGCATCAACTGGAATGGCGGCAGCACCGGTTATGCTGAC AGTGTGAAGGGGAGGTTCACAATTAGCCGGGACAATGCCAAGAACAGCCTGTACCTGCAGA TGAACTCCCTGCGTGCTGAGGACACCGCTCTGTATCACTGCGCGAGAGGCGGTGACGACGCC TTTGACATTTGGGGCCAGGGTACCATGGTTACAGTGAGCTCTGCTAGCACCAAGGGCCCGAG CGTCTTCCCTCTGGCCCCCAGCTCTAAATCTACTTCCGGGGGCACCGCCGCCCTCGGGTGCCT GGTGAAGGACTATTTCCCTGAGCCTGTGACAGTGAGCTGGAACTCCGGAGCATTGACTTCTG GTGTGCACACTTTCCCCGCTGTGCTGCAGTCCTCTGGACTGTATTCCCTGTCCTCCGTGGTGA CTGTCCCAAGCTCCTCTCTGGGGACACAGACATACATCTGTAATGTGAACCACAAACCGTCC AACACTAAGGTGGACAAGAAAGTGGAACCAAAGTCTTGT
113	CGGATCGTTATGACACAGTCCCCGGGCACCCTGAGCGTCAGCCCCGGAGAGACCGCTACAC TCTCCTGCAGGGCCTCCCAGTCTTTTAGCAACATGCTCGCGTGGTACCAACAGAAGAGCGGA CAACCACCTCGCCTGCTCATTTATGGCGTTTCTACCCGGGCAGCTGGGGTGCCTGCGCGGTT CTCTGGCTCCGGGTCCGGAACTGAGTTTACTCTGACAATTAGCAACCTCCAATCCGAGGACT TTGCTGTCTACTACTGTCAACAATACGGAGACTGGCCGCGCTACACCTTTGGCCAAGGGACT AAAGTGGAAAGAAAGCGTACAGTTGCCGCTCCTAGCGTCTTCATCTTCCCCCCCTCTGATGA GCAGTTGAAGTCCGGAACCGCCTCCGTGGTGTGTCTGCTGAACAACTTCTACCCCCGCGAGG CTAAGGTGCAGTGGAAGGTCGATAACGCCTTGCAATCTGGGAACTCTCAGGAAAGCGTGAC AGAGCAGGACTCCAAAGACAGCACCTATAGCCTGAGCTCTACTCTGACCCTGAGCAAGGCT GACTACGAGAAACATAAGGTTTACGCATGCGAGGTGACCCACCAGGGACTGAGTAGTCCTG TCACCAAGAGTTTCAATCGTGGCGAATGT
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Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	AGGTGGACAAGAAAGTGGAACCAAAGTCTTGT
115	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtCGGATCGTTATGACACAGTCCCCGG GCACCCTGAGCGTCAGCCCCGGAGAGACCGCTACACTCTCCTGCAGGGCCTCCCAGTCTTTT AGCAACATGCTCGCGTGGTACCAACAGAAGAGCGGACAACCACCTCGCCTGCTCATTTATG GCGTTTCTACCCGGGCAGCTGGGGTGCCTGCGCGGTTCTCTGGCTCCGGGTCCGGAACTGAG TTTACTCTGACAATTAGCAACCTCCAATCCGAGGACTTTGCTGTCTACTACTGTCAACAATAC GGAGACTGGCCGCGCTACACCTTTGGCCAAGGGACTAAAGTGGAAAGAAAGCGTACAGTTG CCGCTCCTAGCGTCTTCATCTTCCCCCCCTCTGATGAGCAGTTGAAGTCCGGAACCGCCTCCG TGGTGTGTCTGCTGAACAACTTCTACCCCCGCGAGGCTAAGGTGCAGTGGAAGGTCGATAAC GCCTTGCAATCTGGGAACTCTCAGGAAAGCGTGACAGAGCAGGACTCCAAAGACAGCACCT ATAGCCTGAGCTCTACTCTGACCCTGAGCAAGGCTGACTACGAGAAACATAAGGTTTACGCA TGCGAGGTGACCCACCAGGGACTGAGTAGTCCTGTCACCAAGAGTTTCAATCGTGGCGAAT GT
116	GAGGTGCAACTCGTTCAGAGCGGGGGCGGCGTCGTCAGGCCTGGCGGCTCCCTCCGTCTGCC TTGTGCTGCCTCCGGCTTTACCTTCGACGATTACGGAATGTCCTGGGTTCGCCAGGCTCCTGG CAAGGGTCTGGAGTGGGTCTCTGGCATCAACTGGAATGGCGGCAGCACCGGTTATGCTGAC AGTGTGAAGGGGAGGTTCACAATTAGCCGGGACAATGCCAAGAACAGCCTGTACCTGCAGA TGAACTCCCTGCGTGCTGAGGACACCGCTCTGTATCACTGCGCGAGAGGCGGTGACGACGCC TTTGACATTTGGGGCCAGGGTACCATGGTTACAGTGAGCTCTGCTAGCACCAAGGGCCCGAG CGTCTTCCCTCTGGCCCCCAGCTCTAAATCTACTTCCGGGGGCACCGCCGCCCTCGGGTGCCT GGTGAAGGACTATTTCCCTGAGCCTGTGACAGTGAGCTGGAACTCCGGAGCATTGACTTCTG GTGTGCACACTTTCCCCGCTGTGCTGCAGTCCTCTGGACTGTATTCCCTGTCCTCCGTGGTGA CTGTCCCAAGCTCCTCTCTGGGGACACAGACATACATCTGTAATGTGAACCACAAACCGTCC AACACTAAGGTGGACAAGAAAGTGGAACCAAAGTCTTGT
117	CGGATCGTTATGACACAGTCCCCGGGCACCCTGAGCGTCAGCCCCGGAGAGACCGCTACAC TCTCCTGCAGGGCCTCCCAGTCTTTTAGCAACATGCTCGCGTGGTACCAACAGAAGAGCGGA CAACCACCTCGCCTGCTCATTTATGGCGTTTCTACCCGGGCAGCTGGGGTGCCTGCGCGGTT CTCTGGCTCCGGGTCCGGAACTGAGTTTACTCTGACAATTAGCAACCTCCAATCCGAGGACT TTGCTGTCTACTACTGTCAACAATACGGAGACTGGCCGCGCTACACCTTTGGCCAAGGGACT AAAGTGGAAAGAAAGCGTACAGTTGCCGCTCCTAGCGTCTTCATCTTCCCCCCCTCTGATGA GCAGTTGAAGTCCGGAACCGCCTCCGTGGTGTGTCTGCTGAACAACTTCTACCCCCGCGAGG CTAAGGTGCAGTGGAAGGTCGATAACGCCTTGCAATCTGGGAACTCTCAGGAAAGCGTGAC AGAGCAGGACTCCAAAGACAGCACCTATAGCCTGAGCTCTACTCTGACCCTGAGCAAGGCT GACTACGAGAAACATAAGGTTTACGCATGCGAGGTGACCCACCAGGGACTGAGTAGTCCTG TCACCAAGAGTTTCAATCGTGGCGAATGTGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgt ctcaagaaactc
118	GAAGTGCAACTGCAGCAGTCCGGGACTGTGCTGGCCCGTCCCGGAGCAAGCGTCAAGATGA GCTGTAAGGCGTCTGGGTACAGGTTCACCAATTACTGGATCCACTGGGTGAAACAAAGGCC AGGTCAGGGTCTGGAATGGATTGGTGGCATCAACCCAGGAAATAACTATACCACTTACAAA CGTAACCTGAAAGGCAAGGCCACCCTGACTGCCGTTACAAGCGCCAGCACTGCTTATATGG ATCTGAGCAGTCTCACCTCCGAGGATTCCGCTGTGTACTACTGCACACGCGAAGGCTACGGT AACTATGGCGCCTGGTTCGCCTACTGGGGCCAGGGCACCTTGGTTACCGTGTCCTCTGCGTC CACCAAGGGACCAAGCGTGTTTCCCCTCGCCCCAAGCAGCAAGAGCACTTCTGGCGGCACT GCGGCTTTGGGCTGCCTGGTCAAAGATTACTTTCCCGAGCCCGTTACCGTGAGCTGGAACTC CGGAGCTCTGACCTCCGGCGTTCATACCTTTCCGGCGGTGCTGCAGTCCTCTGGCCTGTATTC TCTGTCCTCTGTCGTCACCGTTCCTTCCTCCTCCCTCGGAACCCAAACCTACATCTGTAACGT GAACCACAAACCCTCTAACACAAAGGTTGACAAGAAGGTTGAGCCAAAATCCTGT
119	GATGTGGTCGTGACCCAGACTCCACTGTCTCTGCCTGTGAGTTTCGGTGACCAAGTCAGCAT TTCTTGCAGAAGTTCTCAATCCCTGGCTAACTCTTACGGTAACACCTTTCTGTCTTGGTATCT GGACAAACCTGGCGAGAGCCCTCAGCTGCTGATCTACGGCATCAGCAACCGGTTCAGCGGT GTCCCCGACCGCTTCACCGGTTCTGGCTCCGGCACTGACTTCACACTGAAGATCTCTACTATC AAACCAGAAGACTTGGGCATGTACTATTGTTTGGAAGGCACCCACCAGCCATATACTTTCGG TGGCGGCACAAAGCTGGAGATCAAACGCACCGTCGCCGCCCCTTCCGTGTTCATCTTTCCTC CTTCCGACGAACAGCTGAAGAGTGGCACAGCATCTGTGGTCTGCCTGCTGAACAATTTCTAC CCTAGAGAGGCCAAGGTCCAGTGGAAGGTGGACAATGCACTCCAGTCCGGGAACTCTCAGG AGAGTGTGACAGAGCAGGATTCTAAGGATTCCACTTACTCCCTGAGCTCTACATTGACTCTG TCCAAAGCCGACTACGAAAAGCATAAGGTTTACGCGTGTGAAGTGACCCACCAGGGCCTGT CCAGCCCTGTGACCAAGAGTTTTAACCGGGGGGAGTGC

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
120	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagccGAAGTGCAA CTGCAGCAGTCCGGGACTGTGCTGGCCCGTCCCGGAGCAAGCGTCAAGATGAGCTGTAAGG CGTCTGGGTACAGGTTCACCAATTACTGGATCCACTGGGTGAAACAAAGGCCAGGTCAGGG TCTGGAATGGATTGGTGGCATCAACCCAGGAAATAACTATACCACTTACAAACGTAACCTGA AAGGCAAGGCCACCCTGACTGCCGTTACAAGCGCCAGCACTGCTTATATGGATCTGAGCAGT CTCACCTCCGAGGATTCCGCTGTGTACTACTGCACACGCGAAGGCTACGGTAACTATGGCGC CTGGTTCGCCTACTGGGGCCAGGGCACCTTGGTTACCGTGTCCTCTGCGTCCACCAAGGGAC CAAGCGTGTTTCCCCTCGCCCCAAGCAGCAAGAGCACTTCTGGCGGCACTGCGGCTTTGGGC TGCCTGGTCAAAGATTACTTTCCCGAGCCCGTTACCGTGAGCTGGAACTCCGGAGCTCTGAC CTCCGGCGTTCATACCTTTCCGGCGGTGCTGCAGTCCTCTGGCCTGTATTCTCTGTCCTCTGT CGTCACCGTTCCTTCCTCCTCCCTCGGAACCCAAACCTACATCTGTAACGTGAACCACAAAC CCTCTAACACAAAGGTTGACAAGAAGGTTGAGCCAAAATCCTGT
121	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtGATGTGGTCGTGACCCAGACTCCAC TGTCTCTGCCTGTGAGTTTCGGTGACCAAGTCAGCATTTCTTGCAGAAGTTCTCAATCCCTGG CTAACTCTTACGGTAACACCTTTCTGTCTTGGTATCTGGACAAACCTGGCGAGAGCCCTCAG CTGCTGATCTACGGCATCAGCAACCGGTTCAGCGGTGTCCCCGACCGCTTCACCGGTTCTGG CTCCGGCACTGACTTCACACTGAAGATCTCTACTATCAAACCAGAAGACTTGGGCATGTACT ATTGTTTGGAAGGCACCCACCAGCCATATACTTTCGGTGGCGGCACAAAGCTGGAGATCAA ACGCACCGTCGCCGCCCCTTCCGTGTTCATCTTTCCTCCTTCCGACGAACAGCTGAAGAGTG GCACAGCATCTGTGGTCTGCCTGCTGAACAATTTCTACCCTAGAGAGGCCAAGGTCCAGTGG AAGGTGGACAATGCACTCCAGTCCGGGAACTCTCAGGAGAGTGTGACAGAGCAGGATTCTA AGGATTCCACTTACTCCCTGAGCTCTACATTGACTCTGTCCAAAGCCGACTACGAAAAGCAT AAGGTTTACGCGTGTGAAGTGACCCACCAGGGCCTGTCCAGCCCTGTGACCAAGAGTTTTAA CCGGGGGGAGTGC
122	GAAGTGCAACTGCAGCAGTCCGGGACTGTGCTGGCCCGTCCCGGAGCAAGCGTCAAGATGA GCTGTAAGGCGTCTGGGTACAGGTTCACCAATTACTGGATCCACTGGGTGAAACAAAGGCC AGGTCAGGGTCTGGAATGGATTGGTGGCATCAACCCAGGAAATAACTATACCACTTACAAA CGTAACCTGAAAGGCAAGGCCACCCTGACTGCCGTTACAAGCGCCAGCACTGCTTATATGG ATCTGAGCAGTCTCACCTCCGAGGATTCCGCTGTGTACTACTGCACACGCGAAGGCTACGGT AACTATGGCGCCTGGTTCGCCTACTGGGGCCAGGGCACCTTGGTTACCGTGTCCTCTGCGTC CACCAAGGGACCAAGCGTGTTTCCCCTCGCCCCAAGCAGCAAGAGCACTTCTGGCGGCACT GCGGCTTTGGGCTGCCTGGTCAAAGATTACTTTCCCGAGCCCGTTACCGTGAGCTGGAACTC CGGAGCTCTGACCTCCGGCGTTCATACCTTTCCGGCGGTGCTGCAGTCCTCTGGCCTGTATTC TCTGTCCTCTGTCGTCACCGTTCCTTCCTCCTCCCTCGGAACCCAAACCTACATCTGTAACGT GAACCACAAACCCTCTAACACAAAGGTTGACAAGAAGGTTGAGCCAAAATCCTGTGGCGGA GGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactctaa
123	GATGTGGTCGTGACCCAGACTCCACTGTCTCTGCCTGTGAGTTTCGGTGACCAAGTCAGCAT TTCTTGCAGAAGTTCTCAATCCCTGGCTAACTCTTACGGTAACACCTTTCTGTCTTGGTATCT GGACAAACCTGGCGAGAGCCCTCAGCTGCTGATCTACGGCATCAGCAACCGGTTCAGCGGT GTCCCCGACCGCTTCACCGGTTCTGGCTCCGGCACTGACTTCACACTGAAGATCTCTACTATC AAACCAGAAGACTTGGGCATGTACTATTGTTTGGAAGGCACCCACCAGCCATATACTTTCGG TGGCGGCACAAAGCTGGAGATCAAACGCACCGTCGCCGCCCCTTCCGTGTTCATCTTTCCTC CTTCCGACGAACAGCTGAAGAGTGGCACAGCATCTGTGGTCTGCCTGCTGAACAATTTCTAC CCTAGAGAGGCCAAGGTCCAGTGGAAGGTGGACAATGCACTCCAGTCCGGGAACTCTCAGG AGAGTGTGACAGAGCAGGATTCTAAGGATTCCACTTACTCCCTGAGCTCTACATTGACTCTG TCCAAAGCCGACTACGAAAAGCATAAGGTTTACGCGTGTGAAGTGACCCACCAGGGCCTGT CCAGCCCTGTGACCAAGAGTTTTAACCGGGGGGAGTGCGGCGGAGGCGGGAGCaattatcatcttga aaatgaggtcgctcgtctcaagaaactc
124	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagcccaggtgcagctgcag cagccgggcgcggaactggtgaaaccgggcgcgagcgtgaaaatgagctgcaaagcgagcggctatacctttaccagctataacatgcattgggtga aacagaccccgggccgcggcctggaatggattggcgcgatttatccgggcaacggcgataccagctataaccagaaatttaaaggcaaagcgaccct gaccgcggataaaagcagcagcaccgcgtatatgcagctgagcagcctgaccagcgaagatagcgcggtgtattattgcgcgcgcagcacctattatg gcggcgattggtattttaacgtgtggggcgcgggcaccaccgtgaccgtgagcgcggcgagcaccaagggcccatcggtcttcccccctggcaccctc ctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctg accagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcacccag acctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
125	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtcagattgtgctgagccagagcccggcgattctgagcgcg agcccgggcgaaaaagtgaccatgacctgccgcgcgagcagcagcgtgagctatattcattggtttcagcagaaaccgggcagcagcccgaaaccgt

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
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126	caggtgcagctgcagcagccgggcgcggaactggtgaaaccgggcgcgagcgtgaaaatgagctgcaaagcgagcggctatacctttaccagctat aacatgcattgggtgaaacagaccccgggccgcggcctggaatggattggcgcgatttatccgggcaacggcgataccagctataaccagaaatttaa aggcaaagcgaccctgaccgcggataaaagcagcagcaccgcgtatatgcagctgagcagcctgaccagcgaagatagcgcggtgtattattgcgcg cgcagcacctattatggcggcgattggtattttaacgtgtggggcgcgggcaccaccgtgaccgtgagcgcggcgagcaccaagggcccatcggtctt ccccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtgg aactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagca gcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgtGGCGGAG GCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactc
127	cagattgtgctgagccagagcccggcgattctgagcgcgagcccgggcgaaaaagtgaccatgacctgccgcgcgagcagcagcgtgagctatattc attggtttcagcagaaaccgggcagcagcccgaaaccgtggatttatgcgaccagcaacctggcgagcggcgtgccggtgcgctttagcggcagcgg cagcggcaccagctatagcctgaccattagccgcgtggaagcggaagatgcggcgacctattattgccagcagtggaccagcaacccgccgacctttg gcggcggcaccaagcttgagatcaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtc gtgtgcctgctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagag caggacagcaaggacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacc catcagggcctgtcctcgcccgtcacaaagagcttcaacaggggagagtgtGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtc gctcgtctcaagaaactc
128	CAAGTGCAGCTCGTGCAGAGTGGCGCAGAGGTGAAGAAACCTGGCTCAAGTGTTAAGGTGT CCTGTAAGGCTAGTGGCTACGCTTTTTCTTACAGTTGGATCAACTGGGTTCGCCAAGCCCCC GGGCAGGGATTGGAATGGATGGGCAGGATCTTTCCAGGCGATGGAGACACTGACTATAACG GCAAGTTTAAGGGCAGGGTGACAATCACGGCGGACAAAAGCACAAGCACTGCCTACATGGA GCTGAGCTCACTGCGGTCAGAGGACACGGCTGTATATTACTGCGCCAGGAACGTGTTCGATG GCTACTGGCTGGTGTATTGGGGGCAGGGCACGCTTGTGACTGTTAGCAGCGCAAGTACTAAG GGTCCATCAGTGTTCCCACTGGCTCCATCCTCTAAGTCAACGTCTGGCGGTACAGCAGCTCTT GGCTGTCTCGTTAAGGACTATTTTCCGGAGCCTGTGACCGTCAGTTGGAATTCTGGCGCACT GACGTCAGGAGTGCATACTTTTCCTGCCGTCCTGCAGAGTTCCGGACTGTACAGCCTTTCCTC CGTCGTGACTGTTCCATCCAGCAGCCTGGGAACCCAGACCTATATTTGTAACGTGAACCACA AGCCCTCAAACACCAAGGTTGACAAGAAGGTGGAGCCTAAGAGTTGT
129	GATATAGTAATGACACAAACGCCTCTGTCTCTTCCTGTCACGCCCGGCGAACCAGCCTCCAT ATCCTGCAGATCATCTAAAAGTCTTCTCCACTCCAACGGAATTACGTATTTGTACTGGTATTT GCAGAAGCCTGGGCAGTCTCCCCAACTGCTGATTTATCAGATGTCTAACTTGGTAAGCGGGG TGCCCGATAGGTTTTCAGGGTCCGGAAGCGGCACAGATTTCACGCTGAAGATCAGCAGAGT GGAAGCCGAGGACGTGGGCGTGTATTATTGCGCGCAGAATTTGGAGCTCCCATATACCTTCG GAGGTGGGACCAAGGTAGAAATCAAGCGAACTGTCAGGACTGTCGCTGCCCCGAGCGTTTT CATCTTCCCCCCGTCTGACGAACAGCTTAAAAGCGGCACTGCAAGCGTGGTGTGCCTGCTTA ACAATTTCTATCCCAGAGAAGCGAAGGTTCAGTGGAAGGTGGATAACGCCCTGCAATCTGG CAATAGCCAGGAGTCCGTTACAGAACAAGATTCAAAAGACTCAACGTACTCTCTGTCCTCCA CACTGACCCTGAGCAAAGCTGATTACGAAAAACATAAGGTTTACGCCTGCGAGGTCACACA CCAGGGGCTTTCTAGTCCGGTGACTAAATCTTTTAACCGCGGGGAATGT
130	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagccCAAGTGCAG CTCGTGCAGAGTGGCGCAGAGGTGAAGAAACCTGGCTCAAGTGTTAAGGTGTCCTGTAAGG CTAGTGGCTACGCTTTTTCTTACAGTTGGATCAACTGGGTTCGCCAAGCCCCCGGGCAGGGA TTGGAATGGATGGGCAGGATCTTTCCAGGCGATGGAGACACTGACTATAACGGCAAGTTTA AGGGCAGGGTGACAATCACGGCGGACAAAAGCACAAGCACTGCCTACATGGAGCTGAGCTC ACTGCGGTCAGAGGACACGGCTGTATATTACTGCGCCAGGAACGTGTTCGATGGCTACTGGC TGGTGTATTGGGGGCAGGGCACGCTTGTGACTGTTAGCAGCGCAAGTACTAAGGGTCCATCA GTGTTCCCACTGGCTCCATCCTCTAAGTCAACGTCTGGCGGTACAGCAGCTCTTGGCTGTCTC GTTAAGGACTATTTTCCGGAGCCTGTGACCGTCAGTTGGAATTCTGGCGCACTGACGTCAGG AGTGCATACTTTTCCTGCCGTCCTGCAGAGTTCCGGACTGTACAGCCTTTCCTCCGTCGTGAC TGTTCCATCCAGCAGCCTGGGAACCCAGACCTATATTTGTAACGTGAACCACAAGCCCTCAA ACACCAAGGTTGACAAGAAGGTGGAGCCTAAGAGTTGT
131	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtGATATAGTAATGACACAAACGCCTC TGTCTCTTCCTGTCACGCCCGGCGAACCAGCCTCCATATCCTGCAGATCATCTAAAAGTCTTC

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	TCCACTCCAACGGAATTACGTATTTGTACTGGTATTTGCAGAAGCCTGGGCAGTCTCCCCAA CTGCTGATTTATCAGATGTCTAACTTGGTAAGCGGGGTGCCCGATAGGTTTTCAGGGTCCGG AAGCGGCACAGATTTCACGCTGAAGATCAGCAGAGTGGAAGCCGAGGACGTGGGCGTGTAT TATTGCGCGCAGAATTTGGAGCTCCCATATACCTTCGGAGGTGGGACCAAGGTAGAAATCA AGCGAACTGTCAGGACTGTCGCTGCCCCGAGCGTTTTCATCTTCCCCCCGTCTGACGAACAG CTTAAAAGCGGCACTGCAAGCGTGGTGTGCCTGCTTAACAATTTCTATCCCAGAGAAGCGAA GGTTCAGTGGAAGGTGGATAACGCCCTGCAATCTGGCAATAGCCAGGAGTCCGTTACAGAA CAAGATTCAAAAGACTCAACGTACTCTCTGTCCTCCACACTGACCCTGAGCAAAGCTGATTA CGAAAAACATAAGGTTTACGCCTGCGAGGTCACACACCAGGGGCTTTCTAGTCCGGTGACTA AATCTTTTAACCGCGGGGAATGT
132	CAAGTGCAGCTCGTGCAGAGTGGCGCAGAGGTGAAGAAACCTGGCTCAAGTGTTAAGGTGT CCTGTAAGGCTAGTGGCTACGCTTTTTCTTACAGTTGGATCAACTGGGTTCGCCAAGCCCCC GGGCAGGGATTGGAATGGATGGGCAGGATCTTTCCAGGCGATGGAGACACTGACTATAACG GCAAGTTTAAGGGCAGGGTGACAATCACGGCGGACAAAAGCACAAGCACTGCCTACATGGA GCTGAGCTCACTGCGGTCAGAGGACACGGCTGTATATTACTGCGCCAGGAACGTGTTCGATG GCTACTGGCTGGTGTATTGGGGGCAGGGCACGCTTGTGACTGTTAGCAGCGCAAGTACTAAG GGTCCATCAGTGTTCCCACTGGCTCCATCCTCTAAGTCAACGTCTGGCGGTACAGCAGCTCTT GGCTGTCTCGTTAAGGACTATTTTCCGGAGCCTGTGACCGTCAGTTGGAATTCTGGCGCACT GACGTCAGGAGTGCATACTTTTCCTGCCGTCCTGCAGAGTTCCGGACTGTACAGCCTTTCCTC CGTCGTGACTGTTCCATCCAGCAGCCTGGGAACCCAGACCTATATTTGTAACGTGAACCACA AGCCCTCAAACACCAAGGTTGACAAGAAGGTGGAGCCTAAGAGTTGTGGCGGAGGCGGGA GCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactc
133	GATATAGTAATGACACAAACGCCTCTGTCTCTTCCTGTCACGCCCGGCGAACCAGCCTCCAT ATCCTGCAGATCATCTAAAAGTCTTCTCCACTCCAACGGAATTACGTATTTGTACTGGTATTT GCAGAAGCCTGGGCAGTCTCCCCAACTGCTGATTTATCAGATGTCTAACTTGGTAAGCGGGG TGCCCGATAGGTTTTCAGGGTCCGGAAGCGGCACAGATTTCACGCTGAAGATCAGCAGAGT GGAAGCCGAGGACGTGGGCGTGTATTATTGCGCGCAGAATTTGGAGCTCCCATATACCTTCG GAGGTGGGACCAAGGTAGAAATCAAGCGAACTGTCAGGACTGTCGCTGCCCCGAGCGTTTT CATCTTCCCCCCGTCTGACGAACAGCTTAAAAGCGGCACTGCAAGCGTGGTGTGCCTGCTTA ACAATTTCTATCCCAGAGAAGCGAAGGTTCAGTGGAAGGTGGATAACGCCCTGCAATCTGG CAATAGCCAGGAGTCCGTTACAGAACAAGATTCAAAAGACTCAACGTACTCTCTGTCCTCCA CACTGACCCTGAGCAAAGCTGATTACGAAAAACATAAGGTTTACGCCTGCGAGGTCACACA CCAGGGGCTTTCTAGTCCGGTGACTAAATCTTTTAACCGCGGGGAATGTGGCGGAGGCGGG AGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactc
134	GAGGTGCAGCTGGTCGAGTCAGGCGGAGGCCTGGTTCAGCCAGGGAGATCCCTCAGGCTTT CCTGCGCCGCCTCCGGTTTTACCTTCAACGACTACGCTATGCACTGGGTTCGCCAGGCTCCCG GAAAGGGACTTGAATGGGTGAGCACTATCAGCTGGAATTCTGGAAGCATTGGGTATGCCGA CTCCGTCAAGGGCCGCTTTACTATTTCTCGGGATAATGCGAAGAAGTCTCTGTACCTGCAGA TGAACAGTCTTCGGGCAGAAGACACGGCTCTTTACTATTGCGCAAAAGACATCCAGTACGG AAACTATTATTACGGAATGGATGTGTGGGGTCAGGGCACCACTGTGACAGTAAGCAGTGCT AGTACAAAGGGACCTTCTGTGTTTCCACTTGCTCCTAGCTCCAAATCCACGTCCGGGGGCAC TGCCGCTCTGGGCTGCCTCGTTAAAGATTACTTCCCAGAGCCTGTCACTGTGTCCTGGAATTC CGGCGCCCTTACGTCAGGGGTACACACATTTCCCGCGGTACTCCAGTCAAGCGGCTTGTACA GCCTGTCCTCCGTAGTGACAGTGCCTTCCTCTTCTCTCGGCACTCAAACTTACATCTGCAATG TCAATCACAAACCGAGTAACACTAAGGTTGACAAGAAAGTTGAACCTAAGAGCTGT
135	GAAATCGTCCTGACGCAGTCACCTGCAACCCTGAGTCTCAGCCCTGGTGAGCGGGCCACCCT GAGCTGCAGGGCCAGCCAGAGTGTATCTTCTTACCTGGCTTGGTATCAGCAGAAACCAGGAC AGGCCCCAAGACTGCTGATCTACGACGCTTCCAATAGAGCCACGGGCATCCCTGCCCGATTT TCCGGATCAGGGTCCGGTACAGATTTCACGCTGACCATCAGCTCCCTCGAGCCCGAAGATTT TGCTGTGTATTATTGCCAGCAGCGGTCCAATTGGCCCATTACCTTCGGTCAGGGGACCAGGC TGGAGATTAAACGGACCGTGGCTGCTCCCTCAGTTTTCATCTTTCCCCCATCTGATGAGCAGC TGAAGTCCGGGACCGCAAGCGTCGTGTGCCTCCTTAACAATTTTTACCCACGAGAAGCTAAG GTTCAGTGGAAGGTGGATAATGCTCTCCAGTCCGGTAATTCTCAGGAATCAGTGACCGAACA GGATAGCAAAGATTCTACCTATAGCTTGTCATCAACTCTGACCCTCTCCAAAGCCGACTACG AGAAACACAAAGTCTACGCATGCGAGGTGACTCACCAAGGTCTGAGTTCACCCGTTACTAA AAGCTTTAACAGAGGAGAATGT
136	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagccGAGGTGCAG CTGGTCGAGTCAGGCGGAGGCCTGGTTCAGCCAGGGAGATCCCTCAGGCTTTCCTGCGCCGC

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	CTCCGGTTTTACCTTCAACGACTACGCTATGCACTGGGTTCGCCAGGCTCCCGGAAAGGGAC TTGAATGGGTGAGCACTATCAGCTGGAATTCTGGAAGCATTGGGTATGCCGACTCCGTCAAG GGCCGCTTTACTATTTCTCGGGATAATGCGAAGAAGTCTCTGTACCTGCAGATGAACAGTCT TCGGGCAGAAGACACGGCTCTTTACTATTGCGCAAAAGACATCCAGTACGGAAACTATTATT ACGGAATGGATGTGTGGGGTCAGGGCACCACTGTGACAGTAAGCAGTGCTAGTACAAAGGG ACCTTCTGTGTTTCCACTTGCTCCTAGCTCCAAATCCACGTCCGGGGGCACTGCCGCTCTGGG CTGCCTCGTTAAAGATTACTTCCCAGAGCCTGTCACTGTGTCCTGGAATTCCGGCGCCCTTAC GTCAGGGGTACACACATTTCCCGCGGTACTCCAGTCAAGCGGCTTGTACAGCCTGTCCTCCG TAGTGACAGTGCCTTCCTCTTCTCTCGGCACTCAAACTTACATCTGCAATGTCAATCACAAAC CGAGTAACACTAAGGTTGACAAGAAAGTTGAACCTAAGAGCTGT
137	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtGAAATCGTCCTGACGCAGTCACCTG CAACCCTGAGTCTCAGCCCTGGTGAGCGGGCCACCCTGAGCTGCAGGGCCAGCCAGAGTGT ATCTTCTTACCTGGCTTGGTATCAGCAGAAACCAGGACAGGCCCCAAGACTGCTGATCTACG ACGCTTCCAATAGAGCCACGGGCATCCCTGCCCGATTTTCCGGATCAGGGTCCGGTACAGAT TTCACGCTGACCATCAGCTCCCTCGAGCCCGAAGATTTTGCTGTGTATTATTGCCAGCAGCG GTCCAATTGGCCCATTACCTTCGGTCAGGGGACCAGGCTGGAGATTAAACGGACCGTGGCTG CTCCCTCAGTTTTCATCTTTCCCCCATCTGATGAGCAGCTGAAGTCCGGGACCGCAAGCGTC GTGTGCCTCCTTAACAATTTTTACCCACGAGAAGCTAAGGTTCAGTGGAAGGTGGATAATGC TCTCCAGTCCGGTAATTCTCAGGAATCAGTGACCGAACAGGATAGCAAAGATTCTACCTATA GCTTGTCATCAACTCTGACCCTCTCCAAAGCCGACTACGAGAAACACAAAGTCTACGCATGC GAGGTGACTCACCAAGGTCTGAGTTCACCCGTTACTAAAAGCTTTAACAGAGGAGAATGT
138	GAGGTGCAGCTGGTCGAGTCAGGCGGAGGCCTGGTTCAGCCAGGGAGATCCCTCAGGCTTT CCTGCGCCGCCTCCGGTTTTACCTTCAACGACTACGCTATGCACTGGGTTCGCCAGGCTCCCG GAAAGGGACTTGAATGGGTGAGCACTATCAGCTGGAATTCTGGAAGCATTGGGTATGCCGA CTCCGTCAAGGGCCGCTTTACTATTTCTCGGGATAATGCGAAGAAGTCTCTGTACCTGCAGA TGAACAGTCTTCGGGCAGAAGACACGGCTCTTTACTATTGCGCAAAAGACATCCAGTACGG AAACTATTATTACGGAATGGATGTGTGGGGTCAGGGCACCACTGTGACAGTAAGCAGTGCT AGTACAAAGGGACCTTCTGTGTTTCCACTTGCTCCTAGCTCCAAATCCACGTCCGGGGGCAC TGCCGCTCTGGGCTGCCTCGTTAAAGATTACTTCCCAGAGCCTGTCACTGTGTCCTGGAATTC CGGCGCCCTTACGTCAGGGGTACACACATTTCCCGCGGTACTCCAGTCAAGCGGCTTGTACA GCCTGTCCTCCGTAGTGACAGTGCCTTCCTCTTCTCTCGGCACTCAAACTTACATCTGCAATG TCAATCACAAACCGAGTAACACTAAGGTTGACAAGAAAGTTGAACCTAAGAGCTGTGGCGG AGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactc
139	GAAATCGTCCTGACGCAGTCACCTGCAACCCTGAGTCTCAGCCCTGGTGAGCGGGCCACCCT GAGCTGCAGGGCCAGCCAGAGTGTATCTTCTTACCTGGCTTGGTATCAGCAGAAACCAGGAC AGGCCCCAAGACTGCTGATCTACGACGCTTCCAATAGAGCCACGGGCATCCCTGCCCGATTT TCCGGATCAGGGTCCGGTACAGATTTCACGCTGACCATCAGCTCCCTCGAGCCCGAAGATTT TGCTGTGTATTATTGCCAGCAGCGGTCCAATTGGCCCATTACCTTCGGTCAGGGGACCAGGC TGGAGATTAAACGGACCGTGGCTGCTCCCTCAGTTTTCATCTTTCCCCCATCTGATGAGCAGC TGAAGTCCGGGACCGCAAGCGTCGTGTGCCTCCTTAACAATTTTTACCCACGAGAAGCTAAG GTTCAGTGGAAGGTGGATAATGCTCTCCAGTCCGGTAATTCTCAGGAATCAGTGACCGAACA GGATAGCAAAGATTCTACCTATAGCTTGTCATCAACTCTGACCCTCTCCAAAGCCGACTACG AGAAACACAAAGTCTACGCATGCGAGGTGACTCACCAAGGTCTGAGTTCACCCGTTACTAA AAGCTTTAACAGAGGAGAATGTGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaac tc
140	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagccgaagtgcagctggtg gagtctggcggaggactggtgcagccaggggcagcctgagactgtcttgcgccgcctccggcttcaacatcaaggacacctacatccactgggtcc gccaggcaccaggcaagggactggaatgggtggcccggatctaccctaccaacggctacaccagatacgccgactccgtgaagggccggttcacca tctccgccgacacctccaagaacaccgcctacctgcagatgaattccctgagggccgaggacaccgccgtgtactactgctccagatggggaggcga cggcttctacgccatggactactggggccagggcaccctggtcacagtgtcctctgctagcaccaagggcccatcggtcttccccctggcaccctcctc caagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctgacc agcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgaccgtgccctccagcagcttgggcacccagacc tacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
141	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtgacatccagatgacccagtcccctcctccctgtctgcctc cgtgggcgacagagtgaccatcacctgtcgggcctcccaggatgtgaacaccgccgtggcctggtatcagcagaagcctggcaaggcccctaagctg ctgatctactccgcctccttcctgtactccggcgtgccctcccggttctccggctccagatccggcaccgacttcaccctgaccatctccagcctgcagcct gaggacttcgccacctactactgccagcagcactacaccaccccctccaaccttcggccagggcaccaaggtggagatcaagcgtacggtggctgcac catctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgttgtgtgcctgctgaataacttctatcccagagaggccaaagtacag

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
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142	gaagtgcagctggtggagtctggcggaggactggtgcagccaggggcagcctgagactgtcttgcgccgcctccggcttcaacatcaaggacacct acatccactgggtccgccaggcaccaggcaagggactggaatgggtggcccggatctaccctaccaacggctacaccagatacgccgactccgtgaa gggccggttcaccatctccgccgacacctccaagaacaccgcctacctgcagatgaattccctgagggccgaggacaccgccgtgtactactgctcca gatggggaggcgacggcttctacgccatggactactggggccagggcaccctggtcacagtgtcctctgctagcaccaagggcccatcggtcttcccc ctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactc aggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgaccgtgccctccagcagctt gggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgtGGCGGAGGC GGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactc
143	gacatccagatgacccagtccccctcctccctgtctgcctccgtgggcgacagagtgaccatcacctgtcgggcctcccaggatgtgaacaccgccgtg gcctggtatcagcagaagcctggcaaggcccctaagctgctgatctactccgcctccttcctgtactccggcgtgccctcccggttctccggctccagatc cggcaccgacttcaccctgaccatctccagcctgcagcctgaggacttcgccacctactactgccagcagcactacaccacccctccaaccttcggcca gggcaccaaggtggagatcaagcgtacggtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgttgtgtg cctgctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcagg acagcaaggacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatc agggcctgagctcgcccgtcacaaagagcttcaacaggggagagtgtGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgct cgtctcaagaaactc
144	GAAGTTCAGCTGGTTGAATCTGGTGGTGGTCTGGTTCAGCCGGGTGGTTCTCTGCGTCTGTCT TGCGCTGCTTCTGGTTTCACCTTCTCTAACTTCGACATGGCTTGGGTTCGTCAGGCTCCGGGT AAAGGTCTGGTTTGGGTTTCTTCTATCACCACCGGTGGTGGTGACACCTACTACGCTGACTCT GTTAAAGGTCGTTTCACCATCTCTCGTGACAACGCTAAATCTACCCTGTACCTGCAGATGGA CTCTCTGCGTTCTGAAGACACCGCTGTTTACTACTGCGTTCGTCACGGTTACTACGACGGTTA CCACCTGTTCGACTACTGGGGTCAGGGTACCCTGGTTACCGTTTCTTCTgcctccaccaagggcccatcg gtcttcccccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtc gtggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctct agcagcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
145	aactaccacctggagaatgaagtcgccagactgaagaaactgggcggggggaggctcaGACATCCAGATGACCCAGTCTCCGT CTTCTCTGTCTGCTTCTGTTGGTGACCGTGTTACCATCACCTGCCGTGCTAACCAGGGTATCT CTAACAACCTGAACTGGTACCAGCAGAAACCGGGTAAAGCTCCGAAACCGCTGATCTACTA CACCTCTAACCTGCAGTCTGGTGTTCCGTCTCGTTTCTCTGGTTCTGGTTCTGGTACCGACTA CACCCTGACCATCTCTTCTCTGCAGCCGGAAGACTTCGCTACCTACTACTGCCAGCAGTTCAC CTCTCTGCCGTACACCTTCGGTCAGGGTACCAAACTGGAAATCAAAcgaactgtggctgcaccatctgtcttc atcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcctgctgaataacttctatcccagagaggccaaagtacagtggaaggtg gataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcaaagacagcacctacagcctcagcagcaccctgacgctgagc aaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcagggcctgtcctcgcccgtcacaaagagcttcaacaggggagagtgt
146	aactaccacctggagaatgaagtcgccagactgaagaaactgggcggggggaggctcaggggggaggcgggtcaGACATCCAGATGAC CCAGTCTCCGTCTTCTCTGTCTGCTTCTGTTGGTGACCGTGTTACCATCACCTGCCGTGCTAA CCAGGGTATCTCTAACAACCTGAACTGGTACCAGCAGAAACCGGGTAAAGCTCCGAAACCG CTGATCTACTACACCTCTAACCTGCAGTCTGGTGTTCCGTCTCGTTTCTCTGGTTCTGGTTCTG GTACCGACTACACCCTGACCATCTCTTCTCTGCAGCCGGAAGACTTCGCTACCTACTACTGCC AGCAGTTCACCTCTCTGCCGTACACCTTCGGTCAGGGTACCAAACTGGAAATCAAAcgaactgtg gctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcctgctgaataacttctatcccagagaggcca aagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcaaagacagcacctacagcctcagca gcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcagggcctgtcctcgcccgtcacaaagagcttc aacaggggagagtgt
147	aactaccacctggagaatgaagtcgccagactgaagaaactgggcggggggaggctcaGAAGTTCAGCTGGTTGAATCTGGTG GTGGTCTGGTTCAGCCGGGTGGTTCTCTGCGTCTGTCTTGCGCTGCTTCTGGTTTCACCTTCTC TAACTTCGACATGGCTTGGGTTCGTCAGGCTCCGGGTAAAGGTCTGGTTTGGGTTTCTTCTAT CACCACCGGTGGTGGTGACACCTACTACGCTGACTCTGTTAAAGGTCGTTTCACCATCTCTC GTGACAACGCTAAATCTACCCTGTACCTGCAGATGGACTCTCTGCGTTCTGAAGACACCGCT GTTTACTACTGCGTTCGTCACGGTTACTACGACGGTTACCACCTGTTCGACTACTGGGGTCAG GGTACCCTGGTTACCGTTTCTTCTgcctccaccaagggcccatcggtcttcccctggcaccctcctccaagagcacctctgggg gcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctgaccagcggcgtgcacaccttc cccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcacccagacctacatctgcaacgtgaat cacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
148	aactaccacctggagaatgaagtcgccagactgaagaaactgggcggggggaggctcaggggggaggcgggtcaGAAGTTCAGCTGGTT

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	GAATCTGGTGGTGGTCTGGTTCAGCCGGGTGGTTCTCTGCGTCTGTCTTGCGCTGCTTCTGGT TTCACCTTCTCTAACTTCGACATGGCTTGGGTTCGTCAGGCTCCGGGTAAAGGTCTGGTTTGG GTTTCTTCTATCACCACCGGTGGTGGTGACACCTACTACGCTGACTCTGTTAAAGGTCGTTTC ACCATCTCTCGTGACAACGCTAAATCTACCCTGTACCTGCAGATGGACTCTCTGCGTTCTGA AGACACCGCTGTTTACTACTGCGTTCGTCACGGTTACTACGACGGTTACCACCTGTTCGACTA CTGGGGTCAGGGTACCCTGGTTACCGTTTCTTCTgcctccaccaagggcccatcggtcttcccccctggcaccctcctcca agagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctgaccag cggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcacccagacctac atctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
149	GAGATTGTCCTGACCCAGTCCCCTGCTATTATGTCTGCTTCCCCCGGCGAAAGAGTGACCAT GACCTGTAGTGCCTCCAGCGGCGTCAACTACATGCACTGGTATCAGCAGAAGCCAGGGACC TCTCCCCGGAGATGGATCTACGACACATCAAAGCTGGCCAGCGGAGTGCCTGCACGGTTCTC CGGATCTGGCAGTGGGACTGACTATAGCCTGACCATCAGCAGCATGGAGCCAGAAGATGCC GCTACCTACTATTGCCATCAGAGGGGCTCCTACACATTTGGCGGGGGAACTAAGCTGGAGAT CAAACGCACAGTGGCAGCCCCCAGCGTCTTCATTTTTCCCCCTTCCGATGAACAGCTGAAGT CCGGCACTGCTTCTGTGGTCTGTCTGCTGAACAATTTCTATCCCAGAGAGGCCAAGGTGCAG TGGAAAGTGGACAACGCTCTGCAGTCCGGCAACAGCCAGGAGAGTGTGACCGAACAGGATA GTAAGGACAGCACATATTCTCTGTCTAGTACCCTGACACTGAGTAAGGCAGATTACGAGAA GCACAAAGTGTATGCCTGCGAAGTCACTCATCAGGGACTGTCAAGCCCCGTGACCAAGAGC TTCAACCGGGGCGAGTGT
150	CAGGTGCAGCTGGTCCAGCCAGGGGCAGAGGTCGTCAAGCCAGGAGCATCCGTCAAACTGT CATGTAAAACAAGCGGGTATACTTTCACCAGCAATTGGATGCACTGGGTGAAGCAGGCCCC CGGACAGGGCCTGGAGTGGATCGGGGAAATTGACCCTAGTGATTCATACACTAACTACAAC CAGAACTTCCAGGGAAAGGCCAAACTGACCGTGGACAAAAGCACCTCCACAGCTTATATGG AGGTGAGCAGCCTGCGGTCCGACGATACTGCAGTCTACTATTGCGCCAGAGGCTCTAACCCT TACTATTACGCTATGGATTACTGGGGGCAGGGAACAAGCGTGACTGTCTCTAGTGCATCAAC AAAGGGACCAAGCGTGTTTCCACTGGCCCCCTCAAGCAAGAGCACCTCCGGAGGGACAGCC GCTCTGGGATGTCTGGTGAAAGACTACTTCCCCGAGCCTGTGACTGTCTCTTGGAATAGTGG CGCTCTGACCTCCGGGGTGCACACATTTCCAGCAGTCCTGCAGTCCTCTGGACTGTATTCTCT GAGTTCAGTGGTCACCGTGCCCAGCTCCTCTCTGGGCACTCAGACCTACATCTGCAATGTCA ACCATAAGCCTAGTAACACAAAAGTGGATAAGAAAGTCGAACCAAAGAGCTGT
151	GAGATTGTCCTGACCCAGTCCCCTGCTATTATGTCTGCTTCCCCCGGCGAAAGAGTGACCAT GACCTGTAGTGCCTCCAGCGGCGTCAACTACATGCACTGGTATCAGCAGAAGCCAGGGACC TCTCCCCGGAGATGGATCTACGACACATCAAAGCTGGCCAGCGGAGTGCCTGCACGGTTCTC CGGATCTGGCAGTGGGACTGACTATAGCCTGACCATCAGCAGCATGGAGCCAGAAGATGCC GCTACCTACTATTGCCATCAGAGGGGCTCCTACACATTTGGCGGGGGAACTAAGCTGGAGAT CAAACGCACAGTGGCAGCCCCCAGCGTCTTCATTTTTCCCCCTTCCGATGAACAGCTGAAGT CCGGCACTGCTTCTGTGGTCTGTCTGCTGAACAATTTCTATCCCAGAGAGGCCAAGGTGCAG TGGAAAGTGGACAACGCTCTGCAGTCCGGCAACAGCCAGGAGAGTGTGACCGAACAGGATA GTGGCGGGGGAGGCTCAAACTACCACCTGGAGAATGAAGTCGCCAGACTGAAGAAACTGGG GGGAGGCGGGTCAGACAGCACATATTCTCTGTCTAGTACCCTGACACTGAGTAAGGCAGATT ACGAGAAGCACAAAGTGTATGCCTGCGAAGTCACTCATCAGGGACTGTCAAGCCCCGTGAC CAAGAGCTTCAACCGGGGCGAGTGT
152	CAGGTGCAGCTGGTCCAGCCAGGGGCAGAGGTCGTCAAGCCAGGAGCATCCGTCAAACTGT CATGTAAAACAAGCGGGTATACTTTCACCAGCAATTGGATGCACTGGGTGAAGCAGGCCCC CGGACAGGGCCTGGAGTGGATCGGGGAAATTGACCCTAGTGATTCATACACTAACTACAAC CAGAACTTCCAGGGAAAGGCCAAACTGACCGTGGACAAAAGCACCTCCACAGCTTATATGG AGGTGAGCAGCCTGCGGTCCGACGATACTGCAGTCTACTATTGCGCCAGAGGCTCTAACCCT TACTATTACGCTATGGATTACTGGGGGCAGGGAACAAGCGTGACTGTCTCTAGTGCATCAAC AAAGGGACCAAGCGTGTTTCCACTGGCCCCCTCAAGCAATTATCATCTGGAGAACGAAGTG GCCAGGCTGAAGAAACTGTCCGGAGGGACAGCCGCTCTGGGATGTCTGGTGAAAGACTACT TCCCCGAGCCTGTGACTGTCTCTTGGAATAGTGGCGCTCTGACCTCCGGGGTGCACACATTT CCAGCAGTCCTGCAGTCCTCTGGACTGTATTCTCTGAGTTCAGTGGTCACCGTGCCCAGCTCC TCTCTGGGCACTCAGACCTACATCTGCAATGTCAACCATAAGCCTAGTAACACAAAAGTGGA TAAGAAAGTCGAACCAAAGAGCTGT
153	aactaccacctggagaatgaagtcgccagactgaagaaactgggcgggggaggctcaGAGATTGTCCTGACCCAGTCCCCTG CTATTATGTCTGCTTCCCCCGGCGAAAGAGTGACCATGACCTGTAGTGCCTCCAGCGGCGTC AACTACATGCACTGGTATCAGCAGAAGCCAGGGACCTCTCCCCGGAGATGGATCTACGACA

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	CATCAAAGCTGGCCAGCGGAGTGCCTGCACGGTTCTCCGGATCTGGCAGTGGGACTGACTAT AGCCTGACCATCAGCAGCATGGAGCCAGAAGATGCCGCTACCTACTATTGCCATCAGAGGG GCTCCTACACATTTGGCGGGGGAACTAAGCTGGAGATCAAACGCACAGTGGCAGCCCCCAG CGTCTTCATTTTTCCCCCTTCCGATGAACAGCTGAAGTCCGGCACTGCTTCTGTGGTCTGTCT GCTGAACAATTTCTATCCCAGAGAGGCCAAGGTGCAGTGGAAAGTGGACAACGCTCTGCAG TCCGGCAACAGCCAGGAGAGTGTGACCGAACAGGATAGTAAGGACAGCACATATTCTCTGT CTAGTACCCTGACACTGAGTAAGGCAGATTACGAGAAGCACAAAGTGTATGCCTGCGAAGT CACTCATCAGGGACTGTCAAGCCCCGTGACCAAGAGCTTCAACCGGGGCGAGTGT
154	aactaccacctggagaatgaagtcgccagactgaagaaactgggcgggggaggctcagggggaggcgggtcaGAGATTGTCCTGACC CAGTCCCCTGCTATTATGTCTGCTTCCCCCGGCGAAAGAGTGACCATGACCTGTAGTGCCTC CAGCGGCGTCAACTACATGCACTGGTATCAGCAGAAGCCAGGGACCTCTCCCCGGAGATGG ATCTACGACACATCAAAGCTGGCCAGCGGAGTGCCTGCACGGTTCTCCGGATCTGGCAGTGG GACTGACTATAGCCTGACCATCAGCAGCATGGAGCCAGAAGATGCCGCTACCTACTATTGCC ATCAGAGGGGCTCCTACACATTTGGCGGGGGAACTAAGCTGGAGATCAAACGCACAGTGGC AGCCCCCAGCGTCTTCATTTTTCCCCCTTCCGATGAACAGCTGAAGTCCGGCACTGCTTCTGT GGTCTGTCTGCTGAACAATTTCTATCCCAGAGAGGCCAAGGTGCAGTGGAAAGTGGACAAC GCTCTGCAGTCCGGCAACAGCCAGGAGAGTGTGACCGAACAGGATAGTAAGGACAGCACAT ATTCTCTGTCTAGTACCCTGACACTGAGTAAGGCAGATTACGAGAAGCACAAAGTGTATGCC TGCGAAGTCACTCATCAGGGACTGTCAAGCCCCGTGACCAAGAGCTTCAACCGGGGCGAGT GT
155	aactaccacctggagaatgaagtcgccagactgaagaaactgggcgggggaggctcaCAGGTGCAGCTGGTCCAGCCAGGG GCAGAGGTCGTCAAGCCAGGAGCATCCGTCAAACTGTCATGTAAAACAAGCGGGTATACTT TCACCAGCAATTGGATGCACTGGGTGAAGCAGGCCCCCGGACAGGGCCTGGAGTGGATCGG GGAAATTGACCCTAGTGATTCATACACTAACTACAACCAGAACTTCCAGGGAAAGGCCAAA CTGACCGTGGACAAAAGCACCTCCACAGCTTATATGGAGGTGAGCAGCCTGCGGTCCGACG ATACTGCAGTCTACTATTGCGCCAGAGGCTCTAACCCTTACTATTACGCTATGGATTACTGG GGGCAGGGAACAAGCGTGACTGTCTCTAGTGCATCAACAAAGGGACCAAGCGTGTTTCCAC TGGCCCCCTCAAGCAAGAGCACCTCCGGAGGGACAGCCGCTCTGGGATGTCTGGTGAAAGA CTACTTCCCCGAGCCTGTGACTGTCTCTTGGAATAGTGGCGCTCTGACCTCCGGGGTGCACA CATTTCCAGCAGTCCTGCAGTCCTCTGGACTGTATTCTCTGAGTTCAGTGGTCACCGTGCCCA GCTCCTCTCTGGGCACTCAGACCTACATCTGCAATGTCAACCATAAGCCTAGTAACACAAAA GTGGATAAGAAAGTCGAACCAAAGAGCTGT
156	aactaccacctggagaatgaagtcgccagactgaagaaactgggcgggggaggctcagggggaggcgggtcaCAGGTGCAGCTGGT CCAGCCAGGGGCAGAGGTCGTCAAGCCAGGAGCATCCGTCAAACTGTCATGTAAAACAAGC GGGTATACTTTCACCAGCAATTGGATGCACTGGGTGAAGCAGGCCCCCGGACAGGGCCTGG AGTGGATCGGGGAAATTGACCCTAGTGATTCATACACTAACTACAACCAGAACTTCCAGGG AAAGGCCAAACTGACCGTGGACAAAAGCACCTCCACAGCTTATATGGAGGTGAGCAGCCTG CGGTCCGACGATACTGCAGTCTACTATTGCGCCAGAGGCTCTAACCCTTACTATTACGCTAT GGATTACTGGGGGCAGGGAACAAGCGTGACTGTCTCTAGTGCATCAACAAAGGGACCAAGC GTGTTTCCACTGGCCCCCTCAAGCAAGAGCACCTCCGGAGGGACAGCCGCTCTGGGATGTCT GGTGAAAGACTACTTCCCCGAGCCTGTGACTGTCTCTTGGAATAGTGGCGCTCTGACCTCCG GGGTGCACACATTTCCAGCAGTCCTGCAGTCCTCTGGACTGTATTCTCTGAGTTCAGTGGTCA CCGTGCCCAGCTCCTCTCTGGGCACTCAGACCTACATCTGCAATGTCAACCATAAGCCTAGT AACACAAAAGTGGATAAGAAAGTCGAACCAAAGAGCTGT
157	caggtccaactgcaggagtcaggaggaggcttggtacagcctgggggttctctgagactctcctgtgcaacttctgggttcaccttcactgattactacatg aactgggtccgccagcctccaggaaaggcacttgagtggttgggttttattggaaacaaagctaatggttacacaacagagtacagtgcatctgtgaagg gtcggttcaccatctccagagataaatcccaaagcatcctctatcttcaaatgaacaccctgagagctgaggacagtgccacttattactgtaccagagata gggggctacggttctactttgactactggggccaagggaccacggtcaccgtctcctcagcctccaccaagggcccatcggtcttcccctggcaccct cctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccct gaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcaccca gacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgt
158	gacattgagctcacccagtctccagcaatcctgtctgcatctccaggggagaaggtcacaatgacttgcagggccagctcaagtgtaacttacattcactg gtaccagcagaagccaggatcctccccaaatcctggatttatgccacatccaacctggcttctggagtccctgctcgcttcagtggcagtgggtctggg acctcttactctctcacaatcagcagagtggaggctgaagatgctgccacttattactgccaacattggagtagtaaaccaccgacgttcggtggagggac caagctcgagatcaaaaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcct gctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggaca gcGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactcGGTGGCGGAGGCAGCgacagca cctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcagggcctgtcctcgcc

Table 51. Switch Antibody Chains	
SEQ ID NO	SEQUENCE
	cgtcacaaagagcttcaacaggggagagtgt
159	gacattgagctcacccagtctccagcaatcctgtctgcatctccaggggagaaggtcacaatgacttgcagggccagctcaagtgtaacttacattcactg gtaccagcagaagccaggatcctcccccaaatcctggatttatgccacatccaacctggcttctggagtccctgctcgcttcagtggcagtgggtctggg acctcttactctctcacaatcagcagagtggaggctgaagatgctgccacttattactgccaacattggagtagtaaaccaccgacgttcggtggagggac caagctcgagatcaaaaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgtcgtgtgcct gctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggaca gcAAGgacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatca gggcctgtcctcgcccgtcacaaagagcttcaacaggggagagtgt
160	caggtccaactgcaggagtcaggaggaggcttggtacagcctgggggttctctgagactctcctgtgcaacttctgggttcaccttcactgattactacatg aactgggtccgccagcctccaggaaaggcacttgagtggttgggtttttattggaaacaaagctaatggttacacaacagagtacagtgcatctgtgaagg gtcggttcaccatctccagagataaatcccaaagcatcctctatcttcaaatgaacaccctgagagctgaggacagtgccacttattactgtaccagagata gggggctacggttctactttgactactggggccaagggaccacggtcaccgtctcctcagcctccaccaagggcccatcggtcttcccccctggcaccct cctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccct gaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcaccca gacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgtGGCGGAGGCGGGAGCa attatcatcttgaaaatgaggtcgctcgtctcaagaaactc
161	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagcccaggtgcagctggtg cagagcggcgcggaagtgaaaaaaccgggcagcagcgtgaaagtgagctgcaaagcgagcggctatacctttaccgattataacatgcattgggtgc gccaggcgccgggccagggcctggaatggattggctatatttatccgtataacggcggcaccggctataaccagaaatttaaaagcaaagcgaccatta ccgcggatgaaagcaccaacaccgcgtatatggaactgagcagcctgcgcagcgaagataccgcggtgtattattgcgcgcgcggccgcccggcga tggattattggggccagggcaccctggtgaccgtgagcagcgcctccaccaagggcccatcggtcttcccccctggcaccctcctccaagagcacctct gggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctgaccagcggcgtgcac accttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcacccagacctacatctgcaacgt gaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgtgacaaaactcacaca
162	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcgggggcggaagtgatattcagatgacccagagcccgagcagcctgagcgcg agcgtgggcgatcgcgtgaccattacctgccgcgcgagcgaaagcgtggataactatggcattagctttatgaactggtttcagcagaaaccgggcaaa gcgccgaaactgctgatttatgcggcgagcaaccagggcagcggcgtgccgagccgctttagcggcagcggcagcggcaccgattttaccctgaaca ttagcagcctgcagccggatgattttgcgacctattattgccagcagagcaaagaagtgccgtggacctttggccagggcaccaaagtggaaattaaac gaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgttgtgtgcctgctgaataacttctatcccaga gaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcaaggacagcacctacagc ctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcagggcctgagctcgcccgtcacaa agagcttcaacaggggagagtgt
163	caggtgcagctggtgcagagcggcgcggaagtgaaaaaaccgggcagcagcgtgaaagtgagctgcaaagcgagcggctataccttaccgattata acatgcattgggtgcgccaggcgccgggccagggcctggaatggattggctatatttatccgtataacggcggcaccggctataaccagaaatttaaaa gcaaagcgaccattaccgcggatgaaagcaccaacaccgcgtatatggaactgagcagcctgcgcagcgaagataccgcggtgtattattgcgcgcg cggccgcccggcgatggattattggggccagggcaccctggtgaccgtgagcagcgcctccaccaagggcccatcggtcttcccccctggcaccctcc tccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctga ccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgactgtgccctctagcagcttgggcacccaga cctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatcttgtgacaaaactcacacaGGCGGAG GCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactc
164	gatattcagatgacccagagcccgagcagcctgagcgcgagcgtgggcgatcgcgtgaccattacctgccgcgcgagcgaaagcgtggataactatg gcattagctttatgaactggtttcagcagaaaccgggcaaagcgccgaaactgctgatttatgcggcgagcaaccagggcagcggcgtgccgagccgc tttagcggcagcggcagcggcaccgattttaccctgaacattagcagcctgcagccggatgattttgcgacctattattgccagcagagcaaagaagtgc cgtggacctttggccagggcaccaaagtggaaattaaacgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatctgga actgcctctgttgtgtgcctgctgaataacttctatcccagagaggccaaagtacagtggaaggtggataacgccctccaatcgggtaactcccaggaga gtgtcacagagcaggacagcaaggacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcct gcgaagtcacccatcagggcctgagctcgcccgtcacaaagagcttcaacaggggagagtgtGGCGGAGGCGGGAGCaattatcatctt gaaaatgaggtcgctcgtctcaagaaactc

Table 52. humanized GCN4 scFv –Amino Acid Sequence (protein sequence of a humanized scFv of the murine, phage affinity matured 52SR4 scFv specific for the GCN4 peptide epitope)	
SEQ ID NO	SEQUENCE

Table 52. humanized GCN4 scFv –Amino Acid Sequence (protein sequence of a humanized scFv of the murine, phage affinity matured 52SR4 scFv specific for the GCN4 peptide epitope)	
SEQ ID NO	**SEQUENCE**
165	QAVVTQEPSLTVSPGGTVTLTCGSSTGAVTTSNYASWVQQKPGQAPRGLIGGTNNRAPGVPARF SGSLLGGKAALTISGAQPEDEAEYYCVLWYSDHWVFGGGTKLTVLGGGGSGGGGSGGGGSQV QLQESGPGLVKPSETLSLTCTVSGFLLTDYGVNWIRQPPGKGLEWIGVIWGDGITDYNPSLKSRV TISKDtSKNQFSLKLSSVTAADTAVYYCVTGLFDYWGQGTLVTVSS
166	QAVVTQEPSLTVSPGGTVTLTCGSSTGAVTTSNYASWVQQKPGQAPRGLIGGTNNRAPGVPARF SGSLLGGKAALTISGAQPEDEAEYYCVLWYSDHWVFGGGTKLTVLGGGGSGGGGSGGGGSQV QLQESGPGLVKPSETLSITCTVSGFLLTDYGVNWVRQPPGKGLEWLGVIWGDGITDYNPSLKSRL TVSKDTSKNQVSLKMSSLTAADTAVYYCVTGLFDYWGQGTLLTVSS
167	QAVVTQEPSLTVSPGGTVTLTCGSSTGAVTTSNYASWVQQKPGQAFRGLIGGTNNRAPGVPARF SGSLLGGKAALTISGAQPEDEAEYYCVLWYSDHWVFGGGTKLTVLGGGGSGGGGSGGGGSQV QLQESGPGLVKPSETLSLTCTVSGFLLTDYGVNWIRQPPGKGLEWIGVIWGDGITDYNPSLKSRV TISKDTSKNQFSLKLSSVTAADTAVYYCVTGLFDYWGQGTLVTVSS
168	QAVVTQEPSLTVSPGGTVTLTCGSSTGAVTTSNYASWVQQKPGQAFRGLIGGTNNRAPGVPARF SGSLLGGKAALTISGAQPEDEAEYYCVLWYSDHWVFGGGTKLTVLGGGGSGGGGSGGGGSQV QLQESGPGLVKPSETLSITCTVSGFLLTDYGVNWVRQPPGKGLEWLGVIWGDGITDYNPSLKSRL TVSKDTSKNQVSLKMSSLTAADTAVYYCVTGLFDYWGQGTLLTVSS
169	QAVVTQEPSLTVSPGGTVTLTCGSSTGAVTTSNYASWVQQKPDHLFRGLIGGTNNRAPGVPARF SGSLLGGKAALTISGAQPEDEAEYYCVLWYSDHWVFGGGTKLTVLGGGGSGGGGSGGGGSQV QLQESGPGLVKPSETLSLTCTVSGFLLTDYGVNWIRQPPGKGLEWIGVIWGDGITDYNPSLKSRV TISKDTSKNQFSLKLSSVTAADTAVYYCVTGLFDYWGQGTLVTVSS
170	QAVVTQEPSLTVSPGGTVTLTCGSSTGAVTTSNYASWVQQKPDHLFRGLIGGTNNRAPGVPARF SGSLLGGKAALTISGAQPEDEAEYYCVLWYSDHWVFGGGTKLTVLGGGGSGGGGSGGGGSQV QLQESGPGLVKPSETLSITCTVSGFLLTDYGVNWVRQPPGKGLEWLGVIWGDGITDYNPSLKSRL TVSKDTSKNQVSLKMSSLTAADTAVYYCVTGLFDYWGQGTLLTVSS

Table 53. humanized GCN4 scFv in CAR–Nucleotide Sequence
(DNA sequence of a humanized scFv of the murine, phage affinity matured 52SR4 scFv specific for the GCN4 peptide epitope. The sequence is in the open reading frame of the CAR which includes the leader sequence)

SEQ ID NO	SEQUENCE
171	atggccttaccagtgaccgccttgctcctgccgctggccttgctgctccacgccgccaggccgCAGGCGGTAGTCACCCA GGAGCCAAGTCTCACGGTGAGCCCCGGCGGTACCGTCACACTTACATGCGGAAGCT CTACCGGGGCTGTGACCACAAGCAACTACGCATCCTGGGTCCAGCAGAAACCCGGT CAGGCTCCTCGGGGCCTCATTGGTGGGACAAATAACAGAGCCCCGGGTGTTCCCGC CCGATTTTCTGGCAGTCTTCTGGGAGGAAAGGCCGCTCTGACAATATCTGGCGCAC AGCCCGAAGACGAGGCCGAGTACTATTGCGTGTTGTGGTATAGCGACCACTGGGTA TTCGGTGGAGGAACAAAGCTGACAGTGCTCGGCGGTGGAGGGAGTGGTGGCGGTG GCAGCGGAGGGGGCGGATCACAAGTGCAATTGCAGGAGAGTGGACCTGGACTCGT GAAACCATCTGAAACACTCTCCCTGACTTGTACGGTTTCAGGGTTCCTGCTGACAG ACTATGGAGTAAACTGGATCAGGCAGCCACCCGGCAAGGGCTTGGAGTGGATTGG CGTCATTTGGGGCGACGGAATCACCGACTATAACCCATCACTCAAATCTCGGGTGA CCATTTCCAAGGATAcCAGTAAGAATCAGTTCAGCCTGAAACTTTCATCCGTGACAG CTGCGGACACCGCCGTGTACTACTGTGTGACAGGACTTTTTGACTACTGGGGCCAG GGGACCCTGGTGACAGTTAGCTCCaccacgacgccagcgccgcgaccaccaacaccggcgcccaccatcgcgt cgcagcccctgtccctgcgcccagaggcgtgccggccagcggcgggggggcgcagtgcacacgaggggggctggacttcgcctgtgat atctacatctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaact cctgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaag gaggatgtgaactgagagtgaagttcagcaggagcgcagacgcccccgcgtacaagcagggccagaaccagctctataacgagctca atctaggacgaagagaggagtacgatgttttggacaagagacgtggccgggaccctgagatgggggggaaagccgagaaggaagaac cctcaggaaggcctgtacaatgaactgcagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccggagg ggcaaggggcacgatggcctttaccagggtctcagtacagccaccaaggacacctacgacgcccttcacatgcaggccctgccccctc gc
172	atggccttaccagtgaccgccttgctcctgccgctggccttgctgctccacgccgccaggccgCAGGCGGTAGTCACCCA GGAGCCAAGTCTCACGGTGAGCCCCGGCGGTACCGTCACACTTACATGCGGAAGCT CTACCGGGGCTGTGACCACAAGCAACTACGCATCCTGGGTCCAGCAGAAACCCGGT CAGGCGCCCCGGGGCCTCATTGGTGGGACAAATAACAGAGCCCCGGGTGTTCCCGC CCGATTTTCTGGCAGTCTTCTGGGAGGAAAGGCCGCTCTGACAATATCTGGCGCAC AGCCCGAAGACGAGGCCGAGTACTATTGCGTGTTGTGGTATAGCGACCACTGGGTA TTCGGTGGAGGAACAAAGCTGACAGTGCTCGGCGGTGGAGGGAGTGGTGGCGGTG GCAGCGGAGGGGGCGGATCACAAGTGCAATTGCAGGAGAGTGGACCTGGACTCGT GAAACCATCTGAAACACTCTCCATAACTTGTACGGTTTCAGGGTTCCTGCTGACAG ACTATGGAGTAAACTGGGTTAGGCAGCCACCCGGCAAGGGCTTGGAGTGGCTGGG CGTCATTTGGGGCGACGGAATCACCGACTATAACCCATCACTCAAATCTCGGCTTA CCGTCTCCAAGGATACGAGTAAGAATCAGGTCAGCCTGAAAATGTCATCCCTCACA GCTGCGGACACCGCCGTGTACTACTGTGTGACAGGACTTTTTGACTACTGGGGCCA GGGGACCCTGCTCACAGTTAGCTCCaccacgacgccagcgccgcgaccaccaacaccggcgcccaccatcgc gtcgcagcccctgtccctgcgcccagaggcgtgccggccagcggcgggggggcgcagtgcacacgaggggggctggacttcgcctgtg atatctacatctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaa ctcctgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaaga aggaggatgtgaactgagagtgaagttcagcaggagcgcagacgcccccgcgtacaagcagggccagaaccagctctataacgagct caatctaggacgaagagaggagtacgatgttttggacaagagacgtggccgggaccctgagatgggggggaaagccgagaaggaaga accctcaggaaggcctgtacaatgaactgcagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccgga ggggcaaggggcacgatggcctttaccagggtctcagtacagccaccaaggacacctacgacgcccttcacatgcaggccctgccccc tcgc

Table 53. humanized GCN4 scFv in CAR–Nucleotide Sequence
(DNA sequence of a humanized scFv of the murine, phage affinity matured 52SR4 scFv specific for the GCN4 peptide epitope. The sequence is in the open reading frame of the CAR which includes the leader sequence)

SEQ ID NO	SEQUENCE
173	atggccttaccagtgaccgccttgctcctgccgctggccttgctgctccacgccgccaggccgCAGGCGGTAGTCACCCA GGAGCCAAGTCTCACGGTGAGCCCCGGCGGTACCGTCACACTTACATGCGGAAGCT CTACCGGGGCTGTGACCACAAGCAACTACGCATCCTGGGTCCAGCAGAAACCCGG ACAAGCGTTCCGGGGCCTCATTGGTGGGACAAATAACAGAGCCCCGGGTGTTCCCG CCCGATTTTCTGGCAGTCTTCTGGGAGGAAAGGCCGCTCTGACAATATCTGGCGCA CAGCCCGAAGACGAGGCCGAGTACTATTGCGTGTTGTGGTATAGCGACCACTGGGT ATTCGGTGGAGGAACAAAGCTGACAGTGCTCGGCGGTGGAGGGAGTGGTGGCGGT GGCAGCGGAGGGGGCGGATCACAAGTGCAATTGCAGGAGAGTGGACCTGGACTCG TGAAACCATCTGAAACACTCTCCCTCACTTGTACGGTTTCAGGGTTCCTGCTGACAG ACTATGGAGTAAACTGGATTAGGCAGCCACCCGGCAAGGGCTTGGAGTGGATCGG CGTCATTTGGGGCGACGGAATCACCGACTATAACCCATCACTCAAATCTCGGGTCA CCATCTCCAAGGATACCAGTAAGAATCAGTTCAGCCTGAAACTGTCATCCGTCACA GCTGCGGACACCGCCGTGTACTACTGTGTGACAGGACTTTTTGACTACTGGGGCCA GGGGACCCTGGTAACAGTTAGCTCCaccacgacgccagcgccgcgaccaccaacaccggcgcccaccatcgc gtcgcagcccctgtccctgcgcccagaggcgtgccggccagcggcgggggcgcagtgcacacgaggggctggacttcgcctgtg atatctacatctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaa ctcctgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaaga aggaggatgtgaactgagagtgaagttcagcaggagcgcagacgcccccgcgtacaagcagggccagaaccagctctataacgagct caatctaggacgaagagaggagtacgatgttttggacaagagacgtggccgggaccctgagatgggggaaagccgagaaggaaga accctcaggaaggcctgtacaatgaactgcagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccgga ggggcaaggggcacgatggcctttaccagggtctcagtacagccaccaaggacacctacgacgcccttcacatgcaggccctgccccc tcgc
174	atggccttaccagtgaccgccttgctcctgccgctggccttgctgctccacgccgccaggccgCAGGCGGTAGTCACCCA GGAGCCAAGTCTCACGGTGAGCCCCGGCGGTACCGTCACACTTACATGCGGAAGCT CTACCGGGGCTGTGACCACAAGCAACTACGCATCCTGGGTCCAGCAGAAACCCGGT CAGGCATTCCGGGGCCTCATTGGTGGGACAAATAACAGAGCCCCGGGTGTTCCCGC CCGATTTTCTGGCAGTCTTCTGGGAGGAAAGGCCGCTCTGACAATATCTGGCGCAC AGCCCGAAGACGAGGCCGAGTACTATTGCGTGTTGTGGTATAGCGACCACTGGGTA TTCGGTGGAGGAACAAAGCTGACAGTGCTCGGCGGTGGAGGGAGTGGTGGCGGTG GCAGCGGAGGGGGCGGATCACAAGTGCAATTGCAGGAGAGTGGACCTGGACTCGT GAAACCATCTGAAACACTCTCCATAACTTGTACGGTTTCAGGGTTCCTGCTGACAG ACTATGGAGTAAACTGGGTCAGGCAGCCACCCGGCAAGGGCTTGGAGTGGCTCGG CGTCATTTGGGGCGACGGAATCACCGACTATAACCCATCACTCAAATCTCGGTTGA CCGTGTCCAAGGATACCAGTAAGAATCAGGTCAGCCTGAAAATGTCATCCCTGACA GCTGCGGACACCGCCGTGTACTACTGTGTGACAGGACTTTTTGACTACTGGGGCCA GGGGACCCTGTTGACAGTTAGCTCCaccacgacgccagcgccgcgaccaccaacaccggcgcccaccatcgc gtcgcagcccctgtccctgcgcccagaggcgtgccggccagcggcgggggcgcagtgcacacgaggggctggacttcgcctgtg atatctacatctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaa ctcctgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaaga aggaggatgtgaactgagagtgaagttcagcaggagcgcagacgcccccgcgtacaagcagggccagaaccagctctataacgagct caatctaggacgaagagaggagtacgatgttttggacaagagacgtggccgggaccctgagatgggggaaagccgagaaggaaga accctcaggaaggcctgtacaatgaactgcagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccgga ggggcaaggggcacgatggcctttaccagggtctcagtacagccaccaaggacacctacgacgcccttcacatgcaggccctgccccc tcgc

Table 53. humanized GCN4 scFv in CAR–Nucleotide Sequence (DNA sequence of a humanized scFv of the murine, phage affinity matured 52SR4 scFv specific for the GCN4 peptide epitope. The sequence is in the open reading frame of the CAR which includes the leader sequence)	
SEQ ID NO	**SEQUENCE**
175	atggccttaccagtgaccgccttgctcctgccgctggccttgctgctccacgccgccaggccgCAGGCGGTAGTCACCCA GGAGCCAAGTCTCACGGTGAGCCCCGGCGGTACCGTCACACTTACATGCGGAAGCT CTACCGGGGCTGTGACCACAAGCAACTACGCATCCTGGGTCCAGCAGAAACCCGAT CACCTGTTCCGGGGCCTCATTGGTGGGACAAATAACAGAGCCCCGGGTGTTCCCGC CCGATTTTCTGGCAGTCTTCTGGGAGGAAAGGCCGCTCTGACAATATCTGGCGCAC AGCCCGAAGACGAGGCCGAGTACTATTGCGTGTTGTGGTATAGCGACCACTGGGTA TTCGGTGGAGGAACAAAGCTGACAGTGCTCGGCGGTGGAGGGAGTGGTGGCGGTG GCAGCGGAGGGGGCGGATCACAAGTGCAATTGCAGGAGAGTGGACCTGGACTCGT GAAACCATCTGAAACACTCTCCCTTACTTGTACGGTTTCAGGGTTCCTGCTGACAGA CTATGGAGTAAACTGGATCAGGCAGCCACCCGGCAAGGGCTTGGAGTGGATCGGC GTCATTTGGGGCGACGGAATCACCGACTATAACCCATCACTCAAATCTCGGGTCAC CATCTCCAAGGATACGAGTAAGAATCAGTTCAGCCTGAAACTCTCATCCGTTACAG CTGCGGACACCGCCGTGTACTACTGTGTGACAGGACTTTTTGACTACTGGGGCCAG GGGACCCTGGTAACAGTTAGCTCCaccacgacgccagcgccgcgaccaccaacaccggcgcccaccatcgcgt cgcagcccctgtccctgcgcccagaggcgtgccggccagcggcgggggggcgcagtgcacacgaggggggctggacttcgcctgtgat atctacatctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaact cctgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaag gaggatgtgaactgagagtgaagttcagcaggagcgcagacgcccccgcgtacaagcagggccagaaccagctctataacgagctca atctaggacgaagagaggagtacgatgttttggacaagagacgtggccgggaccctgagatgggggggaaagccgagaaggaagaac cctcaggaaggcctgtacaatgaactgcagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccggagg ggcaaggggcacgatggcctttaccagggtctcagtacagccaccaaggacacctacgacgcccttcacatgcaggccctgcccccctc gc
176	atggccttaccagtgaccgccttgctcctgccgctggccttgctgctccacgccgccaggccgCAGGCGGTAGTCACCCA GGAGCCAAGTCTCACGGTGAGCCCCGGCGGTACCGTCACACTTACATGCGGAAGCT CTACCGGGGCTGTGACCACAAGCAACTACGCATCCTGGGTCCAGCAGAAACCCGAC CATCTGTTTCGGGGCCTCATTGGTGGGACAAATAACAGAGCCCCGGGTGTTCCCGC CCGATTTTCTGGCAGTCTTCTGGGAGGAAAGGCCGCTCTGACAATATCTGGCGCAC AGCCCGAAGACGAGGCCGAGTACTATTGCGTGTTGTGGTATAGCGACCACTGGGTA TTCGGTGGAGGAACAAAGCTGACAGTGCTCGGCGGTGGAGGGAGTGGTGGCGGTG GCAGCGGAGGGGGCGGATCACAAGTGCAATTGCAGGAGAGTGGACCTGGACTCGT GAAACCATCTGAAACACTCTCCATTACTTGTACGGTTTCAGGGTTCCTGCTGACAGA CTATGGAGTAAACTGGGTGAGGCAGCCACCCGGCAAGGGCTTGGAGTGGCTCGGC GTCATTTGGGGCGACGGAATCACCGACTATAACCCATCACTCAAATCTCGGTTGAC CGTGTCCAAGGATACCAGTAAGAATCAGGTGAGCCTGAAAATGTCATCCCTGACAG CTGCGGACACCGCCGTGTACTACTGTGTGACAGGACTTTTTGACTACTGGGGCCAG GGGACCCTGCTGACAGTTAGCTCCaccacgacgccagcgccgcgaccaccaacaccggcgcccaccatcgcgt cgcagcccctgtccctgcgcccagaggcgtgccggccagcggcgggggggcgcagtgcacacgaggggggctggacttcgcctgtgat atctacatctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaact cctgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaag gaggatgtgaactgagagtgaagttcagcaggagcgcagacgcccccgcgtacaagcagggccagaaccagctctataacgagctca atctaggacgaagagaggagtacgatgttttggacaagagacgtggccgggaccctgagatgggggggaaagccgagaaggaagaac cctcaggaaggcctgtacaatgaactgcagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccggagg ggcaaggggcacgatggcctttaccagggtctcagtacagccaccaaggacacctacgacgcccttcacatgcaggccctgcccccctc gc

Table 54. Additional Antibody and sCAR Amino Acid Sequences	
SEQ ID NO	**SEQUENCE**

177	EIVLTQSPATLSLSPGERATLSCRASQSVSSYLAWYQQKPGQAPRLLIYDASNRATGIPARFSGSGSGT DFTLTISSLEPEDFAVYYCQQRSNWPITFGQGTRLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCLLNNF YPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPV TKSFNRGEC
178	EVQLVESGGGLVQPGRSLRLSCAASGFTFNDYAMHWVRQAPGKGLEWVSTISWNSGSIGYADSVKG RFTISRDNAKKSLYLQMNSLRAEDTALYYCAKDIQYGNYYYGMDVWGQGTTVTVSSASTKGPSVFP LAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGT QTYICNVNHKPSNTKVDKKVEPKSC
179	DKTHTCPPCPAPPVAGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAK TKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKGLPSSIEKTISKAKGQPREPQVYTLPPSRD ELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVF SCSVMHEALHNHYTQKSLSLSPGK
180	MALPVTALLLPLALLLHAARPDAVVTQESALTSSPGETVTLTCRSSTGAVTTSNYASWVQEKPDHLF TGLIGGTNNRAPGVPARFSGSLIGDKAALTITGAQTEDEAIYFCVLWYSDHWVFGGGTKLTVLGGGG GSGGGGSGGGGSGGGGSDVQLQESGPGLVAPSQSLSITCTVSGFLLTDYGVNWVRQSPGKGLEWLG VIWGDGITDYNSALKSRLSVTKDNSKSQVFLKMNSLQSGDSARYYCVTGLFDYWGQGTTLTVSSTTT PAPRPPTPAPTIASQPLSLRPEACRPAAGGAVHTRGLDFACDIYIWAPLAGTCGVLLLSLVITLYCKRG RKKLLYIFKQPFMRPVQTTQEEDGCSCRFPEEEEGGCELRVKFSRSADAPAYKQGQNQLYNELNLGR REEYDVLDKRRGRDPEMGGKPRRKNPQEGLYNELQKDKMAEAYSEIGMKGERRRGKGHDGLYQG LSTATKDTYDALHMQALPPR
181	MALPVTALLLPLALLLHAARPDIQMTQTTSSLSASLGDRVTISCRASQDISKYLNWYQQKPDGTVKLL IYHTSRLHSGVPSRFSGSGSGTDYSLTISNLEQEDIATYFCQQGNTLPYTFGGGTKLEITGGGGSGGGGS GGGGSEVKLQESGPGLVAPSQSLSVTCTVSGVSLPDYGVSWIRQPPRKGLEWLGVIWGSETTYYNSA LKSRLTIIKDNSKSQVFLKMNSLQTDDTAIYYCAKHYYYGGSYAMDYWGQGTSVTVSSTTTPAPRPP TPAPTIASQPLSLRPEACRPAAGGAVHTRGLDFACDIYIWAPLAGTCGVLLLSLVITLYCKRGRKKLLY IFKQPFMRPVQTTQEEDGCSCRFPEEEEGGCELRVKFSRSADAPAYKQGQNQLYNELNLGRREEYDV LDKRRGRDPEMGGKPRRKNPQEGLYNELQKDKMAEAYSEIGMKGERRRGKGHDGLYQGLSTATKD TYDALHMQALPPR

Table 55: CAR-EC switch target ing moiety (antibodies) with GCN4 peptide –Amino Acid Sequence		
Name	**Light chain**	**Heavy Chain**
anti-Her2 Fab wild type	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGEC (SEQ ID NO:261)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHT (SEQ ID NO:262)
anti-Her2 Fab (LCNT)	NYHLENEVARLKKLGGGGSDIQMTQSPSSLSAS VGDRVTITCRASQDVNTAVAWYQQKPGKAPK LLIYSASFLYSGVPSRFSGSRSGTDFTLTISSLQPE DFATYYCQQHYTTPPTFGQGTKLEIKRTVAAPS VFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQ WKVDNALQSGNSQESVTEQDSKDSTYSLSSTLT LSKADYEKHKVYACEVTHQGLSSPVTKSFNRGE C (SEQ ID NO:263)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHT (SEQ ID NO:262)
anti-Her2 Fab (LCCT)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGECGGGGSNYHLENEVARLKKL (SEQ ID NO:264)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHT (SEQ ID NO:262)

Table 55: CAR-EC switch target ing moiety (antibodies) with GCN4 peptide –Amino Acid Sequence		
Name	**Light chain**	**Heavy Chain**
anti-Her2 Fab (HCNT)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGEC (SEQ ID NO:261)	NYHLENEVARLKKLGGGGSEVQLVESGGGLVQPGGSLRLSC AASGFNIKDTYIHWVRQAPGKGLEWVARIYPTNGYTRYADS VKGRFTISADTSKNTAYLQMNSLRAEDTAVYYCSRWGGDG FYAMDYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGTAA LGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLS SVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC (SEQ ID NO:265)
anti-Her2 Fab (HCCT)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGEC (SEQ ID NO:261)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHTGGGGSNYHLENEVARLK KL (SEQ ID NO:266)
anti-Her2 Fab (NTBV)	NYHLENEVARLKKLGGGGSDIQMTQSPSSLSAS VGDRVTITCRASQDVNTAVAWYQQKPGKAPK LLIYSASFLYSGVPSRFSGSRSGTDFTLTISSLQPE DFATYYCQQHYTTPPTFGQGTKLEIKRTVAAPS VFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQ WKVDNALQSGNSQESVTEQDSKDSTYSLSSTLT LSKADYEKHKVYACEVTHQGLSSPVTKSFNRGE C (SEQ ID NO:263)	NYHLENEVARLKKLGGGGSEVQLVESGGGLVQPGGSLRLSC AASGFNIKDTYIHWVRQAPGKGLEWVARIYPTNGYTRYADS VKGRFTISADTSKNTAYLQMNSLRAEDTAVYYCSRWGGDG FYAMDYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGTAA LGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLS SVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC (SEQ ID NO:265)
anti-Her2 Fab (CTBV)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGECGGGGSNYHLENEVARLKKL (SEQ ID NO:264)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHTGGGGSNYHLENEVARLK KL (SEQ ID NO:266)

Table 56: CAR-EC switch targeting moiety (antibodies) with FLAG tag –Amino Acid Sequence		
Name	**Light chain**	**Heavy Chain**
anti-Her2 Fab wild type	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGEC (SEQ ID NO:261)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHT (SEQ ID NO:262)
anti-Her2 Fab (LCNT)	DYKDDDDKGGGGSGGGGSDIQMTQSPSSLSA SVGDRVTITCRASQDVNTAVAWYQQKPGKAP KLLIYSASFLYSGVPSRFSGSRSGTDFTLTISSLQP EDFATYYCQQHYTTPPTFGQGTKLEIKRTVAAP SVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQ WKVDNALQSGNSQESVTEQDSKDSTYSLSSTLT LSKADYEKHKVYACEVTHQGLSSPVTKSFNRGE C (SEQ ID NO:267)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHT (SEQ ID NO:262)

Table 56: CAR-EC switch targeting moiety (antibodies) with FLAG tag –Amino Acid Sequence		
Name	**Light chain**	**Heavy Chain**
anti-Her2 Fab (LCCT)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGECGGGGSGGGGSDYKDDDDK (SEQ ID NO:268)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHT (SEQ ID NO:262)
anti-Her2 Fab (HCNT)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGEC (SEQ ID NO:261)	DYKDDDDKGGGGSGGGGSEVQLVESGGGLVQPGGSLRLS CAASGFNIKDTYIHWVRQAPGKGLEWVARIYPTNGYTRYA DSVKGRFTISADTSKNTAYLQMNSLRAEDTAVYYCSRWGG DGFYAMDYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGT AALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLY SLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDK THT (SEQ ID NO:269)
anti-Her2 Fab (HCCT)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGEC (SEQ ID NO:261)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHTGGGGSGGGGSDYKDDD DK (SEQ ID NO:270)
anti-Her2 Fab (NTBV)	DYKDDDDKGGGGSGGGGSDIQMTQSPSSLSA SVGDRVTITCRASQDVNTAVAWYQQKPGKAP KLLIYSASFLYSGVPSRFSGSRSGTDFTLTISSLQP EDFATYYCQQHYTTPPTFGQGTKLEIKRTVAAP SVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQ WKVDNALQSGNSQESVTEQDSKDSTYSLSSTLT LSKADYEKHKVYACEVTHQGLSSPVTKSFNRGE C (SEQ ID NO:267)	DYKDDDDKGGGGSGGGGSEVQLVESGGGLVQPGGSLRLS CAASGFNIKDTYIHWVRQAPGKGLEWVARIYPTNGYTRYA DSVKGRFTISADTSKNTAYLQMNSLRAEDTAVYYCSRWGG DGFYAMDYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGT AALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLY SLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDK THT (SEQ ID NO:269)
anti-Her2 Fab (CTBV)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAV AWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRS GTDFTLTISSLQPEDFATYYCQQHYTTPPTFGQ GTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCL LNNFYPREAKVQWKVDNALQSGNSQESVTEQ DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQG LSSPVTKSFNRGECGGGGSGGGGSDYKDDDDK (SEQ ID NO:268)	EVQLVESGGGLVQPGGSLRLSCAASGFNIKDTYIHWVRQAP GKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQ MNSLRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSS ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWN SGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNV NHKPSNTKVDKKVEPKSCDKTHTGGGGSGGGGSDYKDDD DK (SEQ ID NO:270)

Table 57: sCAR seequences	
Name	**Sequence**
CAR-Her2 (CD8 hinge)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAVAWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRSGTD FTLTISSLQPEDFATYYCQQHYTTPPTFGQGTKVEIKRTGGGGSGGGGSGGGGSEVQLVESGGGLVQPG GSLRLSCAASGFNIKDTYIHWVRQAPGKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQMNS LRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSSAAATTTPAPRPPTPAPTIASQPLSLRPEACRPAA GGAVHTRGLDFACDIYIWAPLAGTCGVLLLSLVITLYCKRGRKKLLYIFKQPFMRPVQTTQEEDGCSCRFP EEEEGGCELRVKFSRSADAPAYKQGQNQLYNELNLGRREEYDVLDKRRGRDPEMGGKPRRKNPQEGLY NELQKDKMAEAYSEIGMKGERRRGKGHDGLYQGLSTATKDTYDALHMQALPPR (SEQ ID NO:271)

Table 57: sCAR seequences	
Name	**Sequence**
CAR-Her2 (IgG4m hinge)	DIQMTQSPSSLSASVGDRVTITCRASQDVNTAVAWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSRSGTD FTLTISSLQPEDFATYYCQQHYTTPPTFGQGTKVEIKRTGGGGSGGGGSGGGGSEVQLVESGGGLVQPG GSLRLSCAASGFNIKDTYIHWVRQAPGKGLEWVARIYPTNGYTRYADSVKGRFTISADTSKNTAYLQMNS LRAEDTAVYYCSRWGGDGFYAMDYWGQGTLVTVSSAAAESKYGPPCPPCPDIYIWAPLAGTCGVLLLSL VITLYCKRGRKKLLYIFKQPFMRPVQTTQEEDGCSCRFPEEEEGGCELRVKFSRSADAPAYKQGQNQLYN ELNLGRREEYDVLDKRRGRDPEMGGKPRRKNPQEGLYNELQKDKMAEAYSEIGMKGERRRGKGHDGL YQGLSTATKDTYDALHMQALPPR (SEQ ID NO:272)
CAR-GCN4 (CD8 hinge)	DAVVTQESALTSSPGETVTLTCRSSTGAVTTSNYASWVQEKPDHLFTGLIGGTNNRAPGVPARFSGSLIG DKAALTITGAQTEDEAIYFCVLWYSDHWVFGGGTKLTVLGGGGGSGGGGSGGGGSGGGGSDVQLQES GPGLVAPSQSLSITCTVSGFLLTDYGVNWVRQSPGKGLEWLGVIWGDGITDYNSALKSRLSVTKDNSKS QVFLKMNSLQSGDSARYYCVTGLFDYWGQGTTLTVSSTTTPAPRPPTPAPTIASQPLSLRPEACRPAAGG AVHTRGLDFACDIYIWAPLAGTCGVLLLSLVITLYCKRGRKKLLYIFKQPFMRPVQTTQEEDGCSCRFPEEE EGGCELRVKFSRSADAPAYKQGQNQLYNELNLGRREEYDVLDKRRGRDPEMGGKPRRKNPQEGLYNEL QKDKMAEAYSEIGMKGERRRGKGHDGLYQGLSTATKDTYDALHMQALPPR (SEQ ID NO:273)
CAR-GCN4 (IgG4m hinge)	DAVVTQESALTSSPGETVTLTCRSSTGAVTTSNYASWVQEKPDHLFTGLIGGTNNRAPGVPARFSGSLIG DKAALTITGAQTEDEAIYFCVLWYSDHWVFGGGTKLTVLGGGGGSGGGGSGGGGSGGGGSDVQLQES GPGLVAPSQSLSITCTVSGFLLTDYGVNWVRQSPGKGLEWLGVIWGDGITDYNSALKSRLSVTKDNSKS QVFLKMNSLQSGDSARYYCVTGLFDYWGQGTTLTVSSESKYGPPCPPCPDIYIWAPLAGTCGVLLLSLVIT LYCKRGRKKLLYIFKQPFMRPVQTTQEEDGCSCRFPEEEEGGCELRVKFSRSADAPAYKQGQNQLYNELN LGRREEYDVLDKRRGRDPEMGGKPRRKNPQEGLYNELQKDKMAEAYSEIGMKGERRRGKGHDGLYQG LSTATKDTYDALHMQALPPR (SEQ ID NO:274)
CAR-FLAG (CD8 hinge)	DIVMTQTPLTLSVTFGQPASISCKSSQSLLDSDGQTYLNWLLQRPGQSPKRLIYLVSKLDSGVPDRFTGSG SGTDFTLKISRVEAEDLGVYYCWQGTHFPWTFGGGTKLEIKGGGGSGGGGSGGGGSEVQLQQSGAELV KPGASVKLSCTASGFNIKDYYMHWVKQRTEQGLEWIGRIDPEDGETKYAPKFQGKATITADTSSKTAYLQ LSSLTSEDTAVYYCARLKGGYWGQGTTLTVSSTTTPAPRPPTPAPTIASQPLSLRPEACRPAAGGAVHTRG LDFACDIYIWAPLAGTCGVLLLSLVITLYCKRGRKKLLYIFKQPFMRPVQTTQEEDGCSCRFPEEEEGGCEL RVKFSRSADAPAYKQGQNQLYNELNLGRREEYDVLDKRRGRDPEMGGKPRRKNPQEGLYNELQKDKM AEAYSEIGMKGERRRGKGHDGLYQGLSTATKDTYDALHMQALPPR (SEQ ID NO:275)
CAR-FLAG (IgG4m hinge)	DIVMTQTPLTLSVTFGQPASISCKSSQSLLDSDGQTYLNWLLQRPGQSPKRLIYLVSKLDSGVPDRFTGSG SGTDFTLKISRVEAEDLGVYYCWQGTHFPWTFGGGTKLEIKGGGGSGGGGSGGGGSEVQLQQSGAELV KPGASVKLSCTASGFNIKDYYMHWVKQRTEQGLEWIGRIDPEDGETKYAPKFQGKATITADTSSKTAYLQ LSSLTSEDTAVYYCARLKGGYWGQGTTLTVSSESKYGPPCPPCPDIYIWAPLAGTCGVLLLSLVITLYCKRG RKKLLYIFKQPFMRPVQTTQEEDGCSCRFPEEEEGGCELRVKFSRSADAPAYKQGQNQLYNELNLGRREE YDVLDKRRGRDPEMGGKPRRKNPQEGLYNELQKDKMAEAYSEIGMKGERRRGKGHDGLYQGLSTATK DTYDALHMQALPPR (SEQ ID NO:276)

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	**SEQUENCE**
182	GAGGTGCAGCTGGTCGAGTCAGGCGGAGGCCTGGTTCAGCCAGGGAGATCCCTCAGGC TTTCCTGCGCCGCCTCCGGTTTTACCTTCAACGACTACGCTATGCACTGGGTTCGCCAGG CTCCCGGAAAGGGACTTGAATGGGTGAGCACTATCAGCTGGAATTCTGGAAGCATTGGG TATGCCGACTCCGTCAAGGGCCGCTTTACTATTTCTCGGGATAATGCGAAGAAGTCTCTG TACCTGCAGATGAACAGTCTTCGGGCAGAAGACACGGCTCTTTACTATTGCGCAAAAGA CATCCAGTACGGAAACTATTATTACGGAATGGATGTGTGGGGTCAGGGCACCACTGTGA CAGTAAGCAGTGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTT CCGGGGGAGGCGGTTCTGAAATCGTCCTGACGCAGTCACCTGCAACCCTGAGTCTCAGC CCTGGTGAGCGGGCCACCCTGAGCTGCAGGGCCAGCCAGAGTGTATCTTCTTACCTGGC TTGGTATCAGCAGAAACCAGGACAGGCCCCAAGACTGCTGATCTACGACGCTTCCAATA

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
	GAGCCACGGGCATCCCTGCCCGATTTTCCGGATCAGGGTCCGGTACAGATTTCACGCTG ACCATCAGCTCCCTCGAGCCCGAAGATTTTGCTGTGTATTATTGCCAGCAGCGGTCCAAT TGGCCCATTACCTTCGGTCAGGGGACCAGGCTGGAGATTAAAaccacgacgccagcgccgcgaccacc aacaccggcgcccaccatcgcgtcgcagcccctgtccctgcgcccagaggcgtgccggccagcggcgggggcgcagtgcacacgaggg ggctggacttcgcctgtgatatctacatctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacgg ggcagaaagaaactcctgtatatattcaaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaa gaagaagaaggaggatgtgaactgagagtgaagttcagcaggagcgcagacgccccgcgtacaagcagggccagaaccagctctataacg agctcaatctaggacgaagagaggagtacgatgttttggacaagagacgtggccgggaccctgagatgggggaaagccgagaaggaagaa ccctcaggaaggcctgtacaatgaactgcagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccggaggggc aaggggcacgatggcctttaccagggtctcagtacagccaccaaggacacctacgacgcccttcacatgcaggccctgccccctcgc
183	caggctgtggtgactcaggagccctcactgactgtgtccccaggagggacagtcactctcacctgtggctccagcactggagctgtcaccacttc caactatgcctcatgggtgcaggagaagcctgAccaCCTCTTCagggggctgattggtggcacaaacaacagggctcctggggtgcctg cccggttctcaggctccctccttgggggcaaagctgccctgaccatttcgggtgcgcagcctgaggatgaggctatttatttctgcgtgctctggtat agtgaccattgggtgttcggcggagggaccaagctgaccgtcctaGGCGGAGGAGGAGGTTCAGGAGGAGGAGGT AGCGGGGGAGGCGGTTCCGGGGGAGGCGGTTCTcaggtgcagctgcagcagtcgggcccaggactggtgaag ccttcggagaccctgtccatcacctgcactgtctctggtttctccctgaccgactacggcgtaaactgggtgcggcagccccgagggaagggact ggagtggctgggggtgatctggggtgacgggagcaccgactacaaccccctccctcaagagtcgactgaccgtgtccaaggacaactccaagaa ccaggtgtccctgaagatgagctctctgaccgccgcagacacggccgtgtattactgtgtcaccggcctgttcgactactggggccagggcaccc tgctgaccgtctcctca
184	caggctgtggtgactcaggagccctcactgactgtgtccccaggagggacagtcactctcacctgtggctccagcactggagctgtcaccacttc caactatgcctcatgggtgcaggagaagcctgAccaCCTCTTCagggggctgattggtggcacaaacaacagggctcctggggtgcctg cccggttctcaggctccctccttgggggcaaagctgccctgaccatttcgggtgcgcagcctgaggatgaggctatttatttctgcgtgctctggtat agtgaccattgggtgttcggcggagggaccaagctgaccgtcctaGGCGGAGGAGGAGGTTCAGGAGGCGGAGGT AGCGGGGGAGGCGGTTCCGGGGGAGGCGGTTCTcaggtgcagctgcagCAGtcgggcccaggactggtgaa gccttcggagaccctgtccatcacctgcactgtctctggtttcCTGctgaccgactacggcgtaaactgggtgcggcagcccccagggaaggg actggagtggctgggggtgatctggggtgacgggATCaccgactacaaccctccctcaagagtcgactgaccgtgtccaaggacACAtc caagaaccaggtgtccctgaagatgagctctctgaccgccgcagacacggccCGGtattactgtgtcaccggcctgttcgactactggggcca gggcaccACCctgaccgtctcctcaGAAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCgatatctacatct gggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaactcctgtatatattcaaa caaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaaggaggatgtgaactgagagt gaagttcagcaggagcgcagacgccccgcgtacaagcagggccagaaccagctctataacgagctcaatctaggacgaagagaggagtac gatgttttggacaagagacgtggccgggaccctgagatgggggaaagccgagaaggaagaaccctcaggaaggcctgtacaatgaactgca gaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccggaggggcaaggggcacgatggcctttaccagggtctc agtacagccaccaaggacacctacgacgcccttcacatgcaggccctgccccctcgc
185	caggctgtggtgactcaggagccctcactgactgtgtccccaggagggacagtcactctcacctgtggctccagcactggagctgtcaccacttc caactatgcctcatgggtgcaggagaagcctgAccaCCTCTTCagggggctgattggtggcacaaacaacagggctcctggggtgcctg cccggttctcaggctccctccttgggggcaaagctgccctgaccatttcgggtgcgcagcctgaggatgaggctatttatttctgcgtgctctggtat agtgaccattgggtgttcggcggagggaccaagctgaccgtcctaGGCGGAGGAGGAGGTTCAGGAGGcGGAGGT AGCGGGGGAGGCGGTTCCGGGGGAGGCGGTTCTcaggtgcagctgcagcagtcgggcccaggactggtgaag ccttcggagaccctgtccatcacctgcactgtctctggtttctccctgaccgactacggcgtaaactgggtgcggcagccccgagggaagggact ggagtggctgggggtgatctggggtgacgggagcaccgactacaaccccctccctcaagagtcgactgaccgtgtccaaggacaCctccaaga accaggtgtccctgaagatgagctctctgaccgccgcagacacggccgtgtattactgtgtcaccggcctgttcgactactggggccagggcacc ctgctgaccgtctcctcaGAAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCgatatctacatctgggcgccct tggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaactcctgtatatattcaaacaaccattta tgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaaggaggatgtgaactgagagtgaagttcag caggagcgcagacgccccgcgtacaagcagggccagaaccagctctataacgagctcaatctaggacgaagagaggagtacgatgttttgg acaagagacgtggccgggaccctgagatgggggaaagccgagaaggaagaaccctcaggaaggcctgtacaatgaactgcagaaagataa gatggcggaggcctacagtgagattgggatgaaaggcgagcgccggaggggcaaggggcacgatggccttaccagggtctcagtacagcc accaaggacacctacgacgcccttcacatgcaggccctgccccctcgc
186	GACATCCAGCTGACCCAGTCCCCCTCCTCCCTGTCCGCCTCCGTGGGCGACCGGGTGAC CATGAGCTGCAAGTCCTCCCAGTCCGTGCTGTACTCCGCCAACCACAAGAACTACCTGG CCTGGTACCAGCAGAAGCCCGGCAAGGCCCCCAAGCTGCTGATCTACTGGGCCAGCACC CGCGAGAGCGGCGTGCCCTCCCGGTTCTCCGGCTCCGGCTCCGGCACCGACTTCACCTTC ACCATCTCCTCCCTGCAGCCCGAGGACATCGCCACCTACTACTGCCACCAGTACCTGTCC TCCTGGACCTTCGGCGGCGGCACCAAGCTGGAGATCAAGCGCacggtgGCCGCCCCCAGTG TCTTCATTTTCCCCCCTTCCGATGAGCAGCTGAAGAGCGGTACAGCCTCTGTTGTTTGTC TGCTGAACAACTTCTATCCACGCGAGGCCAAGGTGCAGTGGAAAGTTGATAACGCGCTG CAGAGTGGCAACTCCCAGGAGTCTGTGACAGAGCAGGACAGTAAAGACAGCACATATT

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
	CCCTGTCTAGCACACTGACTCTGTCCAAGGCTGACTATGAGAAGCACAAGGTGTACGCT TGCGAGGTCACCCACCAGGGACTGAGTTCTCCTGTGACCAAGTCCTTCAATCGCGGCGA GTGTtaa
187	CAGGTGCAGCTGGTGCAGTCCGGCGCCGAGGTGAAGAAGCCCGGCTCCTCCGTGAAGG TGTCCTGCAAGGCCTCCGGCTACACCTTCACCTCCTACTGGCTGCACTGGGTGCGGCAG GCCCCCGGCCAGGGCCTGGAGTGGATCGGCTACATCAACCCCCGGAACGACTACACCG AGTACAACCAGAACTTCAAGGACAAGGCCACCATCACCGCCGACGAGTCCACCAACAC CGCCTACATGGAGCTGTCCTCCCTGCGGTCCGAGGACACCGCCTTCTACTTCTGCGCCCG GCGGGACATCACCACCTTCTACTGGGGCCAGGGCACCACTGTGACCGTGTCCTCCGCCA GGACCAAAGGACCGTCCGTCTTTCCTCTGGCCCCTTCCTCTAAGTCCACAAGCGGTGGG ACCGCAGCACTGGGATGCCTGGTGAAGGATTACTTCCCTGAGCCGGTGACCGTGTCCTG GAACTCCGGAGCTCTCACCTCCGGTGTCCATACCTTTCCTGCCGTCCTGCAGTCCTCCGG CCTGTACAGCCTCTCTAGCGTCGTGACTGTGCCCTCCAGCTCCCTGGGCACCCAAACTTA TATCTGCAATGTTAACCACAAGCCTTCTAATACCAAGGTCGACAAGAAAGTGGAGCCGA AGAGCTGTtaa
188	aactatcacctggaaaacgaagtggcaaggctgaaaaaactgggcggggcggaagtGACATCCAGCTGACCCAGTCCC CCTCCTCCCTGTCCGCCTCCGTGGGCGACCGGGTGACCATGAGCTGCAAGTCCTCCCAGT CCGTGCTGTACTCCGCCAACCACAAGAACTACCTGGCCTGGTACCAGCAGAAGCCCGGC AAGGCCCCCAAGCTGCTGATCTACTGGGCCAGCACCCGCGAGAGCGGCGTGCCCTCCCG GTTCTCCGGCTCCGGCTCCGGCACCGACTTCACCTTCACCATCTCCTCCCTGCAGCCCGA GGACATCGCCACCTACTACTGCCACCAGTACCTGTCCTCCTGGACCTTCGGCGGCGGCA CCAAGCTGGAGATCAAGCGCacggtgGCCGCCCCCAGTGTCTTCATTTTCCCCCCTTCCGAT GAGCAGCTGAAGAGCGGTACAGCCTCTGTTGTTTGTCTGCTGAACAACTTCTATCCACG CGAGGCCAAGGTGCAGTGGAAAGTTGATAACGCGCTGCAGAGTGGCAACTCCCAGGAG TCTGTGACAGAGCAGGACAGTAAAGACAGCACATATTCCCTGTCTAGCACACTGACTCT GTCCAAGGCTGACTATGAGAAGCACAAGGTGTACGCTTGCGAGGTCACCCACCAGGGA CTGAGTTCTCCTGTGACCAAGTCCTTCAATCGCGGCGAGTGTtaa
189	GACATCCAGCTGACCCAGTCCCCCTCCTCCCTGTCCGCCTCCGTGGGCGACCGGGTGAC CATGAGCTGCAAGTCCTCCCAGTCCGTGCTGTACTCCGCCAACCACAAGAACTACCTGG CCTGGTACCAGCAGAAGCCCGGCAAGGCCCCCAAGCTGCTGATCTACTGGGCCAGCACC CGCGAGAGCGGCGTGCCCTCCCGGTTCTCCGGCTCCGGCTCCGGCACCGACTTCACCTTC ACCATCTCCTCCCTGCAGCCCGAGGACATCGCCACCTACTACTGCCACCAGTACCTGTCC TCCTGGACCTTCGGCGGCGGCACCAAGCTGGAGATCAAGCGCacggtgGCCGCCCCCAGTG TCTTCATTTTCCCCCCTTCCGATGAGCAGCTGAAGAGCGGTACAGCCTCTGTTGTTTGTC TGCTGAACAACTTCTATCCACGCGAGGCCAAGGTGCAGTGGAAAGTTGATAACGCGCTG CAGAGTGGCAACTCCCAGGAGTCTGTGACAGAGCAGGACAGTAAAGACAGCACATATT CCCTGTCTAGCACACTGACTCTGTCCAAGGCTGACTATGAGAAGCACAAGGTGTACGCT TGCGAGGTCACCCACCAGGGACTGAGTTCTCCTGTGACCAAGTCCTTCAATCGCGGCGA GTGTGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactctaa
190	aattatcatcttgaaaatgaggtcgctcgtctcaagaaactcctggttggcgaggccgcagctaaggaagccgcagctaaagccCAGGTGC AGCTGGTGCAGTCCGGCGCCGAGGTGAAGAAGCCCGGCTCCTCCGTGAAGGTGTCCTGC AAGGCCTCCGGCTACACCTTCACCTCCTACTGGCTGCACTGGGTGCGGCAGGCCCCCGG CCAGGGCCTGGAGTGGATCGGCTACATCAACCCCCGGAACGACTACACCGAGTACAAC CAGAACTTCAAGGACAAGGCCACCATCACCGCCGACGAGTCCACCAACACCGCCTACAT GGAGCTGTCCTCCCTGCGGTCCGAGGACACCGCCTTCTACTTCTGCGCCCGGCGGGACA TCACCACCTTCTACTGGGGCCAGGGCACCACTGTGACCGTGTCCTCCGCCAGGACCAAA GGACCGTCCGTCTTTCCTCTGGCCCCTTCCTCTAAGTCCACAAGCGGTGGGACCGCAGCA CTGGGATGCCTGGTGAAGGATTACTTCCCTGAGCCGGTGACCGTGTCCTGGAACTCCGG AGCTCTCACCTCCGGTGTCCATACCTTTCCTGCCGTCCTGCAGTCCTCCGGCCTGTACAG CCTCTCTAGCGTCGTGACTGTGCCCTCCAGCTCCCTGGGCACCCAAACTTATATCTGCAA TGTTAACCACAAGCCTTCTAATACCAAGGTCGACAAGAAAGTGGAGCCGAAGAGCTGTt aa
191	CAGGTGCAGCTGGTGCAGTCCGGCGCCGAGGTGAAGAAGCCCGGCTCCTCCGTGAAGG TGTCCTGCAAGGCCTCCGGCTACACCTTCACCTCCTACTGGCTGCACTGGGTGCGGCAG GCCCCCGGCCAGGGCCTGGAGTGGATCGGCTACATCAACCCCCGGAACGACTACACCG AGTACAACCAGAACTTCAAGGACAAGGCCACCATCACCGCCGACGAGTCCACCAACAC CGCCTACATGGAGCTGTCCTCCCTGCGGTCCGAGGACACCGCCTTCTACTTCTGCGCCCG GCGGGACATCACCACCTTCTACTGGGGCCAGGGCACCACTGTGACCGTGTCCTCCGCCA

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
	GGACCAAAGGACCGTCCGTCTTTCCTCTGGCCCCTTCCTCTAAGTCCACAAGCGGTGGG ACCGCAGCACTGGGATGCCTGGTGAAGGATTACTTCCCTGAGCCGGTGACCGTGTCCTG GAACTCCGGAGCTCTCACCTCCGGTGTCCATACCTTTCCTGCCGTCCTGCAGTCCTCCGG CCTGTACAGCCTCTCTAGCGTCGTGACTGTGCCCTCCAGCTCCCTGGGCACCCAAACTTA TATCTGCAATGTTAACCACAAGCCTTCTAATACCAAGGTCGACAAGAAAGTGGAGCCGA AGAGCTGTGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaactctaa
192	GACATCCAGCTGACCCAGTCCCCCTCCTCCCTGTCCGCCTCCGTGGGCGACCGGGTGAC CATGAGCTGCAAGTCCTCCCAGTCCGTGCTGTACTCCGCCAACCACAAGAACTACCTGG CCTGGTACCAGCAGAAGCCCGGCAAGGCCCCCAAGCTGCTGATCTACTGGGCCAGCACC CGCGAGAGCGGCGTGCCCTCCCGGTTCTCCGGCTCCGGCTCCGGCACCGACTTCACCTTC ACCATCTCCTCCCTGCAGCCCGAGGACATCGCCACCTACTACTGCCACCAGTACCTGTCC TCCTGGACCTTCGGCGGCGGCACCAAGCTGGAGATCAAGCGCacggtgGCCGCCCCCAGTG TCTTCATTTTCCCCCCTTCCGATGAGCAGCTGAAGAGCGGTACAGCCTCTGTTGTTTGTC TGCTGAACAACTTCTATCCACGCGAGGCCAAGGTGCAGTGGAAAGTTGATAACGCGCTG CAGAGTGGCAACTCCCAGGAGTCTGTGACAGAGCAGGACAGTAAAGACAGCACATATT CCCTGTCTAGCACACTGACTCTGTCCAAGGCTGACTATGAGAAGCACAAGGTGTACGCT TGCGAGGTCACCCACCAGGGACTGAGTTCTCCTGTGACCAAGTCCTTCAATCGCGGCGA GTGTGGCGGAGGCGGGAGCGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctcaagaaact ctaa
193	GACATCCAGCTGACCCAGTCCCCCTCCTCCCTGTCCGCCTCCGTGGGCGACCGGGTGAC CATGAGCTGCAAGTCCTCCCAGTCCGTGCTGTACTCCGCCAACCACAAGAACTACCTGG CCTGGTACCAGCAGAAGCCCGGCAAGGCCCCCAAGCTGCTGATCTACTGGGCCAGCACC CGCGAGAGCGGCGTGCCCTCCCGGTTCTCCGGCTCCGGCTCCGGCACCGACTTCACCTTC ACCATCTCCTCCCTGCAGCCCGAGGACATCGCCACCTACTACTGCCACCAGTACCTGTCC TCCTGGACCTTCGGCGGCGGCACCAAGCTGGAGATCAAGCGCacggtgGCCGCCCCCAGTG TCTTCATTTTCCCCCCTTCCGATGAGCAGCTGAAGAGCGGTACAGCCTCTGTTGTTTGTC TGCTGAACAACTTCTATCCACGCGAGGCCAAGGTGCAGTGGAAAGTTGATAACGCGCTG CAGAGTGGCAACTCCCAGGAGTCTGTGACAGAGCAGGACAGTAAAGACAGCACATATT CCCTGTCTAGCACACTGACTCTGTCCAAGGCTGACTATGAGAAGCACAAGGTGTACGCT TGCGAGGTCACCCACCAGGGACTGAGTTCTCCTGTGACCAAGTCCTTCAATCGCGGCGA GTGTGGCGGAGGCGGGAGCGGCGGAGGCGGGAGCGGCGGAGGCGGGAGCaattatcatcttgaa aatgaggtcgctcgtctcaagaaactctaa
194	CAGGTGCAGCTGGTGCAGTCCGGCGCCGAGGTGAAGAAGCCCGGCTCCTCCGTGAAGG TGTCCTGCAAGGCCTCCGGCTACACCTTCACCTCCTACTGGCTGCACTGGGTGCGGCAG GCCCCCGGCCAGGGCCTGGAGTGGATCGGCTACATCAACCCCCGGAACGACTACACCG AGTACAACCAGAACTTCAAGGACAAGGCCACCATCACCGCCGACGAGTCCACCAACAC CGCCTACATGGAGCTGTCCTCCCTGCGGTCCGAGGACACCGCCTTCTACTTCTGCGCCCG GCGGGACATCACCACCTTCTACTGGGGCCAGGGCACCACTGTGACCGTGTCCTCCGCCA GGACCAAAGGACCGTCCGTCTTTCCTCTGGCCCCTTCCTCTAAGTCCACAAGCGGTGGG ACCGCAGCACTGGGATGCCTGGTGAAGGATTACTTCCCTGAGCCGGTGACCGTGTCCTG GAACTCCGGAGCTCTCACCTCCGGTGTCCATACCTTTCCTGCCGTCCTGCAGTCCTCCGG CCTGTACAGCCTCTCTAGCGTCGTGACTGTGCCCTCCAGCTCCCTGGGCACCCAAACTTA TATCTGCAATGTTAACCACAAGCCTTCTAATACCAAGGTCGACAAGAAAGTGGAGCCGA AGAGCTGTGGCGGAGGCGGGAGCGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgtctca agaaactctaa
195	CAGGTGCAGCTGGTGCAGTCCGGCGCCGAGGTGAAGAAGCCCGGCTCCTCCGTGAAGG TGTCCTGCAAGGCCTCCGGCTACACCTTCACCTCCTACTGGCTGCACTGGGTGCGGCAG GCCCCCGGCCAGGGCCTGGAGTGGATCGGCTACATCAACCCCCGGAACGACTACACCG AGTACAACCAGAACTTCAAGGACAAGGCCACCATCACCGCCGACGAGTCCACCAACAC CGCCTACATGGAGCTGTCCTCCCTGCGGTCCGAGGACACCGCCTTCTACTTCTGCGCCCG GCGGGACATCACCACCTTCTACTGGGGCCAGGGCACCACTGTGACCGTGTCCTCCGCCA GGACCAAAGGACCGTCCGTCTTTCCTCTGGCCCCTTCCTCTAAGTCCACAAGCGGTGGG ACCGCAGCACTGGGATGCCTGGTGAAGGATTACTTCCCTGAGCCGGTGACCGTGTCCTG GAACTCCGGAGCTCTCACCTCCGGTGTCCATACCTTTCCTGCCGTCCTGCAGTCCTCCGG CCTGTACAGCCTCTCTAGCGTCGTGACTGTGCCCTCCAGCTCCCTGGGCACCCAAACTTA TATCTGCAATGTTAACCACAAGCCTTCTAATACCAAGGTCGACAAGAAAGTGGAGCCGA AGAGCTGTGGCGGAGGCGGGAGCGGCGGAGGCGGGAGCGGCGGAGGCGGGAGCaattatca tcttgaaaatgaggtcgctcgtctcaagaaactctaa

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
196	CAGGTGCAGCTGGTGCAGTCCGGCGCCGAGGTGAAGAAGCCCGGCTCCTCCGTGAAGG TGTCCTGCAAGGCCTCCGGCTACACCTTCACCTCCTACTGGCTGCACTGGGTGCGGCAG GCCCCCGGCCAGGGCCTGGAGTGGATCGGCTACATCAACCCCCGGAACGACTACACCG AGTACAACCAGAACTTCAAGGACAAGGCCACCATCACCGCCGACGAGTCCACCAACAC CGCCTACATGGAGCTGTCCTCCCTGCGGTCCGAGGACACCGCCTTCTACTTCTGCGCCCG GCGGGACATCACCACCTTCTACTGGGGCCAGGGCACCACTGTGACCGTGTCCTCCGCCA GGACCAAAGGACCGTCCGTCTTTCCTCTGGCCCCTTCCTCTAAGTCCACAAGCGGTGGG ACCGCAGCACTGGGATGCCTGGTGAAGGATTACTTCCCTGAGCCGGTGACCGTGTCCTG GAACTCCGGAGCTCTCACCTCCGGTGTCCATACCTTTCCTGCCGTCCTGCAGTCCTCCGG CCTGTACAGCCTCTCTAGCGTCGTGACTGTGCCCTCCAGCTCCCTGGGCACCCAAACTTA TATCTGCAATGTTAACCACAAGCCTTCTAATACCAAGGTCGACAAGAAAGTGGAGCCGA AGAGCTGTgacaaaactcacacatgcccaccgtgcccagcacctCCaGtcGCcggaccgtcagtcttcctcttcccTccaaaaccca aggacaccctcatgatctcccggacccctgaggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttcaactggtacgt ggacggcgtggaggtgcataatgccaagacaaagccgcgggaggagcagtacaacagcacgtaccgtgtggtcagcgtcctcaccgtcctgc accaggactggctgaatggcaaggagtacaagtgcaaggtctccaacaaagGcctcccaAGcTccatcgagaaaaccatctccaaagccaa agggcagccccgagaaccacaggtgtacaccctgccTccatcccgggatgagctgaccaagaaccaggtcagcctgacctgcctggtcaaag gcttctatcccagcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactacaagaccacgcctcccgtgctggactccgac ggctccttcttcctctacagcaagctcaccgtggacaagagcaggtggcagcaggggaacgtcttctcatgctccgtgatgcatgaggctctgcac aaccactacacgcagaagagcctctccctgtctccgggtaaataa
197	CAGGTGCAGCTGGTGCAGTCCGGCGCCGAGGTGAAGAAGCCCGGCTCCTCCGTGAAGG TGTCCTGCAAGGCCTCCGGCTACACCTTCACCTCCTACTGGCTGCACTGGGTGCGGCAG GCCCCCGGCCAGGGCCTGGAGTGGATCGGCTACATCAACCCCCGGAACGACTACACCG AGTACAACCAGAACTTCAAGGACAAGGCCACCATCACCGCCGACGAGTCCACCAACAC CGCCTACATGGAGCTGTCCTCCCTGCGGTCCGAGGACACCGCCTTCTACTTCTGCGCCCG GCGGGACATCACCACCTTCTACTGGGGCCAGGGCACCACTGTGACCGTGTCCTCCGCCA GGACCAAAGGACCGTCCGTCTTTCCTCTGGCCCCTTCCTCTAAGTCCACAAGCGGTGGG ACCGCAGCACTGGGATGCCTGGTGAAGGATTACTTCCCTGAGCCGGTGACCGTGTCCTG GAACTCCGGAGCTCTCACCTCCGGTGTCCATACCTTTCCTGCCGTCCTGCAGTCCTCCGG CCTGTACAGCCTCTCTAGCGTCGTGACTGTGCCCTCCAGCTCCCTGGGCACCCAAACTTA TATCTGCAATGTTAACCACAAGCCTTCTAATACCAAGGTCGACAAGAAAGTGGAGCCGA AGAGCTGTgacaaaactcacacatgcccaccgtgcccagcacctCCaGtcGCcggaccgtcagtcttcctcttcccTccaaaaccca aggacaccctcatgatctcccggacccctgaggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttcaactggtacgt ggacggcgtggaggtgcataatgccaagacaaagccgcgggaggagcagtacaacagcacgtaccgtgtggtcagcgtcctcaccgtcctgc accaggactggctgaatggcaaggagtacaagtgcaaggtctccaacaaagGcctcccaAGcTccatcgagaaaaccatctccaaagccaa agggcagccccgagaaccacaggtgtacaccctgccTccatcccgggatgagctgaccaagaaccaggtcagcctgacctgcctggtcaaag gcttctatcccagcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactacaagaccacgcctcccgtgctggactccgac ggctccttcttcctctacagcaagctcaccgtggacaagagcaggtggcagcaggggaacgtcttctcatgctccgtgatgcatgaggctctgcac aaccactacacgcagaagagcctctccctgtctccgggtaaaGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgctcgt ctcaagaaactctaa
198	caggtacagctgcagcagtcaggtccaggactggtgaagccctcgcagaccctctcactcacctgtgccatctccggggacagtgtctctagcaa cagtgctgcttggaactggatcaggcagtccccatcgagaggccttgagtggctgggaaggacatactacaggtccaagtggtataatgattatgc agtatctgtgaaaagtcgaataaccatcaacccagacacatccaagaaccagttctccctgcagctgaactctgtgactcccgaggacacggctgt gtattactgtgcaagagaagtgactggggatctcgaggatgcttttgatatctggggccaagggacaatggtcaccgtctcctcagcctccaccaa gggcccatcggtcttccccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaa ccggtgacggtgtcgtggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcag cgtggtgactgtgccctctagcagcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagtt gagcccaaatcttgtgacaaaactcacacatgcccaccgtgcccagcacctCCaGtcGCcggaccgtcagtcttcctcttcccTccaaaacc caaggacaccctcatgatctcccggacccctgaggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttcaactggtac gtggacggcgtggaggtgcataatgccaagacaaagccgcgggaggagcagtacaacagcacgtaccgtgtggtcagcgtcctcaccgtcct gcaccaggactggctgaatggcaaggagtacaagtgcaaggtctccaacaaagGcctcccaAGcTccatcgagaaaaccatctccaaagcc aaagggcagccccgagaaccacaggtgtacaccctgccTccatcccgggatgagctgaccaagaaccaggtcagcctgacctgcctggtcaa aggcttctatcccagcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactacaagaccacgcctcccgtgctggactccg acggctccttcttcctctacagcaagctcaccgtggacaagagcaggtggcagcaggggaacgtcttctcatgctccgtgatgcatgaggctctgc acaaccactacacgcagaagagcctctccctgtctccgggtaaataa
199	caggtacagctgcagcagtcaggtccaggactggtgaagccctcgcagaccctctcactcacctgtgccatctccggggacagtgtctctagcaa cagtgctgcttggaactggatcaggcagtccccatcgagaggccttgagtggctgggaaggacatactacaggtccaagtggtataatgattatgc agtatctgtgaaaagtcgaataaccatcaacccagacacatccaagaaccagttctccctgcagctgaactctgtgactcccgaggacacggctgt gtattactgtgcaagagaagtgactggggatctcgaggatgcttttgatatctggggccaagggacaatggtcaccgtctcctcagcctccaccaa

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
	gggcccatcggtcttccccctggcaccctcctccaagagcacctctgggggcacagcggccctgggctgcctggtcaaggactacttccccgaa ccggtgacggtgtcgtggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcag cgtggtgactgtgccctctagcagcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagtt gagcccaaatcttgtgacaaaactcacacatgcccaccgtgcccagcacctCCaGtcGCcggaccgtcagtcttcctcttcccTccaaaacc caaggacaccctcatgatctcccggacccctgaggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttcaactggtac gtggacggcgtggaggtgcataatgccaagacaaagccgcgggaggagcagtacaacagcacgtaccgtgtggtcagcgtcctcaccgtcct gcaccaggactggctgaatggcaaggagtacaagtgcaaggtctccaacaaagGcctcccaAGcTccatcgagaaaaccatctccaaagcc aaagggcagccccgagaaccacaggtgtacaccctgccTccatcccgggatgagctgaccaagaaccaggtcagcctgacctgcctggtcaa aggcttctatcccagcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactacaagaccacgcctcccgtgctggactccg acggctccttcttcctctacagcaagctcaccgtggacaagagcaggtggcagcaggggaacgtcttctcatgctccgtgatgcatgaggctctgc acaaccactacacgcagaagagcctctccctgtctccgggtaaaGGCGGAGGCGGGAGCaattatcatcttgaaaatgaggtcgct cgtctcaagaaactctaa
200	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcgacatccagatgacccagagccctgccagcctgtct accagcctgggcgagacagtgaccatccagtgtcaggccagcgaggacatctactctggcctggcttggtatcagcagaagcccggcaagagc cctcagctgctgatctacggcgccagcgacctgcaggacggcgtgcctagcagattcagcggcagcggctccggaacccagtacagcctgaa gatcaccagcatgcagaccgaggacgagggcgtgtacttctgccagcaaggcctgaccctaccctagaaccttcggaggaggcaccaagctgg aactgaagggcggaggcggaagtggaggcggaggatctggcggcggaggctctgaagtgcagctgcagcagtctggcgctgaactggtccg gcctggcactagcgtgaagctgtcctgcaaggtgtccggcgacaccatcaccttctactacatgcacttcgtgaagcagaggccaggacagggc ctggaatggatcggcagaatcgaccctgaggacgagagcaccaagtacagcgagaagttcaagaacaaggccaccctgaccgccgacacca gcagcaacaccgcctacctgaagctgtctagcctgacctccgaggacaccgccacctacttttgcatctacggcggctactacttcgactactggg gccagggcgtgatggtcaccgtgtccagcatcgagttcatgtaccccctccctacctggacaacgagagaagcaacggcaccatcatccacat caaagaaaagcacctgtgccacacccagagcagccccaagctgttctgggccctggtggtggtggccggcgtgctgttctgttacggcctgctg gtcacagtggccctgtgcgtgatctggaccaacagcagaagaaacagaggcggccagagcgactacatgaacatgaccccagaaggccag gcctgaccagaaagccctaccagccctacgccctgccagagacttcgccgcctacagacccagagccaagttcagcagatccgccgagaca gccgccaacctgcaggatcccaaccagctgttcaacgagctgaacctgggcagacgggaggaattcgacgtgctggaaaagaagagagccag ggaccccgagatgggcggcaagcagcagagaagaagaaaccctcaggaaggcgtctacaacgccctgcagaaagacaagatggccgaggc ctacagcgagatcggcaccaagggcgagagaagaaggggcaagggccacgatggcctgttccagggcctgtccaccgccaccaaggacac cttcgacgccctgcacatgcagaccctggcccccagatga
201	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGG GCTGTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTAC TGGCCTGATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTT CCCTGATTGGGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGC GATCTATTTTTGCGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAAC TGACAGTGCTGGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTC CGGGGGAGGCGGTTCTGATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTT CTCAGAGTCTGTCAATTACATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGA ACTGGGTTCGTCAGAGCCCAGGCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGA TGGAATCACAGACTACAATAGCGCACTGAAATCTCGGCTGAGTGTTACCAAAGATAACA GCAAGTCCCAGGTCTTCCTGAAGATGAACAGCCTGCAAAGCGGCGACTCCGCTCGCTAT TACTGCGTTACCGGACTGTTTGATTATTGGGGGCAGGGGACAACTCTGACTGTTTCCTCC atcgagttcatgtaccccctccctacctggacaacgagagaagcaacggcaccatcatccacatcaaagaaaagcacctgtgccacacccaga gcagccccaagctgttctgggccctggtggtggtggccggcgtgctgttctgttacggcctgctggtcacagtggccctgtgcgtgatctggacca acagcagaagaaacagaggcggccagagcgactacatgaacatgaccccagaaggccaggcctgaccagaaagccctaccagccctacg cccctgccagagacttcgccgcctacagacccagagccaagttcagcagatccgccgagacagccgccaacctgcaggatcccaaccagctgt tcaacgagctgaacctgggcagacgggaggaattcgacgtgctggaaaagaagagagccagggaccccgagatgggcggcaagcagcaga gaagaagaaaccctcaggaaggcgtctacaacgccctgcagaaagacaagatggccgaggcctacagcgagatcggcaccaagggcgaga gaagaaggggcaagggccacgatggcctgttccagggcctgtccaccgccaccaaggacaccttcgacgccctgcacatgcagaccctggcc cccagatga
202	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGG GCTGTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTAC TGGCCTGATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTT CCCTGATTGGGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGC GATCTATTTTTGCGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAAC TGACAGTGCTGGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTC CGGGGGAGGCGGTTCTGATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTT CTCAGAGTCTGTCAATTACATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGA

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
	ACTGGGTTCGTCAGAGCCCAGGCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGA TGGAATCACAGACTACAATAGCGCACTGAAATCTCGGCTGAGTGTTACCAAAGATAACA GCAAGTCCCAGGTCTTCCTGAAGATGAAttcCCTGCAAAGCGGCGACTCCGCTCGCTATTA CTGCGTTACCGGACTGTTTGATTATTGGGGGCAGGGGACAACTCTGACTGTTTCCTCCGA AAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCATTTACATCTGGGCACCCTTGGCCGG AATCTGCGTGGCCCTTCTGCTGTCCTTGATCATCACTCTCATCTGCAAATGGATCAGGAA AAAATTCCCCCACATATTCAAGCAACCATTTAAGAAGACCACTGGAGCAGCTCAAGAGG AAGATGCTTGTAGCTGCCGATGTCCACAGGAAGAAGAAGGAGGAGGAGGAGGCTATGA GCTGagagccaagttcagcagatccgccgagacagccgccaacctgcaggatcccaaccagctgttcaacgagctgaacctgggcagacg ggaggaattcgacgtgctggaaaagaagagagccagggaccccgagatgggcggcaagcagcagagaagaagaaaccctcaggaaggcg tctacaacgccctgcagaaagacaagatggccgaggcctacagcgagatcggcaccaagggcgagagaagaaggggcaagggccacgatg gcctgttccagggcctgtccaccgccaccaaggacaccttcgacgccctgcacatgcagaccctggcccccagatga
203	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGG GCTGTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTAC TGGCCTGATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTT CCCTGATTGGGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGC GATCTATTTTTGCGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAAC TGACAGTGCTGGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTC CGGGGGAGGCGGTTCTGATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTT CTCAGAGTCTGTCAATTACATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGA ACTGGGTTCGTCAGAGCCCAGGCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGA TGGAATCACAGACTACAATAGCGCACTGAAATCTCGGCTGAGTGTTACCAAAGATAACA GCAAGTCCCAGGTCTTCCTGAAGATGAAttcCCTGCAAAGCGGCGACTCCGCTCGCTATTA CTGCGTTACCGGACTGTTTGATTATTGGGGGCAGGGGACAACTCTGACTGTTTCCTCCGA AAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCATTTACATCTGGGCACCCTTGGCCGG AATCTGCGTGGCCCTTCTGCTGTCCTTGATCATCACTCTCATCTGCAAATGGATCAGGAA AAAATTCCCCCACATATTCAAGCAACCATTTAAGAAGACCACTGGAGCAGCTCAAGAGG AAGATGCTTGTAGCTGCCGATGTCCACAGGAAGAAGAAGGAGGAGGAGGAGGCTATGA GCTGAGAGCAAAATTCAGCAGGAGTGCAGAGACTGCTGCCAACCTGCAGGACCCCAAC CAGCTCTACAATGAGCTCAATCTAGGGCGAAGAGAGGAATATGACGTCTTGGAGAAGA AGCGGGCTCGGGATCCAGAGATGGGAGGCAAACAGCAGAGGAGGAGGAACCCCCAGG AAGGCGTATACAATGCACTGCAGAAAGACAAGATGGCAGAAGCCTACAGTGAGATCGG CACAAAAGGCGAGAGGCGGAGAGGCAAGGGGCACGATGGCCTTTACCAGGGTCTCAGC ACTGCCACCAAGGACACCTATGATGCCCTGCATATGCAGACCCTGGCCCCTCGCTAA
204	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGG GCTGTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTAC TGGCCTGATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTT CCCTGATTGGGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGC GATCTATTTTTGCGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAAC TGACAGTGCTGGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTC CGGGGGAGGCGGTTCTGATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTT CTCAGAGTCTGTCAATTACATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGA ACTGGGTTCGTCAGAGCCCAGGCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGA TGGAATCACAGACTACAATAGCGCACTGAAATCTCGGCTGAGTGTTACCAAAGATAACA GCAAGTCCCAGGTCTTCCTGAAGATGAAttcCCTGCAAAGCGGCGACTCCGCTCGCTATTA CTGCGTTACCGGACTGTTTGATTATTGGGGGCAGGGGACAACTCTGACTGTTTCCTCCAC TACTACCAAGCCAGTGCTGCGAACTCCCTCACCTGTGCACCCTACCGGGACATCTCAGC CCCAGAGACCAGAAGATTGTCGGCCCCGTGGCTCAGTGAAGGGGACCGGATTGGACTTC GCCTGTGATATTTACATCTGGGCACCCTTGGCCGGAATCTGCGTGGCCCTTCTGCTGTCC TTGATCATCACTCTCATCTGCAAATGGATCAGGAAAAAATTCCCCCACATATTCAAGCA ACCATTTAAGAAGACCACTGGAGCAGCTCAAGAGGAAGATGCTTGTAGCTGCCGATGTC CACAGGAAGAAGAAGGAGGAGGAGGAGGCTATGAGCTGagagccaagttcagcagatccgccgagacag ccgccaacctgcaggatcccaaccagctgttcaacgagctgaacctgggcagacgggaggaattcgacgtgctggaaaagaagagagccagg gaccccgagatgggcggcaagcagcagagaagaagaaaccctcaggaaggcgtctacaacgccctgcagaaagacaagatggccgaggcc tacagcgagatcggcaccaagggcgagagaagaaggggcaagggccacgatggcctgttccagggcctgtccaccgccaccaaggacacct tcgacgccctgcacatgcagaccctggcccccagatga

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
205	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGG GCTGTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTAC TGGCCTGATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTT CCCTGATTGGGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGC GATCTATTTTTGCGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAAC TGACAGTGCTGGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTC CGGGGGAGGCGGTTCTGATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTT CTCAGAGTCTGTCAATTACATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGA ACTGGGTTCGTCAGAGCCCAGGCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGA TGGAATCACAGACTACAATAGCGCACTGAAATCTCGGCTGAGTGTTACCAAAGATAACA GCAAGTCCCAGGTCTTCCTGAAGATGAAttcCCTGCAAAGCGGCGACTCCGCTCGCTATTA CTGCGTTACCGGACTGTTTGATTATTGGGGGCAGGGGACAACTCTGACTGTTTCCTCCAC TACTACCAAGCCAGTGCTGCGAACTCCCTCACCTGTGCACCCTACCGGGACATCTCAGC CCCAGAGACCAGAAGATTGTCGGCCCCGTGGCTCAGTGAAGGGGACCGGATTGGACTTC GCCTGTGATATTTACATCTGGGCACCCTTGGCCGGAATCTGCGTGGCCCTTCTGCTGTCC TTGATCATCACTCTCATCTGCAAATGGATCAGGAAAAAATTCCCCCACATATTCAAGCA ACCATTTAAGAAGACCACTGGAGCAGCTCAAGAGGAAGATGCTTGTAGCTGCCGATGTC CACAGGAAGAAGAAGGAGGAGGAGGAGGCTATGAGCTGAGAGCAAAATTCAGCAGGA GTGCAGAGACTGCTGCCAACCTGCAGGACCCCAACCAGCTCTACAATGAGCTCAATCTA GGGCGAAGAGAGGAATATGACGTCTTGGAGAAGAAGCGGGCTCGGGATCCAGAGATGG GAGGCAAACAGCAGAGGAGGAGGAACCCCCAGGAAGGCGTATACAATGCACTGCAGA AAGACAAGATGGCAGAAGCCTACAGTGAGATCGGCACAAAAGGCGAGAGGCGGAGAG GCAAGGGGCACGATGGCCTTTACCAGGGTCTCAGCACTGCCACCAAGGACACCTATGAT GCCCTGCATATGCAGACCCTGGCCCCTCGCTAA
206	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcgacatccagatgacccagagccctgccagcctgtct accagcctgggcgagacagtgaccatccagtgtcaggccagcgaggacatctactctggcctggcttggtatcagcagaagcccggcaagagc cctcagctgctgatctacggcgccagcgacctgcaggacggcgtgcctagcagattcagcggcagcggctccggaacccagtacagcctgaa gatcaccagcatgcagaccgaggacgagggcgtgtacttctgccagcaaggcctgacctaccctagaaccttcggaggaggcaccaagctgg aactgaagggcggaggcggaagtggaggcggaggatctggcggcggaggctctgaagtgcagctgcagcagtctggcgctgaactggtccg gcctggcactagcgtgaagctgtcctgcaaggtgtccggcgacaccatcaccttctactacatgcacttcgtgaagcagaggccaggacagggc ctggaatggatcggcagaatcgaccctgaggacgagagcaccaagtacagcgagaagttcaagaacaaggccaccctgaccgccgacacca gcagcaacaccgcctacctgaagctgtctagcctgacctccgaggacaccgccacctacttttgcatctacggcggctactacttcgactactggg gccagggcgtgatggtcaccgtgtccagcGAAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCATTTA CATCTGGGCACCCTTGGCCGGAATCTGCGTGGCCCTTCTGCTGTCCTTGATCATCACTCT CATCTGCAAATGGATCAGGAAAAAATTCCCCCACATATTCAAGCAACCATTTAAGAAGA CCACTGGAGCAGCTCAAGAGGAAGATGCTTGTAGCTGCCGATGTCCACAGGAAGAAGA AGGAGGAGGAGGAGGCTATGAGCTGagagccaagttcagcagatccgccgagacagccgccaacctgcaggatccca accagctgttcaacgagctgaacctgggcagacgggaggaattcgacgtgctggaaaagaagagagccagggaccccgagatgggcggcaa gcagcagagaagaagaaaccctcaggaaggcgtctacaacgccctgcagaaagacaagatggccgaggcctacagcgagatcggcaccaa gggcgagagaagaaggggcaagggccacgatggcctgttccagggcctgtccaccgccaccaaggacaccttcgacgccctgcacatgcag accctggcccccagatga
207	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcgacatccagatgacccagagccctgccagcctgtct accagcctgggcgagacagtgaccatccagtgtcaggccagcgaggacatctactctggcctggcttggtatcagcagaagcccggcaagagc cctcagctgctgatctacggcgccagcgacctgcaggacggcgtgcctagcagattcagcggcagcggctccggaacccagtacagcctgaa gatcaccagcatgcagaccgaggacgagggcgtgtacttctgccagcaaggcctgacctaccctagaaccttcggaggaggcaccaagctgg aactgaagggcggaggcggaagtggaggcggaggatctggcggcggaggctctgaagtgcagctgcagcagtctggcgctgaactggtccg gcctggcactagcgtgaagctgtcctgcaaggtgtccggcgacaccatcaccttctactacatgcacttcgtgaagcagaggccaggacagggc ctggaatggatcggcagaatcgaccctgaggacgagagcaccaagtacagcgagaagttcaagaacaaggccaccctgaccgccgacacca gcagcaacaccgcctacctgaagctgtctagcctgacctccgaggacaccgccacctacttttgcatctacggcggctactacttcgactactggg gccagggcgtgatggtcaccgtgtccagcGAAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCATTTA CATCTGGGCACCCTTGGCCGGAATCTGCGTGGCCCTTCTGCTGTCCTTGATCATCACTCT CATCTGCAAATGGATCAGGAAAAAATTCCCCCACATATTCAAGCAACCATTTAAGAAGA CCACTGGAGCAGCTCAAGAGGAAGATGCTTGTAGCTGCCGATGTCCACAGGAAGAAGA AGGAGGAGGAGGAGGCTATGAGCTGAGAGCAAAATTCAGCAGGAGTGCAGAGACTGCT GCCAACCTGCAGGACCCCAACCAGCTCTACAATGAGCTCAATCTAGGGCGAAGAGAGG AATATGACGTCTTGGAGAAGAAGCGGGCTCGGGATCCAGAGATGGGAGGCAAACAGCA GAGGAGGAGGAACCCCCAGGAAGGCGTATACAATGCACTGCAGAAAGACAAGATGGC

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
	AGAAGCCTACAGTGAGATCGGCACAAAAGGCGAGAGGCGGAGAGGCAAGGGGCACGA TGGCCTTTACCAGGGTCTCAGCACTGCCACCAAGGACACCTATGATGCCCTGCATATGC AGACCCTGGCCCCTCGCTAA
208	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcgacatccagatgacccagagccctgccagcctgtct accagcctgggcgagacagtgaccatccagtgtcaggccagcgaggacatctactctggcctggcttggtatcagcagaagcccggcaagagc cctcagctgctgatctacggcgccagcgacctgcaggacggcgtgcctagcagattcagcggcagcggctccggaacccagtacagcctgaa gatcaccagcatgcagaccgaggacgagggcgtgtacttctgccagcaaggcctgacctaccctagaaccttcggaggaggcaccaagctgg aactgaagggcggaggcggaagtggaggcggaggatctggcggcggaggctctgaagtgcagctgcagcagtctggcgctgaactggtccg gcctggcactagcgtgaagctgtcctgcaaggtgtccggcgacaccatcaccttctactacatgcacttcgtgaagcagaggccaggacagggc ctggaatggatcggcagaatcgaccctgaggacgagagcaccaagtacagcgagaagttcaagaacaaggccaccctgaccgccgacacca gcagcaacaccgcctacctgaagctgtctagcctgacctccgaggacaccgccacctacttttgcatctacggcggctactacttcgactactggg gccagggcgtgatggtcaccgtgtccagcACTACTACCAAGCCAGTGCTGCGAACTCCCTCACCTGTGCA CCCTACCGGGACATCTCAGCCCCAGAGACCAGAAGATTGTCGGCCCCGTGGCTCAGTGA AGGGGACCGGATTGGACTTCGCCTGTGATATTTACATCTGGGCACCCTTGGCCGGAATC TGCGTGGCCCTTCTGCTGTCCTTGATCATCACTCTCATCTGCAAATGGATCAGGAAAAAA TTCCCCCACATATTCAAGCAACCATTTAAGAAGACCACTGGAGCAGCTCAAGAGGAAGA TGCTTGTAGCTGCCGATGTCCACAGGAAGAAGAAGGAGGAGGAGGAGGCTATGAGCTG agagccaagttcagcagatccgccgagacagccgccaacctgcaggatcccaaccagctgttcaacgagctgaacctgggcagacgggagg aattcgacgtgctggaaaagaagagagccagggaccccgagatgggcggcaagcagcagagaagaagaaaccctcaggaaggcgtctaca acgccctgcagaaagacaagatggccgaggcctacagcgagatcggcaccaagggcgagagaagaaggggcaagggccacgatggcctgt tccagggcctgtccaccgccaccaaggacaccttcgacgccctgcacatgcagaccctggccccccagatga
209	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcgacatccagatgacccagagccctgccagcctgtct accagcctgggcgagacagtgaccatccagtgtcaggccagcgaggacatctactctggcctggcttggtatcagcagaagcccggcaagagc cctcagctgctgatctacggcgccagcgacctgcaggacggcgtgcctagcagattcagcggcagcggctccggaacccagtacagcctgaa gatcaccagcatgcagaccgaggacgagggcgtgtacttctgccagcaaggcctgacctaccctagaaccttcggaggaggcaccaagctgg aactgaagggcggaggcggaagtggaggcggaggatctggcggcggaggctctgaagtgcagctgcagcagtctggcgctgaactggtccg gcctggcactagcgtgaagctgtcctgcaaggtgtccggcgacaccatcaccttctactacatgcacttcgtgaagcagaggccaggacagggc ctggaatggatcggcagaatcgaccctgaggacgagagcaccaagtacagcgagaagttcaagaacaaggccaccctgaccgccgacacca gcagcaacaccgcctacctgaagctgtctagcctgacctccgaggacaccgccacctacttttgcatctacggcggctactacttcgactactggg gccagggcgtgatggtcaccgtgtccagcACTACTACCAAGCCAGTGCTGCGAACTCCCTCACCTGTGCA CCCTACCGGGACATCTCAGCCCCAGAGACCAGAAGATTGTCGGCCCCGTGGCTCAGTGA AGGGGACCGGATTGGACTTCGCCTGTGATATTTACATCTGGGCACCCTTGGCCGGAATC TGCGTGGCCCTTCTGCTGTCCTTGATCATCACTCTCATCTGCAAATGGATCAGGAAAAAA TTCCCCCACATATTCAAGCAACCATTTAAGAAGACCACTGGAGCAGCTCAAGAGGAAGA TGCTTGTAGCTGCCGATGTCCACAGGAAGAAGAAGGAGGAGGAGGAGGCTATGAGCTG AGAGCAAAATTCAGCAGGAGTGCAGAGACTGCTGCCAACCTGCAGGACCCCAACCAGC TCTACAATGAGCTCAATCTAGGGCGAAGAGAGGAATATGACGTCTTGGAGAAGAAGCG GGCTCGGGATCCAGAGATGGGAGGCAAACAGCAGAGGAGGAGGAACCCCCAGGAAGG CGTATACAATGCACTGCAGAAAGACAAGATGGCAGAAGCCTACAGTGAGATCGGCACA AAAGGCGAGAGGCGGAGAGGCAAGGGGCACGATGGCCTTTACCAGGGTCTCAGCACTG CCACCAAGGACACCTATGATGCCCTGCATATGCAGACCCTGGCCCCTCGCTAA
210	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGG GCTGTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTAC TGGCCTGATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTT CCCTGATTGGGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGC GATCTATTTTTGCGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAAC TGACAGTGCTGGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTC CGGGGGAGGCGGTTCTGATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTT CTCAGAGTCTGTCAATTACATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGA ACTGGGTTCGTCAGAGCCCAGGCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGA TGGAATCACAGACTACAATAGCGCACTGAAATCTCGGCTGAGTGTTACCAAAGATAACA GCAAGTCCCAGGTCTTCCTGAAGATGAACAGCCTGCAAAGCGGCGACTCCGCTCGCTAT TACTGCGTTACCGGACTGTTTGATTATTGGGGGCAGGGGACAACTCTGACTGTTTCCTCC GAAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCttctgggccctggtggtggtggccggcgtgctgttctgtt acggcctgctggtcacagtggccctgtgcgtgatctggaccaacagcagaagaaacagaggcggccagagcgactacatgaacatgaccccc agaaggccaggcctgaccagaaagccctaccagccctacgcccctgccagagacttcgccgcctacagacccagagccaagttcagcagatc cgccgagacagccgccaacctgcaggatcccaaccagctgttcaacgagctgaacctgggcagacgggaggaattcgacgtgctggaaaaga

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
	agagagccagggaccccgagatgggcggcaagcagcagagaagaagaaaccctcaggaaggcgtctacaacgccctgcagaaagacaag atggccgaggcctacagcgagatcggcaccaagggcgagagaagaaggggcaagggccacgatggcctgttccagggcctgtccaccgcc accaaggacaccttcgacgccctgcacatgcagaccctggcccccagatga
211	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcGATGTGCAGCTGCAAGAATCCG GGCCAGGACTGGTTGCGCCTTCTCAGAGTCTGTCAATTACATGTACTGTTAGTGGCTTTC TGCTGACCGACTATGGTGTGAACTGGGTTCGTCAGAGCCCAGGCAAGGGTCTGGAGTGG CTGGGAGTGATTTGGGGGGATGGAATCACAGACTACAATAGCGCACTGAAATCTCGGCT GAGTGTTACCAAAGATAACAGCAAGTCCCAGGTCTTCCTGAAGATGAACAGCCTGCAAA GCGGCGACTCCGCTCGCTATTACTGCGTTACCGGACTGTTTGATTATTGGGGGCAGGGG ACAACTCTGACTGTTTCCTCCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAG GCGGTTCCGGGGGAGGCGGTTCTGACGCCGTTGTGACCCAGGAATCCGCTCTGACCTCT TCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGGGCTGTGACCACATC TAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTACTGGCCTGATTGGCG GCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTTCCCTGATTGGGGAC AAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGCGATCTATTTTTGCGT CCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAACTGACAGTGCTGGGCG AAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCttctgggccctggtggtggtggccggcgtgctgttctgtta cggcctgctggtcacagtggccctgtgcgtgatctggaccaacagcagaagaaacagaggcggccagagcgactacatgaacatgacccca gaaggccaggcctgaccagaaagccctaccagccctacgcccctgccagagacttcgccgcctacagacccagagccaagttcagcagatcc gccgagacagccgccaacctgcaggatcccaaccagctgttcaacgagctgaacctgggcagacgggaggaattcgacgtgctggaaaagaa gagagccagggaccccgagatgggcggcaagcagcagagaagaagaaaccctcaggaaggcgtctacaacgccctgcagaaagacaagat ggccgaggcctacagcgagatcggcaccaagggcgagagaagaaggggcaagggccacgatggcctgttccagggcctgtccaccgccac caaggacaccttcgacgccctgcacatgcagaccctggcccccagatga
212	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcGACGCCGTTGTGACCCAGGAAT CCGCTCTGACCTCTTCTCCAGGCGAAACCGTGACTCTGACTTGCCGTAGTAGCACCGGG GCTGTGACCACATCTAACTATGCCAGTTGGGTCCAGGAAAAACCGGATCACCTGTTTAC TGGCCTGATTGGCGGCACCAACAATCGCGCACCGGGTGTGCCCGCTCGTTTCAGCGGTT CCCTGATTGGGGACAAGGCAGCACTGACTATCACCGGCGCCCAGACCGAAGATGAGGC GATCTATTTTTGCGTCCTGTGGTACAGCGACCATTGGGTGTTCGGGGGAGGCACCAAAC TGACAGTGCTGGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTAGCGGGGGAGGCGGTTC CGGGGGAGGCGGTTCTGATGTGCAGCTGCAAGAATCCGGGCCAGGACTGGTTGCGCCTT CTCAGAGTCTGTCAATTACATGTACTGTTAGTGGCTTTCTGCTGACCGACTATGGTGTGA ACTGGGTTCGTCAGAGCCCAGGCAAGGGTCTGGAGTGGCTGGGAGTGATTTGGGGGGA TGGAATCACAGACTACAATAGCGCACTGAAATCTCGGCTGAGTGTTACCAAAGATAACA GCAAGTCCCAGGTCTTCCTGAAGATGAACAGCCTGCAAAGCGGCGACTCCGCTCGCTAT TACTGCGTTACCGGACTGTTTGATTATTGGGGGCAGGGGACAACTCTGACTGTTTCCTCC GAAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCgatatctacatctgggcgcccttggccgggacttgtggg gtccttctcctgtcactggttatcacccttttactgcaaacggggcagaaagaaactcctgtatatattcaaacaaccatttatgagaccagtacaaact actcaagaggaagatggctgtagctgccgatttccagaagaagaagaaggaggatgtgaactgagagtgaagttcagcaggagcgcagacgc ccccgcgtacaagcagggccagaaccagctctataacgagctcaatctaggacgaagagaggagtacgatgttttggacaagagacgtggccg ggaccctgagatgggggaaagccgagaaggaagaaccctcaggaaggcctgtacaatgaactgcagaaagataagatggcggaggcctac agtgagattgggatgaaaggcgagcgccggaggggcaaggggcacgatggcctttaccagggtctcagtacagccaccaaggacacctacg acgcccttcacatgcaggccctgcccccctcgctaa
213	atgggtgtccctacccagctcctgggactgctcctgctgtggatcaccgacgccatctgcgacatccagatgacccagagccctgccagcctgtct accagcctgggcgagacagtgaccatccagtgtcaggccagcgaggacatctactctggcctggcttggtatcagcagaagcccggcaagagc cctcagctgctgatctacggcgccagcgacctgcaggacggcgtgcctagcagattcagcggcagcggctccggaacccagtacagcctgaa gatcaccagcatgcagaccgaggacgagggcgtgtacttctgccagcaaggcctgacctaccctagaaccttcggaggaggcaccaagctgg aactgaagggcggaggcggaagtggaggcggaggatctggcggcggaggctctgaagtgcagctgcagcagtctggcgctgaactggtccg gcctggcactagcgtgaagctgtcctgcaaggtgtccggcgacaccatcaccttctactacatgcacttcgtgaagcagaggccaggacagggc ctggaatggatcggcagaatcgaccctgaggacgagagcaccaagtacagcgagaagttcaagaacaaggccaccctgaccgccgacacca gcagcaacaccgcctacctgaagctgtctagcctgacctccgaggacaccgccacctacttttgcatctacggcggctactacttcgactactggg gccagggcgtgatggtcaccgtgtccagcaccacgacgccagcgccgcgaccaccaacaccggcgcccaccatcgcgtcgcagccccctgtc cctgcgcccagaggcgtgccggccagcggcgggggcgcagtgcacacgaggggctggacttcgcctgtgatatctacatctgggcgccct tggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaactcctgtatatattcaaacaaccattta tgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaaggaggatgtgaactgagagtgaagttcag caggagcgcagacgcccccgcgtacaagcagggccagaaccagctctataacgagctcaatctaggacgaagagaggagtacgatgttttgg acaagagacgtggccgggaccctgagatgggggaaagccgagaaggaagaaccctcaggaaggcctgtacaatgaactgcagaaagataa gatggcggaggcctacagtgagattgggatgaaaggcgagcgccggaggggcaaggggcacgatggcctttaccagggtctcagtacagcc

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	**SEQUENCE**
	accaaggacacctacgacgcccttcacatgcaggccctgcccccctcgctaa
214	GG
215	MYRMQLLSCIALSLALVTNS**NYHLENEVARLKKLGG**DIQLTQSPASLSTSLGETVTIQCQA SEDIYSGLAWYQQKPGKSPQLLIYGASDLQDGVPSRFSGSGSGTQYSLKITSMQTEDEGVYF CQQGLTYPRTFGGGTKLEIKRTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWK VDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFN RGEC.
216	MYRMQLLSCIALSLALVTNS**NYHLENEVARLKKLGG**QVQLVQSGAELVRPGTSVKLSCK VSGDTITFYYMHFVKQRPGQGLEWIGRIDPEDESTKYSEKFKNKATLTADTSSNTAYLKLSS LTSEDTATYFCIYGGYYFDYWGPGTMVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKD YFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTK VDKKVEPKSC.
217	**NYHLENEVARLKKL**GGGGSDIQLTQSPSTLSASVGDRVTITCRASESLDNYGIRFLTWFQQ KPGKAPKLLMYAASNQGSGVPSRFSGSGSGTEFTLTISSLQPDDFATYYCQQTKEVPWSFGQ GTKVEVRTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQES VTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
218	**NYHLENEVARLKKL**GGGGSGGGGSDIQLTQSPSTLSASVGDRVTITCRASESLDNYGIRFLT WFQQKPGKAPKLLMYAASNQGSGVPSRFSGSGSGTEFTLTISSLQPDDFATYYCQQTKEVP WSFGQGTKVEVRTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSG NSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
219	**NYHLENEVARLKKL**GGGGSGGGGSGGGGSDIQLTQSPSTLSASVGDRVTITCRASESLDNY GIRFLTWFQQKPGKAPKLLMYAASNQGSGVPSRFSGSGSGTEFTLTISSLQPDDFATYYCQQ TKEVPWSFGQGTKVEVRTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDN ALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
220	**NYHLENEVARLKKLL**VGEAAAKEAAAKAEVQLVQSGAEVKKPGSSVKVSCKASGYTITD SNIHWVRQAPGQSLEWIGYIYPYNGGTDYNQKFKNRATLTVDNPTNTAYMELSSLRSEDTA FYYCVNGNPWLAYWGQGTLVTVSSARTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPV TVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVE PKSC
221	**NYHLENEVARLKKL**EAAAKEAAAKEAAAKAEVQLVQSGAEVKKPGSSVKVSCKASGYTI TDSNIHWVRQAPGQSLEWIGYIYPYNGGTDYNQKFKNRATLTVDNPTNTAYMELSSLRSED TAFYYCVNGNPWLAYWGQGTLVTVSSARTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPE PVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKK VEPKSC
222	DIQLTQSPSTLSASVGDRVTITCRASESLDNYGIRFLTWFQQKPGKAPKLLMYAASNQGSGV PSRFSGSGSGTEFTLTISSLQPDDFATYYCQQTKEVPWSFGQGTKVEVRTVAAPSVFIFPPSDE QLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKA DYEKHKVYACEVTHQGLSSPVTKSFNRGECGGGGS**NYHLENEVARLKKL**
223	DIQLTQSPSTLSASVGDRVTITCRASESLDNYGIRFLTWFQQKPGKAPKLLMYAASNQGSGV PSRFSGSGSGTEFTLTISSLQPDDFATYYCQQTKEVPWSFGQGTKVEVRTVAAPSVFIFPPSDE QLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKA DYEKHKVYACEVTHQGLSSPVTKSFNRGECGGGGSGGGGS**NYHLENEVARLKKL**
224	DIQLTQSPSTLSASVGDRVTITCRASESLDNYGIRFLTWFQQKPGKAPKLLMYAASNQGSGV PSRFSGSGSGTEFTLTISSLQPDDFATYYCQQTKEVPWSFGQGTKVEVRTVAAPSVFIFPPSDE QLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKA DYEKHKVYACEVTHQGLSSPVTKSFNRGECGGGGSGGGGSGGGGS**NYHLENEVARLKKL**
225	EVQLVQSGAEVKKPGSSVKVSCKASGYTITDSNIHWVRQAPGQSLEWIGYIYPYNGGTDYN QKFKNRATLTVDNPTNTAYMELSSLRSEDTAFYYCVNGNPWLAYWGQGTLVTVSSARTKG PSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSV VTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCGGGGS**NYHLENEVARLKKL**
226	EVQLVQSGAEVKKPGSSVKVSCKASGYTITDSNIHWVRQAPGQSLEWIGYIYPYNGGTDYN QKFKNRATLTVDNPTNTAYMELSSLRSEDTAFYYCVNGNPWLAYWGQGTLVTVSSARTKG PSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSV VTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCGGGGSGGGGS**NYHLENEVARLKKL**
227	EVQLVQSGAEVKKPGSSVKVSCKASGYTITDSNIHWVRQAPGQSLEWIGYIYPYNGGTDYN QKFKNRATLTVDNPTNTAYMELSSLRSEDTAFYYCVNGNPWLAYWGQGTLVTVSSARTKG PSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSV VTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCGGGGSGGGGSGGGGS**NYHLENEVAR**

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	**SEQUENCE**
	LKKL
228	EVQLVQSGAEVKKPGSSVKVSCKASGYTITDSNIHWVRQAPGQSLEWIGYIYPYNGGTDYN QKFKNRATLTVDNPTNTAYMELSSLRSEDTAFYYCVNGNPWLAYWGQGTLVTVSSARTKG PSVFPLAPSS**NYHLENEVARLKKL**SGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPA VLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC
229	EVQLVQSGAEVKKPGSSVKVSCKASGYTITDSNIHWVRQAPGQSLEWIGYIYPYNGGTDYN QKFKNRATLTVDNPTNTAYMELSSLRSEDTAFYYCVNGNPWLAYWGQGTLVTVSSARTKG PSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSGGGGS**NYH LENEVARLKKL**GGGGSLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC
230	DIQLTQSPSTLSASVGDRVTITCRASESLDNYGIRFLTWFQQKPGKAPKLLMYAASNQGSGV PSRFSGSGSGTEFTLTISSLQPDDFATYYCQQTKEVPWSFGQGTKVEV RTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDS GGGGS**NYHLENEVARLKKL**GGGGSDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPV TKSFNRGEC
231	DIQLTQSPSTLSASVGDRVTITCRASESLDNYGIRFLTWFQQKPGKAPKLLMYAASNQGSGV PSRFSGSGSGTEFTLTISSLQPDDFATYYCQQTKEVPWSFGQGTKVEVKRTVAAPSVFIFPPS DEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLS KADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
232	EVQLVQSGAEVKKPGSSVKVSCKASGYTITDSNIHWVRQAPGQSLEWIGYIYPYNGGTDYN QKFKNRATLTVDNPTNTAYMELSSLRSEDTAFYYCVNGNPWLAYWGQGTLVTVSSASTKG PSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSV VTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDKTHT
233	DIVLTQSPASLAVSLGQRATISCRASESVDNYGNTFMHWYQQKPGQPPKLLIYRASNLESGIP ARFSGSGSRTDFTLTINPVEADDVATYYCQQSNEDPPTFGAGTKLELRTVAAPSVFIFPPSDE QLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKA DYEKHKVYACEVTHQGLSSPVTKSFNRGEC
234	QIQLVQSGPELKKPGETVKISCKASGYIFTNYGMNWVKQAPGKSFKWMGWINTYTGESTYS ADFKGRFAFSLETSASTAYLHINDLKNEDTATYFCARSGGYDPMDYWGQGTSVTVSSARTK GPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSS VVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC
235	DVQITQSPSYLAASPGETITINCRASKSISKDLAWYQEKPGKTNKLLIYSGSTLQSGIPSRFSGS GSGTDFTLTISSLEPEDFAMYYCQQHNKYPYTFGGGTKLEIRTVAAPSVFIFPPSDEQLKSGT ASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHK VYACEVTHQGLSSPVTKSFNRGEC
236	QVQLQQPGAELVRPGASVKLSCKASGYTFTSYWMNWVKQRPDQGLEWIGRIDPYDSETHY NQKFKDKAILTVDKSSSTAYMQLSSLTSEDSAVYYCARGNWDDYWGQGTTLTVSSARTKG PSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSV VTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC
237	**NYHLENEVARLKKL**GGGGSDVQITQSPSYLAASPGETITINCRASKSISKDLAWYQEKPGK TNKLLIYSGSTLQSGIPSRFSGSGSGTDFTLTISSLEPEDFAMYYCQQHNKYPYTFGGGTKLEI RTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDS KDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
238	**NYHLENEVARLKKL**GGGGSDIVLTQSPASLAVSLGQRATISCRASESVDNYGNTFMHWYQ QKPGQPPKLLIYRASNLESGIPARFSGSGSRTDFTLTINPVEADDVATYYCQQSNEDPPTFGA GTKLELRTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQES VTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
239	**NYHLENEVARLKKL**GGGGSGGGGSGGGGSDIVLTQSPASLAVSLGQRATISCRASESVDN YGNTFMHWYQQKPGQPPKLLIYRASNLESGIPARFSGSGSRTDFTLTINPVEADDVATYYCQ QSNEDPPTFGAGTKLELRTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDN ALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
240	**NYHLENEVARLKKL**GGGGSGGGGSDIVLTQSPASLAVSLGQRATISCRASESVDNYGNTF MHWYQQKPGQPPKLLIYRASNLESGIPARFSGSGSRTDFTLTINPVEADDVATYYCQQSNED PPTFGAGTKLELRTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSG NSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
241	**NYHLENEVARLKKL**LVGEAAAKEAAAKAQVQLQQPGAELVRPGASVKLSCKASGYTFTS YWMNWVKQRPDQGLEWIGRIDPYDSETHYNQKFKDKAILTVDKSSSTAYMQLSSLTSEDS AVYYCARGNWDDYWGQGTTLTVSSARTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEP VTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKV

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	**SEQUENCE**
	EPKSC
242	**NYHLENEVARLKKLL**VGEAAAKEAAAKAQIQLVQSGPELKKPGETVKISCKASGYIFTNY GMNWVKQAPGKSFKWMGWINTYTGESTYSADFKGRFAFSLETSASTAYLHINDLKNEDTA TYFCARSGGYDPMDYWGQGTSVTVSSARTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPE PVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKK VEPKSC
243	**NYHLENEVARLKKL**EAAAKEAAAKEAAAKAQIQLVQSGPELKKPGETVKISCKASGYIFT NYGMNWVKQAPGKSFKWMGWINTYTGESTYSADFKGRFAFSLETSASTAYLHINDLKNED TATYFCARSGGYDPMDYWGQGTSVTVSSARTKGPSVFPLAPSSKSTSGGTAALGCLVKDYF PEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVD KKVEPKSC
244	DVQITQSPSYLAASPGETITINCRASKSISKDLAWYQEKPGKTNKLLIYSGSTLQSGIPSRFSGS GSGTDFTLTISSLEPEDFAMYYCQQHNKYPYTFGGGTKLEIRTVAAPSVFIFPPSDEQLKSGT ASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHK VYACEVTHQGLSSPVTKSFNRGEC**GGGGS****NYHLENEVARLKKL**
245	DIVLTQSPASLAVSLGQRATISCRASESVDNYGNTFMHWYQQKPGQPPKLLIYRASNLESGIP ARFSGSGSRTDFTLTINPVEADDVATYYCQQSNEDPPTFGAGTKLELRTVAAPSVFIFPPSDE QLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKA DYEKHKVYACEVTHQGLSSPVTKSFNRGEC**GGGGS****NYHLENEVARLKKL**
246	DIVLTQSPASLAVSLGQRATISCRASESVDNYGNTFMHWYQQKPGQPPKLLIYRASNLESGIP ARFSGSGSRTDFTLTINPVEADDVATYYCQQSNEDPPTFGAGTKLELRTVAAPSVFIFPPSDE QLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKA DYEKHKVYACEVTHQGLSSPVTKSFNRGEC**GGGGSGGGGS****NYHLENEVARLKKL**
247	DIVLTQSPASLAVSLGQRATISCRASESVDNYGNTFMHWYQQKPGQPPKLLIYRASNLESGIP ARFSGSGSRTDFTLTINPVEADDVATYYCQQSNEDPPTFGAGTKLELRTVAAPSVFIFPPSDE QLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKA DYEKHKVYACEVTHQGLSSPVTKSFNRGEC**GGGGSGGGGSGGGGS****NYHLENEVARLKKL**
248	QVQLQQPGAELVRPGASVKLSCKASGYTFTSYWMNWVKQRPDQGLEWIGRIDPYDSETHY NQKFKDKAILTVDKSSSTAYMQLSSLTSEDSAVYYCARGNWDDYWGQGTTLTVSSARTKG PSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSV VTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC**GGGGS****NYHLENEVARLKKL**
249	QIQLVQSGPELKKPGETVKISCKASGYIFTNYGMNWVKQAPGKSFKWMGWINTYTGESTYS ADFKGRFAFSLETSASTAYLHINDLKNEDTATYFCARSGGYDPMDYWGQGTSVTVSSARTK GPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSS VVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC**GGGGS****NYHLENEVARLKKL**
250	QIQLVQSGPELKKPGETVKISCKASGYIFTNYGMNWVKQAPGKSFKWMGWINTYTGESTYS ADFKGRFAFSLETSASTAYLHINDLKNEDTATYFCARSGGYDPMDYWGQGTSVTVSSARTK GPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSS VVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC**GGGGSGGGGS****NYHLENEVARLKKL**
251	QIQLVQSGPELKKPGETVKISCKASGYIFTNYGMNWVKQAPGKSFKWMGWINTYTGESTYS ADFKGRFAFSLETSASTAYLHINDLKNEDTATYFCARSGGYDPMDYWGQGTSVTVSSARTK GPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSS VVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC**GGGGSGGGGSGGGGS****NYHLENEVA RLKKL**
252	QIQLVQSGPELKKPGETVKISCKASGYIFTNYGMNWVKQAPGKSFKWMGWINTYTGESTYS ADFKGRFAFSLETSASTAYLHINDLKNEDTATYFCARSGGYDPMDYWGQGTSVTVSSARTK GPSVFPLAPSSN**YHLENEVARLKK**LSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFP AVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC
253	QIQLVQSGPELKKPGETVKISCKASGYIFTNYGMNWVKQAPGKSFKWMGWINTYTGESTYS ADFKGRFAFSLETSASTAYLHINDLKNEDTATYFCARSGGYDPMDYWGQGTSVTVSSARTK GPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQS**GGGGS****NY HLENEVARLKKL**GGGGSLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSC
254	DIVLTQSPASLAVSLGQRATISCRASESVDNYGNTFMHWYQQKPGQPPKLLIYRASNLESGIP ARFSGSGSRTDFTLTINPVEADDVATYYCQQSNEDPPTFGAGTKLELRTVAAPSVFIFPPSDE QLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDS**GGGGS****NYHLENEVA RLKKL**GGGGSDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC
255	caggctgtggtgactcaggagccctcactgactgtgtccccaggagggacagtcactctcacctgtggctccagcactggagctgtcaccacttc caactatgcctcatgggtgcaggagaagcctggccaagccTTcaggggctgattggtggcacaaacaacagggctcctggggtgcctgccc

Table 58: sCAR sequences, heavy and light chain sequences, and other sequences	
SEQ ID NO	SEQUENCE
	ggttctcaggctccctccttgggggcaaagctgccctgaccatttcgggtgcgcagcctgaggatgaggctatttatttctgcgtgctctggtatagt gaccattgggtgttcggcggagggaccaagctgaccgtcctaGGCGGAGGAGGAGGTTCAGGAGGcGGAGGTAG CGGGGGAGGCGGTTCCGGGGGAGGCGGTTCTcaggtgcagctgcagGAGtcgggcccaggactggtgaagcc ttcggagaccctgtccatcacctgcactgtctctggtttcCTGctgaccgactacggcgtaaactgggtgcggcagcccccagggaagggact ggagtggctgggggtgatctggggtgacgggATCaccgactacaaccccctccctcaagagtcgactgaccgtgtccaaggacACAtccaa gaaccaggtgtccctgaagatgagctctctgaccgccgcagacacggccCGGtattactgtgtcaccggcctgttcgactactggggccaggg caccACCctgaccgtctcctcaGAAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCgatatctacatctggg cgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaactcctgtatatattcaaacaa ccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaaggaggatgtgaactgagagtga agttcagcaggagcgcagacgccccgcgtacaagcagggccagaaccagctctataacgagctcaatctaggacgaagagaggagtacgat gttttggacaagagacgtggccgggaccctgagatgggggaaagccgagaaggaagaaccctcaggaaggcctgtacaatgaactgcaga aagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccggaggggcaaggggcacgatggcctttaccagggtctcagt acagccaccaaggacacctacgacgcccttcacatgcaggccctgcccccgc
256	caggctgtggtgactcaggagccctcactgactAGCtccccaggagggacagtcactctcacctgtggctccagcactggagctgtcaccact tccaactatgcctcatgggtgcaggagaagcctgAccaCCTCTTCaggggctgattggtggcacaaacaacagggctcctggggtgcc tgcccggttctcaggctccctccttgggggcaaagctgccctgaccatttcgggtgcgcagcctgaggatgaggctatttatttctgcgtgctctggt atagtgaccattgggtgttcggcggagggaccaagctgaccgtcctaGGCGGAGGAGGAGGTTCAGGAGGcGGAGG TAGCGGGGGAGGCGGTTCCGGGGGAGGCGGTTCTcaggtgcagctgcagCAGtcgggcccaggactggtg aagccttcggagaccctgtccatcacctgcactgtctctggtttcCTGctgaccgactacggcgtaaactgggtgcggcagcccccagggaag ggactggagtggctgggggtgatctggggtgacgggATCaccgactacaaccccctccctcaagagtcgactgaccgtgtccaaggacAC AtccaagaaccaggtgtccctgaagatgagctctctgaccgccgcagacacggccCGGtattactgtgtcaccggcctgttcgactactgggg ccagggcaccACCctgaccgtctcctcaGAAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCgatatctac atctgggcgcccttggccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaactcctgtatatatt caaacaaccatttatgagaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaaggaggatgtgaactg agagtgaagttcagcaggagcgcagacgccccgcgtacaagcagggccagaaccagctctataacgagctcaatctaggacgaagagagg agtacgatgttttggacaagagacgtggccgggaccctgagatgggggaaagccgagaaggaagaaccctcaggaaggcctgtacaatgaa ctgcagaaagataagatggcggaggcctacagtgagattgggatgaaaggcgagcgccggaggggcaaggggcacgatggcctttaccagg gtctcagtacagccaccaaggacacctacgacgcccttcacatgcaggccctgcccccgc
257	caggctgtggtgactcaggagccctcactgactgtgtccccaggagggacagtcactctcacctgtggctccagcactggagctgtcaccacttc caactatgcctcatgggtgcaggagaagcctggccaagcccccaggggctgattggtggcacaaacaacagggctcctggggtgcctgccc ggttctcaggctccctccttgggggcaaagctgccctgaccatttcgggtgcgcagcctgaggatgaggctatttatttctgcgtgctctggtatagt gaccattgggtgttcggcggagggaccaagctgaccgtcctaGGCGGAGGAGGAGGTTCAGGAGGAGGAGGTA GCGGGGGAGGCGGTTCCGGGGGAGGCGGTTCTcaggtgcagctgcagcagtcgggcccaggactggtgaagcc ttcggagaccctgtccatcacctgcactgtctctggtttctccctgaccgactacggcgtaaactgggtgcggcagcccccagggaagggactgg agtggctgggggtgatctggggtgacgggagcaccgactacaaccccctccctcaagagtcgactgaccgtgtccaaggacaactccaagaacc aggtgtccctgaagatgagctctctgaccgccgcagacacggccgtgtattactgtgtcaccggcctgttcgactactggggccagggcaccctg ctgaccgtctcctcaGAAAGCAAGTATGGCCCaCCTTGTCCACCTTGTCCCgatatctacatctgggcgcccttgg ccgggacttgtggggtccttctcctgtcactggttatcacccttactgcaaacggggcagaaagaaactcctgtatatattcaaacaaccatttatga gaccagtacaaactactcaagaggaagatggctgtagctgccgatttccagaagaagaagaaggaggatgtgaactgagagtgaagttcagca ggagcgcagacgccccgcgtacaagcagggccagaaccagctctataacgagctcaatctaggacgaagagaggagtacgatgttttggac aagagacgtggccgggaccctgagatgggggaaagccgagaaggaagaaccctcaggaaggcctgtacaatgaactgcagaaagataag atggcggaggcctacagtgagattgggatgaaaggcgagcgccggaggggcaaggggcacgatggcctttaccagggtctcagtacagcca ccaaggacacctacgacgcccttcacatgcaggccctgcccccgc

Table 59. Sequence Identifier Description	
SEQ ID NO.	NAME/ DESCRIPTION
1	LV-EF1a-GCN4(52SR4)-BBZ
2	yeast transcription factor GCN4 (7P14P)
3	yeast transcription factor GCN4 minimal binding peptide
4	yeast transcription factor GCN4 minimal binding peptide with linkers
5	Hydrophilic target peptide (HTP)
6	Hydrophilic target peptide (HTP) P
7	FLAG®
8	Light chain of anti-CD19 antibody
9	Heavy chain of anti-CD19 antibody Fab

Table 59. Sequence Identifier Description	
SEQ ID NO.	**NAME/ DESCRIPTION**
10	Heavy chain of anti-CD19 IgG
11	Light chain of Trastuzumab (anti-Her2)
12	Heavy chain of Trastuzumab (anti-Her2)
13	Light Chain of Rituximab (anti-CD20)
14	Heavy Chain of Rituximab (anti-CD20)
15	Light chain of Clone C225 (anti-EGFR)
16	Heavy chain of Clone C225 (anti-EGFR)
17	Light chain of anti-CLL1 antibody
18	Heavy chain of anti-CLL1 antibody
19	Light chain of anti-CD33 antibody
20	Heavy chain of anti-CD33 antibody
21	Light chain of wildtype anti-CS1 antibody
22	Heavy chain of wildtype anti-CS1 antibody Fab
23	Light chain of anti-EGFRvIII antibody (Hu806) Fab
24	Heavy chain of anti-EGFRvIII antibody (Hu806) Fab
25	Light chain of anti-BCMA antibody (BCMA98) Fab
26	Heavy chain of anti-BCMA antibody (BCMA98) Fab
27	Light Chain of anti-CD19 antibody
28	Heavy Chain of anti-CD19 antibody IgG
29	Heavy Chain of anti-CD19 antibody Fab
30	anti-CD19 Fab CL1-GCN4 switch Light Chain
31	anti-CD19 IgG CL1-GCN4 switch Light Chain
32	anti-CD19 Fab HC1-GCN4 switch Heavy Chain
33	anti-CD19 IgG HC1-GCN4 switch Heavy Chain
34	anti-CD19 Fab C term-GCN4 switch Heavy Chain
35	anti-CD19 IgG hinge-GCN4 switch Heavy Chain
36	anti-CD19 Fab Light Chain NT1
37	anti-BCMA GCN4 CL1 light chain
38	anti-BCMA heavy chain WT IgG
39	pBAD-CD19wt
40	GGGGS linker
41	GGGS linker
42	GGS linker
43	GS linker
44	XS linker
45	rigid switch fusion/grafting linker 3
46	rigid switch fusion/grafting linker 4
47	rigid switch fusion/grafting linker 4a
48	flexible switch fusion/grafting linker - prophetic
49	rigid switch fusion/grafting linker 5
50	prolyl switch fusion/grafting linker - prophetic
51	GCN4-CD28-CD3z(1-3)
52	mCD19(1D3)-LC-CL1
53	mCD19(1D3)-LC-WT
54	mCD19(1D3)-HC-WT Fab
55	mCD19(1D3)-HC_NT3
56	mCD19(1D3)-HC-Cterm
57	mCD19(1D3)-LC-Cterm
58	mCD19(1D3)-LC_NT1
59	mCD19(1D3)-LC_NT2
60	mCD19(1D3)-HC_NT1
61	mCD19(1D3)-HC_NT2
62	NYESO1(1G4-113)-TCRb-WT
63	NYESO1(1G4-113)-TCRb-GCN4-NT1
64	NYESO1(1G4-113)-TCRa-GCN4-NT1
65	NYESO1(1G4-113)-TCRa-WT

Table 59. Sequence Identifier Description	
SEQ ID NO.	**NAME/ DESCRIPTION**
66	NYESO1(1G4-113)-TCRb-GCN4-Cterm
67	NYESO1(1G4-113)-TCRa-GCN4-Cterm
68	CD8 hinge peptide sequence
69	no hinge peptide sequence
70	IgG4 hinge peptide sequence
71	IgG4 m hinge peptide sequence
72	LV-EF1a-GCN4(52SR4)-BBZ_no hinge
73	LV-EF1a-GCN4(52SR4)-BBZ_IgG4(Pro) (CAR containing hinge)
74	LV-EF1a-GCN4(52SR4)-BBZ_IgG4(Ser) (CAR containing hinge)
75	GCN4 epitope alanine mutant 1
76	GCN4 epitope alanine mutant 2
77	GCN4 epitope alanine mutant 3
78	GCN4 epitope alanine mutant 4
79	GCN4 epitope alanine mutant 5
80	GCN4 epitope alanine mutant 6
81	GCN4 epitope alanine mutant 7
82	GCN4 epitope alanine mutant 8
83	GCN4 epitope extended 1
84	GCN4 epitope extended 2
85	CD19(FMC63)-LC-NT2 (N-terminal fusion using flexible GGGGSGGGGS linker)
86	CD19(FMC63)-HC-NT1 (N-terminal fusion using flexible GGGGS linker)
87	CD19(FMC63)-HC-NT2 (N-terminal fusion using flexible GGGGSGGGGS linker)
88	CD19(FMC63)-HC-NT3 (N-terminal fusion using rigid linker design 3)
89	CD19(FMC63)-HC-NT4 (N-terminal fusion using rigid linker design 4)
90	CD19(FMC63)-HC2 (grafting the GCN4 peptide to region 2 of the heavy chain constant region)
91	CD19(FMC63)-S74_1 (grafting the GCN4 peptide to the region of S74 in the heavy chain, this version places it inbeween S74 and K75 of the wild type sequence)
92	CD19(FMC63)-S74_2 (grafting the GCN4 peptide to the region of S74 in the heavy chain, this version replaces S74 and K75 of the wild type sequence with the GCN4 peptide sequence (with GGGGS linkers on either side))
93	CD19(FMC63)-LC-NT4a (N-terminal light chain fusion using rigid linker design 4a)
94	CD19(FMC63)-LC-NT5 (N-terminal light chain fusion using flexible linker design 5)
95	CD19(FMC63)-HC-NT4a (N-terminal heavy chain fusion using rigid linker design 4a)
96	CD19(FMC63)-HC-NT5 (N-terminal heavy chain fusion using flexible linker design 5)
97	CD19(FMC63)-LC-Cterm (C-terminal fusion of GCN4 epitope to the light chain)
98	CD19(FMC63)-LC-NT1_LLPKN (Extension of the Nterminus with LLPKN of the GCN4 epitope in the light chain N-terminal fusion with a flexible linker GGGGS)
99	CD19(FMC63)-LC-NT1_DLPKQ (Extension of the Nterminus with DLPKQ of the GCN4 epitope in the light chain N-terminal fusion with a flexible linker GGGGS)
100	CD19(FMC63)-HC-WT/LC-NT1 (Entire vector sequence of the pBAD vector harboring the anti-CD19(FMC63) LC-NT1 switch (both chains))
101	CD19(FMC63)-HC-WT/LC-NT1 (Entire vector sequence of the pBAD vector harboring the anti-CD19(FMC63) LC-NT1 switch (both chains) in which the protein sequence has been codon optimized)
102	CLL1(1075.7)-HC_NT3 (N-terminal fusion to the heavy chain using rigid linker design 3)
103	CLL1(1075.7)-LC_NT1 (N-terminal fusion to the light chain using flexible GGGGS linker)
104	CLL1(1075.7)-HC_Cterm (C-terminal fusion to the heavy chain using flexible linker)
105	CLL1(1075.7)-LC_Cterm (C-terminal fusion to the light chain using flexible linker)
106	CD22(m971)-HC-WT Fab (wild type heavy chain sequence)
107	CD22(m971)-LC-WT (wild type light chain sequence)
108	CD22(m971)-HC_NT3 (N-terminal fusion to the heavy chain using rigid linker design 3)
109	CD22(m971)-LC_NT1 (N-terminal fusion to the light chain using flexible GGGGS linker)
110	CD22(m971)-HC_Cterm (C-terminal fusion to the heavy chain using flexible linker)
111	CD22(m971)-LC_Cterm (C-terminal fusion to the light chain using flexible linker)

Table 59. Sequence Identifier Description	
SEQ ID NO.	NAME/ DESCRIPTION
112	CD22(m972)-HC-WT Fab (wild type heavy chain sequence)
113	CD22(m972)-LC-WT (wild type light chain sequence)
114	CD22(m972)-HC_NT3 (N-terminal fusion to the heavy chain using rigid linker design 3)
115	CD22(m972)-LC_NT1 (N-terminal fusion to the light chain using flexible GGGGS linker)
116	CD22(m972)-HC_Cterm (C-terminal fusion to the heavy chain using flexible linker)
117	CD22(m972)-LC_Cterm (C-terminal fusion to the light chain using flexible linker)
118	CD22(CMC544)-HC-WT Fab (wild type heavy chain sequence)
119	CD22(CMC544)-LC-WT (wild type light chain sequence)
120	CD22(CMC544)-HC_NT3 (N-terminal fusion to the heavy chain using rigid linker design 3)
121	CD22(CMC544)-LC_NT1 (N-terminal fusion to the light chain using flexible GGGGS linker)
122	CD22(CMC544)-HC_Cterm (C-terminal fusion to the heavy chain using flexible linker)
123	CD22(CMC544)-LC_Cterm (C-terminal fusion to the light chain using flexible linker)
124	CD20(RTX)-HC_NT3 (N-terminal fusion to the heavy chain using rigid linker design 3)
125	CD20(RTX)-LC_NT1 (N-terminal fusion to the light chain using flexible GGGGS linker)
126	CD20(RTX)-HC_Cterm (C-terminal fusion to the heavy chain using flexible linker)
127	CD20(RTX)-LC_Cterm (C-terminal fusion to the light chain using flexible linker)
128	CD20(GA101[34I])-HC-WT Fab (wild type heavy chain sequence)
129	CD20(GA101[34I])-LC-WT (wild type light chain sequence)
130	CD20(GA101[34I])-HC_NT3 (N-terminal fusion to the heavy chain using rigid linker design 3)
131	CD20(GA101[34I])-LC_NT1 (N-terminal fusion to the light chain using flexible GGGGS linker)
132	CD20(GA101[34I])-HC_Cterm (C-terminal fusion to the heavy chain using flexible linker)
133	CD20(GA101[34I])-LC_Cterm (C-terminal fusion to the light chain using flexible linker)
134	CD20(OFA)-HC-WT Fab (wild type heavy chain sequence)
135	CD20(OFA)-LC-WT (wild type light chain sequence)
136	CD20(OFA)-HC_NT3 (N-terminal fusion to the heavy chain using rigid linker design 3)
137	CD20(OFA)-LC_NT1 (N-terminal fusion to the light chain using flexible GGGGS linker)
138	CD20(OFA)-HC_Cterm (C-terminal fusion to the heavy chain using flexible linker)
139	CD20(OFA)-LC_Cterm (C-terminal fusion to the light chain using flexible linker)
140	Her2(trastuzumab)-HC_NT3 (N-terminal fusion to the heavy chain using rigid linker design 3)
141	Her2(trastuzumab)-LC_NT1 (N-terminal fusion to the light chain using flexible GGGGS linker)
142	Her2(trastuzumab)-HC_Cterm (C-terminal fusion to the heavy chain using flexible linker)
143	Her2(trastuzumab)-LC_Cterm (C-terminal fusion to the light chain using flexible linker)
144	BCMA(BCMA-98)-HC-WT Fab (wild type heavy chain sequence Fab)
145	BCMA(BCMA-98)-LC-NT1 (N-terminal fusion using flexible GGGGS linker)
146	BCMA(BCMA-98)-LC-NT2 (N-terminal fusion using flexible GGGGSGGGGS linker)
147	BCMA(BCMA-98)-HC-NT1 (N-terminal fusion using flexible GGGGS linker)
148	BCMA(BCMA-98)-HC-NT2 (N-terminal fusion using flexible GGGGSGGGGS linker)
149	CD19(huB4)-LC-WT (wild type light chain sequence)
150	CD19(huB4)-HC-WT Fab (wild type heavy chain sequence)
151	CD19(huB4)-LC1 (fusion to the constant region 1 of the light chain)
152	CD19(huB4)-HC1 (fusion to the constant region 1 of the heavy chain)
153	CD19(huB4)-LC-NT1 (N-terminal fusion using flexible GGGGS linker)
154	CD19(huB4)-LC-NT2 (N-terminal fusion using flexible GGGGSGGGGS linker)
155	CD19(huB4)-HC-NT1 (N-terminal fusion using flexible GGGGS linker)
156	CD19(huB4)-HC-NT2 (N-terminal fusion using flexible GGGGSGGGGS linker)
157	CEA(A5B7)-HC-WT Fab (wild type heavy chain sequence)
158	CEA(A5B7)-CL1 (fusion to the constant region 1 of the light chain)
159	CEA(A5B7)-LC-WT (wild type light chain sequence)
160	CEA(A5B7)-HC-Cterm (C-terminal fusion to the heavy chain using flexible linker)
161	CD33(hM195)-HC_NT3 (N-terminal fusion to the heavy chain using rigid linker design 3)

Table 59. Sequence Identifier Description	
SEQ ID NO.	**NAME/ DESCRIPTION**
162	CD33(hM195)-LC_NT1 (N-terminal fusion to the light chain using flexible GGGGS linker)
163	CD33(hM195)-HC_Cterm (C-terminal fusion to the heavy chain using flexible linker)
164	CD33(hM195)-LC_Cterm (C-terminal fusion to the light chain using flexible linker)
165	h52SR4L2_h52SR4H2
166	h52SR4L2_h52SR4H3
167	h52SR4L3_h52SR4H2
168	h52SR4L3_h52SR4H3
169	h52SR4L4_h52SR4H2
170	h52SR4L4_h52SR4H3
171	LV-EF1a-huGCN4-BBZ_L2,H2
172	LV-EF1a-huGCN4-BBZ_L2,H3
173	LV-EF1a-huGCN4-BBZ_L3,H2
174	LV-EF1a-huGCN4-BBZ_L3,H3
175	LV-EF1a-huGCN4-BBZ_L4,H2
176	LV-EF1a-huGCN4-BBZ_L4,H3
177	Anti-CD20 OFA Light chain WT
178	Anti-CD20 OFA Heavy chain (Fab) WT
179	IgG1 Fc region (E233P/L234V/L235A/ΔG236 + A327G/A330S/P331S)
180	sCAR (long) sequence
181	CART-19 sequence
182	CART20 BBZ
183	hu 52SR4 L5 H6
184	hu 52SR4 L5 H4b
185	hu 52SR4 L5 H6b
186	hLL2 LC WT FAB
187	hLL2 HC WT FAB
188	hLL2 LCNT FAB
189	hLL2 LCCT FAB
190	hLL2 HCNT FAB
191	hLL2 HCCT FAB
192	hLL2 LCCT2 FAB
193	hLL2 LCCT3 FAB
194	hLL2 HCCT2 FAB
195	hLL2 HCCT3 FAB
196	hLL2 HC WT IgG
197	hLL2 HCCT IgG
198	m971 HC WT IgG
199	m971 HCCT IgG
200	1D3 CART19
201	murine sCAR 28Z
202	52SR4, co-stim chimera 1
203	52SR4, co-stim chimera 2
204	52SR4, co-stim chimera 3
205	52SR4, co-stim chimera 4
206	1D3, co-stim chimera 1
207	1D3, co-stim chimera 2
208	1D3, co-stim chimera 3
209	1D3, co-stim chimera 4
210	52SR4, co-stim chimera 5
211	52SR4, co-stim chimera 6
212	52SR4, co-stim chimera 7
213	1D3, co-stim chimera 5
214	GG linker
215	1D3 LCNT short linker
216	1D3 HCNT short linker

Table 59. Sequence Identifier Description	
SEQ ID NO.	**NAME/ DESCRIPTION**
217	CD33 (hP67.6) LCNT1
218	CD33 (hP67.6) LCNT2
219	CD33 (hP67.6) LCNT3
220	CD33 (hP67.6) HCNT1
221	CD33 (hP67.6) HCNT2
222	CD33 (hP67.6) LCCT1
223	CD33 (hP67.6) LCCT2
224	CD33 (hP67.6) LCCT3
225	CD33 (hP67.6) HCCT1
226	CD33 (hP67.6) HCCT2
227	CD33 (hP67.6) HCCT3
228	CD33 (hP67.6) HCC1
229	CD33 (hP67.6) HCC1 G4S
230	CD33 (hP67.6) LCC1 G4S
231	CD33 (hP67.6) LCWT
232	CD33 (hP67.6) HCWT
233	CD123 32716 LCWT
234	CD123 32716 HCWT
235	CD123 26292 LCWT
236	CD123 26292 HCWT
237	CD123 26292 LCNT1
238	CD123 32716 LCNT1
239	CD123 32716 LCNT3
240	CD123 32716 LCNT2
241	CD123 26292 HCNT1
242	CD123 32716 HCNT1
243	CD123 32716 HCNT2
244	CD123 26292 LCCT1
245	CD123 32716 LCCT1
246	CD123 32716 LCCT2
247	CD123 32716 LCCT3
248	CD123 26292 HCCT1
249	CD123 32716 HCCT1
250	CD123 32716 HCCT2
251	CD123 32716 HCCT3
252	CD123 32716 HCC1
253	CD123 32716 HCC1 G4S
254	CD123 32716 LCC1 G4S
255	hu 52SR4 L6b H4
256	hu 52SR4 L5b H4b
257	hu 52SR4 L6 H6

WHAT IS CLAIMED IS:

1. A chimeric antigen receptor comprising an extracellular domain, a transmembrane domain an intracellular signaling domain, wherein the extracellular domain comprises:

a. a region that interacts with a chimeric antigen receptor switch; and

b. a hinge domain.

2. The chimeric antigen receptor of claim 1, wherein the hinge domain is about one to about twenty amino acids long.

3. The chimeric antigen receptor of claim 1, wherein the hinge domain is greater than about 20 amino acids long.

4. The chimeric antigen receptor of any one of claims 1-3, wherein the hinge domain is flexible.

5. The chimeric antigen receptor of any one of claims 1-3, wherein the hinge domain is rigid.

6. The chimeric antigen receptor of any one of claims 1-5, wherein a first cysteine of a first chimeric antigen receptor and a second cysteine of a second chimeric antigen receptor form a disulfide bond, resulting in multimerization of the first chimeric antigen receptor and the second chimeric antigen receptor.

7. The chimeric antigen receptor of any one of claims 1-6, wherein the hinge domain has a sequence selected from SEQ ID NOS: 68-71.

8. The chimeric antigen receptor of any one of claims 1-7, wherein the hinge domain has a sequence that is at least 50% homologous to a sequence selected from SEQ ID NOS: 68-71.

9. The chimeric antigen receptor of any one of claims 1-8, wherein the extracellular domain comprises a humanized anti-GCN4 scFv.

10. The chimeric antigen receptor of claim 9, wherein the humanized anti-GCN4 scFv has a sequence selected from SEQ ID NOS: 171-176.

11. The chimeric antigen receptor of claim 10, wherein the humanized anti-GCN4 scFv has a sequence that is at least 50% homologous to a sequence selected from SEQ ID NOS: 171-176.

12. The chimeric antigen receptor of any one of claims 1-11, wherein the hinge domain comprises a peptide derived from a protein selected from a CD8, an IgG, portions thereof, and combinations thereof.

13. The chimeric antigen receptor of any one of claims 1-12, wherein the region that interacts with a chimeric antigen receptor switch interacts with a chimeric antigen receptor binding peptide of the chimeric antigen receptor switch, wherein the chimeric antigen receptor switch further comprises targeting moiety that interacts with a cell surface molecule on the target.

14. The chimeric antigen receptor of claim 1, wherein the chimeric antigen receptor has a sequence selected from SEQ ID NOS: 51, 180, 273, 274, 275, 276, 73, and 74.

15. The chimeric antigen receptor of claim 1, wherein the chimeric antigen receptor has a sequence that is at least 50% homologous to a sequence selected from SEQ ID NOS: 51, 180, 273, 274, 275, 276, 73, and 74.

16. A soluble T cell receptor switch comprising:

a. a chimeric antigen receptor binding peptide; and

b. a soluble T cell receptor or portion thereof.

17. The soluble T cell receptor switch of claim 16, wherein the chimeric antigen receptor binding peptide is fused to a terminus of a domain of the soluble T cell receptor.

18. The soluble T cell receptor switch of claim 16, wherein the chimeric antigen receptor binding peptide is grafted into an internal site of a domain of the soluble T cell receptor.

19. The soluble T cell receptor switch of claim 17 or 18, wherein the domain of the soluble T cell receptor is selected from an alpha chain and a beta chain.

20. The soluble T cell receptor switch of claim 16, wherein the soluble T cell receptor switch has a sequence selected from SEQ ID NOS: 62-67.

21. The soluble T cell receptor switch of claim 16, wherein the soluble T cell receptor switch has a sequence at least 50% homologous to a sequence selected from SEQ ID NOS: 62-67.

22. The soluble T cell receptor switch of claim 16, further comprising a linker, wherein the linker links the chimeric antigen receptor binding peptide to the soluble T cell receptor or portion thereof.

23. The soluble T cell receptor switch of claim 22, wherein the linker is flexible.

24. The soluble T cell receptor switch of claim 22, wherein the linker is rigid.

25. The soluble T cell receptor switch of claim 22, wherein the linker is selected from SEQ ID NOS: 40-50.

26. A chimeric antigen receptor switch comprising:

a. a chimeric antigen receptor binding peptide;

b. a targeting moiety;

c. and a linker,

wherein the linker links the chimeric antigen receptor binding peptide to the targeting moiety.

27. The chimeric antigen receptor switch of claim 26, wherein the linker is rigid.

28. The chimeric antigen receptor switch of claim 26 or 27, wherein the linker comprises an alpha helix.

29. The chimeric antigen receptor switch of claim 26, wherein the linker is flexible.

30. A chimeric antigen receptor switch comprising:

a. a fusion antibody comprising:

i. a chimeric antigen receptor binding peptide; and

ii. a light chain of an antibody or antibody fragment,

wherein the chimeric antigen receptor binding peptide is connected to the light chain of the targeting antibody or antibody fragment; and

b. a heavy chain of the targeting antibody or antibody fragment.

31. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 85, 93, 94, 97, 97-99, 151, 153 and 154 and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence selected from SEQ ID NOS. 9, 10 and 150.

32. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 85, 93, 94, 97, 97-99, 151, 153 and 154, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS. 9, 10 and 150.

33. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 103 and 105, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence of SEQ ID NO. 18.

34. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 103 and 105, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO. 18.

35. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 109, 111, 115, 117, 121 and 123, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence selected from SEQ ID NOS: 106, 112 and 118.

36. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 109, 111, 115, 117, 121 and 123, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 106, 112 and 118.

37. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 125, 127, 131, 133, 137 and 139, and the

heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence selected from SEQ ID NOS: 14, 128 and 134.

38. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 125, 127, 131, 133, 137 and 139, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 14, 128 and 134.

39. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 141 and 143, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence of SEQ ID NO: 12.

40. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 141 and 143, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 12.

41. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 145 and 146, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence of SEQ ID NO: 144.

42. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 145 and 146, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 144.

43. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence of SEQ ID NO: 158, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence of SEQ ID NO: 157.

44. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 158, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 157.

45. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 162 and 164, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence of SEQ ID NO: 20.

46. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 162 and 164, and the heavy chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 20.

47. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody and the heavy chain of the targeting antibody or antibody fragment are encoded by one or more nucleotide sequences in a polynucleotide vector, wherein the polynucleotide vector has a sequence selected from SEQ ID NOS: 100 and 101.

48. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody and the heavy chain of the targeting antibody or antibody fragment are encoded by one or more nucleotide sequences in a vector, wherein the vector has a sequence that is at least 50% homologous to a sequence selected from SEQ ID NOS: 100 and 101.

49. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody has a sequence selected from SEQ ID NOS: 30 and 31, and the heavy chain of the targeting antibody or antibody fragment has a sequence selected from SEQ ID NOS: 28 and 29.

50. The chimeric antigen receptor switch of claim 30, wherein the fusion antibody has a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 30 and 31, and the heavy chain of the targeting antibody or antibody fragment has a sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 28 and 29.

51. A chimeric antigen receptor switch comprising:

a. a fusion antibody comprising:

i. a chimeric antigen receptor binding peptide; and

ii. a heavy chain of an antibody or antibody fragment,

wherein the chimeric antigen receptor binding peptide is connected to the heavy chain of the targeting antibody or antibody fragment; and

b. a light chain of the targeting antibody or antibody fragment.

52. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 86-92, 95, 96, 152, 155 and 156, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence selected from SEQ ID NOS: 8 and 149.

53. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 86-92, 95, 96, 152, 155 and 156, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 8 and 149.

54. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 102 and 104, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence of SEQ ID NO. 17.

55. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 102 and 104, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO. 17.

56. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 108, 110, 116, 120 and 122, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence selected from SEQ ID NOS: 113 and 119.

57. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 108, 110, 116, 120 and 122 and 104, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 113 and 119.

58. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 124, 126, 130, 132, 136 and 138, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence selected from SEQ ID NOS: 129 and 135.

59. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 124, 126, 130, 132, 136 and 138, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 129 and 135.

60. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 140 and 142, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence of SEQ ID NO: 11.

61. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 140 and 142, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 11.

62. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 147 and 148.

63. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a sequence selected from SEQ ID NOS: 147 and 148.

64. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence of SEQ ID NO: 160, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence of SEQ ID NO: 159.

65. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 160, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence that is at least about 50% homologous to SEQ ID NO: 159.

66. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence selected from SEQ ID NOS: 161 and 163, and the light chain of the targeting antibody or antibody fragment is encoded by a nucleotide sequence of SEQ ID NO: 19.

67. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody is encoded by a nucleotide sequence that is at least about 50% homologous to a nucleotide sequence selected from SEQ ID NOS: 161 and 163, and the light chain of the targeting antibody or antibody fragment is encoded by a sequence that is at least about 50% homologous to SEQ ID NO: 19.

68. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody has a sequence selected from SEQ ID NOS: 32-25 and the light chain of the targeting antibody or antibody fragment has a sequence of SEQ ID NO. 27.

69. The chimeric antigen receptor switch of claim 51, wherein the fusion antibody has a sequence at least about 50% homologous to a sequence selected from SEQ ID NOS: 32-25 and the light chain of the targeting antibody or antibody fragment has a sequence at least about 50% homologous to SEQ ID NO. 27.

70. A pharmaceutical composition comprising the chimeric antibody antigen receptor switch of any one of claims 26-69.

71. A method comprising, administering by a method selected from intraperitoneal injection and intravenous injection (i) the chimeric antigen receptor switch of any one of claims 26-69 or the pharmaceutical composition of claim 70 and (ii) a chimeric antigen receptor effector cell to a subject in need thereof, c the chimeric antigen receptor switch and/or chimeric antigen receptor effector cell is administered .

72. The method of claim 71, comprising administering the chimeric antigen receptor switch and/or the chimeric antigen receptor effector cell multiple times.

73. A method of producing an optimal switchable chimeric antigen receptor platform, comprising:

a. incorporating a first chimeric antigen receptor binding peptide to a first site of a targeting moiety that binds a first cell surface molecule on a first target cell to produce a first switch;

b. incorporating a second chimeric antigen receptor binding peptide to a second site of a second targeting moiety that binds a second cell surface molecule on a second target cell to produce a second switch;

c. contacting the first target cell with the first switch and a first chimeric antigen receptor effector cell expressing a first chimeric antigen receptor;

d. contacting the second target cell with the second switch and a second chimeric antigen receptor effector cell expressing a second chimeric antigen receptor; and

e. comparing a first cytotoxic effect of the first switch and the first chimeric antigen receptor effector cell on the first target cell to a second cytotoxic effect of the second switch and the second chimeric antigen receptor effector cell on the second target cell; and

f. selecting the first switch and first chimeric antigen receptor effector cell or the second switch and the second chimeric antigen receptor effector cell as the optimal switchable chimeric antigen receptor platform based on comparing the first cytotoxic effect to the second cytotoxic effect.

74. The method of claim 73, wherein the first chimeric antigen receptor binding peptide and the second chimeric antigen receptor binding peptide are the same.

75. The method of claim 73 or 74, wherein the first targeting moiety and the second targeting moiety are the same.

76. The method of any one of claims 73-75, wherein the first site and the second site are the same.

77. The method of any one of claims 73-75, wherein the first site and the second site are different.

78. The method of any one of claims 73-77, wherein the first and/or second targeting moiety comprises a peptide or protein.

79. The method of claim 78, wherein the first site and/or second site is selected from an N terminus of the peptide or protein, a C terminus of the peptide or protein, and an internal site of the peptide or protein.

80. The method of any one of claims 73-77, wherein the first and/or second targeting moiety comprises an antibody or antibody fragment.

81. The method of claim 80, wherein the first site and/or second site is selected from an N terminus of the antibody or antibody fragment, a C terminus of the antibody or antibody fragment, and an internal site of the antibody or antibody fragment.

82. The method of claim 80, wherein the first site and/or second site is selected from a light chain of the antibody or antibody fragment and a heavy chain of the antibody or antibody fragment.

83. The method of claim 80, wherein the first site and/or second site is selected from a variable region of the antibody or antibody fragment and a constant region of the antibody or antibody fragment.

84. The method of claim 80, wherein the first site and/or second site is selected from a VL domain, a CL domain, a VH domain, a CH1 domain, a CH2 domain, a CH3 domain, and a hinge domain of the antibody or antibody fragment.

85. The method of any one of claims 73-84, wherein the incorporating the first/second chimeric antigen receptor binding peptide comprises a method selected from fusing, grafting, conjugating, linking, and combinations thereof.

86. The method of any one of claims 73-85, further comprising incorporating a first linker to the first site, wherein the first linker links the first chimeric antigen receptor binding peptide to the first targeting moiety.

87. The method of claim 86, further comprising incorporating a second linker to the second site wherein the second linker links the second chimeric antigen receptor binding peptide to the second targeting moiety.

88. The method of claim 87, wherein the first linker and the second linker are the same.

89. The method of claim 87, wherein the first linker and the second linker are different.

90. The method of claim 89, wherein the first linker and the second linker differ by a feature selected from flexibility, length, amino acid sequence, and combinations thereof.

91. The method of claim 86-90, wherein the first and/or second linker has a sequence selected from SEQ ID NOS: 40-50.

92. The method of any one of claims 73-91, wherein the first chimeric antigen receptor and the second chimeric antigen receptor are the same.

93. The method of any one of claims 73-91, wherein the first chimeric antigen receptor and the second chimeric antigen receptor are different.

94. The method of claim 93, wherein the first chimeric antigen receptor and the second chimeric antigen receptor differ by a domain selected from an extracellular domain, a transmembrane domain, an intracellular domain and a hinge domain.

95. The method of claim 93, wherein a first hinge domain of the first chimeric antigen receptor and a second hinge domain of the second chimeric antigen receptor differ by a feature selected from flexibility, length, amino acid sequence and combinations thereof.

96. The method of any one of claims 73-95, further comprising incorporating one or more additional chimeric antigen receptor binding peptides to the first and/or second targeting moiety to produce a first multivalent switch and/or a second multivalent switch.

97. The method of any one of claims 73-96, further comprising incorporating a cysteine residue into the first chimeric antigen receptor and/or the second chimeric antigen receptor in order to multimerize the first chimeric antigen receptor and/or the second chimeric antigen receptor through a disulfide bond.

98. The method of any one of claims 73-97, wherein contacting the first target cell and/or contacting the second target cell occurs *in vitro*.

99. The method of any one of claims 73-97, wherein contacting the first target cell and/or contacting the second target cell occurs *in vivo*.

100. The method of claim 99, wherein comparing the first cytotoxic effect to the second cytotoxic effect comprises comparing a feature selected from viability of target cells, viability of off-target cells, tumor burden, and health of an *in vivo* model.

101. A method of producing an optimal switchable chimeric antigen receptor platform, comprising modulating a parameter of a first switchable chimeric antigen receptor platform or a second switchable chimeric antigen receptor platform, and comparing a first outcome of the first switchable chimeric antigen receptor platform in response to modulating the paramater to a second outcome of the second switchable chimeric antigen receptor platform in response to modulating the paramater, wherein the paramater is selected from:

a. affinity of the chimeric antigen receptor for the chimeric antigen receptor–effector cell switch;

b. distance between the chimeric antigen receptor–effector cell membrane and a target cell;

c. a number of chimeric antigen receptor–effector cell binding peptides on the chimeric antigen receptor–effector cell switch;

d. chimeric antigen receptor density on the chimeric antigen receptor–effector cell membrane; and

e. number of engagments between the chimeric antigen receptor–effector cell and the target cell,

and any combination thereof.

102. The method of claim 101, wherein the affinity of the chimeric antigen receptor for the chimeric antigen receptor–effector cell switch is picomolar affinity or nanomolar affinity.

103. The method of claim 101, wherein the distance between the chimeric antigen receptor–effector cell membrane and a target cell is between about 100 Å and 200 Å.

104. The method of claim 101, wherein the number of chimeric antigen receptor–effector cell binding peptides is between about 1 and about 8.

105. The method of claim 101, wherein the chimeric antigen receptor density is a magnitude of about 100 to about $10^{\wedge 10}$ chimeric antigen receptor per chimeric antigen receptor–effector cell.

106. The method of claim 101, wherein the number of engagments is about 1 to about 100.

107. An optimized chimeric antigen receptor–effector cell platform, comprising:

a. a chimeric antigen receptor–effector cell switch comprising a chimeric antigen receptor binding peptide and a targeting moiety; and

b. a chimeric antigen receptor–effector cell that expresses a chimeric antigen receptor, wherein the chimeric antigen receptor–effector cell platform is derived by a method selected from claims 73-106.

108. The optimized chimeric antigen receptor–effector cell platform of claim 107, wherein the chimeric antigen receptor effector cell is a modified T cell.

109. The optimized chimeric antigen receptor–effector cell platform of claim 107 or 108, wherein the chimeric antigen receptor-binding peptide comprises a peptide selected from a non-human peptide, a non-mammalian peptide, a synthetic non-naturally occurring peptide, a non-endogenous peptide, a non-immunogenic peptide, and a peptide that has low immunogenicity in a human subject.

110. The optimized chimeric antigen receptor–effector cell platform of any one of claims 101-104, wherein the targeting moiety is selected from a protein, a peptide, an antibody, an antibody fragment, a small molecule, and a soluble T cell receptor or portion thereof.

111. The optimized chimeric antigen receptor–effector cell platform of any one of claims 101-104, wherein the targeting moiety comprises an antibody or antibody fragment that binds a cell surface molecule selected from CD19, CD20, CD22, CD33, CEA, CLL1, BCMA, CS1, CD123 and Her2.

112. The optimized chimeric antigen receptor–effector cell platform of any one of claims 101-104, wherein the targeting moiety comprises a sequence selected from SEQ ID NOS: 21-38, or a portion thereof, or a homolog thereof.

113. The optimized chimeric antigen receptor–effector cell platform of any one of claims 101-104, wherein the targeting moiety is encoded by a sequence selected from SEQ ID NOS: 8-20, or a portion thereof, or a homolog thereof.

114. A method of enriching a population of chimeric antigen receptor effector cells comprising contacting the chimeric antigen receptor effector cells with an antigen that binds the chimeric antigen receptor of the chimeric antigen receptor effector cells.

115. The method of claim 109, wherein the antigen is located on a chimeric antigen receptor effector cell switch.

116. The method of claims 109 or 110, wherein contacting occurs multiple times.

117. The method of claim 111, wherein the antigen is removed between the multiple times.

118. A model system for testing a CAR-EC platform, comprising:

a. a chimeric antigen receptor–effector cell switch comprising a chimeric antigen receptor binding peptide and a targeting moiety, wherein the targeting moiety binds a non-human cell surface molecule on a non-human target cell; and

b. a chimeric antigen receptor–effector cell that expresses a chimeric antigen receptor, wherein the chimeric antigen receptor–effector cell is a non-human cell.

119. The model system of claim 113, wherein the non-human target cell is produced by a cell line.

120. The model system of claim 114, wherein the model system is an in vitro model system.

121. The model system of claim 113, wherein the non-human target cell is in vivo.

122. The model system of claim 116, wherein the model system is selected from a rat, a mouse, and a monkey.

123. The model system of claim 116, wherein the targeting moiety comprises an anti-mouse antibody or antibody fragment.

124. The model system of claim 113, wherein the targeting moiety has a sequence selected from SEQ ID NOS: 52-61.

125. The model system of claim 113, wherein the targeting moiety has a sequence at least 50% homologous to a sequence selected from SEQ ID NOS: 52-61.

126. The model system of claim 113, wherein the chimeric antigen receptor is encoded by SEQ ID NO. 51.

127. The model system of claim 113, wherein the chimeric antigen receptor is encoded by a sequence at least 50% homologous to SEQ ID NO. 51.

128. A pharmaceutical composition comprising the soluble T cell receptor switch of any one of claims 16-29.

129. A method of treating a condition in a subject in need thereof, comprising administering to the subject:

a. a chimeric antigen receptor switch selected from the soluble T cell receptor switches of claims 16-29 and the chimeric antigen receptor switches of claims X-Y; and

b. a chimeric antigen receptor effector cell comprsing a chimeric antigen receptor.

130. A method of treating a condition in a subject in need thereof, comprising administering to the subject the chimeric antigen receptor switch and the chimeric antigen receptor effector cell of the optimized chimeric antigen receptor–effector cell platform of any one of claims 101-108.

131. The method of claim 129 or 130, wherien the condition is a cancer.

132. The method of claim 131, wherein the cancer is breast cancer.

133. The method of claim 132, wherein the breast cancer comprises Her2-positive cells.

134. The method of claim 133, wherein the Her2-positive cells comprise Her2 (1+) cells.

135. The method of claim 133, wherein the majority of Her2-positive cells are Her2 (+1) cells.

136. The method of claim 129, wherein the chimeric antigen receptor effector cell is administered to the subject prior to administration of the chimeric antigen receptor switch.

137. The method of claim 135, wherein the chimeric antigen receptor switch is administered after the chimeric antigen receptor effector cell is known to have cleared a non-target tissue.

138. The method of claim 135 or claim 136, wherein the chimeric antigen receptor switch comprises the soluble T cell receptor switch of any one of claims 16-25 or the chimeric antigen receptor switch of any one of claims 26 to 69.

139. The method of any one of claims 128 to 137, wherein the chimeric antigen receptor switch is administered in an amount titrated in the subject to optimize the treatment of the cancer.

140. The method of claim 138, wherein the chimeric antigen receptor switch is administered at an initial dose, wherein the initial dose is the smallest dose necessary to treat the cancer.

141. The method of claim 138 or 139, wherein the chimeric antigen receptor switch is administered at a second dose after about 1, 2, 3, 4, 5, 6, 7, 8, or more weeks of treatment at the initial dose, wherein the second dose is larger than the initial dose.

142. The method of any one of claims 122-133, wherein administration of the chimeric antigen receptor switch is terminated after one or more of a) an adverse effect or b) elimination of the condition.

143. The method of claim 134, wherein the adverse effect is cellular aplasia.

144. The method of claim 136, wherein the cellular aplasia is a B cell aplasia.

145. The method of claim 134, wherein adverse effect comprises one or more of tumor lysis syndrome or cytokine release syndrome.

146. The method of claim 134, wherein administration of the chimeric antigen receptor switch is continued after recurrence of the condition.

147. A method of treating relapsed cancer, comprising administering:

a. a first chimeric antigen receptor switch comprising a first chimeric antigen receptor binding peptide and a first targeting moiety;

b. a second chimeric antigen receptor switch comrising a second chimeric antigen receptor binding peptide and a second targeting moiety; and

c. a chimeric antigen receptor effector cell that binds the first chimeric antigen receptor binding peptide and the second CAR-BP,

wherein the first chimeric antigen receptor switch is administered before a relaspe of the subject and the second chimeric antigen receptor switch is administered after the relaspe of the subject.

148. The method of claim 147, wherein the first targeting moiety binds a first cell surface molecule and the second targeting moiety binds a second cell surface molecule, wherein the first cell surface molecule is expressed on a cancer cell before the relapse, and the second cell surface molecule is expressed on the cancer cell after the relapse.

149. The method of claim 148, wherein the first cell surface molecule is:

a. expressed at lower levels after the relapse compared to before the relapse; or

b. not expressed after the relapse.

150. A two-component cancer theraputic comprising:

a. chimeric antigen receptor switch comprising a chimeric antigen receptor binding peptide and a targeting moiety, wherein the chimeric antigen receptor binding peptide is a non-endogenous peptide; and

b. a chimeric antigen receptor effector cell that binds the chimeric antigen receptor binding peptide.

151. A method of activating a chimeric antigen receptor effector cell comprising contacting the chimeric antigen receptor effector cell with a chimeric antigen receptor switch of any one of claims 26-69.

152. The method of claim 151, wherein the chimeric antigen receptor binding peptide is a non-endogenous peptide.

153. The method of claim 152, comprising contacting the chimeric antigen receptor switch with a target cell.

FIG. 1

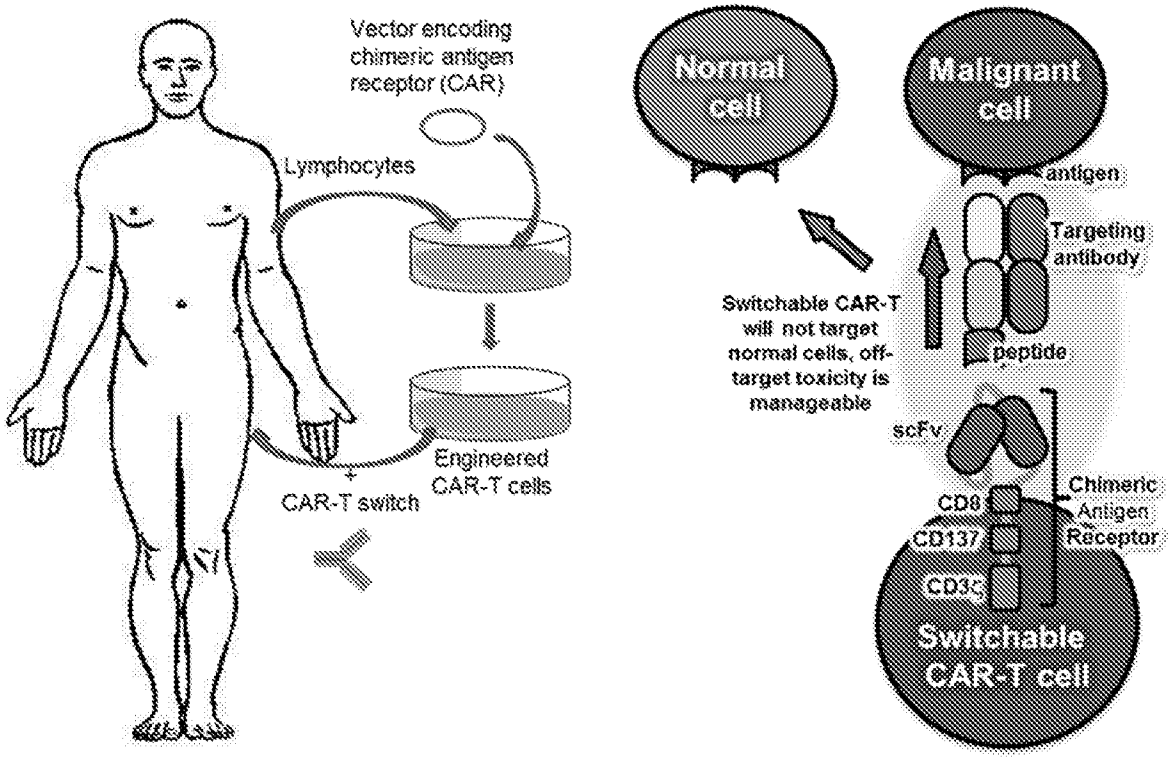

Vector encoding chimeric antigen receptor (CAR)
Lymphocytes
Engineered CAR-T cells
CAR-T switch
Normal cell
Malignant cell
antigen
Targeting antibody
peptide
Switchable CAR-T will not target normal cells, off-target toxicity is manageable
scFv
CD8
CD137
CD3ζ
Chimeric Antigen Receptor
Switchable CAR-T cell

FIG. 2

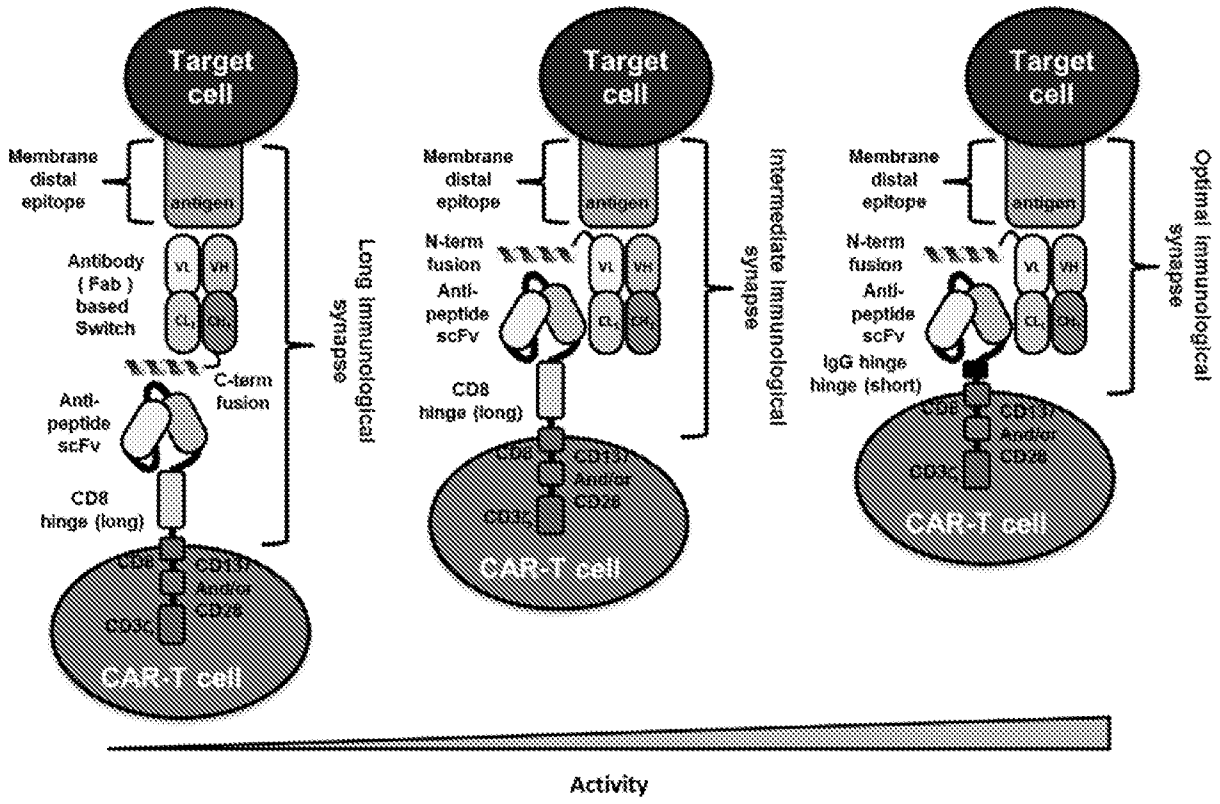

Target cell
Membrane distal epitope
antigen
Antibody (Fab) based Switch
C-term fusion
Anti-peptide scFv
CD8 hinge (long)
CD3ζ
CD137 and/or CD28
CAR-T cell
Long immunological synapse
N-term fusion
Intermediate immunological synapse
IgG hinge hinge (short)
Optimal immunological synapse
Activity

FIG. 3

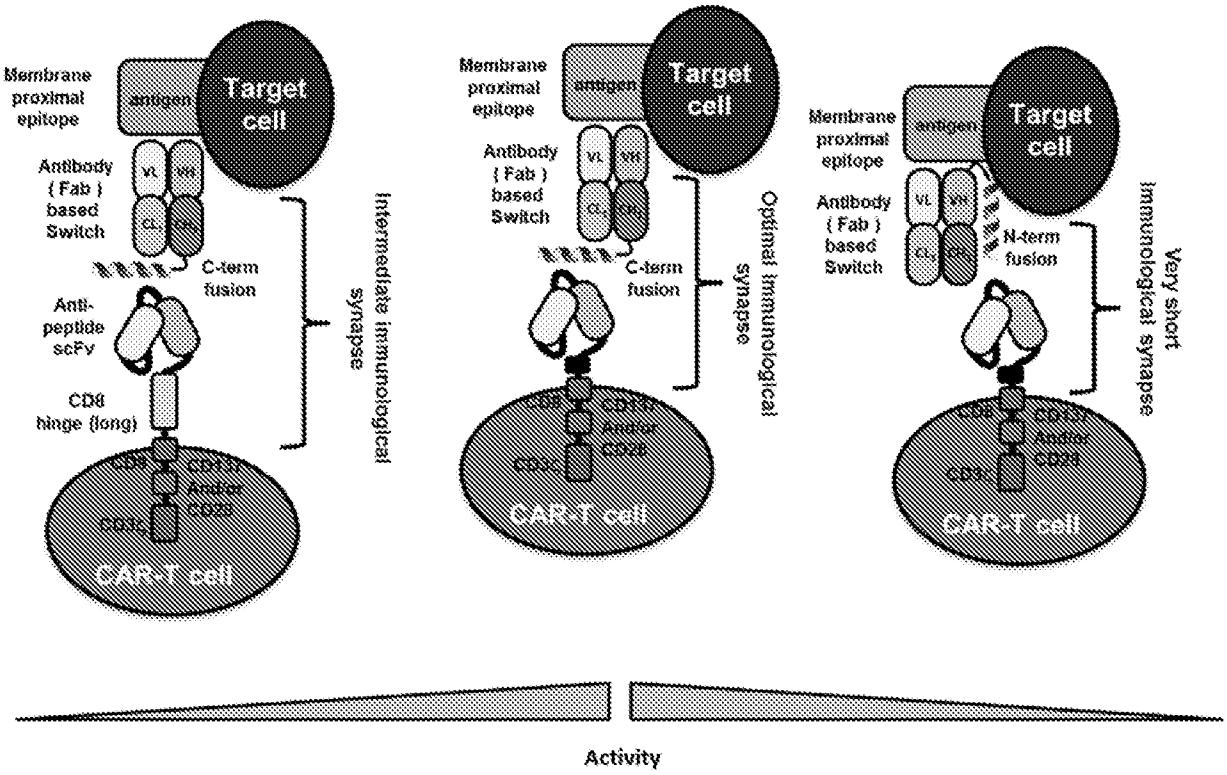
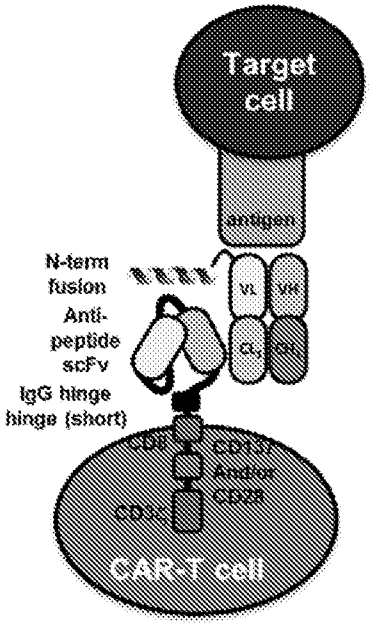
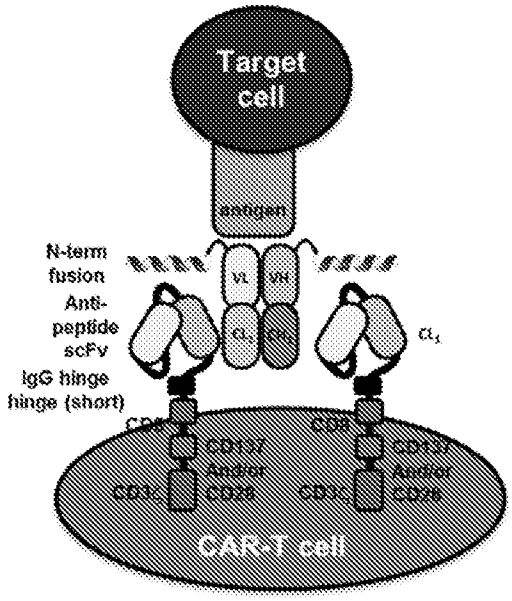

Membrane proximal epitope
antigen
Target cell
Antibody (Fab) based Switch
VL
VH
CL
CH1
C-term fusion
Anti-peptide scFv
CD8 hinge (long)
CD8
CD137 And/or CD28
CD3ζ
CAR-T cell
Intermediate immunological synapse
Optimal immunological synapse
N-term fusion
Very short immunological synapse
Activity

FIG. 4A


Target cell
antigen
N-term fusion
VL
VH
CL
CH1
Anti-peptide scFv
IgG hinge hinge (short)
CD8
CD137 And/or CD28
CD3ζ
CAR-T cell

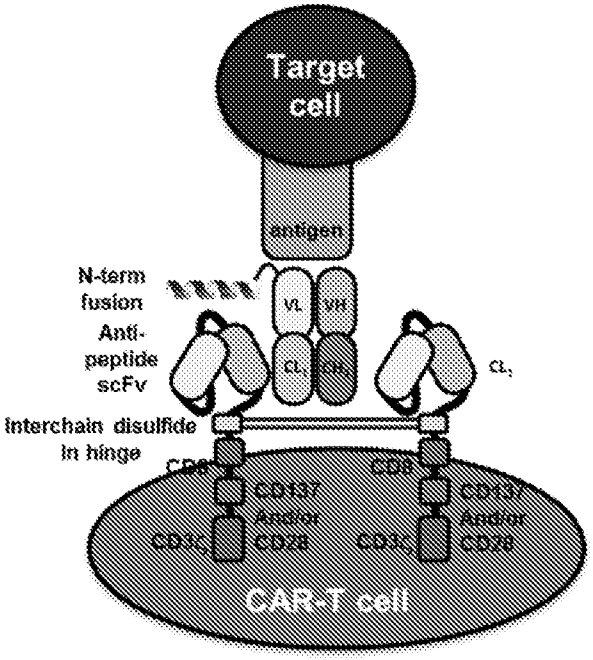
+

FIG. 4B


Target cell
antigen
N-term fusion
Anti-peptide scFv
IgG hinge
hinge (short)
VL
VH
CL
CH1
CD8
CD137 And/or CD28
CD3ζ
CAR-T cell

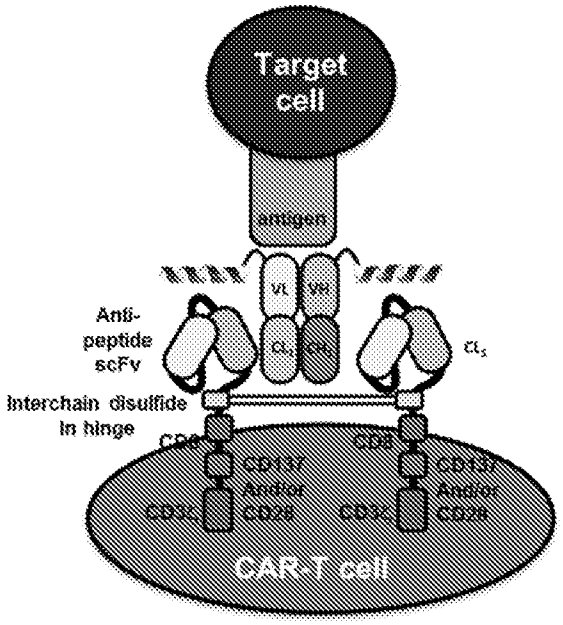
++

FIG. 4C


Target cell
antigen
N-term fusion
Anti-peptide scFv
Interchain disulfide in hinge
VL
VH
CL
CH1
CD8
CD137 And/or CD28
CD3ζ
CAR-T cell

++

FIG. 4D



++ or +++

FIG. 5

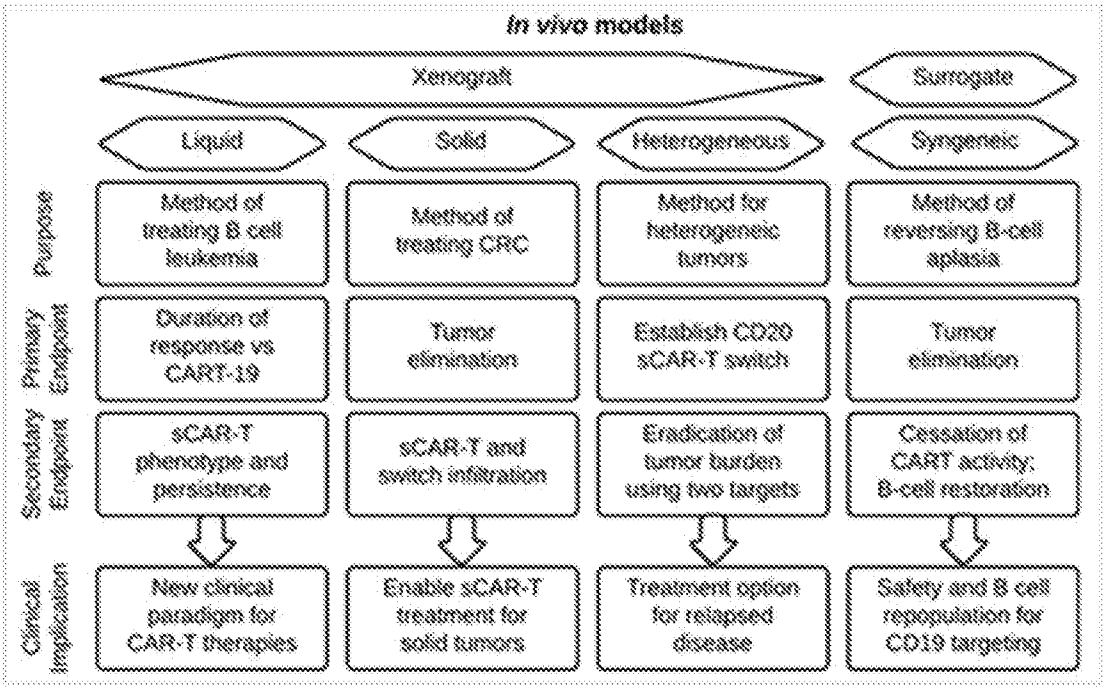


FIG. 6

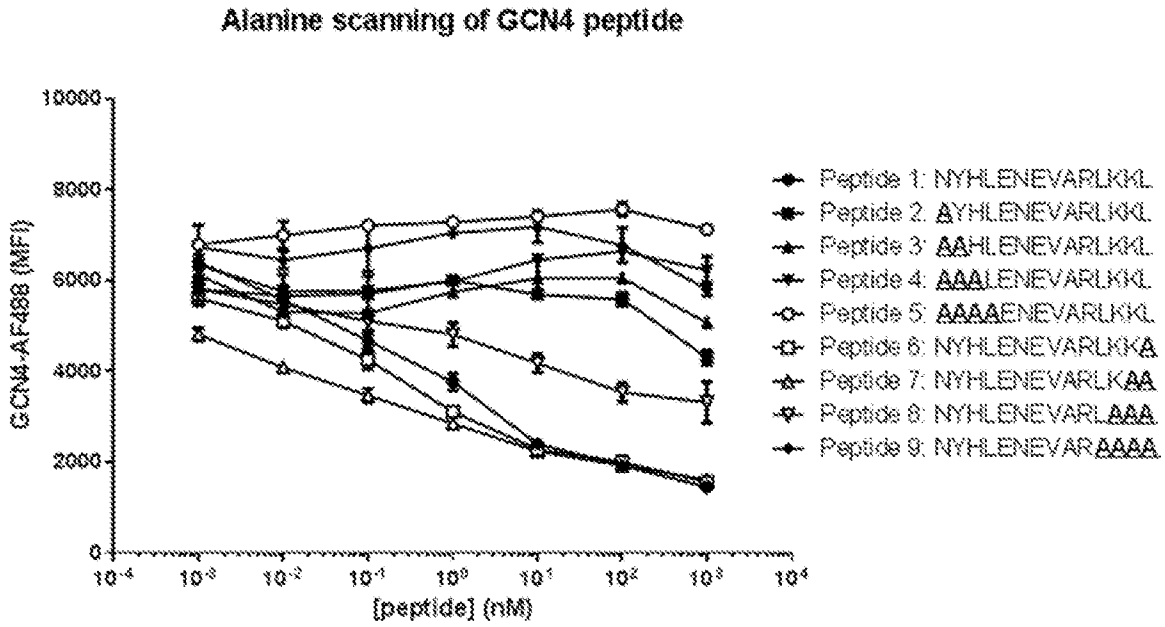

Alanine scanning of GCN4 peptide
GCN4-AF488 (MFI)
10000
8000
6000
4000
2000
0
10^-4
10^-3
10^-2
10^-1
10^0
10^1
10^2
10^3
10^4
[peptide] (nM)
Peptide 1: NYHLENEVARLKKL
Peptide 2: AYHLENEVARLKKL
Peptide 3: AAHLENEVARLKKL
Peptide 4: AAALENEVARLKKL
Peptide 5: AAAAENEVARLKKL
Peptide 6: NYHLENEVARLKKA
Peptide 7: NYHLENEVARLKAA
Peptide 8: NYHLENEVARLAAA
Peptide 9: NYHLENEVARAAAA

FIG. 7A

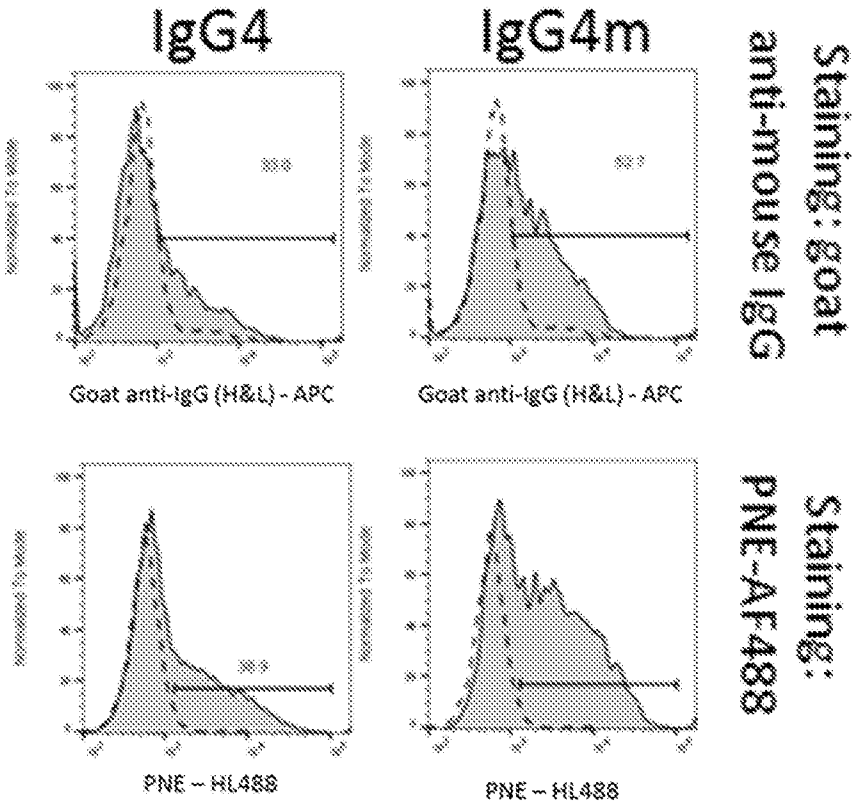

IgG4
IgG4m
Staining: goat anti-mouse IgG
Goat anti-IgG (H&L) - APC
Goat anti-IgG (H&L) - APC
Staining: PNE-AF488
PNE – HL488
PNE – HL488

FIG. 7B

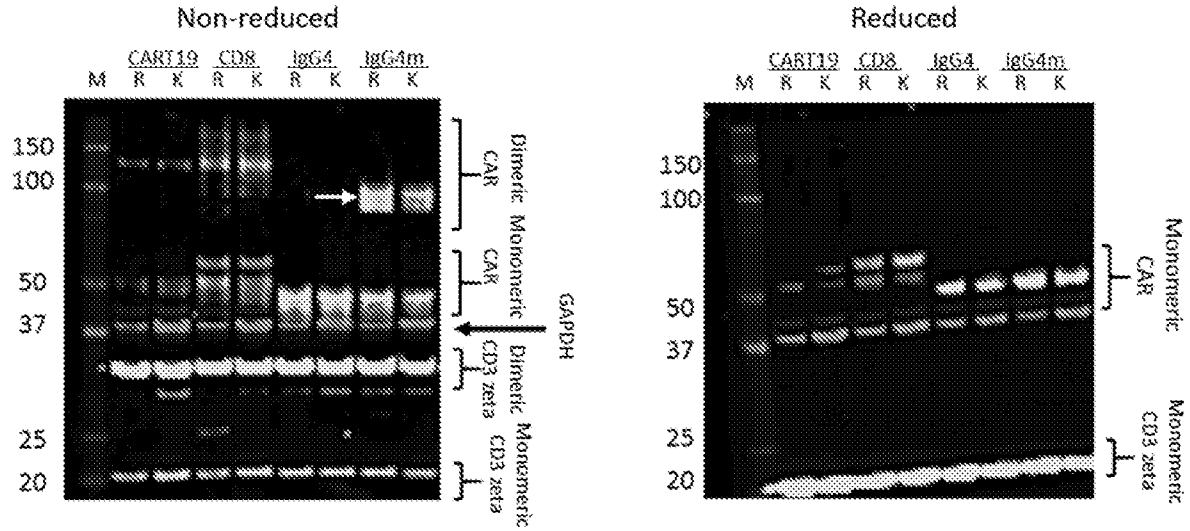


FIG. 8A



FIG. 8B

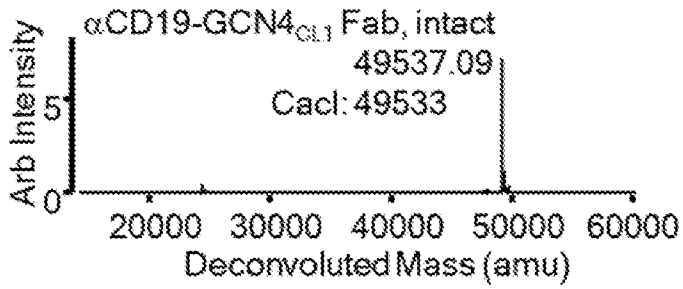


FIG. 9

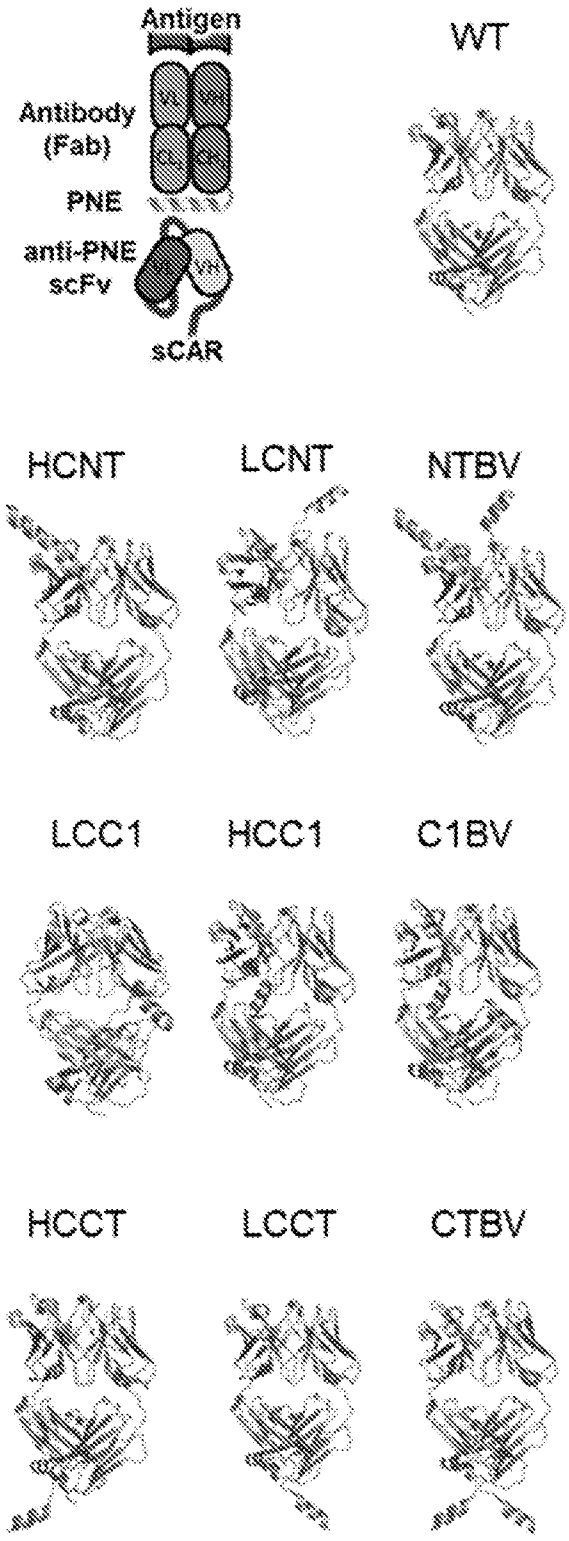

Antigen
Antibody (Fab)
PNE
anti-PNE scFv
sCAR
WT
HCNT
LCNT
NTBV
LCC1
HCC1
C1BV
HCCT
LCCT
CTBV

FIG. 10A

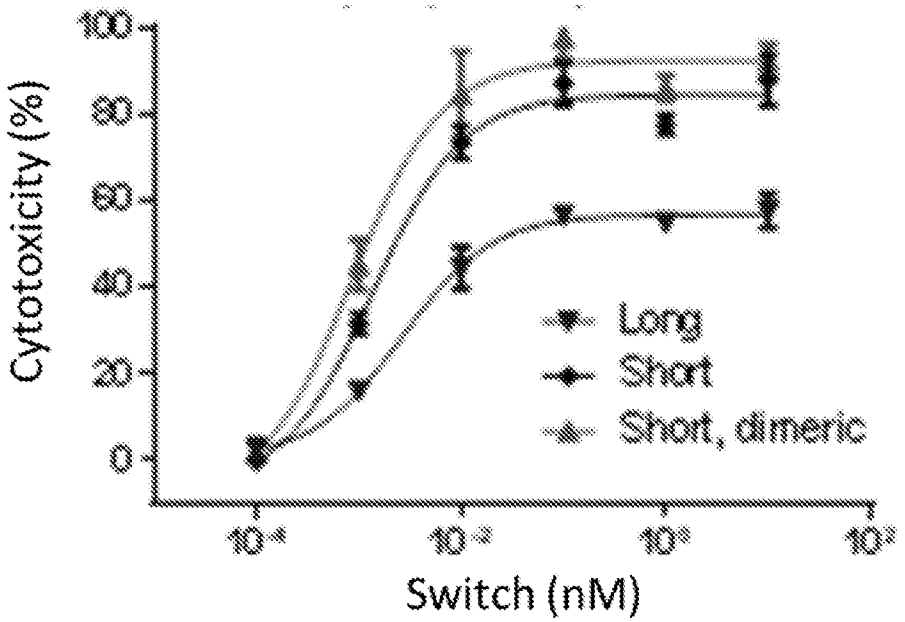


FIG. 10B

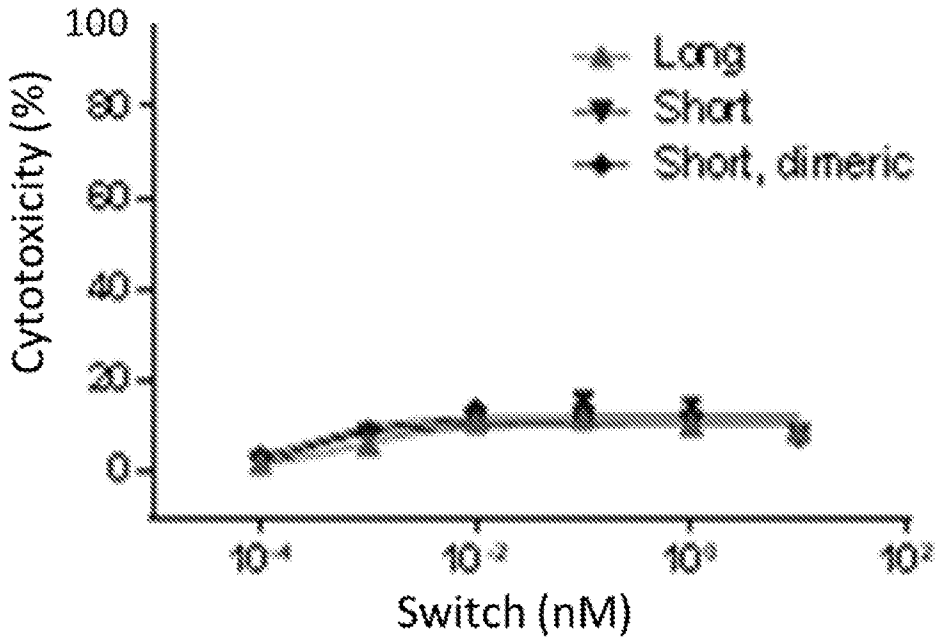


FIG. 10C

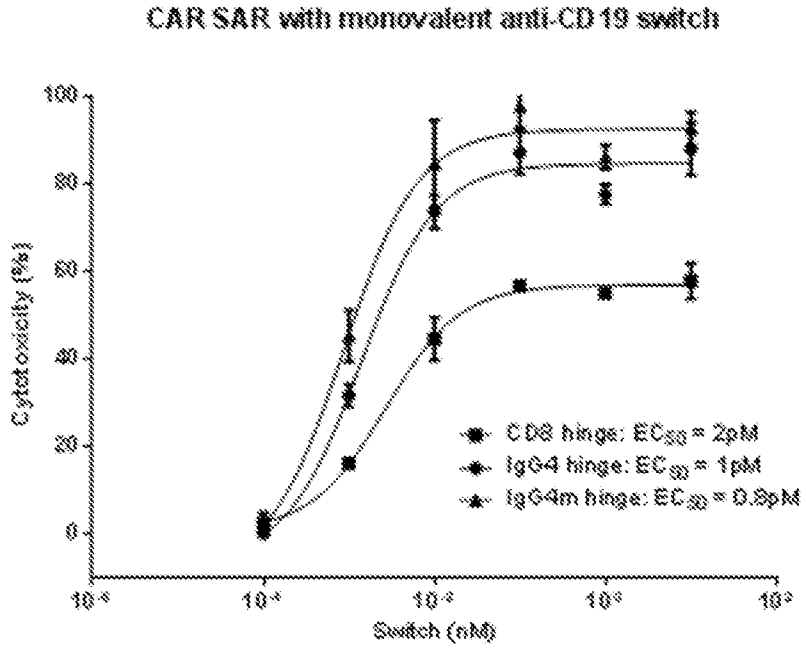


FIG. 10D

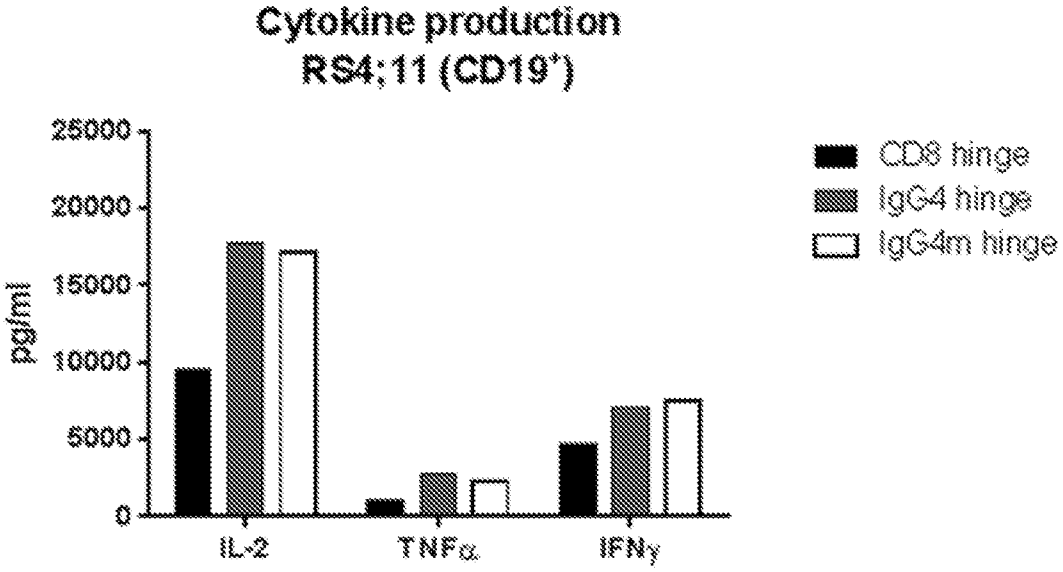


FIG. 11A

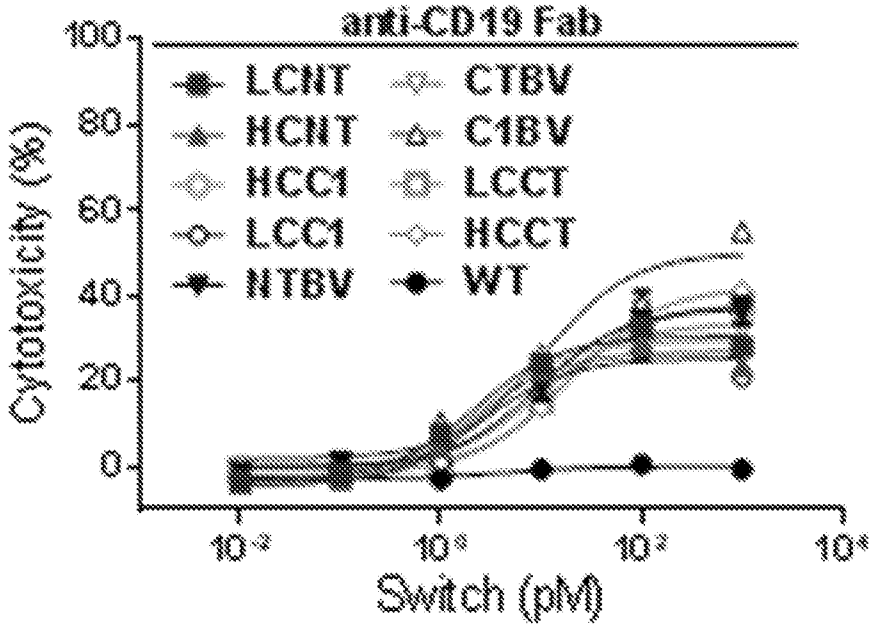


FIG. 11B

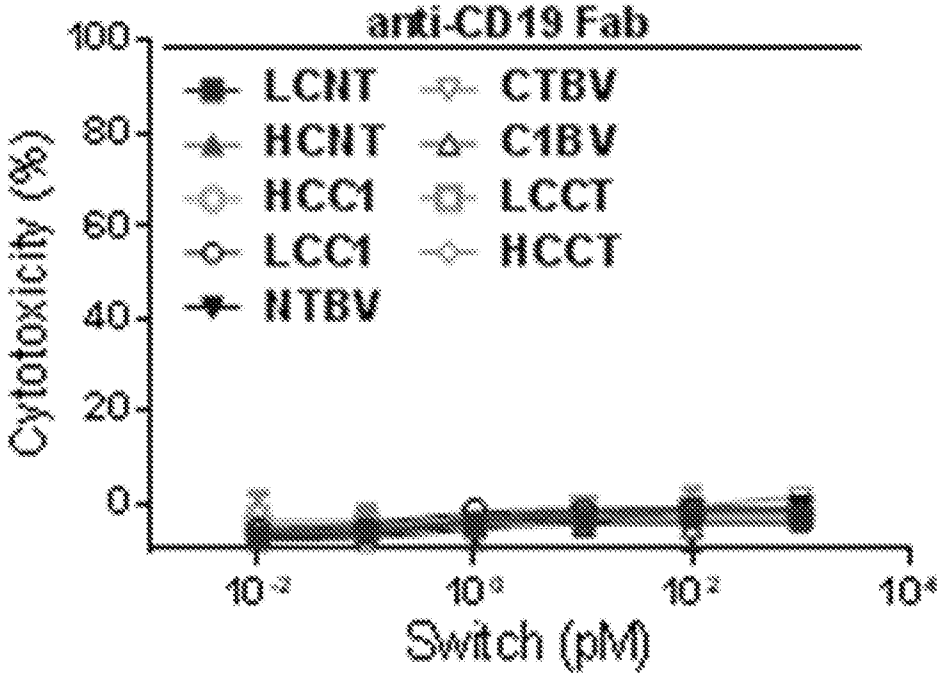


FIG. 11C

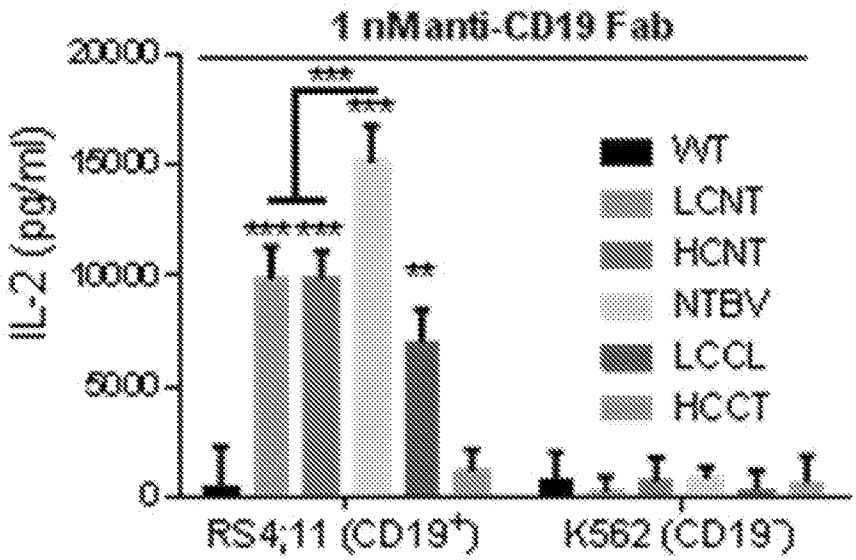


FIG. 12A

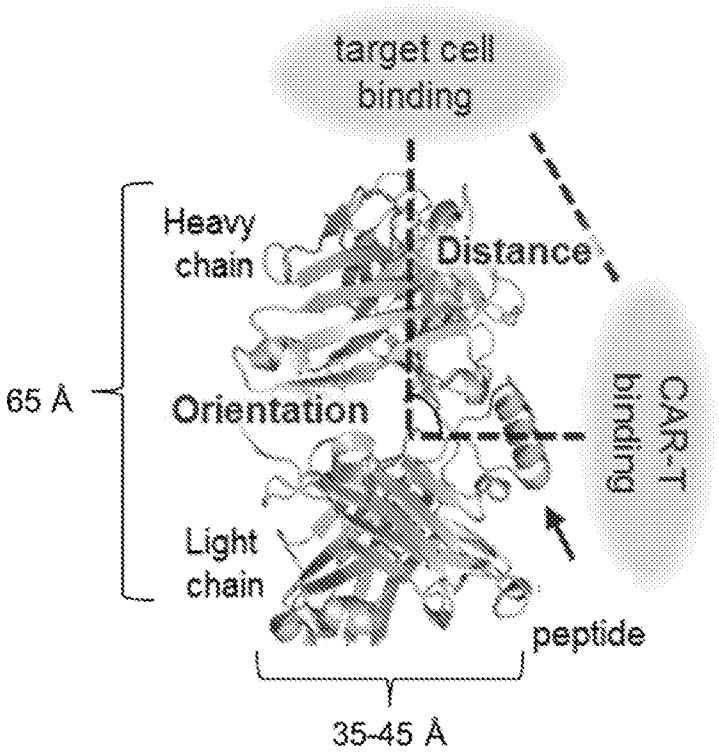


FIG. 12B

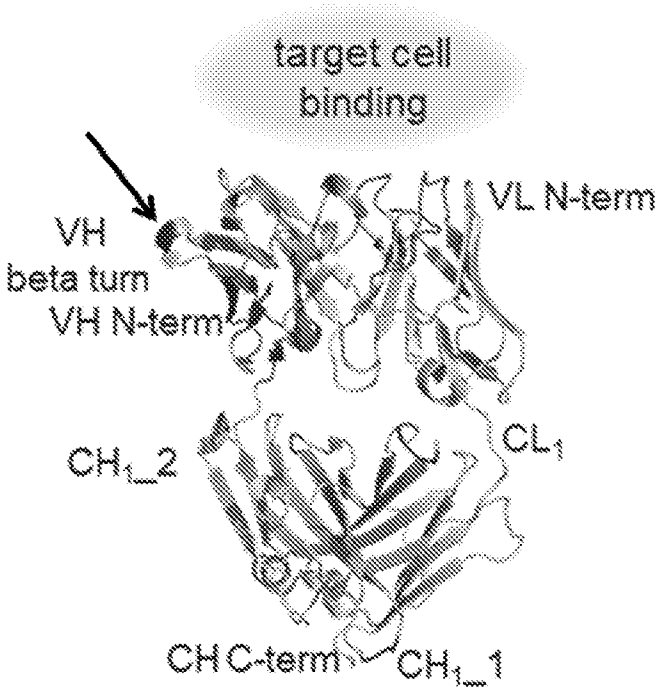


FIG. 13A

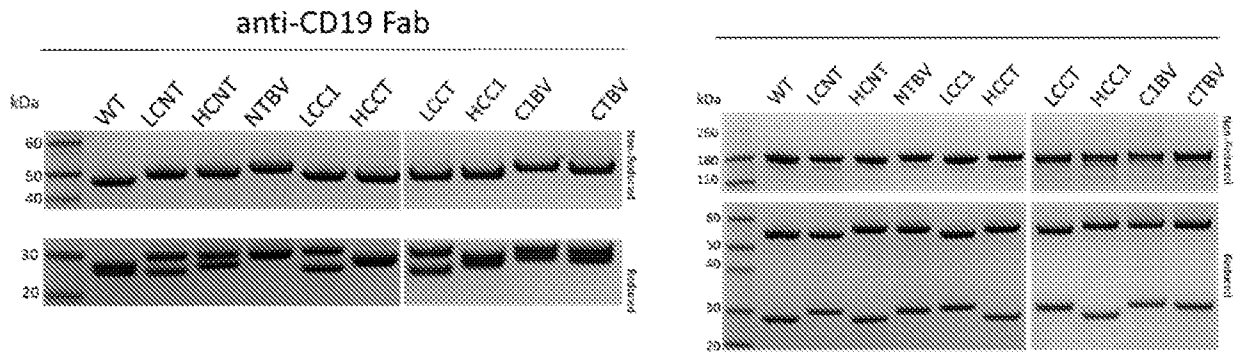


FIG. 13B

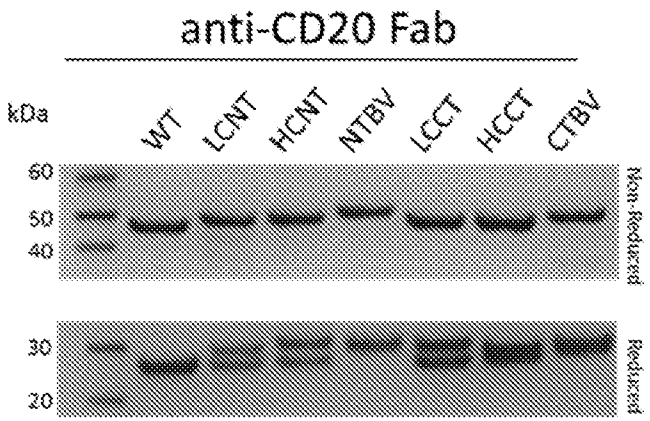


FIG. 14

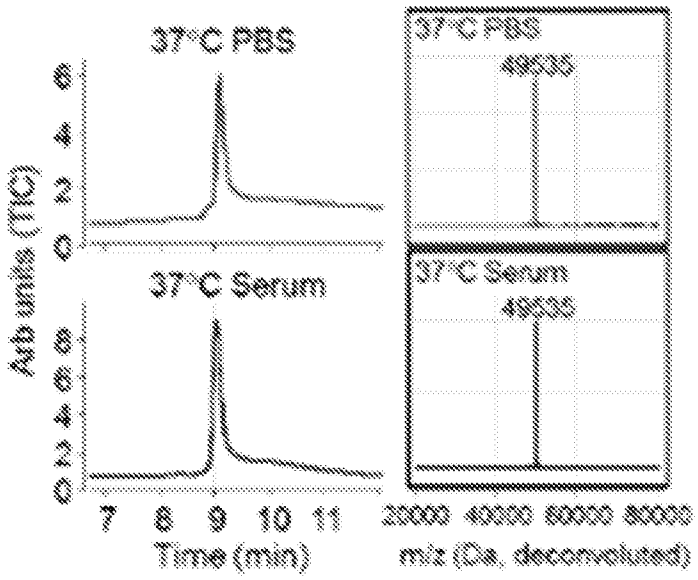


FIG. 15

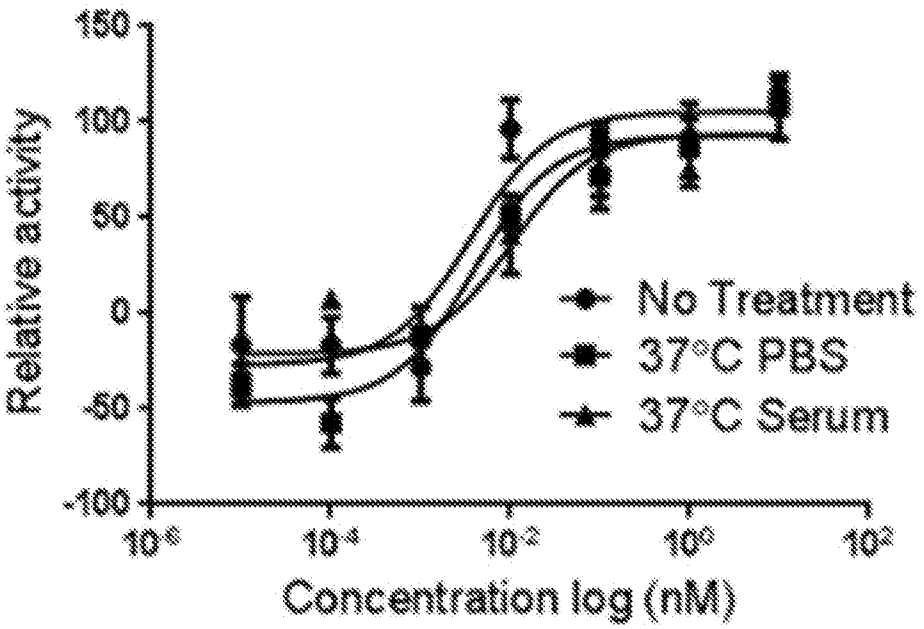

150
100
50
0
-50
-100
Relative activity
No Treatment
37°C PBS
37°C Serum
10-6
10-4
10-2
100
102
Concentration log (nM)

FIG. 16

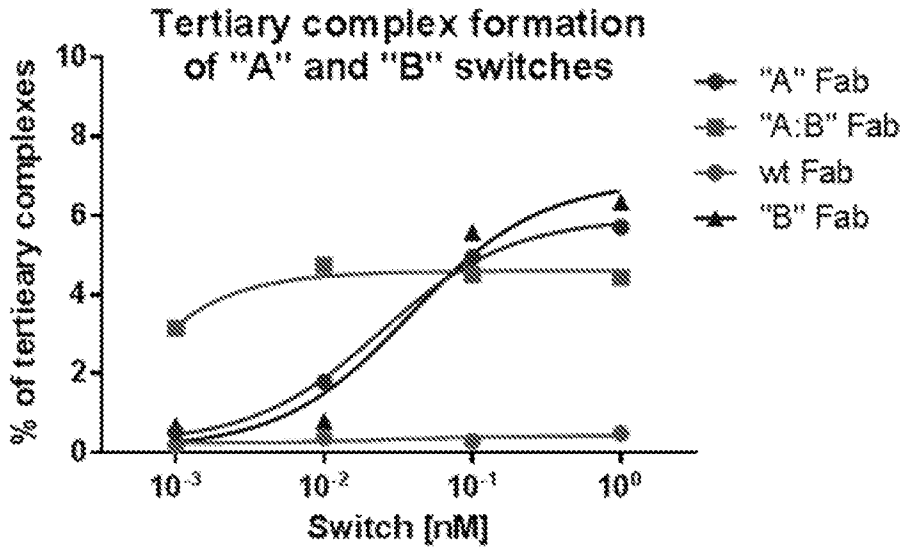

Tertiary complex formation
of "A" and "B" switches
% of tertieary complexes
10
8
6
4
2
0
10-3
10-2
10-1
100
Switch [nM]
"A" Fab
"A:B" Fab
wt Fab
"B" Fab

FIG. 17

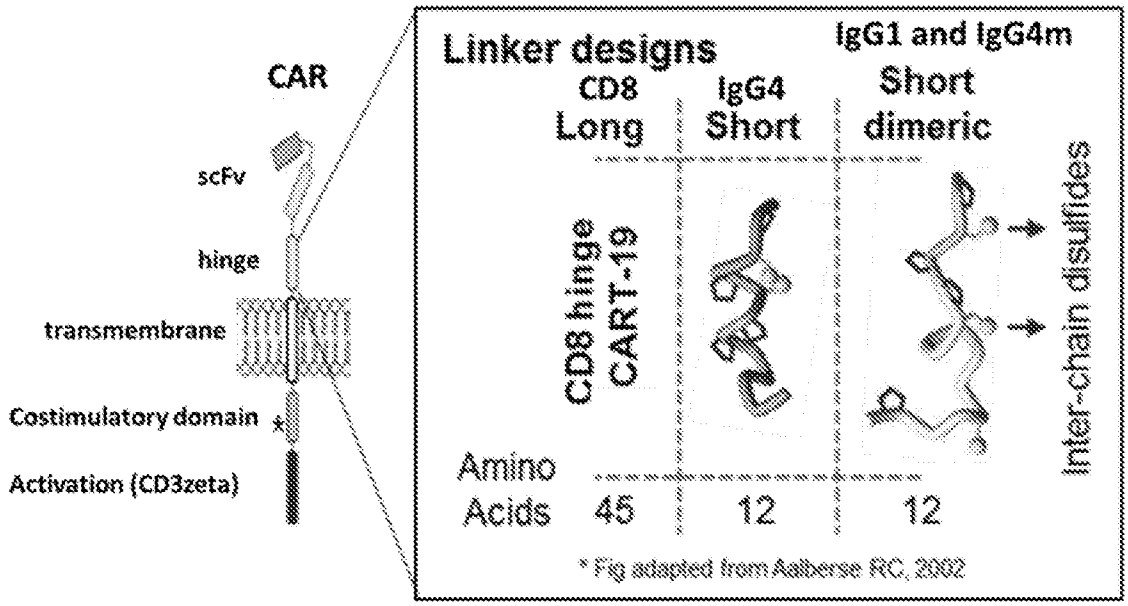

CAR
scFv
hinge
transmembrane
Costimulatory domain
Activation (CD3zeta)
Linker designs
IgG1 and IgG4m
CD8
Long
IgG4
Short
Short
dimeric
CD8 hinge
CART-19
Inter-chain disulfides
Amino
Acids
45
12
12
* Fig adapted from Aalberse RC, 2002

FIG. 18

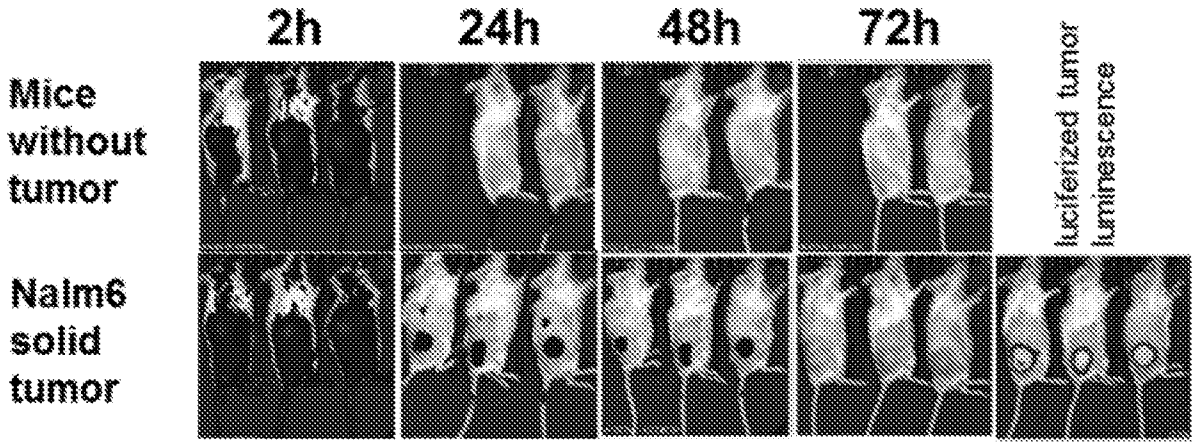

2h
24h
48h
72h
Mice without tumor
Naim6 solid tumor
luciferized tumor luminescence

FIG. 19

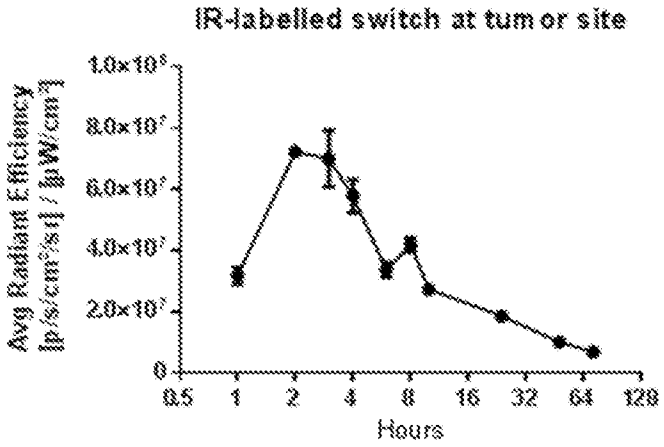


FIG. 20A

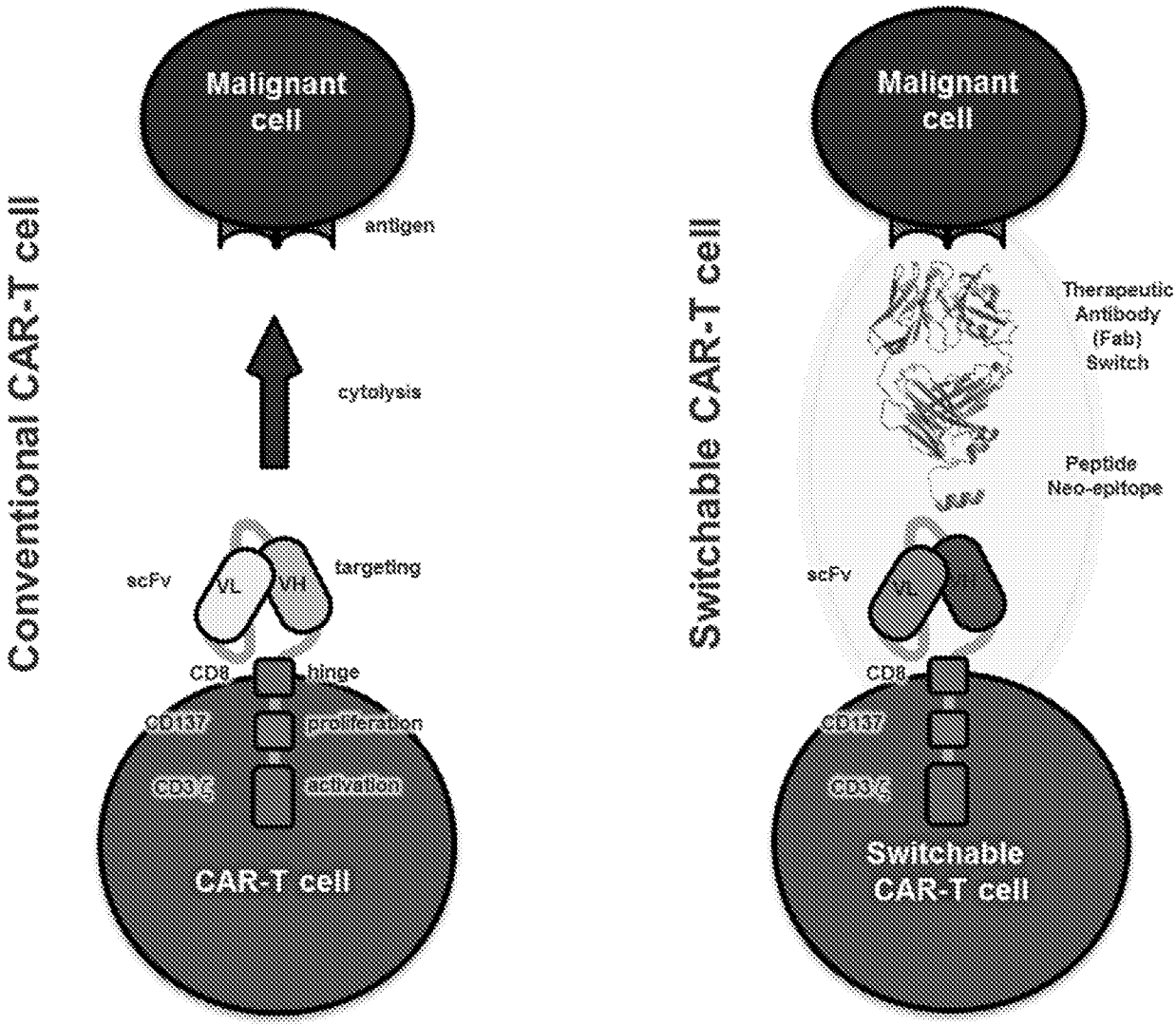


FIG. 20B

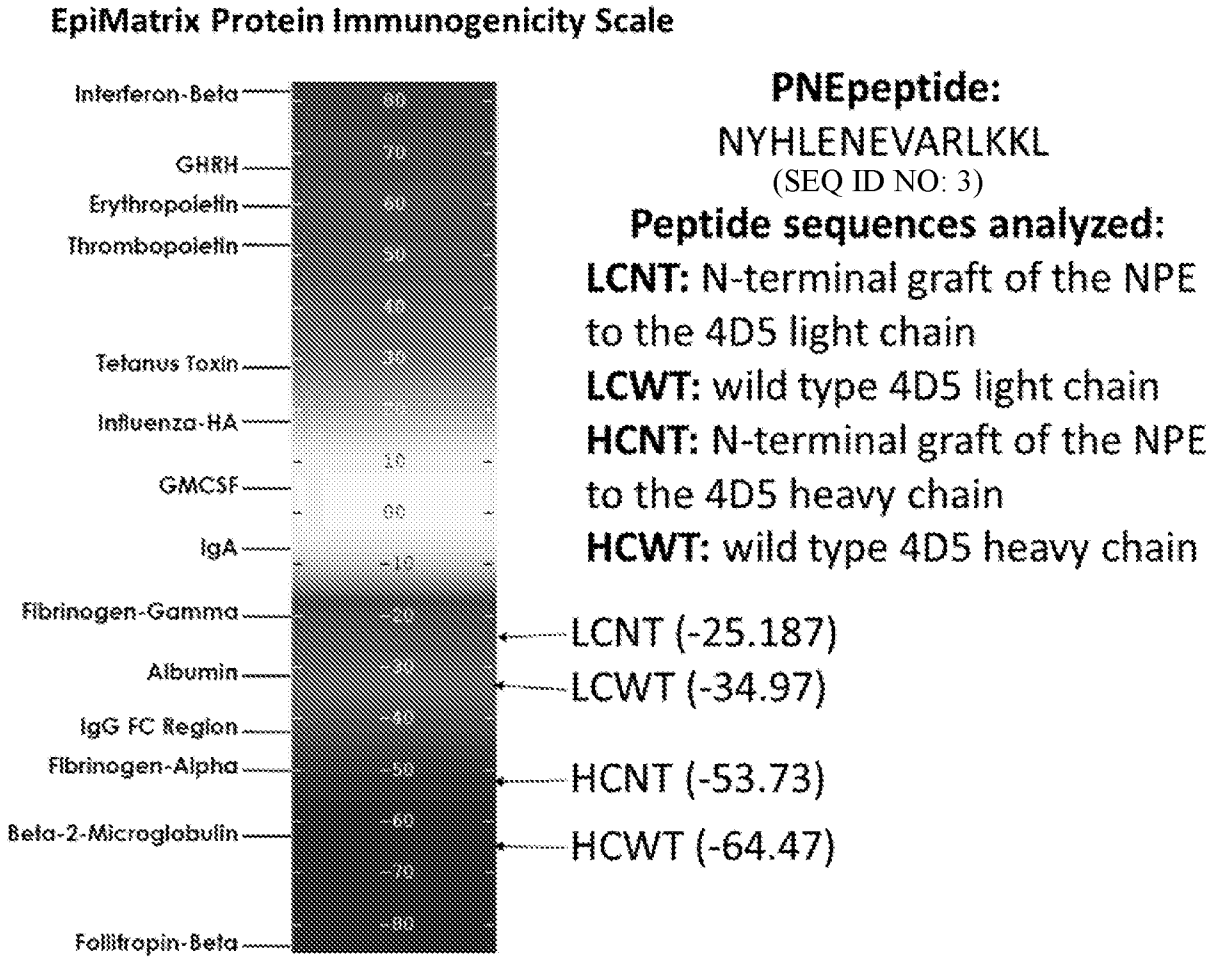

EpiMatrix Protein Immunogenicity Scale
Interferon-Beta
GHRH
Erythropoietin
Thrombopoietin
Tetanus Toxin
Influenza-HA
GMCSF
IgA
Fibrinogen-Gamma
Albumin
IgG FC Region
Fibrinogen-Alpha
Beta-2-Microglobulin
Follitropin-Beta
PNEpeptide:
NYHLENEVARLKKL
(SEQ ID NO: 3)
Peptide sequences analyzed:
LCNT: N-terminal graft of the NPE to the 4D5 light chain
LCWT: wild type 4D5 light chain
HCNT: N-terminal graft of the NPE to the 4D5 heavy chain
HCWT: wild type 4D5 heavy chain
LCNT (-25.187)
LCWT (-34.97)
HCNT (-53.73)
HCWT (-64.47)

FIG. 21A

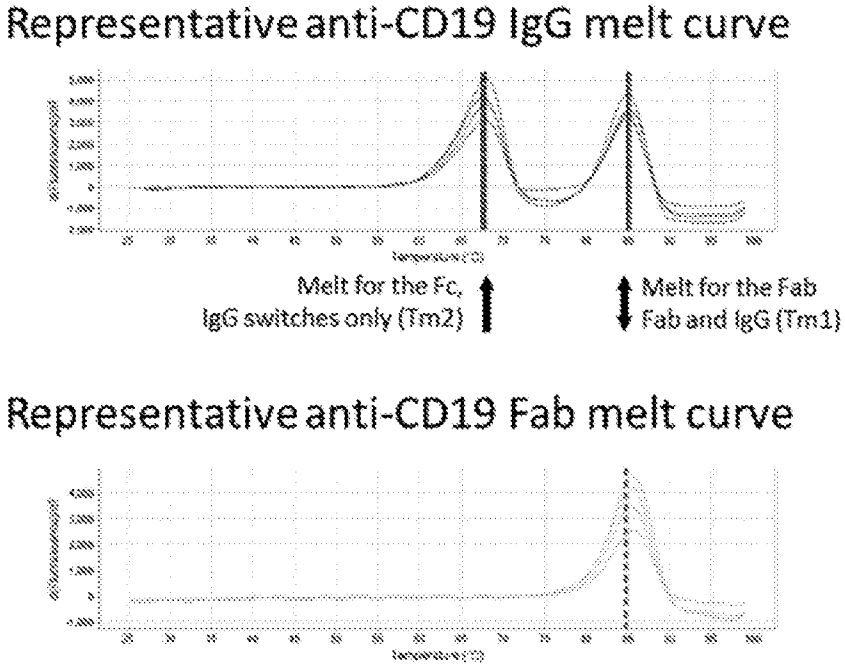


FIG. 21B

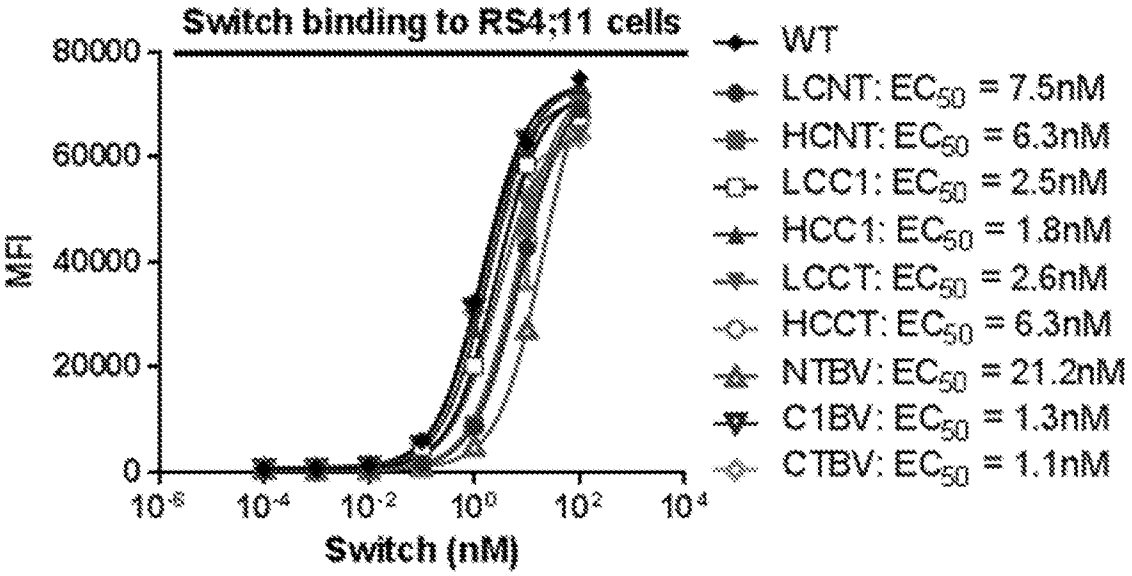


FIG. 21C

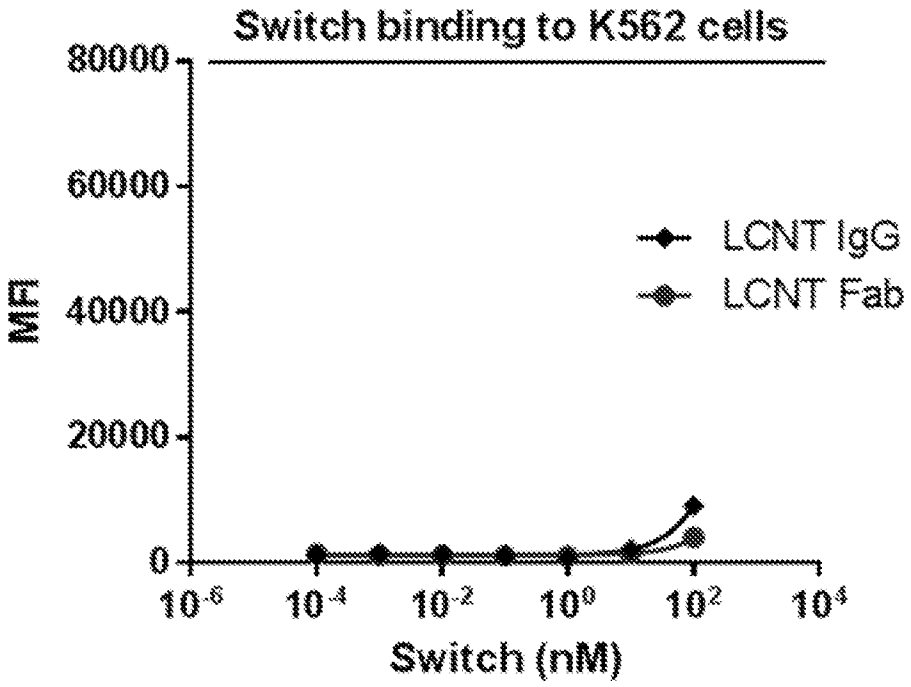


FIG. 22A

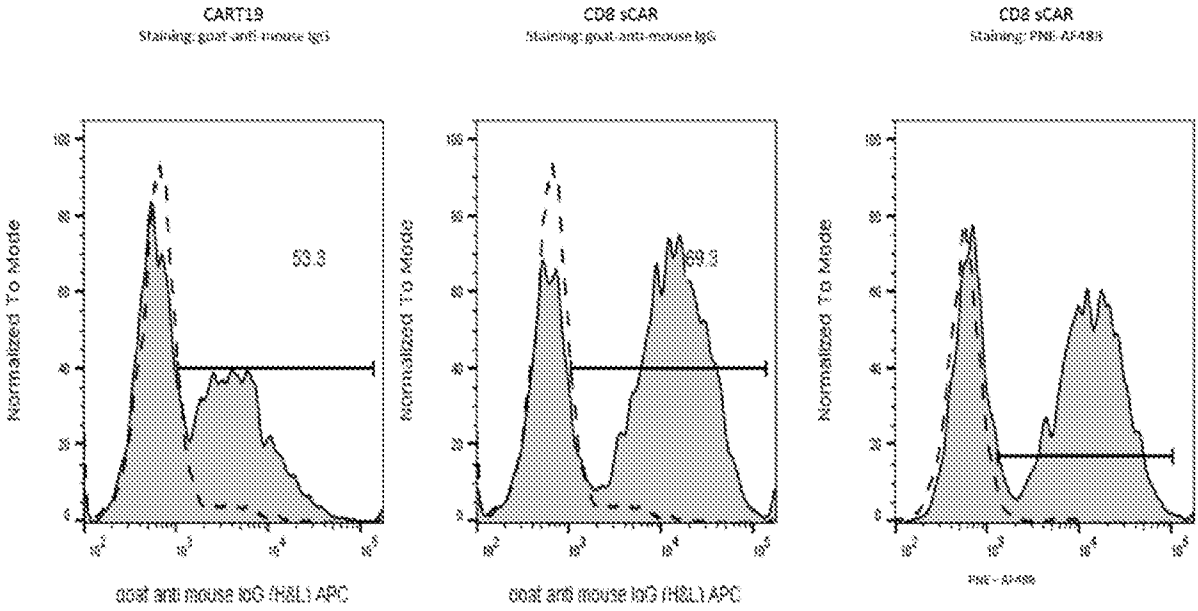


FIG. 22B

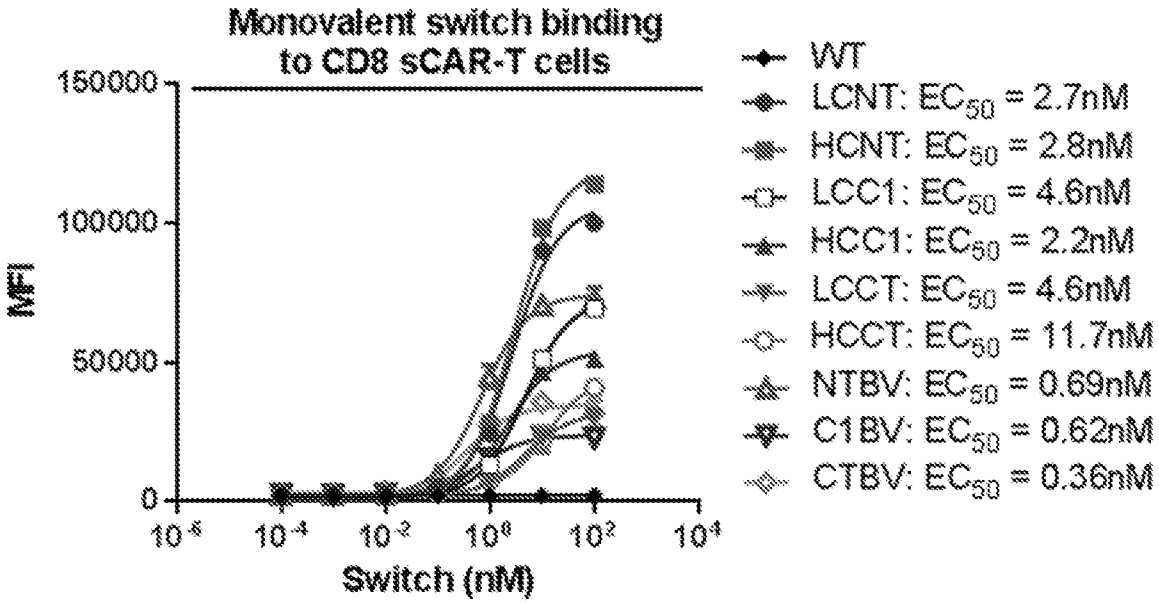


FIG. 22C

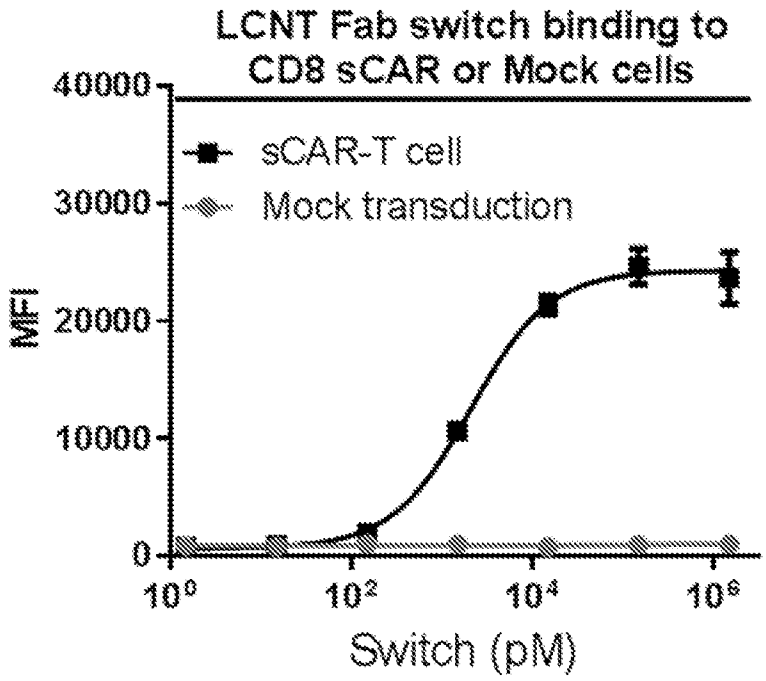


FIG. 23A

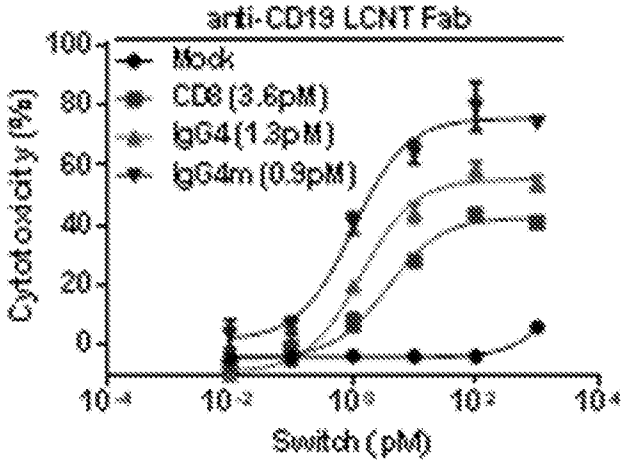


FIG. 23B

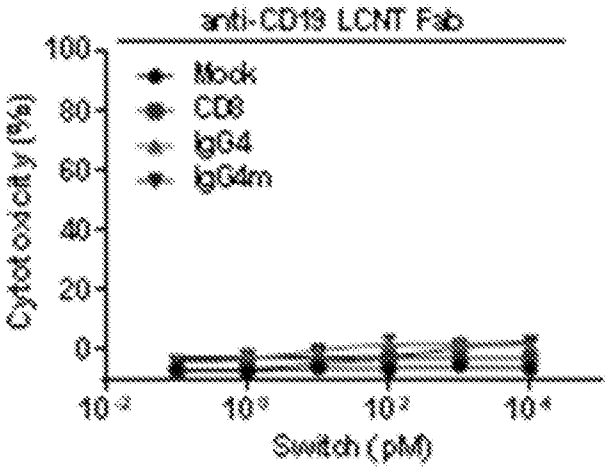


FIG. 23C

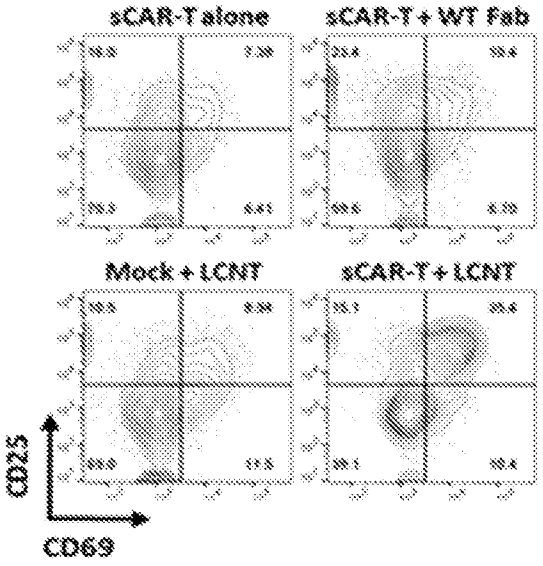


FIG. 23D

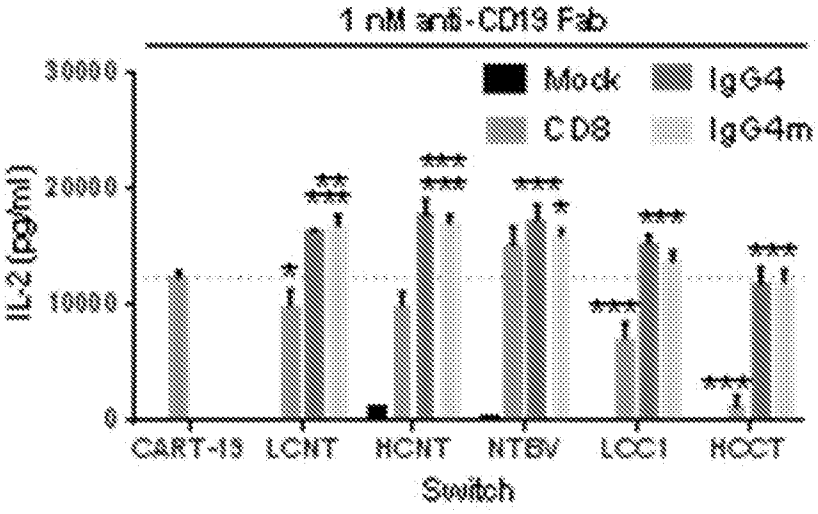
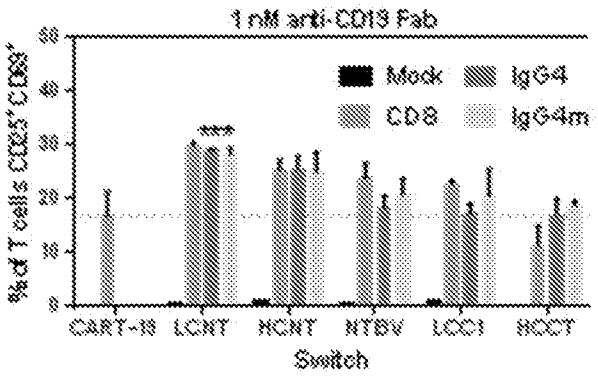


FIG. 23E



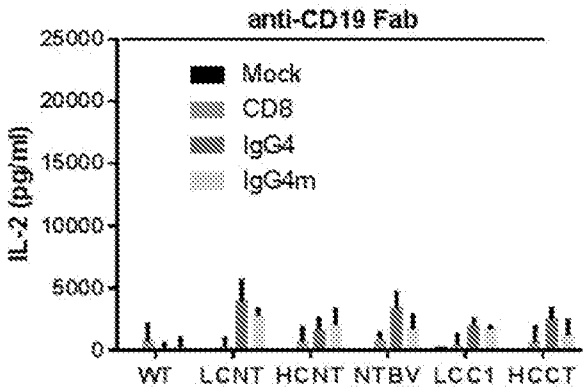


FIG. 24A

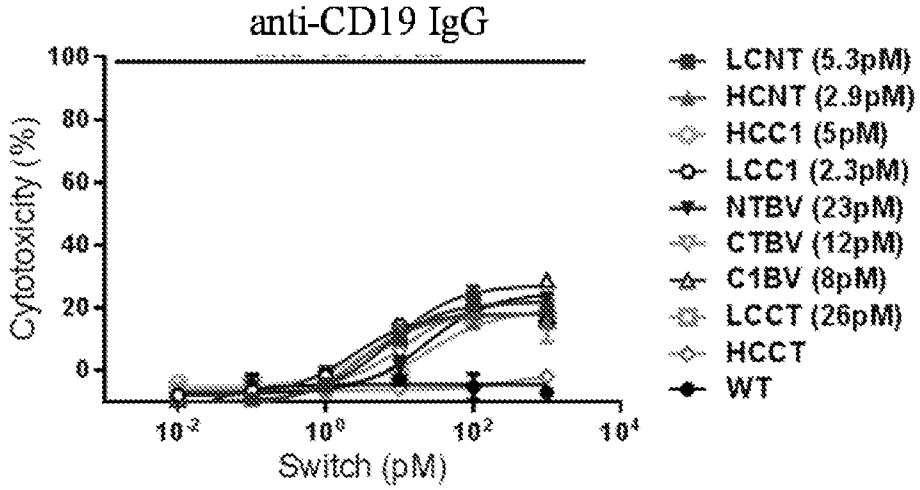


FIG. 24B

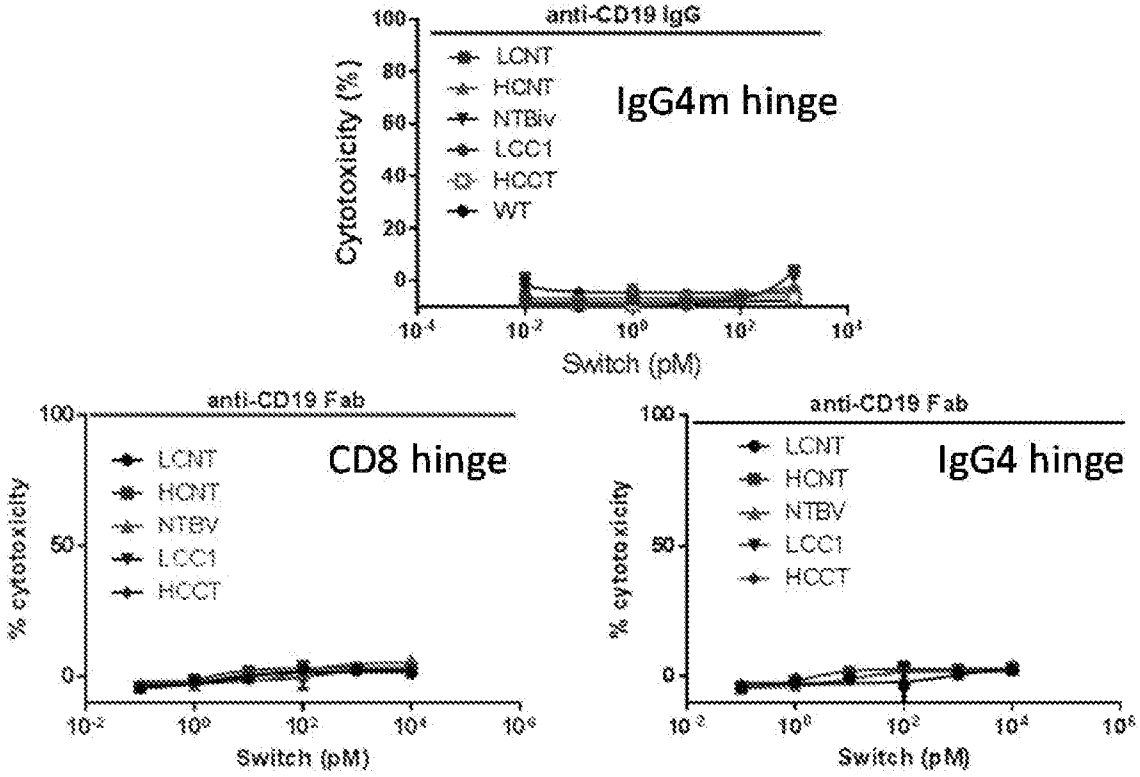


FIG. 24C

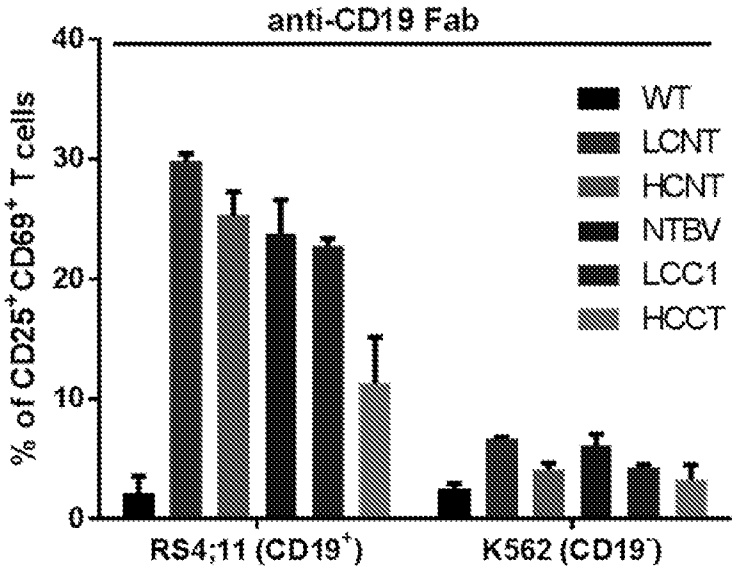


FIG. 25A

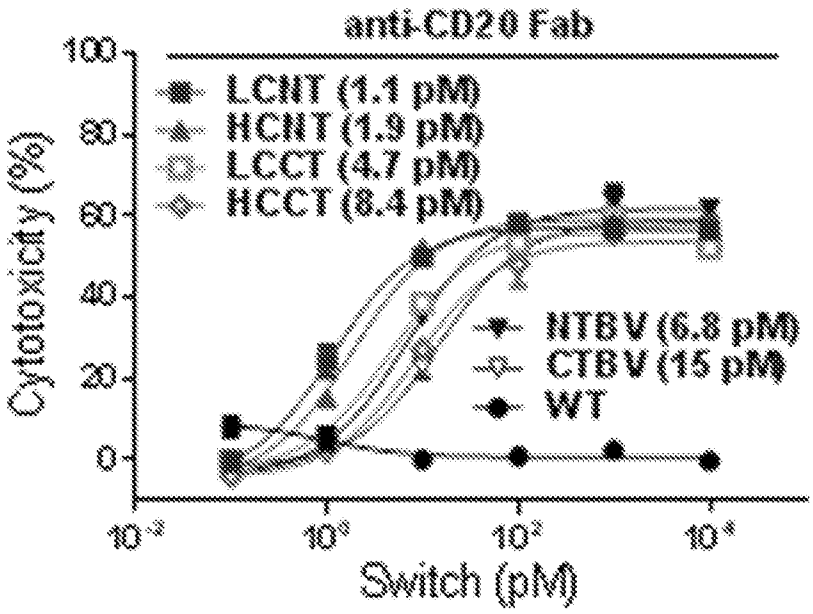


FIG. 25B

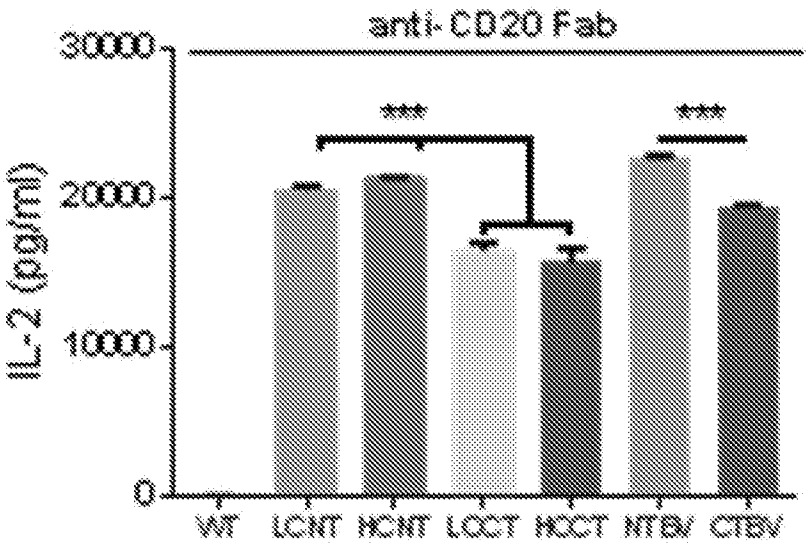


FIG. 26A

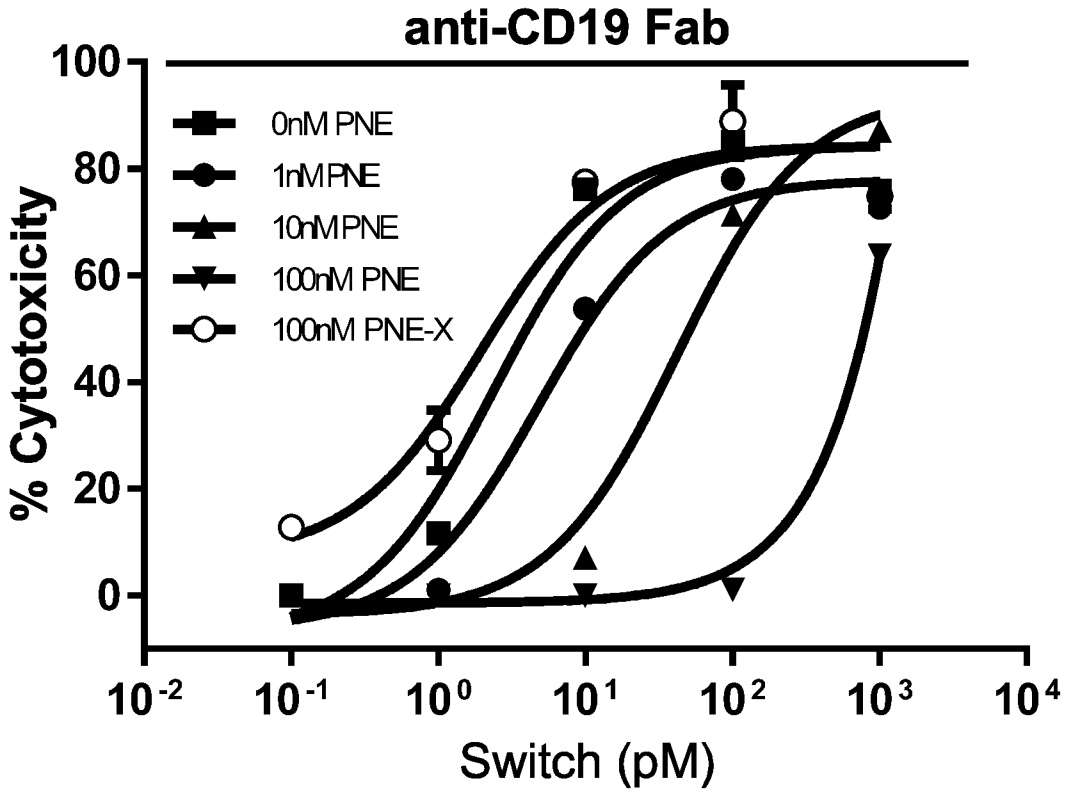


FIG. 26B

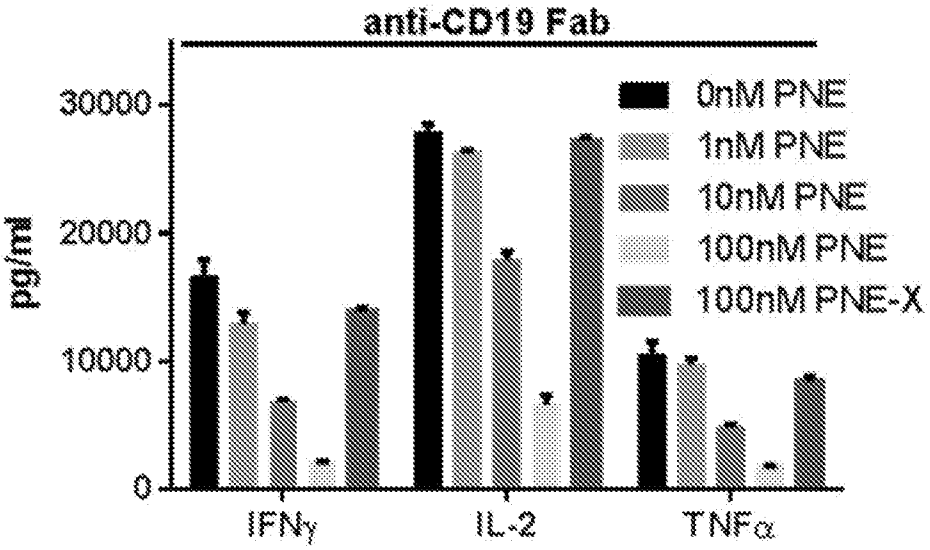


FIG. 26C

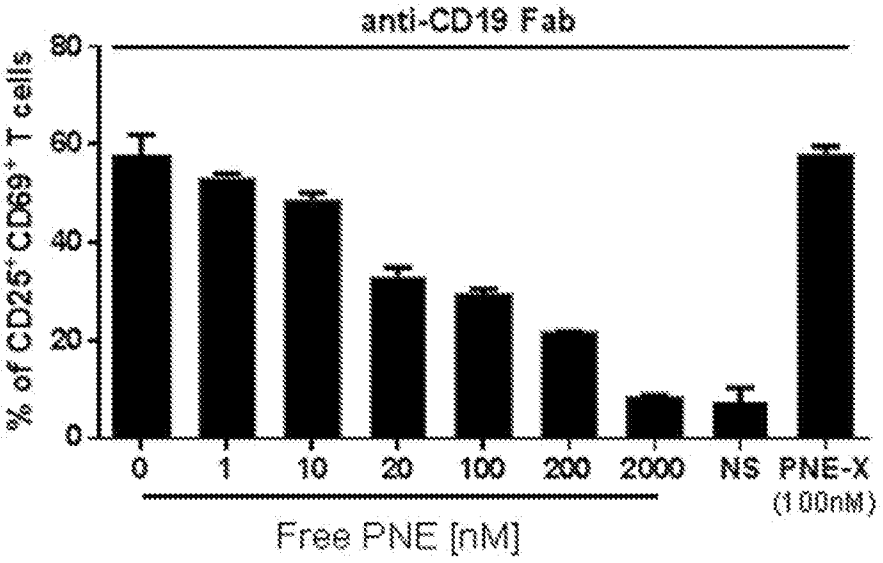


FIG. 26D

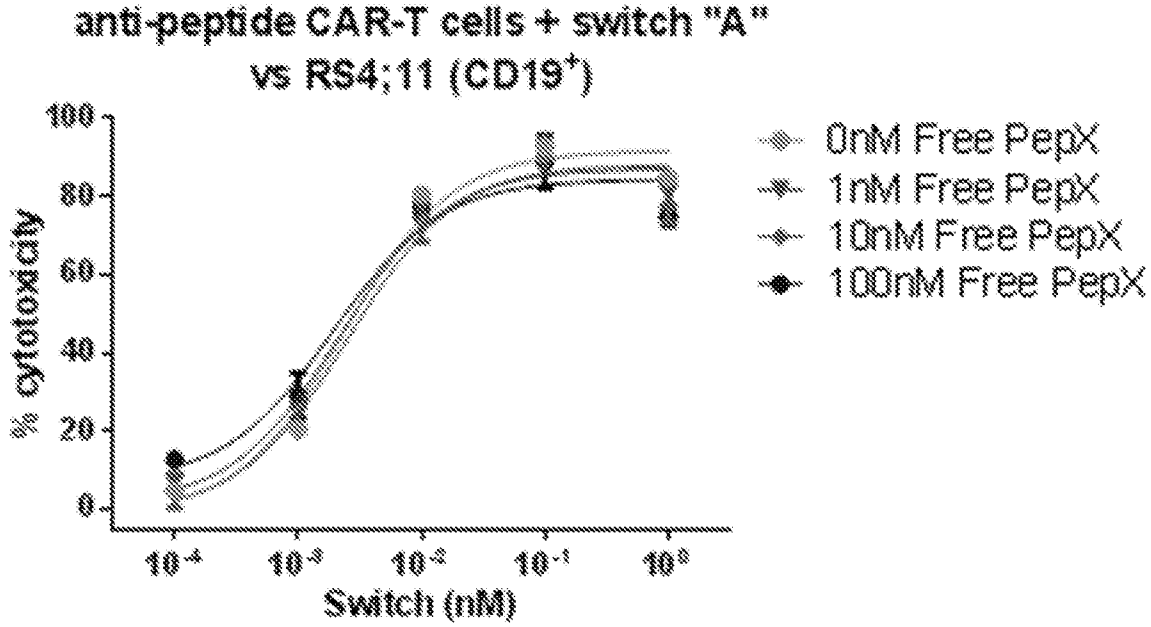


FIG. 26E

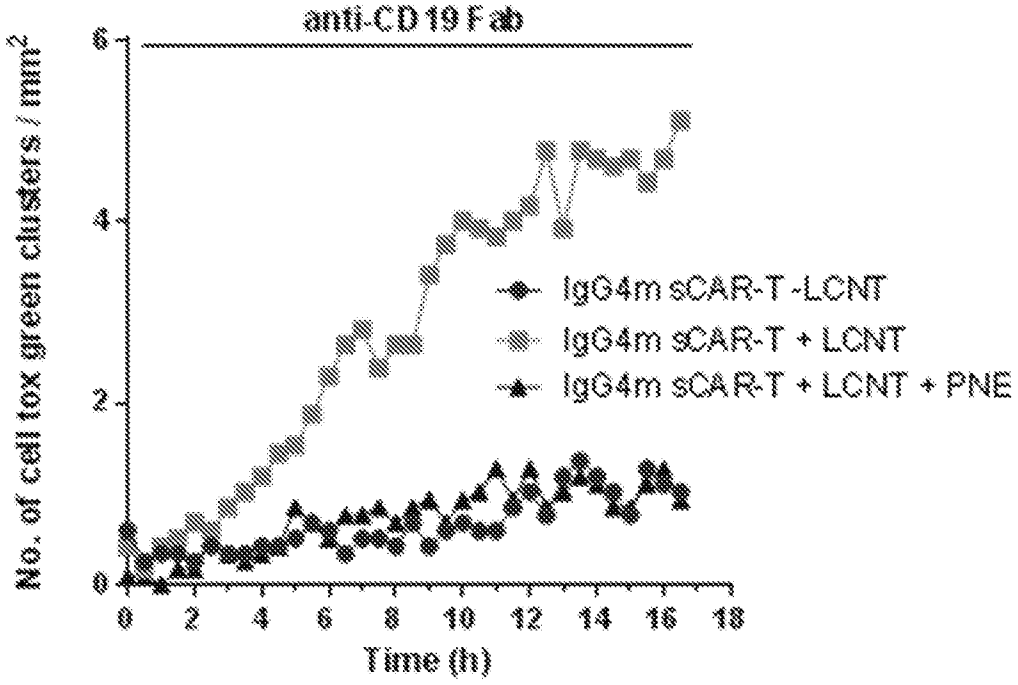


FIG. 26F

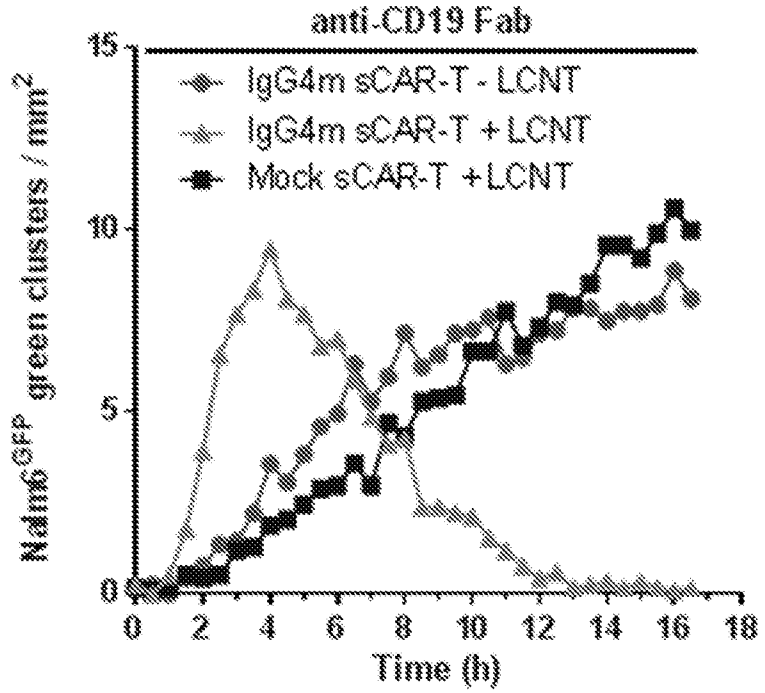


FIG. 27A

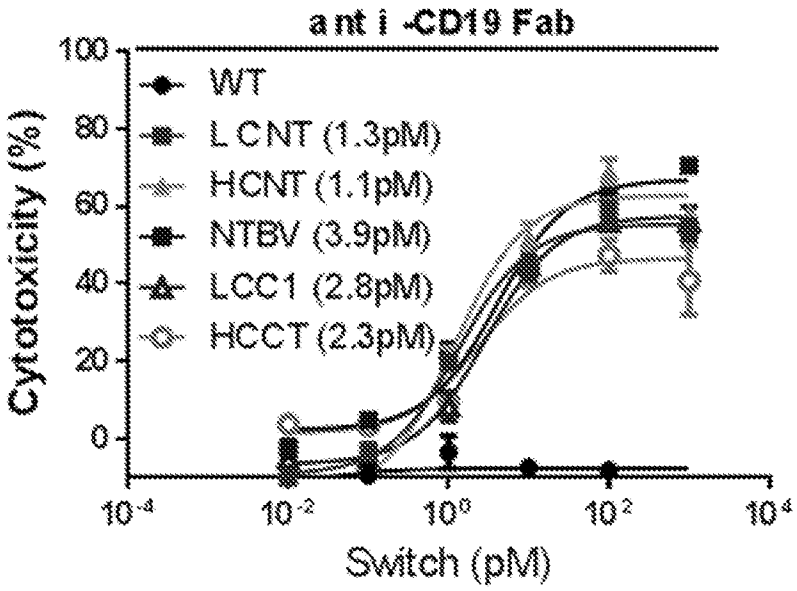


FIG. 27B

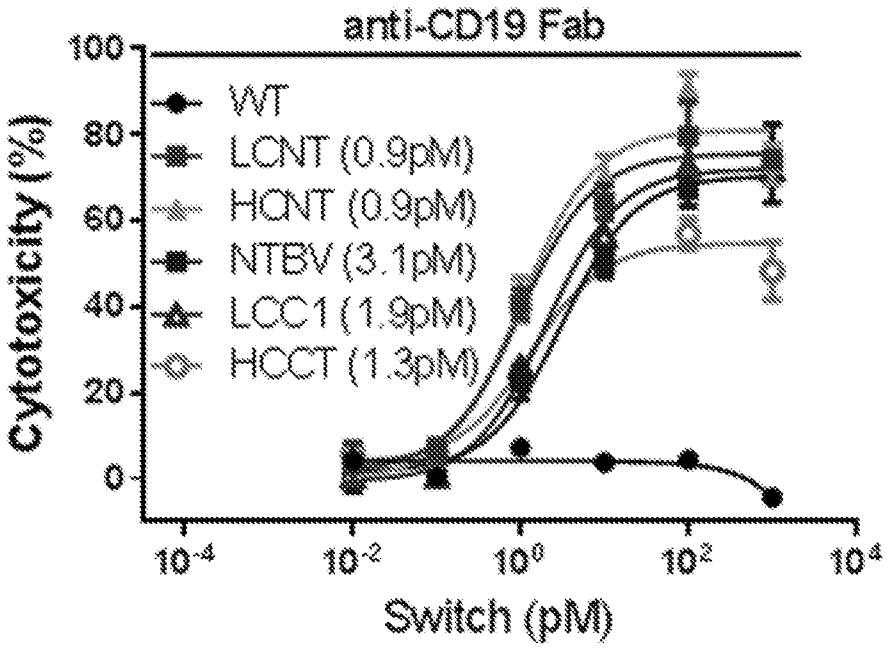


FIG. 28A

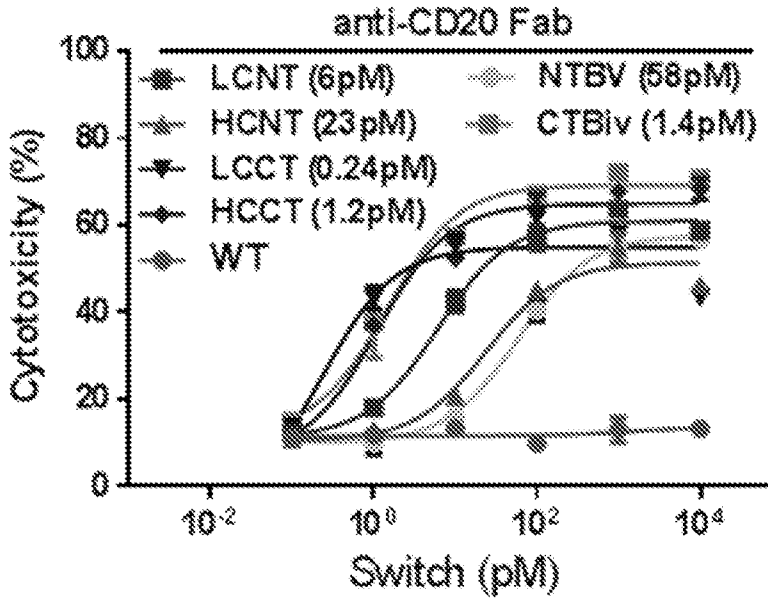


FIG. 28B

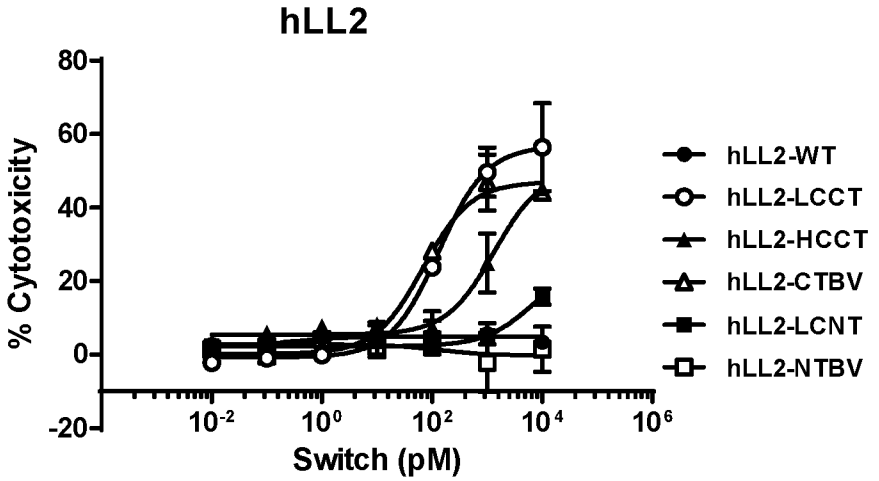


FIG. 28C

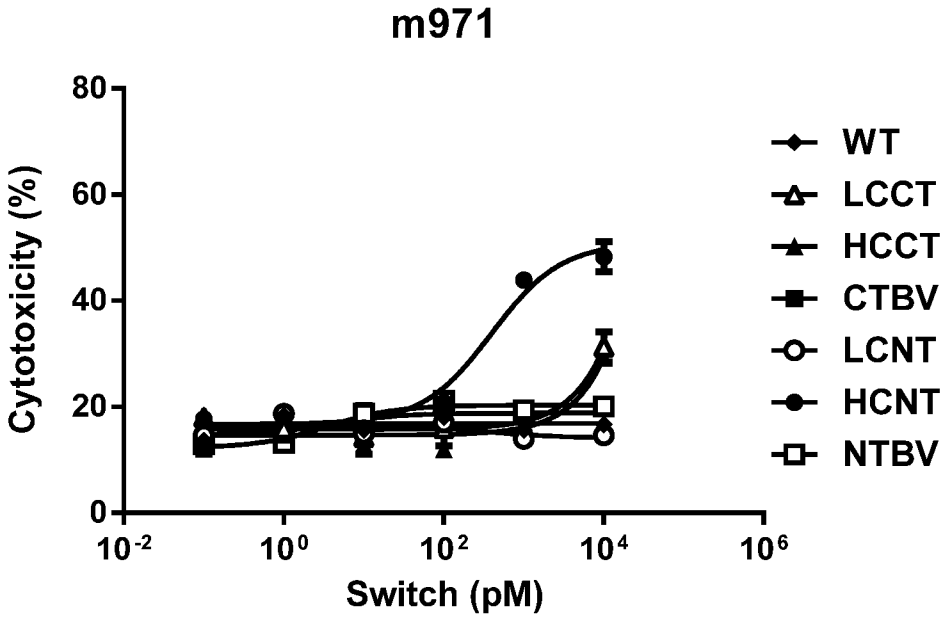


FIG. 28D

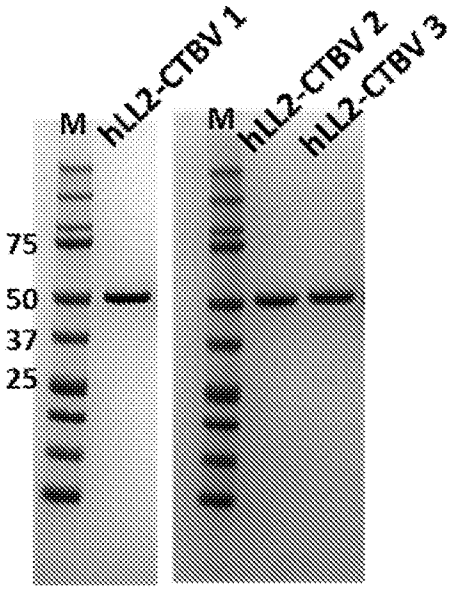


FIG. 28E

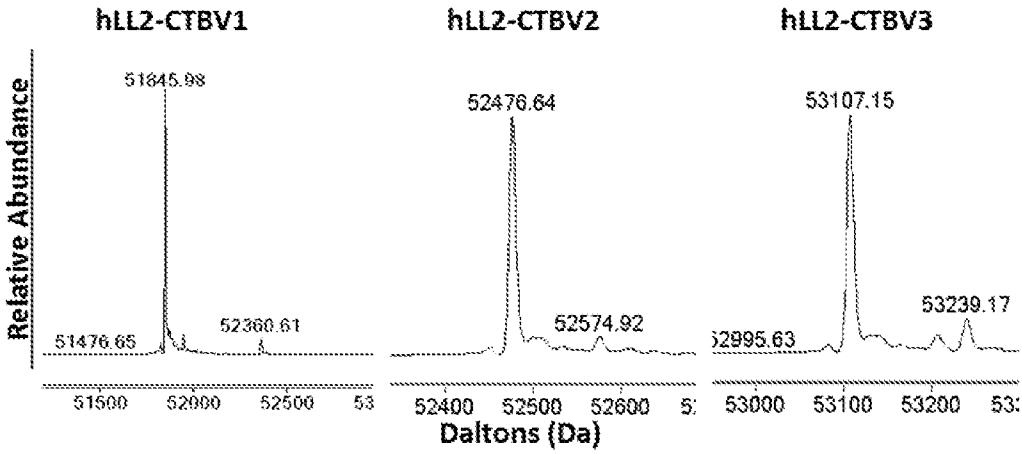


FIG. 28F

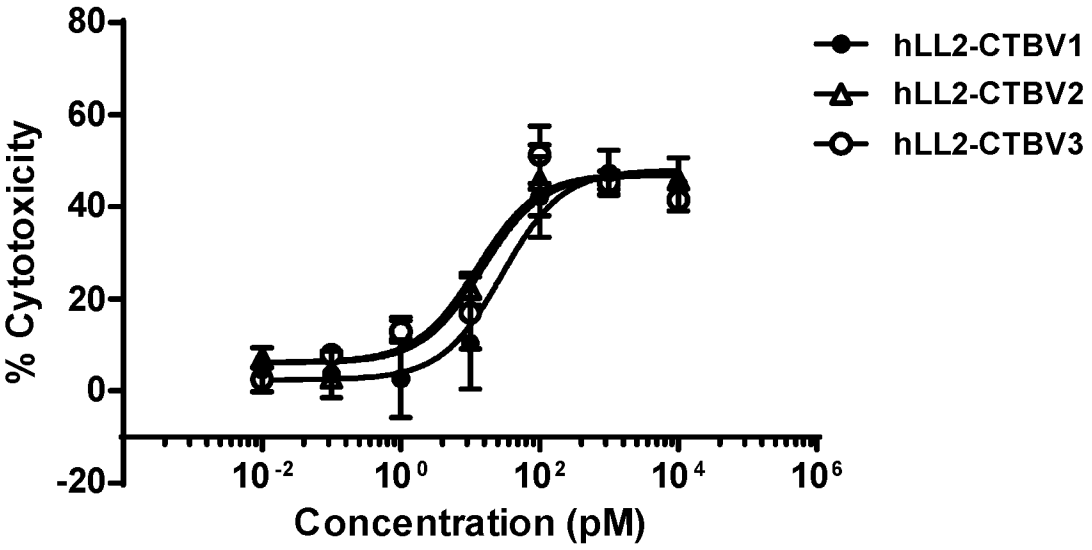


FIG. 28G

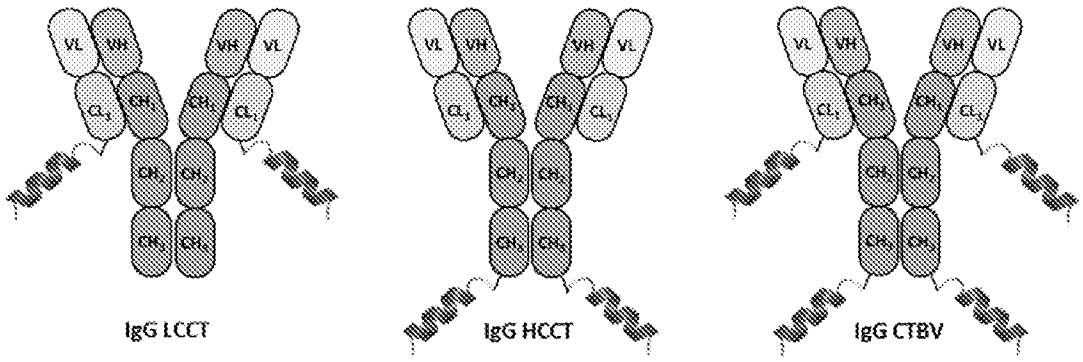


FIG. 28H

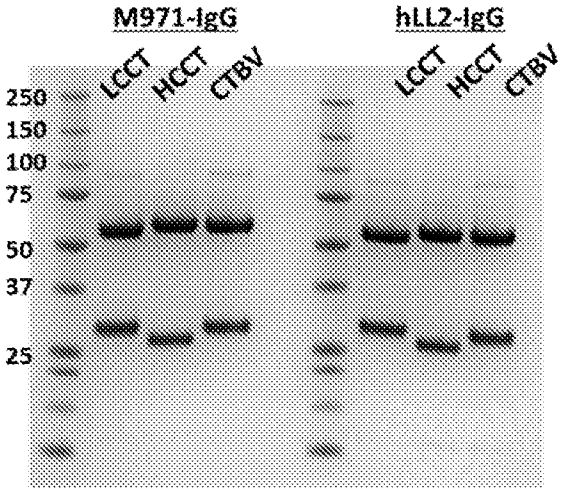


FIG. 28I

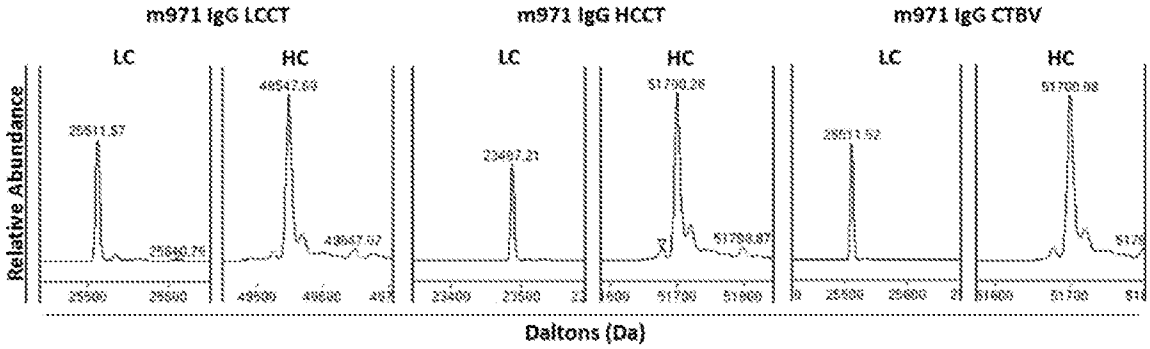


FIG. 28J

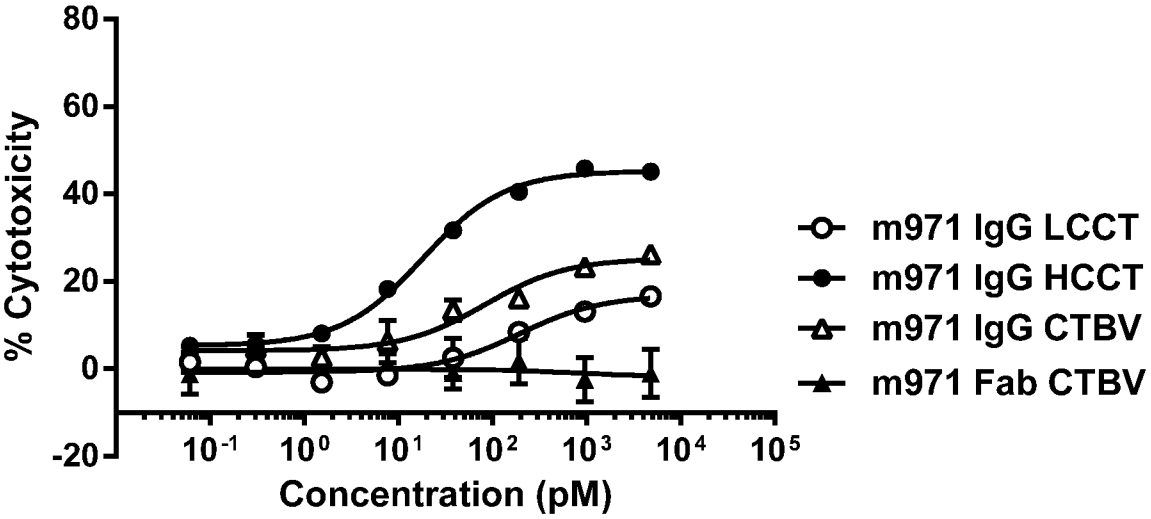


FIG. 28K

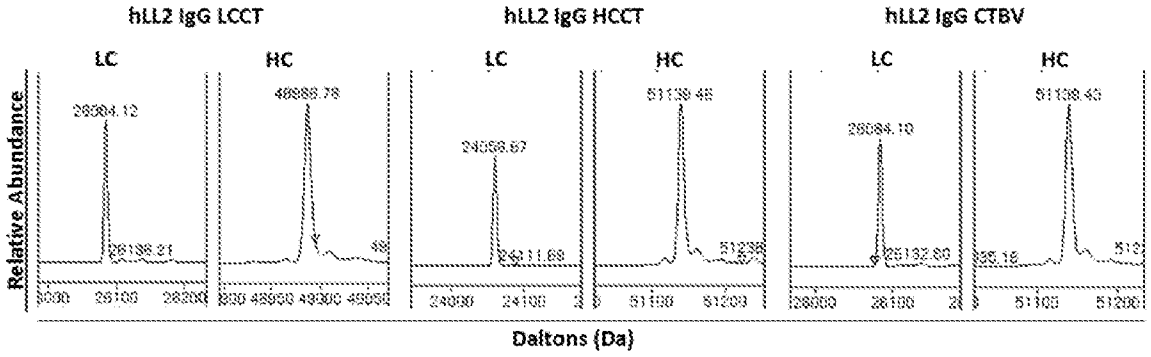


FIG. 28L

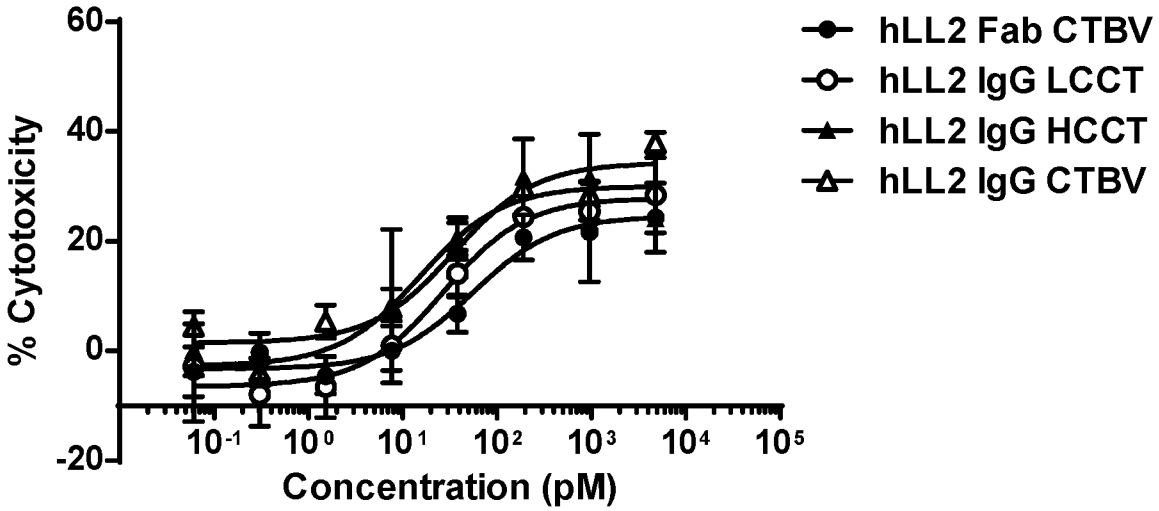


FIG. 29A

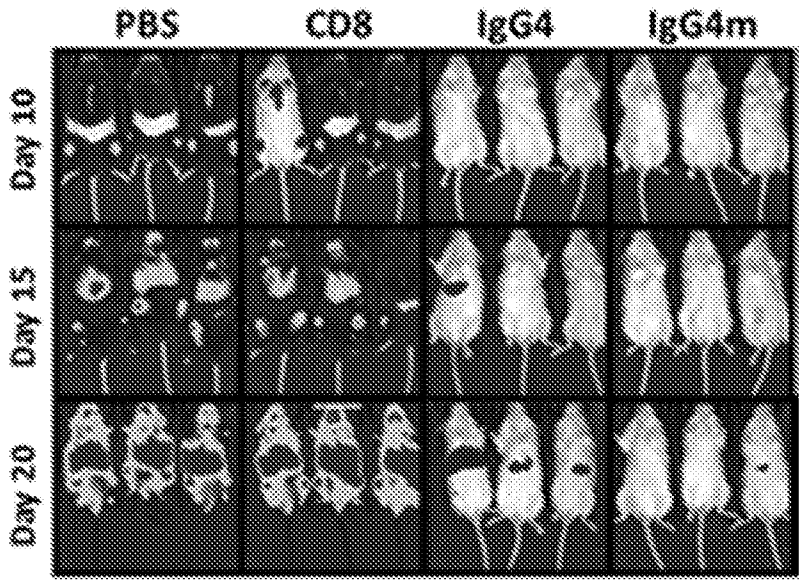


FIG. 29B

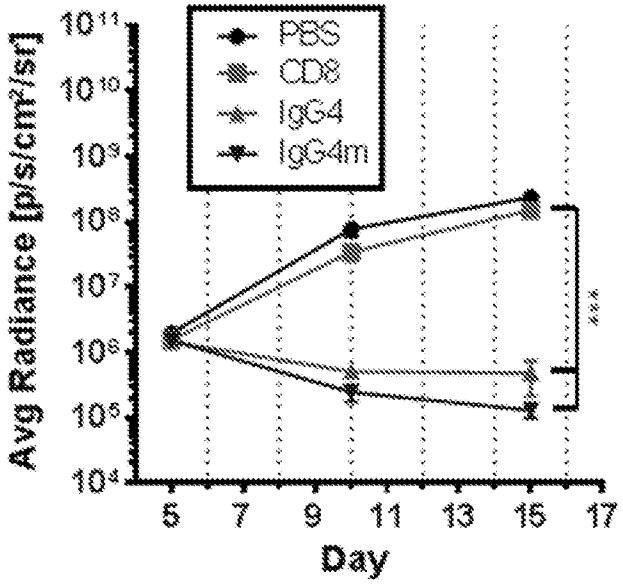


FIG. 29C

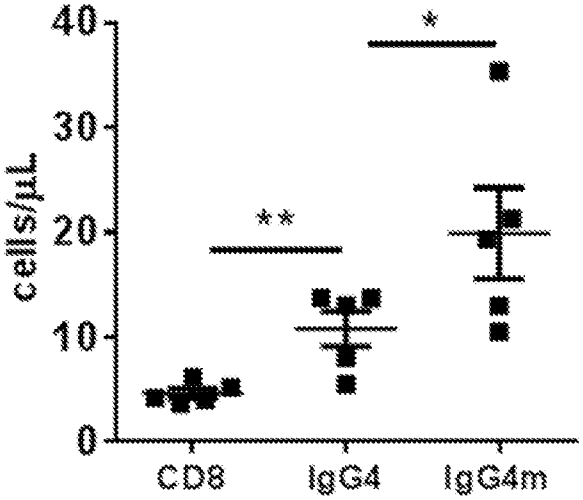


FIG. 29D

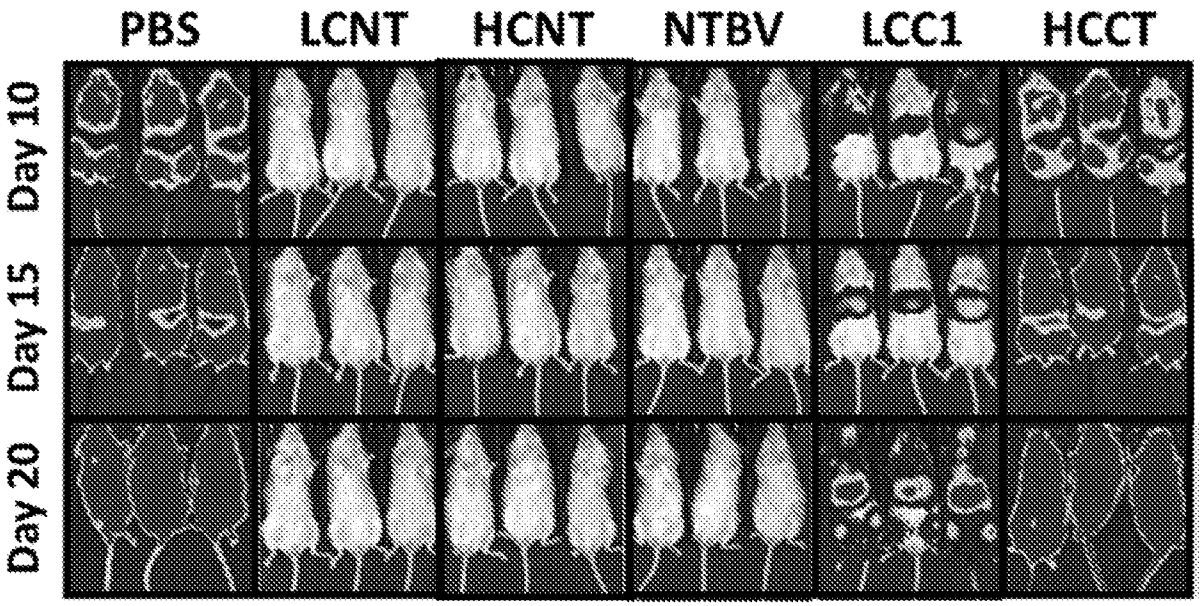


FIG. 29E

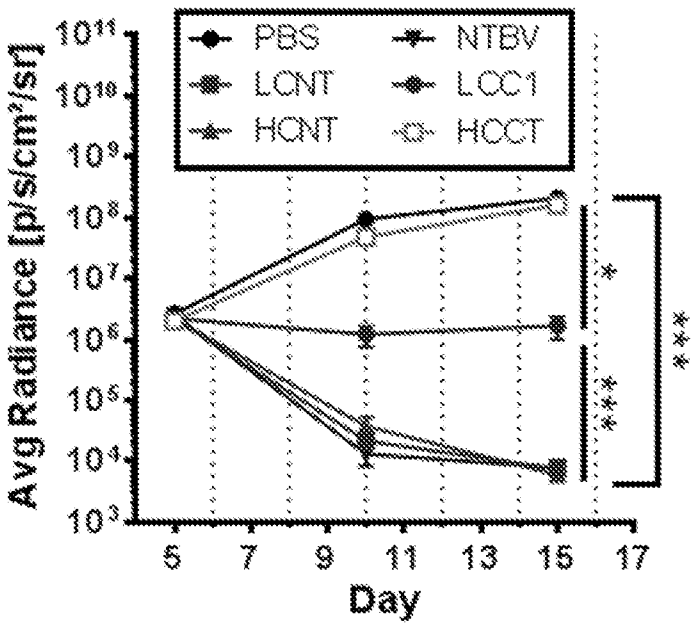


FIG. 29F

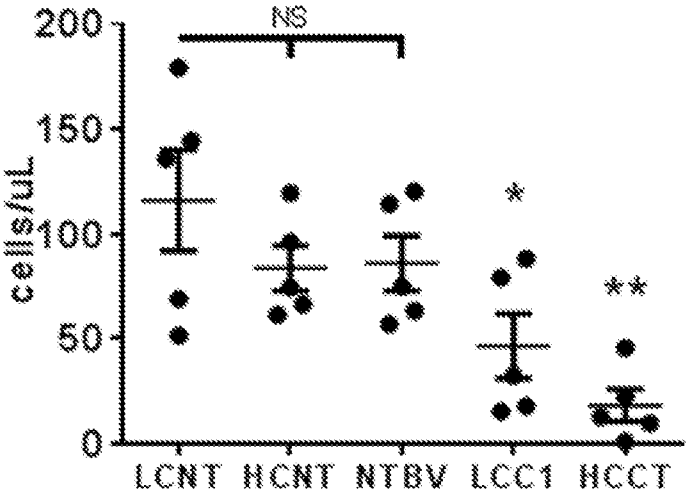


FIG. 30A

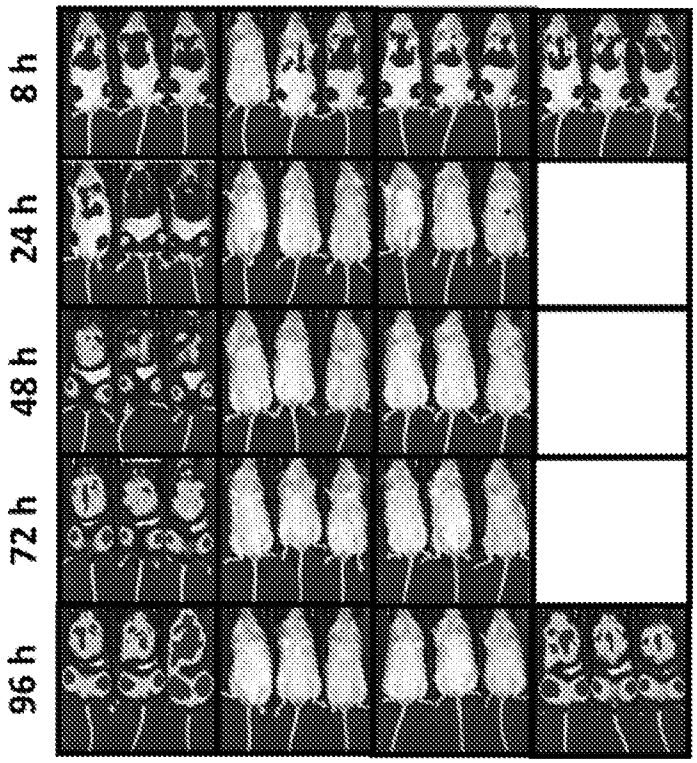


FIG. 30B

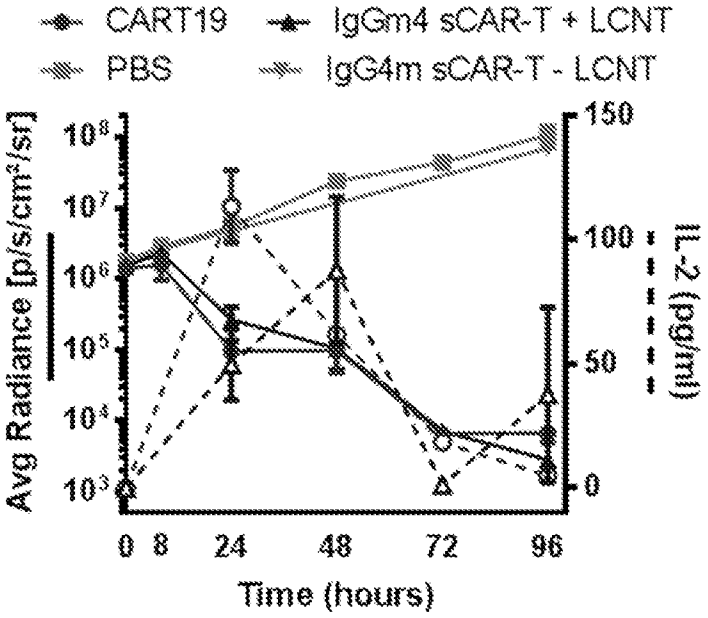


FIG. 30C

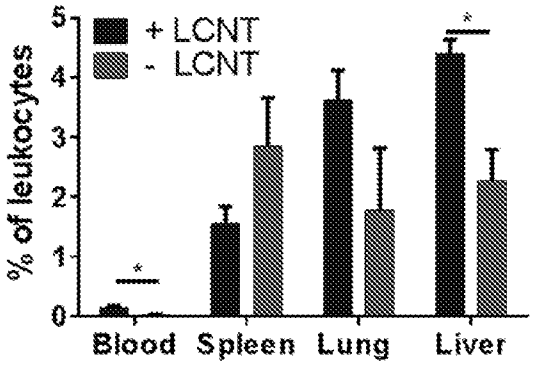


FIG. 30D

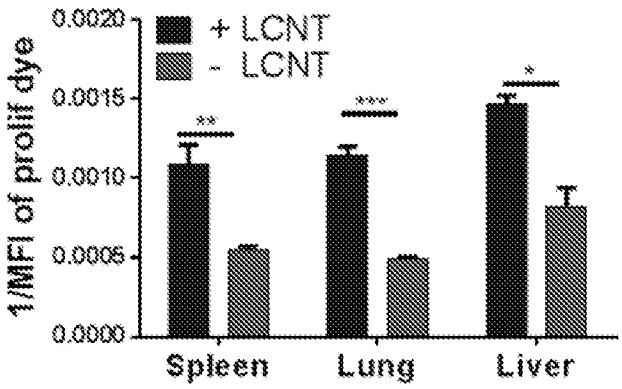


FIG. 31A

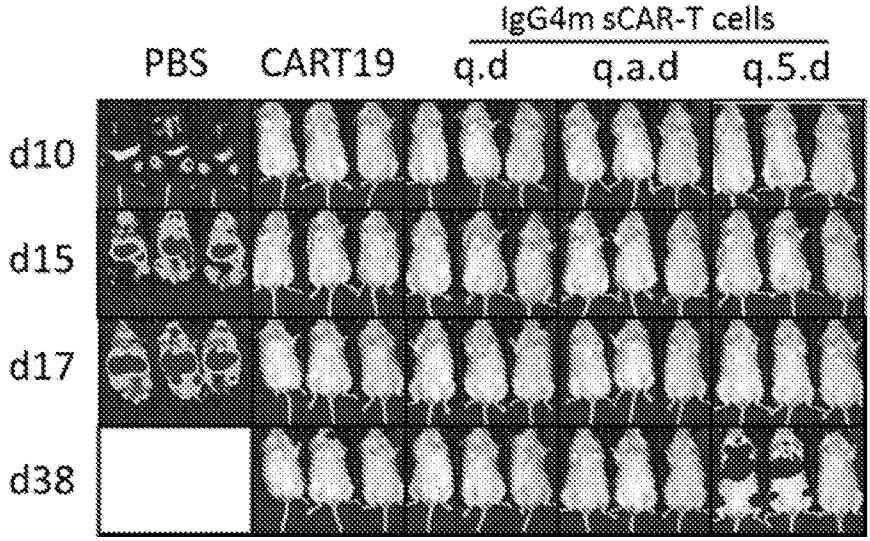


FIG.31B

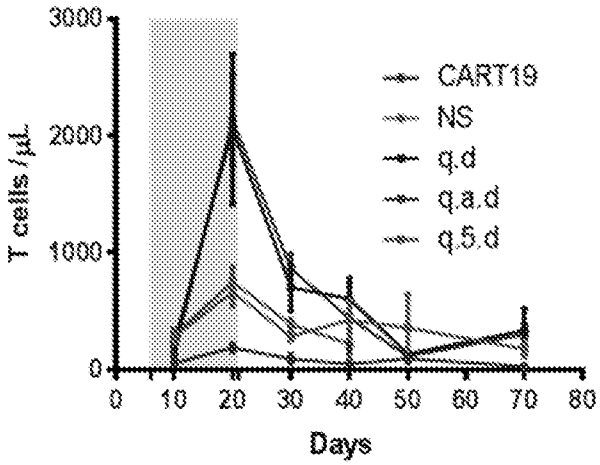


FIG. 31C

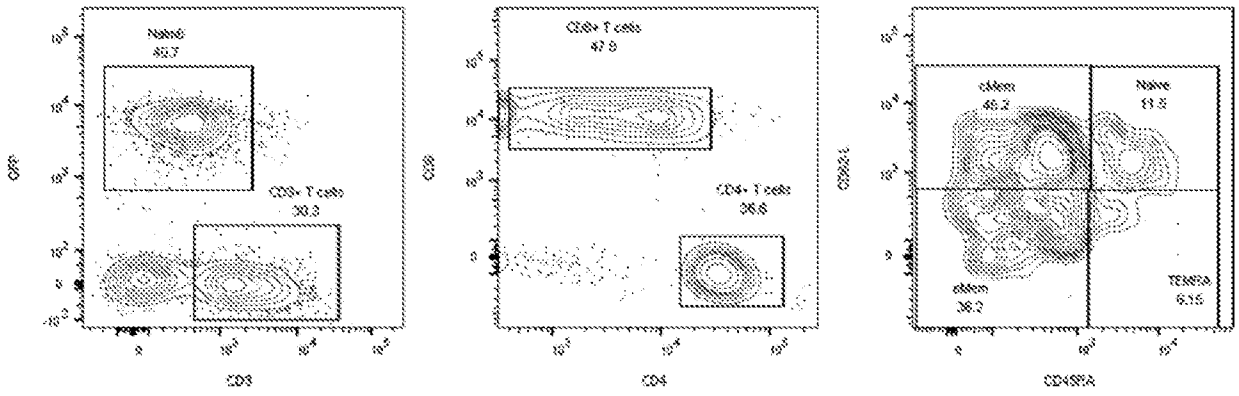


FIG. 32A

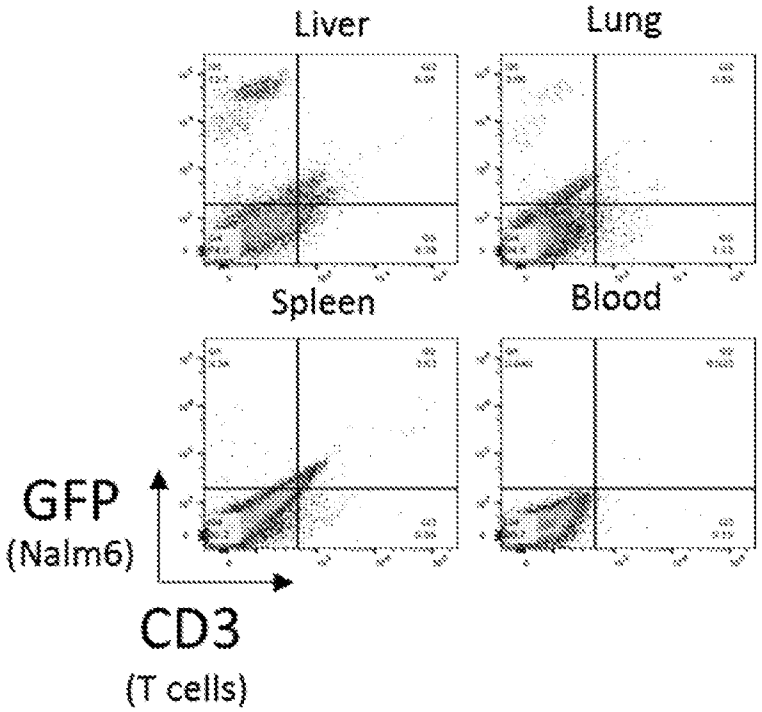


FIG. 32B

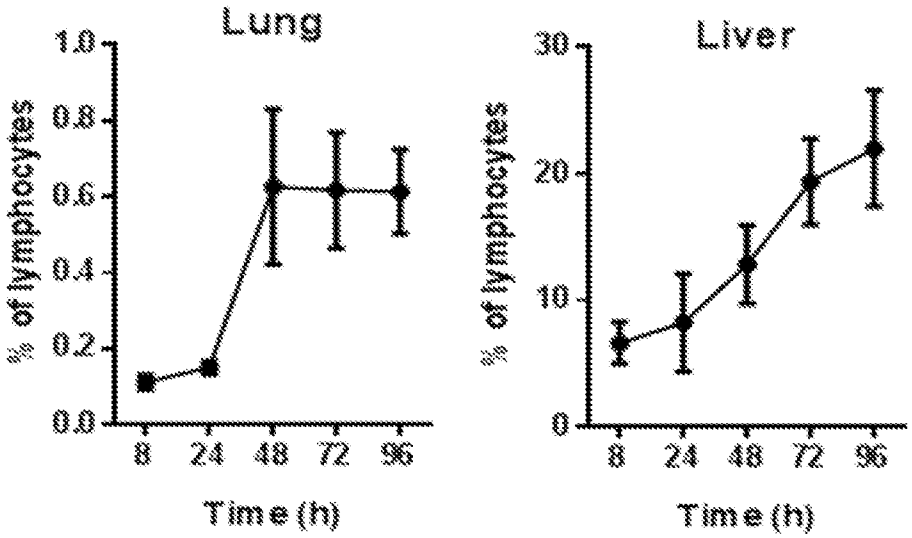


FIG. 32C

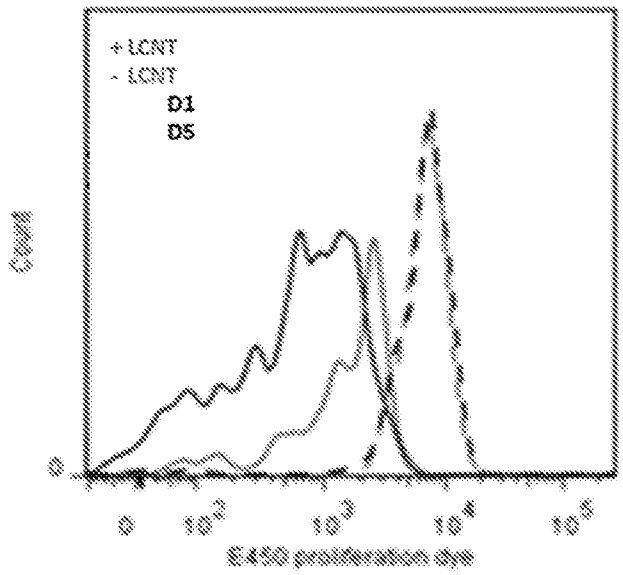


FIG. 32D

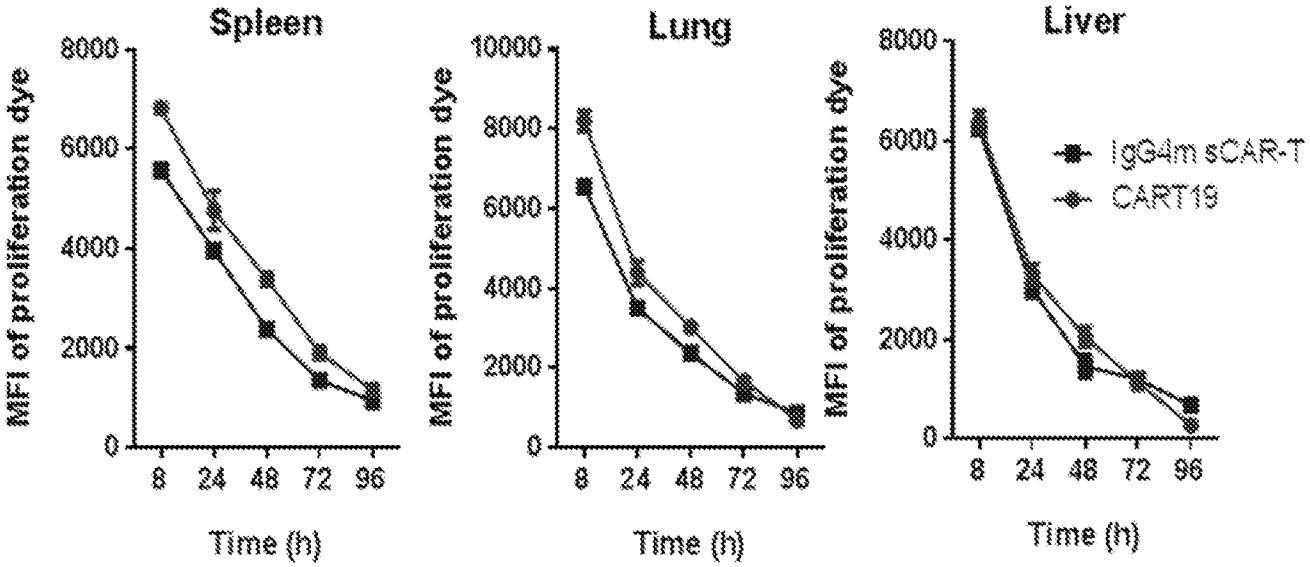


FIG. 33A

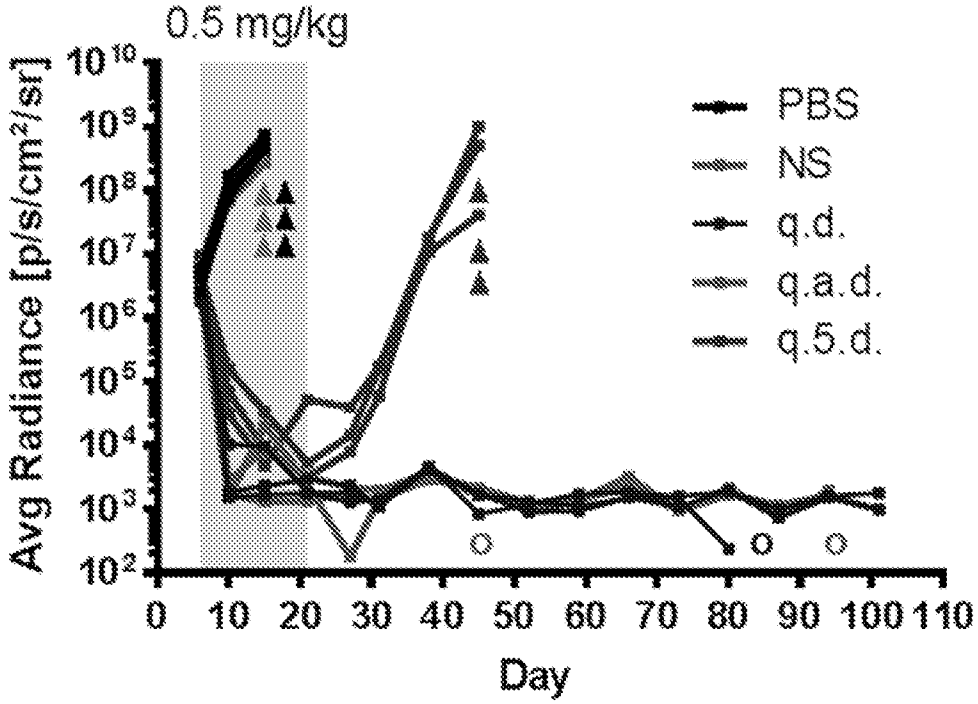


FIG. 33B

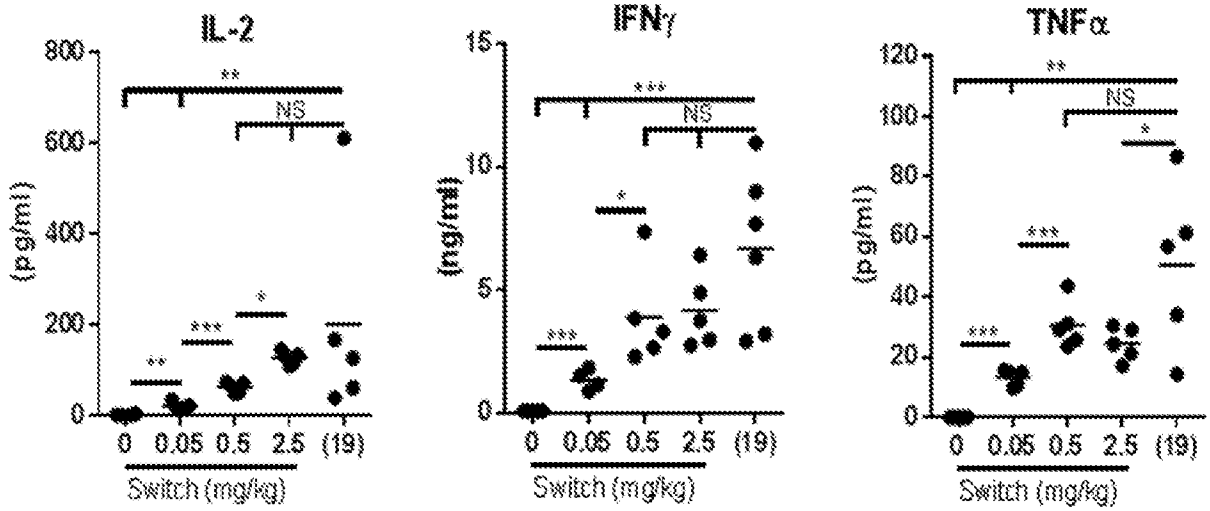


FIG. 33C

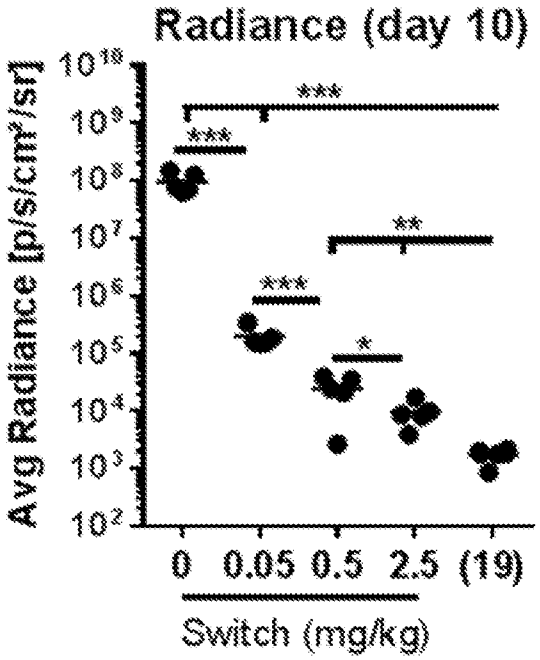


FIG. 33D

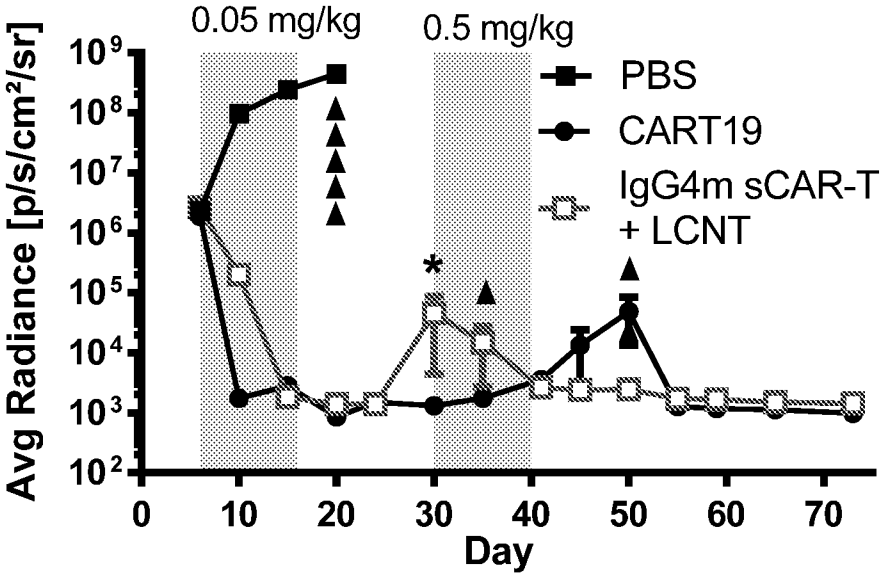


FIG. 33E

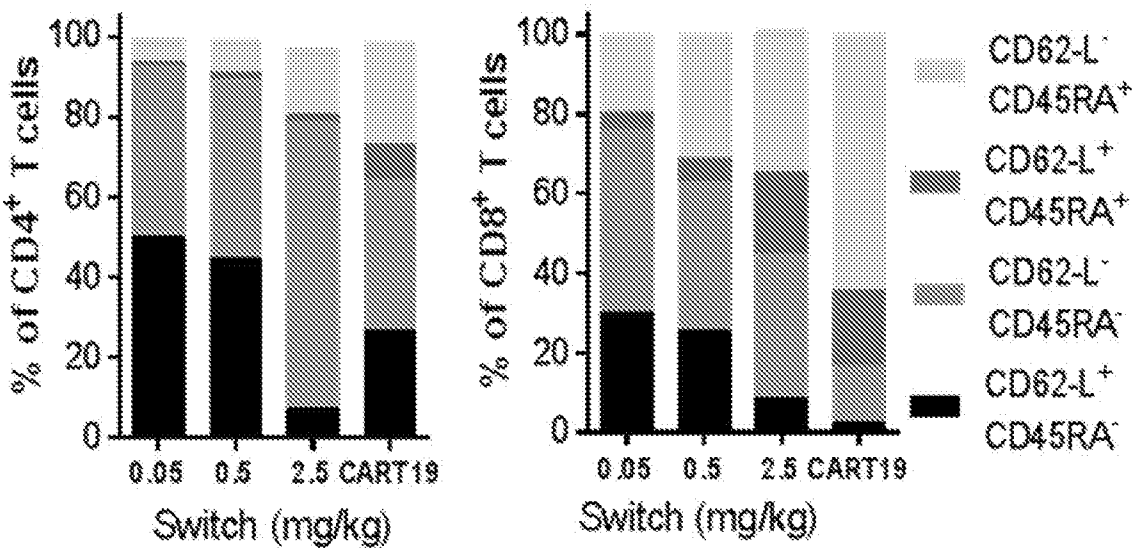


FIG. 34A

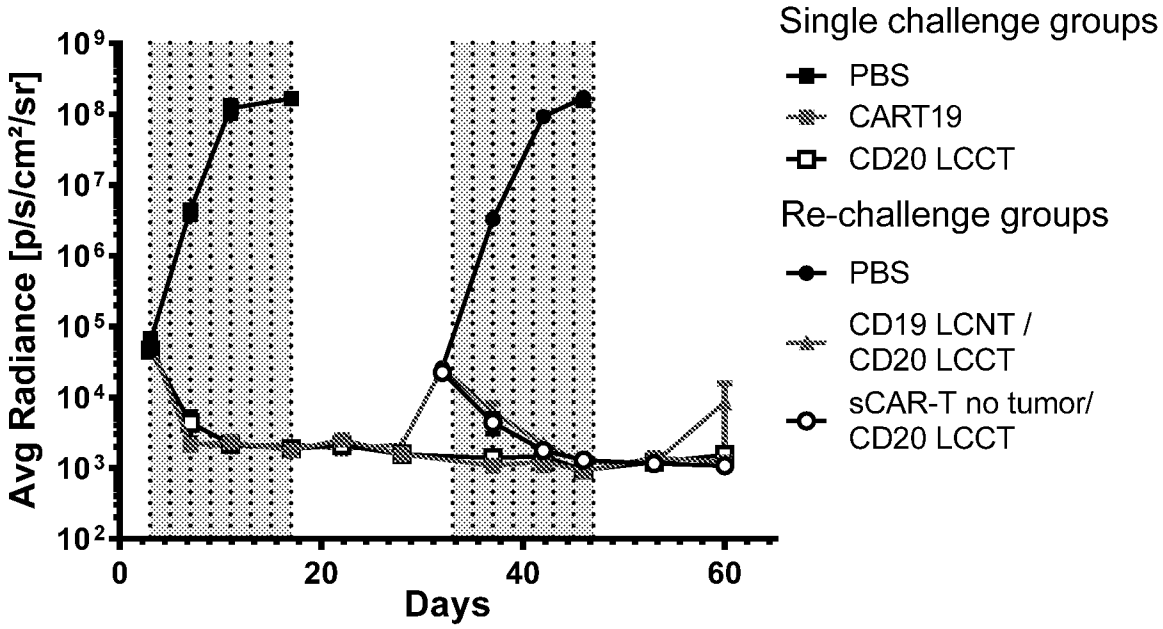


FIG. 34B

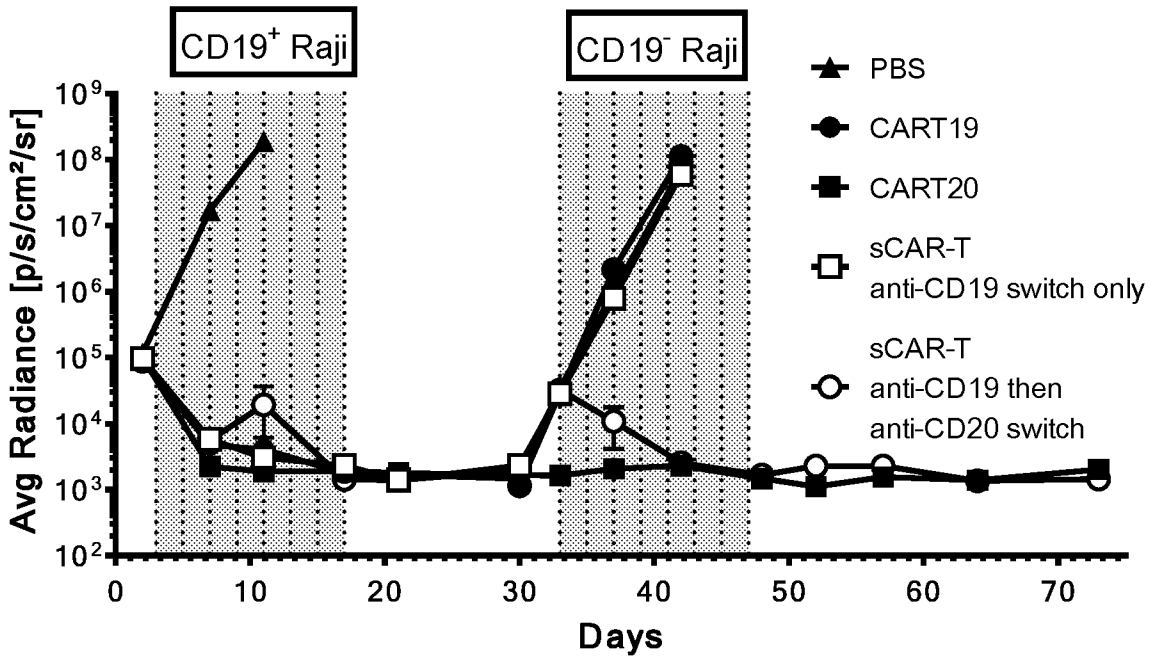


FIG. 35

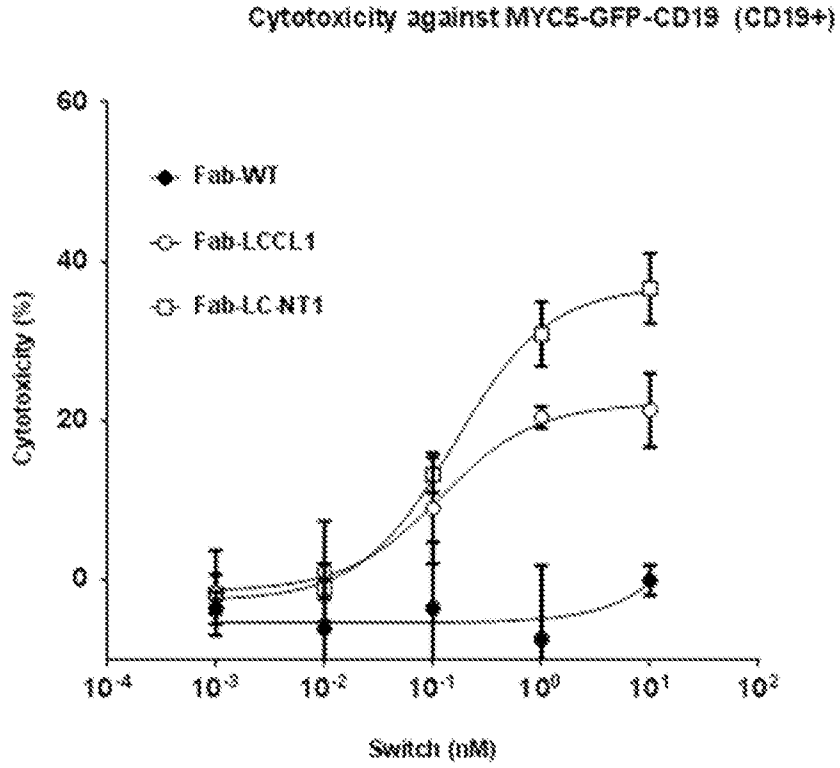


FIG. 36A

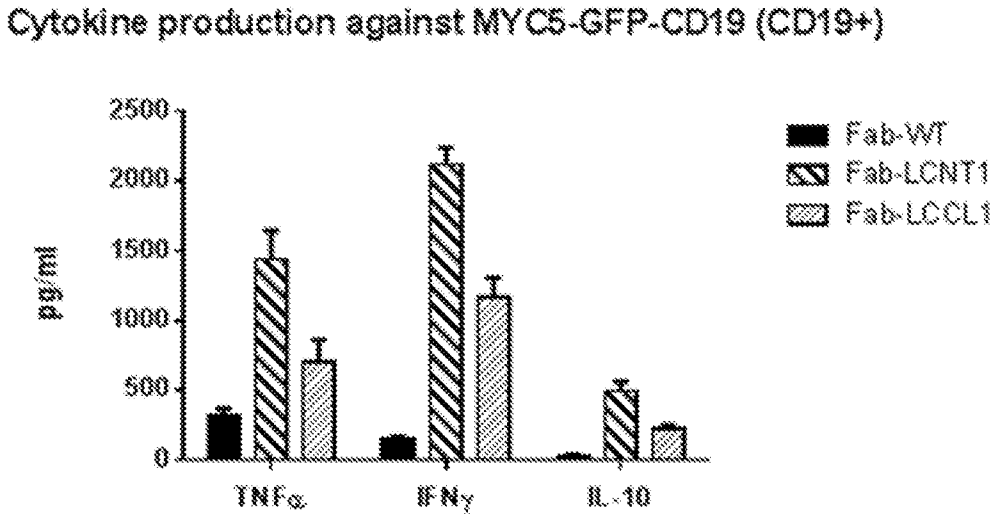


FIG. 36B

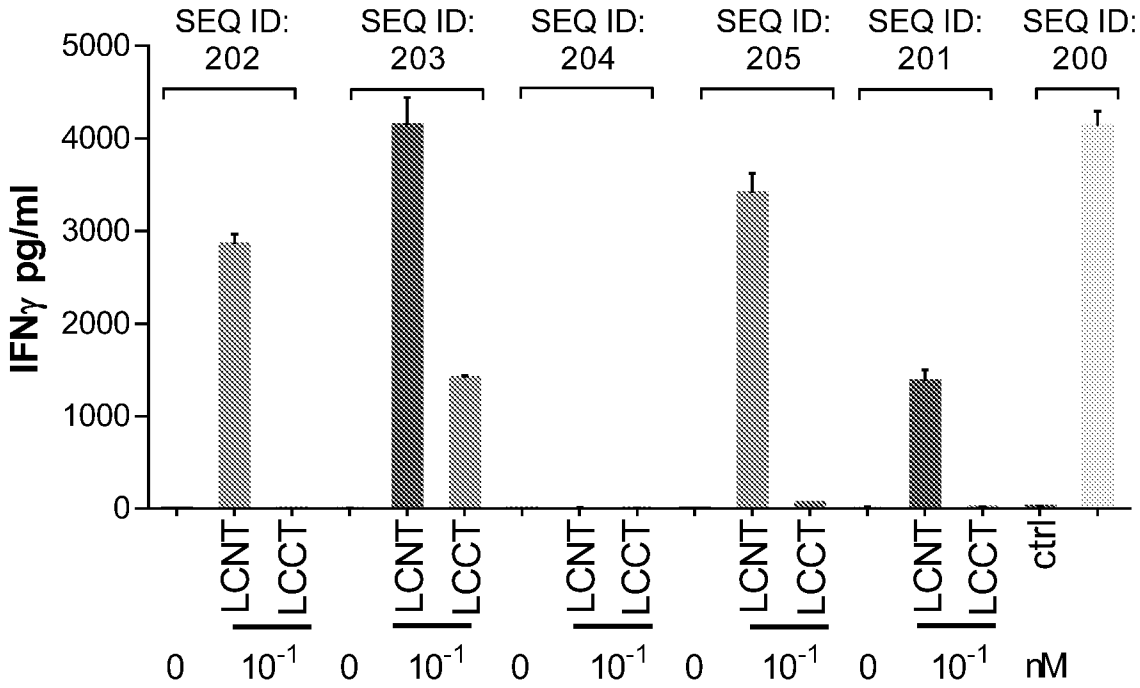


FIG. 37

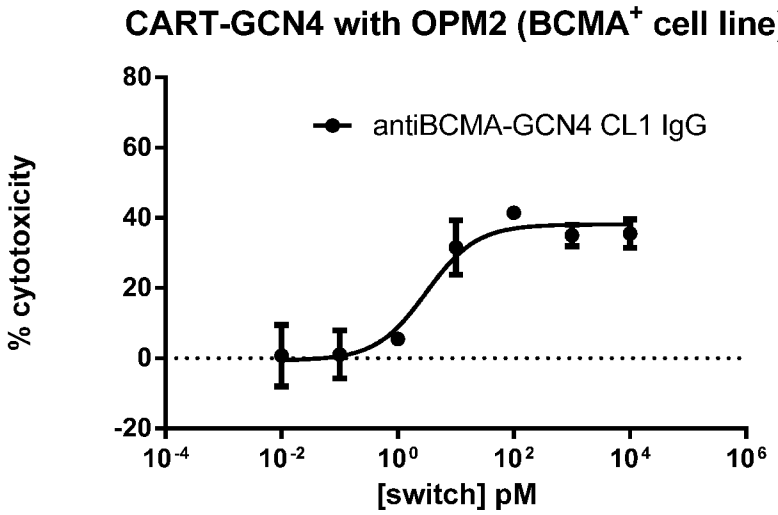


FIG. 38A

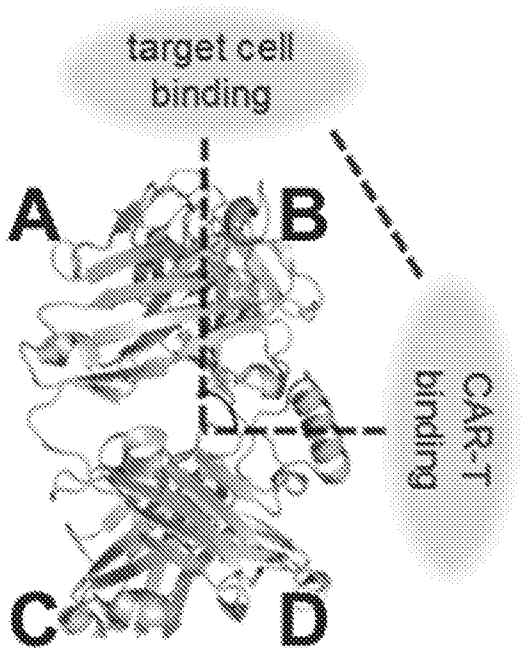


FIG. 38B

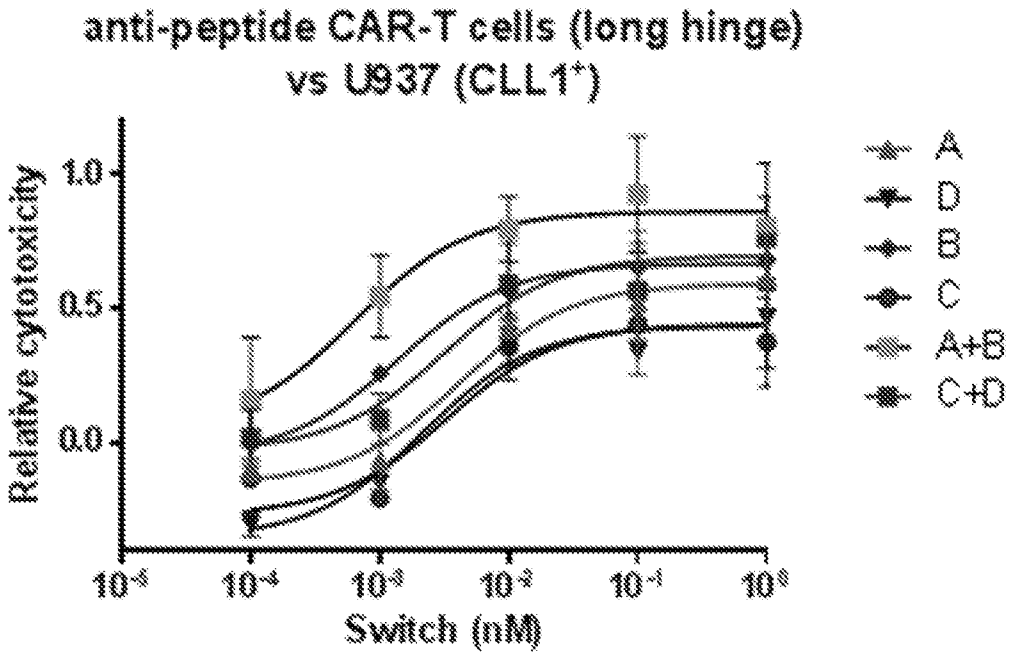


FIG. 38C

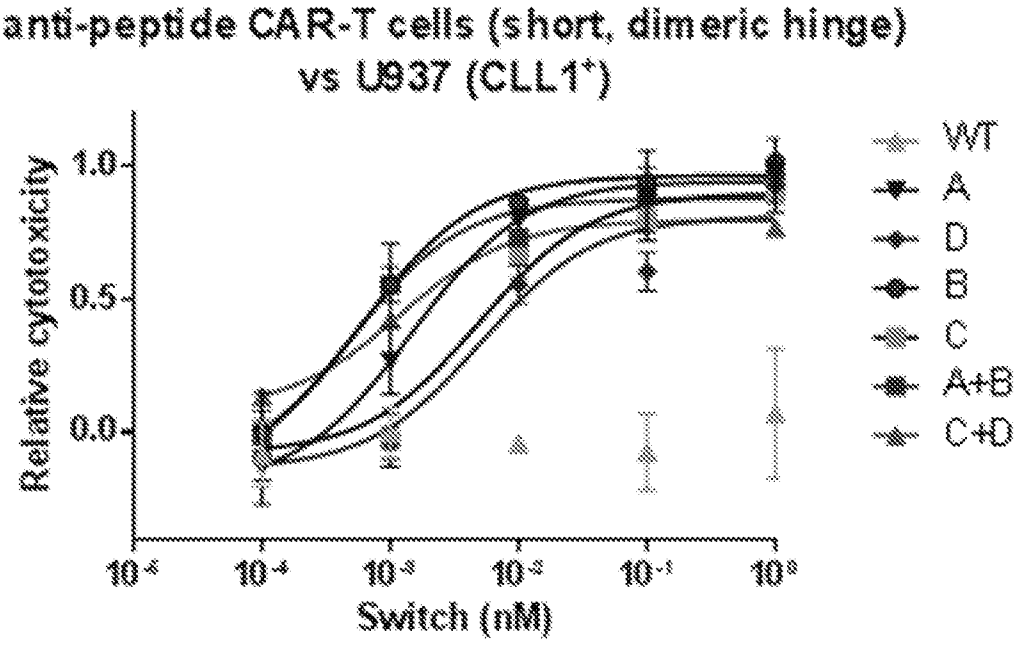


FIG. 38D

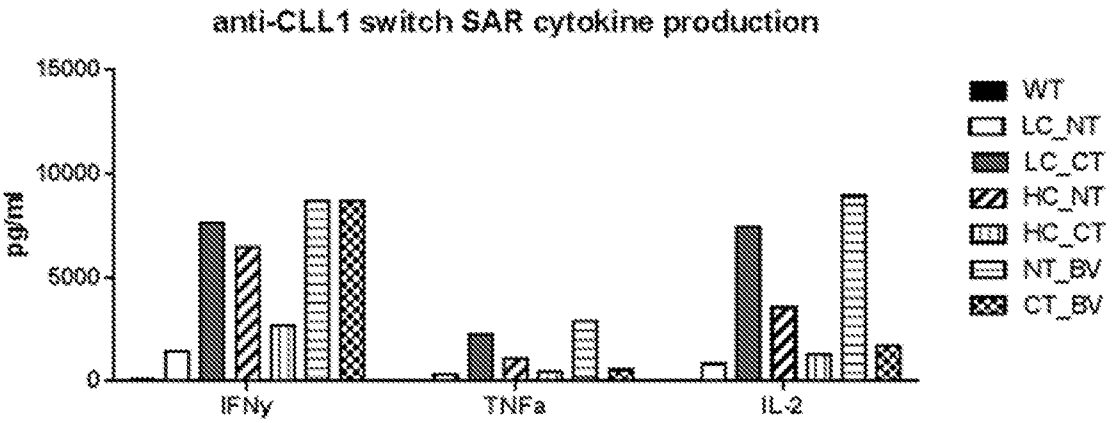


FIG. 38E

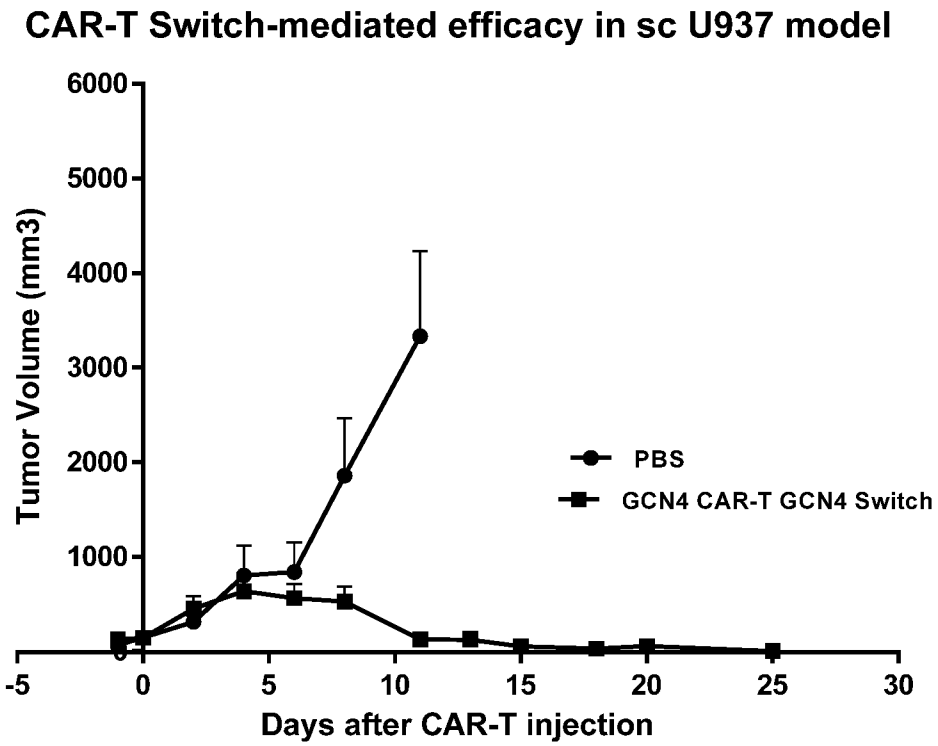


FIG. 38F

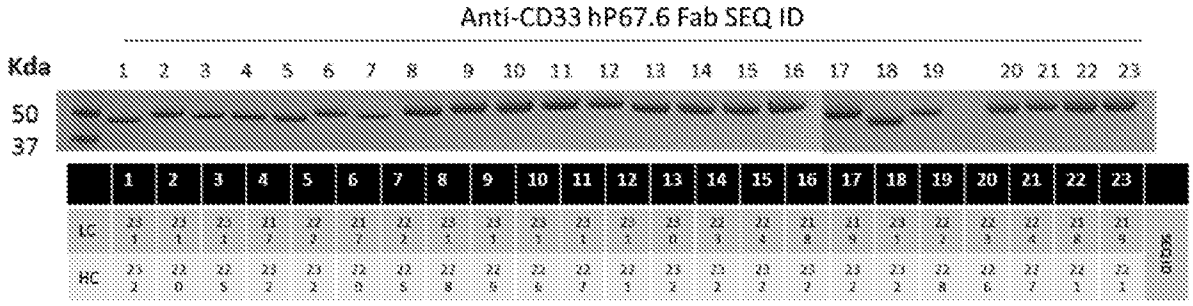


FIG. 38G

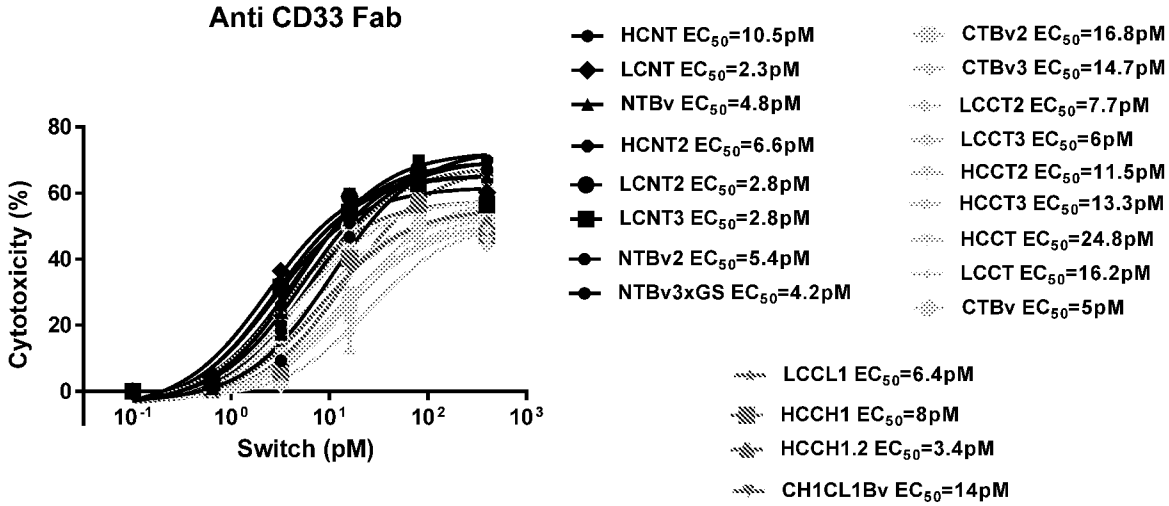


FIG. 38H

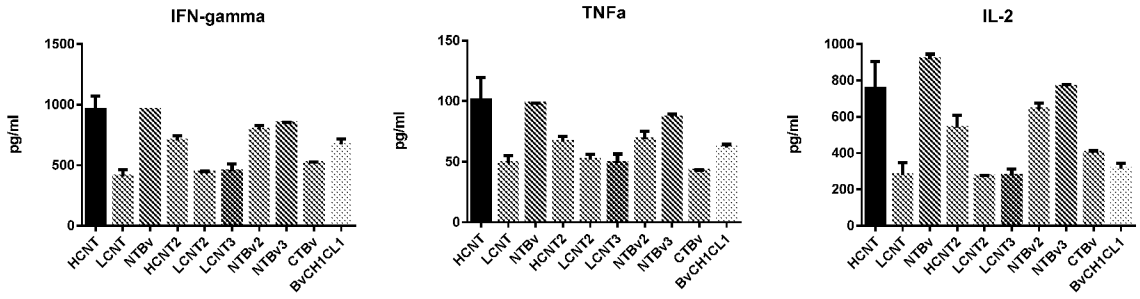


FIG. 38I

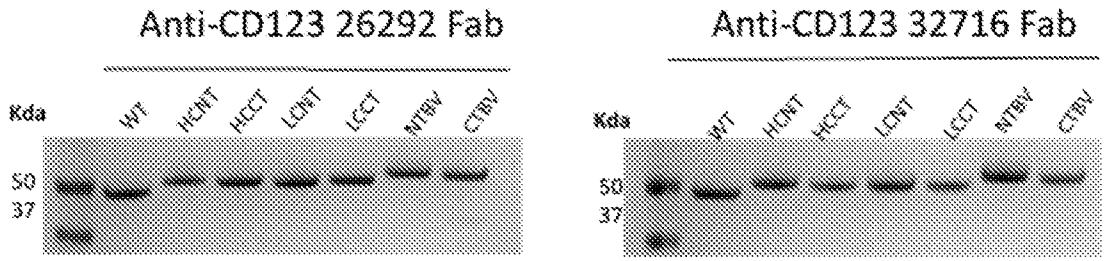


FIG. 38J

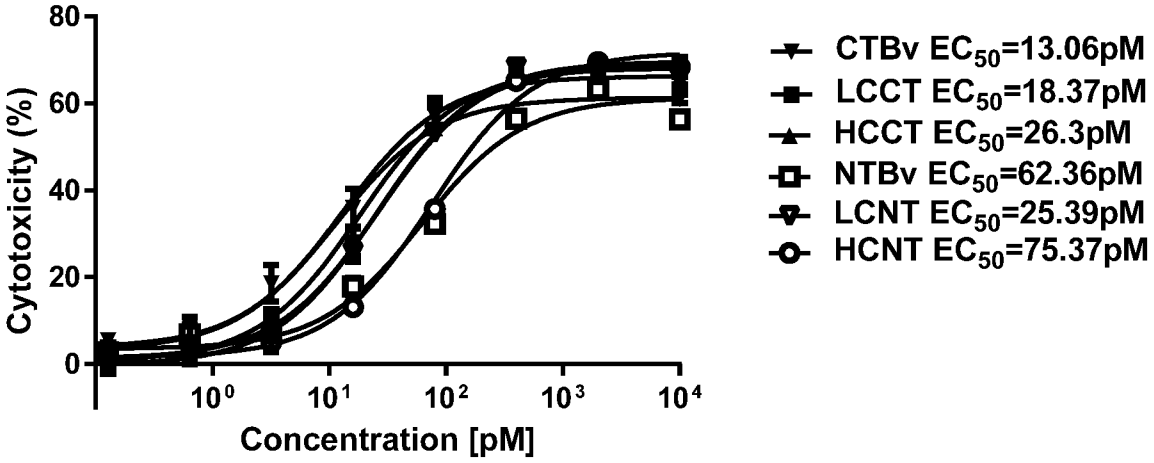


FIG. 38K

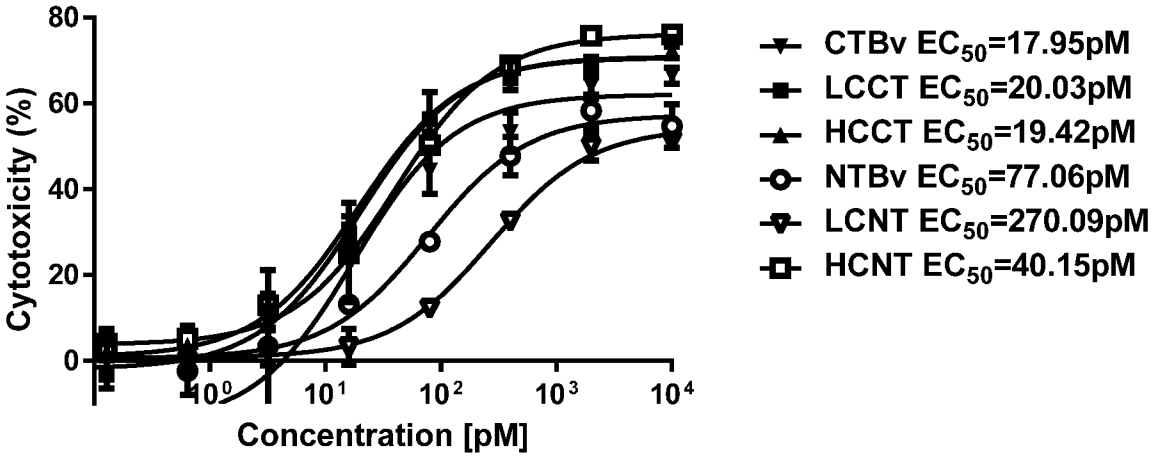


FIG. 39

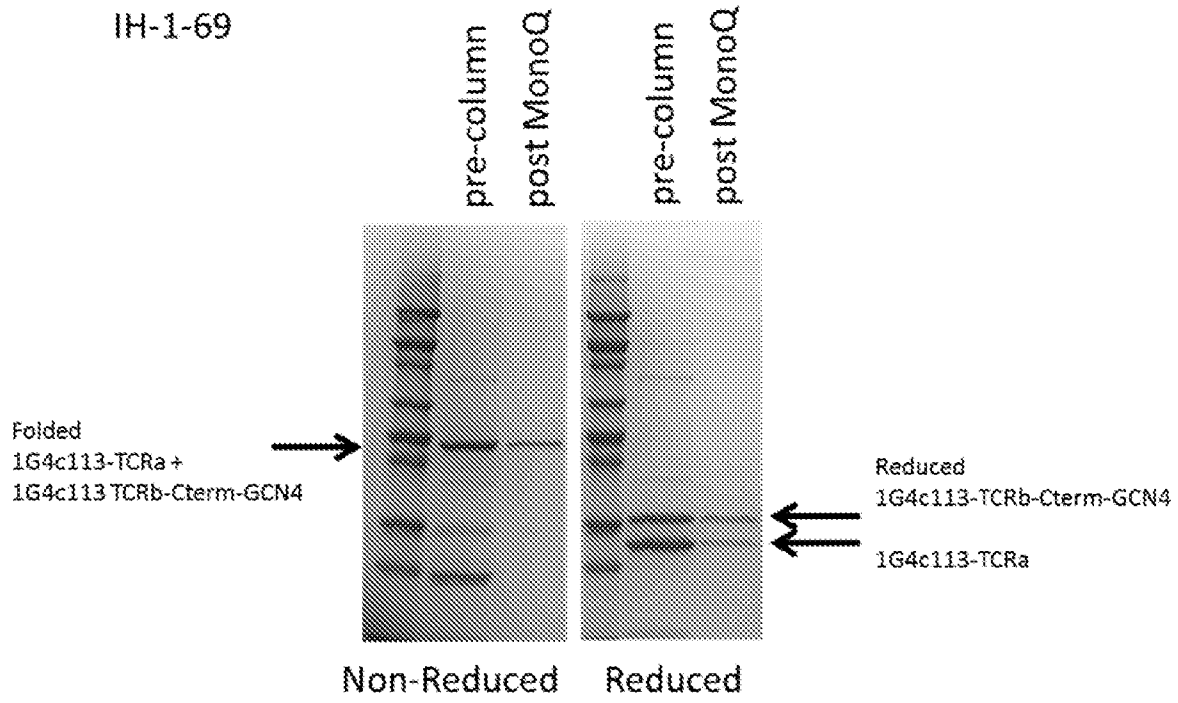


FIG. 40A

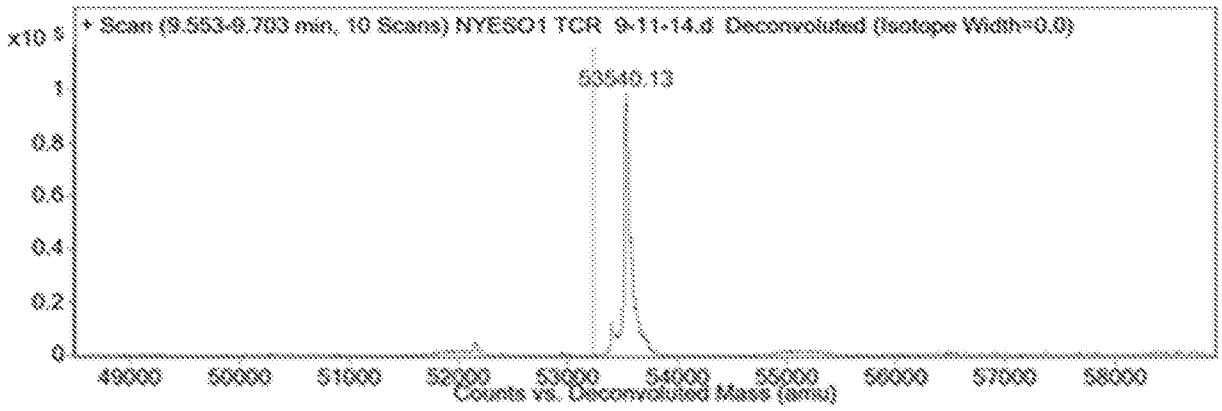


FIG. 40B

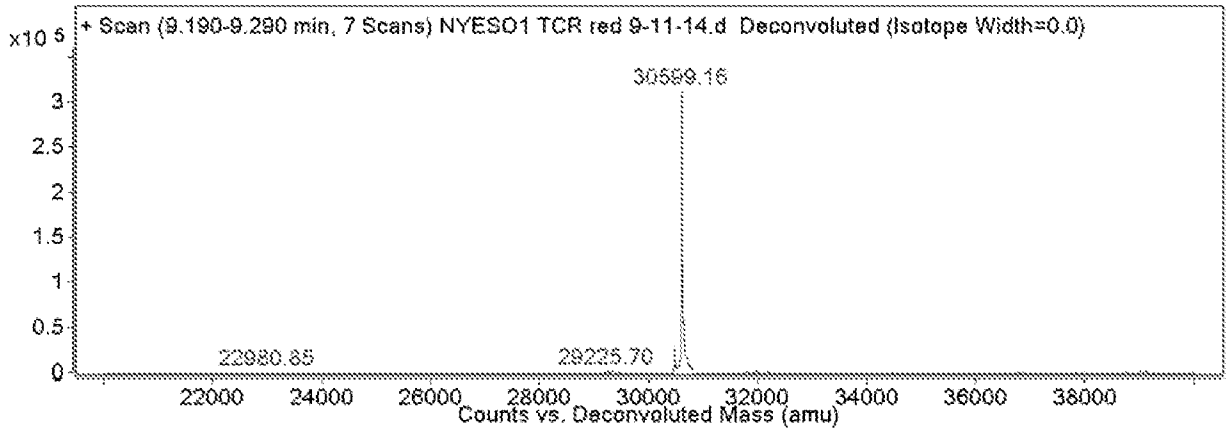


FIG. 40C

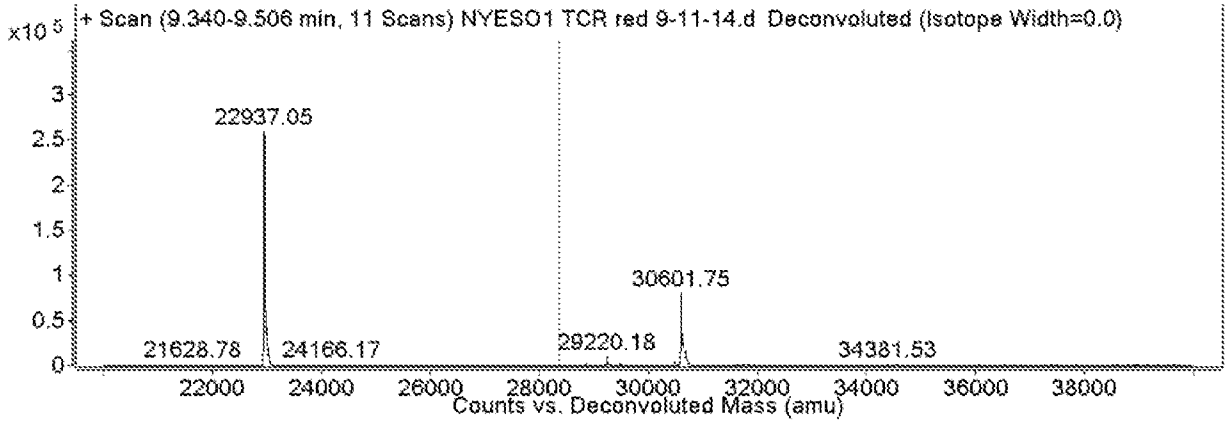


FIG. 41A

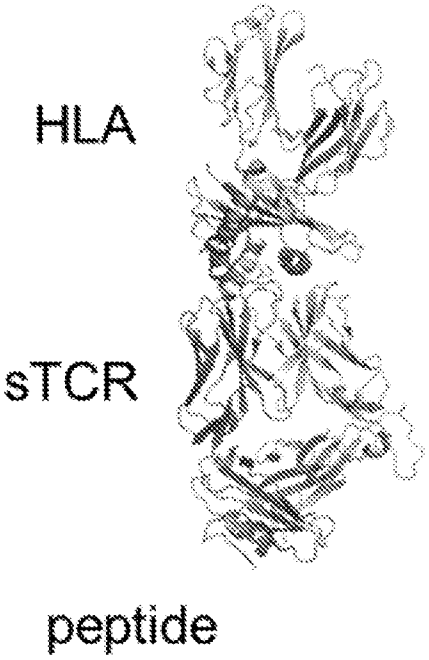


FIG. 41B

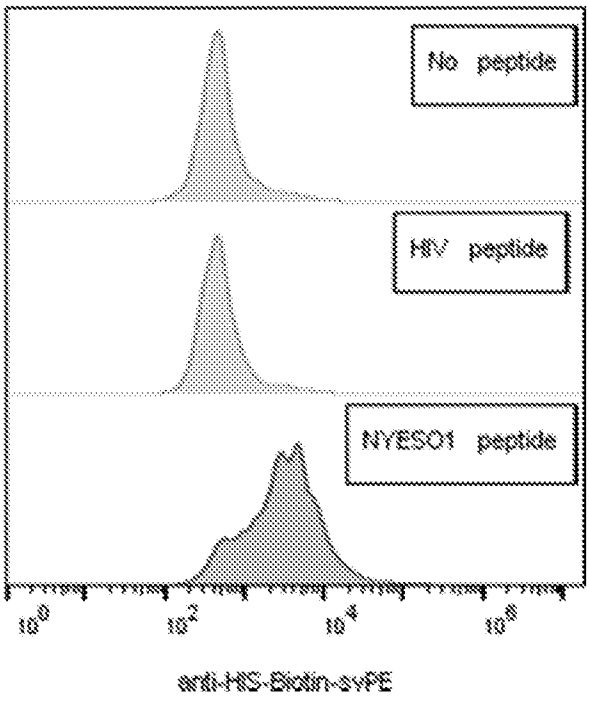


FIG. 41C

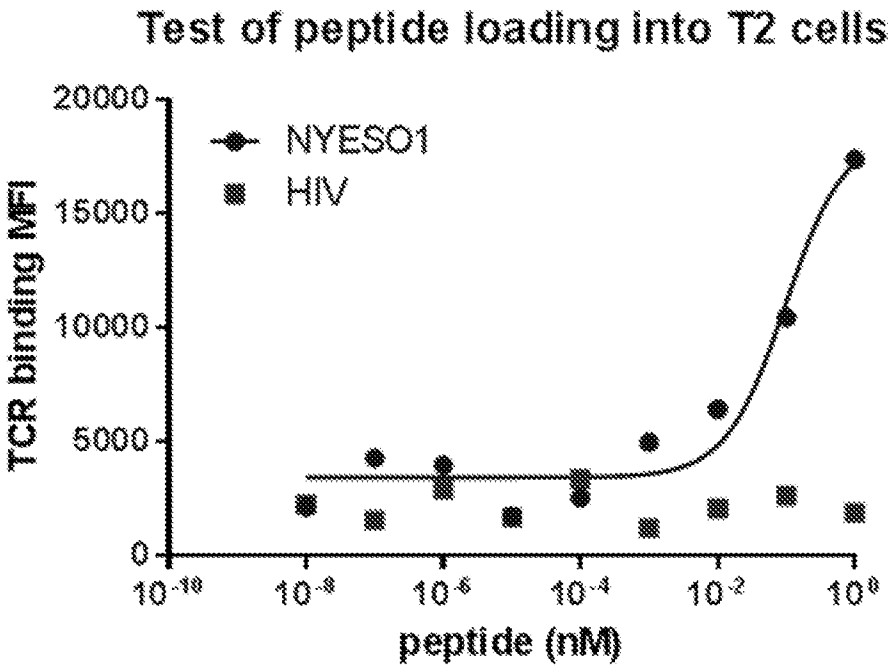


FIG. 41D

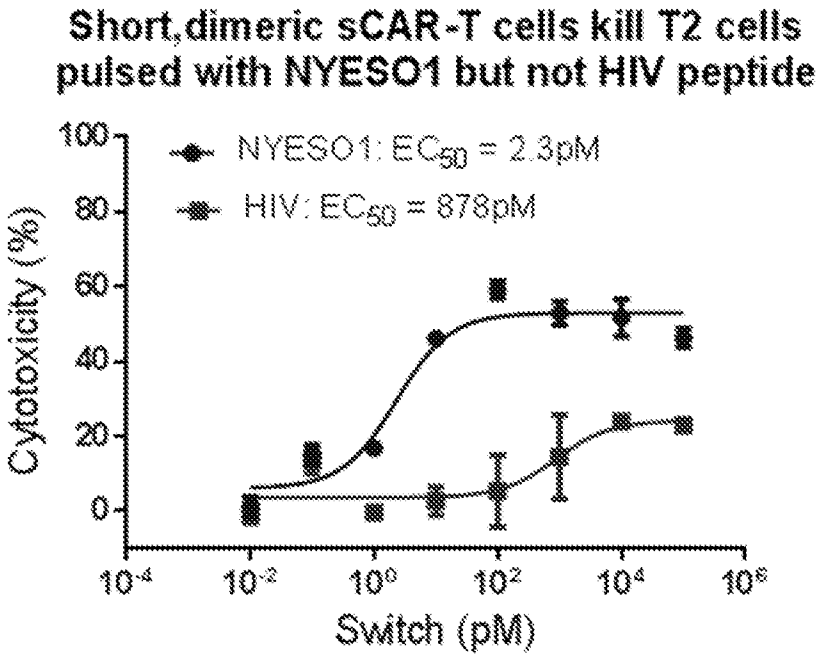


FIG. 41E

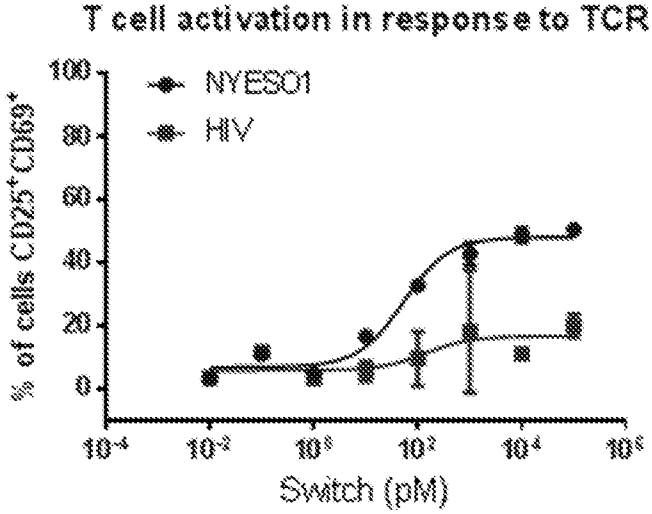


FIG. 41F

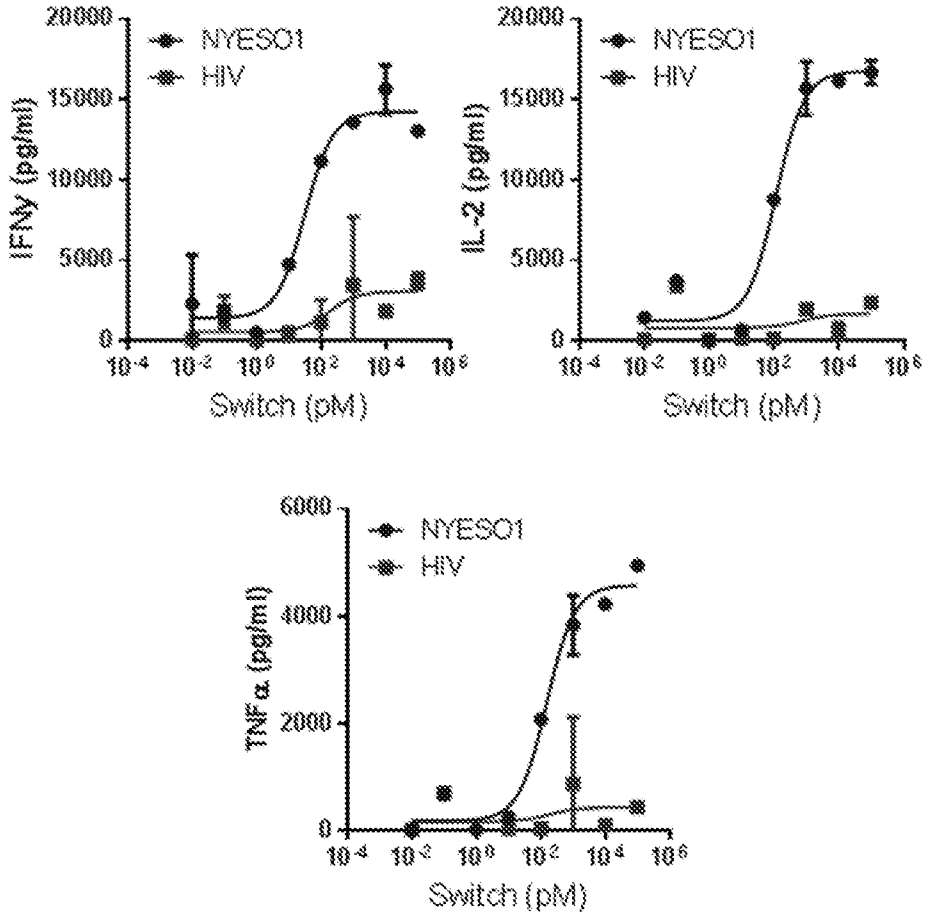


FIG. 42A

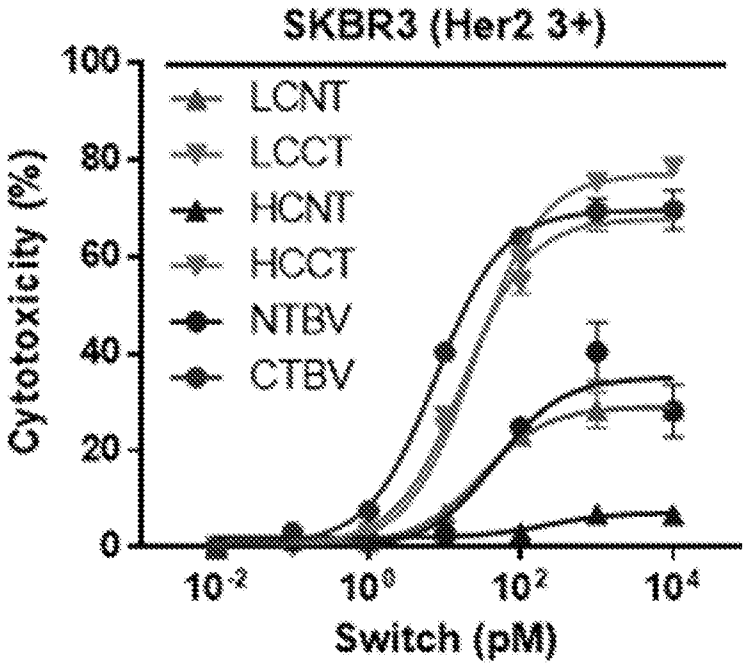


FIG. 42B

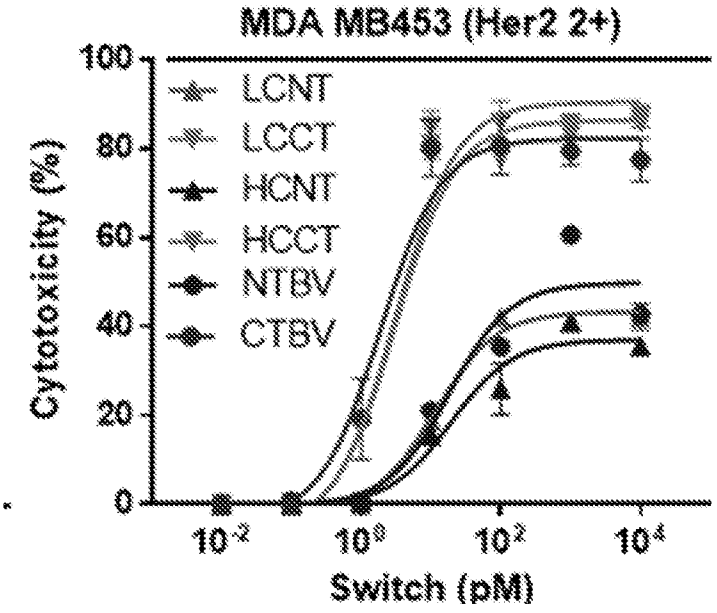


FIG. 42C

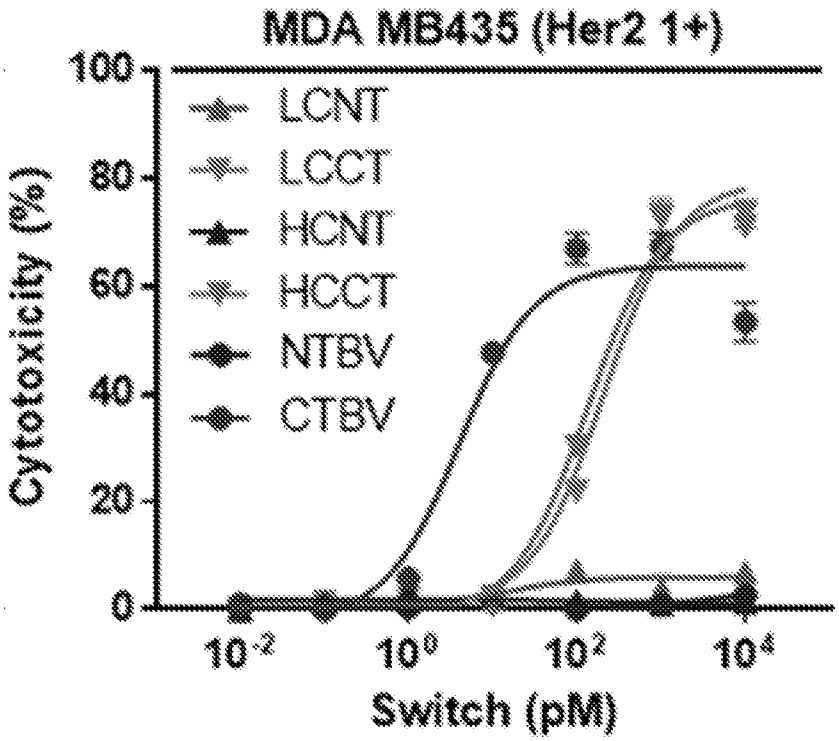
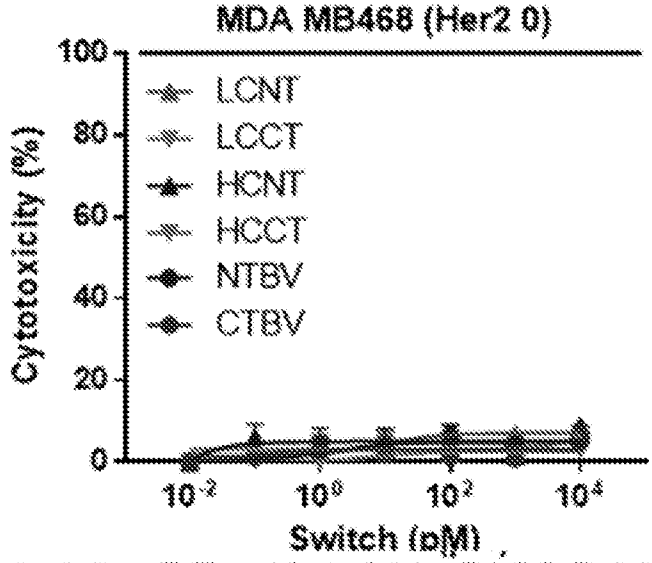


FIG. 42D



Cytotoxicity, E:T = 10:1, 24 h, FACS 7-AAD

FIG. 42E

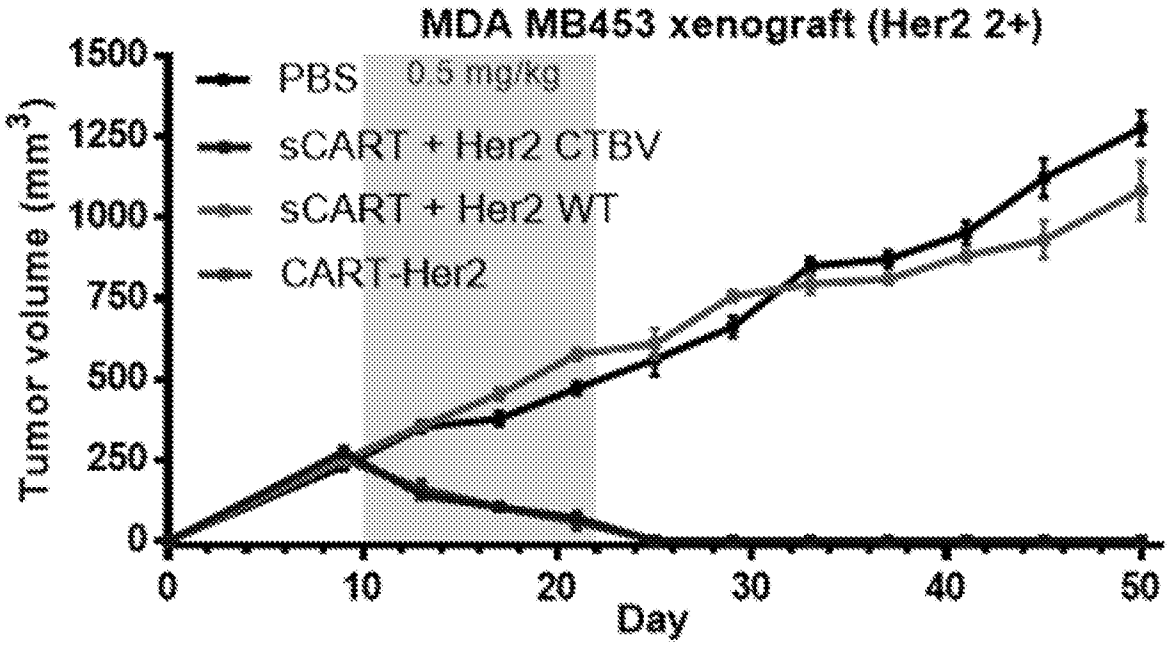
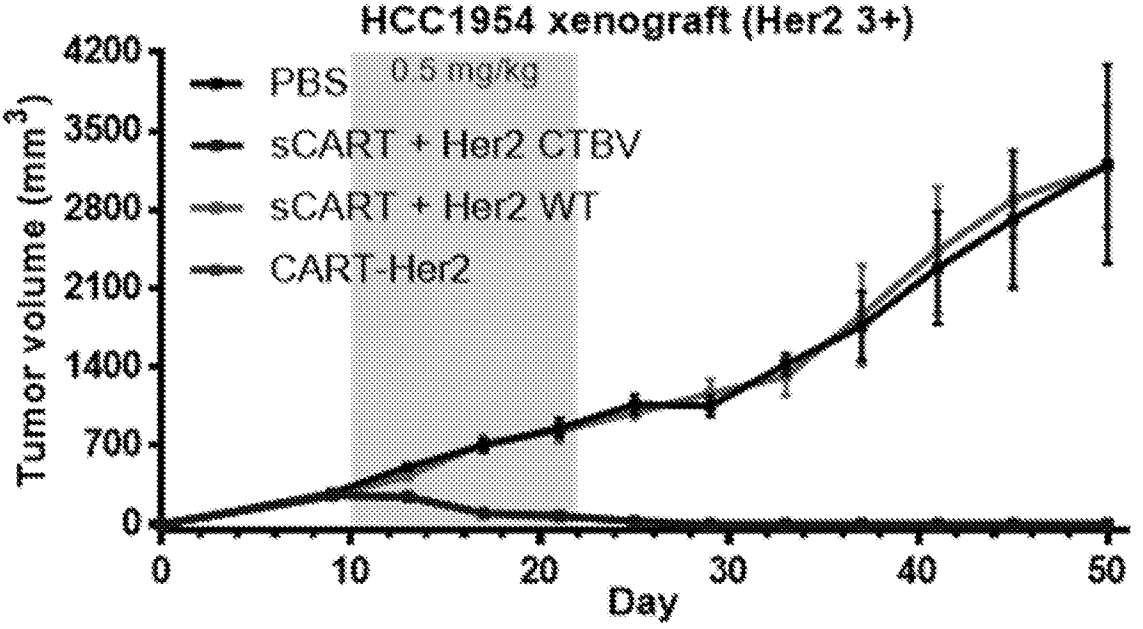


FIG. 42F



5.0e^{6} Her2^{+} cells SC; 3e^{7} sCAR-T (50% transd) day 10; *q.a.d.* switch

FIG. 43A

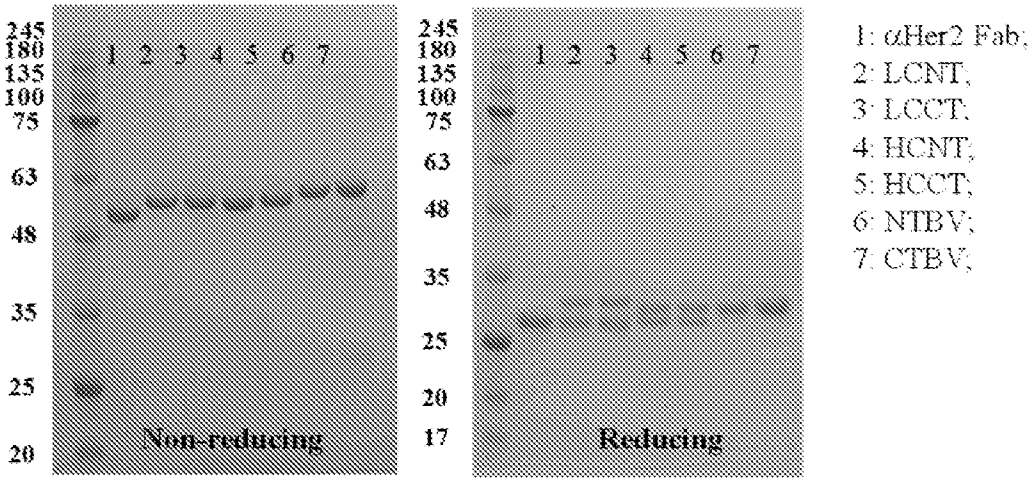


FIG. 43B

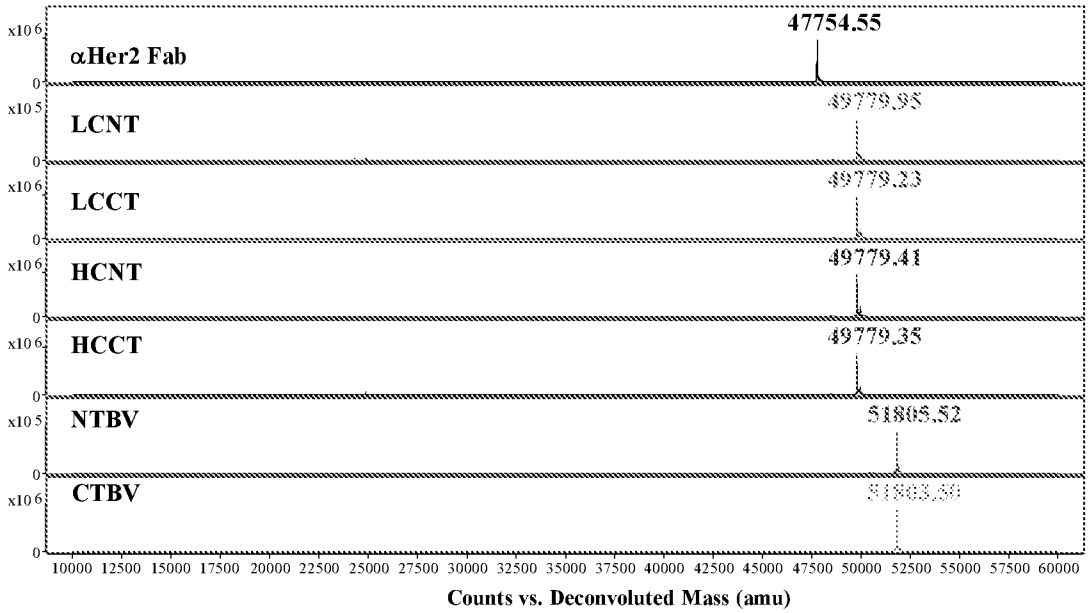


FIG. 44A

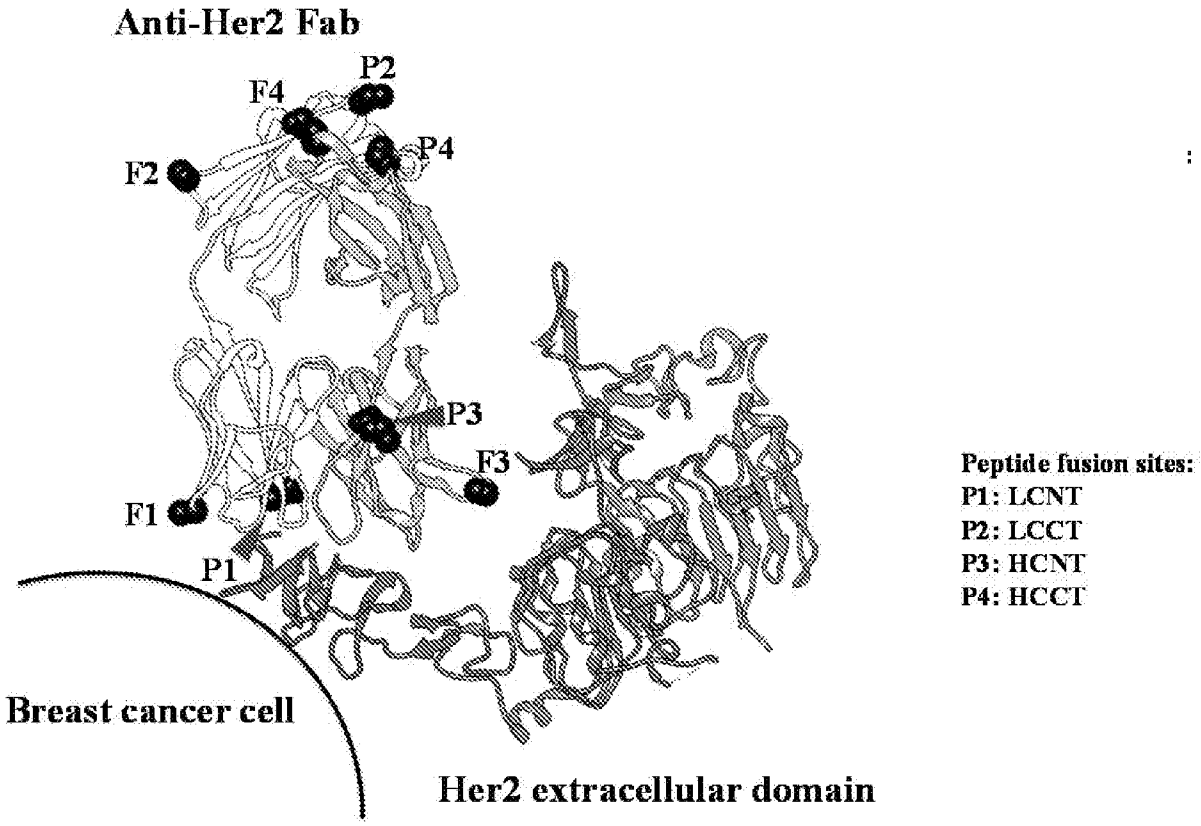


FIG. 44B

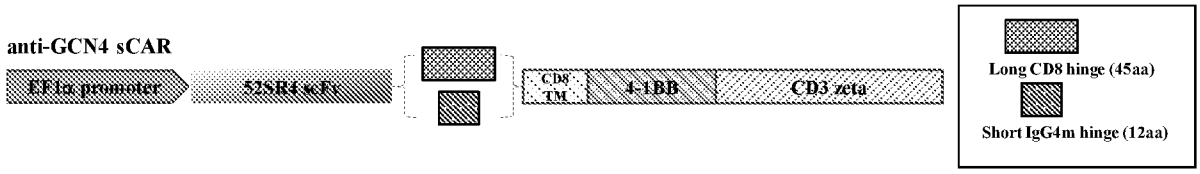


FIG. 44C

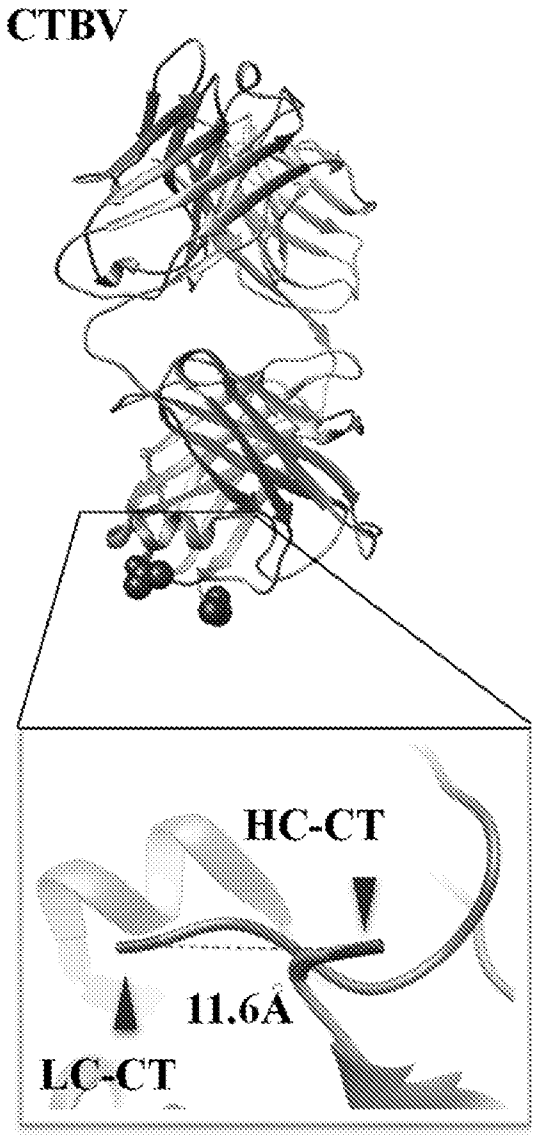


FIG. 44D

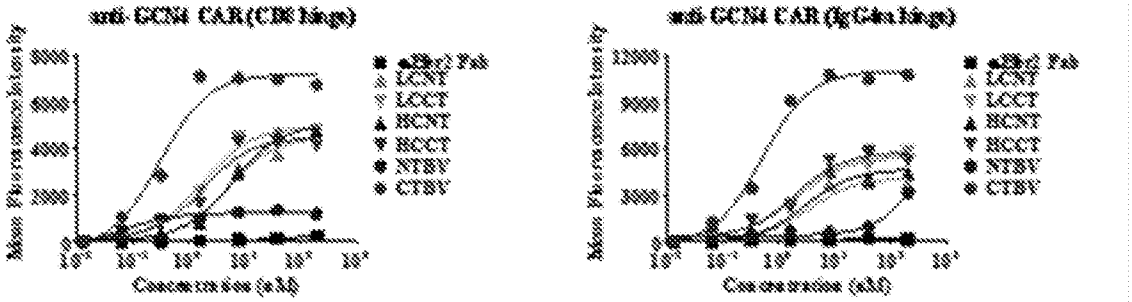


FIG. 45

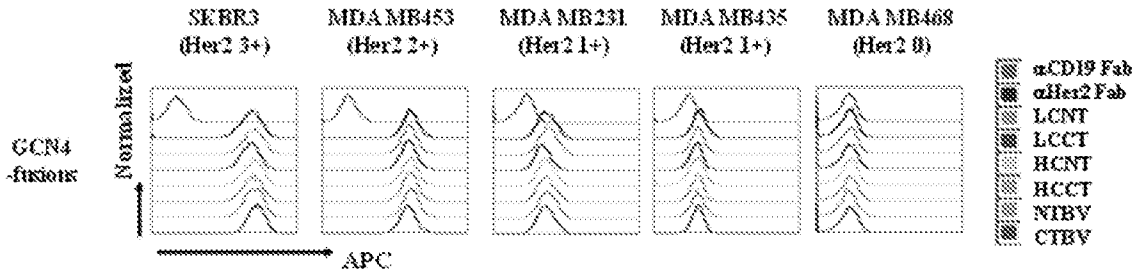
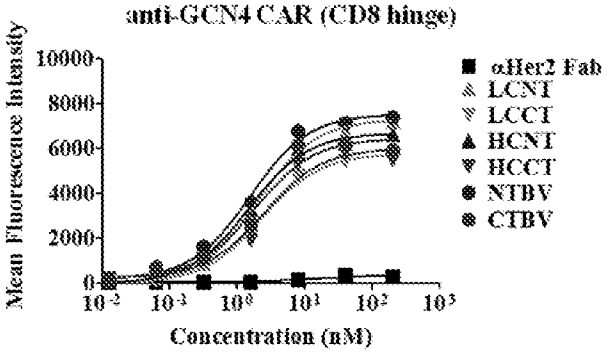
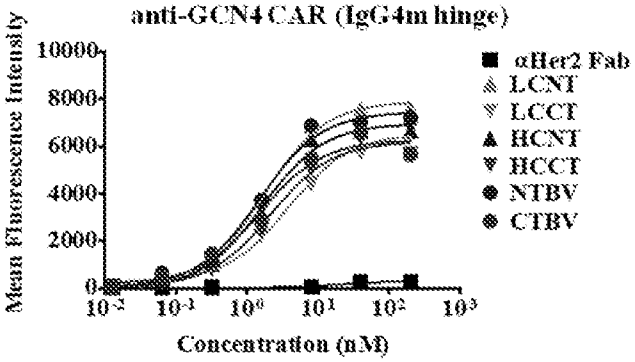


FIG. 46A



	EC50 (nM)
αHer2 Fab	N.D.
LCNT	2.0±0.2
LCCT	2.3±0.4
HCNT	1.5±0.2
HCCT	2.5±0.2
NTBV	1.6±0.2
CTBV	1.8±0.2

FIG. 46B



	EC50 (nM)
αHer2 Fab	N.D.
LCNT	1.7±0.1
LCCT	3.8±0.3
HCNT	1.7±0.4
HCCT	2.2±0.3
NTBV	1.4±0.2
CTBV	1.6±0.2

FIG. 46C

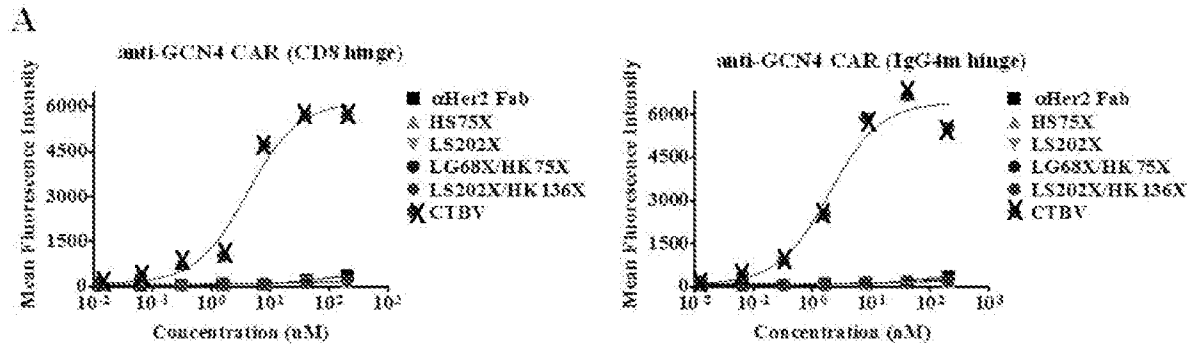


FIG. 47

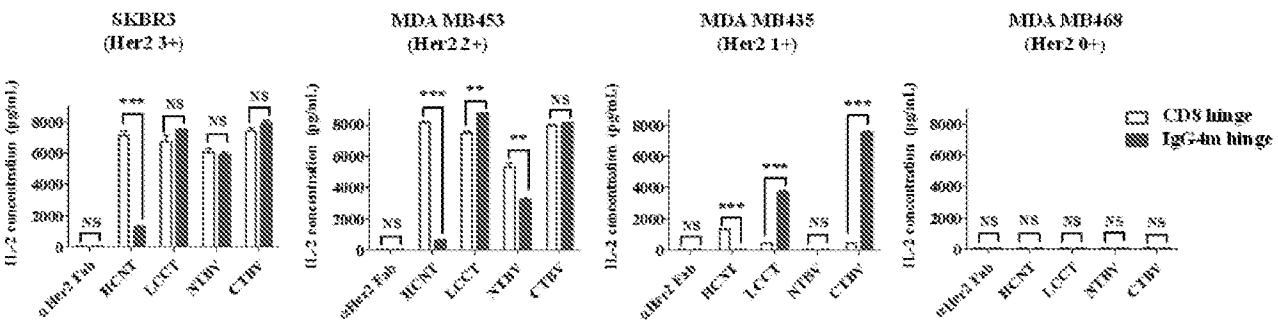


FIG. 48A

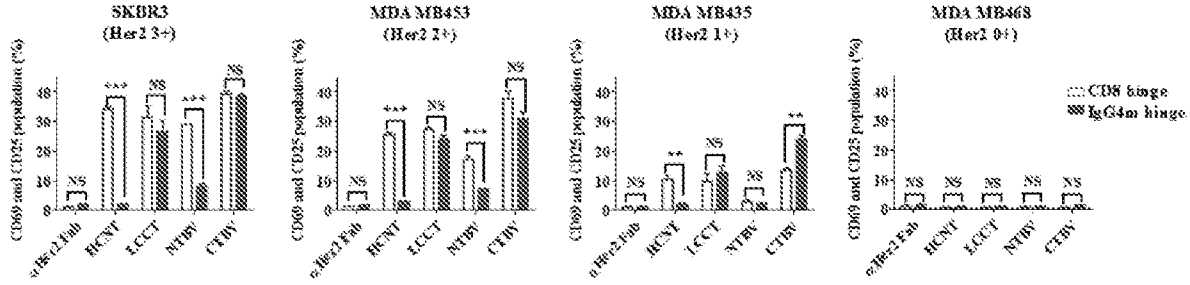


FIG. 48B

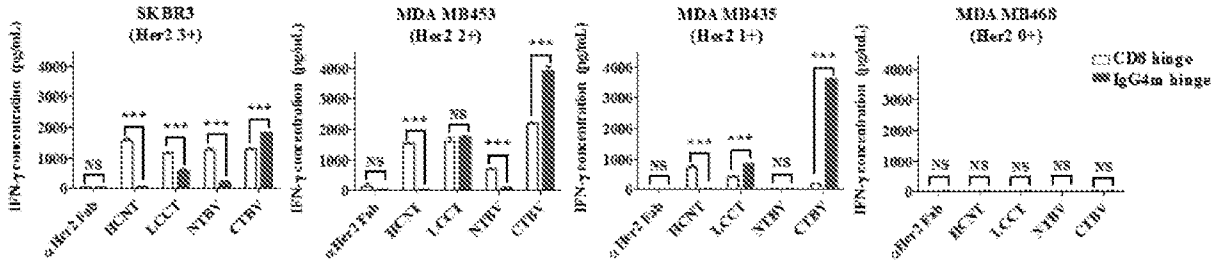


FIG. 48C

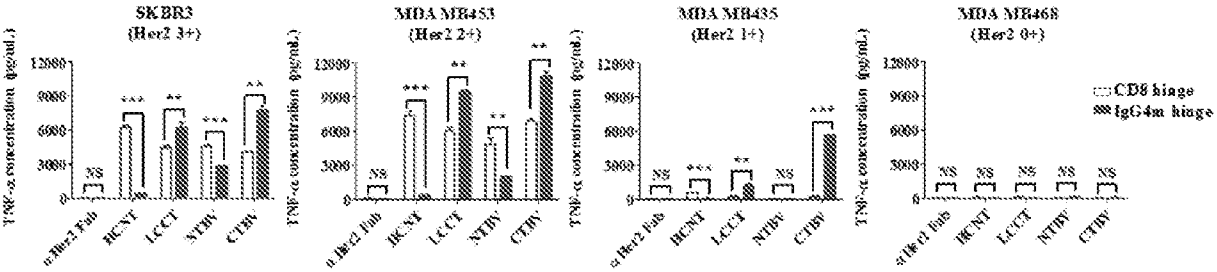


FIG. 49

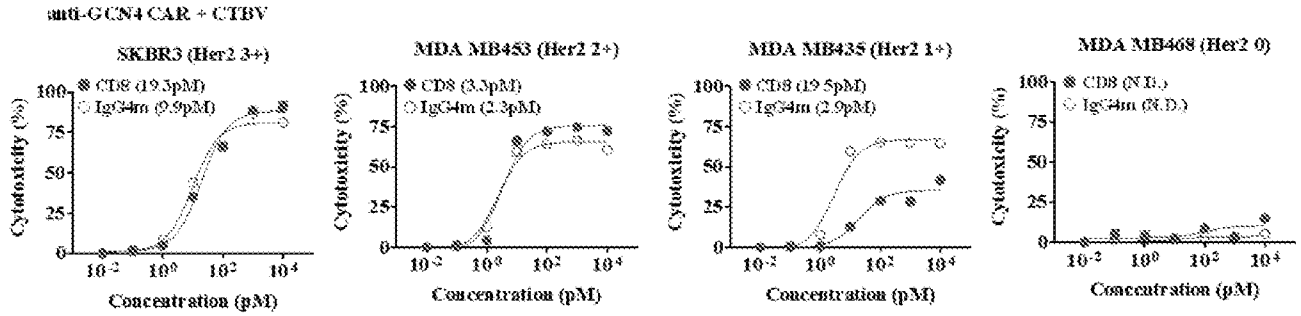


FIG. 50A

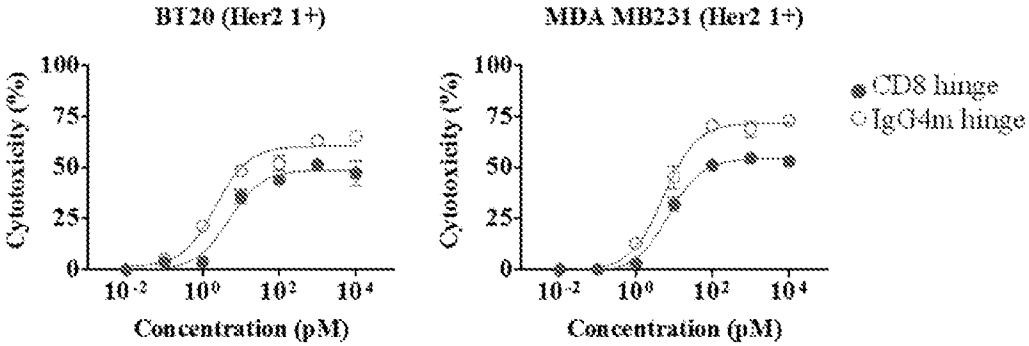


FIG. 50B

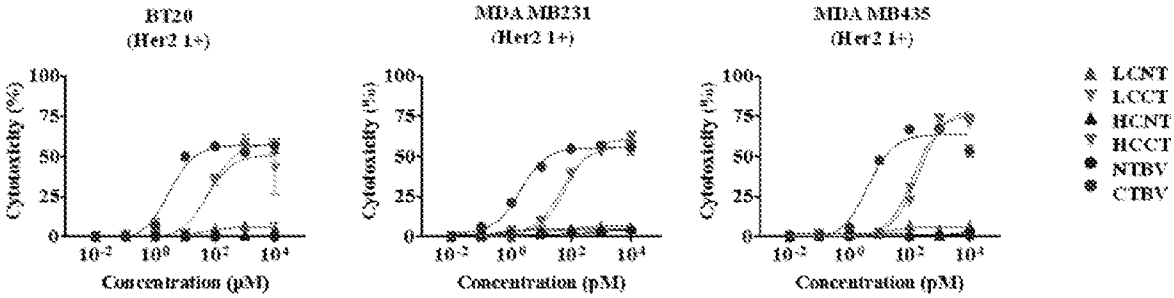
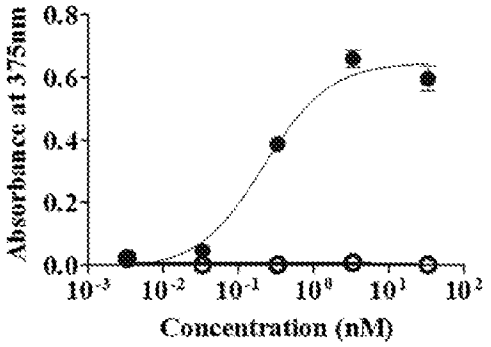


FIG. 51



	EC_{50} (nM)
CTBV	0.22 ± 0.03
αHer2 Fab	N.D

FIG. 52A

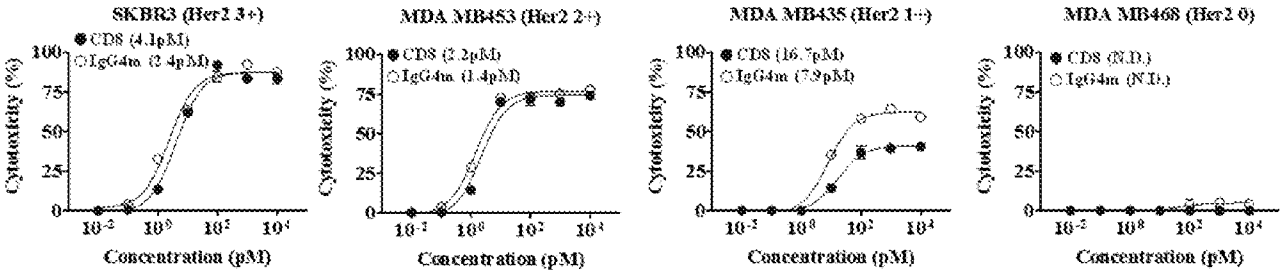


FIG. 52B

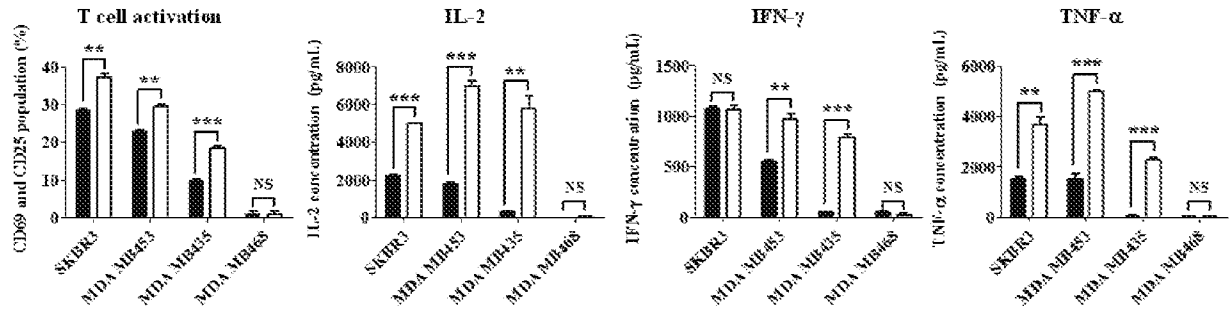


FIG. 53

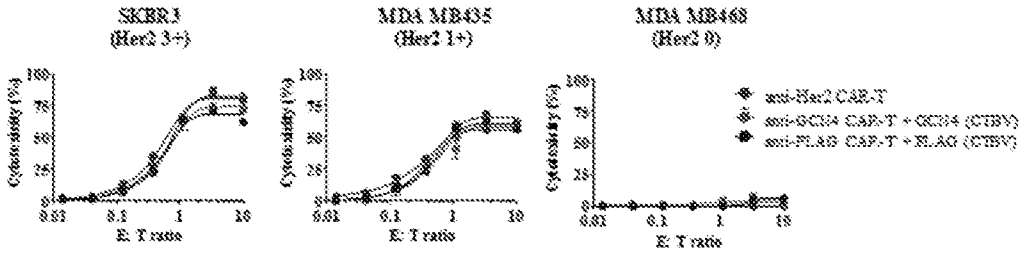

SKBR3
(Her2 3+)
MDA MB435
(Her2 1+)
MDA MB468
(Her2 0)
Cytotoxicity (%)
E: T ratio
anti-Her2 CAR-T
anti-GCN4 CAR-T + GCN4 (CTBV)
anti-FLAG CAR-T + FLAG (CTBV)

FIG. 54

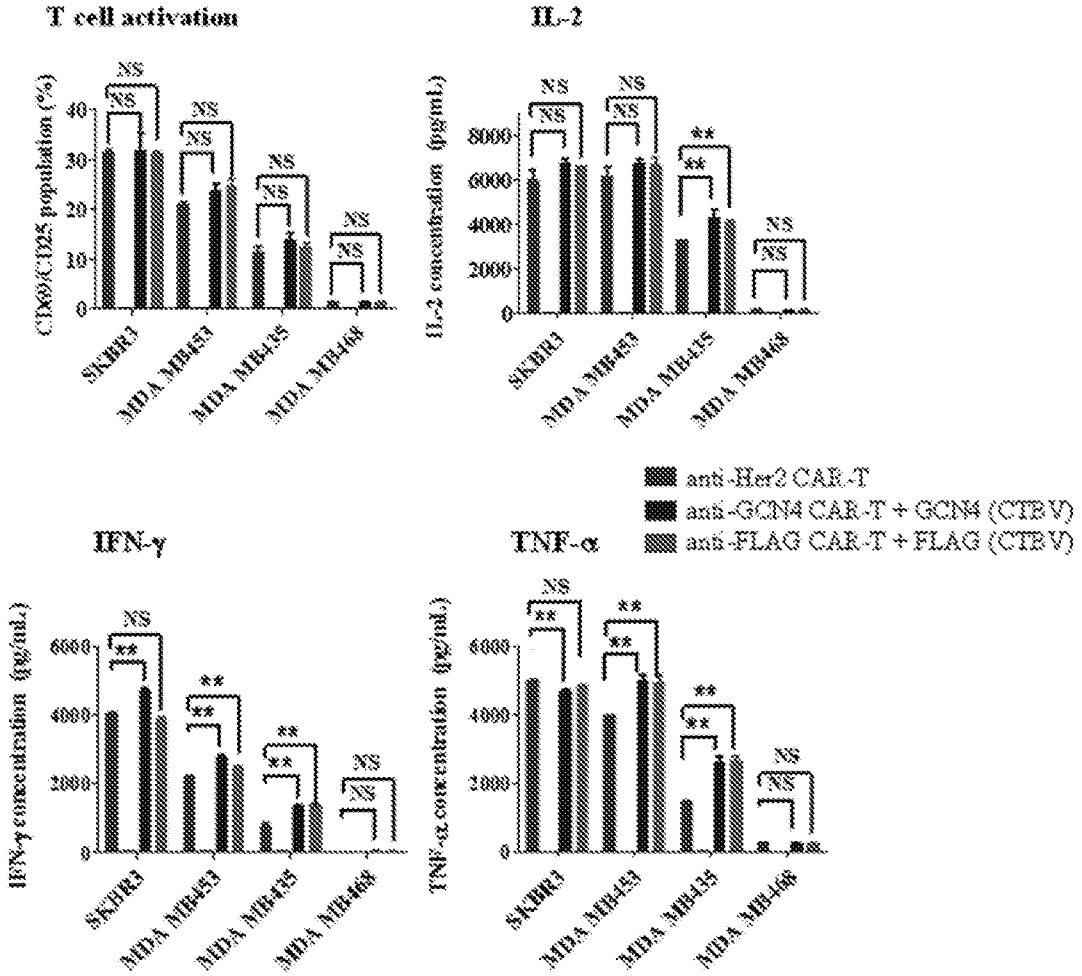

T cell activation
IL-2
IFN-γ
TNF-α
CD69/CD25 population (%)
IL-2 concentration (pg/mL)
IFN-γ concentration (pg/mL)
TNF-α concentration (pg/mL)
SKBR3
MDA MB453
MDA MB435
MDA MB468
NS
**
anti-Her2 CAR-T
anti-GCN4 CAR-T + GCN4 (CTBV)
anti-FLAG CAR-T + FLAG (CTBV)

FIG. 55A

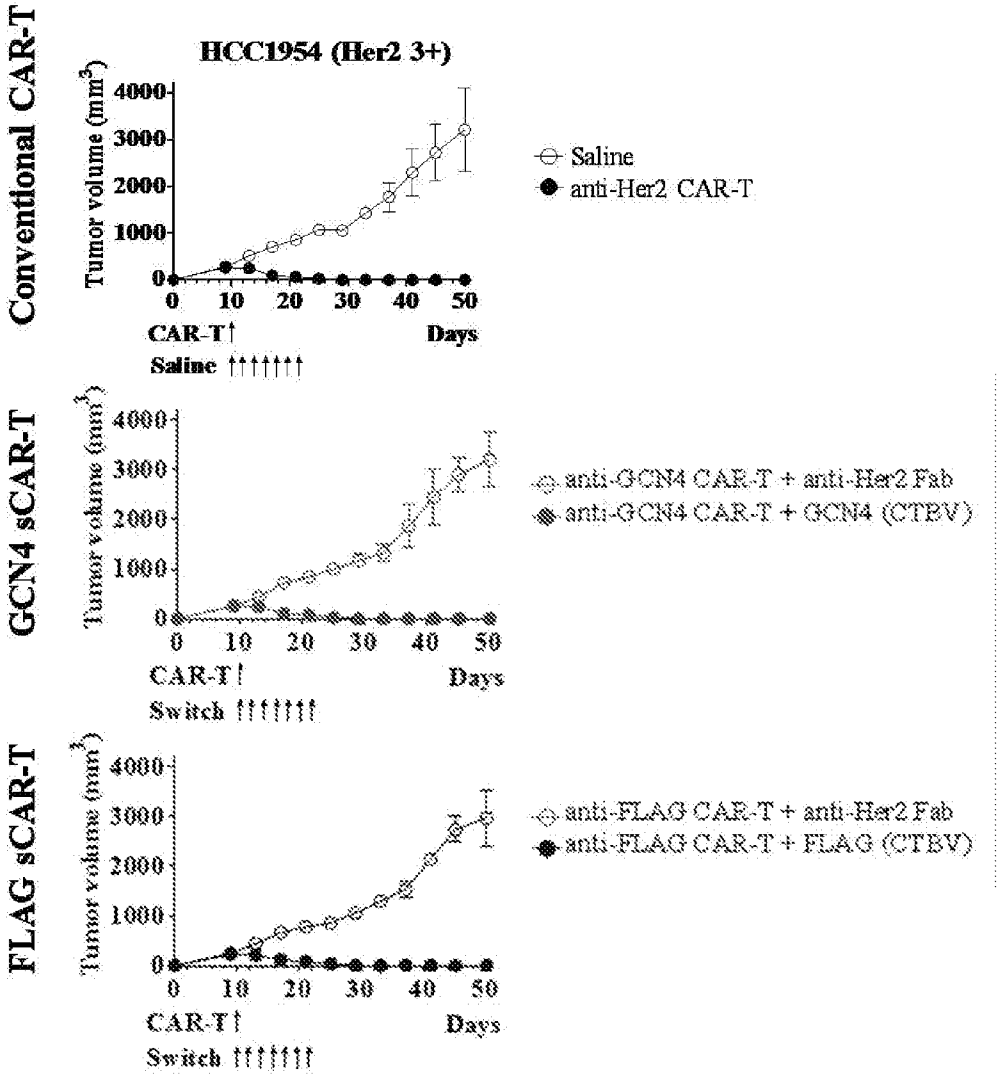

Conventional CAR-T
HCC1954 (Her2 3+)
Tumor volume (mm3)
4000
3000
2000
1000
0
0 10 20 30 40 50
CAR-T
Days
Saline
Saline
anti-Her2 CAR-T
GCN4 sCAR-T
Tumor volume (mm3)
4000
3000
2000
1000
0
0 10 20 30 40 50
CAR-T
Days
Switch
anti-GCN4 CAR-T + anti-Her2 Fab
anti-GCN4 CAR-T + GCN4 (CTBV)
FLAG sCAR-T
Tumor volume (mm3)
4000
3000
2000
1000
0
0 10 20 30 40 50
CAR-T
Days
Switch
anti-FLAG CAR-T + anti-Her2 Fab
anti-FLAG CAR-T + FLAG (CTBV)

FIG. 55B

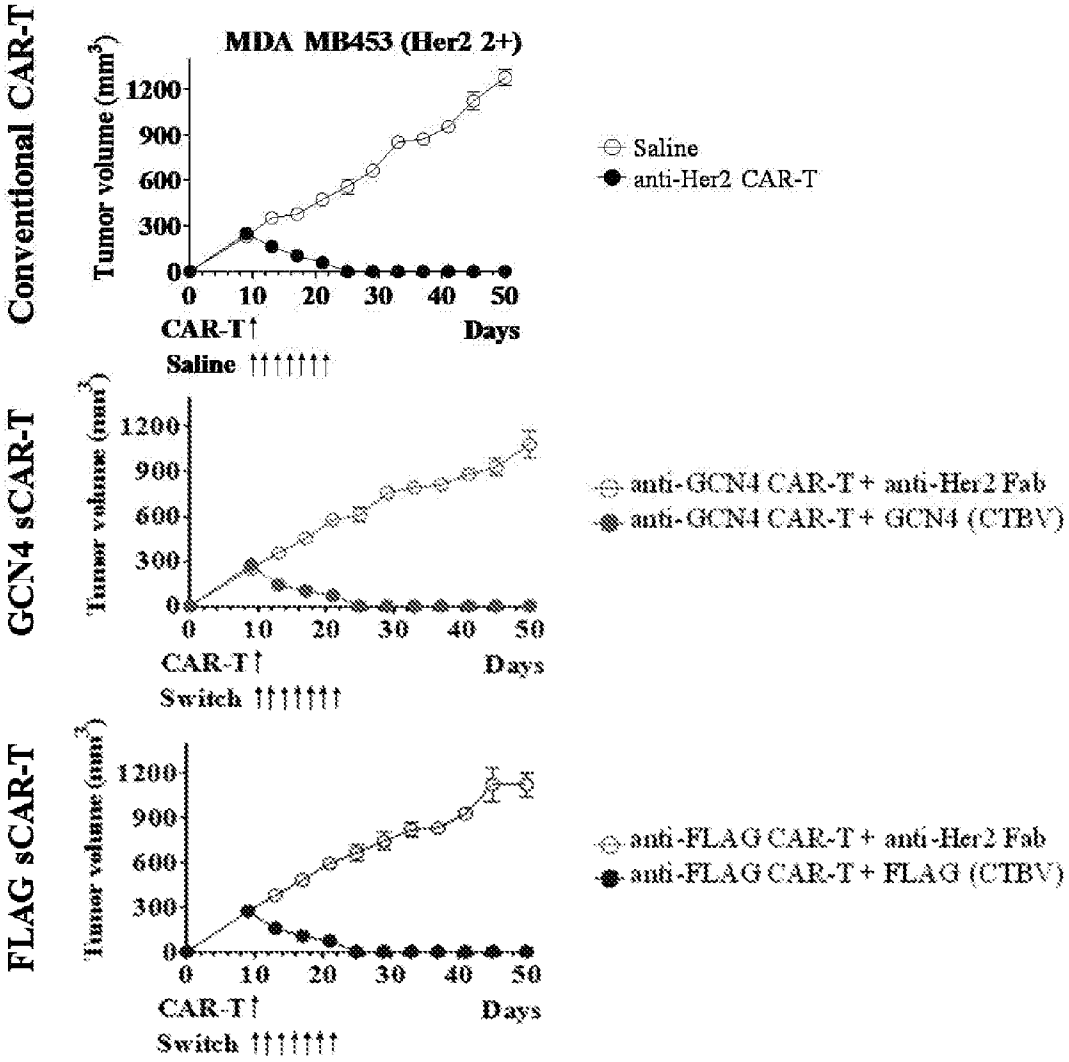

Conventional CAR-T
MDA MB453 (Her2 2+)
Tumor volume (mm3)
1200
900
600
300
0
0 10 20 30 40 50
CAR-T↑
Days
Saline ↑↑↑↑↑↑
Saline
anti-Her2 CAR-T
GCN4 sCAR-T
Tumor volume (mm3)
1200
900
600
300
0
0 10 20 30 40 50
CAR-T↑
Days
Switch ↑↑↑↑↑↑
anti-GCN4 CAR-T + anti-Her2 Fab
anti-GCN4 CAR-T + GCN4 (CTBV)
FLAG sCAR-T
Tumor volume (mm3)
1200
900
600
300
0
0 10 20 30 40 50
CAR-T↑
Days
Switch ↑↑↑↑↑↑
anti-FLAG CAR-T + anti-Her2 Fab
anti-FLAG CAR-T + FLAG (CTBV)

FIG. 55C

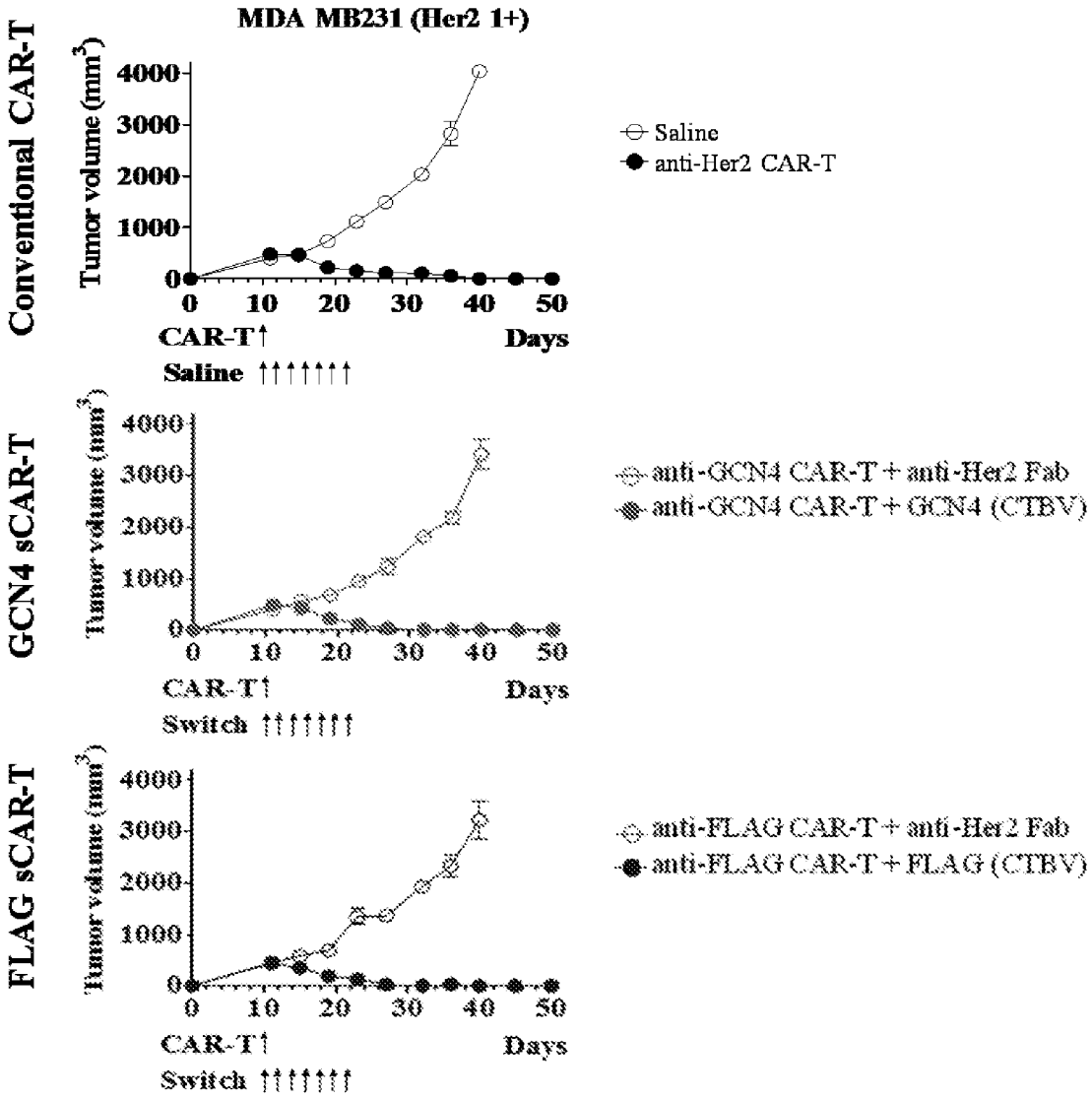
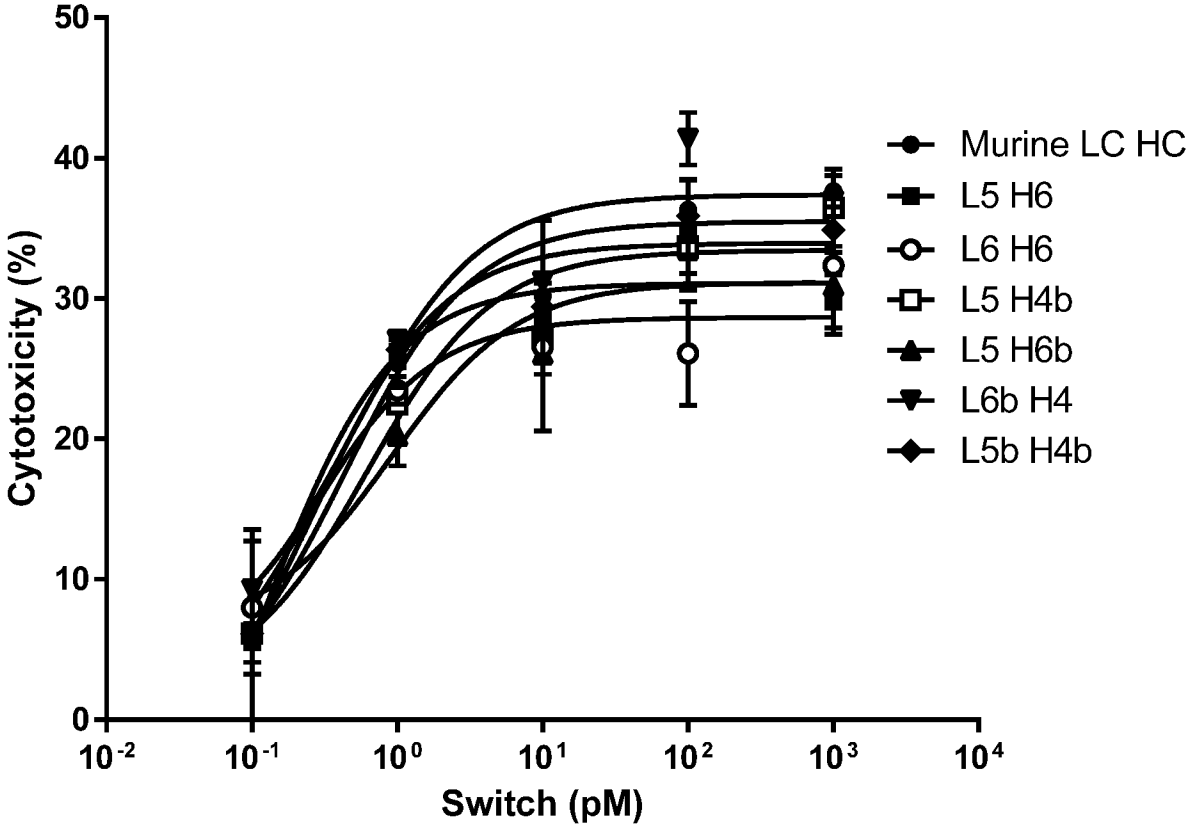

MDA MB231 (Her2 1+)
Conventional CAR-T
Tumor volume (mm3)
4000
3000
2000
1000
0
0 10 20 30 40 50
CAR-T↑
Days
Saline ↑↑↑↑↑↑↑
Saline
anti-Her2 CAR-T
GCN4 sCAR-T
Tumor volume (mm3)
4000
3000
2000
1000
0
0 10 20 30 40 50
CAR-T↑
Days
Switch ↑↑↑↑↑↑↑
anti-GCN4 CAR-T + anti-Her2 Fab
anti-GCN4 CAR-T + GCN4 (CTBV)
FLAG sCAR-T
Tumor volume (mm3)
4000
3000
2000
1000
0
0 10 20 30 40 50
CAR-T↑
Days
Switch ↑↑↑↑↑↑↑
anti-FLAG CAR-T + anti-Her2 Fab
anti-FLAG CAR-T + FLAG (CTBV)

FIG. 56


Cytotoxicity (%)
50
40
30
20
10
0
10-2
10-1
100
101
102
103
104
Switch (pM)
Murine LC HC
L5 H6
L6 H6
L5 H4b
L5 H6b
L6b H4
L5b H4b