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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 September 2020 (24.09.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/190725 A1

(51) International Patent Classification:
A61K 47/68 (2017.01) *A61P 35/00* (2006.01)

(21) International Application Number:
PCT/US2020/022645

(22) International Filing Date:
13 March 2020 (13.03.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/819,356 15 March 2019 (15.03.2019) US

(71) Applicants: **BOLT BIOTHERAPEUTICS, INC.** [US/US]; 900 Chesapeake Drive, Redwood City, California 94063 (US). **THE BOARD OF TRUSTEES OF THE LELAND STANFORD JUNIOR UNIVERSITY** [US/US]; Office of the General Counsel, P.O. Box 20386, Building 170, 3rd Floor, Main Quad, Stanford, California 94305-2038 (US).

(72) Inventors: **ACKERMAN, Shelley Erin**; c/o Bolt Biotherapeutics, Inc., 640 Galveston Drive, Redwood City, California 94063 (US). **ALONSO, Michael N.**; c/o Bolt Biotherapeutics, Inc., 640 Galveston Drive, Redwood City, California 94063 (US). **JACKSON, David Y.**; c/o Bolt Biotherapeutics, Inc., 640 Galveston Drive, Redwood City, California 94063 (US). **LEE, Arthur**; c/o Bolt Biotherapeutics, Inc., 640 Galveston Drive, Redwood City, California 94063 (US). **ENGLEMAN, Edgar George**; 60 Lane Place, Atherton, California 94027 (US).

(74) Agent: **KILYK, JR., John**; Leydig, Voit & Mayer, Ltd., Two Prudential Plaza — Suite 4900, 180 North Stetson Avenue, Chicago, Illinois 60601-6731 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,

(54) Title: IMMUNOCONJUGATES TARGETING HER2

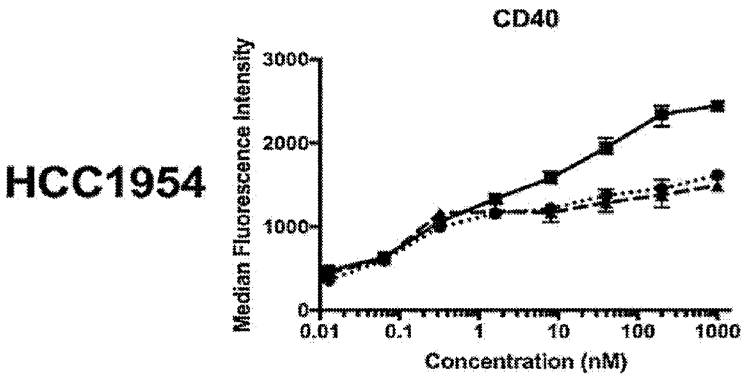
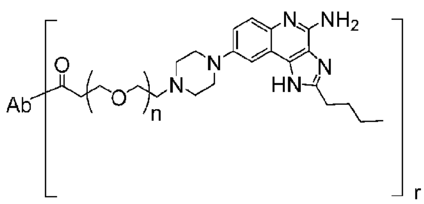


FIG. 1A



(57) Abstract: The invention provides an immunoconjugate of formula: formula or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10, subscript n is an integer from about 2 to about 25, and "Ab" is an antibody construct that has an antigen binding domain that binds HER2. The invention further provides compositions comprising and methods of treating cancer with the immunoconjugate.

WO 2020/190725 A1

[Continued on next page]

SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

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

Published:

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

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

IMMUNOCONJUGATES TARGETING HER2

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims the benefit of U.S. Provisional Patent Application No. 62/819,356, filed March 15, 2019, which is incorporated by reference in its entirety herein.

INCORPORATION-BY-REFERENCE OF MATERIAL SUBMITTED ELECTRONICALLY

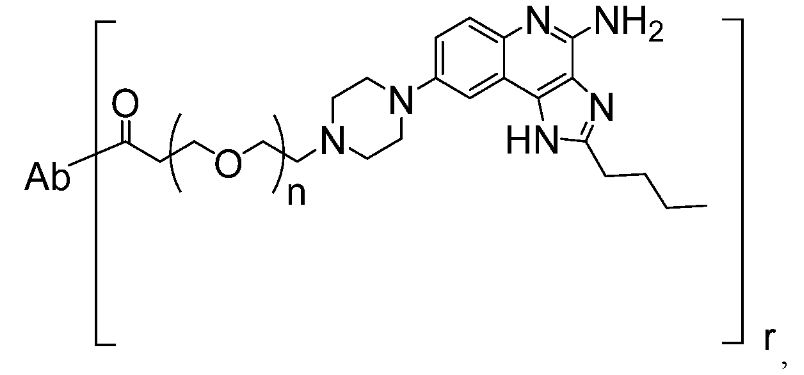
[0002] Incorporated by reference in its entirety herein is a computer-readable nucleotide/amino acid sequence listing submitted concurrently herewith and identified as follows: one 28,602 Byte ASCII (Text) file named "747235_ST25.txt," created March 10, 2020.

BACKGROUND OF THE INVENTION

[0003] It is now well appreciated that tumor growth necessitates the acquisition of mutations that facilitate immune evasion. Even so, tumorigenesis results in the accumulation of mutated antigens, or neoantigens, that are readily recognized by the host immune system following *ex vivo* stimulation. Why and how the immune system fails to recognize neoantigens are beginning to be elucidated. Groundbreaking studies by Carmi et al. (*Nature*, 521: 99-104 (2015)) have indicated that immune ignorance can be overcome by delivering neoantigens to activated dendritic cells via antibody-tumor immune complexes. In these studies, simultaneous delivery of tumor binding antibodies and dendritic cell adjuvants via intratumoral injections resulted in robust anti-tumor immunity. New compositions and methods for the delivery of antibodies and dendritic cell adjuvants are needed in order to reach inaccessible tumors and/or to expand treatment options for cancer patients and other subjects. The invention provides such compositions and methods.

BRIEF SUMMARY OF THE INVENTION

[0004] The invention provides an immunoconjugate of formula:



or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10, subscript n is an integer from about 2 to about 25, and “Ab” is an antibody construct that has an antigen binding domain that binds the protein human epidermal growth factor receptor 2 (“HER2”).

[0005] The invention provides a composition comprising a plurality of immunoconjugates described herein.

[0006] The invention provides a method for treating cancer in a subject comprising administering a therapeutically effective amount of an immunoconjugate or a composition described herein to a subject in need thereof.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0007] Fig. 1A shows the effect of Immunoconjugate A on myeloid activation in myeloid APC-tumor co-cultures, using the HCC1954 human ductal carcinoma tumor cell line. Median fluorescence intensity of co-stimulatory molecule CD40 (cells gated on viable CD45+CD11c+HLA-DR+) was measured by flow cytometry and is shown for trastuzumab (dotted line, circle), trastuzumab + Compound 7 (dashed line, triangle) or Immunoconjugate A (solid line, square).

[0008] Fig. 1B shows the effect of Immunoconjugate A on myeloid activation in myeloid APC-tumor co-cultures, using the HCC1954 human ductal carcinoma tumor cell line. Median fluorescence intensity of co-stimulatory molecule CD86 (cells gated on viable CD45+CD11c+HLA-DR+) was measured by flow cytometry and is shown for trastuzumab (dotted line, circle), trastuzumab + Compound 7 (dashed line, triangle) or Immunoconjugate A (solid line, square).

[0009] Fig. 1C shows the effect of Immunoconjugate A on myeloid activation in myeloid APC-tumor co-cultures, using the HCC1954 human ductal carcinoma tumor cell. TNFα secretion was measured by cytokine bead array (cells gated on viable CD45+CD11c+HLA-DR+) for trastuzumab (dotted line, circle), trastuzumab + Compound 7 (dashed line, triangle) or Immunoconjugate A (solid line, square).

[0010] Fig. 1D shows the effect of Immunoconjugate A on myeloid activation in myeloid APC-tumor co-cultures, using the JIMT-1 human ductal carcinoma tumor cell line. Median fluorescence intensity of co-stimulatory molecule CD40 (cells gated on viable CD45+CD11c+HLA-DR+) was measured by flow cytometry and is shown for trastuzumab (dotted line, circle), trastuzumab + Compound 7 (dashed line, triangle) or Immunoconjugate A (solid line, square).

[0011] Fig. 1E shows the effect of Immunoconjugate A on myeloid activation in myeloid APC-tumor co-cultures, using the JIMT-1 human ductal carcinoma tumor cell line. Median fluorescence intensity of co-stimulatory molecule CD86 (cells gated on viable CD45+CD11c+HLA-DR+) was measured by flow cytometry and is shown for trastuzumab (dotted line, circle), trastuzumab + Compound 7 (dashed line, triangle) or Immunoconjugate A (solid line, square).

[0012] Fig. 1F shows the effect of Immunoconjugate A on myeloid activation in myeloid APC-tumor co-cultures, using the JIMT-1 human ductal carcinoma tumor cell. TNFα secretion was measured by cytokine bead array (cells gated on viable CD45+CD11c+HLA-DR+) for trastuzumab (dotted line, circle), trastuzumab + Compound 7 (dashed line, triangle) or Immunoconjugate A (solid line, square).

[0013] Fig. 1G shows the effect of Immunoconjugate A on myeloid activation in myeloid APC-tumor co-cultures, using the COLO 205 human colon adenocarcinoma cell line. Median fluorescence intensity of co-stimulatory molecule CD40 (cells gated on viable CD45+CD11c+HLA-DR+) was measured by flow cytometry and is shown for trastuzumab (dotted line, circle), trastuzumab + Compound 7 (dashed line, triangle) or Immunoconjugate A (solid line, square).

[0014] Fig. 1H shows the effect of Immunoconjugate A on myeloid activation in myeloid APC-tumor co-cultures, using the COLO 205 human colon adenocarcinoma cell line. Median fluorescence intensity of co-stimulatory molecule CD86 (cells gated on viable CD45+CD11c+HLA-DR+) was measured by flow cytometry and is shown for trastuzumab (dotted line, circle), trastuzumab + Compound 7 (dashed line, triangle) or Immunoconjugate A (solid line, square).

[0015] Fig. 1I shows the effect of Immunoconjugate A on myeloid activation in myeloid APC-tumor co-cultures, using the COLO 205 human colon adenocarcinoma cell line. TNFα secretion was measured by cytokine bead array (cells gated on viable CD45+CD11c+HLA-DR+) for trastuzumab (dotted line, circle), trastuzumab + Compound 7 (dashed line, triangle) or Immunoconjugate A (solid line, square).

[0016] Fig. 2A shows that Immunoconjugate B elicits myeloid differentiation as indicated by CD14 downregulation.

[0017] Fig. 2B shows that Immunoconjugate B elicits myeloid activation as indicated by CD40 upregulation.

[0018] Fig. 2C shows that Immunoconjugate B elicits myeloid activation as indicated by CD86 upregulation.

[0019] Fig. 2D shows TNFα secretion from myeloid cells following an 18 hour incubation with Immunoconjugate B.

[0020] Fig. 3A shows that Immunoconjugate C elicits myeloid differentiation as indicated by CD14 downregulation.

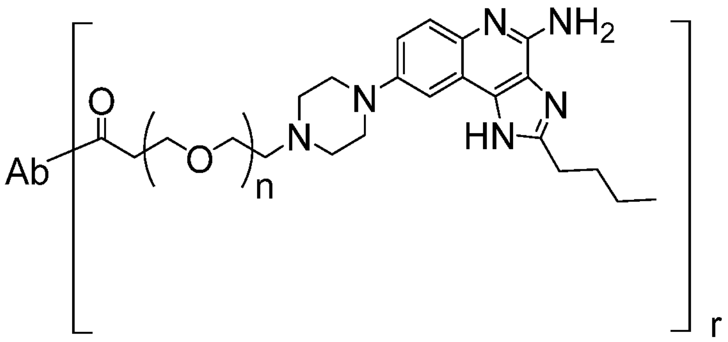
[0021] Fig. 3B shows that Immunoconjugate C elicits myeloid activation as indicated by CD40 upregulation.

[0022] Fig. 3C shows that Immunoconjugate C elicits myeloid activation as indicated by CD86 upregulation.

[0023] Fig. 3D shows TNFα secretion from myeloid cells following an 18 hour incubation with Immunoconjugate C.

DETAILED DESCRIPTION OF THE INVENTION

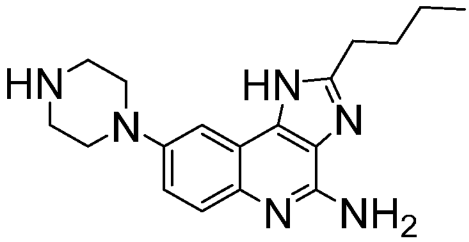
[0024] The invention provides an immunoconjugate of formula:



,

or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10, subscript n is an integer from about 2 to about 25, and "Ab" is an antibody construct that has an antigen binding domain that binds human epidermal growth factor receptor 2 ("HER2").

[0025] Antibody-adjuvant immunoconjugates of the invention, comprising an antibody construct that has an antigen binding domain that binds HER2 linked to one or more adjuvant of formula:



demonstrate superior pharmacological properties over conventional antibody conjugates. The polyethylene glycol-based linker ("PEG linker") is the preferred linker to provide adequate purification and isolation of the immunoconjugate, maintain function of the one or more adjuvant moieties and antibody construct, and produce ideal pharmacokinetic ("PK") properties of the immunoconjugate. Additional embodiments and benefits of the inventive antibody-adjuvant immunoconjugates will be apparent from description herein.

Definitions

[0026] As used herein, the term "immunoconjugate" refers to an antibody construct that is covalently bonded to an adjuvant moiety via a linker.

[0027] As used herein, the phrase "antibody construct" refers to an antibody or a fusion protein comprising (i) an antigen binding domain and (ii) an Fc domain.

[0028] As used herein, the term "antibody" refers to a polypeptide comprising an antigen binding region (including the complementarity determining region (CDRs)) from an immunoglobulin gene or fragments thereof that specifically binds and recognizes HER2.

[0029] An exemplary immunoglobulin (antibody) structural unit comprises a tetramer. Each tetramer is composed of two identical pairs of polypeptide chains, each pair having one "light" (about 25 kDa) and one "heavy" chain (about 50-70 kDa) connected by disulfide bonds. Each chain is composed of structural domains, which are referred to as immunoglobulin domains. These domains are classified into different categories by size and function, e.g., variable domains or regions on the light and heavy chains (V_L and V_H, respectively) and constant domains or regions on the light and heavy chains (C_L and C_H, respectively). The N-terminus of each chain defines a variable region of about 100 to 110 or more amino acids, referred to as the paratope, primarily responsible for antigen recognition, i.e., the antigen binding domain. Light chains are classified as either kappa or lambda. Heavy chains are classified as gamma, mu, alpha, delta, or epsilon, which in turn define the immunoglobulin classes, IgG, IgM, IgA, IgD and IgE, respectively. IgG antibodies are large molecules of about 150 kDa composed of four peptide chains. IgG antibodies contain two identical class γ heavy chains of about 50 kDa and two identical light chains of about 25 kDa, thus a tetrameric quaternary structure. The two heavy chains are linked to each other and to a light chain each by disulfide bonds. The resulting tetramer has two identical halves, which together form the Y-like shape. Each end of the fork contains an identical antigen binding domain. There are four IgG subclasses (IgG1, IgG2, IgG3, and IgG4) in humans, named in order of their abundance in serum (i.e., IgG1 is the most abundant). Typically, the antigen binding domain of an antibody will be most critical in specificity and affinity of binding to cancer cells.

[0030] Antibodies can exist as intact immunoglobulins or as a number of well-characterized fragments produced by digestion with various peptidases. Thus, for example, pepsin digests an antibody below the disulfide linkages in the hinge region to produce $F(ab)'_2$, a dimer of Fab which itself is a light chain joined to V_H-C_H1 by a disulfide bond. The $F(ab)'_2$ may be reduced under mild conditions to break the disulfide linkage in the hinge region, thereby converting the $F(ab)'_2$ dimer into a Fab′ monomer. The Fab′ monomer is essentially Fab with part of the hinge region (*see, e.g., Fundamental Immunology* (Paul, editor, 7th edition, 2012)). While various antibody fragments are defined in terms of the digestion of an intact antibody, such fragments may be synthesized *de novo* either chemically or by using recombinant DNA methodology. Thus, the term antibody, as used herein, also includes antibody fragments either produced by the modification of whole antibodies, or those synthesized *de novo* using recombinant DNA methodologies (e.g., single chain Fv), or those identified using phage display libraries (see, e.g., McCafferty et al., *Nature*, 348: 552-554 (1990)).

[0031] The term "antibody" specifically encompasses monoclonal antibodies (including full length monoclonal antibodies), polyclonal antibodies, multispecific antibodies (e.g., bispecific antibodies), and antibody fragments that exhibit the desired biological activity.

[0032] As used herein, the term "epitope" means any antigenic determinant or epitopic determinant of an antigen to which an antigen binding domain binds (i.e., at the paratope of the antigen binding domain). Antigenic determinants usually consist of chemically active surface groupings of molecules, such as amino acids or sugar side chains, and usually have specific three dimensional structural characteristics, as well as specific charge characteristics.

[0033] As used herein, "HER2" refers to the protein human epidermal growth factor receptor 2 (SEQ ID NO: 1), or an antigen with least about 70%, about 75%, about 80%, about 85%, about 90%, about 91%, about 92%, about 93%, about 94%, about 95%, about 96%, about 97%, about 98%, about 99%, or more sequence identity to SEQ ID NO: 1.

[0034] Percent (%) identity of sequences can be calculated, for example, as 100 x [(identical positions)/min(TG_A, TG_B)], where TG_A and TG_B are the sum of the number of residues and internal gap positions in peptide sequences A and B in the alignment that minimizes TG_A and TG_B. See, e.g., Russell et al., *J. Mol Biol.*, 244: 332–350 (1994).

[0035] As used herein, the term "adjuvant" refers to a substance capable of eliciting an immune response in a subject exposed to the adjuvant. The phrase "adjuvant moiety" refers to an adjuvant that is covalently bonded to an antibody construct, e.g., through a linker, as described herein. The adjuvant moiety can elicit the immune response while bonded to the antibody construct or after cleavage (e.g., enzymatic cleavage) from the antibody construct following administration of an immunoconjugate to the subject.

[0036] As used herein, the terms "Toll-like receptor" and "TLR" refer to any member of a family of highly-conserved mammalian proteins which recognizes pathogen-associated molecular patterns and acts as key signaling elements in innate immunity. TLR polypeptides share a characteristic structure that includes an extracellular domain that has leucine-rich repeats, a transmembrane domain, and an intracellular domain that is involved in TLR signaling.

[0037] The terms "Toll-like receptor 7" and "TLR7" refer to nucleic acids or polypeptides sharing at least about 70%, about 80%, about 90%, about 95%, about 96%, about 97%, about 98%, about 99%, or more sequence identity to a publicly-available TLR7 sequence, e.g., GenBank accession number AAZ99026 for human TLR7 polypeptide, or GenBank accession number AAK62676 for murine TLR7 polypeptide.

[0038] The terms "Toll-like receptor 8" and "TLR8" refer to nucleic acids or polypeptides sharing at least about 70%, about 80%, about 90%, about 95%, about 96%, about 97%, about 98%, about 99%, or more sequence identity to a publicly-available TLR7 sequence, e.g., GenBank accession number AAZ95441 for human TLR8 polypeptide, or GenBank accession number AAK62677 for murine TLR8 polypeptide.

[0039] A "TLR agonist" is a substance that binds, directly or indirectly, to a TLR (e.g., TLR7 and/or TLR8) to induce TLR signaling. Any detectable difference in TLR signaling can indicate that an agonist stimulates or activates a TLR. Signaling differences can be manifested, for example, as changes in the expression of target genes, in the phosphorylation of signal transduction components, in the intracellular localization of downstream elements such as nuclear factor-κB (NF-κB), in the association of certain components (such as IL-1 receptor associated kinase (IRAK)) with other proteins or intracellular structures, or in the biochemical activity of components such as kinases (such as mitogen-activated protein kinase (MAPK)).

[0040] As used herein, "Ab" refers to an antibody construct that has an antigen-binding domain that binds HER2 (e.g., trastuzumab (also known as HERCEPTIN™), a biosimilar thereof, or a biobetter thereof.

[0041] As used herein, the term "biosimilar" refers to an approved antibody construct that has active properties similar to the antibody construct previously approved (e.g., trastuzumab).

[0042] As used herein, the term "biobetter" refers to an approved antibody construct that is an improvement of a previously approved antibody construct (e.g., trastuzumab). The biobetter can have one or more modifications (e.g., an altered glycan profile, or a unique epitope) over the previously approved antibody construct.

[0043] As used herein, the term "amino acid" refers to any monomeric unit that can be incorporated into a peptide, polypeptide, or protein. Amino acids include naturally-occurring α-amino acids and their stereoisomers, as well as unnatural (non-naturally occurring) amino acids and their stereoisomers. "Stereoisomers" of a given amino acid refer to isomers having the same molecular formula and intramolecular bonds but different three-dimensional arrangements of bonds and atoms (e.g., an L-amino acid and the corresponding D-amino acid). The amino acids can be glycosylated (e.g., *N*-linked glycans, *O*-linked glycans, phosphoglycans, *C*-linked glycans, or glypiation) or deglycosylated.

[0044] Naturally-occurring amino acids are those encoded by the genetic code, as well as those amino acids that are later modified, e.g., hydroxyproline, γ-carboxyglutamate, and *O*-phosphoserine. Naturally-occurring α-amino acids include, without limitation, alanine (Ala), cysteine (Cys), aspartic acid (Asp), glutamic acid (Glu), phenylalanine (Phe), glycine (Gly), histidine (His), isoleucine (Ile), arginine (Arg), lysine (Lys), leucine (Leu), methionine (Met), asparagine (Asn), proline (Pro), glutamine (Gln), serine (Ser), threonine (Thr), valine

(Val), tryptophan (Trp), tyrosine (Tyr), and combinations thereof. Stereoisomers of naturally-occurring α-amino acids include, without limitation, D-alanine (D-Ala), D-cysteine (D-Cys), D-aspartic acid (D-Asp), D-glutamic acid (D-Glu), D-phenylalanine (D-Phe), D-histidine (D-His), D-isoleucine (D-Ile), D-arginine (D-Arg), D-lysine (D-Lys), D-leucine (D-Leu), D-methionine (D-Met), D-asparagine (D-Asn), D-proline (D-Pro), D-glutamine (D-Gln), D-serine (D-Ser), D-threonine (D-Thr), D-valine (D-Val), D-tryptophan (D-Trp), D-tyrosine (D-Tyr), and combinations thereof.

[0045] Unnatural (non-naturally occurring) amino acids include, without limitation, amino acid analogs, amino acid mimetics, synthetic amino acids, *N*-substituted glycines, and *N*-methyl amino acids in either the L- or D-configuration that function in a manner similar to the naturally-occurring amino acids. For example, "amino acid analogs" can be unnatural amino acids that have the same basic chemical structure as naturally-occurring amino acids (i.e., a carbon that is bonded to a hydrogen, a carboxyl group, an amino group) but have modified side-chain groups or modified peptide backbones, e.g., homoserine, norleucine, methionine sulfoxide, and methionine methyl sulfonium. "Amino acid mimetics" refer to chemical compounds that have a structure that is different from the general chemical structure of an amino acid, but that functions in a manner similar to a naturally-occurring amino acid.

[0046] Amino acids may be referred to herein by either the commonly known three letter symbols or by the one-letter symbols recommended by the IUPAC-IUB Biochemical Nomenclature Commission.

[0047] As used herein, the term "linker" refers to a functional group that covalently bonds two or more moieties in a compound or material. For example, the linking moiety can serve to covalently bond an adjuvant moiety to an antibody construct in an immunoconjugate.

[0048] As used herein, the terms "treat," "treatment," and "treating" refer to any indicia of success in the treatment or amelioration of an injury, pathology, condition (e.g., cancer), or symptom (e.g., cognitive impairment), including any objective or subjective parameter such as abatement; remission; diminishing of symptoms or making the symptom, injury, pathology, or condition more tolerable to the patient; reduction in the rate of symptom progression; decreasing the frequency or duration of the symptom or condition; or, in some situations, preventing the onset of the symptom. The treatment or amelioration of symptoms can be based on any objective or subjective parameter, including, for example, the result of a physical examination.

[0049] The terms "cancer," "neoplasm," and "tumor" are used herein to refer to cells which exhibit autonomous, unregulated growth, such that the cells exhibit an aberrant growth phenotype characterized by a significant loss of control over cell proliferation. Cells of interest for detection, analysis, and/or treatment in the context of the invention include cancer cells (e.g., cancer cells from an individual with cancer), malignant cancer cells, pre-metastatic cancer cells, metastatic cancer cells, and non-metastatic cancer cells. Cancers of virtually every tissue are known. The phrase "cancer burden" refers to the quantum of cancer cells or cancer volume in a subject. Reducing cancer burden accordingly refers to reducing the number of cancer cells or the cancer cell volume in a subject. The term "cancer cell" as used herein refers to any cell that is a cancer cell (e.g., from any of the cancers for which an individual can be treated, e.g., isolated from an individual having cancer) or is derived from a cancer cell, e.g., clone of a cancer cell. For example, a cancer cell can be from an established cancer cell line, can be a primary cell isolated from an individual with cancer, can be a progeny cell from a primary cell isolated from an individual with cancer, and the like. In some embodiments, the term can also refer to a portion of a cancer cell, such as a sub-cellular portion, a cell membrane portion, or a cell lysate of a cancer cell. Many types of cancers are known to those of skill in the art, including solid tumors such as carcinomas, sarcomas, glioblastomas, melanomas, lymphomas, and myelomas, and circulating cancers such as leukemias.

[0050] As used herein, the term "cancer" includes any form of cancer, including but not limited to, solid tumor cancers (e.g., lung, prostate, breast, gastric, bladder, colon, ovarian, pancreas, kidney, liver, glioblastoma, medulloblastoma, leiomyosarcoma, head & neck squamous cell carcinomas, melanomas, and neuroendocrine) and liquid cancers (e.g., hematological cancers); carcinomas; soft tissue tumors; sarcomas; teratomas; melanomas; leukemias; lymphomas; and brain cancers, including minimal residual disease, and including both primary and metastatic tumors. Any HER2 expressing cancer is a suitable cancer to be treated by the subject methods and compositions. As used herein "HER2 expression" refers to a cell that has a HER2 receptor on the cell's surface. For example, a cell may have from about 20,000 to about 50,000 HER2 receptors on the cell's surface. As used herein "HER2 overexpression" refers to a cell that has more than about 50,000 HER2 receptors. For example, a cell 2, 5, 10, 100, 1,000, 10,000, 100,000, or 1,000,000 times the number of HER2 receptors as compared to corresponding non-cancer cell (e.g., about 1 or 2 million HER2 receptors). It is estimated that HER2 is overexpressed in about 25% to about 30% of breast cancers.

[0051] Carcinomas are malignancies that originate in the epithelial tissues. Epithelial cells cover the external surface of the body, line the internal cavities, and form the lining of glandular tissues. Examples of carcinomas include, but are not limited to, adenocarcinoma (cancer that begins in glandular (secretory) cells such as cancers of the breast, pancreas, lung, prostate, stomach, gastroesophageal junction, and colon) adrenocortical carcinoma; hepatocellular carcinoma; renal cell carcinoma; ovarian carcinoma; carcinoma in situ; ductal carcinoma; carcinoma of the breast; basal cell carcinoma; squamous cell carcinoma; transitional cell carcinoma; colon carcinoma; nasopharyngeal carcinoma; multilocular cystic renal cell carcinoma; oat cell carcinoma; large cell lung carcinoma; small cell lung carcinoma; non-small cell lung carcinoma; and the like. Carcinomas may be found in prostrate, pancreas, colon, brain (usually as secondary metastases), lung, breast, and skin.

[0052] Soft tissue tumors are a highly diverse group of rare tumors that are derived from connective tissue. Examples of soft tissue tumors include, but are not limited to, alveolar soft part sarcoma; angiomatoid fibrous histiocytoma; chondromyoxid fibroma; skeletal chondrosarcoma; extraskeletal myxoid chondrosarcoma; clear cell sarcoma; desmoplastic small round-cell tumor; dermatofibrosarcoma protuberans; endometrial stromal tumor; Ewing’s sarcoma; fibromatosis (Desmoid); fibrosarcoma, infantile; gastrointestinal stromal tumor; bone giant cell tumor; tenosynovial giant cell tumor; inflammatory myofibroblastic tumor; uterine leiomyoma; leiomyosarcoma; lipoblastoma; typical lipoma; spindle cell or pleomorphic lipoma; atypical lipoma; chondroid lipoma; well-differentiated liposarcoma; myxoid/round cell liposarcoma; pleomorphic liposarcoma; myxoid malignant fibrous histiocytoma; high-grade malignant fibrous histiocytoma; myxofibrosarcoma; malignant peripheral nerve sheath tumor; mesothelioma; neuroblastoma; osteochondroma; osteosarcoma; primitive neuroectodermal tumor; alveolar rhabdomyosarcoma; embryonal rhabdomyosarcoma; benign or malignant schwannoma; synovial sarcoma; Evan’s tumor; nodular fasciitis; desmoid-type fibromatosis; solitary fibrous tumor; dermatofibrosarcoma protuberans (DFSP); angiosarcoma; epithelioid hemangioendothelioma; tenosynovial giant cell tumor (TGCT); pigmented villonodular synovitis (PVNS); fibrous dysplasia; myxofibrosarcoma; fibrosarcoma; synovial sarcoma; malignant peripheral nerve sheath tumor; neurofibroma; pleomorphic adenoma of soft tissue; and neoplasias derived from fibroblasts, myofibroblasts, histiocytes, vascular cells/endothelial cells, and nerve sheath cells.

[0053] A sarcoma is a rare type of cancer that arises in cells of mesenchymal origin, e.g., in bone or in the soft tissues of the body, including cartilage, fat, muscle, blood vessels, fibrous tissue, or other connective or supportive tissue. Different types of sarcoma are based on where the cancer forms. For example, osteosarcoma forms in bone, liposarcoma forms in fat, and rhabdomyosarcoma forms in muscle. Examples of sarcomas include, but are not limited to, askin's tumor; sarcoma botryoides; chondrosarcoma; ewing's sarcoma; malignant hemangioendothelioma; malignant schwannoma; osteosarcoma; and soft tissue sarcomas (e.g., alveolar soft part sarcoma; angiosarcoma; cystosarcoma phyllodesdermatofibrosarcoma protuberans (DFSP); desmoid tumor; desmoplastic small round cell tumor; epithelioid sarcoma; extraskeletal chondrosarcoma; extraskeletal osteosarcoma; fibrosarcoma; gastrointestinal stromal tumor (GIST); hemangiopericytoma; hemangiosarcoma (more commonly referred to as “angiosarcoma”); kaposi’s sarcoma; leiomyosarcoma; liposarcoma; lymphangiosarcoma; malignant peripheral nerve sheath tumor (MPNST); neurofibrosarcoma; synovial sarcoma; and undifferentiated pleomorphic sarcoma).

[0054] A teratoma is a type of germ cell tumor that may contain several different types of tissue (e.g., can include tissues derived from any and/or all of the three germ layers: endoderm, mesoderm, and ectoderm), including, for example, hair, muscle, and bone. Teratomas occur most often in the ovaries in women, the testicles in men, and the tailbone in children.

[0055] Melanoma is a form of cancer that begins in melanocytes (cells that make the pigment melanin). Melanoma may begin in a mole (skin melanoma), but can also begin in other pigmented tissues, such as in the eye or in the intestines.

[0056] Leukemias are cancers that start in blood-forming tissue, such as the bone marrow, and cause large numbers of abnormal blood cells to be produced and enter the bloodstream. For example, leukemias can originate in bone marrow-derived cells that normally mature in the bloodstream. Leukemias are named for how quickly the disease develops and progresses (e.g., acute versus chronic) and for the type of white blood cell that is affected (e.g., myeloid versus lymphoid). Myeloid leukemias are also called myelogenous or myeloblastic leukemias. Lymphoid leukemias are also called lymphoblastic or lymphocytic leukemia. Lymphoid leukemia cells may collect in the lymph nodes, which can become swollen. Examples of leukemias include, but are not limited to, Acute myeloid leukemia (AML), Acute lymphoblastic leukemia (ALL), Chronic myeloid leukemia (CML), and Chronic lymphocytic leukemia (CLL).

[0057] Lymphomas are cancers that begin in cells of the immune system. For example, lymphomas can originate in bone marrow-derived cells that normally mature in the lymphatic system. There are two basic categories of lymphomas. One category of lymphoma is Hodgkin lymphoma (HL), which is marked by the presence of a type of cell called the Reed-Sternberg cell. There are currently 6 recognized types of HL. Examples of Hodgkin lymphomas include nodular sclerosis classical Hodgkin lymphoma (CHL), mixed cellularity CHL, lymphocyte-depletion CHL, lymphocyte-rich CHL, and nodular lymphocyte predominant HL.

[0058] The other category of lymphoma is non-Hodgkin lymphomas (NHL), which includes a large, diverse group of cancers of immune system cells. Non-Hodgkin lymphomas can be further divided into cancers that have an indolent (slow-growing) course and those that have an aggressive (fast-growing) course. There are currently 61 recognized types of NHL. Examples of non-Hodgkin lymphomas include, but are not limited to, AIDS-related Lymphomas, anaplastic large-cell lymphoma, angioimmunoblastic lymphoma, blastic NK-cell lymphoma, Burkitt's lymphoma, Burkitt-like lymphoma (small non-cleaved cell lymphoma), chronic lymphocytic leukemia/small lymphocytic lymphoma, cutaneous T-Cell lymphoma, diffuse large B-Cell lymphoma, enteropathy-type T-Cell lymphoma, follicular lymphoma, hepatosplenic gamma-delta T-Cell lymphomas, T-Cell leukemias, lymphoblastic lymphoma, mantle cell lymphoma, marginal zone lymphoma, nasal T-Cell lymphoma, pediatric lymphoma, peripheral T-Cell lymphomas, primary central nervous system lymphoma, transformed lymphomas, treatment-related T-Cell lymphomas, and Waldenstrom's macroglobulinemia.

[0059] Brain cancers include any cancer of the brain tissues. Examples of brain cancers include, but are not limited to, gliomas (e.g., glioblastomas, astrocytomas, oligodendrogliomas, ependymomas, and the like), meningiomas, pituitary adenomas, and vestibular schwannomas, primitive neuroectodermal tumors (medulloblastomas).

[0060] The "pathology" of cancer includes all phenomena that compromise the well-being of the patient. This includes, without limitation, abnormal or uncontrollable cell growth, metastasis, interference with the normal functioning of neighboring cells, release of cytokines or other secretory products at abnormal levels, suppression or aggravation of inflammatory or immunological response, neoplasia, premalignancy, malignancy, and invasion of surrounding or distant tissues or organs, such as lymph nodes.

[0061] As used herein, the phrases "cancer recurrence" and "tumor recurrence," and grammatical variants thereof, refer to further growth of neoplastic or cancerous cells after diagnosis of cancer. Particularly, recurrence may occur when further cancerous cell growth occurs in the cancerous tissue. "Tumor spread," similarly, occurs when the cells of a tumor disseminate into local or distant tissues and organs, therefore, tumor spread encompasses tumor metastasis. "Tumor invasion" occurs when the tumor growth spread out locally to compromise the function of involved tissues by compression, destruction, or prevention of normal organ function.

[0062] As used herein, the term "metastasis" refers to the growth of a cancerous tumor in an organ or body part, which is not directly connected to the organ of the original cancerous tumor. Metastasis will be understood to include micrometastasis, which is the presence of an undetectable amount of cancerous cells in an organ or body part that is not directly connected to the organ of the original cancerous tumor. Metastasis can also be defined as several steps of a process, such as the departure of cancer cells from an original tumor site, and migration and/or invasion of cancer cells to other parts of the body.

[0063] As used herein the phrases "effective amount" and "therapeutically effective amount" refer to a dose of a substance such as an immunoconjugate that produces therapeutic effects for which it is administered. The exact dose will depend on the purpose of the treatment, and will be ascertainable by one skilled in the art using known techniques (see, e.g., Lieberman, *Pharmaceutical Dosage Forms* (vols. 1-3, 1992); Lloyd, *The Art, Science and Technology of Pharmaceutical Compounding* (1999); Pickar, *Dosage Calculations* (1999); *Goodman & Gilman's The Pharmacological Basis of Therapeutics*, 11th Edition (McGraw-Hill, 2006); and *Remington: The Science and Practice of Pharmacy*, 22nd Edition, (Pharmaceutical Press, London, 2012)).

[0064] As used herein, the terms "recipient," "individual," "subject," "host," and "patient" are used interchangeably and refer to any mammalian subject for whom diagnosis, treatment, or therapy is desired (e.g., humans). "Mammal" for purposes of treatment refers to any animal classified as a mammal, including humans, domestic and farm animals, and zoo, sports, or pet animals, such as dogs, horses, cats, cows, sheep, goats, pigs, camels, etc. In certain embodiments, the mammal is human.

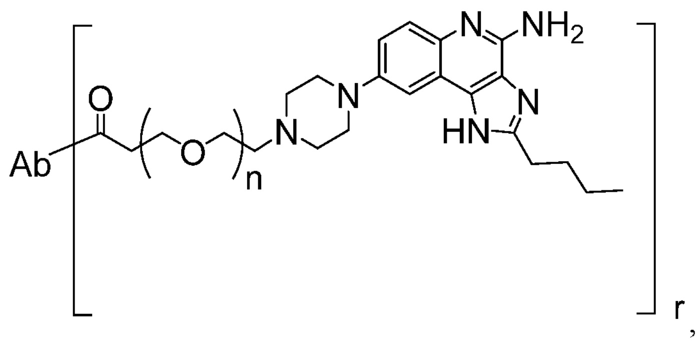
[0065] The phrase "synergistic adjuvant" or "synergistic combination" in the context of this invention includes the combination of two immune modulators such as a receptor agonist, cytokine, and adjuvant polypeptide, that in combination elicit a synergistic effect on immunity relative to either administered alone. Particularly, the immunoconjugates disclosed herein comprise synergistic combinations of the claimed adjuvant and antibody construct. These synergistic combinations upon administration elicit a greater effect on immunity, e.g., relative to when the antibody construct or adjuvant is administered in the absence of the other moiety. Further, a decreased amount of the immunoconjugate may be administered (as measured by the total number of antibody constructs or the total number of adjuvants administered as part of the immunoconjugate) compared to when either the antibody construct or adjuvant is administered alone.

[0066] As used herein, the term "administering" refers to parenteral, intravenous, intraperitoneal, intramuscular, intratumoral, intralesional, intranasal, or subcutaneous administration, oral administration, administration as a suppository, topical contact, intrathecal administration, or the implantation of a slow-release device, e.g., a mini-osmotic pump, to the subject.

[0067] The terms "about" and "around," as used herein to modify a numerical value, indicate a close range surrounding the numerical value. Thus, if "X" is the value, "about X" or "around X" indicates a value of from 0.9X to 1.1X, e.g., from 0.95X to 1.05X or from 0.99X to 1.01X. A reference to "about X" or "around X" specifically indicates at least the values X, 0.95X, 0.96X, 0.97X, 0.98X, 0.99X, 1.01X, 1.02X, 1.03X, 1.04X, and 1.05X. Accordingly, "about X" and "around X" are intended to teach and provide written description support for a claim limitation of, e.g., "0.98X."

Antibody Adjuvant Conjugates

[0068] The invention provides an immunoconjugate of formula:

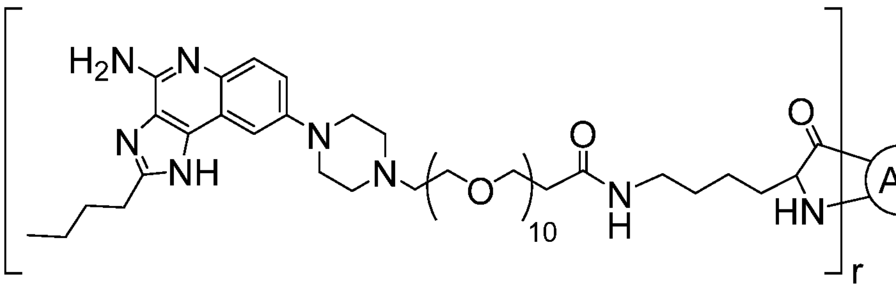


or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10, subscript n is an integer from about 2 to about 25 (e.g., about 2 to about 16, about 6 to about 25, about 6 to about 16, about 8 to about 25, about 8 to about 16, about 6 to about 12, or about 8 to about 12), and "Ab" is an antibody construct that has an antigen binding domain that binds human epidermal growth factor receptor 2 ("HER2"). "Ab" can be any suitable antibody construct that has an antigen binding domain that binds HER2, such as, for example, trastuzumab and pertuzumab. In certain embodiments, "Ab" is trastuzumab (also known as HERCEPTIN™), a biosimilar thereof, or a biobetter thereof. For example, "Ab" can be MYL-14010, ABP 980, BCD-022, CT-P6, EG12014, HD201, ONS-1050, PF-05280014, Ontruzant, Saiputing, Herzuma, or HLX02. In preferred embodiments, "Ab" is trastuzumab (also known as HERCEPTIN™).

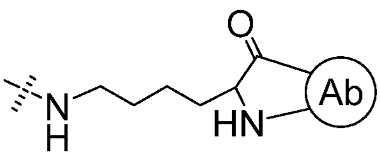
[0069] Generally, the immunoconjugates of the invention comprise about 1 to about 10 adjuvants, each adjuvant linked via a PEG linker to the antibody construct, as designated with subscript "r." Each of the adjuvants linked via a PEG linker to the antibody construct is conjugated to the antibody construct at an amine of a lysine residue of the antibody construct. In an embodiment, r is 1, such that there is a single adjuvant linked via a PEG linker to the antibody construct. In some embodiments, r is an integer from about 2 to about 10 (e.g., about 2 to about 9, about 3 to about 9, about 4 to about 9, about 5 to about 9, about 6 to about 9, about 3 to about 8, about 3 to about 7, about 3 to about 6, about 4 to about 8, about 4 to about 7, about 4 to about 6, about 5 to about 6, about 1 to about 6, about 1 to about 4, about 2 to about 4, or about 1 to about 3). Accordingly, the immunoconjugates can have (i.e., subscript "r" can be) 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 adjuvants linked via a PEG linker. In preferred embodiments, the immunoconjugates have (i.e., subscript "r" can be) 1, 2, 3, or 4 adjuvants linked via a PEG linker. The desirable adjuvant to antibody construct ratio (i.e., the value of the subscript "r") can be determined by a skilled artisan depending on the desired effect of the treatment.

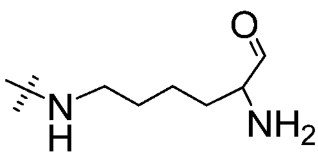
[0070] Generally, the immunoconjugates of the invention comprise about 2 to about 25 (e.g., about 2 to about 16, about 6 to about 25, about 6 to about 16, about 8 to about 25, about 8 to about 16, about 6 to about 12, or about 8 to about 12) ethylene glycol units, as designated with subscript "n." Accordingly, the immunoconjugates of the invention can comprise at least 2 ethylene glycol groups (e.g., at least 3 ethylene glycol groups, at least 4 ethylene glycol groups, at least 5 ethylene glycol groups, at least 6 ethylene glycol groups, at least 7 ethylene glycol groups, at least 8 ethylene glycol groups, at least 9 ethylene glycol groups, or at least 10 ethylene glycol groups). Accordingly, the immunoconjugate can comprise from about 2 to about 25 ethylene glycol units, for example, from about 6 to about 25 ethylene glycol units, from about 6 to about 16 ethylene glycol units, from about 8 to about 25 ethylene glycol units, from about 8 to about 16 ethylene glycol units, from about 8 to about 12 ethylene glycol units, or from about 8 to about 12 ethylene glycol units. In certain embodiments, the immunoconjugate comprises a di(ethylene glycol) group, a tri(ethylene glycol) group, a tetra(ethylene glycol) group, 5 ethylene glycol groups, 6 ethylene glycol groups, 7 ethylene glycol groups, 8 ethylene glycol groups, 9 ethylene glycol groups, 10 ethylene glycol groups, 11 ethylene glycol groups, 12 ethylene glycol groups, 13 ethylene glycol groups, 14 ethylene glycol groups, 15 ethylene glycol groups, 16 ethylene glycol groups, 24 ethylene glycol groups, or 25 ethylene glycol groups. In preferred embodiments, the immunoconjugate comprises 6 ethylene glycol groups, 8 ethylene glycol groups, 10 ethylene glycol groups, or 12 ethylene glycol groups (i.e., about 6 ethylene glycol groups to about 12 ethylene glycol groups).

[0071] The PEG linker can be linked to the antibody construct that has an antigen binding domain that binds HER2 (e.g., trastuzumab, pertuzumab, biosimilars thereof, and biobetters thereof) via an amine of a lysine residue of the antibody construct. Accordingly, the immunoconjugates of the invention can be represented by the following formula:



,

wherein 

is an antibody construct that has an antigen binding domain that binds HER2 with residue 

representing a lysine residue of the antibody construct, wherein "" represents a point of attachment to the linker.

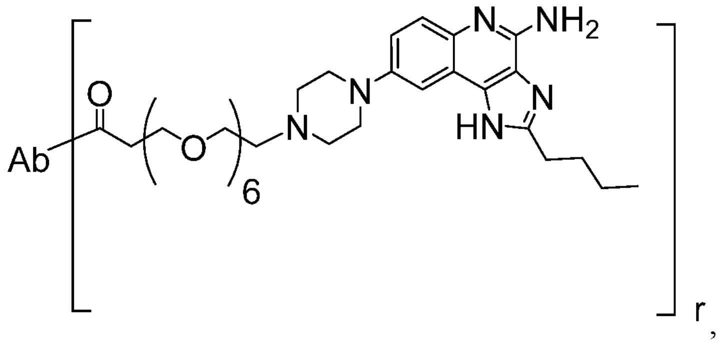
[0072] The adjuvant can be linked via the PEG linker to any suitable residue of the antibody construct, but desirably is linked to any lysine residue of the antibody construct. For example, the adjuvant can be linked via the PEG linker to one or more of K103, K107, K149, K169, K183, and/or K188 of the light chain of the antibody construct, as numbered using the Kabat numbering system. Alternatively, or additionally, the adjuvant can be linked via the PEG linker to one or more of K30, K43, K65, K76, K136, K216, K217, K225, K293, K320, K323, K337, K395, and/or K417 of the heavy chain of the antibody construct, as numbered using the Kabat numbering system. Generally, the adjuvant is predominantly linked via the PEG linker at K107 or K188 of the light chain of the antibody construct, or K30, K43, K65, or K417 of the heavy chain of the antibody construct. In certain embodiments, the adjuvant is linked via the PEG linker at K188 of the light chain of the antibody construct, and optionally one or more other lysine residues of the antibody construct.

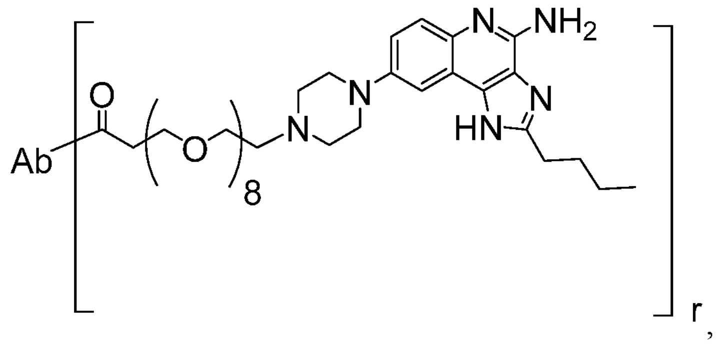
[0073] Immunoconjugates as described herein can provide an unexpectedly increased activation response of an antigen presenting cell ("APC"). This increased activation can be detected *in vitro* or *in vivo*. In some embodiments, the increased APC activation can be detected in the form of a reduced time to achieve a specified level of APC activation. For example, in an *in vitro* assay, % APC activation can be achieved at an equivalent dose with an immunoconjugate within about 1%, about 10%, about 20%, about 30%, about 40%, or about 50% of the time required to obtain the same or similar percentage of APC activation with a mixture of unconjugated antibody construct and adjuvant, under otherwise identical concentrations and conditions. In some embodiments, an immunoconjugate can activate APCs (e.g., dendritic cells) and/or NK cells in a reduced amount of time. For example, in some embodiments, a mixture of unconjugated antibody construct and adjuvant can activate APCs (e.g., dendritic cells) and/or NK cells and/or induce dendritic cell differentiation after incubation with the mixture for 2, 3, 4, 5, 1-5, 2-5, 3-5, or 4-7 days, while, in contrast, immunoconjugates described herein can activate and/or induce differentiation within 4 hours, 8 hours, 12 hours, 16 hours, or 1 day, under otherwise identical concentrations and conditions. Alternatively, the increased APC activation can be detected in the form of a reduced concentration of immunoconjugate required to achieve an amount (e.g., percent APCs), level (e.g., as measured by a level of upregulation of a suitable marker) or rate (e.g., as detected by a time of incubation required to activate) of APC activation.

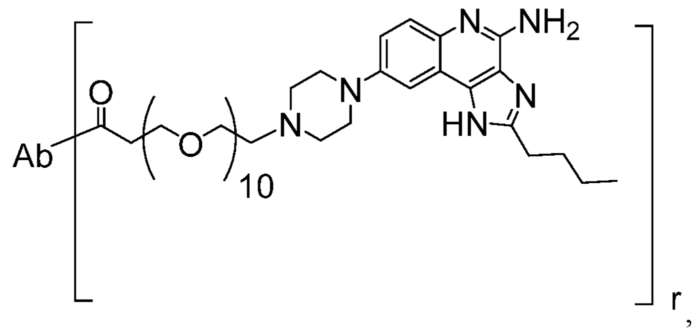
[0074] In some embodiments, the immunoconjugates of the invention provide more than an about 5% increase in activity compared to a mixture of unconjugated antibody construct and adjuvant, under otherwise identical conditions. In other embodiments, the immunoconjugates of the invention provide more than an about 10%, about 15%, about 20%, about 25%, about 30%, about 35%, about 40%, about 45%, about 50%, about 55%, about

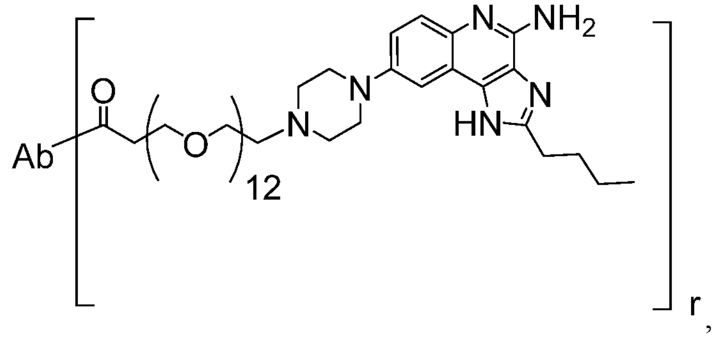
60%, about 65%, or about 70% increase in activity compared to a mixture of unconjugated antibody construct and adjuvant, under otherwise identical conditions. The increase in activity can be assessed by any suitable means, many of which are known to those ordinarily skilled in the art and can include myeloid activation, assessment by cytokine secretion, or a combination thereof.

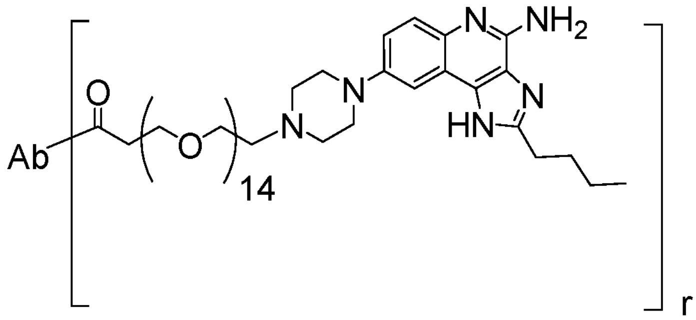
[0075] In some embodiments, the invention provides an immunoconjugate of formula:



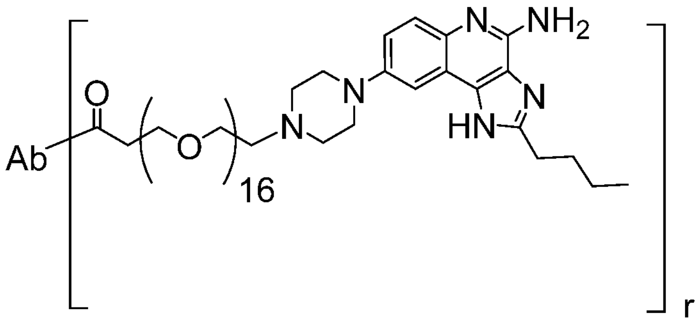




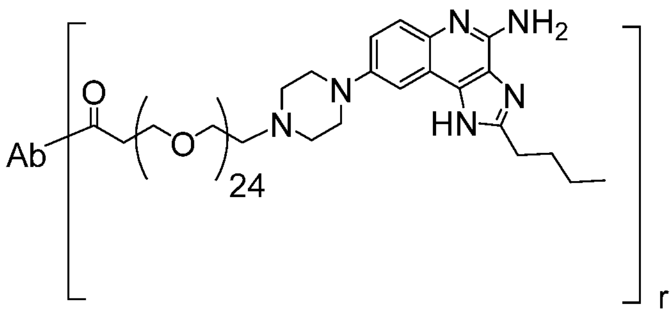




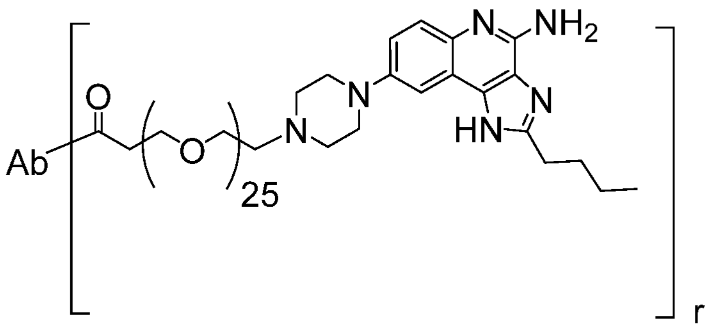
,



,



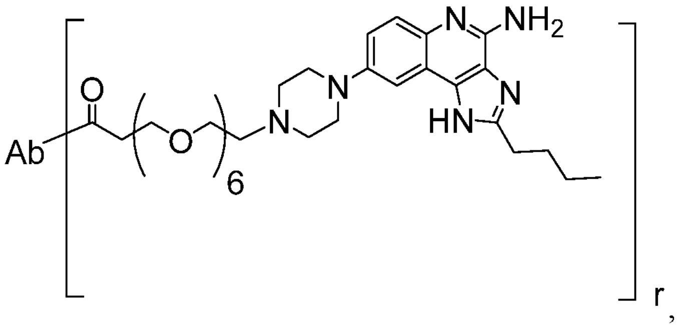
, or

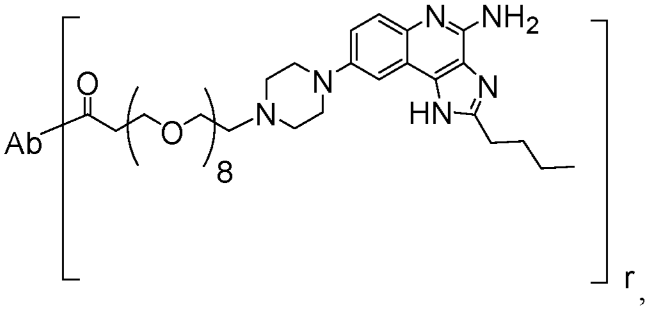


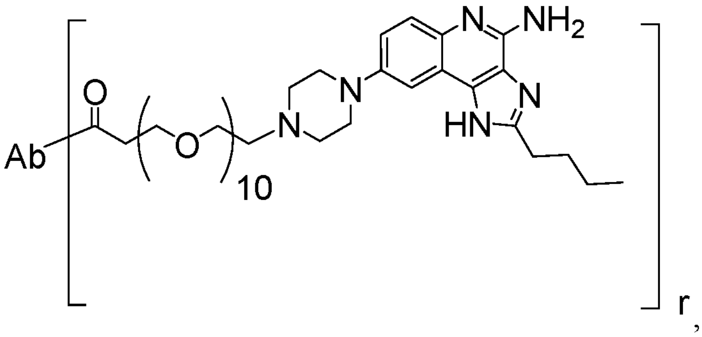
,

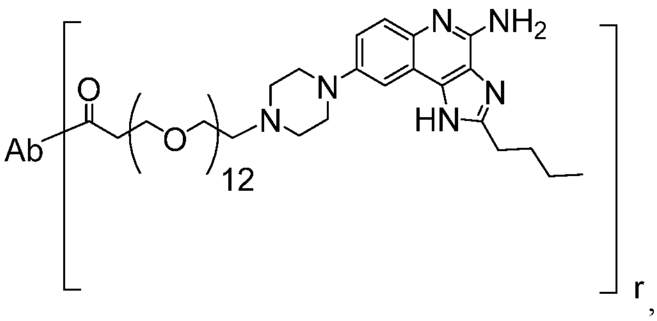
or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds human epidermal growth factor receptor 2 ("HER2").

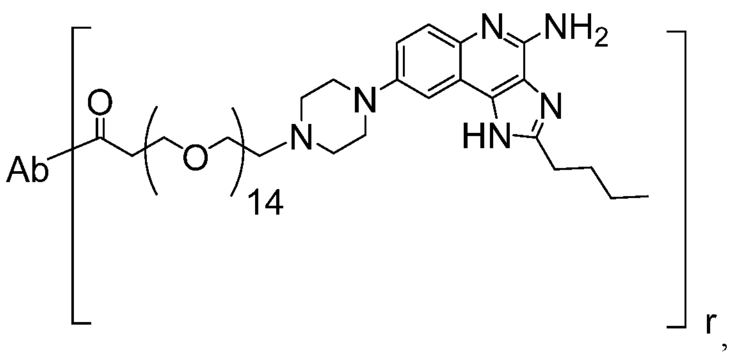
[0076] In certain embodiments, the invention provides an immunoconjugate of formula:

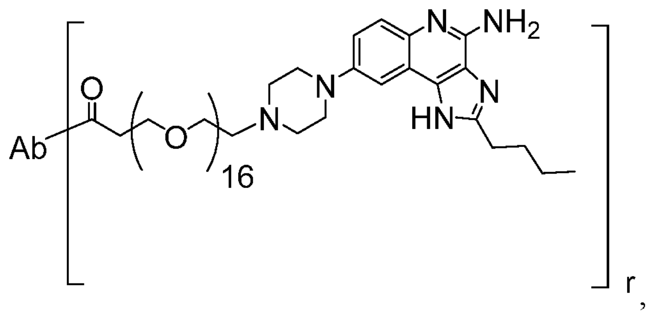


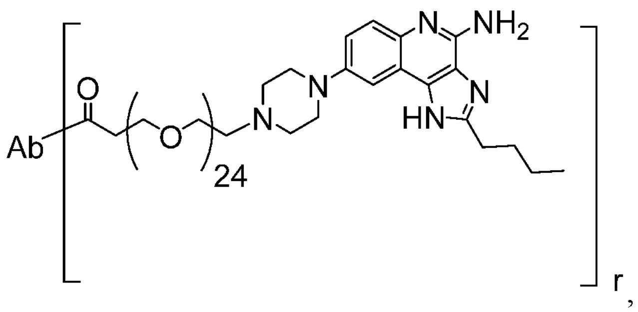




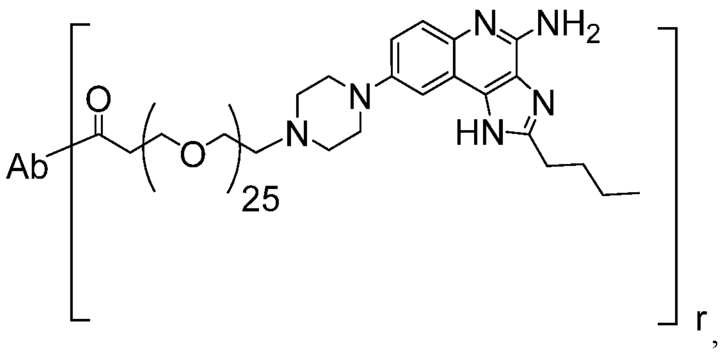






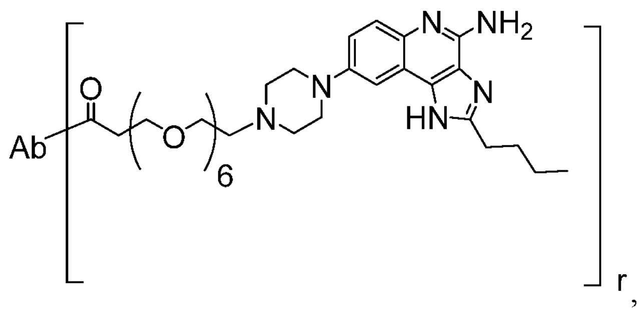


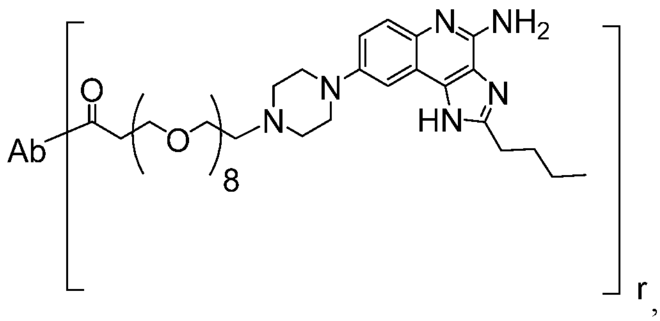
, or

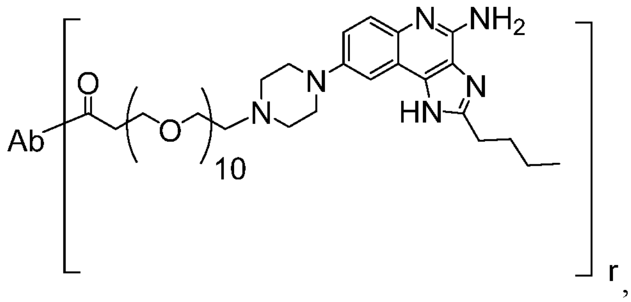


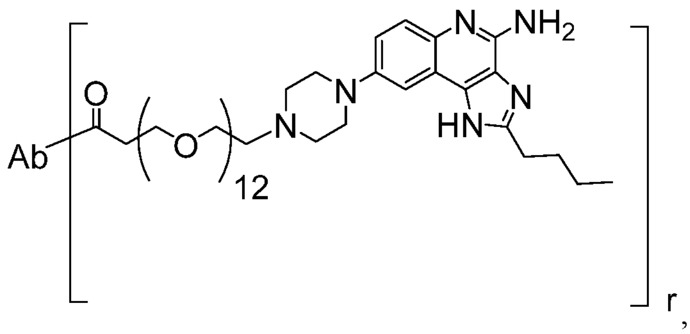
or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is trastuzumab (also known as HERCEPTIN™), pertuzumab, biosimilars thereof, and biobetters thereof. For example, "Ab" can be MYL-14010, ABP 980, BCD-022, CT-P6, EG12014, HD201, ONS-1050, PF-05280014, Ontruzant, Saiputing, Herzuma, or HLX02.

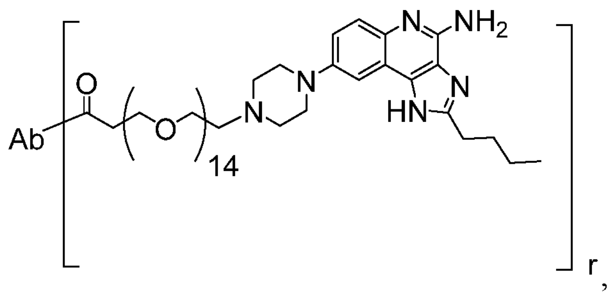
[0077] In preferred embodiments, the invention provides an immunoconjugate of formula:

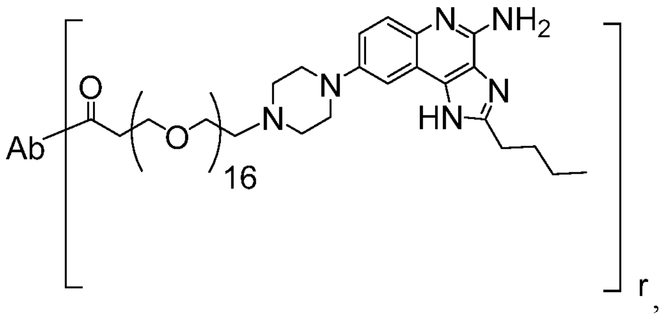


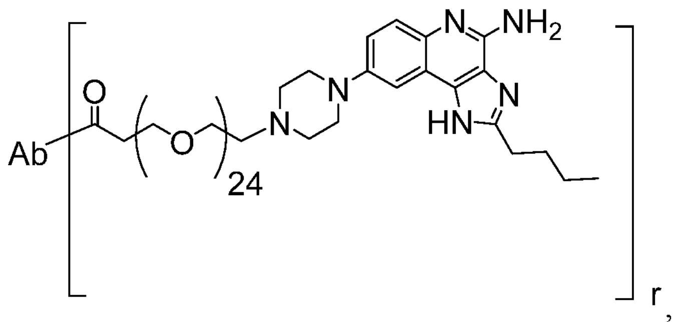




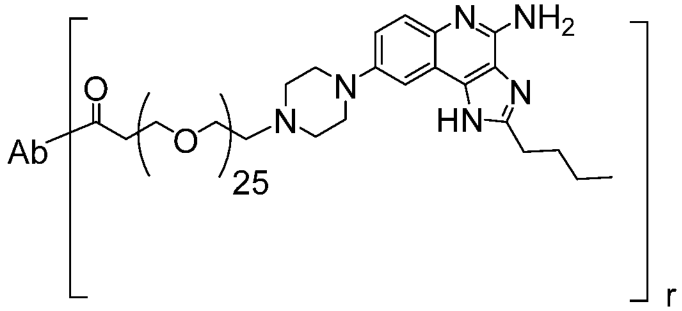








, or

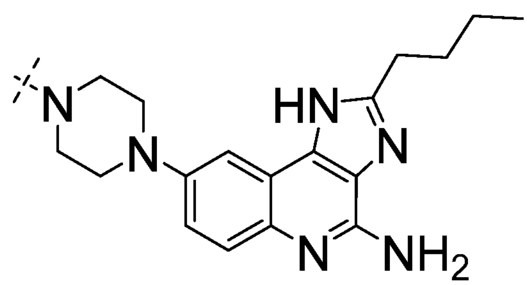


,

or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is trastuzumab (also known as HERCEPTIN™).

Adjuvants

[0078] The immunoconjugate of the invention comprises an adjuvant moiety of formula:



wherein the dashed line ("⸝⸍") represents a point of attachment of the adjuvant moiety to the linker.

[0079] The adjuvant moiety described herein is a TLR agonist.

Antigen Binding Domain and Fc Domain

[0080] The immunoconjugates of the invention comprise an antibody construct that comprises an antigen binding domain that binds HER2. In some embodiments, the antibody construct further comprises an Fc domain. In certain embodiments, the antibody construct is an antibody. In certain embodiments, the antibody construct is a fusion protein.

[0081] The antigen binding domain can be a single-chain variable region fragment (scFv). A single-chain variable region fragment (scFv), which is a truncated Fab fragment including the variable (V) domain of an antibody heavy chain linked to a V domain of a light antibody chain via a synthetic peptide, can be generated using routine recombinant DNA technology techniques. Similarly, disulfide-stabilized variable region fragments (dsFv) can be prepared by recombinant DNA technology.

[0082] An embodiment of the invention provides antibody construct or antigen binding domain which specifically recognizes and binds to HER2 (SEQ ID NO: 1). The antibody construct or antigen binding domain may comprise one or more variable regions (e.g., two variable regions) of an antigen binding domain of an anti-HER2 antibody, each variable region comprising a CDR1, a CDR2, and a CDR3.

[0083] An embodiment of the invention provides an antibody construct or antigen binding domain comprising the CDR regions of trastuzumab. In this regard, the antibody construct or antigen binding domain may comprise a first variable region comprising a CDR1 comprising the amino acid sequence of SEQ ID NO: 2 (CDR1 of first variable region), a CDR2 comprising the amino acid sequence of SEQ ID NO: 3 (CDR2 of first variable region), and a CDR3 comprising the amino acid sequence of SEQ ID NO: 4 (CDR3 of first variable region), and a second variable region comprising a CDR1 comprising the amino acid sequence of SEQ ID NO: 5 (CDR1 of second variable region), a CDR2 comprising the amino acid sequence of SEQ ID NO: 6 (CDR2 of second variable region), and a CDR3 comprising the amino acid sequence of SEQ ID NO: 7 (CDR3 of second variable region). In this regard, the antibody construct can comprise (i) all of SEQ ID NOs: 2-4, (ii) all of SEQ ID NOs: 5-7, or (iii) all of SEQ ID NOs: 2-7. Preferably, the antibody construct or antigen binding domain comprises all of SEQ ID NOs: 2-7.

[0084] In an embodiment of the invention, the antibody construct or antigen binding domain comprising the CDR regions of trastuzumab further comprises the framework regions of the trastuzumab. In this regard, the antibody construct or antigen binding domain comprising the CDR regions of the trastuzumab further comprises the amino acid sequence of SEQ ID NO: 8 (framework region ("FR") 1 of first variable region), the amino acid sequence of SEQ ID NO: 9 (FR2 of first variable region), the amino acid sequence of SEQ ID NO: 10 (FR3 of first variable region), the amino acid sequence of SEQ ID NO: 11 (FR4 of first variable region), the amino acid sequence of SEQ ID NO: 12 (FR1 of second variable region), the amino acid sequence of SEQ ID NO: 13 (FR2 of second variable region), the amino acid sequence of SEQ ID NO: 14 (FR3 of second variable region), and the amino acid sequence of SEQ ID NO: 15 (FR4 of second variable region). In this regard, the antibody construct or antigen binding domain can comprise (i) all of SEQ ID NOs: 2-4 and 8-11, (ii) all of SEQ ID NOs: 5-7 and 12-15; or (iii) all of SEQ ID NOs: 2-7 and 8-15.

[0085] An embodiment of the invention provides an antibody construct or antigen binding domain comprising one or both variable regions of trastuzumab. In this regard, the first variable region may comprise SEQ ID NO: 16. The second variable region may comprise SEQ ID NO: 17. Accordingly, in an embodiment of the invention, the antibody construct or antigen binding domain comprises SEQ ID NO: 16, SEQ ID NO: 17, or both SEQ ID NOs: 16 and 17. Preferably, the polypeptide comprises both of SEQ ID NOs: 16-17.

[0086] An embodiment of the invention provides an antibody construct or antigen binding domain comprising the CDR regions of pertuzumab. In this regard, the antibody construct or antigen binding domain may comprise a first variable region comprising a CDR1 comprising the amino acid sequence of SEQ ID NO: 18 (CDR1 of first variable region), a CDR2 comprising the amino acid sequence of SEQ ID NO: 19 (CDR2 of first variable region), and a CDR3 comprising the amino acid sequence of SEQ ID NO: 20 (CDR3 of first variable region), and a second variable region comprising a CDR1 comprising the amino acid sequence of SEQ ID NO: 21 (CDR1 of second variable region), a CDR2 comprising the amino acid sequence of SEQ ID NO: 22 (CDR2 of second variable region), and a CDR3 comprising the amino acid sequence of SEQ ID NO: 23 (CDR3 of second variable region). In this regard, the antibody construct can comprise (i) all of SEQ ID NOs: 18-20, (ii) all of SEQ ID NOs: 21-23, or (iii) all of SEQ ID NOs: 18-23. Preferably, the antibody construct or antigen binding domain comprises all of SEQ ID NOs: 18-23.

[0087] In an embodiment of the invention, the antibody construct or antigen binding domain comprising the CDR regions of pertuzumab further comprises the framework regions of the pertuzumab. In this regard, the antibody construct or antigen binding domain comprising the CDR regions of the pertuzumab further comprises the amino acid sequence of SEQ ID NO: 24 (framework region (“FR”) 1 of first variable region), the amino acid sequence of SEQ ID NO: 25 (FR2 of first variable region), the amino acid sequence of SEQ ID NO: 26 (FR3 of first variable region), the amino acid sequence of SEQ ID NO: 27 (FR4 of first variable region), the amino acid sequence of SEQ ID NO: 28 (FR1 of second variable region), the amino acid sequence of SEQ ID NO: 29 (FR2 of second variable region), the amino acid sequence of SEQ ID NO: 30 (FR3 of second variable region), and the amino acid sequence of SEQ ID NO: 31 (FR4 of second variable region). In this regard, the antibody construct or antigen binding domain can comprise (i) all of SEQ ID NOs: 18-20 and 24-26, (ii) all of SEQ ID NOs: 21-23 and 27-31; or (iii) all of SEQ ID NOs: 18-21 and 24-31.

[0088] An embodiment of the invention provides an antibody construct or antigen binding domain comprising one or both variable regions of pertuzumab. In this regard, the first variable region may comprise SEQ ID NO: 32. The second variable region may comprise SEQ ID NO: 33. Accordingly, in an embodiment of the invention, the antibody construct or antigen binding domain comprises SEQ ID NO: 32, SEQ ID NO: 33, or both SEQ ID NOs: 32 and 33. Preferably, the polypeptide comprises both of SEQ ID NOs: 32-33.

[0089] Included in the scope of the embodiments of the invention are functional variants of the antibody constructs or antigen binding domain described herein. The term "functional variant" as used herein refers to an antibody construct having an antigen binding domain with substantial or significant sequence identity or similarity to a parent antibody construct or antigen binding domain, which functional variant retains the biological activity of the antibody construct or antigen binding domain of which it is a variant. Functional variants encompass, for example, those variants of the antibody constructs or antigen binding domain described herein (the parent antibody construct or antigen binding domain) that retain the ability to recognize target cells expressing HER2 to a similar extent, the same extent, or to a higher extent, as the parent antibody construct or antigen binding domain.

[0090] In reference to the antibody construct or antigen binding domain, the functional variant can, for instance, be at least about 30%, about 50%, about 75%, about 80%, about 85%, about 90%, about 91%, about 92%, about 93%, about 94%, about 95%, about 96%, about 97%, about 98%, about 99% or more identical in amino acid sequence to the antibody construct or antigen binding domain.

[0091] A functional variant can, for example, comprise the amino acid sequence of the parent antibody construct or antigen binding domain with at least one conservative amino acid substitution. Alternatively, or additionally, the functional variants can comprise the amino acid sequence of the parent antibody construct or antigen binding domain with at least one non-conservative amino acid substitution. In this case, it is preferable for the non-conservative amino acid substitution to not interfere with or inhibit the biological activity of the functional variant. The non-conservative amino acid substitution may enhance the biological activity of the functional variant, such that the biological activity of the functional variant is increased as compared to the parent antibody construct or antigen binding domain.

[0092] Amino acid substitutions of the inventive antibody constructs or antigen binding domains are preferably conservative amino acid substitutions. Conservative amino acid substitutions are known in the art, and include amino acid substitutions in which one amino acid having certain physical and/or chemical properties is exchanged for another amino acid that has the same or similar chemical or physical properties. For instance, the conservative amino acid substitution can be an acidic/negatively charged polar amino acid substituted for another acidic/negatively charged polar amino acid (e.g., Asp or Glu), an amino acid with a nonpolar side chain substituted for another amino acid with a nonpolar side chain (e.g., Ala, Gly, Val, Ile, Leu, Met, Phe, Pro, Trp, Cys, Val, etc.), a basic/positively charged polar amino acid substituted for another basic/positively charged polar amino acid (e.g., Lys, His, Arg, etc.), an uncharged amino acid with a polar side chain substituted for another uncharged amino acid with a polar side chain (e.g., Asn, Gln, Ser, Thr, Tyr, etc.), an amino acid with a beta-branched side-chain substituted for another amino acid with a beta-branched side-chain (e.g., Ile, Thr, and Val), an amino acid with an aromatic side-chain substituted for another amino acid with an aromatic side chain (e.g., His, Phe, Trp, and Tyr), etc.

[0093] The antibody construct or antigen binding domain can consist essentially of the specified amino acid sequence or sequences described herein, such that other components, e.g., other amino acids, do not materially change the biological activity of the antibody construct or antigen binding domain functional variant.

[0094] The antibody constructs and antigen binding domains of embodiments of the invention (including functional portions and functional variants) can be of any length, i.e., can comprise any number of amino acids, provided that the antibody constructs (or functional portions or functional variants thereof) retain their biological activity, e.g., the ability to specifically bind to HER2, detect cancer cells in a mammal, or treat or prevent cancer in a mammal, etc. For example, the antibody construct or antigen binding domain can be about 50 to about 5,000 amino acids long, such as 50, 70, 75, 100, 125, 150, 175, 200, 300, 400, 500, 600, 700, 800, 900, 1,000, or more amino acids in length.

[0095] The antibody constructs and antigen binding domains of embodiments of the invention (including functional portions and functional variants of the invention) can comprise synthetic amino acids in place of one or more naturally-occurring amino acids. Such synthetic amino acids are known in the art, and include, for example, aminocyclohexane carboxylic acid, norleucine, α-amino n-decanoic acid, homoserine, S-acetylaminomethyl-cysteine, trans-3- and trans-4-hydroxyproline, 4-aminophenylalanine, 4- nitrophenylalanine, 4-chlorophenylalanine, 4-carboxyphenylalanine, β-phenylserine β-hydroxyphenylalanine, phenylglycine, α-naphthylalanine, cyclohexylalanine, cyclohexylglycine, indoline-2-carboxylic acid, 1,2,3,4-tetrahydroisoquinoline-3-carboxylic acid, aminomalonic acid, aminomalonic acid monoamide, N'-benzyl-N'-methyl-lysine, N',N'-dibenzyl-lysine, 6-hydroxylysine, ornithine, α-aminocyclopentane carboxylic acid, α-aminocyclohexane carboxylic acid, α-aminocycloheptane carboxylic acid, α-(2-amino-2-norbornane)-carboxylic acid, α,γ-diaminobutyric acid, α,β-diaminopropionic acid, homophenylalanine, and α-tert-butylglycine.

[0096] The antibody constructs of embodiments of the invention (including functional portions and functional variants) can be glycosylated, amidated, carboxylated, phosphorylated, esterified, N-acylated, cyclized via, e.g., a disulfide bridge, or converted into an acid addition salt and/or optionally dimerized or polymerized.

[0097] In some embodiments, the antibody construct is a monoclonal antibody of a defined sub-class (e.g., IgG_1, IgG_2, IgG_3, IgG_4, IgA_1, or IgA_2). If combinations of antibodies are used, the antibodies can be from the same subclass or from different subclasses. Typically, the antibody construct is an IgG_1 antibody. Various combinations of different subclasses, in different relative proportions, can be obtained by those of skill in the art. In some embodiments, a specific subclass or a specific combination of different subclasses can be particularly effective at cancer treatment or tumor size reduction. Accordingly, some embodiments of the invention provide immunoconjugates wherein the antibody is a monoclonal antibody. In some embodiments, the monoclonal antibody is a humanized monoclonal antibody.

[0098] In some embodiments, the antibody construct or antigen binding domain binds to HER2 on a cancer or immune cell at a higher affinity than a corresponding HER2 antigen on a non-cancer cell. For example, the antibody construct or antigen binding domain may preferentially recognize HER2 containing a polymorphism that is found on a cancer or immune cell as compared to recognition of a corresponding wild-type HER2 antigen on the non-cancer. In some embodiments, the antibody construct or antigen binding domain binds a cancer cell with greater avidity than a non-cancer cell. For example, the cancer cell can express a higher density of HER2, thereby providing for a higher affinity binding of a multivalent antibody to the cancer cell.

[0099] In some embodiments, the antibody construct or antigen binding domain does not significantly bind non-cancer antigens (e.g., the antibody binds one or more non-cancer antigens with at least 10, 100, 1,000, 10,000, 100,000, or 1,000,000-fold lower affinity (higher Kd) than HER2). In some embodiments, the corresponding non-cancer cell is a cell of the same tissue or origin that is not hyperproliferative or otherwise cancerous. HER2 need not be specific to the cancer cell or even enriched in cancer cells relative to other cells (e.g., HER2 can be expressed by other cells). Thus, in the phrase "an antibody construct that specifically binds to an antigen of a cancer cell," the term "specifically" refers to the specificity of the antibody construct and not to the uniqueness of the presence of HER2 in that particular cell type.

Modified Fc Region

[0100] In some embodiments, the antibodies in the immunoconjugates contain a modified Fc region, wherein the modification modulates the binding of the Fc region to one or more Fc receptors.

[0101] The terms "Fc receptor" or "FcR" refer to a receptor that binds to the Fc region of an antibody. There are three main classes of Fc receptors: (1) FcγR which bind to IgG, (2) FcαR which binds to IgA, and (3) FcεR which binds to IgE. The FcγR family includes several members, such as FcγI (CD64), FcγRIIA (CD32A), FcγRIIB (CD32B), FcγRIIIA (CD16A), and FcγRIIIB (CD16B). The Fcγ receptors differ in their affinity for IgG and also have different affinities for the IgG subclasses (e.g., IgG1, IgG2, IgG3, and IgG4).

[0102] In some embodiments, the antibodies in the immunoconjugates (e.g., antibodies conjugated to at least two adjuvant moieties) contain one or more modifications (e.g., amino acid insertion, deletion, and/or substitution) in the Fc region that results in modulated binding (e.g., increased binding or decreased binding) to one or more Fc receptors (e.g., FcγRI (CD64), FcγRIIA (CD32A), FcγRIIB (CD32B), FcγRIIIA (CD16a), and/or FcγRIIIB (CD16b)) as compared to the native antibody lacking the mutation in the Fc region. In some embodiments, the antibodies in the immunoconjugates contain one or more modifications (e.g., amino acid insertion, deletion, and/or substitution) in the Fc region that reduce the binding of the Fc region of the antibody to FcγRIIB. In some embodiments, the antibodies in the immunoconjugates contain one or more modifications (e.g., amino acid insertion, deletion, and/or substitution) in the Fc region of the antibody that reduce the binding of the antibody to FcγRIIB while maintaining the same binding or having increased binding to FcγRI (CD64), FcγRIIA (CD32A), and/or FcRγIIIA (CD16a) as compared to the native antibody lacking the mutation in the Fc region. In some embodiments, the antibodies in the immunoconjugates contain one of more modifications in the Fc region that increase the binding of the Fc region of the antibody to FcγRIIB.

[0103] In some embodiments, the modulated binding is provided by mutations in the Fc region of the antibody relative to the native Fc region of the antibody. The mutations can be in a CH2 domain, a CH3 domain, or a combination thereof. A "native Fc region" is synonymous with a "wild-type Fc region" and comprises an amino acid sequence that is identical to the amino acid sequence of an Fc region found in nature or identical to the amino acid sequence of the Fc region found in the native antibody (e.g., trastuzumab). Native sequence human Fc regions include a native sequence human IgG1 Fc region, native sequence human IgG2 Fc region, native sequence human IgG3 Fc region, and native sequence human IgG4 Fc region, as well as naturally occurring variants thereof. Native sequence Fc includes the various allotypes of Fcs (see, e.g., Jefferis et al., *mAbs*, 1(4): 332-338 (2009)).

[0104] In some embodiments, the mutations in the Fc region that result in modulated binding to one or more Fc receptors can include one or more of the following mutations: SD (S239D), SDIE (S239D/I332E), SE (S267E), SELF (S267E/L328F), SDIE (S239D/I332E), SDIEAL (S239D/I332E/A330L), GA (G236A), ALIE (A330L/I332E), GASDALIE (G236A/S239D/A330L/I332E), V9 (G237D/P238D/P271G/A330R), and V11 (G237D/P238D/H268D/P271G/A330R), and/or one or more mutations at the following amino acids: E233, G237, P238, H268, P271, L328 and A330. Additional Fc region modifications for modulating Fc receptor binding are described in, for example, U.S. Patent Application Publication 2016/0145350 and U.S. Patents 7,416,726 and 5,624,821, which are hereby incorporated by reference in their entireties.

[0105] In some embodiments, the Fc region of the antibodies of the immunoconjugates are modified to have an altered glycosylation pattern of the Fc region compared to the native non-modified Fc region.

[0106] Human immunoglobulin is glycosylated at the Asn297 residue in the Cγ2 domain of each heavy chain. This *N*-linked oligosaccharide is composed of a core heptasaccharide, N-acetylglucosamine4Mannose3 (GlcNAc4Man3). Removal of the heptasaccharide with endoglycosidase or PNGase F is known to lead to conformational changes in the antibody Fc region, which can significantly reduce antibody-binding affinity to activating FcγR and lead to decreased effector function. The core heptasaccharide is often decorated with galactose, bisecting GlcNAc, fucose, or sialic acid, which differentially impacts Fc binding to activating and inhibitory FcγR. Additionally, it has been demonstrated that α2,6-sialyation enhances anti-inflammatory activity *in vivo*, while defucosylation leads to improved FcγRIIIa binding and a 10-fold increase in antibody-dependent cellular cytotoxicity and antibody-dependent phagocytosis. Specific glycosylation patterns, therefore, can be used to control inflammatory effector functions.

[0107] In some embodiments, the modification to alter the glycosylation pattern is a mutation. For example, a substitution at Asn297. In some embodiments, Asn297 is mutated to glutamine (N297Q). Methods for controlling immune response with antibodies that modulate FcγR-regulated signaling are described, for example, in U.S. Patent 7,416,726 and U.S. Patent Application Publications 2007/0014795 and 2008/0286819, which are hereby incorporated by reference in their entireties.

[0108] In some embodiments, the antibodies of the immunoconjugates are modified to contain an engineered Fab region with a non-naturally occurring glycosylation pattern. For example, hybridomas can be genetically engineered to secrete afucosylated mAb, desialylated mAb or deglycosylated Fc with specific mutations that enable increased FcRγIIIa binding and effector function. In some embodiments, the antibodies of the immunoconjugates are engineered to be afucosylated.

[0109] In some embodiments, the entire Fc region of an antibody construct in the immunoconjugates is exchanged with a different Fc region, so that the Fab region of the antibody is conjugated to a non-native Fc region. For example, the Fab region of trastuzumab, which normally comprises an IgG1 Fc region, can be conjugated to IgG2, IgG3, IgG4, or IgA, or the Fab region of nivolumab, which normally comprises an IgG4 Fc region, can be conjugated to IgG1, IgG2, IgG3, IgA1, or IgG2. In some embodiments, the Fc modified antibody with a non-native Fc domain also comprises one or more amino acid modification, such as the S228P mutation within the IgG4 Fc, that modulate the stability of the Fc domain described. In some embodiments, the Fc modified antibody with a non-native Fc domain also comprises one or more amino acid modifications described herein that modulate Fc binding to FcR.

[0110] In some embodiments, the modifications that modulate the binding of the Fc region to FcR do not alter the binding of the Fab region of the antibody to its antigen when compared to the native non-modified antibody. In other embodiments, the modifications that modulate the binding of the Fc region to FcR also increase the binding of the Fab region of the antibody to its antigen when compared to the native non-modified antibody.

Linker

[0111] Some of the immunoconjugates disclosed herein can be easier to purify than an immunoconjugate comprising the same adjuvant, the same antibody construct, and a different PEG linker length (e.g., PEG6 to PEG12 vs. PEG2 or PEG25). Without wishing to be bound by any particular theory, it is believed that the PEG6 to PEG12 immunoconjugates described herein provide a good balance of hydrophobicity and hydrophilicity to facilitate the purification process. Some of the immunoconjugates disclosed herein can be easier to solubilize than an immunoconjugate comprising the same adjuvant, the same antibody construct, and a different PEG linker length (e.g., PEG6 to PEG12 vs. PEG2 or PEG25). Without wishing to be bound by any particular theory, it is believed that the PEG6 to PEG12 immunoconjugate described herein provide a good balance of hydrophobicity and hydrophilicity to maintain solubility and be effective under biological conditions. It is also believed that the PEG6 to PEG12 immunoconjugate include a desirable number PEG units to provide enough hydrophobicity to be readily purified and/or isolated, while maintaining enough hydrophilicity to be easily solubilized. In preferred embodiments, the immunoconjugate comprises a PEG10 linker.

Immunoconjugate Composition

[0112] The invention provides a composition, e.g., a pharmaceutically acceptable composition or formulation, comprising a plurality of immunoconjugates as described herein and optionally a carrier therefor, e.g., a pharmaceutically acceptable carrier. The immunoconjugates can be the same or different in the composition, i.e., the composition can comprise immunoconjugates that have the same number of adjuvants linked to the same positions on the antibody construct and/or immunoconjugates that have the same number of adjuvants linked to different positions on the antibody construct, that have different numbers of adjuvants linked to the same positions on the antibody construct, or that have different numbers of adjuvants linked to different positions on the antibody construct.

[0113] As described herein, the adjuvant can be linked via the PEG linker to any suitable residue of the antibody construct, desirably to a lysine residue of the antibody construct. Thus, for example, the composition can comprise a plurality of immunoconjugates, wherein, for each immunoconjugate, one or more adjuvants are linked via PEG linkers to one or more lysine residues selected from K103, K107, K149, K169, K183, and K188 of the light chain of the antibody construct, and K30, K43, K65, K76, K136, K216, K217, K225, K293, K320, K323, K337, K395, and K417 of the heavy chain of the antibody construct, as numbered using the Kabat numbering system. Without wishing to be bound by any particular theory, the composition generally has a distribution of conjugation sites such that there is an average adjuvant to antibody construct ratio with a given profile of preferred conjugation sites. In some embodiments, at least about 40% (e.g., at least about 50%, at least about 60%, at least about 70%, at least about 80%, or at least about 90%) of the sum total of lysine linkages occur at K188 of the light chain of the antibody construct.

[0114] A composition of immunoconjugates of the invention can have an average adjuvant to antibody construct ratio of about 0.4, 0.6, 0.8, 1, 1.2, 1.4, 1.6, 1.8, 2, 2.2, 2.4, 2.6, 2.8, 3, 3.2, 3.4, 3.6, 3.8, 4.0, 4.2, 4.4, 4.6, 4.8, 5.0, 5.2, 5.4, 5.6, 5.8, 6.0, 6.2, 6.4, 6.6, 6.8, 7, 7.2, 7.4, 7.6, 7.8, 8, 8.2, 8.4, 8.6, 8.8, 9, 9.2, 9.4, 9.6, 9.8, or 10, or within a range bounded by any two of the aforementioned values. A skilled artisan will recognize that the number of adjuvant conjugated to the antibody construct may vary from immunoconjugate to immunoconjugate in a composition comprising multiple immunoconjugates of the invention, and, thus, the adjuvant to antibody construct (e.g., antibody) ratio can be measured as an average. The adjuvant to antibody construct (e.g., antibody) ratio can be assessed by any suitable means, many of which are known in the art.

[0115] In some embodiments, the composition further comprises one or more pharmaceutically acceptable excipients. For example, the immunoconjugates of the invention can be formulated for parenteral administration, such as IV administration or administration into a body cavity or lumen of an organ. Alternatively, the immunoconjugates can be injected intra-tumorally. Compositions for injection will commonly comprise a solution of the immunoconjugate dissolved in a pharmaceutically acceptable carrier. Among the acceptable vehicles and solvents that can be employed are water and an isotonic solution of one or more salts such as sodium chloride, e.g., Ringer's solution. In addition, sterile fixed oils can conventionally be employed as a solvent or suspending medium. For this purpose, any bland fixed oil can be employed, including synthetic monoglycerides or diglycerides. In addition, fatty acids such as oleic acid can likewise be used in the preparation of injectables. These compositions desirably are sterile and generally free of undesirable matter. These compositions can be sterilized by conventional, well known sterilization techniques. The compositions can contain pharmaceutically acceptable auxiliary substances as required to approximate physiological conditions such as pH adjusting and buffering agents, toxicity adjusting agents, e.g., sodium acetate, sodium chloride, potassium chloride, calcium chloride, sodium lactate and the like.

[0116] The composition can contain any suitable concentration of the immunoconjugate. The concentration of the immunoconjugate in the composition can vary widely, and will be selected primarily based on fluid volumes, viscosities, body weight, and the like, in accordance with the particular mode of administration selected and the patient's needs. In certain embodiments, the concentration of an immunoconjugate in a solution formulation for injection will range from about 0.1% (w/w) to about 10% (w/w).

Methods of Using the Immunoconjugate

[0117] The invention provides a method for treating cancer. The method includes comprising administering a therapeutically effective amount of an immunoconjugate as described herein (e.g., as a composition as described herein) to a subject in need thereof, e.g., a subject that has cancer and is in need of treatment for the cancer.

[0118] Trastuzumab and pertuzumab, biosimilars thereof, and biobetters thereof are known to be useful in the treatment of cancer, particularly breast cancer, especially HER2-overexpressing breast cancer, gastric cancer, especially HER2-overexpressing gastric cancer, and gastroesophageal junction adenocarcinoma. The immunoconjugate described herein can be used to treat the same types of cancers as trastuzumab, pertuzumab, biosimilars thereof, and biobetters thereof particularly breast cancer, especially HER2-overexpressing breast cancer, gastric cancer, especially HER2-overexpressing gastric cancer, and gastroesophageal junction adenocarcinoma.

[0119] The immunoconjugate is administered to a subject in need thereof in any therapeutically effective amount using any suitable dosing regimen, such as the dosing regimens utilized for trastuzumab, pertuzumab, biosimilars thereof, and biobetters thereof. For example, the methods can include administering the immunoconjugate to provide a dose of from about 100 ng/kg to about 50 mg/kg to the subject. The immunoconjugate dose can range from about 5 mg/kg to about 50 mg/kg, from about 10 μg/kg to about 5 mg/kg, or from about 100 μg/kg to about 1 mg/kg. The immunoconjugate dose can be about 100, 200, 300, 400, or 500 μg/kg. The immunoconjugate dose can be about 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 mg/kg. The immunoconjugate dose can also be outside of these ranges, depending on the particular conjugate as well as the type and severity of the cancer being treated. Frequency of administration can range from a single dose to multiple doses per week, or more frequently. In some embodiments, the immunoconjugate is administered from about once per month to about five times per week. In some embodiments, the immunoconjugate is administered once per week.

[0120] In another aspect, the invention provides a method for preventing cancer. The method comprises administering a therapeutically effective amount of an immunoconjugate (e.g., as a composition as described above) to a subject. In certain embodiments, the subject is susceptible to a certain cancer to be prevented. For example, the methods can include administering the immunoconjugate to provide a dose of from about 100 ng/kg to about 50 mg/kg to the subject. The immunoconjugate dose can range from about 5 mg/kg to about 50 mg/kg, from about 10 µg/kg to about 5 mg/kg, or from about 100 µg/kg to about 1 mg/kg. The immunoconjugate dose can be about 100, 200, 300, 400, or 500 µg/kg. The immunoconjugate dose can be about 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 mg/kg. The immunoconjugate dose can also be outside of these ranges, depending on the particular conjugate as well as the type and severity of the cancer being treated. Frequency of administration can range from a single dose to multiple doses per week, or more frequently. In some embodiments, the immunoconjugate is administered from about once per month to about five times per week. In some embodiments, the immunoconjugate is administered once per week.

[0121] Some embodiments of the invention provide methods for treating cancer as described above, wherein the cancer is breast cancer. Breast cancer can originate from different areas in the breast, and a number of different types of breast cancer have been characterized. For example, the immunoconjugates of the invention can be used for treating ductal carcinoma *in situ;* invasive ductal carcinoma (*e.g.,* tubular carcinoma; medullary carcinoma; mucinous carcinoma; papillary carcinoma; or cribriform carcinoma of the breast); lobular carcinoma *in situ*; invasive lobular carcinoma; inflammatory breast cancer; and other forms of breast cancer. In some embodiments, methods for treating breast cancer include administering an immunoconjugate containing an antibody construct that is capable of binding HER2 (e.g., trastuzumab, pertuzumab, biosimilars thereof, and biobetters thereof).

[0122] Some embodiments of the invention provide methods for treating cancer as described above, wherein the cancer is gastric cancer. Gastric (stomach) cancer can originate from different cells in the stomach and several types of gastric cancer have been characterized including adenocarcinoma, carcinoid tumors, squamous cell carcinoma, small cell carcinoma, leiomyosarcoma, and gastrointestinal stromal tumors. In some embodiments, methods for treating gastric cancer include administering an immunoconjugate containing an antibody construct that is capable of binding HER2 (e.g., trastuzumab).

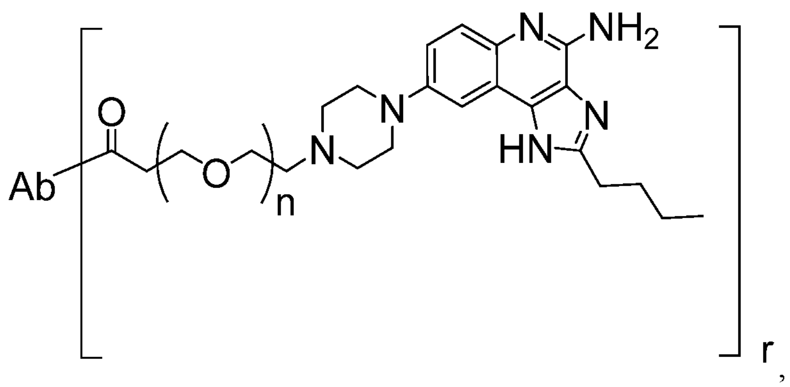
[0123] Some embodiments of the invention provide methods for treating cancer as described above, wherein the cancer is gastroesophageal junction carcinoma. This carcinoma occurs in the area where the esophagus meats the stomach. There are three types of gastroesophageal junction carcinoma. In Type 1, the cancer the cancer grows down from above and into the gastroesophageal junction. The normal lining of the lower end of the esophagus is replaced by mutations (also called Barrett's esophagus). In Type 2, the cancer grows at the gastroesophageal junction by itself. In Type 3, the cancer grows up into the gastroesophageal junction from the stomach upwards. In some embodiments, methods for treating gastroesophageal junction carcinoma include administering an immunoconjugate containing an antibody construct that is capable of binding HER2 (e.g., trastuzumab).

[0124] In some embodiments, the cancer is susceptible to a pro-inflammatory response induced by TLR7 and/or TLR8.

Examples of Non-Limiting Aspects of the Disclosure

[0125] Aspects, including embodiments, of the invention described herein may be beneficial alone or in combination, with one or more other aspects or embodiments. Without limiting the foregoing description, certain non-limiting aspects of the disclosure numbered 1-33 are provided below. As will be apparent to those of skill in the art upon reading this disclosure, each of the individually numbered aspects may be used or combined with any of the preceding or following individually numbered aspects. This is intended to provide support for all such combinations of aspects and is not limited to combinations of aspects explicitly provided below:

[0126] 1. An immunoconjugate of formula:



or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10, subscript n is an integer from about 2 to about 25, and "Ab" is an antibody construct that has an antigen binding domain that binds HER2.

[0127] 2. The immunoconjugate of aspect 1, wherein subscript r is an integer from 1 to 6.

[0128] 3. The immunoconjugate of aspect 2, wherein subscript r is an integer from 1 to 4.

[0129] 4. The immunoconjugate of aspect 3, wherein subscript r is 1.

[0130] 5. The immunoconjugate of aspect 3, wherein subscript r is 2.

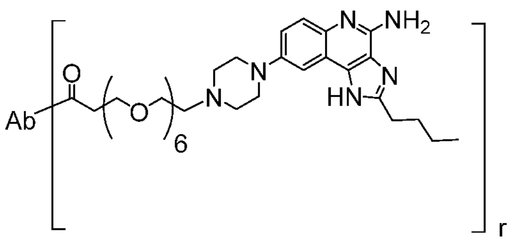
[0131] 6. The immunoconjugate of aspect 3, wherein subscript r is 3.

[0132] 7. The immunoconjugate of aspect 3, wherein subscript r is 4.

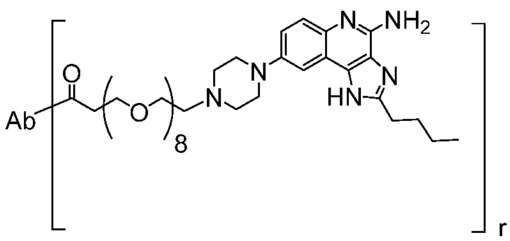
[0133] 8. The immunoconjugate of any one of aspects 1-7, wherein subscript n is an integer from 6 to 12.

[0134] 9. The immunoconjugate of aspect 8, wherein subscript n is an integer from 8 to 12.

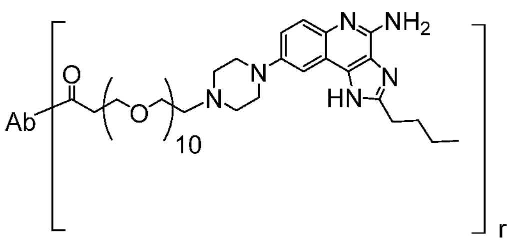
[0135] 10. The immunoconjugate of aspect 1, wherein the immunoconjugate is of formula:



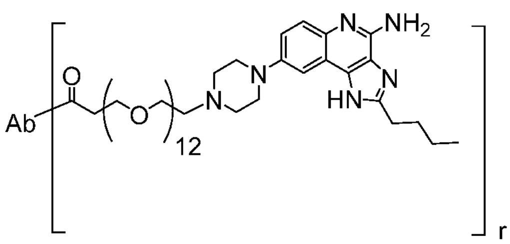
,



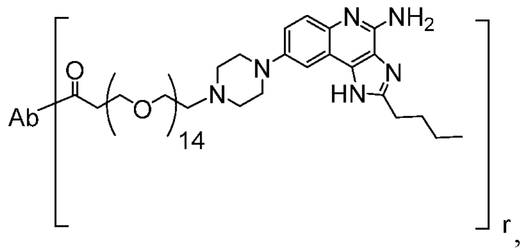
,

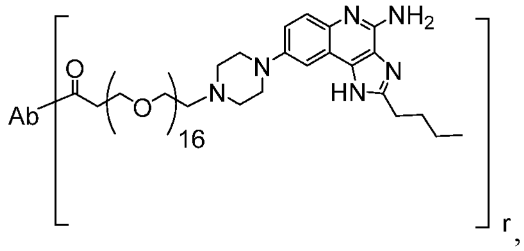


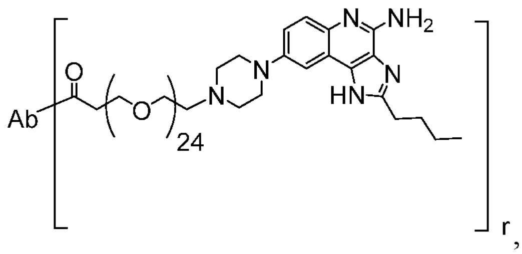
,



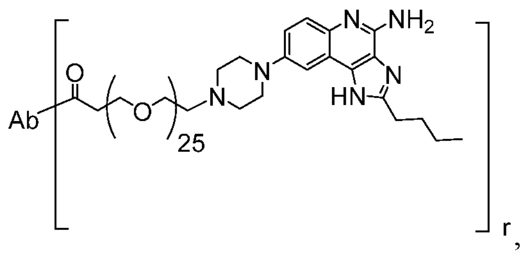
,





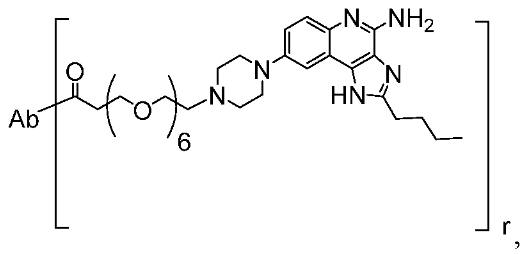


or



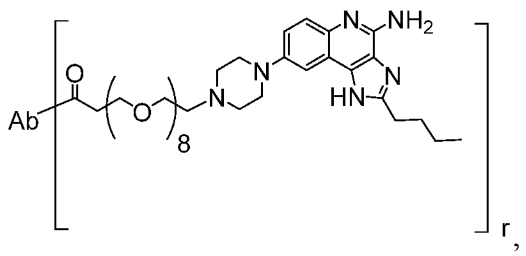
or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2 (e.g., trastuzumab (also known as HERCEPTIN™), a biosimilar thereof, or a biobetter thereof).

[0136] 11. The immunoconjugate of aspect 1, wherein the immunoconjugate is of formula:



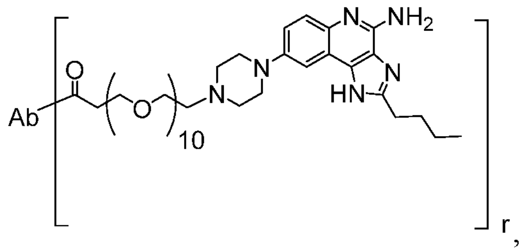
or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2 (e.g., trastuzumab (also known as HERCEPTIN™), a biosimilar thereof, or a biobetter thereof).

[0137] 12. The immunoconjugate of aspect 1, wherein the immunoconjugate is of formula:



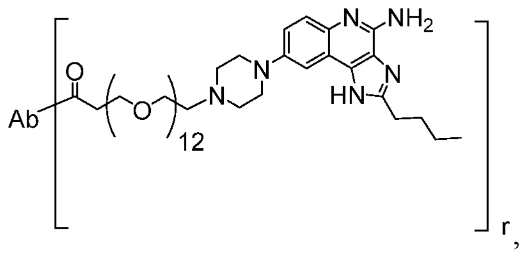
or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2 (e.g., trastuzumab (also known as HERCEPTIN™), a biosimilar thereof, or a biobetter thereof).

[0138] 13. The immunoconjugate of aspect 1, wherein the immunoconjugate is of formula:



or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2 (e.g., trastuzumab (also known as HERCEPTIN™), a biosimilar thereof, or a biobetter thereof).

[0139] 14. The immunoconjugate of aspect 1, wherein the immunoconjugate is of formula:



or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2 (e.g., trastuzumab (also known as HERCEPTIN™), a biosimilar thereof, or a biobetter thereof).

[0140] 15. The immunoconjugate of any one of aspects 1-14, wherein "Ab" is trastuzumab, a biosimilar thereof, or a biobetter thereof.

[0141] 16. The immunoconjugate of any one of aspects 1-14, wherein "Ab" is pertuzumab, a biosimilar thereof, or a biobetter thereof.

[0142] 17. The immunoconjugate of aspect 15, wherein "Ab" is trastuzumab.

[0143] 18. The immunoconjugate of aspect 15, wherein "Ab" is a biosimilar of trastuzumab.

[0144] 19. A composition comprising a plurality of immunoconjugates according to any one of aspects 1-18.

[0145] 20. The composition of aspect 19, wherein the average adjuvant to antibody construct ratio is from about 0.01 to about 10.

[0146] 21. The composition of aspect 20, wherein the average adjuvant to antibody construct ratio is from about 1 to about 10.

[0147] 22. The composition of aspect 21, wherein the average adjuvant to antibody construct ratio is from about 1 to about 6.

[0148] 23. The composition of aspect 22, wherein the average adjuvant to antibody construct ratio is from about 1 to about 4.

[0149] 24. The composition of aspect 23, wherein the average adjuvant to antibody construct ratio is from about 1 to about 3.

[0150] 25. A method for treating cancer comprising administering a therapeutically effective amount of an immunoconjugate according to any one of aspects 1-18 or a composition according to any one of aspects 19-24 to a subject in need thereof.

[0151] 26. The method of aspect 25, wherein the cancer is susceptible to a pro-inflammatory response induced by TLR7 and/or TLR8 agonism.

[0152] 27. The method of aspect 25 or 26, wherein the cancer is a HER2-expressing cancer.

[0153] 28. The method of any one of aspects 25-27, wherein the cancer is breast cancer.

[0154] 29. The method of aspect 28, wherein the breast cancer is HER2 overexpressing breast cancer.

[0155] 30. The method of any one of aspect 25-27, wherein the cancer is gastric cancer.

[0156] 31. The method of aspect 30, wherein the gastric cancer is HER2 overexpressing gastric cancer.

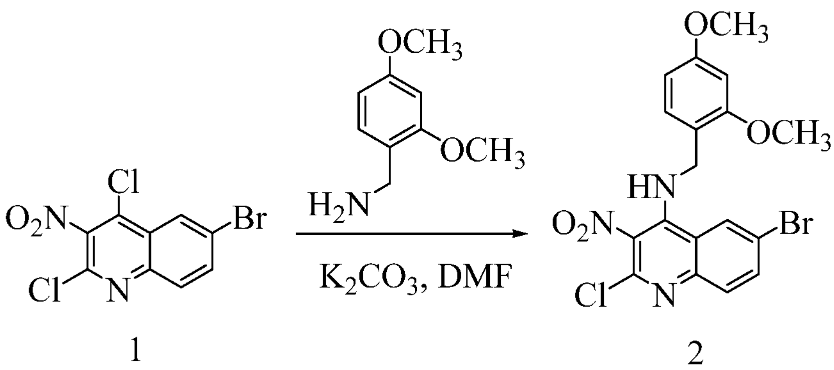
[0157] 32. The method of any one of aspect 25-27, 30, or 31, wherein the cancer is gastroesophageal junction adenocarcinoma.

[0158] 33. Use of an immunoconjugate according to any one of aspect 1-18 or a composition according to any one of aspects 19-24 for treating cancer.

EXAMPLES

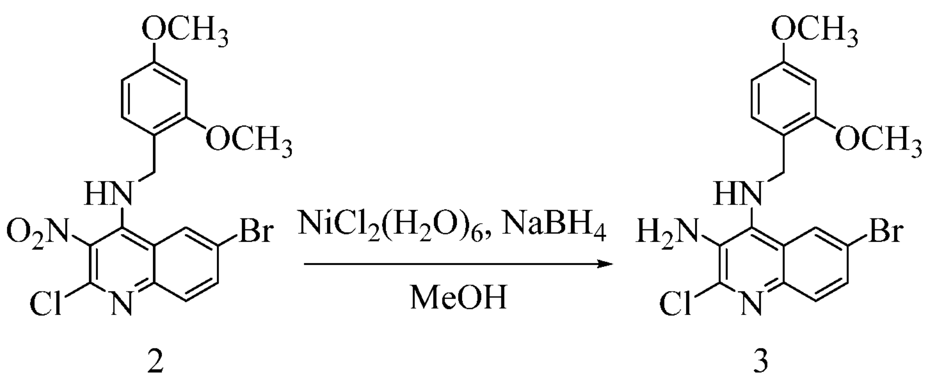
[0159] The following examples further illustrate the invention but, of course, should not be construed as in any way limiting its scope.

[0160] Example 1: Synthesis of Compound 2



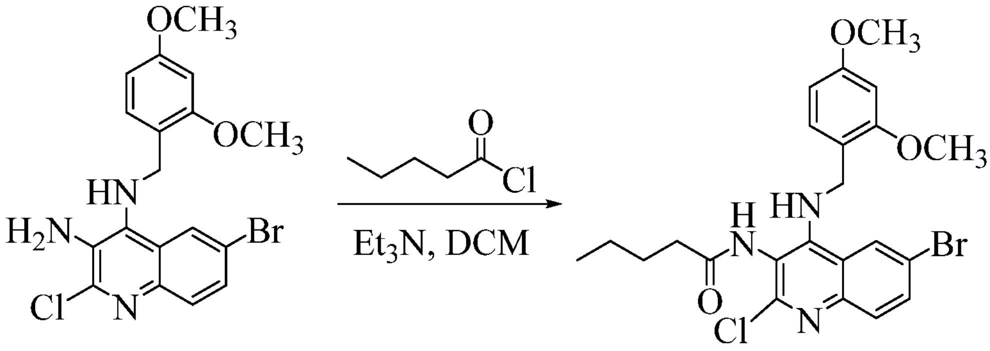
[0161] To a solution of 6-bromo-2,4-dichloro-3-nitroquinoline (5.6 g, 17.4 mmol, 1 eq.) and solid K_2CO_3 (3.6 g, 26 mmol, 1.5 eq.) in dimethylformamide (DMF, 100 mL) at room temperature was added neat 2,4-dimethoxybenzylamine (3.5 g, 20.1 mmol, 1.2 eq.). The mixture was stirred for 15 minutes, water (300 mL) was added, and then the mixture was stirred for 5 minutes. The resultant solid was filtered and then dissolved in ethyl acetate (100 mL). The solution was washed with water (100 mL), brine (100 mL), separated, dried (Na_2SO_4), then filtered and concentrated in vacuo. The brown solid was triturated with 1:1 hexanes/diethyl ether (150 mL) and filtered to obtain 6-bromo-2-chloro-4-(2,4-dimethoxybenzyl)amino-3-nitroquinoline (6.9 g, 15.3 mmol, 88%) as a yellow solid. The compound was used without further purification.

[0162] Example 2: Synthesis of Compound 3



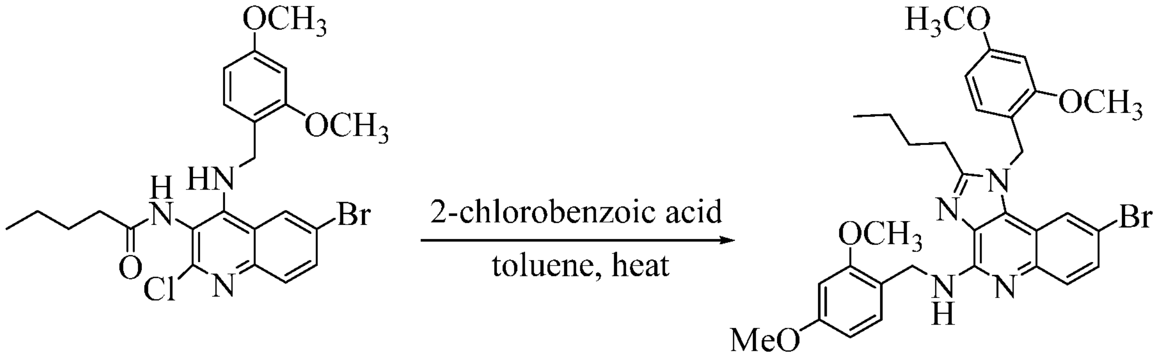
[0163] $NiCl_2{\cdot}6H_2O$ (0.36 g, 1.5 mmol, 0.1 eq.) was added to 6-bromo-2-chloro-4-(2,4-dimethoxybenzyl)amino-3-nitroquinoline (6.9 g, 15.3 mmol, 88%) in methanol (200 mL) at 0 °C. Sodium borohydride (pellets, 1.42 g, 38 mmol, 2.5 eq.) was added and the reaction was stirred for 1 h at 0 °C then warmed to room temperature and stirred for another 15 minutes. Glacial acetic acid (5 mL) was added until a pH of ~5 was obtained. The solvent was evaporated in vacuo and the crude solid was re-dissolved in ethyl acetate (150 mL) then filtered through a bed of diatomaceous earth to remove a black insoluble material. The ethyl acetate was removed in vacuo. The dark brown solid was triturated with ether (75 mL) then filtered to obtain 3-amino-6-bromo-2-chloro-4-(2,4-dimethoxybenzyl)aminoquinoline (5.81 g, 13.7 mmol, 90%) as a tan solid. The compound was used without further purification.

[0164] Example 3: Synthesis of Compound 4



[0165] Neat valeroyl chloride (2.0 mL, 2.0 g, 16 mmol, 1.2 eq) was added to a solution of 3-amino-6-bromo-2-chloro-4-(2,4-dimethoxybenzyl)aminoquinoline (5.75 g, 13.6 mmol, 1 eq.) in dichloromethane (100 mL) containing triethylamine (2.1 g, 2.8 mL, 20 mmol, 1.5 eq.) while stirred at room temperature. The mixture was washed with water (150 mL), brine (150 mL), separated, then dried (Na_2SO_4), filtered, and concentrated. The solid was triturated with ether, filtered, and then dried under vacuum. N-(6-bromo-2-chloro-4-((2,4-dimethoxybenzyl)amino)quinolin-3-yl)pentanamide was obtained as a brown solid (5.8 g, 11.4 mmol, 84%). The compound was used without further purification.

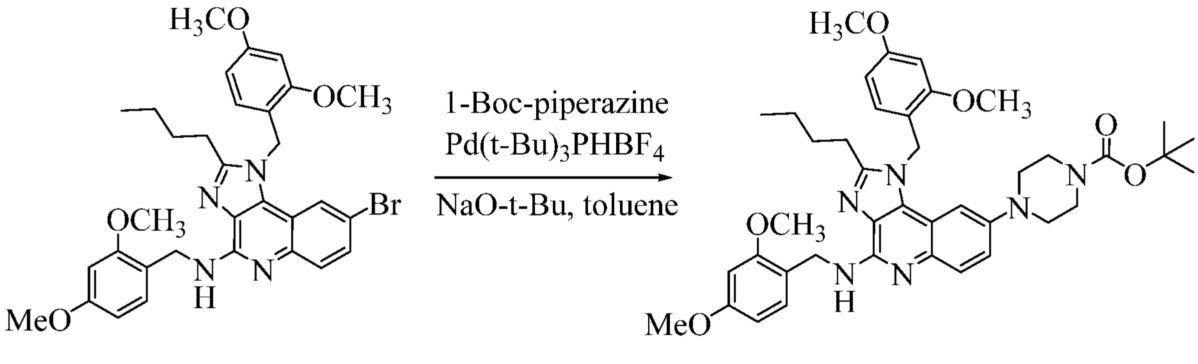
[0166] Example 4: Synthesis of Compound 5



4 5

[0167] In a 100 mL beaker a mixture of N-(6-bromo-2-chloro-4-((2,4-dimethoxybenzyl)amino)quinolin-3-yl)pentanamide (5.8 g, 11.4 mmol, 1 eq.) and 2-chlorobenzoic (0.90 g, 5.7 mmol. 0.5 eq.) was boiled in 50 mL toluene for 2 hours. Toluene was added to 50 mL each time the volume reached 25 mL. 2,4-dimethoxybenzylamine (9.5 g, 57 mmol, 5 eq.) was added and the reaction was maintained at 120 °C for 2 hours. The reaction was cooled to room temperature and water (80 mL) then acetic acid (3.5 mL) was added. The supernatant was decanted and the crude product was washed with water (80 mL). The wet solid was triturated with methanol (100 mL) to provide 8-bromo-2-butyl-N,1-bis(2,4-dimethoxybenzyl)-1H-imidazo[4,5-c]quinolin-4-amine (4.80 g, 7.7 mmol, 68%) as an off-white solid. The compound was used without further purification.

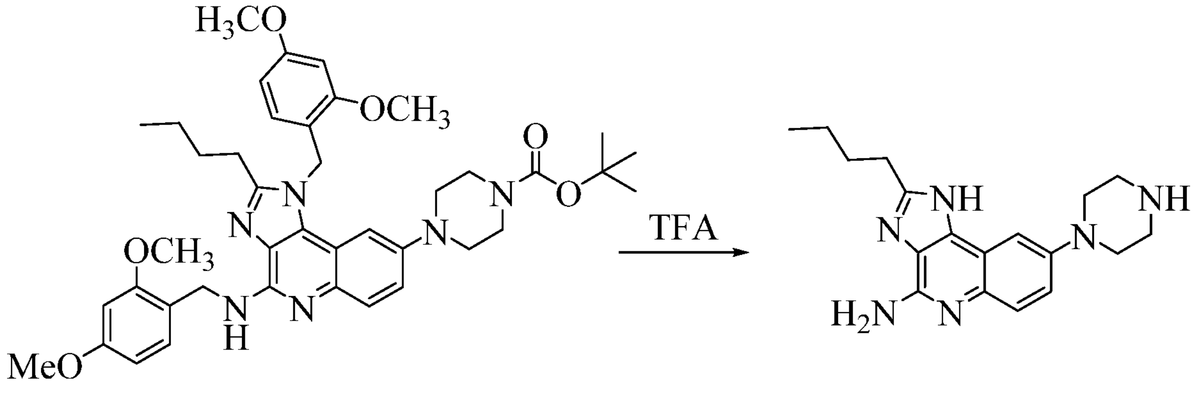
[0168] Example 5: Synthesis of Compound 6



5 6

[0169] A mixture of 8-bromo-2-butyl-N,1-bis(2,4-dimethoxybenzyl)-1H-imidazo[4,5-c]quinolin-4-amine (0.31 g, 0.5 mmol, 1 eq.) and tert-butyl piperazine-1-carboxylate (0.19 g, 1 mmol, 2 eq.) were combined in toluene (2 mL) then degassed with argon. Pd_2dba_3 (45 mg, 0.05 mmol, 0.1 eq.), tri-tert-butylphosphine tetrafluoroborate (29 mg, 0.10 mmol, 0.2 eq) and sodium tert-butoxide (144 mg, 1.5 mmol, 3 eq) were added. The mixture was heated in a capped vial at 110 °C for 30 minutes. The mixture was cooled then partitioned between ethyl acetate (50 mL) and water (50 mL). The organic layer was washed with brine (50 mL), dried with sodium sulfate, filtered and concentrated in vacuo. The crude product was purified on silica gel (20 g) and then eluted with 50% ethyl acetate/hexanes to yield tert-butyl 4-(2-butyl-1-(2,4-dimethoxybenzyl)-4-((2,4-dimethoxybenzyl)amino)-1H-imidazo[4,5-c]quinolin-8-yl)piperazine-1-carboxylate (0.28 g, 0.39 mmol, 78%) as an off-white solid. LC/MS [M+H] 725.40 (calculated); LC/MS [M+H] 725.67 (observed).

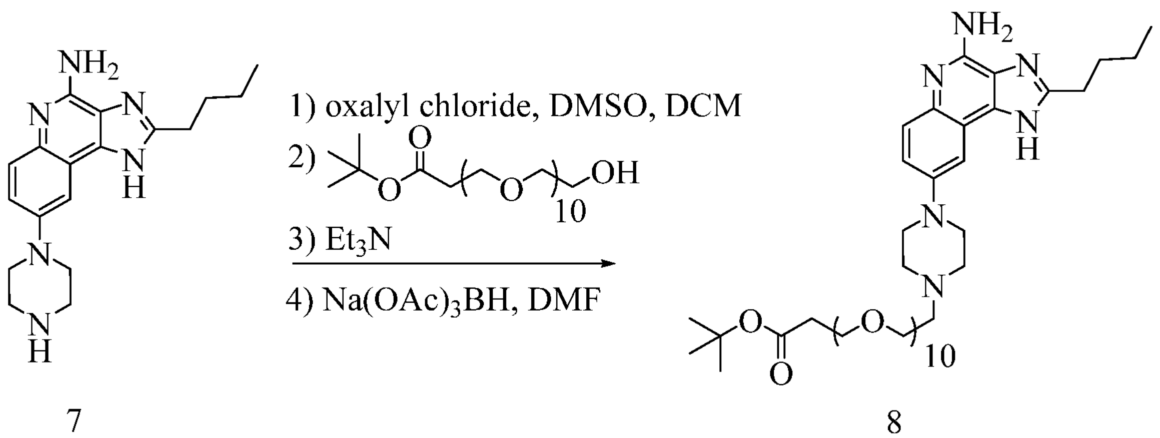
[0170] Example 6: Synthesis of Compound 7



6 7

[0171] *Tert*-butyl 4-(2-butyl-1-(2,4-dimethoxybenzyl)-4-((2,4-dimethoxybenzyl)amino)-1H-imidazo[4,5-c]quinolin-8-yl)piperazine-1-carboxylate (0.28 g, 0.39 mmol, 1 eq.) was dissolved in TFA (3 mL) and heated to reflux for 5 min. The TFA was removed in vacuo and the crude product was dissolved in acetonitrile, filtered then concentrated to obtain the TFA salt of 2-butyl-8-(piperazin-1-yl)-1H-imidazo[4,5-c]quinolin-4-amine (0.16 g, 0.37 mmol, 95%) as an off-white solid. LC/MS [M+H] 325.21 (calculated); LC/MS [M+H] 325.51 (observed).

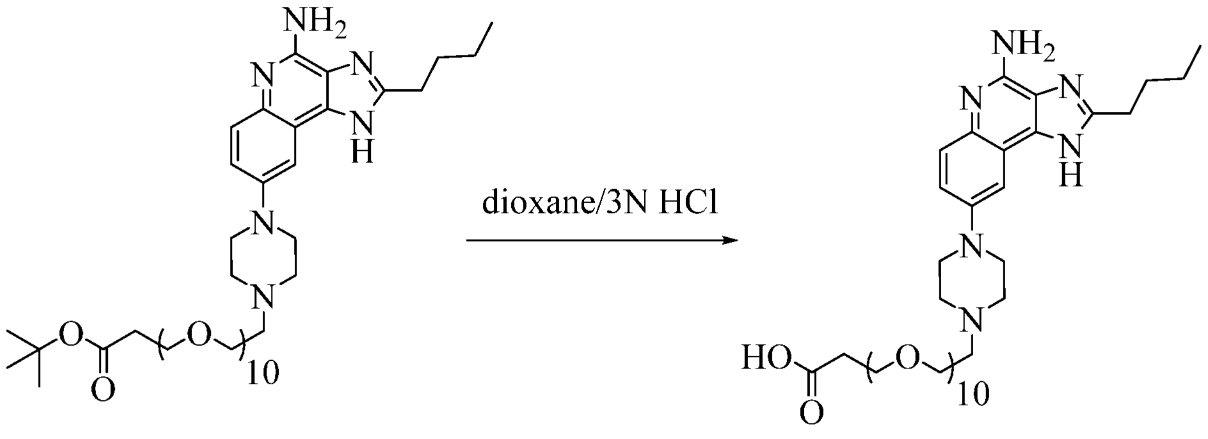
[0172] Example 7: Synthesis of Compound 8



7 8

[0173] In a 40 mL vial flushed with nitrogen, oxalyl chloride (1.84 g, 1.24 mL, 14.5 mmol, 2.5 eq) was added then dichloromethane (10 mL). The solution was cooled to -78 °C. A solution of DMSO (2.26 g, 2.05 mL, 29 mmol, 5 eq) in dichloromethane (9 mL) was added dropwise and the mixture was stirred for 15 minutes. A solution of *tert*-butyl 1-hydroxy-3,6,9,12,15,18,21,24,27,30-decaoxatritriacontan-33-oate (3.4 g, 5.8 mmol, 1 eq) in dichloromethane (9 mL) was added dropwise and the mixture was stirred for 30 minutes at -78 °C. Triethylamine (4.4 g, 6.0 mL, 43.5 mmol, 7.5 eq) was added dropwise. This mixture was stirred for 30 min at -78 °C then warmed to room temperature over 30 minutes. To a 100 mL round bottom flask containing 2-butyl-8-(piperazin-1-yl)-1*H*-imidazo[4,5-*c*]quinolin-4-amine hydrochloride (2.1 g, 5.8 mmol, 1 eq) and sodium triacetoxyborohydride (5.5 g, 26 mmol, 4.5 eq) in DMF (30 mL) was slowly added *tert*-butyl 1-oxo-3,6,9,12,15,18,21,24,27,30-decaoxatritriacontan-33-oate (theoretical amount 5.8 mmol, 1 eq) and the reaction was stirred at room temperature for 1 hour. The dichloromethane was removed under reduced pressure, and then 20% Na_2CO_3 (20 mL) was added and the mixture was stirred vigorously for 15 minutes. All of the solvent was removed and the solid material was suspended and sonicated in 10% methanol/dichloromethane, then filtered through diatomaceous earth. The filter cake was washed with 10% methanol/dichloromethane and the combined filtrates were concentrated. Purification by flash chromatography (80 g REDISEP™ gold silica column) was performed using a 2-20% MeOH/dichloromethane + 0.1% triethylamine (55 mL/min) gradient over 28 min. The pure fractions were combined and concentrated to obtain *tert*-butyl 1-(4-(4-amino-2-butyl-1*H*-imidazo[4,5-*c*]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30-decaoxatritriacontan-33-oate (3.9 g, 4.4 mmol, 75%) as a slightly golden syrup. The impure fractions containing were re-purified then combined to give a final mass (4.26 g, 4.8 mmol, 83%). LC/MS [M+H] 893.55 (calculated); LC/MS [M+H] 893.98 (observed).

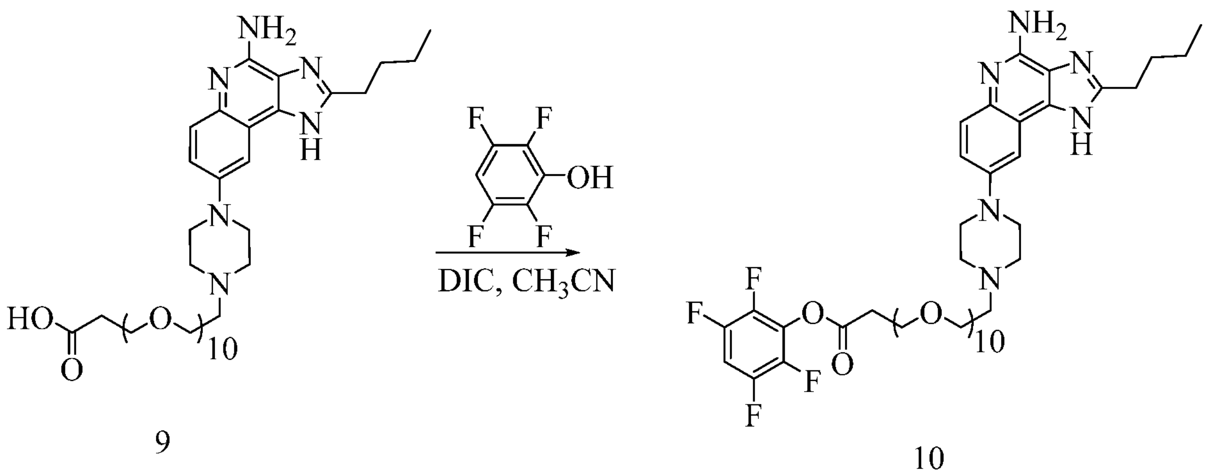
[0174] Example 8: Synthesis of Compound 9



8 9

[0175] *Tert*-butyl 1-(4-(4-amino-2-butyl-1*H*-imidazo[4,5-*c*]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30-decaoxatritriacontan-33-oate (4.26 g, 4.8 mmol) was dissolved in a 1:1 mixture of 3 M aq. HCl and dioxane (100 mL) and heated at 60 °C for 60 min. After hydrolysis was complete the solvent was removed under reduced pressure. The 1-(4-(4-amino-2-butyl-1*H*-imidazo[4,5-*c*]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30-decaoxatritriacontan-33-oic acid hydrochloride obtained was azeotroped 4 times with acetonitrile (75 mL) then suspended in acetonitrile (75 mL) and centrifuged at 4000 rpm for 4 minutes. This process was repeated. The solid was transferred to a 100 mL round bottom flask with acetonitrile and concentrated by under reduced pressure to obtain a yellow, hygroscopic solid (4.0 g, 4.6 mmol, 95%) that was used as is in the next reaction. LC/MS [M+H] 837.49 (calculated); LC/MS [M+H] 837.84 (observed).

[0176] Example 9: Synthesis of Compound 10

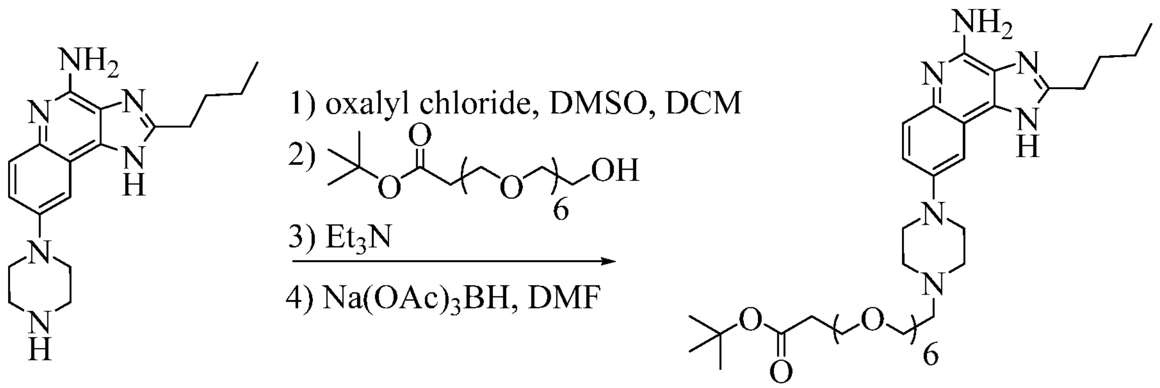


9 10

[0177] To a 250 mL round bottom flask containing the 1-(4-(4-amino-2-butyl-1*H*-imidazo[4,5-*c*]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30-decaoxatritriacontan-

33-oic acid hydrochloride (4.0 g, 4.6 mmol, 1 eq) was added a suspension of 2,3,5,6-tetrafluorophenol (1.64 g, 10 mmol, 2.4 eq) and EDC (2.0 g, 11 mmol, 2.3 eq.) in anhydrous DMF (50 mL) and the mixture was allowed to stir at room temperature for 30 minutes. The mixture was then heated at 50 °C for 30 minutes. Most of the DMF (~90%) was removed by azeotroping with toluene (80 mL) under reduced pressure with the bath temperature set to 50 °C. To this crude material was added diethyl ether (100 mL) and the pasty solid was stirred vigorously. The supernatant was discarded. This process was repeated. The crude material was dissolved in 40 mL ethyl acetate/acetone/acetic acid/water (6:2:1:1). The crude solution was divided into two equal portions and each was purified on a 40 g REDISEP™ gold silica column (Teledyne Isco, Lincoln, Nebraska) using isocratic eluent ethyl acetate/acetone/acetic acid/water (6:2:1:1) to obtain 2,3,5,6-tetrafluorophenyl 1-(4-(4-amino-2-butyl-1*H*-imidazo[4,5-*c*]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30-decaoxatritriacontan-33-oate (3.34 g, 3.4 mmol, 74%) as an orange paste. LC/MS [M+H] 985.49 (calculated); LC/MS [M+H] 985.71 (observed).

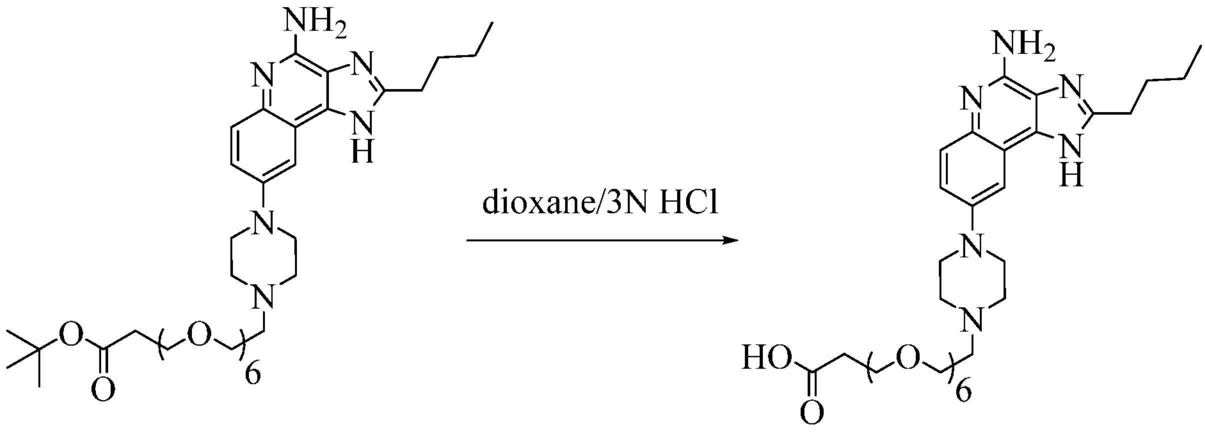
[0178] Example 10: Synthesis of Compound 11



7 11

[0179] 2-butyl-8-(piperazin-1-yl)-1*H*-imidazo[4,5-*c*]quinolin-4-amine was converted into *tert*-butyl 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18-hexaoxahenicosan-21-oate according to the procedure described in Example 7. LC/MS [M+H] 717.45 (calculated); LC/MS [M+H] 717.75 (observed).

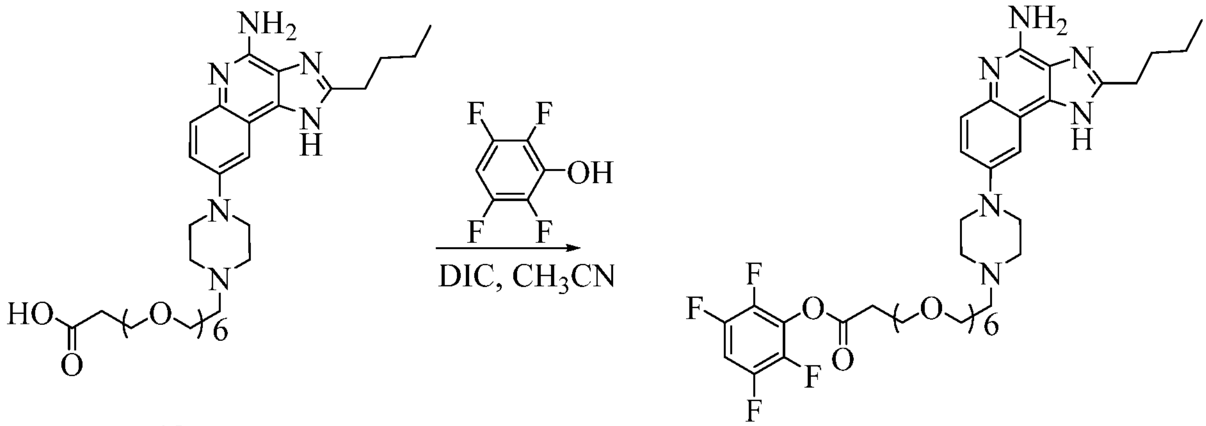
[0180] Example 11: Synthesis of Compound 12



11 12

[0181] *Tert*-butyl 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18-hexaoxahenicosan-21-oate was converted into 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18-hexaoxahenicosan-21-oic acid according to the procedure described in Example 8. LC/MS [M+H] 661.39 (calculated); LC/MS [M+H] 661.60 (observed).

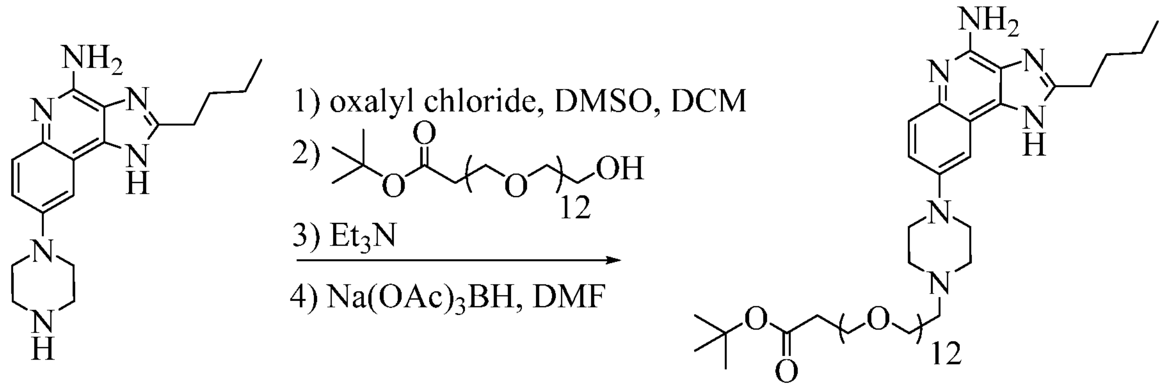
[0182] Example 12: Synthesis of Compound 13



12 13

[0183] 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18-hexaoxahenicosan-21-oic acid was converted into 2,3,5,6-tetrafluorophenyl 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18-hexaoxahenicosan-21-oate according to the procedure described in Example 9. LC/MS [M+H] 809.39 (calculated); LC/MS [M+H] 809.62 (observed).

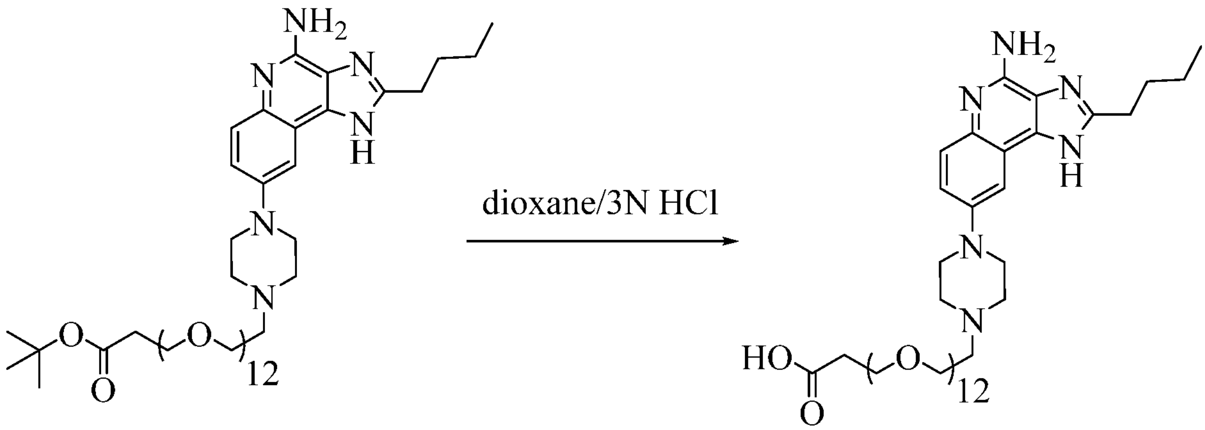
[0184] Example 13: Synthesis of Compound 14



7 14

[0185] 2-butyl-8-(piperazin-1-yl)-1*H*-imidazo[4,5-*c*]quinolin-4-amine was converted into tert-butyl 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30,33,36-dodecaoxanonatriacontan-39-oate according to the procedure described in Example 7. LC/MS [M+H] 981.61 (calculated); LC/MS [M+H] 981.86 (observed).

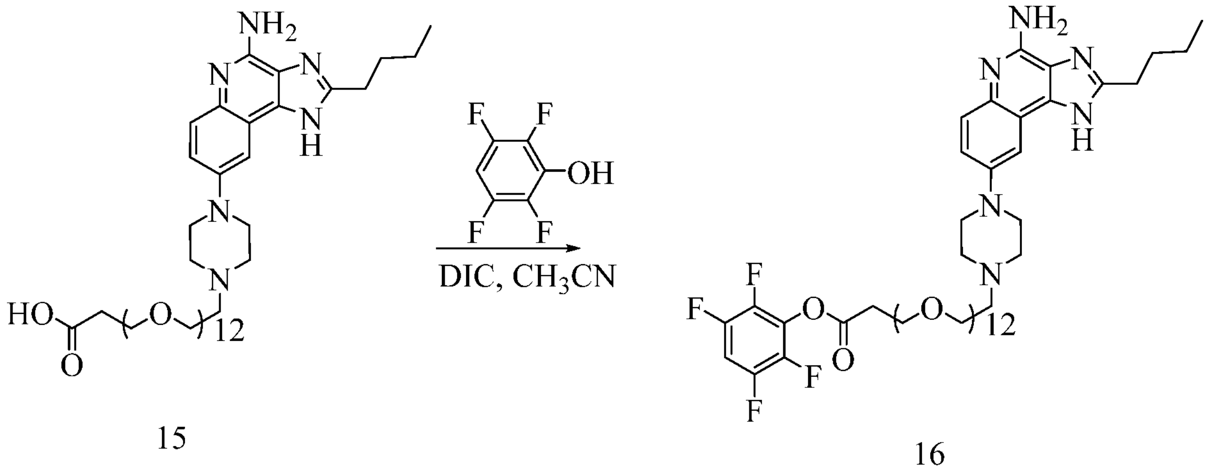
[0186] Example 14: Synthesis of Compound 15



14 15

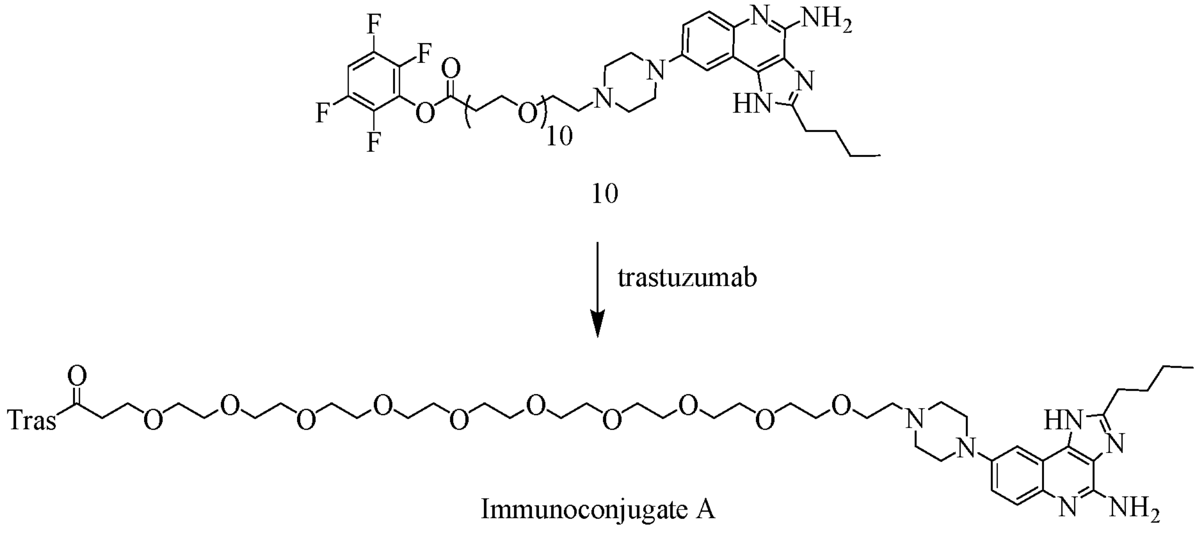
[0187] *Tert*-butyl 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30,33,36-dodecaoxanonatriacontan-39-oate was converted into 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30,33,36-dodecaoxanonatriacontan-39-oic acid according to the procedure described in Example 8. Compound was used without further purification.

[0188] Example 15: Synthesis of Compound 16



[0189] 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30,33,36-dodecaoxanonatriacontan-39-oic acid was converted into 2,3,5,6-tetrafluorophenyl 1-(4-(4-amino-2-butyl-1H-imidazo[4,5-c]quinolin-8-yl)piperazin-1-yl)-3,6,9,12,15,18,21,24,27,30,33,36-dodecaoxanonatriacontan-39-oate according to the procedure described in Example 9. LC/MS [M+H] 1073.54 (calculated); LC/MS [M+H] 1073.81 (observed).

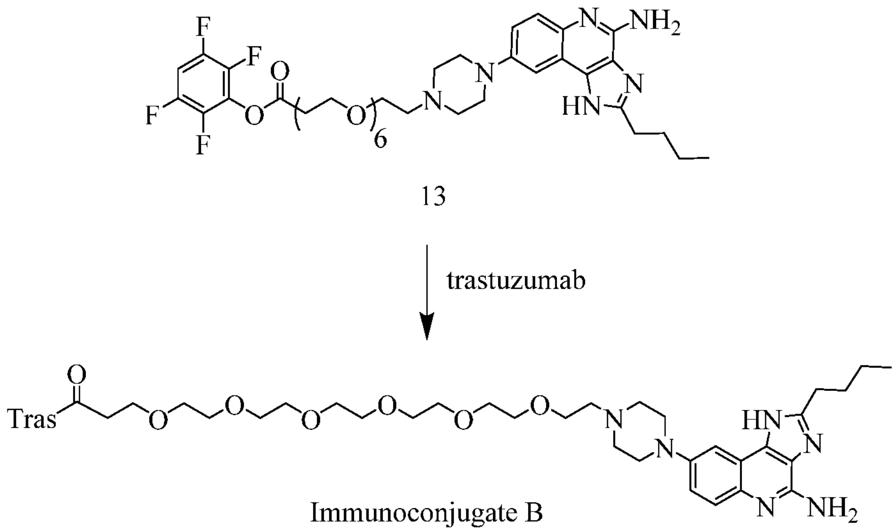
[0190] Example 16: Synthesis of Immunoconjugate A



[0191] This example demonstrates the synthesis of Immunoconjugate A with trastuzumab as the antibody construct (Tras).

[0192] Trastuzumab was buffer exchanged into the conjugation buffer containing 100 mM boric acid, 50 mM sodium chloride, 1 mM ethylenediaminetetraacetic acid at pH 8.3, using G-25 SEPHADEX™ desalting columns (Sigma-Aldrich, St. Louis, MO). The eluates were then each adjusted to 6 mg/ml using the buffer and sterile filtered. Trastuzumab at 6 mg/ml was pre-warmed to 30 °C and rapidly mixed with 7 molar equivalents of Compound 10. The reaction was allowed to proceed for 16 hours at 30 °C and Immunoconjugate A was separated from reactants by running over two successive G-25 desalting columns equilibrated in phosphate buffered saline at pH 7.2. Adjuvant-antibody ratios (DAR) was determined by liquid chromatography mass spectrometry analysis using a C4 reverse phase column on an ACQUITY™ UPLC H-class (Waters Corporation, Milford, Massachusetts) connected to a XEVO™ G2-XS TOF mass spectrometer (Waters Corporation). Immunoconjugate A had a DAR of 2.5.

[0193] Example 17: Synthesis of Immunoconjugate B

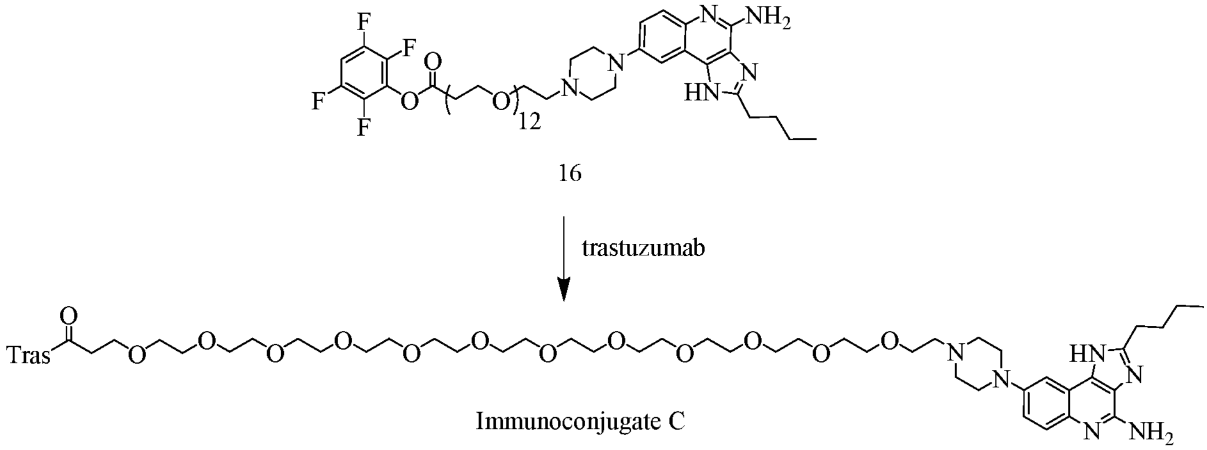


Immunoconjugate B

[0194] This example demonstrates the synthesis of Immunoconjugate B with trastuzumab as the antibody construct (Tras).

[0195] Trastuzumab was buffer exchanged into the conjugation buffer containing 100 mM boric acid, 50 mM sodium chloride, 1 mM ethylenediaminetetraacetic acid at pH 8.3, using G-25 SEPHADEX™ desalting columns (Sigma-Aldrich). The eluates were then each adjusted to 6 mg/ml using the buffer and sterile filtered. Trastuzumab at 6 mg/ml was pre-warmed to 30 °C and rapidly mixed with 8.5 molar equivalents of Compound 13. The reaction was allowed to proceed for 16 hours at 30 °C and Immunoconjugate B was separated from reactants by running over two successive G-25 SEPHADEX™ desalting columns (Sigma-Aldrich) equilibrated in phosphate buffered saline at pH 7.2. Adjuvant-antibody ratios (DAR) was determined by liquid chromatography mass spectrometry analysis using a C4 reverse phase column on an ACQUITY™ UPLC H-class (Waters Corporation, Milford, Massachusetts) connected to a XEVO™ G2-XS TOF mass spectrometer (Waters Corporation). Immunoconjugate B had a DAR of 2.37.

[0196] Example 18: Synthesis of Immunoconjugate C



[0197] This example demonstrates the synthesis of Immunoconjugate C with trastuzumab as the antibody construct (Tras).

[0198] Trastuzumab was buffer exchanged into the conjugation buffer containing 100 mM boric acid, 50 mM sodium chloride, 1 mM ethylenediaminetetraacetic acid at pH 8.3, using G-25 SEPHADEX™ desalting columns (Sigma-Aldrich). The eluates were then each adjusted to 6 mg/ml using the buffer and sterile filtered. Trastuzumab at 6 mg/ml was pre-warmed to 30 °C and rapidly mixed with 6 molar equivalents of Compound 16. The reaction was allowed to proceed for 16 hours at 30 °C and Immunoconjugate C was separated from reactants by running over two successive G-25 desalting columns equilibrated in phosphate buffered saline at pH 7.2. Adjuvant-antibody ratios (DAR) was determined by liquid chromatography mass spectrometry analysis using a C4 reverse phase column on an ACQUITY™ UPLC H-class (Waters Corporation, Milford, Massachusetts) connected to a XEVO™ G2-XS TOF mass spectrometer (Waters Corporation). Immunoconjugate C had a DAR of 2.15.

[0199] Example 19. Assessment of Immunoconjugate Activity *In Vitro*

[0200] This example shows that Immunoconjugate A, Immunoconjugate B, and Immunoconjugate C are effective at eliciting myeloid activation, and therefore are useful for the treatment of cancer.

[0201] *Isolation of Human Antigen Presenting Cells.* Human myeloid antigen presenting cells (APCs) were negatively selected from human peripheral blood obtained from healthy blood donors (Stanford Blood Center, Palo Alto, California) by density gradient centrifugation using a ROSETTESEP™ Human Monocyte Enrichment Cocktail (Stem Cell Technologies, Vancouver, Canada) containing monoclonal antibodies against CD14, CD16, CD40, CD86, CD123, and HLA-DR. Immature APCs were subsequently purified to >97% purity via negative selection using an EASYSEP™ Human Monocyte Enrichment Kit (Stem Cell Technologies) without CD16 depletion containing monoclonal antibodies against CD14, CD16, CD40, CD86, CD123, and HLA-DR.

[0202] *Preparation of Tumor Cells.* Three tumor cell lines were used: HCC1954, JIMT-1, and COLO 205. HCC1954 (American Type Culture Collection (ATCC), Manassas, Virginia) was derived from a primary stage IIA, grade 3 invasive ductal carcinoma with no lymph node metastases. HCC1954 is positive for the epithelial cell specific marker Epithelial Glycoprotein 2 and for cytokeratin 19, and is negative for expression of estrogen receptor (ER) and progesterone receptor (PR). HCC1954 overexpresses HER2 (as determined by enzyme-linked immunosorbent assay (ELISA)). JIMT-1 (DSMZ, Braunschweig, Germany) was derived from the pleural effusion of a woman with ductal breast cancer (grade 3 invasive, stage IIB) following postoperative radiation. JIMT-1 overexpresses HER2 at what is considered to be a "medium" level of overexpression, but is insensitive to HER2-inhibiting drugs (e.g. trastuzumab). COLO 205 (ATCC) was derived from the ascites fluid of man with carcinoma of the colon. COLO 205 expresses carcinoembryonic antigen (CEA), keratin, interleukin 10 (IL-10), and is considered to overexpress HER2 at relatively "low" level of overexpression.

[0203] Tumor cells from each cell line were separately re-suspended in PBS with 0.1% fetal bovine serum (FBS) at 1 to 10 x 10^6 cells/mL. Cells were subsequently incubated with 2 μM carboxyfluorescein succinimidyl ester (CFSE) to yield a final concentration of 1 μM. The reaction was quenched after 2 minutes via the addition of 10 mL complete medium with 10% FBS and washed twice with complete medium. Cells were either fixed in 2% paraformaldehyde and washed three times with PBS or left viable prior to use.

[0204] *APC-Tumor Co-cultures.* 2 x 10^5 APCs were incubated with (e.g., FIG. 1A-1I) or without (e.g., FIG. 2A-3D) CFSE-labeled tumor cells between a 5:1 and 10:1 effector to target (tumor) cell ratio in 96-well plates (Corning, Corning, NY) containing iscove's modified dulbecco's medium (IMDM) (Thermo Fisher Scientific, Waltham, MA) supplemented with 10% FBS, 100 U/mL penicillin, 100 μg/mL streptomycin, 2 mM L-glutamine, sodium pyruvate, non-essential amino acids, and, where indicated, various concentrations of unconjugated HER2 antibody, Immunoconjugate A, Immunoconjugate B, and Immunoconjugate C of the invention (as prepared according to the examples above). Cells and cell-free supernatants were analyzed after 18 hours via flow cytometry or ELISA.

[0205] The results of this assay are shown in the figures, for example, FIG. 1A (CD40) and FIG. 1B (CD86) for Immunoconjugate A on the HCC1954 cell line, FIG. 1D (CD40) and FIG. 1E (CD86) for Immunoconjugate A on the JIMT-1 cell line, and FIG. 1G (CD40) and FIG. 1H (CD86) for Immunoconjugate A on the COLO 205 cell line.

[0206] FIG. 2A shows that Immunoconjugate B elicits myeloid differentiation as indicated by CD14 downregulation. Fig. 2B shows that Immunoconjugate B elicits myeloid activation as indicated by CD40 upregulation. Fig. 2C shows that Immunoconjugate B elicits myeloid activation as indicated by CD86 upregulation. Fig. 3A shows that Immunoconjugate C elicits myeloid differentiation as indicated by CD14 downregulation. Fig. 3B shows that Immunoconjugate C elicits myeloid activation as indicated by CD40 upregulation. Fig. 3C shows that Immunoconjugate C elicits myeloid activation as indicated by CD86 upregulation.

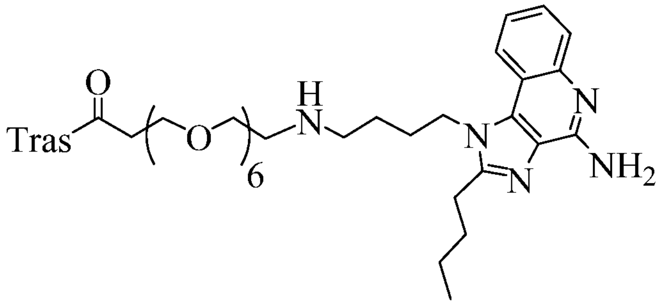
[0207] While the expression of T cell stimulatory molecules such as CD40 and CD86 are necessary for effective T cell activation, APCs also influence the nature of the ensuing immune response through the secretion of proinflammatory cytokines. Therefore, the capacity of immunoconjugates to elicit cytokine secretion in human APCs following stimulation was investigated. The data indicate that the immunoconjugate-stimulated cells secreted high levels of TNFα. See FIG. 1C for Immunoconjugate A co-cultured with the HCC1954 cell line, FIG. 1F for Immunoconjugate A co-cultured with the JIMT-1 cell line, and FIG. 1I for Immunoconjugate A co-cultured with the COLO 205 cell line. Fig. 2D shows TNFα secretion from myeloid cells following an 18 hour incubation with Immunoconjugate B. Fig. 3D shows TNFα secretion from myeloid cells following an 18 hour incubation with Immunoconjugate C.

[0208] Example 20. Assessment of the pharmacokinetics (PK) properties of Immunoconjugate B and Immunoconjugate C

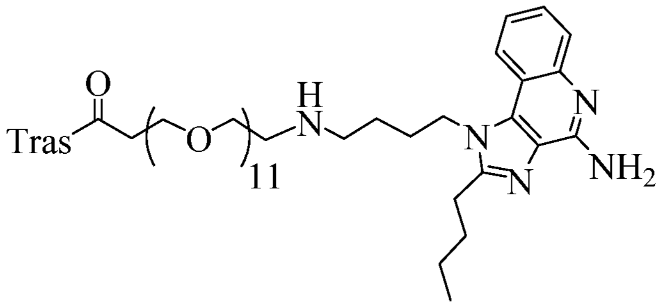
[0209] This example shows that Immunoconjugate B and Immunoconjugate C have favorable PK properties.

[0210] Cynomolgus primates (*Macaca fascicularis*) were dosed with 10 mg/kg of Immunoconjugate B, Immunoconjugate C, Immunoconjugate D, Immunoconjugate E, Immunoconjugate F, or Immunoconjugate G, as shown in Scheme 1, and the PK properties were assessed for 28 days following administration.

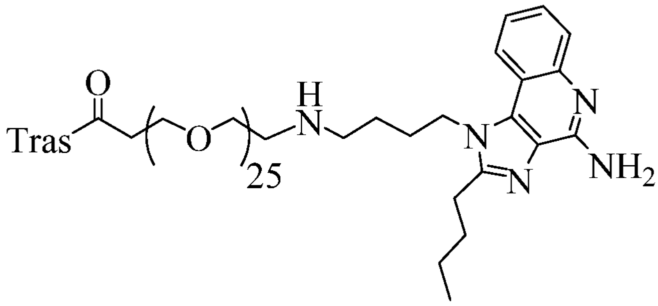
[0211] Scheme 1.



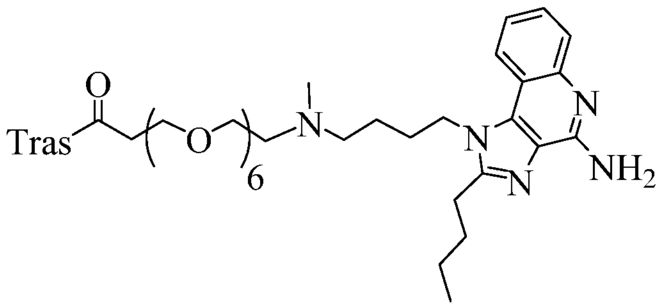
Immunoconjugate D



Immunoconjugate E



Immunoconjugate F



Immunoconjugate G

[0212] A trastuzumab PK assay was configured to capture trastuzumab with HCA169 anti-idiotype mAb and to detect with peroxidase labeled HCA176 (HCA176P). An antibody drug conjugate assay was configured to capture trastuzumab with HCA169 anti-idiotype mAb and to detect with a rabbit mAb to A103 followed by detection with peroxidase labeled

Goat anti-rabbit IgG. Immunoconjugate B and Immunoconjugate C demonstrated higher serum levels in both PK assays as compared to Immunoconjugate D, Immunoconjugate E, Immunoconjugate, F, and Immunoconjugate G.

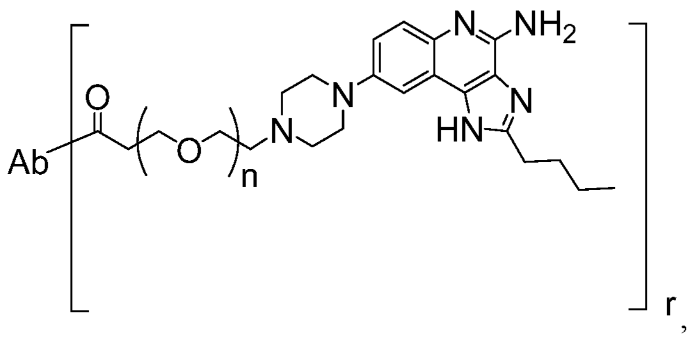
[0213] All references, including publications, patent applications, and patents, cited herein are hereby incorporated by reference to the same extent as if each reference were individually and specifically indicated to be incorporated by reference and were set forth in its entirety herein.

[0214] The use of the terms "a" and "an" and "the" and "at least one" and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The use of the term "at least one" followed by a list of one or more items (for example, "at least one of A and B") is to be construed to mean one item selected from the listed items (A or B) or any combination of two or more of the listed items (A and B), unless otherwise indicated herein or clearly contradicted by context. The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

[0215] Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. Variations of those preferred embodiments may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

CLAIMS:

1. An immunoconjugate of formula:



or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10, subscript n is an integer from about 2 to about 25, and “Ab” is an antibody construct that has an antigen binding domain that binds HER2.

2. The immunoconjugate of claim 1, wherein subscript r is an integer from 1 to 6.

3. The immunoconjugate of claim 1, wherein subscript r is an integer from 1 to 4.

4. The immunoconjugate of claim 1, wherein subscript r is 1.

5. The immunoconjugate of claim 1, wherein subscript r is 2.

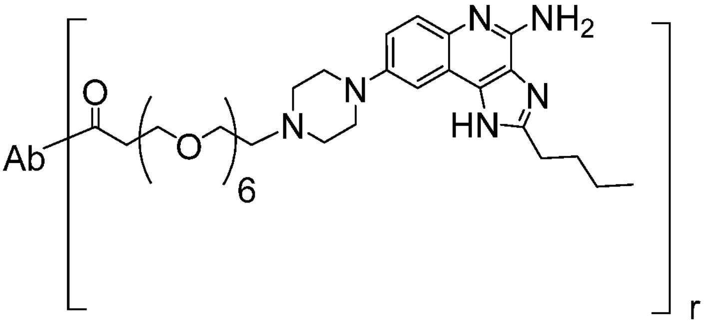
6. The immunoconjugate of claim 1, wherein subscript r is 3.

7. The immunoconjugate of claim 1, wherein subscript r is 4.

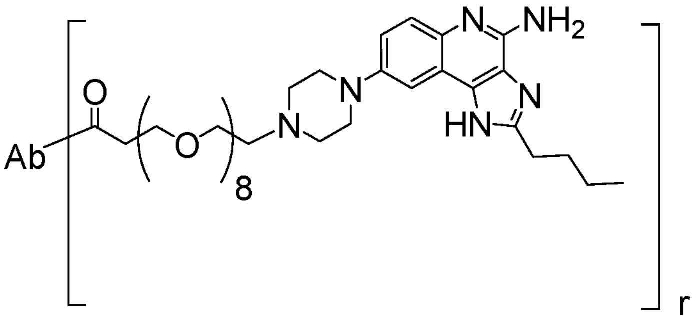
8. The immunoconjugate of any one of claims 1-7, wherein subscript n is an integer from 6 to 12.

9. The immunoconjugate of claim 8, wherein subscript n is an integer from 8 to 12.

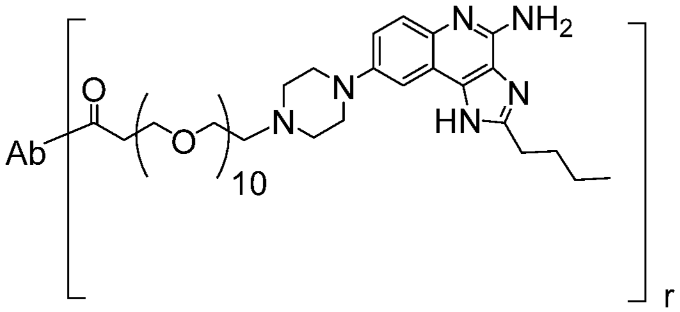
10. The immunoconjugate of claim 1, wherein the immunoconjugate is of formula:


Ab
O
O
6
N
N
N
NH2
N
HN
r

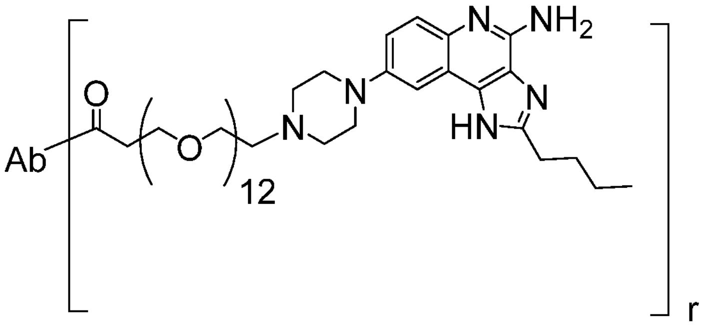
,


Ab
O
O
8
N
N
N
NH2
N
HN
r

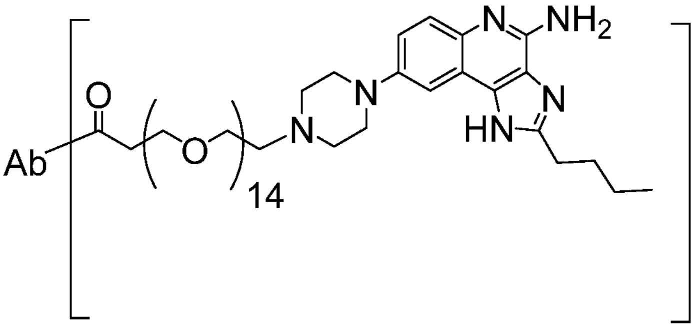
,


Ab
O
O
10
N
N
N
NH2
N
HN
r

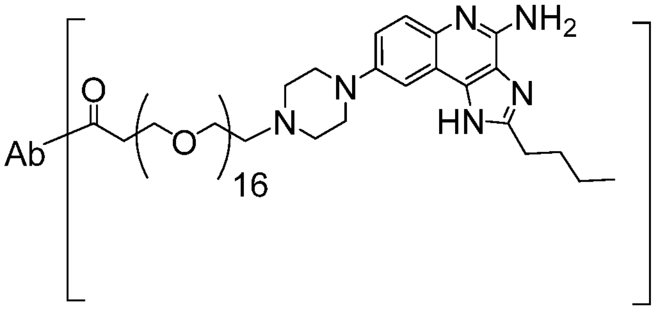
,


Ab
O
O
12
N
N
N
NH2
N
HN
r

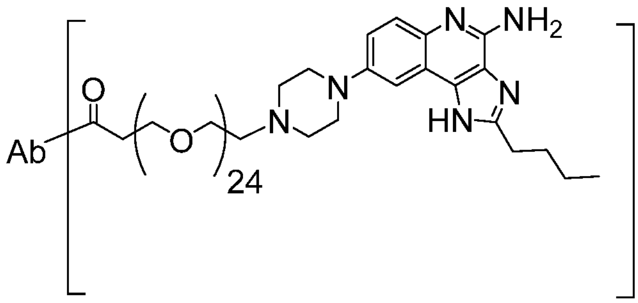
,



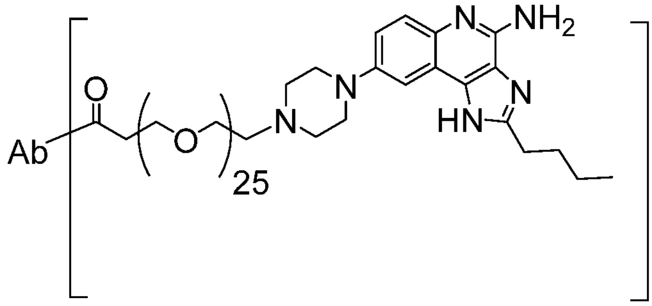
r,



r,



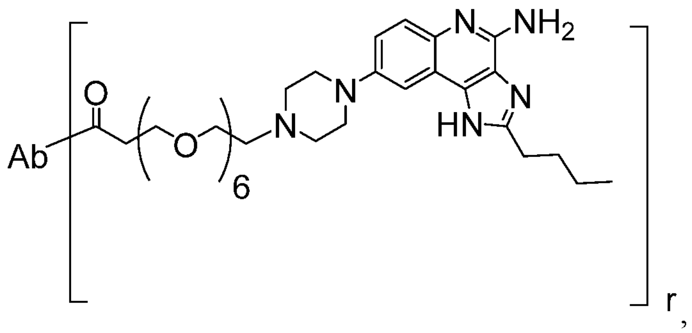
r, or



r,

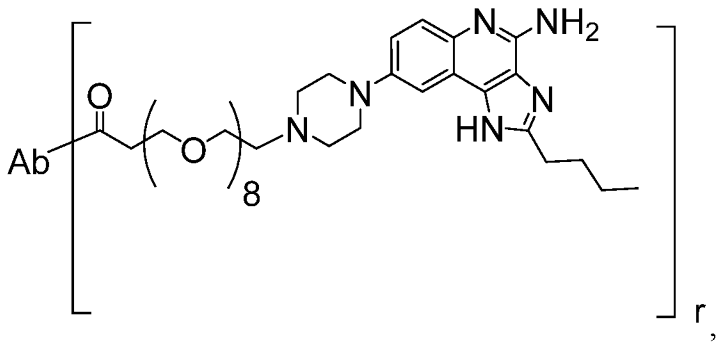
or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2.

11. The immunoconjugate of claim 1, wherein the immunoconjugate is of formula:



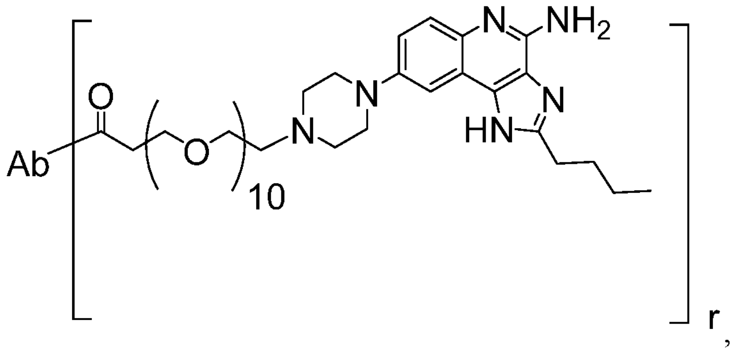
or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2.

12. The immunoconjugate of claim 1, wherein the immunoconjugate is of formula:



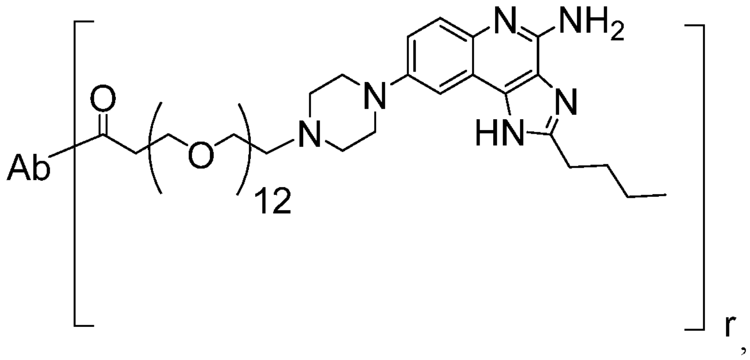
or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2.

13. The immunoconjugate of claim 1, wherein the immunoconjugate is of formula:



or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2.

14. The immunoconjugate of claim 1, wherein the immunoconjugate is of formula:



or pharmaceutically acceptable salt thereof, wherein subscript r is an integer from 1 to 10 and "Ab" is an antibody construct that has an antigen binding domain that binds HER2.

15. The immunoconjugate of any one of claims 1-14, wherein "Ab" is trastuzumab, a biosimilar thereof, or a biobetter thereof.

16. The immunoconjugate of any one of claims 1-14, wherein "Ab" is pertuzumab, a biosimilar thereof, or a biobetter thereof.

17. The immunoconjugate of claim 15, wherein "Ab" is trastuzumab.

18. The immunoconjugate of claim 15, wherein "Ab" is a biosimilar of trastuzumab.

19. A composition comprising a plurality of immunoconjugates according to any one of claims 1-18.

20. The composition of claim 19, wherein the average adjuvant to antibody construct ratio is from about 0.01 to about 10.

21. The composition of claim 20, wherein the average adjuvant to antibody construct ratio is from about 1 to about 10.

22. The composition of claim 21, wherein the average adjuvant to antibody construct ratio is from about 1 to about 6.

23. The composition of claim 22, wherein the average adjuvant to antibody construct ratio is from about 1 to about 4.

24. The composition of claim 23, wherein the average adjuvant to antibody construct ratio is from about 1 to about 3.

25. A method for treating cancer comprising administering a therapeutically effective amount of an immunoconjugate according to any one of claims 1-18 or a composition according to any one of claims 19-24 to a subject in need thereof.

26. The method of claim 25, wherein the cancer is susceptible to a pro-inflammatory response induced by TLR7 and/or TLR8 agonism.

27. The method of claim 25 or 26, wherein the cancer is a HER2-expressing cancer.

28. The method of any one of claims 25-27, wherein the cancer is breast cancer.

29. The method of claim 28, wherein the breast cancer is HER2 overexpressing breast cancer.

30. The method of any one of claims 25-27, wherein the cancer is gastric cancer.

31. The method of claim 30, wherein the gastric cancer is HER2 overexpressing gastric cancer.

32. The method of any one of claims 25-27, 30, or 31, wherein the cancer is gastroesophageal junction adenocarcinoma.

33. Use of an immunoconjugate according to any one of claims 1-18 or a composition according to any one of claims 19-24 for treating cancer.

HCC1954

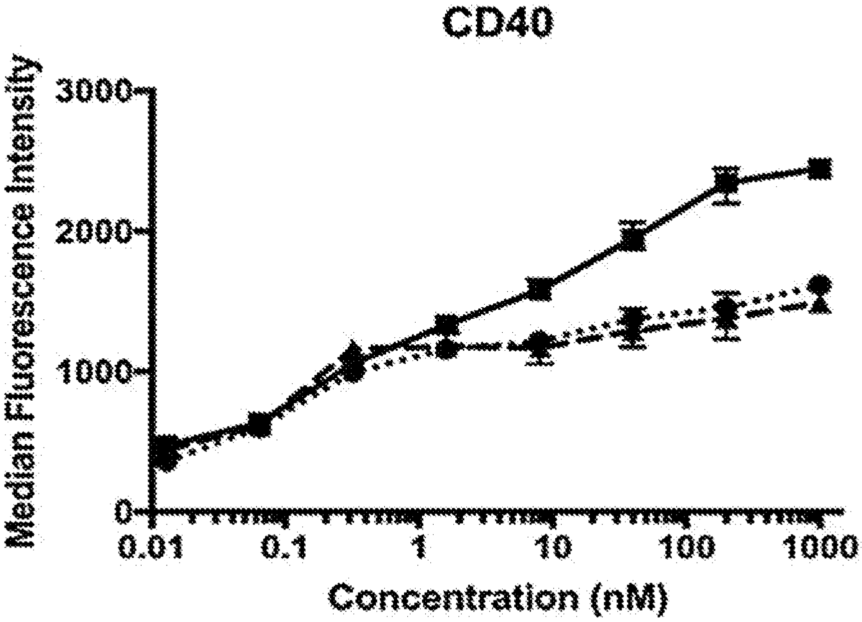


FIG. 1A

HCC1954

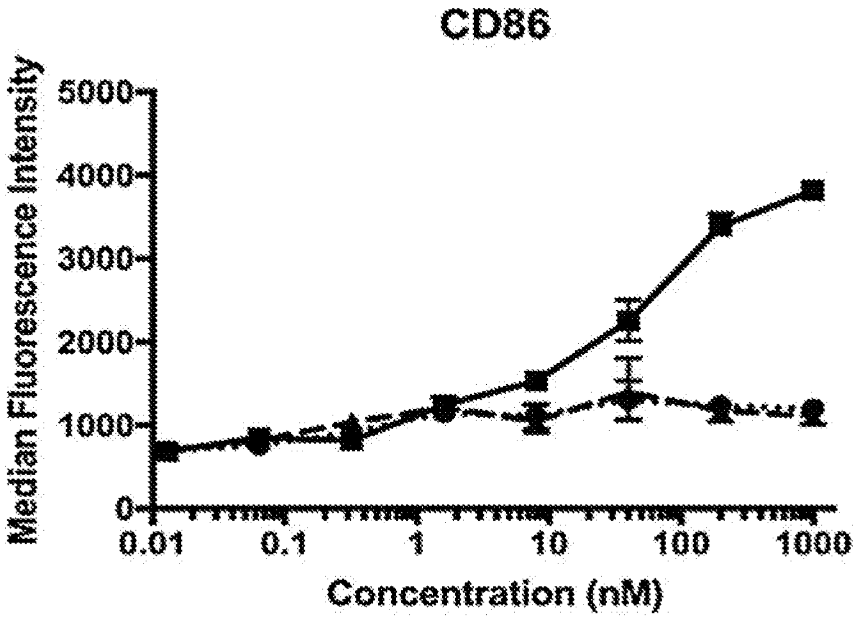


FIG. 1B

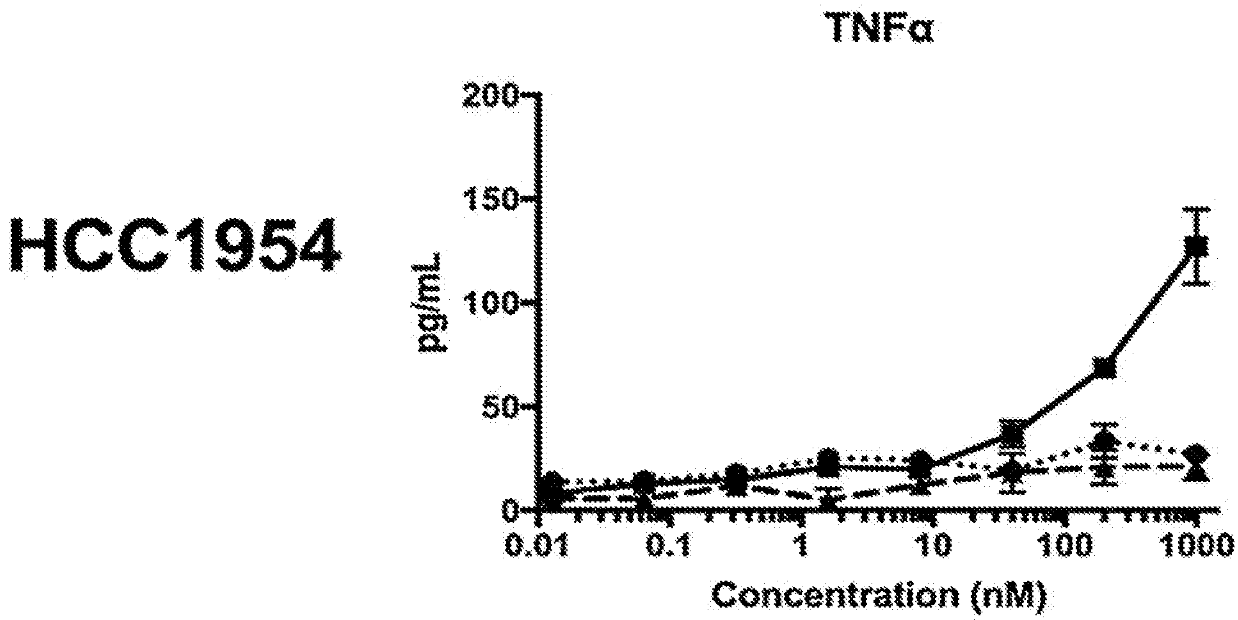

HCC1954
TNFα
pg/mL
200
150
100
50
0
0.01
0.1
1
10
100
1000
Concentration (nM)

FIG. 1C

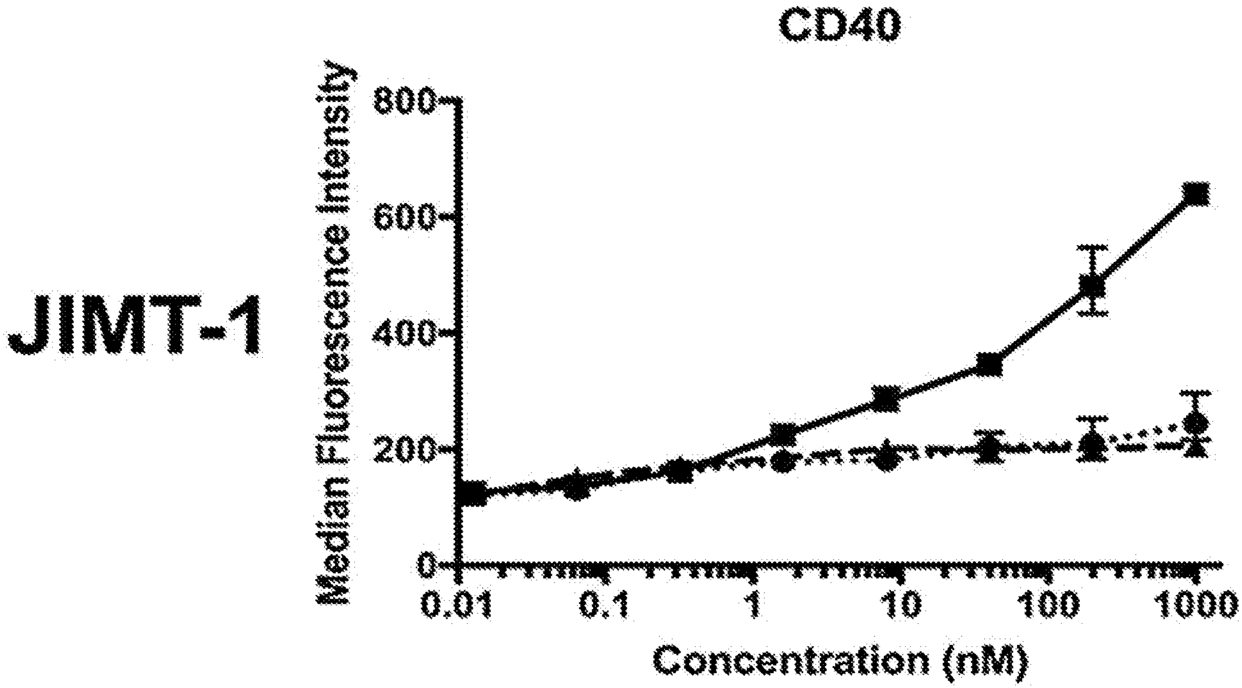

JIMT-1
CD40
Median Fluorescence Intensity
800
600
400
200
0
0.01
0.1
1
10
100
1000
Concentration (nM)

FIG. 1D

JIMT-1

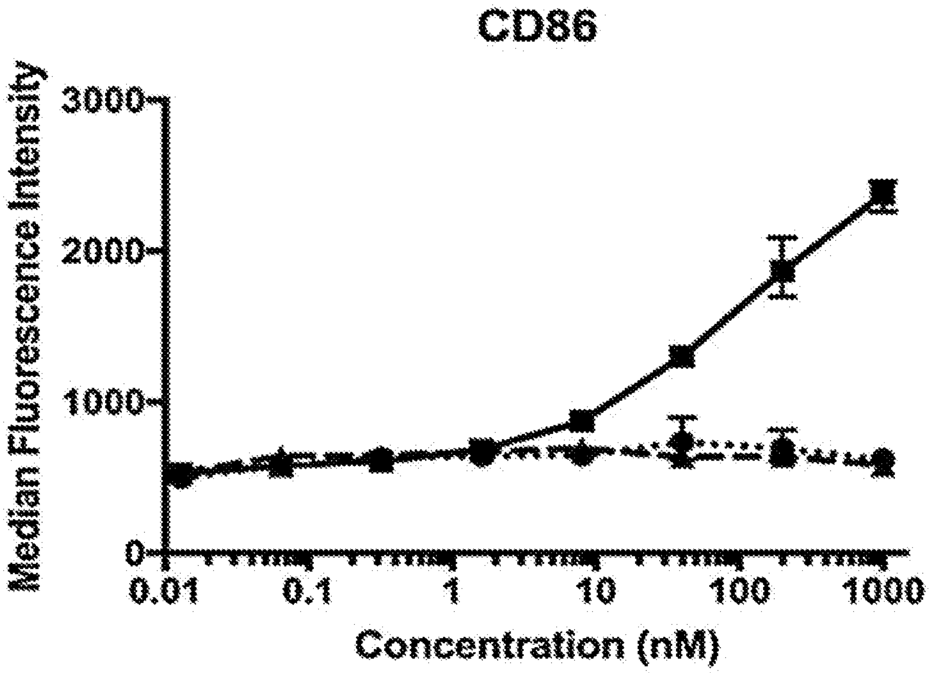


FIG. 1E

JIMT-1

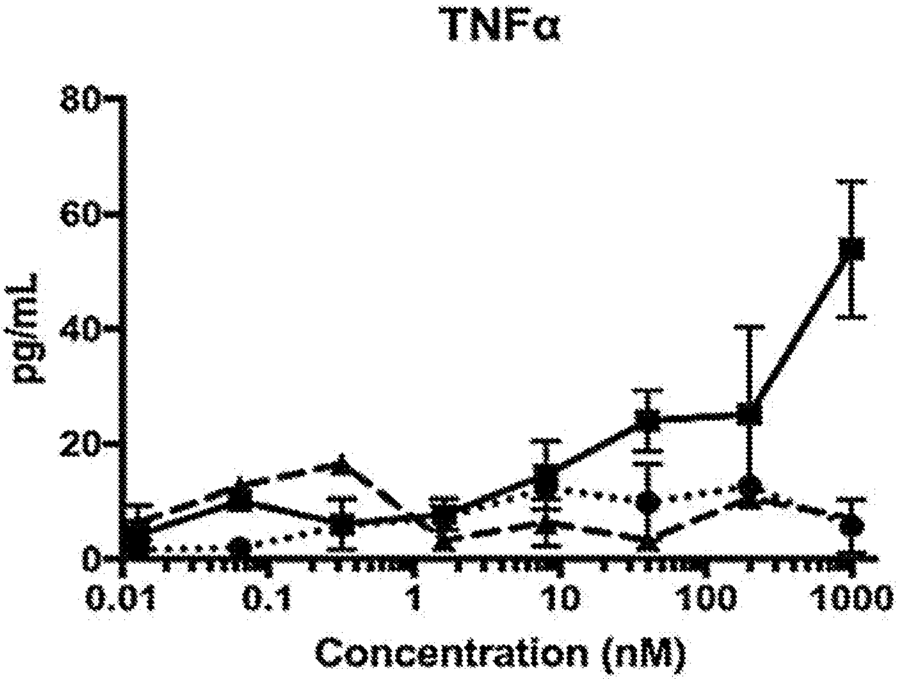


FIG. 1F

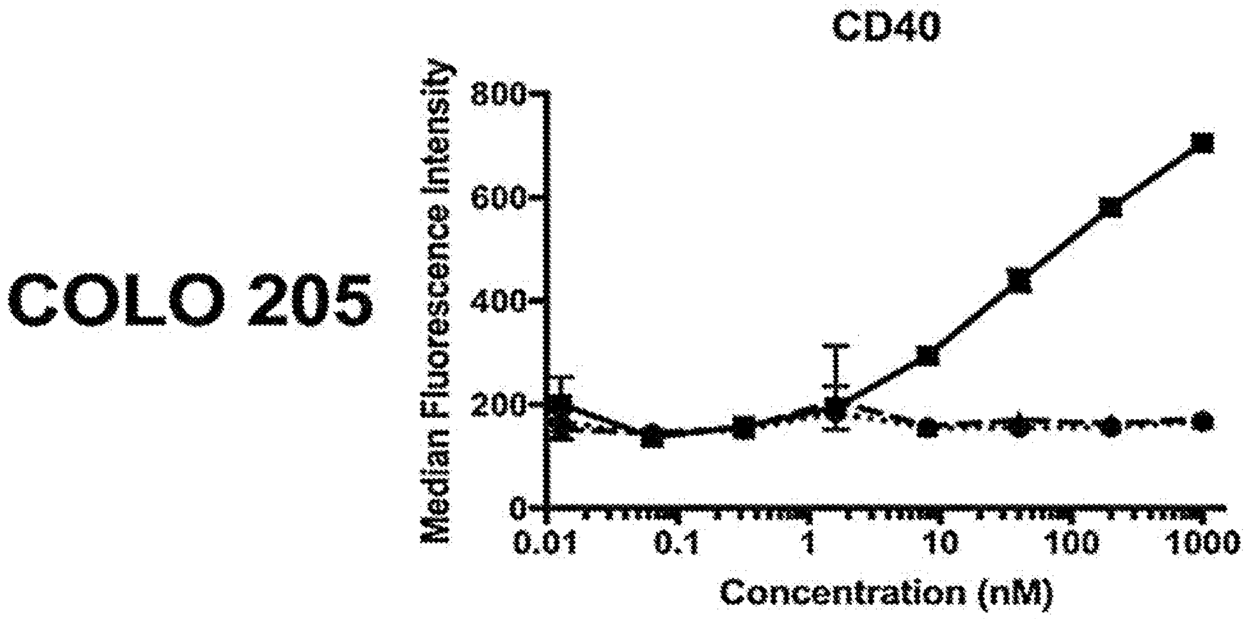

COLO 205
CD40
Median Fluorescence Intensity
800
600
400
200
0
0.01
0.1
1
10
100
1000
Concentration (nM)

FIG. 1G

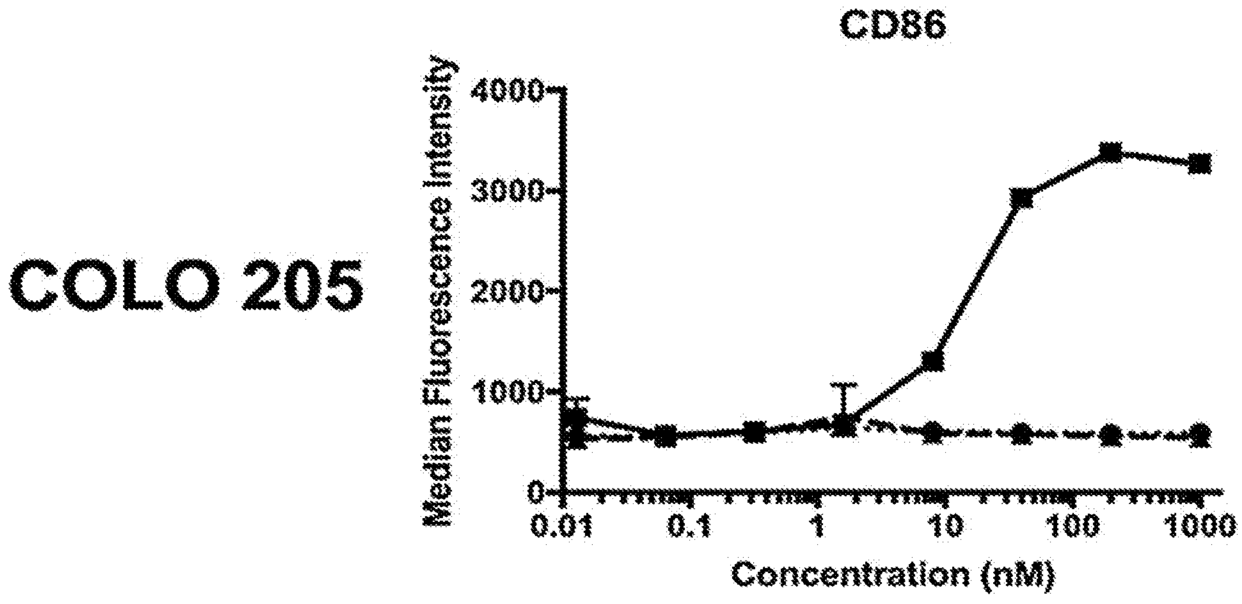

COLO 205
CD86
Median Fluorescence Intensity
4000
3000
2000
1000
0
0.01
0.1
1
10
100
1000
Concentration (nM)

FIG. 1H

COLO 205

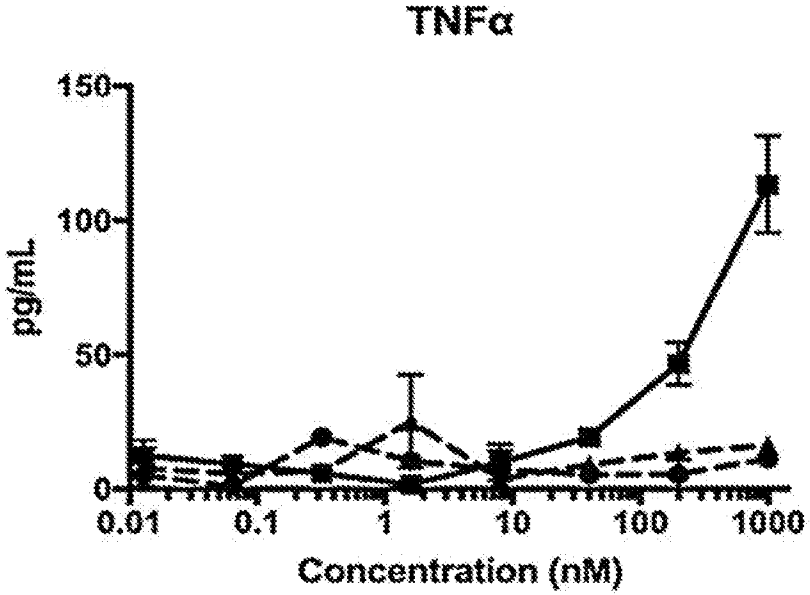


FIG. 1I

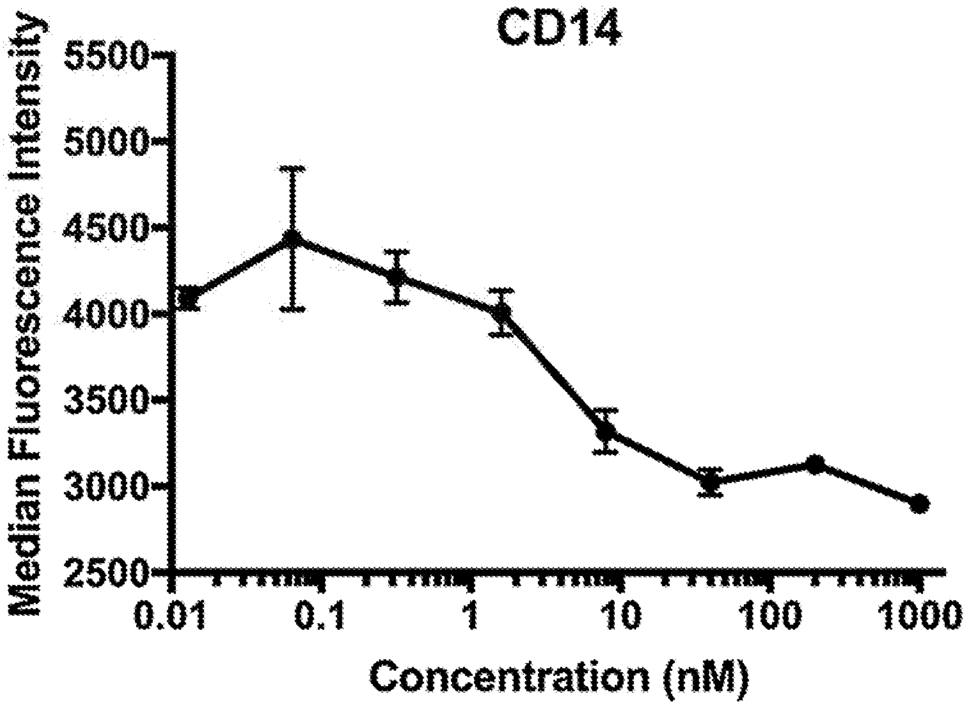

CD14
Median Fluorescence Intensity
5500
5000
4500
4000
3500
3000
2500
0.01
0.1
1
10
100
1000
Concentration (nM)

FIG. 2A

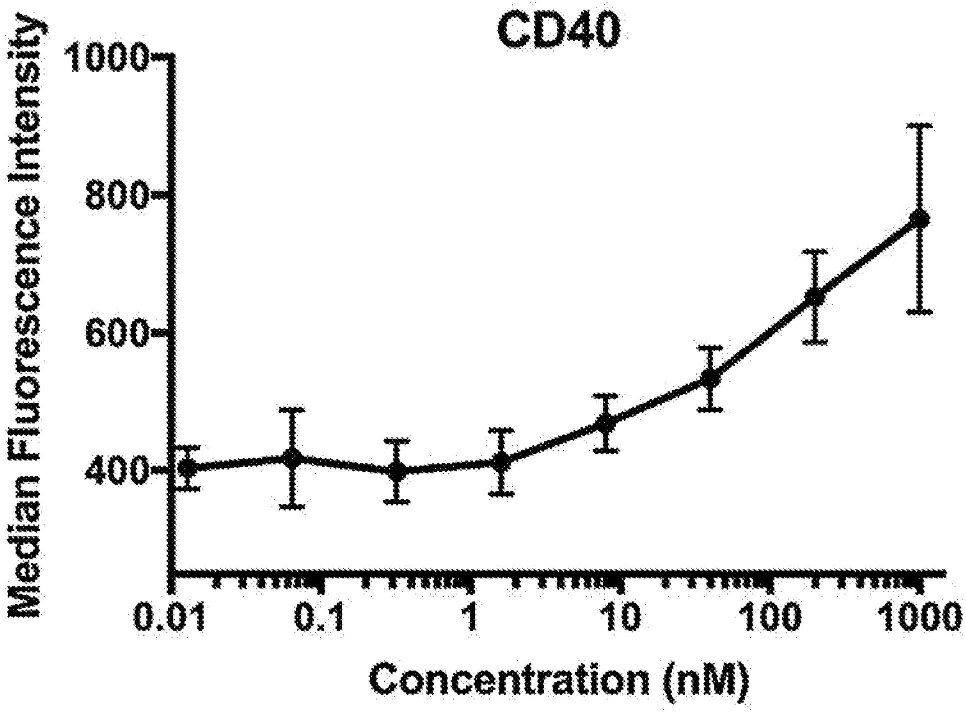

CD40
Median Fluorescence Intensity
1000
800
600
400
0.01
0.1
1
10
100
1000
Concentration (nM)

FIG. 2B

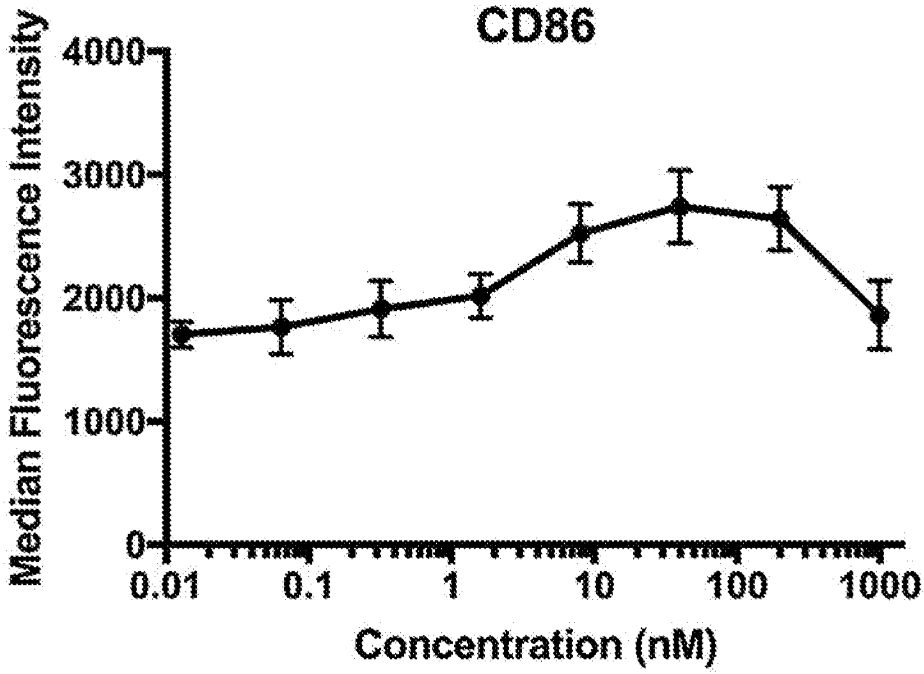

CD86
Median Fluorescence Intensity
4000
3000
2000
1000
0
0.01
0.1
1
10
100
1000
Concentration (nM)

FIG. 2C

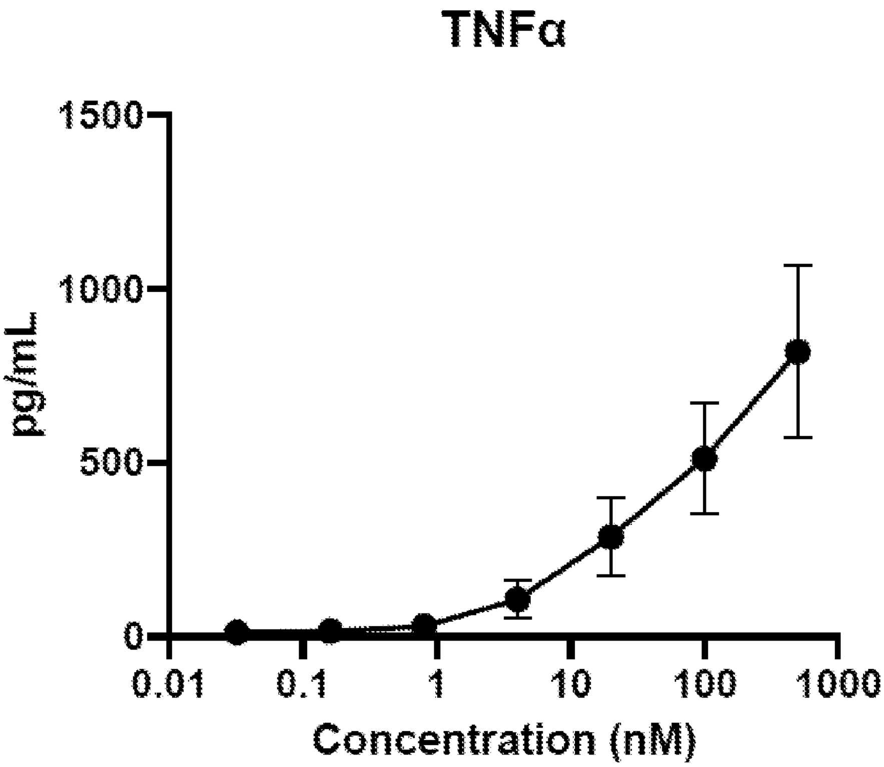
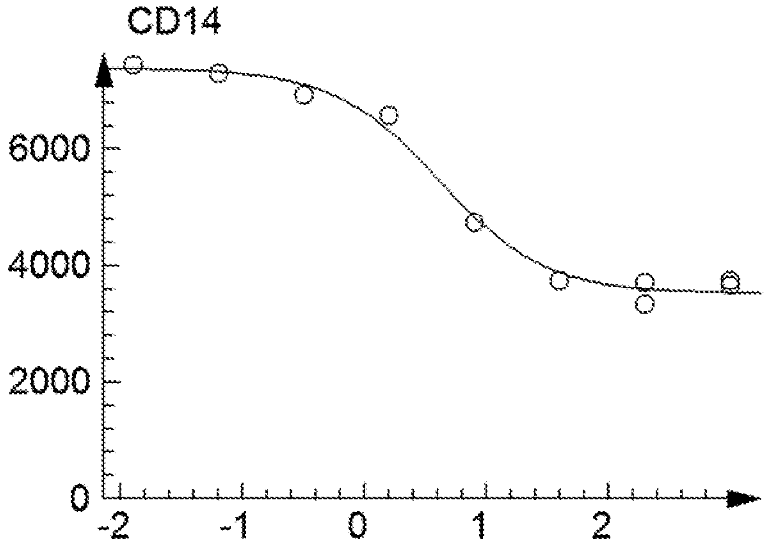
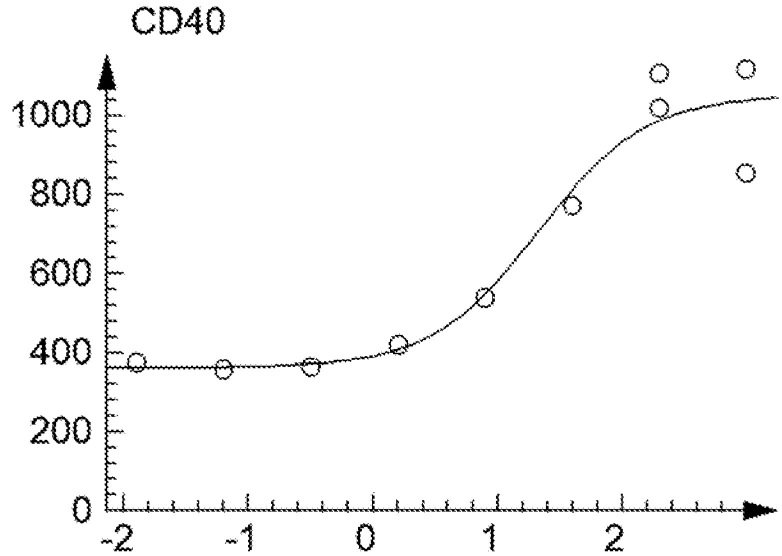

TNFα
pg/mL
1500
1000
500
0
0.01
0.1
1
10
100
1000
Concentration (nM)

FIG. 2D



Max = 7386 Slope = -1
Min = 3521 EC50 = 4.149
R2 = 0.9897

FIG. 3A



Max = 1053 Slope = 1
Min = 360 EC50 = 21.29
R2 = 0.9354

FIG. 3B

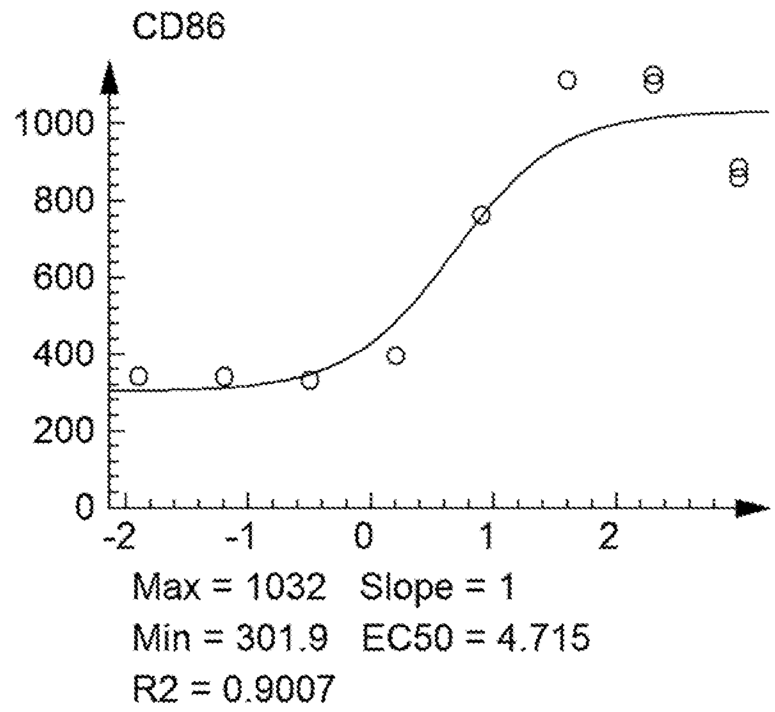

CD86
1000
800
600
400
200
0
-2
-1
0
1
2
Max = 1032 Slope = 1
Min = 301.9 EC50 = 4.715
R2 = 0.9007

FIG. 3C

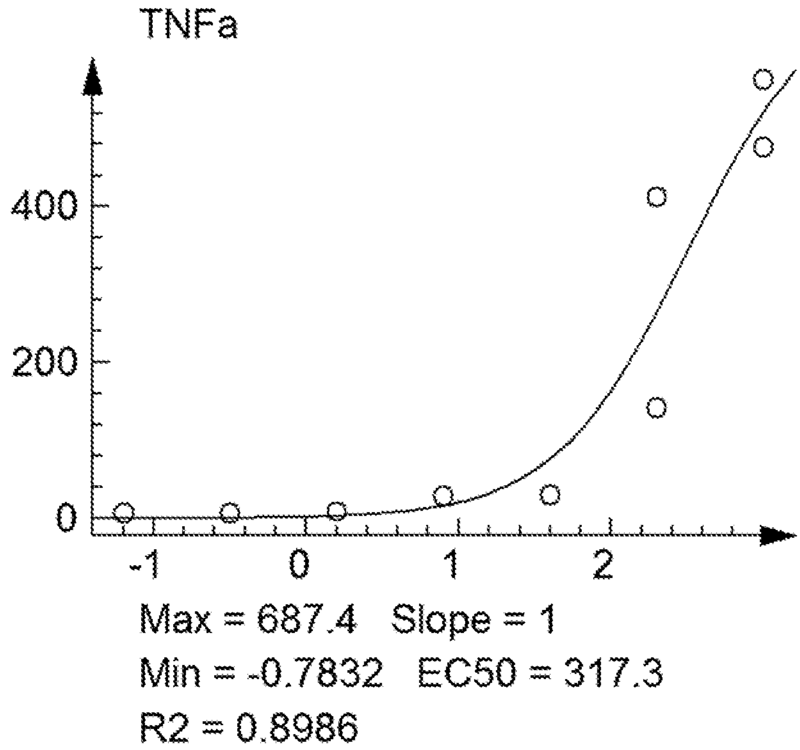

TNFa
400
200
0
-1
0
1
2
Max = 687.4 Slope = 1
Min = -0.7832 EC50 = 317.3
R2 = 0.8986

FIG. 3D

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2020/022645

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61K47/68 A61P35/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2018/191746 A1 (BOLT BIOTHERAPEUTICS INC [US]) 18 October 2018 (2018-10-18) paragraphs [0009], [0010], [0084] [0097], [0124]-[0127],[0153], paragraph [0209] on page 53, paragraphs [0263], [0454]-[0461], scheme 22; claim 20; figures 28-33; examples 19-21	1-33
X	WO 2018/009916 A1 (UNIV LELAND STANFORD JUNIOR [US]; BOLT BIOTHERAPEUTICS INC [US]) 11 January 2018 (2018-01-11) paragraphs [0005], [0357]-[0369], [0383]-[0393], [0929], [1005], [1081], [1095], [1098], [1100], scheme 14, paragraphs [1215]ff; aspect 68, page 196, aspect 87, page 205; figures 80,82	1-33

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 June 2020	03/07/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Burema, Shiri

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 2019/222676 A1 (BOLT BIOTHERAPEUTICS INC [US]; UNIV LELAND STANFORD JUNIOR [US]) 21 November 2019 (2019-11-21) the whole document	1-33
X,P	WO 2020/047187 A1 (BOLT BIOTHERAPEUTICS INC [US]; UNIV LELAND STANFORD JUNIOR [US]) 5 March 2020 (2020-03-05) the whole document	1-33
X,P	- Bolt Biotherapeutics: "A First-in-human Study Using BDC-1001 in Advanced and HER2-Expressing Solid Tumors", , 20 February 2020 (2020-02-20), XP055705762, Retrieved from the Internet: URL:https://clinicaltrials.gov/ct2/show/record/NCT04278144?term=Bolt+Investigative+Site&draw=2&rank=1 [retrieved on 2020-06-17] the whole document	1-33
A	WO 2018/112108 A1 (BOLT BIOTHERAPEUTICS INC [US]) 21 June 2018 (2018-06-21) the whole document	1-33
A	US 2017/121421 A1 (CORTEZ A; GEIERSTANGER B H ET AL.) 4 May 2017 (2017-05-04) the whole document	1-33
A	WO 2018/198091 A1 (NOVARTIS AG [CH]) 1 November 2018 (2018-11-01) the whole document	1-33

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2020/022645

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2018191746 A1	18-10-2018	EP 3609540 A1	19-02-2020
		WO 2018191746 A1	18-10-2018
WO 2018009916 A1	11-01-2018	AU 2017292934 A1	17-01-2019
		BR 112019000071 A2	02-07-2019
		CA 3029902 A1	11-01-2018
		CN 109843327 A	04-06-2019
		EP 3484518 A1	22-05-2019
		JP 2019520352 A	18-07-2019
		KR 20190026761 A	13-03-2019
		US 2019076547 A1	14-03-2019
		WO 2018009916 A1	11-01-2018
WO 2019222676 A1	21-11-2019	NONE	
WO 2020047187 A1	05-03-2020	NONE	
WO 2018112108 A1	21-06-2018	AU 2017376460 A1	20-06-2019
		CA 3046790 A1	21-06-2018
		CN 110290810 A	27-09-2019
		EP 3554550 A1	23-10-2019
		JP 2020511501 A	16-04-2020
		KR 20190095329 A	14-08-2019
		US 2019015516 A1	17-01-2019
		US 2020108151 A1	09-04-2020
		WO 2018112108 A1	21-06-2018
US 2017121421 A1	04-05-2017	AR 106491 A1	17-01-2018
		AU 2016347385 A1	26-04-2018
		BR 112018007296 A2	23-10-2018
		CA 3001482 A1	04-05-2017
		CL 2018000920 A1	15-03-2019
		CN 108430515 A	21-08-2018
		CO 2018004315 A2	19-07-2018
		CR 20180229 A	24-08-2018
		CU 20180033 A7	05-09-2018
		EA 201891040 A1	31-10-2018
		EC SP18038868 A	31-05-2018
		EP 3368092 A1	05-09-2018
		JP 2018534297 A	22-11-2018
		KR 20180068989 A	22-06-2018
		PE 20181347 A1	22-08-2018
		PH 12018500815 A1	01-10-2018
		RU 2018119296 A	29-11-2019
		SG 11201802769R A	30-05-2018
		TW 201722482 A	01-07-2017
		US 2017121421 A1	04-05-2017
		UY 36968 A	31-05-2017
		WO 2017072662 A1	04-05-2017
WO 2018198091 A1	01-11-2018	AR 111651 A1	07-08-2019
		AU 2018260505 A1	31-10-2019
		CA 3059466 A1	01-11-2018
		CL 2019003050 A1	07-02-2020
		CN 110678183 A	10-01-2020
		EP 3615033 A1	04-03-2020
		JP 2020517724 A	18-06-2020
		KR 20190140472 A	19-12-2019

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2020/022645

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		TW 201841661 A	01-12-2018
		US 2020164084 A1	28-05-2020
		WO 2018198091 A1	01-11-2018

Form PCT/ISA/210 (patent family annex) (April 2005)