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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 November 2020 (26.11.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/237050 A1

(51) International Patent Classification:
A61P 35/00 (2006.01) *A61P 25/28* (2006.01)
C07K 7/00 (2006.01)

(21) International Application Number:
PCT/US2020/033996

(22) International Filing Date:
21 May 2020 (21.05.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/851,142 22 May 2019 (22.05.2019) US

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,

(54) Title: LAG3 BINDING PEPTIDES

FIG. 2A

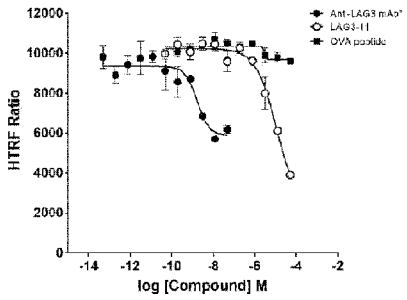


FIG. 2B

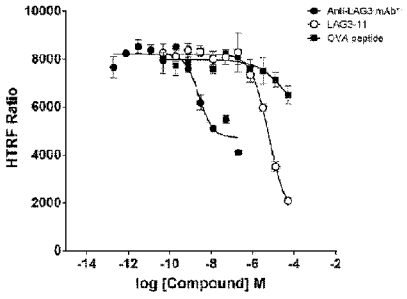


FIG. 2C

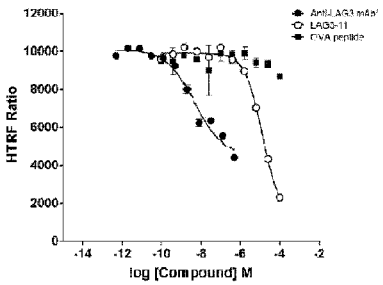
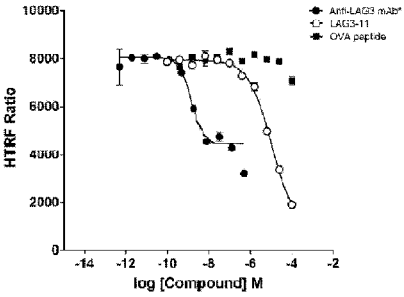


FIG. 2D



(57) Abstract: This disclosure provides peptides which bind to LAG3 and can be used to block the interaction of LAG 3 with other molecules such as MHC-II, FGL1, and α-synuclein. These peptides can be used for various therapeutic purposes, such as inhibiting the progression of a hyperproliferative disorder, including cancer, or inhibiting the progression of a synucleinopathy, inhibiting the progression of sepsis, inhibiting the progression of an infectious disease, and enhancing a response to a vaccine.

[Continued on next page]

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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))*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*
— *with sequence listing part of description (Rule 5.2(a))*

LAG3 BINDING PEPTIDES

[01] This application incorporates by reference the contents of a 2.37 kb text filed created on May 20, 2020 and named "PCTsequencelisting.txt," which is the sequence listing for this application.

[02] Each scientific reference, patent, and published patent application cited in this disclosure is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[03] This disclosure relates generally to immunomodulatory peptides.

BACKGROUND

[04] Lymphocyte activation gene 3 (LAG3, also known as LAG-3, LAG 3, Lag3, CD223, FDC protein) is a member of the immunoglobulin superfamily of receptors.

[05] LAG3 is expressed on immune cells (activated T cells, Huard et al., 1994; natural killer cells, Triebel et al., 1990; B cells, Kisielow et al., 2005; plasmacytoid dendritic cells, Workman et al., 2009), where it binds to MHC class II (MHC-II) and serves as an immune checkpoint receptor. LAG3 also binds to fibrinogen-like protein (FGL1), and disrupting this binding can potentiate anti-tumor immunity (Wang et al., 2019). There is a continuing need for useful modulators of immune checkpoint pathways.

[06] LAG3 is also expressed on neurons, where it serves as a receptor for the α-synuclein aggregates characteristic of synucleinopathies (Mao et al., 2016). Synucleinopathies are disorders characterized by the abnormal accumulation of aggregates of α-synuclein protein in neurons, nerve fibers, or glial cells. Synucleinopathies include idiopathic and inherited forms of Parkinson's disease (PD); Diffuse Lewy Body (DLB) disease, also known as Dementia with Lewy Bodies or Lewy body dementia; incidental Lewy body disease; Lewy body variant of Alzheimer's disease (LBV); Combined Alzheimer's and Parkinson disease (CAPD); pure autonomic failure (PAF); multiple system atrophy (MSA), such as olivopontocerebellar atrophy, striatonigral degeneration, and Shy-Drager Syndrome; pantothenate kinase-associated neurodegeneration; Down's Syndrome; Gaucher disease-related synucleinopathies; and

neurodegeneration with brain iron accumulation. There is a continuing need for therapeutic agents for treating or managing symptoms of synucleinopathies.

BRIEF DESCRIPTION OF THE FIGURES

[07] **Figure 1A** and **Figure 1B** are graphs showing the results of LAG3 blockage functional inhibition assays described in Example 2.

[08] **Figure 2A, Figure 2B, Figure 2C,** and **Figure 2D** are a graphs showing the results of four independent homogeneous time-resolved fluorescence (HTRF) assays for peptide LAG3-11. Reference Ab-LAG3 is an anti-LAG3 antibody. OVA, the ovalbumin (OVA) peptide (ISQAVHAAHAEINEAGR, SEQ ID NO:8). "HTRF ratio" is the emission at 665 nm (Acceptor) / emission at 620 nm (Donor) multiplied by a factor or 10^4.

[09] **Figure 3** is a graph showing the results of an HTRF assay for peptide LAG3-11. Anti-LAG-3 GMP-A092 is an anti-LAG3 antibody.

[10] **Figure 4** is a graph showing the results of an HTRF assay for peptide LAG3-42.

[11] **Figure 5** is a graph showing the results of an HTRF assay for peptide LAG3-48.

[12] **Figure 6** is a graph showing the results of an HTRF assay for peptide LAG3-51.

[13] **Figure 7** is a graph showing the results of an HTRF assay for peptide LAG3-54.

[14] **Figure 8** is a graph showing the results of an HTRF assay for peptide LAG3-56.

[15] **Figure 9** is a graph showing the results of an HTRF assay for peptide LAG3-60.

[16] **Figure 10** is a graph showing the results of a peripheral blood mononuclear cell (PBMC) assay.

[17] **Figure 11** is a graph showing the results of a Human LAG3/FGL1 TR-FRET Binding Assay.

DETAILED DESCRIPTION

[18] This disclosure provides peptides that bind to LAG3 and can be used to block its interaction with other molecules such as MHC-II, FGL1, and α-synuclein.

Table 1.

peptide	amino acid sequence	SEQ ID NO:
LAG3-11	SAPWEPLHWPEDWWQGTGEW	1
LAG3-42	DWNFQQWDWKKHNHLDSHVV	2
LAG3-48	FYSPNHEEYHDWNVDSSVNE	3
LAG3-51	KVWQVPQDTQHWLSPNFYSV	4
LAG3-54	ACGPGSFGDCGGG	5
LAG3-56	HIQNWSYWLNQDMMNQQVWKS	6
LAG3-60	HESGSVPHPWQFFTHYVS	7

[19] In some embodiments, a disclosed peptide is modified using chemical or recombinant methods to enhance its stability or other pharmacokinetic properties. See, *e.g.*, US 2017/0020956. Modifications include, but are not limited to, replacement of one or more L-amino acid with its corresponding D-form, acetylation on a C- and/or N-terminal residue, amidation on a C- and/or N-terminal residue, cyclization, esterification, glycosylation, acylation, attachment of myristic or palmitic acid, addition of an N-terminal glycine, addition of lipophilic moieties such as long fatty acid chains, and PEGylation.

[20] Peptides can be made by any method known in the art, including synthetic methods, recombinant methods, or both. Synthetic methods include solid-phase and solution methods, and may include the use of protective groups. See, *e.g.*, Bodanszky et al. (1976), McOmie (1973), Merrifield (1963), Neurath et al. (1976), Stuart & Young (1984).

[21] Recombinant production of peptides can be carried out using any nucleotide sequence(s) encoding the peptides in any suitable expression system. Nucleic acid molecules encoding one or more of the disclosed peptides can be incorporated into an expression cassette that includes

control elements operably linked to the coding sequences. Control elements include, but are not limited to, initiators, promoters (including inducible, repressible, and constitutive promoters), enhancers, and polyadenylation signals. Signal sequences can be included. The expression cassette can be provided in a vector that can be introduced into an appropriate host cell for production of the peptide(s). Methods of constructing expression cassettes and expression vectors are well known. Expression vectors can include one or more expression cassettes encoding one or more peptides comprising, consisting essentially or, or consisting of any of SEQ ID NOS:1-7.

[22] In some embodiments, one or more peptides are expressed as a component of a fusion protein. Other components of the fusion protein can be, for example, a cytokine or an engineered T cell receptor (TCR). A fusion protein can comprise one or more linkers between its components. In some embodiments, a linker between a peptide and another component of the fusion protein can comprise a proteolytic cleavage site to release the peptide after expression of the fusion protein. *See*, *e.g.*, US 2016/0138066; US 2018/0135060; US 2014/0343251; US 2012/0142891; Rodríguez et al., 2014.

[23] In some embodiments, a component of a fusion protein is a moiety, such as albumin or transthyretin, which can enhance the plasma half-life of the peptide. In other embodiments, a peptide or a modified version of a peptide is conjugated to the moiety. Methods of preparing such conjugates are well known in the art (*e.g.*, Penchala *et al.*, 2015; Kontermann, 2016; Zorzi *et al.*, 2017).

[24] In some embodiments, a component of a fusion protein is a partner molecule, such as a peptide or protein such as an antibody intended to increase the half-life of a peptide or modified peptide *in vivo* and/or to provide specific delivery to a target tissue or cell. Alternatively, a peptide or modified version thereof can be conjugated to the partner molecule. Conjugation may be direct or can be via a linker. In some of these embodiments, a peptide or a modified version thereof can be altered to substitute one or more amino acids with amino acids used to attach partner molecules, such as lysine, or by N-terminal extension of the peptide with, *e.g.*, 1, 2, 3, or 4 glycine spacer molecules.

[25] This disclosure also provides CAR-T cells that express one or more of the disclosed peptides. Methods of preparing CAR-T cells are disclosed, for example, in U.S. Patent 9,328,156; U.S. Patent 9,845,362; and U.S. Patent 9,101,584.

[26] This disclosure also provides oncolytic viruses containing a nucleic acid molecule encoding one or more of the disclosed peptides. See US 2017/0157188; Lawler et al., 2017; US 2015/0250837. Oncolytic viruses include, but are not limited to, reovirus, Seneca Valley virus, vesicular stomatitis virus, Newcastle disease virus, herpes simplex virus, morbillivirus virus, retrovirus, influenza virus, Sindbis virus, poxvirus, and adenovirus.

[27] Examples of oncolytic reovirus include REOLYSIN® (pelareorep) and reoviruses disclosed in US 2017/0049829.

[28] Examples of oncolytic Seneca Valley virus include NTX-101 (Rudin et al., 2011).

[29] Examples of oncolytic vesicular stomatitis virus are disclosed in Stojdl et al., 2000; and Stojdl et al., 2003.

[30] Examples of oncolytic Newcastle disease virus include 73-T PV701 and HDV-HUJ strains (see also Phuangsab et al., 2001; Lorence et al., 2007; and Freeman et al., 2006).

[31] Examples of oncolytic herpes simplex virus include NV1020 (Geevarghese et al., 2010) and T-VEC (Andtbacka et al., 2013).

[32] Examples of oncolytic morbillivirus virus include oncolytic measles viruses such as MV-Edm (McDonald et al., 2006) and HMWMAA (Kaufmann et al., 2013).

[33] Examples of oncolytic retrovirus are disclosed in Lu et al., 2012.

[34] Examples of oncolytic influenza virus are disclosed, for example, in US 2018/0057594.

[35] Examples of oncolytic Sindbis virus are disclosed, for example, in Lundstrom, 2017.

[36] Examples of oncolytic poxvirus are disclosed, for example, in Chan & McFadden, 2014.

[37] Examples of oncolytic adenovirus include ONYX-015 (Khuri et al., 2000) and H101 or Oncorine (Liang, 2018).

Therapeutic Uses

[38] The peptides and modified versions thereof disclosed herein have a number of therapeutic applications, including treating hyperproliferative disorders (*e.g.*, cancer). "Treat," as used herein, includes reducing or inhibiting the progression of one or more symptoms of the condition

for which a peptide or modified version thereof is administered. The peptides and modified versions thereof may also be useful for reducing one or more symptoms of or for treating synucleopathies, infectious diseases, and sepsis and for enhancing a response to vaccination.

[39] "Administer" as used herein includes administration of a disclosed peptide or modified version thereof itself as well as administration by various vehicles described below.

[40] In some embodiments, one or more of the disclosed peptides and/or modified versions thereof, are directly administered. In some of these embodiments, a peptide carrier system is used. A number of peptide carrier systems are known in the art, including microparticles, polymeric nanoparticles, liposomes, solid lipid nanoparticles, hydrophilic mucoadhesive polymers, thiolated polymers, polymer matrices, nanoemulsions, and hydrogels. *See* Patel et al. (2014), Bruno et al. (2013), Feridooni et al. (2016). Any suitable system can be used.

[41] In some embodiments, an engineered T cell that expresses and secretes one or more disclosed peptides can be used to deliver LAG3 inhibition at the site of engagement of the T cell receptor with an antigen. The T cell-based therapy can be, for example, a CAR-T cell that expresses one or more of the disclosed peptides. Either inducible or constitutive expression can be used.

[42] In some embodiments, an oncolytic virus can be used to deliver one or more of the disclosed peptides. Either inducible or constitutive expression can be used.

[43] In other embodiments one or more of the disclosed peptides are delivered using one or more nucleic acids encoding the peptide(s) (*e.g.*, DNA, cDNA, PNA, RNA or a combination thereof); see, *e.g.*, US 2017/0165335. Nucleic acids encoding one or more peptides can be delivered using a variety of delivery systems known in the art. Nucleic acid delivery systems include, but are not limited to, gene-gun; cationic lipids and cationic polymers; encapsulation in liposomes, microparticles, or microcapsules; electroporation; virus-based, and bacterial-based delivery systems. Virus-based systems include, but are not limited to, modified viruses such as adenovirus, adeno-associated virus, herpes virus, retroviruses, vaccinia virus, or hybrid viruses containing elements of one or more viruses. US 2002/0111323 describes use of "naked DNA," *i.e.*, a "non-infectious, non-immunogenic, non-integrating DNA sequence," free from "transfection-facilitating proteins, viral particles, liposomal formulations, charged lipids and calcium phosphate precipitating agents," to administer a peptide. Bacterial-based delivery systems are disclosed, *e.g.*, in Van Dessel et al. (2015) and Yang et al. (2007).

[44] In some embodiments, a peptide is administered via an RNA molecule encoding the peptide. In some embodiments, the RNA molecule is encapsulated in a nanoparticle. In some embodiments, the nanoparticle comprises a cationic polymer (*e.g.*, poly-L-lysine, polyamidoamine, polyethyleneimine, chitosan, poly(β-amino esters). In some embodiments, the nanoparticle comprises a cationic lipid or an ionizable lipid. In some embodiments, the RNA molecule is conjugated to a bioactive ligand (*e.g.*, N-acetylgalactosamine (GalNAc), cholesterol, vitamin E, antibodies, cell-penetrating peptides). See, *e.g.*, Akinc et al. (2008), Akinc et al. (2009), Anderson et al. (2003), Behr (1997), Boussif et al. (1995), Chen et al. (2012), Dahlman et al. (2014), Desigaux et al. (2007), Dong et al. (2014), Dosta et al. (2015), Fenton et al. (2016), Guo et al. (2012), Howard et al. (2006), Kaczmarek et al. (2016), Kanasty et al. (2013), Kauffman et al. (2015), Kozielski et al. (2013), Leus et al. (2014), Lorenz et al. (2004), Love et al. (2010), Lynn & Langer (2000), Moschos et al. (2007), Nair et al. (2014), Nishina et al. (2008), Pack et al. (2005), Rehman et al. (2013), Schroeder et al. (2010), Tsutsumi et al. (2007), Tzeng et al. (2012), Won et al. (2009), Xia et al. (2009), Yu et al. (2016).

[45] In some embodiments, an RNA molecule can be modified to reduce its chances of degradation or recognition by the immune system. The ribose sugar, the phosphate linkage, and/or individual bases can be modified. See, *e.g.*, Behlke (2008), Bramsen (2009), Chiu (2003), Judge & MacLachlan (2008), Kauffman (2016), Li (2016), Morrissey (2005), Prakash (2005), Pratt & MacRae (2009), Sahin (2014), Soutschek (2004), Wittrup & Lieberman (2015). In some embodiments, the modification is one or more of a ribo-difluorotoluyl nucleotide, a 4′-thio modified RNA, a boranophosphate linkage, a phosphorothioate linkage, a 2′-O-methyl (2’-OMe) sugar substitution, a 2′-fluoro (2′-F), a 2′-O-methoxyethyl (2′-MOE) sugar substitution, a locked nucleic acid (LNA), and an L-RNA.

[46] In some embodiments, administration is carried out in conjunction with one or more other therapies. “In conjunction with” includes administration together with, before, or after administration of the one or more other therapies.

Pharmaceutical Compositions, Routes of Administration, and Devices

[47] One or more peptides, modified peptides, nucleic acid molecules, CAR-T cells, and/or oncolytic viruses, as discussed above, are typically administered in a pharmaceutical composition comprising a pharmaceutically acceptable vehicle. The “pharmaceutically acceptable vehicle” may comprise one or more substances which do not affect the biological

activity of the peptides or modified versions thereof and, when administered to a patient, does not cause an adverse reaction. Pharmaceutical compositions may be liquid or may be lyophilized. Lyophilized compositions may be provided in a kit with a suitable liquid, typically water for injection (WFI) for use in reconstituting the composition. Other suitable forms of pharmaceutical compositions include suspensions, emulsions, and tablets.

[48] Pharmaceutical compositions can be administered by any suitable route, including, but not limited to, intravenous, intramuscular, intradermal, intraperitoneal, subcutaneous, epidural, intratumoral, transdermal (*e.g.*, US 2017/0281672), mucosal (*e.g.*, intranasal or oral), pulmonary, and topical (*e.g.*, US 2017/0274010) routes. See, *e.g.*, US 2017/0101474.

[49] Administration can be systemic or local. In addition to local infusions and injections, implants can be used to achieve a local administration. Examples of suitable materials include, but are not limited to, sialastic membranes, polymers, fibrous matrices, and collagen matrices.

[50] Topical administration can be by way of a cream, ointment, lotion, transdermal patch (such as a microneedle patch), or other suitable forms well known in the art.

[51] Administration can also be by controlled release, for example, using a microneedle patch, pump and/or suitable polymeric materials. Examples of suitable materials include, but are not limited to, poly(2-hydroxy ethyl methacrylate), poly(methyl methacrylate), poly(acrylic acid), poly(ethylene-co-vinyl acetate), poly(methacrylic acid), polyglycolides (PLG), polyanhydrides, poly(N-vinyl pyrrolidone), poly(vinyl alcohol), polyacrylamide, poly(ethylene glycol), polylactides (PLA), poly(lactide-co-glycolides) (PLGA), and polyorthoesters.

[52] Devices comprising any of the peptides, modified peptides, nucleic acid molecules, CAR-T cells, and/or oncolytic viruses described above include, but are not limited to, syringes, pumps, transdermal patches, spray devices, vaginal rings, and pessaries.

Treatment of Hyperproliferative Disorders, Including Cancer

[53] In some embodiments, one or more of the peptides, modified peptides, nucleic acid molecules, CAR-T cells, and/or oncolytic viruses described above are administered to a patient to inhibit the progression of a hyperproliferative disorder, including cancer. Such inhibition may include, for example, reducing proliferation of neoplastic or pre-neoplastic cells; destroying neoplastic or pre-neoplastic cells; and inhibiting metastasis or decreasing the size of a tumor.

[54] Examples of cancers include, but are not limited to, melanoma (including cutaneous or intraocular malignant melanoma), renal cancer, prostate cancer, breast cancer, colon cancer, lung cancer, bone cancer, pancreatic cancer, skin cancer, cancer of the head or neck, uterine cancer, ovarian cancer, rectal cancer, cancer of the anal region, stomach cancer, testicular cancer, carcinoma of the fallopian tubes, carcinoma of the endometrium, carcinoma of the cervix, carcinoma of the vagina, carcinoma of the vulva, Hodgkin's Disease, non-Hodgkin's lymphoma, cancer of the esophagus, cancer of the small intestine, cancer of the endocrine system, cancer of the thyroid gland, cancer of the parathyroid gland, cancer of the adrenal gland, sarcoma of soft tissue, cancer of the urethra, cancer of the penis, chronic or acute leukemias including acute myeloid leukemia, chronic myeloid leukemia, acute lymphoblastic leukemia, chronic lymphocytic leukemia, lymphocytic lymphoma, cancer of the bladder, cancer of the kidney or ureter, carcinoma of the renal pelvis, neoplasm of the central nervous system (CNS), primary CNS lymphoma, tumor angiogenesis, spinal axis tumor, brain stem glioma, pituitary adenoma, Kaposi's sarcoma, epidermoid cancer, squamous cell cancer, and T-cell lymphoma.

Combination Cancer Therapies

[55] In some embodiments, one or more of the peptides, modified peptides, nucleic acid molecules, CAR-T cells, and/or oncolytic viruses described above are administered in conjunction with one or more other cancer therapies or immunotherapies, such as those described below.

[56] In some embodiments, the second therapy comprises a second agent that reduces or blocks the activity of PD-1 (*e.g.*, nivolumab, pembrolizumab, durvalumab) or CTLA-4 (*e.g.*, ipilimumab, tremelimumab).

[57] In some embodiments, the second therapy comprises an agent that reduces or blocks the activity of PD-L1 (*e.g.*, atezolizumab).

[58] In some embodiments, the second therapy comprises an agent that reduces or blocks the activity of LAG3 or other inhibitory checkpoint molecules and/or molecules that suppress the immune system. These molecules include, but are not limited to:

1. V-domain Immunoglobulin Suppressor of T cell Activation (VISTA, also known as c10orf54, PD-1H, DD1α, Gi24, Dies1, and SISP1; see US 2017/0334990, US 2017/0112929, Gao et al., 2017, Wang et al., 2011; Liu et al., 2015);

2. T-cell Immunoglobulin domain and Mucin domain 3 (TIM-3; see US 2017/0198041, US 2017/0029485, US 2014/0348842, Sakuishi et al., 2010);

3. killer immunoglobulin-like receptors (KIRs; see US 2015/0290316);

4. agents that inhibit indoleamine (2,3)-dioxygenase (IDO; see Mellemgaard et al., 2017);

5. B and T Lymphocyte Attenuator (BTLA; see US 2016/09222114); and

6. A2A adenosine receptor (A2AR; see Beavis et al., 2015; US 2013/0267515; US 2017/0166878; Leone et al., 2015; Mediavilla-Varela et al., 2017; Young et al., 2016).

[59] Agents that reduce or block the activity of LAG3 include, but are not limited to, BMS-986016, IMP321, and GSK2831781 (He et al., 2016).

[60] Agents that reduce or block the activity of VISTA include, but are not limited to, small molecules, such as CA-170, and antibodies (*e.g.*, Le Mercier et al., 2014).

[61] Agents that reduce or block the activity of TIM-3 include, but are not limited to, antibodies such as MBG453 and TSR-022; see Dempke et al., 2017.

[62] Agents that reduce or block the activity of KIRs include, but are not limited to, monoclonal antibodies such as IPH2101 and Lirilumab (BMS-986015, formerly IPH2102); see Benson & Caligiuri, 2014.

[63] Agents that reduce or block the activity of IDO include, but are not limited to, epacadostat and agents disclosed in US 2017/0037125.

[64] Agents that reduce or block the activity of BTLA include, but are not limited to, peptides (*e.g.*, Spodzieja et al., 2017).

[65] Agents that reduce or block the activity of A2AR include, but are not limited to, small molecules such as CPI-444 and vipadenant.

[66] In some embodiments, the second therapy comprises a cytokine (*e.g.*, interleukin 7).

[67] In some embodiments, the second therapy comprises an agonist of a stimulatory checkpoint molecule. These molecules include, but are not limited to:

1. CD40;

2. OX40;

3. glucocorticoid-induced tumor necrosis factor-related protein (GITR); and

4. Inducible T-cell COStimulator (ICOS).

[68] Agonists of CD40 include, but are not limited to, CD40 agonist monoclonal antibodies such as cp-870,893, ChiLob7/4, dacetuzumab, and lucatumumab. See, *e.g.*, Vonderheide et al., 2007; Khubchandani et al., 2009; Johnson et al., 2010; Bensinger et al., 2012; Vonderheide and Glennie, 2013; Johnson et al., 2015.

[69] Agonists of OX40 include, but are not limited to, OX40 agonist antibodies such as MOXR0916, MED16469, MED10562, PF-045618600, GSK3174998, and INCCAGN01949, and OX40L-Fc fusion proteins, such as MEDI6383. See, *e.g.*, Huseni et al., 2014; Linch et al., 2015; Messenheimer et al., 2017. See also Shrimali et al., 2017.

[70] Agonists of GITR include, but are not limited to, MEDI1873. See, *e.g.*, Schaer et al., 2012; Tigue et al., 2017.

[71] Agonists of ICOS include, but are not limited to, ICOS agonist antibodies JTX-2011 and GSK3359609. See, *e.g.*, Harvey et al., 2015; Michaelson et al., 2016.

[72] In other embodiments, the second therapy comprises a 4-1BB agonist (Shindo et al., 2015), such as urelumab; a 4-1BB antagonist (see US 2017/0174773); an inhibitor of anaplastic lymphoma kinase (ALK; Wang et al., 2014; US 2017/0274074), such as crizotinib, ceritinib, alectinib, PF-06463922, NVP-TAE684, AP26113, TSR-011, X-396, CEP-37440, RXDX-101; an inhibitor of histone deacetylase (HDAC; see US 2017/0327582); a VEGFR inhibitor, such as axitinib, sunitinib, sorafenib, tivozanib, bevacizumab; and/or an anti-CD27 antibody, such as varlilumab.

[73] In some embodiments, the second therapy comprises a cancer vaccine (*e.g.*, Duraiswamy et al., 2013). A "cancer vaccine" is an immunogenic composition intended to elicit an immune response against a particular antigen in the individual to which the cancer vaccine is administered. A cancer vaccine typically contains a tumor antigen which is able to induce or stimulate an immune response against the tumor antigen. A "tumor antigen" is an antigen that is present on the surface of a target tumor. A tumor antigen may be a molecule which is not

expressed by a non-tumor cell or may be, for example, an altered version of a molecule expressed by a non-tumor cell (*e.g.*, a protein that is misfolded, truncated, or otherwise mutated).

[74] In some embodiments, the second therapy comprises a chimeric antigen receptor (CAR) T cell therapy. See, *e.g.*, John et al., 2013; Chong et al., 2016.

[75] In some embodiments, one or more of the peptides, modified peptides, nucleic acid molecules, CAR-T cells, and/or oncolytic viruses described above are administered in conjunction with a CAR-T cell cancer therapy to increase the efficacy of the CAR-T cell cancer therapy.

[76] In some embodiments, one or more of the peptides, modified peptides, nucleic acid molecules, CAR-T cells, and/or oncolytic viruses described above are administered in conjunction with an oncolytic virus as disclosed, for example, in US 2017/0143780.Non-limiting examples of oncolytic viruses are described above.

Additional Therapeutic Uses

Synucleinopathies

[77] In some embodiments, one or more of the peptides, modified peptides, nucleic acid molecules, CAR-T cells, and/or oncolytic viruses described above may be useful to reduce a symptom of a synucleinopathy, either alone or in combination with other therapeutic interventions such as L-DOPA, dopamine agonists (*e.g.*, ropinirole, pramipexole), dopamine reuptake inhibitors (*e.g.*, amantadine), and cholinesterase inhibitors (*e.g.*, donepezil, rivastigmine, galantamine). Examples of synucleinopathies include idiopathic and inherited forms of Parkinson's disease (PD); Diffuse Lewy Body (DLB) disease, also known as Dementia with Lewy Bodies or Lewy body dementia; incidental Lewy body disease; Lewy body variant of Alzheimer's disease (LBV); Combined Alzheimer's and Parkinson disease (CAPD); pure autonomic failure (PAF); multiple system atrophy (MSA), such as olivopontocerebellar atrophy, striatonigral degeneration, and Shy-Drager Syndrome; pantothenate kinase-associated neurodegeneration; Down's Syndrome; Gaucher disease-related synucleinopathies; and neurodegeneration with brain iron accumulation.

Sepsis

[78] LAG3 expression is up-regulated in sepsis (Patil et al., 2017). Accordingly, one or more of the peptides, modified peptides, or nucleic acids described above may be useful to treat sepsis, either alone or in combination with other therapeutic interventions such as antibiotics, intravenous fluids, and vasopressors.

Infectious Diseases

[79] In some embodiments, one or more of the disclosed peptides, modified peptides, or nucleic acids described above can be administered to treat infectious diseases, including chronic infections, caused, *e.g.*, by viruses, fungi, bacteria, and protozoa, and helminths, either alone or in combination with other therapeutic interventions.

[80] Examples of viral agents include human immunodeficiency virus (HIV), Epstein Barr Virus (EBV), *Herpes simplex* (HSV, including HSV1 and HSV2), Human Papillomavirus (HPV), *Varicella zoster* (VSV) *Cytomegalovirus* (CMV), and hepatitis A, B, and C viruses.

[81] Examples of fungal agents include *Aspergillus*, *Candida*, *Coccidioides*, *Cryptococcus*, *and Histoplasma capsulatum*.

[82] Examples of bacterial agents include *Streptococcal* bacteria (*e.g.*, *pyogenes*, *agalactiae*, *pneumoniae*), *Chlamydia pneumoniae, Listeria monocytogenes*, and *Mycobacterium tuberculosis*.

[83] Examples of protozoa include *Sarcodina* (*e.g.*, *Entamoeba*), *Mastigophora* (*e.g.*, *Giardia*), *Ciliophora* (*e.g.*, *Balantidium*), and *Sporozoa* (*e.g.*, *Plasmodium falciparum*, *Cryptosporidium*).

[84] Examples of helminths include *Platyhelminths* (*e.g.*, trematodes, cestodes), *Acanthocephalins*, and *Nematodes*.

Vaccine Adjuvants

[85] In some embodiments one or more of the disclosed peptides, modified peptides, or nucleic acids described above can be administered as a vaccine adjuvant in conjunction with a vaccine to enhance a response to vaccination (*e.g.*, by increasing effector T cells and/or reducing T cell exhaustion). The vaccine can be, for example, an RNA vaccine (*e.g.*, US 2016/0130345,

US 2017/0182150), a DNA vaccine, a recombinant vector, a protein vaccine, or a peptide vaccine. Such vaccines can be delivered, for example, using virus-like particles, as is well known in the art.

EXAMPLE 1. Peptide Library Screening

[86] The TriCo-20™, TriCo-16™, Ph.D.-12™, and Ph.D. C7™ Phage Display Peptide Libraries (Creative Biolabs, 45-1 Ramsey Road, Shirley, NY 11967) were screened by performing several rounds of bio-panning to identify binders of soluble recombinant human LAG3.

[87] After four rounds of screening, seven peptides showed clear enrichment for specific binders as defined by greater than 2-fold higher coated signal over uncoated signal in the clonal phage ELISA (Table 2).

Table 2.

	Clonal Phase ELISA			
clone	**coated signal**	**uncoated signal**	**peptide sequence**	**SEQ ID NO:**
LAG3-11	0.271	0.093	SAPWEPLHWPEDWWQGTGEW	1
LAG3-42	0.378	0.084	DWNFQQWDWKKHNHLDSHVV	2
LAG3-48	0.227	0.094	FYSPNHEEYHDWNVDSSVNE	3
LAG3-51	0.234	0.076	KVWQVPQDTQHWLSPNFYSV	4
LAG3-54	0.417	0.103	ACGPGSFGDCGGG	5
LAG3-56	0.529	0.101	HIQNWSYWLNQDMMNQQVWKS	6
LAG3-60	0.330	0.091	HESGSVPHPWQFFTHYVS	7

EXAMPLE 2. Peptide Blockage of LAG3 Signaling

[88] A cell-based reporter assay was used to assess whether binding of the seven peptides identified above was sufficient to block the interaction with LAG3 and its ligand MHC-II. The components of the assay include (1) a Jurkat T cell line that stably expresses human LAG3 and a stable NFAT-luc2P luciferase reporter, (2) a Raji cell line that expresses human MHC-II, and (3) a positive control anti-LAG3 antibody that blocks the interaction of LAG3 and MHC-II. In brief, Jurkat cells expressing LAG3 are stimulated with a T cell receptor (TCR) activator molecule, resulting in expression of luciferase. When the Jurkat cells are co-cultured with an a Raji cell line expressing the MHC-II molecule, the interaction of LAG3 on the surface of a Jurkat cell with MHC-II on the surface of a Raji cell inhibits T cell activation, leading to a reduction in luciferase

expression. The addition of a neutralizing antibody against LAG3 blocks the inhibition signal and allows luciferase expression to proceed. BIO-GLO™ (Promega) was used to measure luciferase expression. The seven LAG3 peptides were tested at concentrations of 0, 0.64, 1.6, 4, 10, 25, & 100μM.

[89] Results of the positive control assay using the anti-LAG3 control antibody are shown in Figure 1A. These results demonstrate that the control antibody restores luciferase expression in a dose-dependent manner, with peak-fold inhibition of approximately 5 at an antibody concentration of 25μg/ml.

[90] Results of the assay testing the seven LAG3 peptides identified above and a negative control peptide (SSYHHFKMPELHFGKNTFHQ; SEQ ID NO:9) are shown in Figure 1B. These data are presented as fold increase in luciferase activity, where for each peptide the relative light units (RLUs) measured at 100μM was compared to the RLUs measured at 0.64μM. The results demonstrate that two of the peptides, LAG3-11 and LAG3-56, restore luciferase expression with fold inhibition of approximately 2.8 and 2.2, respectively, at a concentration of 100μM.

EXAMPLE 3. Peptide Disruption of LAG3-MHC-II Interaction

[91] A Homogeneous Time-resolved Fluorescence (HTRF) LAG3/MHC-II binding assay (Cisbio US Inc.) was used to measure the interaction between MHC-II and LAG3 in the presence of peptides. In this assay, the interaction between Tag1-LAG3 and Tag2-MHC-II is detected by using anti-Tag1-Terbium (HTRF donor) and anti-Tag2-XL665 (HTRF acceptor). When the donor and acceptor antibodies are brought into close proximity due to LAG3 and MHC-II binding, excitation of the donor antibody triggers fluorescent resonance energy transfer (FRET) towards the acceptor antibody, which in turn emits specifically at 665 nm. This specific signal is directly proportional to the extent of LAG3/MHC-II interaction. Thus, an agent that blocks the interaction between LAG3 and MHC-II will cause a reduction in HTRF ratio.

[92] An anti-human LAG3 antibody (Novoprotein #GMP-A092, Lot 0331158, 500 nM) was tested in the assay at an eleven-point, serially diluted semi-log dose response curve starting at 100nM and served as a positive control. The ovalbumin peptide was used as a negative control. Peptides were reconstituted at a concentration of 20 mM in 100 μM DMSO and tested at an eleven-point dose response curve starting at 100μM followed by 4-fold dilutions. Each dose was tested in triplicate.

[93] Figures 2A-D are graphs showing the results of four independent experiments testing peptide LAG3-11. These results demonstrate that peptide LAG3-11 disrupts the interaction of LAG3 and MHC-II.

[94] Figures 3-9 are graphs showing the results of experiments testing peptides LAG3-11 (Figure 3), LAG3-42 (Figure 4), LAG3-48 (Figure 5), LAG3-51 (Figure 6), LAG3-54 (Figure 7), LAG3-56 (Figure 8), and LAG3-60 (Figure 9). The individual HTRF ratios used to construct these graphs are shown in Table 3A and Table 3B.

Table 3A.

LOG [Compound] M tested for Ab	LOG [Compound] M tested for peptide	Anti-LAG3 Ab plate 1			Anti-LAG3 Ab plate 2			OVA peptide			LAG3-11			LAG3-42		
-6.30103	-4	2261	2359	2383	2234	2090	2346	8492	8909	7154	3213	3460	3458	7234	7037	7142
-6.90309	-4.60206	2647	2555	2743	2551	2501	2502	8472	8683	8449	4749	5287	5014	8389	8097	8045
-7.50515	-5.20412	2867	2915	2884	2971	2846	2840	8616	8579	9015	6812	6892	6696	8629	8765	8733
-8.10721	-5.80618	3203	3242	3170	3397	3262	3125	8833	9374	9180	7774	8164	7993	9281	8905	8572
-8.70927	-6.40824	4160	4457	4334	4286	4196	4352	8634	9280	9189	8538	8718	8858	9189	8945	8784
-9.31133	-7.0103	7218	7408	7295	7240	7263	7467	8654	8970	8380	8794	8729	8889	9432	8649	9072
-9.91339	-7.61236	8483	8643	8452	8987	8533	8601	8776	8568	9015	9090	9036	9329	9209	8787	9109
-10.5154	-8.21442	9213	8795	8849	9499	9021	8595	8624	8987	9219	9012	9293	9067	9407	8205	9247
-11.1175	-8.81648	9027	9147	8987	9102	9305	8453	8724	8639	8684	8877	8955	8992	9579	9134	8703
-11.7196	-9.41854	9013	8676	8552	9004	9330	8893	8396	8788	8625	8591	6950	8287	9137	8550	8958
-12.3216	-10.0206	8724	8742	8355	8952	8717	8824	8986	8457	8356	8212	8748	8700	8860	8937	8907
-12.9237	-10.6227	8512	9425	9136	9058	8523	8363	9086	8892	8633	8886	8842	9097	9016	8914	9210

Table 3B.

LOG [Compound] M tested for Ab	LOG [Compound] M tested for peptide	LAG3-48			LAG3-51			LAG3-54			LAG3-56			LAG3-60		
-6.30103	-4	3507	2809	3028	3058	2773	2875	4122	3912	2283	4194	4083	4373	2986		3079
-6.90309	-4.60206	5662	5088	5724	6649	6521	6468	6709	6833	7055	6880	7058	7142	5934	5959	5991
-7.50515	-5.20412	8301	8213	8200	7908	8071	8322	8561	8512	8691	8218	8349	8414	8233	7988	7918
-8.10721	-5.80618	8663	9082	9045	8723	8946	8748	9205	9142	9156	8791	8658	8464	8525	8398	8342
-8.70927	-6.40824	9264	9194	9135	9265	8583	8662	9048	8773	9161	9040	9185	9082	8614	8929	9290
-9.31133	-7.0103	8727	9103	9142	8098	9193	9017	9141	9004	9105	8147	9275	9111	9142	8745	8892
-9.91339	-7.61236	8936	9357	9297	8762	9360	9173	9031	9075	8674	8935	9303	9093	8987	8983	9320
-10.5154	-8.21442	9082	9139	9095	8950	8608	8357	8645	8867	8996	8765	9591	9178	9275	8931	9366
-11.1175	-8.81648	8708	9153	8757	8834	8187	8957	8918	8630	8130	8856	8856	8869	9059	9248	8887
-11.7196	-9.41854	8564	8922	8442	8867	8809	8630	8930	8755	8942	9050	9029	9176	8772	8594	9169
-12.3216	-10.0206	8765	9097	8602	8784	8779	8696	9203	8748	8344	9022	8887	8540	8924	8349	8904
-12.9237	-10.6227	8663	8904	9303	9082	9104	9298	9262	8921	9100	8885	9204	8617	8795	9240	9350

EXAMPLE 5. Peptide Enhancement of CD8+ T Cell Responses

[95] This Example demonstrates the effect of peptide LAG3-11 on the IFN-γ secretion and proliferation in a human peripheral blood mononuclear cell (PBMC)-based recall assay. PBMCs were obtained from a human donor who had previously been identified as a positive responder to Epstein–Barr virus (EBV) and Cytomegalovirus (CMV) viral-specific peptides. 5 x 10^5 PBMCs in 200μL of media were stimulated with EBV and CMV viral-specific peptides in the presence or absence of LAG3-11. Seven days post-stimulation, the percentage of virus-specific CD8+ T cells were identified via flow cytometry using MHC-I tetramers. Supernatants were also collected and the amount of IFN-γ determined via ELISA.

[96] The results, shown in Figure 11, demonstrate that LAG3-11 increases IFN-γ secretion by human PBMCs 3-fold relative to the viral-specific peptides alone. The ~2-fold increase in percentage of tetramer$^+$ CD8 T cells indicates that the LAG3-11 peptide may enhance T cell proliferation.

EXAMPLE 6. Interaction of Peptides with FGL1

[97] This example demonstrates the ability of LAG-11 and LAG-56 to inhibit the interaction between human LAG3 and FGL1. The peptides were tested using a Human LAG3/FGL1 TR-FRET Binding Assay (BPS Bioscience) carried out according to the manufacturer's instructions.

[98] Peptide stocks of LAG3-11, LAG3-42, LAG3-48, LAG3-51, LAG3-54, LAG3-56, LAG3-60 and OVA were prepared at 1 mM followed by a 1:5 dilution in plate reactions. LAG3-11 and OVA were tested at 200, 50, 13, 3, 0.8, 0.2, 0.05, and 0.01 μM. The other peptides were tested at 200, 50, 13, and 3 μM. A neutralizing anti-human LAG3 antibody (BPS Bioscience Cat. #71219) was used as a positive control.

[99] Reaction mixes were incubated 1 hr at RT before development. After development, plate was read in a Tecan M1000 TR-FRET instrument. Percent activity was calculated as follows:

$$\%\text{Activity} = 100 \times [(\text{sample} - \text{minimum})/(\text{maximum} - \text{minimum})]$$

[100] The results are shown in Figure 11.

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CLAIMS

1. A peptide comprising an amino acid sequence selected from the group consisting of SEQ ID NOS:1, 2, 3, 4, 5, 6, and 7.

2. The peptide of claim 1, which consists essentially of the amino acid sequence.

3. The peptide of claim 2, which consists of the amino acid sequence.

4. A nucleic acid encoding the peptide of claim 1.

5. The nucleic acid of claim 4, which is an expression construct.

6. The nucleic acid of claim 5, which is present in a CAR-T cell or an oncolytic virus.

7. The nucleic acid of claim 4, wherein the nucleic acid is selected from the group consisting of DNA, cDNA, PNA, and RNA.

8. A host cell comprising the nucleic acid of claim 4 or claim 5.

9. A peptide composition consisting essentially of one or more peptides of claim 1.

10. A pharmaceutical composition comprising:

(a) an active agent selected from the group consisting of:

(i) a peptide of any one of claims 1-3;

(ii) a nucleic acid encoding the peptide;

(iii) a CAR-T cell expressing the peptide; and

(iv) an oncolytic virus expressing the peptide; and

(b) a pharmaceutically acceptable carrier.

11. The pharmaceutical composition of claim 10, wherein the active agent is the nucleic acid, wherein the nucleic acid is selected from the group consisting of DNA, cDNA, PNA, and RNA.

12. The pharmaceutical composition of claim 10, wherein the nucleic acid is RNA.

13. The pharmaceutical composition of claim 12, wherein the RNA comprises a modification selected from the group consisting of (i) modification of a ribose sugar, (ii) modification of a phosphate linkage, and (iii) modification of a base.

14. The pharmaceutical composition of claim 13, wherein the modification is selected from the group consisting of a ribo-difluorotoluyl nucleotide, a 4′-thio modified RNA, a boranophosphate linkage, a phosphorothioate linkage, a 2′-O-methyl (2′-OMe) sugar substitution, a 2′-fluoro (2′-F), a 2′-O-methoxyethyl (2′-MOE) sugar substitution, a locked nucleic acid (LNA), and an L-RNA.

15. The pharmaceutical composition of claim 10, wherein the active agent is the peptide, wherein the peptide is provided with a peptide carrier system selected from the group consisting of a microparticle, a polymeric nanoparticle, a liposome, a solid lipid nanoparticle, a hydrophilic mucoadhesive polymer, a thiolated polymer, a polymer matrix, a nanoemulsion, and a hydrogel.

16. A method of inhibiting the progression of a hyperproliferative disorder, inhibiting the progression of a synucleinopathy, inhibiting the progression of sepsis, inhibiting the progression of an infectious disease, or enhancing a response to a vaccine, comprising administering to an individual in need thereof an effective amount of the pharmaceutical composition of any one of claims 10-15.

17. The method of claim 16, wherein the pharmaceutical composition is administered to inhibit progression of the hyperproliferative disorder.

18. The method of claim 17, wherein the hyperproliferative disorder is a cancer.

19. The method of claim 18, wherein the cancer is a melanoma.

20. The method of claim 19, wherein the second therapy is selected from the group consisting of:

(i) a cancer vaccine;

(ii) a chimeric antigen receptor (CAR) T cell therapy;

(iii) a therapy that comprises reducing or blocking activity of a molecule selected from the group consisting of PD-1, PD-L1, lymphocyte-activation gene-3 (LAG3), cytotoxic T-lymphocyte–associated antigen 4 (CTLA-4), V-domain Immunoglobulin Suppressor of T cell Activation (VISTA), T-cell Immunoglobulin domain and Mucin domain 3 (TIM-3), a killer immunoglobulin-like receptor (KIR), indoleamine (2,3)-dioxygenase (IDO), B and T Lymphocyte Attenuator (BTLA), A2A adenosine receptor (A2AR);

(iv) a cytokine;

(v) an agonist of a molecule selected from the group consisting of CD40, OX40, glucocorticoid-induced tumor necrosis factor-related protein (GITR), and Inducible T-cell COStimulator (ICOS);

(vi) an oncolytic virus; and

(vii) a therapeutic agent selected from the group consisting of a 4-1BB agonist, a 4-1BB antagonist, an inhibitor of anaplastic lymphoma kinase (ALK), an inhibitor of histone deacetylase (HDAC), and an inhibitor of VEGFR.

21. The method of claim 16, wherein the pharmaceutical composition is administered to inhibit the progression of a synucleinopathy.

22. The method of claim 21, wherein the synucleinopathy is selected from the group consisting of Parkinson's disease (PD), dementia with Lewy bodies (DLB), pure autonomic failure (PAF), and multiple system atrophy (MSA).

23. The method of claim 16, wherein the pharmaceutical composition is administered to inhibit the progression of sepsis.

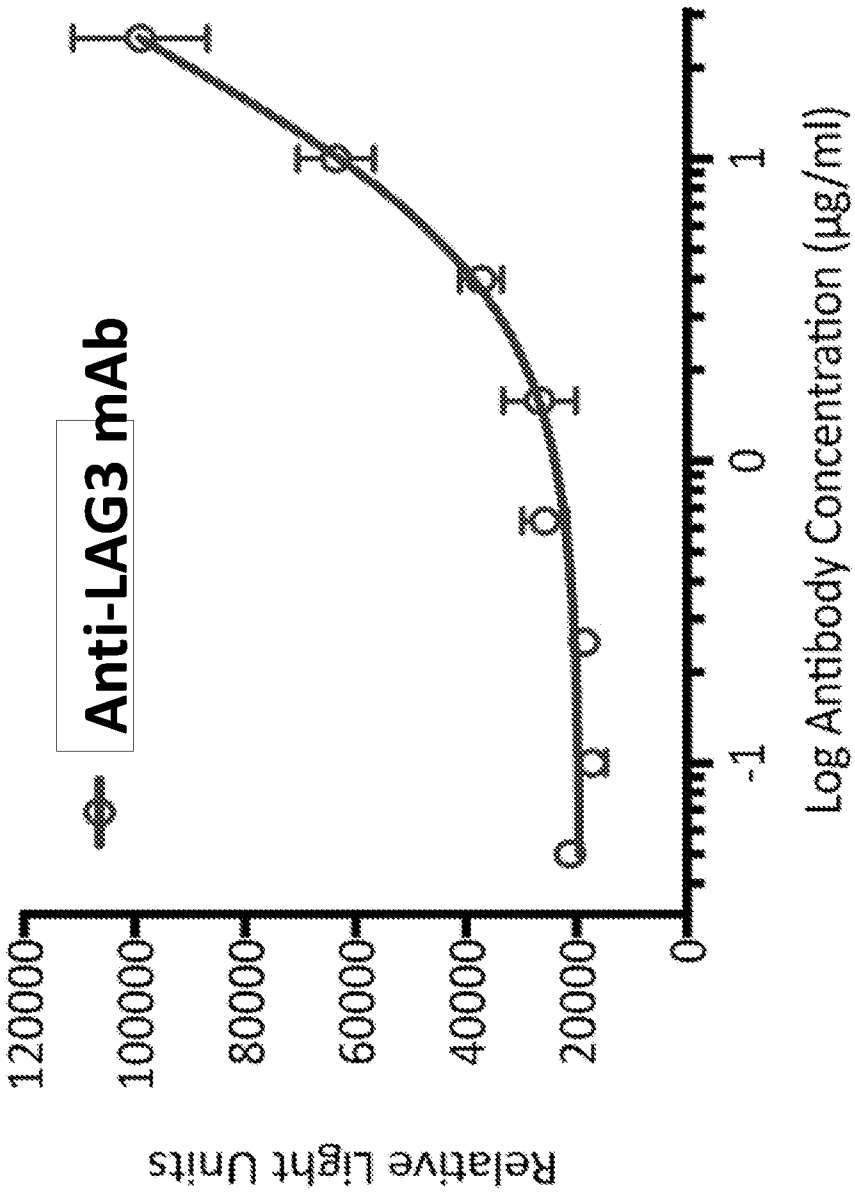
24. The method of claim 16, wherein the pharmaceutical composition is administered to inhibit the progression of an infectious disease.

25. The method of claim 16, wherein the pharmaceutical composition is administered to enhance a response to a vaccine.

26. Use of the peptide of any one of claims 1-3 or the nucleic acid of any one of claims 4-7 in the manufacture of a medicament for inhibiting the progression of a hyperproliferative disorder, inhibiting the progression of a synucleinopathy, inhibiting the progression of sepsis, inhibiting the progression of an infectious disease, or enhancing a response to a vaccine.

27. Use of the peptide of any one of claims 1-3 or the nucleic acid of any one of claims 4-7 for inhibiting the progression of a hyperproliferative disorder, inhibiting the progression of a synucleinopathy, inhibiting the progression of sepsis, inhibiting the progression of an infectious disease, or enhancing a response to a vaccine.

28. The composition of any one of claims 10-15 for inhibiting the progression of a hyperproliferative disorder, inhibiting the progression of a synucleinopathy, inhibiting the progression of sepsis, inhibiting the progression of an infectious disease, or enhancing a response to a vaccine.


Anti-LAG3 mAb
Relative Light Units
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80000
60000
40000
20000
0
-1
0
1
Log Antibody Concentration (µg/ml)

FIG. 1A

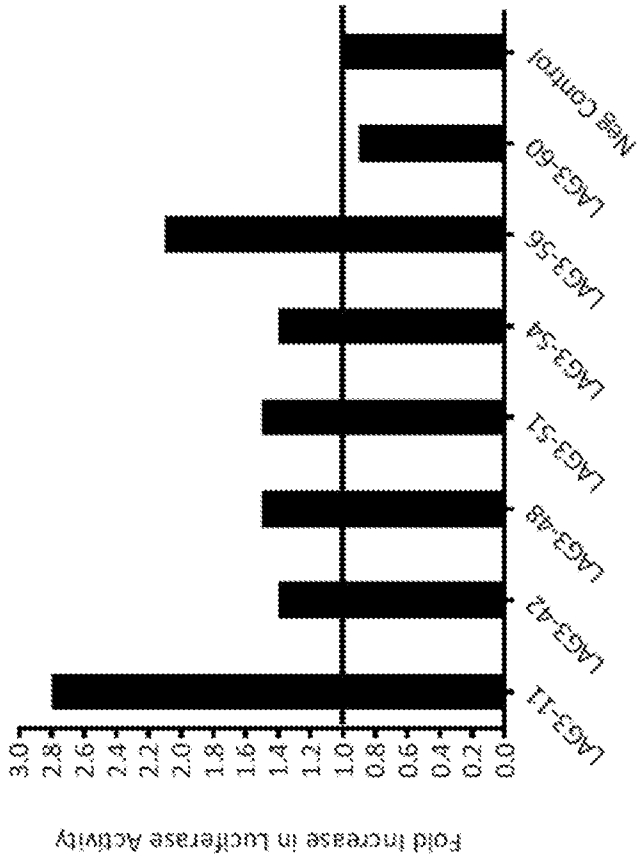
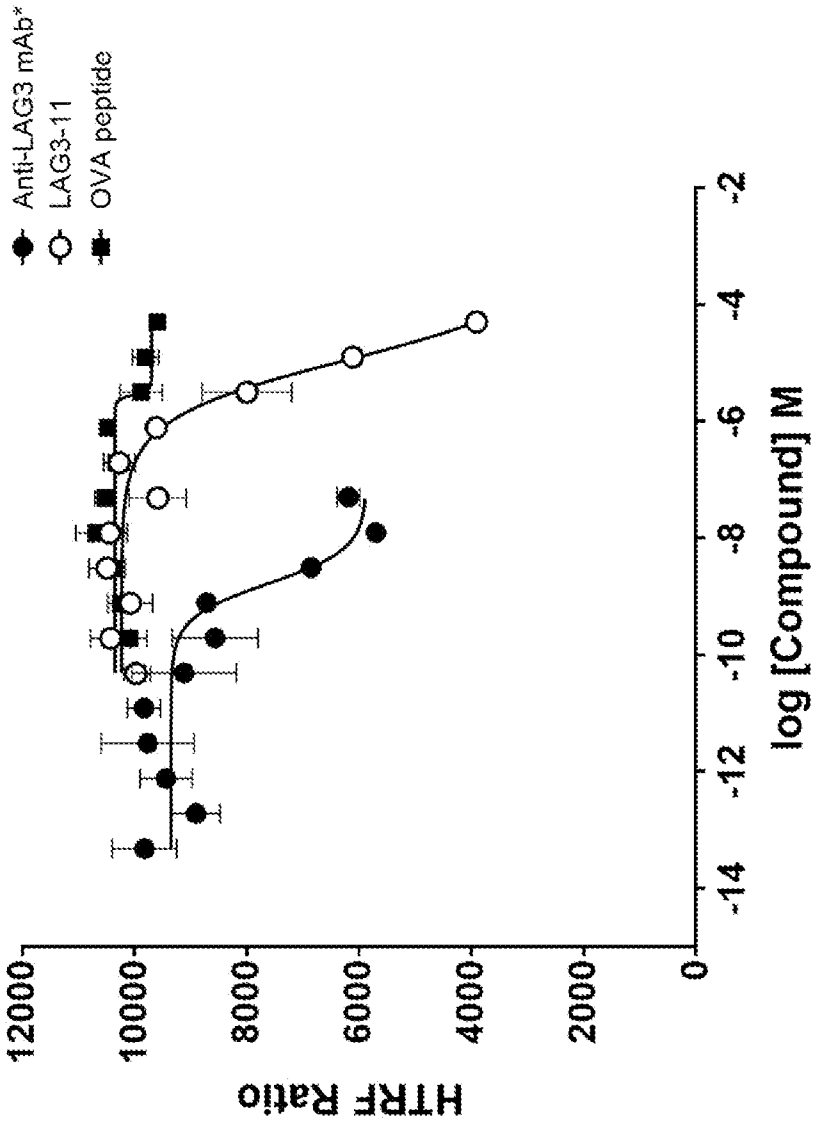

Fold Increase in Luciferase Activity
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
LAG3-11
LAG3-42
LAG3-49
LAG3-51
LAG3-54
LAG3-56
LAG3-60
Nss Control

FIG. 1B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LAG3-11
OVA peptide
HTRF Ratio
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-14
-12
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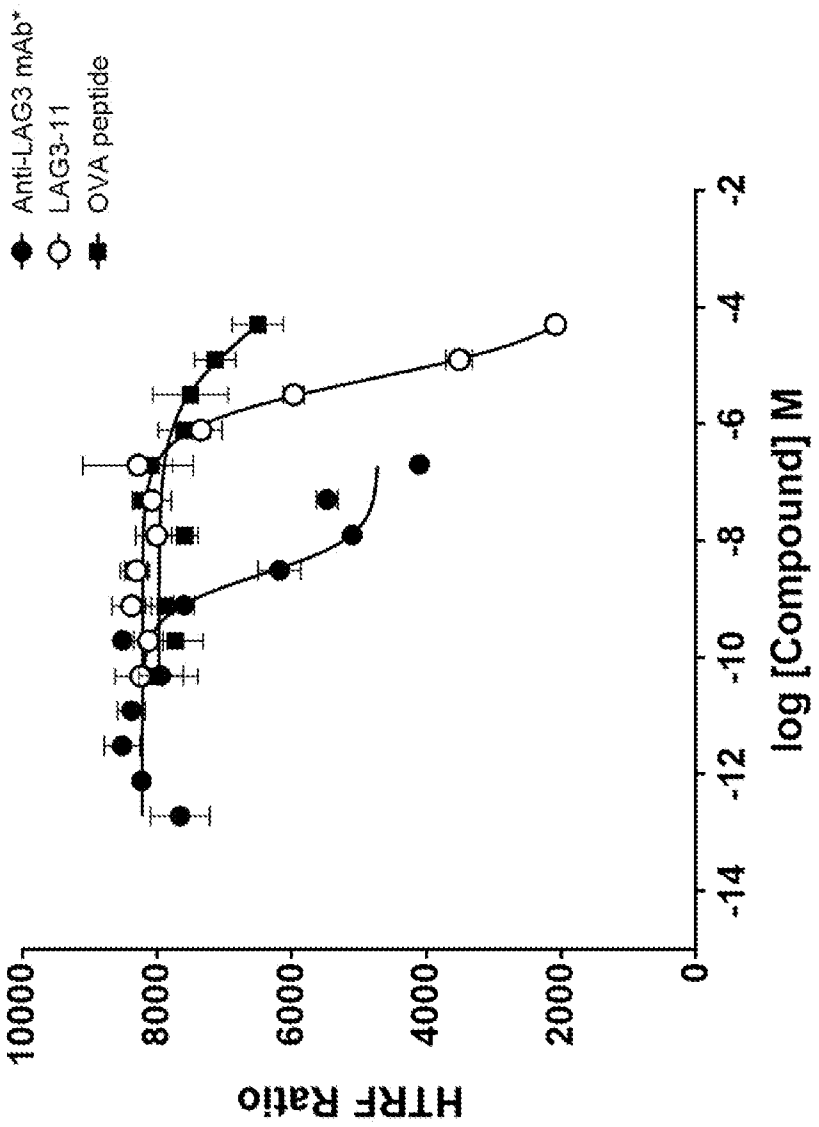
-4
-2
log [Compound] M

FIG. 2A


Anti-LAG3 mAb*
LAG3-11
OVA peptide
HTRF Ratio
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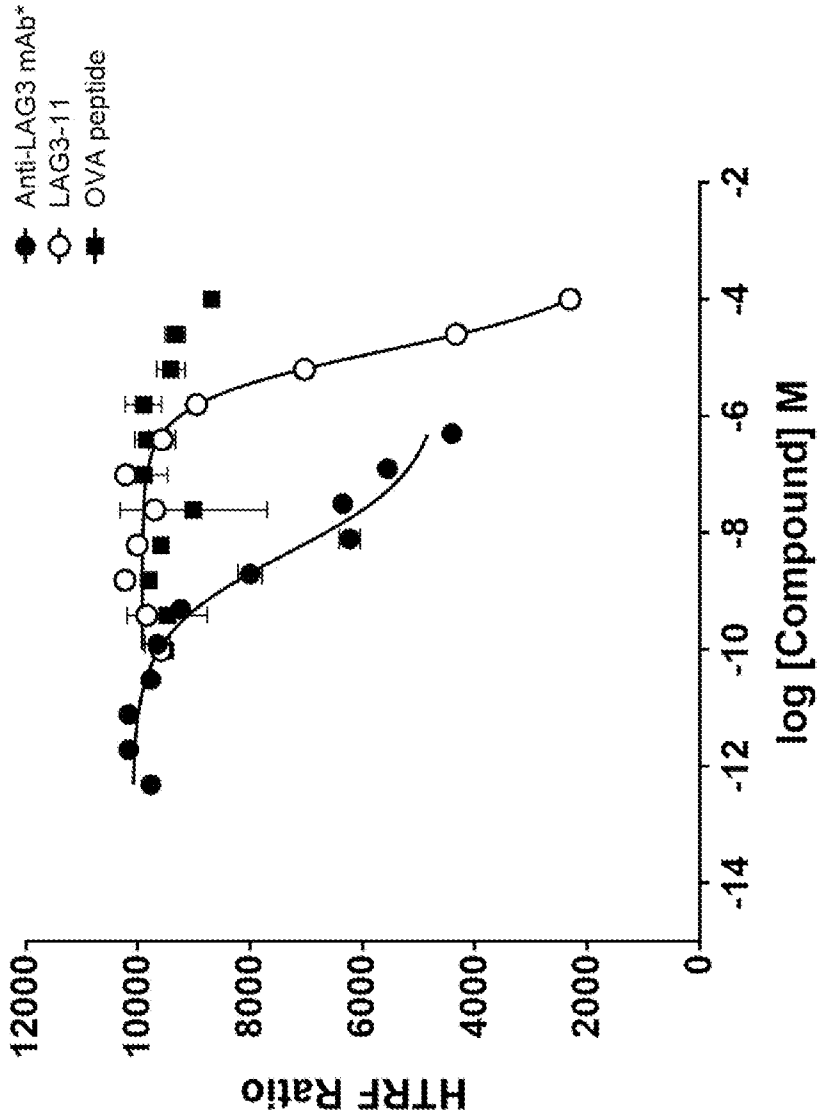
-2
log [Compound] M

FIG. 2B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OVA peptide
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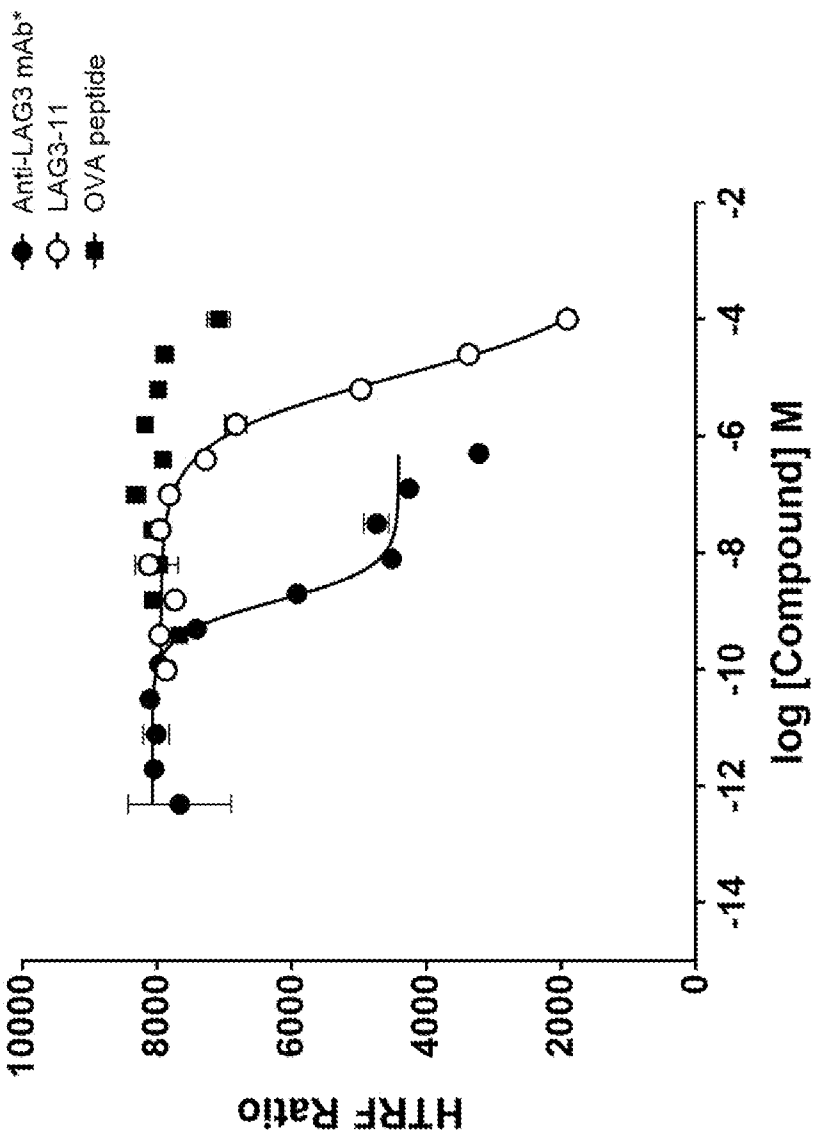
log [Compound] M

FIG. 2C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OVA peptide
HTRF Ratio
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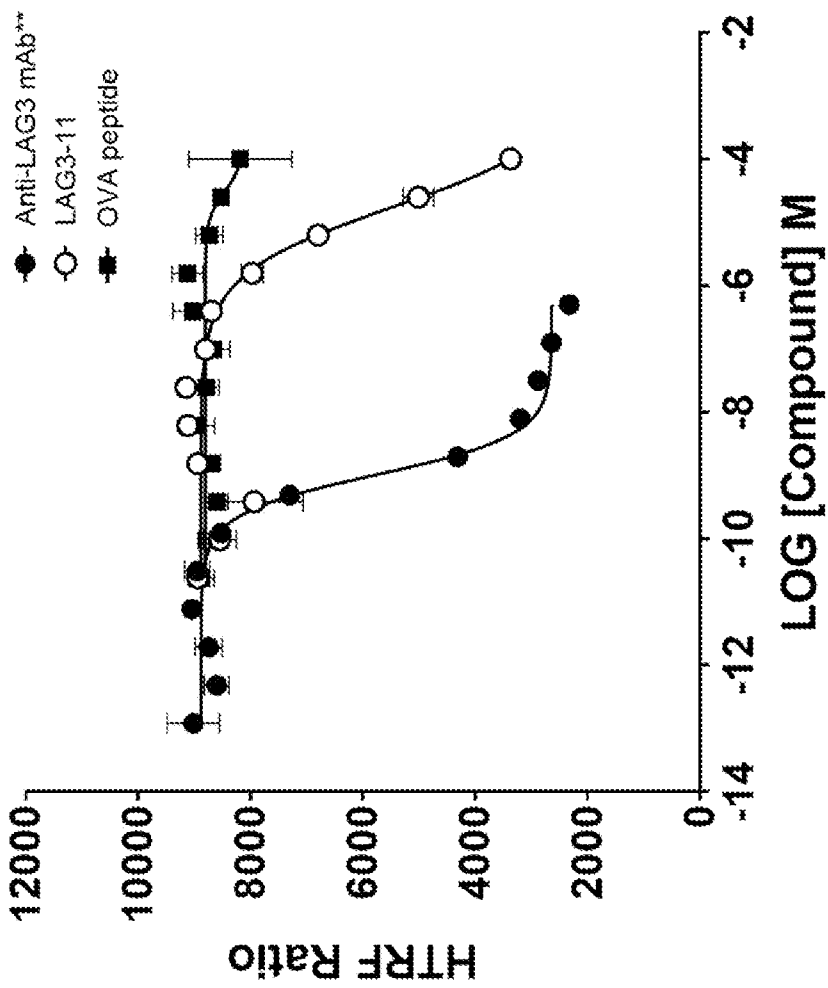
log [Compound] M

FIG. 2D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OVA peptide
HTRF Ratio
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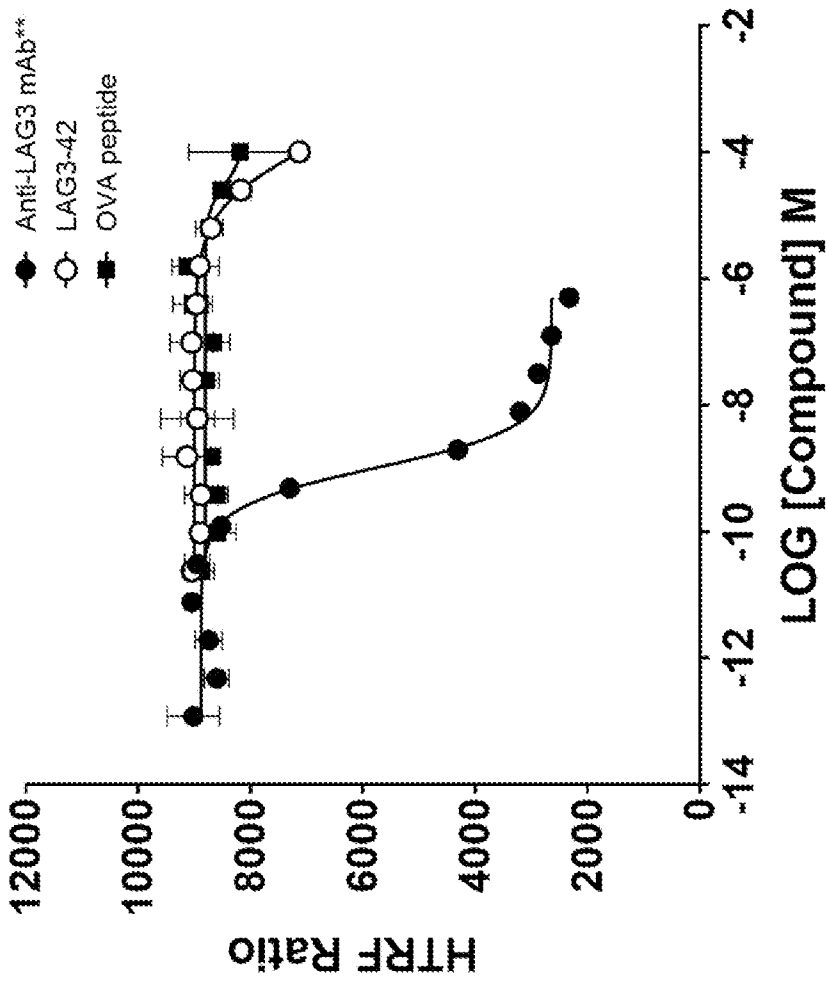
LOG [Compound] M

FIG. 3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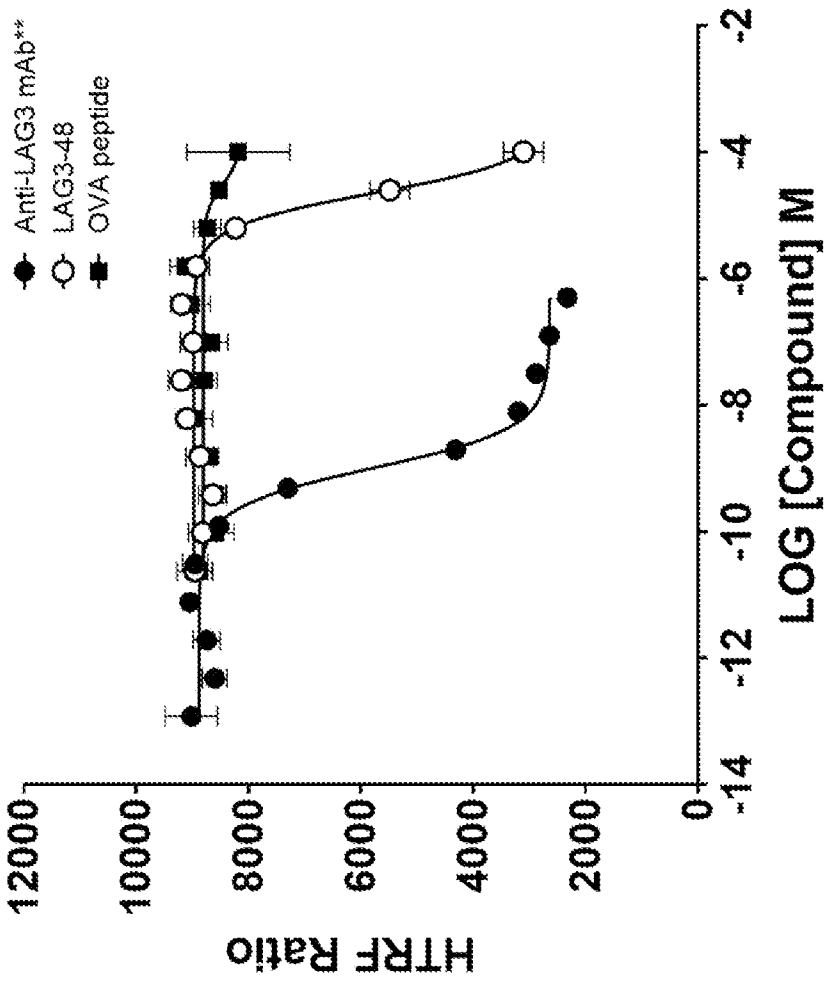
LOG [Compound] M

FIG. 4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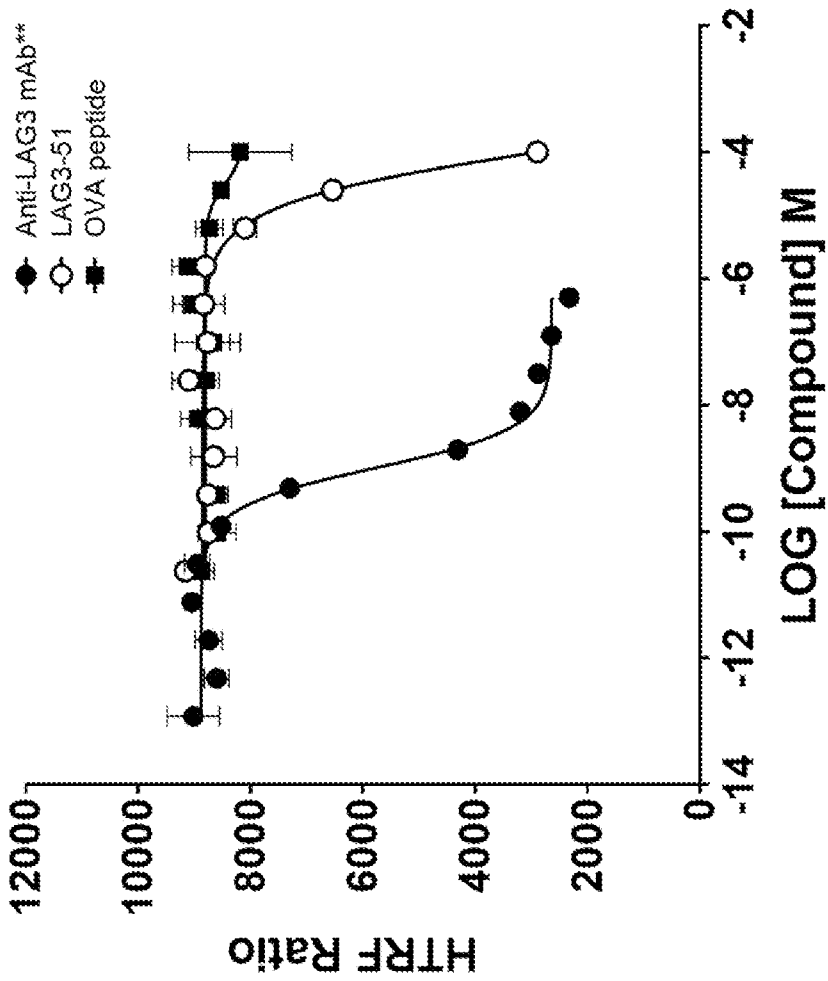
-2
LOG [Compound] M

FIG. 5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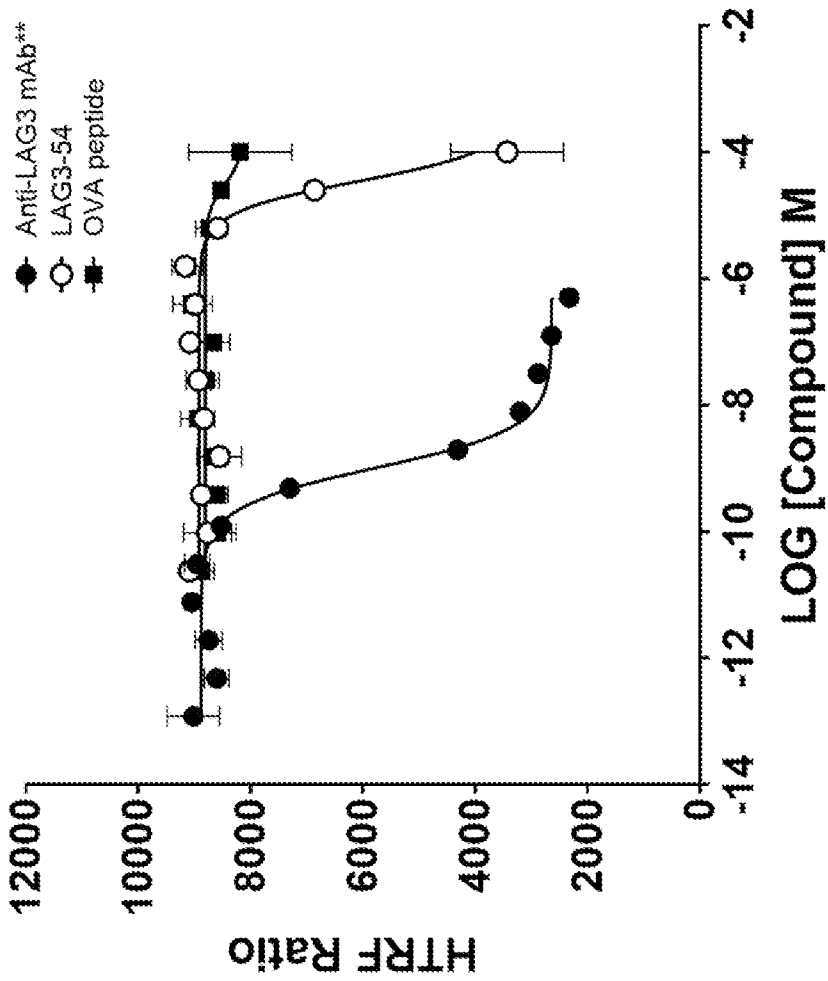
LOG [Compound] M

FIG. 6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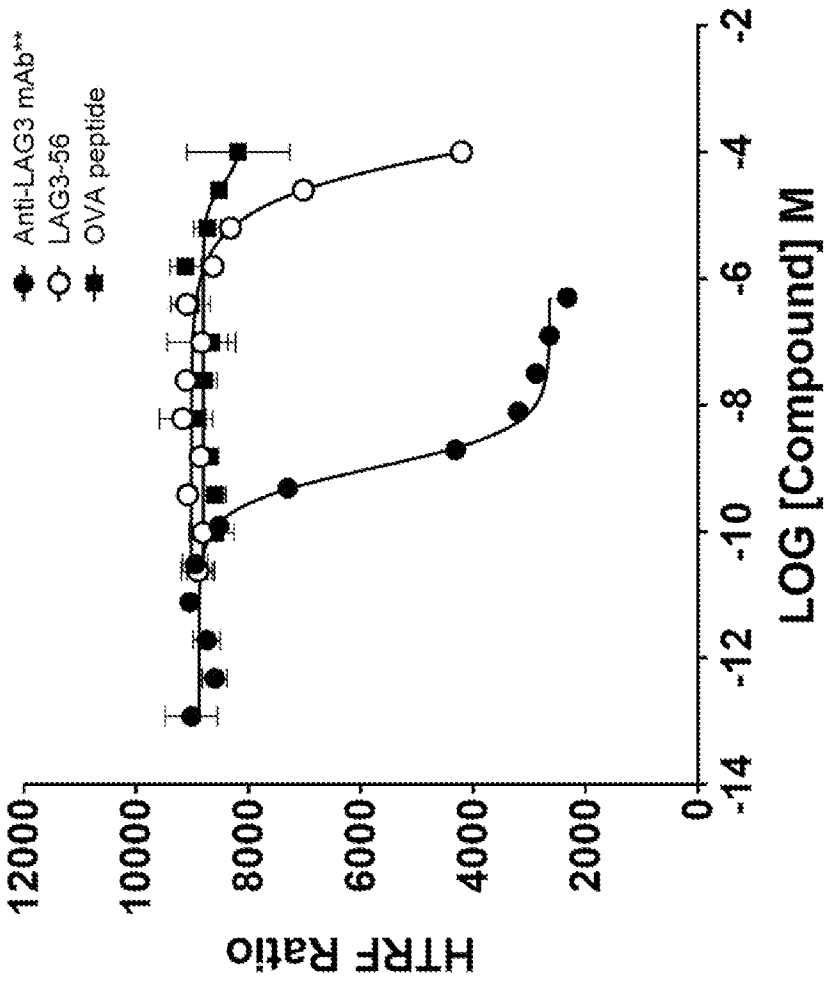
-2
LOG [Compound] M

FIG. 7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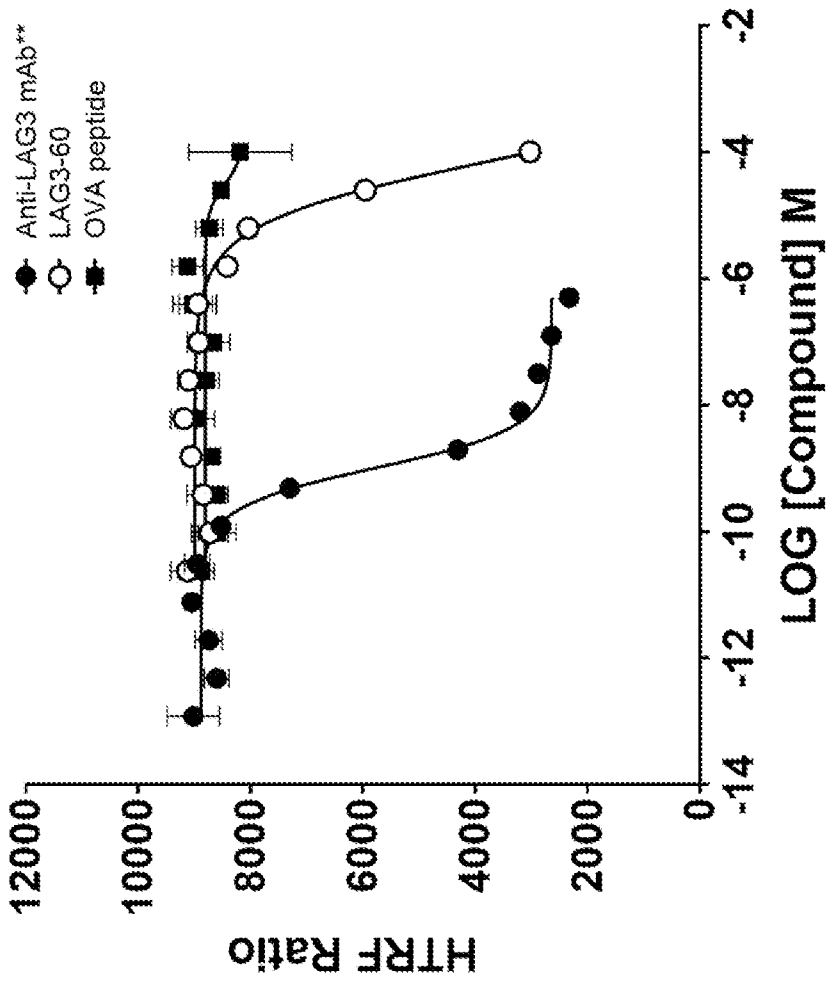
LOG [Compound] M

FIG. 8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LOG [Compound] M

FIG. 9

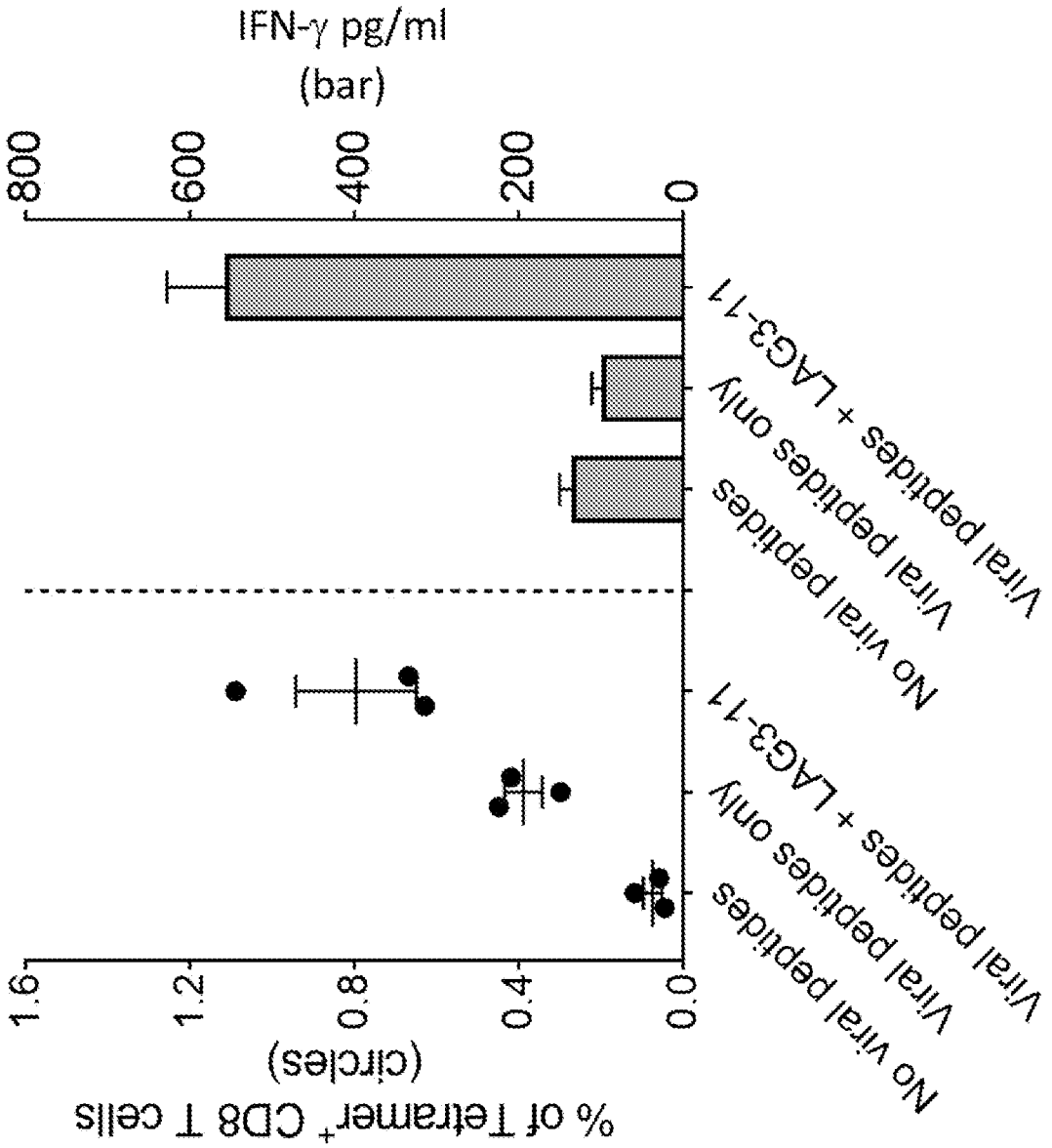
IFN-γ pg/ml
(bar)
800
600
400
200
0
Viral peptides + LAG3-17
Viral peptides only
No viral peptides
Viral peptides + LAG3-17
Viral peptides only
No viral peptides
1.6
1.2
0.8
0.4
0.0
(circles)
% of Tetramer+ CD8 T cells

FIG. 10

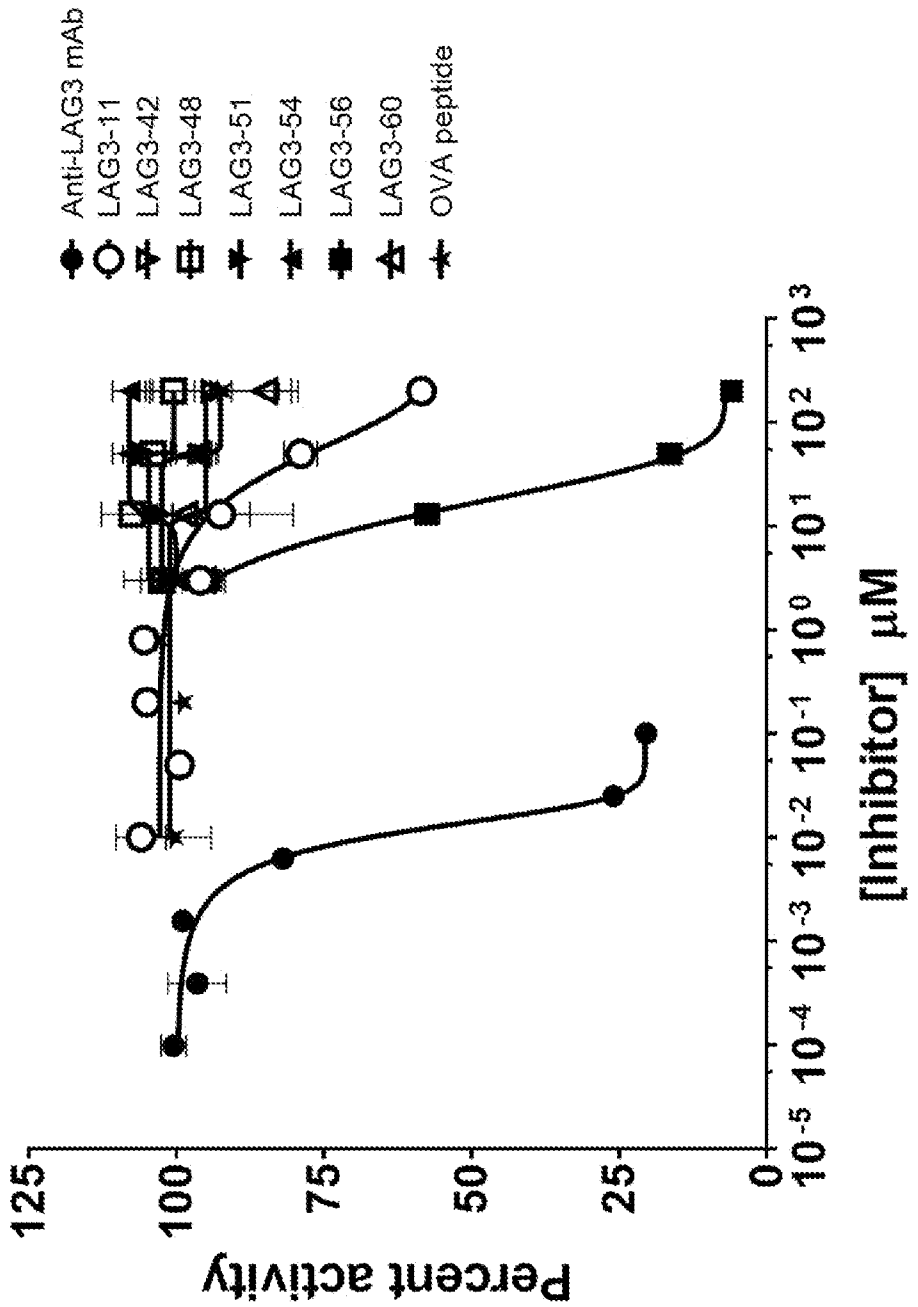
Anti-LAG3 mAb
LAG3-11
LAG3-42
LAG3-48
LAG3-51
LAG3-54
LAG3-56
LAG3-60
OVA peptide
Percent activity
125
100
75
50
25
0
10-5 10-4 10-3 10-2 10-1 100 101 102 103
[Inhibitor] µM

FIG. 11

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<151>2019-05-22

<160> 9

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Ser His Val Val
            20

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<400> 4
Lys Val Trp Gln Val Pro Gln Asp Thr Gln His Trp Leu Ser Pro Asn
 1   5   10   15
Phe Tyr Ser Val
            20

<210> 5
<211> 13
<212> PRT
<213> Artificial Sequence

<220>
<223> LAG3-54 peptide

<400> 5
Ala Cys Gly Pro Gly Ser Phe Gly Asp Cys Gly Gly Gly
 1   5   10

<210> 6
<211> 21
<212> PRT
<213> Artificial Sequence

<220>
<223> LAG3-56 peptide

<400> 6
His Ile Gln Asn Trp Ser Tyr Trp Leu Asn Gln Asp Met Met Asn Gln
 1   5   10   15
Gln Val Trp Lys Ser
            20

<210> 7
<211> 18
<212> PRT
<213> Artificial Sequence

<220>
<223> LAG3-60 peptide

<400> 7
His Glu Ser Gly Ser Val Pro His Pro Trp Gln Phe Phe Thr His Tyr
 1   5   10   15
Val Ser

<210> 8
<211> 17
<212> PRT
<213> Gallus gallus

<400> 8
Ile Ser Gln Ala Val His Ala Ala His Ala Glu Ile Asn Glu Ala Gly
 1   5   10   15
Arg

<210> 9
<211> 20
<212> PRT
<213> Artificial Sequence

<220>
<223> negative control peptide

<400> 9
Ser Ser Tyr His His Phe Lys Met Pro Glu Leu His Phe Gly Lys Asn
 1   5   10   15
Thr Phe His Gln
            20