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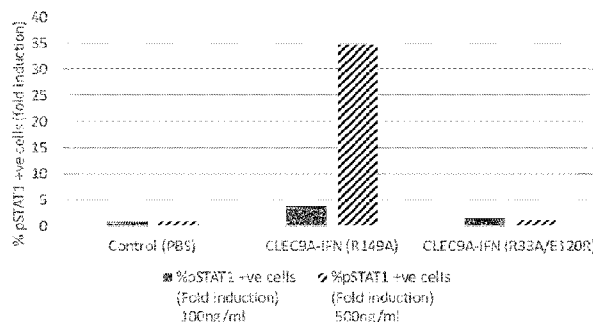
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[Continued on next page]

(54) Title: CLEC9A BINDING AGENTS

FIGURE 13



(57) Abstract: The present invention relates, in part, to agents that bind Clec9A and their use as diagnostic and therapeutic agents. The present invention further relates to pharmaceutical compositions comprising the Clec9A binding agents and their use in the treatment of various diseases.

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CLEC9A BINDING AGENTS AND USE THEREOF**CROSS-REFERENCE TO RELATED APPLICATIONS**

This application claims the benefit of U.S. Provisional Patent Application Nos. 62/291,769, filed February 5, 2016; 62/335,880, filed May 13, 2016; 62/411,805, filed October 24, 2016; 62/291,772, filed February 5, 2016; 62/291,774, filed February 5, 2016; 62/335,965, filed May 13, 2016; 62/291,776, filed February 5, 2016; 62/335,968, filed May 13, 2016; 62/335,979, filed May 13, 2016; 62/336,030, filed May 13, 2016; 62/353,607, filed June 23, 2016; and 62/291,779, filed February 5, 2016, the entire contents of all of which are herein incorporated by reference.

FIELD

The present invention relates, in part, to binding agents which bind Clec9A and their use as therapeutic and diagnostic agents.

DESCRIPTION OF THE TEXT FILE SUBMITTED ELECTRONICALLY

The contents of the text file submitted electronically herewith are incorporated herein by reference in their entirety: A computer readable format copy of the Sequence Listing (filename: ORN-012PC_Sequence_listing, date recorded: February 1, 2017; file size: 281 KB).

BACKGROUND

Dendritic cells (DCs) are antigen-presenting cells (APCs) equipped with the ability to induce primary immune responses and play an important role in various aspects of immunity. Activated dendritic cells are capable of recruiting additional immune cells such as macrophages, eosinophils, natural killer cells, and T cells such as natural killer T cells. Dendritic cells also capture antigens and present the antigens on their surfaces to activate T cells (e.g. cytotoxic T cells (CTLs)).

Despite major advances in cancer treatment, cancer remains one of the leading causes of death globally. Hurdles in designing effective therapies include cancer immune evasion, in which cancer cells escape destructive immunity, as well as the toxicity of many conventional cancer treatments such as radiation therapy and chemotherapy, which significantly impacts a patient's ability to tolerate the therapy and/or impacts the efficacy of the treatment.

One mechanism by which cancers evade immune detection and destruction is by crippling dendritic cell functionality through prevention of dendritic cell (DC) recruitment and activation. Accordingly, there remains a need for cancer therapies that can effectively derail tumor evasion and enhance anti-tumor immunity as mediated, for example, by dendritic cells.

Multiple sclerosis (MS) is an autoimmune disease of the central nervous system with both autoimmune and neurodegenerative features. The most frequent form of MS is relapsing-remitting multiple sclerosis (RRMS),

which is clinically characterized by recurring episodes of neurological symptoms. More than 2.3 million people worldwide suffer from MS, with 400,000 people in the U.S. alone having the disease.

Current pharmacological treatments for MS, including disease modifying therapies (DMTs), either modify or suppress the body's immune system. Many of the current pharmacological agents for MS are limited by incomplete efficacy, side effects and medical risks. These treatments have been shown to modestly reduce neurological relapses of the disease and, in some instances, incompletely slow the progression of neurological disability. Accordingly, there also remains a pressing need for improved MS treatments.

SUMMARY

In various aspects, the present invention relates to Clec9A binding agents having at least one targeting moiety that specifically binds to Clec9A. In various embodiments, these Clec9A binding agents bind to, but do not functionally modulate (*e.g.* partially or fully neutralize) Clec9A. Therefore, in various embodiments, the present Clec9A binding agents have use in, for instance, directly or indirectly recruiting a Clec9A-expressing cell to a site of interest while still allowing the Clec9A-expressing cell to signal via Clec9A (*i.e.* the binding of the Clec9A binding agent does not reduce or eliminate Clec9A signaling at the site of interest). In an embodiment, the targeting moiety is a single domain antibody (VHH, or NANOBODY). In various embodiments, the Clec9A binding agent further comprises a signaling agent, *e.g.*, without limitation, an interferon, an interleukin, and a tumor necrosis factor, that may be modified to attenuate activity. In various embodiments, the Clec9A binding agent comprises additional targeting moieties that bind to other targets (*e.g.* antigens, receptor) of interest. In an embodiment, the other targets (*e.g.* antigens, receptor) of interest are present on tumor cells. In another embodiment, the other targets (*e.g.* antigens, receptor) of interest are present on immune cells. In some embodiments, the present Clec9A binding agent may directly or indirectly recruit an immune cell (*e.g.* a dendritic cell) to a site of action (such as, by way of non-limiting example, the tumor microenvironment). In some embodiments, the present Clec9A binding agent facilitates the presentation of antigens (*e.g.*, tumor antigens) by dendritic cells.

In various embodiments, the present Clec9A binding agents find use in the treatment of various diseases or disorders such as cancer, infections, immune disorders, and other diseases and disorders, and the present invention encompasses various methods of treatment.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 panels A-F provide histograms showing the binding of six VHHs specific for mouse Clec9A to CHO cells transfected with Clec9A.

Figure 2 panel A shows that the administration of a fusion of a VHH specific for mouse Clec9A with a modified human interferon (Q124R mutant, "Clec9A-targeted AcTaferon") led to reductions in tumor size (lines from top to bottom at last time point: PBS, "untargeted AcTaferon" (*i.e.* modified human interferon (Q124R mutant) fused to a targeting moiety for an irrelevant target - hCD20, "Clec9A-targeted AcTaferon" - fusion of a VHH specific for

mouse Clec9A with a modified human interferon (Q124R mutant), and “WT mIFN” (*i.e.* unmodified murine interferon). Panels B and C show that the administration of the fusion of a VHH specific for mouse Clec9A with a modified human interferon (Q124R mutant) did not result in weight loss or hematological toxicity, respectively (in panel B, lines from top to bottom at last time point: untargeted AcTaferon, PBS, Clec9A-targeted AcTaferon, and WT mIFN, in panel C all graphs, the histograms left to right are: naive mice, PBS, mIFN WT, untargeted AcTaferon, and Clec9A-targeted AcTaferon).

Figure 3 depicts the nucleotide sequence of 27 different VHHs specific for human Clec9A. Gaps were introduced in order to align sequences. The sequences of **Figure 3** are assigned sequence identifiers as shown in Example 2 below.

Figure 4 shows the amino acid sequences of 27 different VHHs specific for human Clec9A. Complementarity determining regions (CDR1, CDR2 and CDR3) as indicated are defined according to Kabat. Gaps were introduced in order to align sequences. The above 27 different VHHs belong to 11 different groups (see Figure 5). VHHs belonging to the same group are very similar and their amino acid sequences suggest that they are from clonally-related B-cells resulting from somatic hypermutation or from the same B-cell but diversified due to RT and/or PCR error during library construction. VHHs belonging to the same group recognize the same epitope but their other characteristics (*e.g.* affinity, potency, stability, expression yield, *etc.*) can be different. The sequences of **Figure 4** are assigned sequence identifiers as shown in Example 2 below.

Figure 5 provides a table depicting that the 27 different VHHs belonged to 11 different groups. Members of groups 5 and 7 bind to both mouse and human Clec9A.

Figure 6 shows the anti-tumor potential of a chimeric protein comprising a VHH specific for mouse Clec9A fused to a modified human interferon alpha 2 (Q124R mutant, “Acta-Clec9A”) in combination with tumor necrosis factor (TNF). Panel A demonstrates that combination treatment using the chimeric protein and TNF exhibited potent anti-tumor activity with no tumor recurrence by day 38 (or 23 days post-dosing). Panel B shows that the combination treatment was well tolerated with no significant hematological toxicity such as thrombocytopenia compared to treatment with wild type IFN or wild type IFN combined with TNF.

Figure 7 shows the combined effect of chimera of a VHH specific for mouse Clec9A fused to a modified human interferon alpha 2 (Q124R mutant) and an anti-PD-L1 antibody (“Clec9A-AcTaferon + anti-PD-L1”) in comparison to PBS (negative control), chimera of a VHH specific for mouse Clec9A fused to a modified human interferon alpha 2 alone (Q124R mutant, “Clec9A-AcTaferon”), and anti-PD-L1 antibody alone (“anti-PD-L1”).

Figure 8 shows the combined effect of a chimera of a VHH specific for mouse Clec9A fused to a modified human interferon alpha 2 (Q124R) and also fused to an anti-PD-L1 VHH and doxorubicin (“Clec9A-Q124R-PD-L1 + doxo”), compared to a chimera of a VHH specific for mouse Clec9A fused to a modified human interferon alpha 2 (“Q124R”) and fused to an anti-PD-L1 VHH (“Clec9A-Q124R-PD-L1”), doxorubicin (“doxo”), and PBS (negative control).

Figure 9 shows a substantial induction of T cell proliferation in mice in response to administration of a VHH specific for mouse Clec9A fused to a modified human interferon alpha 2 (Q124R mutant, "Actakine").

Figure 10, panel A shows mean clinical scores as described in Example 7 for various treatments (including various fusions) also described in Example 7. **Figure 10**, panel B shows mean body weight as described in Example 7 for various treatments (including various fusions) also described in Example 7.

Figure 11 shows the cumulative clinical score for various treatments; the histograms are (left to right: PBS (negative control), fusion of anti-CD20 and human IFN with a Q124R mutation ("Q-CD20"), fusion of anti-CD8 and human IFN with a Q124R mutation ("Q-CD8"), fusion of anti-Clec9A and human IFN with a Q124R mutation ("Q-Clec9A"), fusion of anti-Bcl10 and human IFN with a Q124R mutation ("Q-Bcl10," *i.e.* the untargeted control), and wild type IFN at two doses as indicated. Q124R is a human IFN mutation that is suitable for use in the mouse (*i.e.* it is a human mutant IFN that functions in mouse). See *Nat. Comm.* 2014;5:3016. doi: 10.1038/ncomms4016, the entire contents of which are hereby incorporated by reference.

Figure 12 shows various side effects in the treatments outlined in **Figure 11** above (same histogram order left to right for panels B-F).

Figure 13 shows a human dendritic cell pSTAT1 signaling assay. Chimeras studied were anti-human Clec9A VHH/human IFN R149A and anti-human Clec9A VHH/human IFN R33A/E120R. Two doses of the agents were studied: 100 ng/ml and 500 ng/ml. PBS was the control and the data are expressed as a fold change of the percentage of pSTAT1⁺ dendritic cells (data is an average of a triplicate data set).

Figure 14 shows anti-human Clec9a VHH/anti-human PD-L1 VHH/human IFN -R149A bi-specific chimera anti-tumor effects on a human tumor (RL) grown in humanized mice. With reference to day 18 on the X axis, the constructs studied were, from top to bottom: PBS (control); anti-human Clec9a VHH/anti-human PD-L1 VHH/human IFN-R149A bi-specific chimera; and anti-human Clec9a VHH/anti-human PD-L1 VHH/human IFN-R149A bi-specific chimera plus FMS-like tyrosine kinase 3 ligand (FLT3L).

DETAILED DESCRIPTION

The present invention is based, in part, on the discovery of agents (*e.g.* antibodies such as, by way of non-limiting example, VHHs) that recognize and bind to Clec9A. In some embodiments, the present Clec9A binding agents are part of a chimeric or fusion protein with one or more targeting moieties and/or one or more signaling agents. In some embodiments, these Clec9A binding agents bind to, but do not functionally modulate Clec9A.

In some embodiments, these Clec9A binding agents may bind and directly or indirectly recruit immune cells to sites in need of therapeutic action (*e.g.* a tumor or tumor microenvironment). In some embodiments, the Clec9A binding agents enhance tumor antigen presentation for elicitation of effective antitumor immune response.

In some embodiments, the Clec9A binding agents modulate antigen presentation. In some embodiments, the Clec9A binding agents temper the immune response to avoid or reduce autoimmunity. In some embodiments, the Clec9A binding agents provide immunosuppression. In some embodiments, the Clec9A binding agents cause

an increase a ratio of Tregs to CD8+ T cells and/or CD4+ T cells in a patient. In some embodiments, the present methods relate to reduction of auto-reactive T cells in a patient.

The present invention provides pharmaceutical compositions comprising the Clec9A binding agents and their use in the treatment of various diseases, including cancer, autoimmune, and/or neurodegenerative diseases.

Clec9A Binding Agents

In various embodiments, the present Clec9A binding agent is a protein-based agent capable of specific binding to Clec9A. In various embodiments, the present Clec9A binding agent is a protein-based agent capable of specific binding to Clec9A without functional modulation (e.g., partial or full neutralization) of Clec9A. Clec9A is a group V C-type lectin-like receptor (CTLR) expressed on the surface of a subset of dendritic cells (*i.e.*, BDCA₃+ dendritic cells) specialized for the uptake and processing of materials from dead cells. Clec9A recognizes a conserved component within nucleated and nonnucleated cells, exposed when cell membranes are damaged. Clec9A is expressed at the cell surface as a glycosylated dimer and can mediate endocytosis, but not phagocytosis. Clec9A possesses a cytoplasmic immunoreceptor tyrosine-based activation-like motif that can recruit Syk kinase and induce proinflammatory cytokine production (see Huysamen *et al.* (2008), JBC, 283:16693-701).

In various embodiments, the Clec9A binding agent of the invention comprises a targeting moiety having an antigen recognition domain that recognizes an epitope present on Clec9A. In an embodiment, the antigen-recognition domain recognizes one or more linear epitopes present on Clec9A. As used herein, a linear epitope refers to any continuous sequence of amino acids present on Clec9A. In another embodiment, the antigen-recognition domain recognizes one or more conformational epitopes present on Clec9A. As used herein, a conformation epitope refers to one or more sections of amino acids (which may be discontinuous) which form a three-dimensional surface with features and/or shapes and/or tertiary structures capable of being recognized by an antigen recognition domain.

In various embodiments, the Clec9A binding agent of the present invention may bind to the full-length and/or mature forms and/or isoforms and/or splice variants and/or fragments and/or any other naturally occurring or synthetic analogs, variants, or mutants of human Clec9A. In various embodiments, the Clec9A binding agent of the invention may bind to any forms of the human Clec9A, including monomeric, dimeric, heterodimeric, multimeric and associated forms. In an embodiment, the Clec9A binding agent binds to the monomeric form of Clec9A. In another embodiment, the Clec9A binding agent binds to a dimeric form of Clec9A. In a further embodiment, the Clec9A binding agent binds to glycosylated form of Clec9A, which may be either monomeric or dimeric.

In an embodiment, the present Clec9A binding agent comprises a targeting moiety with an antigen recognition domain that recognizes one or more epitopes present on human Clec9A. In an embodiment, the human Clec9A comprises the amino acid sequence of:

MHEEEIYTSLQWDSPAPDTYQKCLSSNKCSGACCLVMVISCVFCMGLLTA
 SIFLGVKLLQVSTIAMQQQEKLIIQGERALLNFTWKRSCALQMKYCQAFMQ
 NSLSSAHNSSPCPNNWIQNRESCYYVSEIWSIWHTSQENCLKEGSTLLQIE
 SKEEMDFITGSLRKIKGSYDYWVGLSQDGHSGRWLWQDGSSPSPGLLPA
 ERSQSANQVCGYVKNSNLLSSNCSTWKYFICEKYALRSSV (SEQ ID
 NO:1).

In various embodiments, the present Clec9A binding agent comprises a targeting moiety capable of specific binding. In various embodiments, the Clec9A binding agent comprises a targeting moiety having an antigen recognition domain such as an antibody or derivatives thereof. In an embodiment, the Clec9A binding agent comprises a targeting moiety which is an antibody. In various embodiments, the antibody is a full-length multimeric protein that includes two heavy chains and two light chains. Each heavy chain includes one variable region (e.g., V_H) and at least three constant regions (e.g., CH₁, CH₂ and CH₃), and each light chain includes one variable region (V_L) and one constant region (C_L). The variable regions determine the specificity of the antibody. Each variable region comprises three hypervariable regions also known as complementarity determining regions (CDRs) flanked by four relatively conserved framework regions (FRs). The three CDRs, referred to as CDR1, CDR2, and CDR3, contribute to the antibody binding specificity. In some embodiments, the antibody is a chimeric antibody. In some embodiments, the antibody is a humanized antibody.

In some embodiments, the Clec9A binding agent comprises a targeting moiety which is an antibody derivative or format. In some embodiments, the present Clec9A binding agent comprises a targeting moiety which is a single-domain antibody, a recombinant heavy-chain-only antibody (VHH), a single-chain antibody (scFv), a shark heavy-chain-only antibody (VNAR), a microprotein (cysteine knot protein, knottin), a DARPin; a Tetranectin; an Affibody; an Affimer, a Transbody; an Anticalin; an AdNectin; an Affilin; a Microbody; a peptide aptamer; an alterase; a plastic antibody; a phylomer; a stradobody; a maxibody; an evibody; a fynomer, an armadillo repeat protein, a Kunitz domain, an avimer, an atrimer, a probody, an immunobody, a triomab, a troybody; a pepbody; a vaccibody, a UniBody; a DuoBody, a Fv, a Fab, a Fab', a F(ab')₂, a peptide mimetic molecule, or a synthetic molecule, as described in US Patent Nos. or Patent Publication Nos. US 7,417,130, US 2004/132094, US 5,831,012, US 2004/023334, US 7,250,297, US 6,818,418, US 2004/209243, US 7,838,629, US 7,186,524, US 6,004,746, US 5,475,096, US 2004/146938, US 2004/157209, US 6,994,982, US 6,794,144, US 2010/239633, US 7,803,907, US 2010/119446, and/or US 7,166,697, the contents of which are hereby incorporated by reference in their entireties. See also, Storz MABs. 2011 May-Jun; 3(3): 310–317.

In some embodiments, the Clec9A binding agent comprises a targeting moiety which is a single-domain antibody, such as a VHH. The VHH may be derived from, for example, an organism that produces VHH antibody such as a camelid, a shark, or the VHH may be a designed VHH. VHHs are antibody-derived therapeutic proteins that contain the unique structural and functional properties of naturally-occurring heavy-chain antibodies. VHH technology is based on fully functional antibodies from camelids that lack light chains. These heavy-chain antibodies contain a single variable domain (V_HH) and two constant domains (CH₂ and CH₃). VHHs are

commercially available under the trademark of NANOBODIES. In an embodiment, the Clec9A binding agent comprises a VHH.

In some embodiments, the Clec9A binding agent comprises a targeting moiety which is a VHH comprising a single amino acid chain having four "framework regions" or FRs and three "complementary determining regions" or CDRs. As used herein, "framework region" or "FR" refers to a region in the variable domain which is located between the CDRs. As used herein, "complementary determining region" or "CDR" refers to variable regions in VHHs that contains the amino acid sequences capable of specifically binding to antigenic targets.

In various embodiments, the Clec9A binding agent comprises a VHH having a variable domain comprising at least one CDR1, CDR2, and/or CDR3 sequences. In various embodiments, the Clec9A binding agent comprises a VHH having a variable region comprising at least one FR1, FR2, FR3, and FR4 sequences.

In exemplary embodiments, the CDR1 sequence is selected from:

GSISSINVMG (SEQ ID NO:2);
GSFSSINVMG (SEQ ID NO:3);
GSISSINIMG (SEQ ID NO:4);
GSISSINIMG (SEQ ID NO:5);
VSIFSINAMG (SEQ ID NO:6);
GSIFSLNAMG (SEQ ID NO:7);
GRTISNYDMA (SEQ ID NO:8);
GRTFTTSLMQ (SEQ ID NO:9);
ERNLRIYDMA (SEQ ID NO:10);
ERNLRSYDMA (SEQ ID NO:11);
GLTFSNYHMG (SEQ ID NO:12);
GLTFSSYHMG (SEQ ID NO:13);
GLTFSTRYHMG (SEQ ID NO:14);
GLTLSSYYIA (SEQ ID NO:15);
GLTFSSYYTG (SEQ ID NO:16);
GLTLSSYHMG (SEQ ID NO:17);
GRTSSPYVTG (SEQ ID NO:18);
GFTFSGYVMS (SEQ ID NO:19);
GFTFSGYVMT (SEQ ID NO:20); or

GFTFSGYLMs (SEQ ID NO:21).

In exemplary embodiments, the CDR2 sequence is selected from:

RITNLGLPNYADWLKD (SEQ ID NO:22);
RITNLGLPNYADSVTG (SEQ ID NO:23);
RITNIGLPNYADSVKG (SEQ ID NO:24);
RITNLGLPNYADSVKG (SEQ ID NO:25);
AITSGGRVVYSDSVKG (SEQ ID NO:26);
AITSGGRTAYADSVKG (SEQ ID NO:27);
HITSDGRIVYADPVKG (SEQ ID NO:28);
RISGSGDRTDYADSVKG (SEQ ID NO:29);
SITWSTGNTHYADSVKG (SEQ ID NO:30);
VISSSGDSTHYSDVKG (SEQ ID NO:31);
VITSSGDSTHYSDVKG (SEQ ID NO:32);
QITWSDASIYYAGSVKG (SEQ ID NO:33);
QITWSDTSIYYAGSVKG (SEQ ID NO:34);
QITWSDGTTYPPGSVKG (SEQ ID NO:35);
QIRWSDSTYYPPGSVKG (SEQ ID NO:36);
QISWSDSTYYADSVKG (SEQ ID NO:37);
TVSWGGVTYYADSVKG (SEQ ID NO:38);
SIGSGGGYPSYTDSVEG (SEQ ID NO:39);
SIGSGGGYPSYTGsVEG (SEQ ID NO:40);
HIGSGGGYPSYTDSVQG (SEQ ID NO:41);
HIGSGGGHATYTDSVEG (SEQ ID NO:42); or
TIGSGGGITSYADSVKG (SEQ ID NO:43).

In exemplary embodiments, the CDR3 sequence is selected from:

VALSAEY (SEQ ID NO:44);
VALKAEY (SEQ ID NO:45);
VGLKAEY (SEQ ID NO:46);

KTKSAVLFGGMDY (SEQ ID NO:47);

YIRGEDY (SEQ ID NO:48);

KHYASNY (SEQ ID NO:49);

QDFGSPSF (SEQ ID NO:50);

QDFRSPDF (SEQ ID NO:51);

QIFGSPNF (SEQ ID NO:52);

LAIHGDY (SEQ ID NO:53);

NQIRQWP (SEQ ID NO:54);

NSIRQWP (SEQ ID NO:55);

NAIRQWP (SEQ ID NO:56);

RKVGGPDY (SEQ ID NO:57);

NTFGNVY (SEQ ID NO:58);

LGR; or

VIK.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:2, SEQ ID NO:22, and SEQ ID NO:44.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:3, SEQ ID NO:23, and SEQ ID NO:45.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:4, SEQ ID NO:24, and SEQ ID NO:45.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:2, SEQ ID NO:25, and SEQ ID NO:46.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:5, SEQ ID NO:26, and SEQ ID NO:47.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:6, SEQ ID NO:27, and SEQ ID NO:48.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:7, SEQ ID NO:28, and SEQ ID NO:49.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:8, SEQ ID NO:29, and SEQ ID NO:50.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:8, SEQ ID NO:29, and SEQ ID NO:51.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:8, SEQ ID NO:29, and SEQ ID NO:52.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:9, SEQ ID NO:30, and SEQ ID NO:53.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:10, SEQ ID NO:31, and SEQ ID NO:54.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:10, SEQ ID NO:31, and SEQ ID NO:55.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:11, SEQ ID NO:32, and SEQ ID NO:56.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:12, SEQ ID NO:33, and SEQ ID NO:57.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:13, SEQ ID NO:34, and SEQ ID NO:57.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:14, SEQ ID NO:35, and SEQ ID NO:57.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:15, SEQ ID NO:36, and SEQ ID NO:57.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:16, SEQ ID NO:37, and SEQ ID NO:57.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:17, SEQ ID NO:37, and SEQ ID NO:57.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:18, SEQ ID NO:38, and SEQ ID NO:58.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:19, SEQ ID NO:39, and LGR.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:19, SEQ ID NO:40, and LGR.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:19, SEQ ID NO:41, and LGR.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:20, SEQ ID NO:42, and LGR.

In an exemplary embodiment, the Clec9A binding agent comprises SEQ ID NO:21, SEQ ID NO:43, and VIK.

In various exemplary embodiments, the Clec9A binding agent comprises an amino acid sequence selected from the following sequences:

R2CHCL8

QVQLVESGGGLVHPGGSRLRLSCAASGSISSINVMGWYRQAPGKERELVAR
ITNLGLPNYADWLKDRFTISRDNKNTVYLMNSLKPEDTAVYYCYLVALS
AEYWGQGTQVTVSS (SEQ ID NO:59);

R1CHCL50

QVQLVESGGGLVHPGGSRLRLSCAASGSFSSINVMGWYRQAPGKERELVA
RITNLGLPNYADSVTGRFTISRDNKNTVYLMNSLKPEDTAVYYCYLVALK
AEYWGQGTQVTVSS (SEQ ID NO:60);

R1CHCL21

QVQLVESGGGLVHRGGSRLRLSCAASGSISSINIMGWYRQAPGKERELVARI
TNIGLPNYADSVKGRFTISRDNKSTVYLMNSLNAEDTAVYYCYLVALKA
EYWGQGTQVTVSS (SEQ ID NO:61);

R2CHCL87

QVQLVESGGGLVQPGGSRLRLSCAASGSISSINVMGWYRQAPGKERELVA
RITNLGLPNYADSVGRFTISRDKDENTVYLEMNTLKPEDTAVYYCYLVGLK
AEYWGQGTQVTVSS (SEQ ID NO:62);

R2CHCL24

QVQLVESGGGLVQPGGSRLRLSCAASGSSDSINAMGWYRQAPGKERELVA
AITSGGRVVYSDSVKGRGTISRDNKNTVYLQIASLKPEDTAVYYCNVTK
SAVLFGGMDYWGKGTQVTVSS (SEQ ID NO:63);

R2CHCL38

QVQLVESGGGLVQPGGSRLRLSCAASVSIFSINAMGWYRQAPGKERELVAA
ITSGGRTAYADSVKGRFTISRDNKNTVYLMNSLKPEDTDVYYCKAYIRG
EDYWGKGTQVTVSS (SEQ ID NO:64);

R1CHCL16

DVQLVESGGGLVQPGGSRLRLSCAASGSIFSLNAMGWYRQAPGKERELVA
HITS DGRIVYADPVKGRFTISRVDGKNMVTLMNSLKPEDTAVYYCNAKH
Y ASNYWGQGTQVTVSS (SEQ ID NO:65);

R2CHCL10

QVQLVESGGGSVQAGGSLRLSCAASGRTISNYDMAWSRQAPGKEREFVA
RISGSGDRTDYADSVKGRFTISRDNKNTVYLMNSLKPEDTAIYYCQIQD
FGSPSFSGQGTQVTSS (SEQ ID NO:66);

R1CHCL34

DVQLVESGGGSVQAGGSLRLSCAASGRTISNYDMAWSRQAPGKEREFVA
RISGSGDRTDYADSVKGRFTISRDNKNTVYLMNSLKPEDTAIYYCQIQD
FRSPDFWSQGTQVTSS (SEQ ID NO:67);

R1CHCL82

QVQLVESGGESVQAGGSLRLSCAASGRTISNYDMAWSRQAPGKEREFVA
RISGSGDRTDYADSVKGRFTISRDNKNTVYLMNSLKPEDTAIYNCQTQI
FGSPNFSGQGTQVTSS (SEQ ID NO:68);

R2CHCL3

QVQLVESGGGLVQAGDSLRLSCAASGRTFTTSLMQWHRQAPGKEREFVA
SITWSTGNTHYADSVKGRFTISRDNARNTVYLMNSLKPEDTAIYTCRVLAI
HGDYWGQGTQVTSS (SEQ ID NO:69);

R2CHCL69

DVQLVESGGGLVQAGDSLRLSCAASERNLRIYDMAWYRQAPGKEREYVA
VISSSGDSTHYSDFKGRFTISRDNKNTVSLQMDSLKPEDTAFYYCQNVN
IRQWPWGQGTQVTSS (SEQ ID NO:70);

R1CHCL56

QVQLVESGGGLVQAGDSLRLSCAASERNLRIYDMAWYRQAPGKEREYVA
VISSSGDSTHYSDFKGRFTISRDNKNTVSLQMDSLKPEDTAFYYCQNVN
IRQWPWGQGTQVTSS (SEQ ID NO:71);

R2CHCL32

QVQLVESGGGLVQAGDSLRLSCTASERNLRSYDMAWWRQAPGKEREYV
AVITSSGDSTHYSDFKGRFTISRDNKNTVSLQMDSLKPEDTASYCQNVN
AIRQWPWGQGTQVTSS (SEQ ID NO:72);

R2CHCL49

DVQLVESGGGSVQAGGSLRLSCAISGLTFSNYHMGWYRQAPGREREFVA
QITWSDASIYYAGSVKGRFTISRDNVKNIVYLQIDNLKPEDTAIYYCDARKVG
GPDYWGQGTQVTSS (SEQ ID NO:73);

R2CHCL53

QVQLVESGGGLVQAGGSLTSCAISGLTFSSYHMGWYRQAPGREREFVA
QITWSDTSIYYAGSVKGRFTISRDNVKNIVYLQIDNLKPEDTAIYYCDARKVG
GPDYWGQGTQVTVSS (SEQ ID NO:74);

R2CHCL22

DVQLVESGGGLVQAGGSLRLSCAISGLTFSRYHMGWYRQAPGREREFVA
QITWSDGTTYYPGSVKGRFTISRDNARNTVYLQIDNLKPEDTAIYYCDARKV
GGPDYWGQGTQVTVSS (SEQ ID NO:75);

R2CHCL25

QVQLVESGGGLVQAGGSLRLSCATSGTLSSYYIAWYRQAPGREREFVAQ
IRWSDDSTYYPGSVKGRFTISRDNARNTVYLRMDNLKPEDTARYYCDARK
VGGPDYWGQGTQVTVSS (SEQ ID NO:76);

R2CHCL18

DVQLVESGGGLVQAGGSLRLSCATSGTLFSSYYTGWYRQAPGREREFVA
QISWSDSTYYADSVKGRFTISRDNARNTVYLMNNLKPGDTAIYYCDARK
VGGPDYWGQGTQVTVSS (SEQ ID NO:77);

R1CHCL23

DVQLVESGGGLVQAGGSLRLSCATSGTLSSYHMGWYRQAPGREREFVA
QISWSDSTYYADSVKGRFTISRDNARNTVYLMNNLKPEDTAIYYCDARK
VGGPDYWGQGTQVTVSS (SEQ ID NO:78);

R1CHCL27

DVQLVESGGGLVQAGGSLRLSCAASGRTSSPYVTGWYRQTPGKEREPVA
TVSWGCVTYADSVKGRFTISRDNKNTVYLMNALKPEDTAIYYCNVNTF
GNVYWGQGTQVTVSS (SEQ ID NO:79);

R2CHCL13

QVQLVESGGGLVQPGGSLRLSCAASGFTFSGYVMSWVRQAPGKGLEWV
ASIGSGGGYPSYTDSVEGRFTISRDNKNTLYLLMDNLKPDDTAVYYCEML
GRRGQGTQVTVSS (SEQ ID NO:80);

R2CHCL14

QVQLVESGGGLVQPGGSLRLSCAASGFTFSGYVMSWVRQAPGKGLEWV
ASIGSGGGYPSYTDSVEGRFTISRDNKNTLYLMNNLKPDDTAVYYCEM
LGRRGQGTQVTVSS (SEQ ID NO:81);

R2CHCL42

QVQLVESGGGLVQPGGSLRLSCAASGFTFSGYVMSWVRQAPGKGLEWV
 ASIGSGGGYPSYTGSVEGRFTISRDNANTLYLLMNNLKPDDTAVYYCEML
 GRRGQGTQVTSS (SEQ ID NO:82);

R2CHCL41

QVQLVESGGGLVQPGGSLRLSCAASGFTFSGYVMSWVRQAPGKGLEWV
 AHIGSGGGYPSYTDVQGRFTISRDNANTLYLQMNNLKPEDTAVYYCEM
 LGRRGQGTQVTSS (SEQ ID NO:83);

R2CHCL94

QVQLVESGGGLVQPGGSLRLSCAASGFTFSGYVMTWVRQAPGKGLEWV
 AHIGSGGGHATYTDVVEGRFTISRDNANTLYLQMNNLKAEDTAVYYCEFL
 GRRGQGTQVTSS (SEQ ID NO:84); or

R2CHCL27

QVQLVESGGGLVQPGGSLRLSCAASGFTFSGYVMSWVRQAPGKGLEWV
 ATIGSGGGITSYADSVKGRFTISRDNANTLYLQMNNLKHEDTAVYYCETVI
 KRGQGTQVTSS (SEQ ID NO:85).

In various embodiments, the present invention contemplates the use of any natural or synthetic analogs, mutants, variants, alleles, homologs and orthologs (herein collectively referred to as "analog") of the Clec9A binding agent of the invention as described herein. In various embodiments, the amino acid sequence of the Clec9A binding agent further includes an amino acid analog, an amino acid derivative, or other non-classical amino acids.

In various embodiments, the Clec9A binding agent comprises a targeting moiety comprising a sequence that is at least 60% identical to any one of the sequences disclosed herein. For example, the Clec9A binding agent may comprise a targeting moiety comprising a sequence that is at least about 60%, at least about 61%, at least about 62%, at least about 63%, at least about 64%, at least about 65%, at least about 66%, at least about 67%, at least about 68%, at least about 69%, at least about 70%, at least about 71%, at least about 72%, at least about 73%, at least about 74%, at least about 75%, at least about 76%, at least about 77%, at least about 78%, at least about 79%, at least about 80%, at least about 81%, at least about 82%, at least about 83%, at least about 84%, at least about 85%, at least about 86%, at least about 87%, at least about 88%, at least about 89%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identical to any of the sequences disclosed herein (e.g. about 60%, or about 61%, or about 62%, or about 63%, or about 64%, or about 65%, or about 66%, or about 67%, or about 68%, or about 69%, or about 70%, or about 71%, or about 72%, or about 73%, or about 74%, or about 75%, or about 76%, or about 77%, or about 78%, or about 79%, or about 80%, or about 81%, or about 82%, or about 83%, or about 84%, or about 85%, or about 86%, or about 87%, or

about 88%, or about 89%, or about 90%, or about 91%, or about 92%, or about 93%, or about 94%, or about 95%, or about 96%, or about 97%, or about 98%, about 99% or about 100% sequence identity to any one of the sequences disclosed herein).

In various embodiments, the Clec9A binding agent comprises a targeting moiety comprising an amino acid sequence having one or more amino acid mutations with respect to any one of the sequences disclosed herein. In various embodiments, the Clec9A binding agent comprises a targeting moiety comprising an amino acid sequence having one, or two, or three, or four, or five, or six, or seven, or eight, or nine, or ten, or fifteen, or twenty amino acid mutations with respect to any one of the sequences disclosed herein. In some embodiments, the one or more amino acid mutations may be independently selected from substitutions, insertions, deletions, and truncations.

In some embodiments, the amino acid mutations are amino acid substitutions, and may include conservative and/or non-conservative substitutions.

"Conservative substitutions" may be made, for instance, on the basis of similarity in polarity, charge, size, solubility, hydrophobicity, hydrophilicity, and/or the amphipathic nature of the amino acid residues involved. The 20 naturally occurring amino acids can be grouped into the following six standard amino acid groups: (1) hydrophobic: Met, Ala, Val, Leu, Ile; (2) neutral hydrophilic: Cys, Ser, Thr, Asn, Gln; (3) acidic: Asp, Glu; (4) basic: His, Lys, Arg; (5) residues that influence chain orientation: Gly, Pro; and (6) aromatic: Trp, Tyr, Phe.

As used herein, "conservative substitutions" are defined as exchanges of an amino acid by another amino acid listed within the same group of the six standard amino acid groups shown above. For example, the exchange of Asp by Glu retains one negative charge in the so modified polypeptide. In addition, glycine and proline may be substituted for one another based on their ability to disrupt α -helices.

As used herein, "non-conservative substitutions" are defined as exchanges of an amino acid by another amino acid listed in a different group of the six standard amino acid groups (1) to (6) shown above.

In various embodiments, the substitutions may also include non-classical amino acids. Exemplary non-classical amino acids include, but are not limited to, selenocysteine, pyrrolysine, *N*-formylmethionine β -alanine, GABA and δ -Aminolevulinic acid, 4-aminobenzoic acid (PABA), D-isomers of the common amino acids, 2,4-diaminobutyric acid, α -amino isobutyric acid, 4-aminobutyric acid, Abu, 2-amino butyric acid, γ -Abu, ϵ -Ahx, 6-amino hexanoic acid, Aib, 2-amino isobutyric acid, 3-amino propionic acid, ornithine, norleucine, norvaline, hydroxyproline, sarcosine, citrulline, homocitrulline, cysteic acid, t-butylglycine, t-butylalanine, phenylglycine, cyclohexylalanine, β -alanine, fluoro-amino acids, designer amino acids such as β methyl amino acids, C α -methyl amino acids, N α -methyl amino acids, and amino acid analogs in general.

In various embodiments, the amino acid mutation may be in the CDRs of the targeting moiety (e.g., the CDR1, CDR2 or CDR3 regions). In another embodiment, amino acid alteration may be in the framework regions (FRs) of the targeting moiety (e.g., the FR1, FR2, FR3, or FR4 regions).

Modification of the amino acid sequences may be achieved using any known technique in the art *e.g.*, site-directed mutagenesis or PCR based mutagenesis. Such techniques are described, for example, in Sambrook *et al.*, *Molecular Cloning: A Laboratory Manual*, Cold Spring Harbor Press, Plainview, N.Y., 1989 and Ausubel *et al.*, *Current Protocols in Molecular Biology*, John Wiley & Sons, New York, N.Y., 1989.

In various embodiments, the mutations do not substantially reduce the present Clec9A binding agent's capability to specifically bind to Clec9A. In various embodiments, the mutations do not substantially reduce the present Clec9A binding agent's capability to specifically bind to Clec9A and without functionally modulating (*e.g.*, partially or fully neutralizing) Clec9A.

In various embodiments, the binding affinity of the Clec9A binding agent of the invention for the full-length and/or mature forms and/or isoforms and/or splice variants and/or fragments and/or monomeric and/or dimeric forms and/or any other naturally occurring or synthetic analogs, variants, or mutants (including monomeric and/or dimeric forms) of human Clec9A may be described by the equilibrium dissociation constant (K_D). In various embodiments, the Clec9A binding agent comprises a targeting moiety that binds to the full-length and/or mature forms and/or isoforms and/or splice variants and/or fragments and/or any other naturally occurring or synthetic analogs, variants, or mutants (including monomeric and/or dimeric forms) of human Clec9A with a K_D of less than about 1 μ M, about 900 nM, about 800 nM, about 700 nM, about 600 nM, about 500 nM, about 400 nM, about 300 nM, about 200 nM, about 100 nM, about 90 nM, about 80 nM, about 70 nM, about 60 nM, about 50 nM, about 40 nM, about 30 nM, about 20 nM, about 10 nM, or about 5 nM, or about 1 nM.

In various embodiments, the Clec9A binding agent comprises a targeting moiety that binds but does not functionally modulate (*e.g.*, partially or fully neutralize) the antigen of interest, *i.e.*, Clec9A. For instance, in various embodiments, the targeting moiety of the Clec9A binding agent simply targets the antigen but does not substantially functionally modulate (*e.g.* partially or fully inhibit, reduce or neutralize) a biological effect that the antigen has. In various embodiments, the targeting moiety of the Clec9A binding agent binds an epitope that is physically separate from an antigen site that is important for its biological activity (*e.g.* an antigen's active site).

Such binding without significant function modulation finds use in various embodiments of the present invention, including methods in which the present Clec9A binding agent is used to directly or indirectly recruit active immune cells to a site of need via an effector antigen. For example, in various embodiments, the present Clec9A binding agent may be used to directly or indirectly recruit dendritic cells via Clec9A to a tumor cell in a method of reducing or eliminating a tumor (*e.g.* the Clec9A binding agent may comprise a targeting moiety having an anti-Clec9A antigen recognition domain and a targeting moiety having a recognition domain (*e.g.* antigen recognition domain) directed against a tumor antigen or receptor). In such embodiments, it is desirable to directly or indirectly recruit dendritic cells but not to functionally modulate or neutralize the Clec9A activity. In these embodiments, Clec9A signaling is an important piece of the tumor reducing or eliminating effect.

In some embodiments, the Clec9A binding agent enhances antigen-presentation by dendritic cells. For example, in various embodiments, the present Clec9A binding agent directly or indirectly recruits dendritic cells via Clec9A

to a tumor cell, where tumor antigens are subsequently endocytosed and presented on the dendritic cell for induction of potent humoral and cytotoxic T cell responses.

In other embodiments (for example, related to treating autoimmune or neurodegenerative disease), the Clec9A binding agent comprises a targeting moiety that binds and neutralizes the antigen of interest, *i.e.*, Clec9A. For instance, in various embodiments, the present methods may inhibit or reduce Clec9A signaling or expression, *e.g.* to cause a reduction in an immune response.

Therapeutic Agents Comprising the Present Clec9A Binding Agents

Chimeras and Fusions with Signaling Agents

In various embodiments, the Clec9A binding agent of the invention is part of a chimera or fusion with one or more signaling agents. Accordingly, the present invention provides for chimeric or fusion proteins that include, for example, a targeting moiety against Clec9A and one or more signaling agents.

In various embodiments, the signaling agent is modified to have reduced affinity or activity for one or more of its receptors, which allows for attenuation of activity (inclusive of agonism or antagonism) and/or prevents non-specific signaling or undesirable sequestration of the chimeric or fusion protein. In various embodiments, the signaling agent is antagonistic in its wild type form and bears one or more mutations that attenuate its antagonistic activity. In various embodiments, the signaling agent is antagonistic due to one or more mutations, *e.g.* an agonistic signaling agent is converted to an antagonistic signaling agent and, such a converted signaling agent, optionally, also bears one or more mutations that attenuate its antagonistic activity (*e.g.* as described in WO 2015/007520, the entire contents of which are hereby incorporated by reference).

Accordingly, in various embodiments, the signaling agent is a modified (*e.g.* mutant) form of the signaling agent having one or more mutations. In various embodiments, the modifications (*e.g.* mutations) allow for the modified signaling agent to have one or more of attenuated activity such as one or more of reduced binding affinity, reduced endogenous activity, and reduced specific bioactivity relative to unmodified or unmutated, *i.e.* the wild type form of the signaling agent (*e.g.* comparing the same signaling agent in a wild type form versus a modified or mutant form). In some embodiments, the mutations which attenuate or reduce binding or affinity include those mutations which substantially reduce or ablate binding or activity. In some embodiments, the mutations which attenuate or reduce binding or affinity are different than those mutations which substantially reduce or ablate binding or activity. Consequentially, in various embodiments, the mutations allow for the signaling agent to have improved safety, *e.g.* reduced systemic toxicity, reduced side effects, and reduced off-target effects relative to unmutated, *i.e.* wild type, signaling agent (*e.g.* comparing the same signaling agent in a wild type form versus a modified (*e.g.* mutant) form).

As described herein, the agent may have improved safety due to one of more modifications, *e.g.* mutations. In various embodiments, improved safety means that the present chimeric protein provides lower toxicity (*e.g.* systemic toxicity and/or tissue/organ-associated toxicities); and/or lessened or substantially eliminated side

effects; and/or increased tolerability, lessened or substantially eliminated adverse events; and/or reduced or substantially eliminated off-target effects; and/or an increased therapeutic window.

In various embodiments, the signaling agent is modified to have one or more mutations that reduce its binding affinity or activity for one or more of its receptors. In some embodiments, the signaling agent is modified to have one or more mutations that substantially reduce or ablate binding affinity or activity for the receptors. In some embodiments, the activity provided by the wild type signaling agent is agonism at the receptor (e.g. activation of a cellular effect at a site of therapy). For example, the wild type signaling agent may activate its receptor. In such embodiments, the mutations result in the modified signaling agent to have reduced or ablated activating activity at the receptor. For example, the mutations may result in the modified signaling agent to deliver a reduced activating signal to a target cell or the activating signal could be ablated. In some embodiments, the activity provided by the wild type signaling agent is antagonism at the receptor (e.g. blocking or dampening of a cellular effect at a site of therapy). For example, the wild type signaling agent may antagonize or inhibit the receptor. In these embodiments, the mutations result in the modified signaling agent to have a reduced or ablated antagonizing activity at the receptor. For example, the mutations may result in the modified signaling agent to deliver a reduced inhibitory signal to a target cell or the inhibitory signal could be ablated. In various embodiments, the signaling agent is antagonistic due to one or more mutations, e.g. an agonistic signaling agent is converted to an antagonistic signaling agent (e.g. as described in WO 2015/007520, the entire contents of which are hereby incorporated by reference) and, such a converted signaling agent, optionally, also bears one or more mutations that reduce its binding affinity or activity for one or more of its receptors or that substantially reduce or ablate binding affinity or activity for one or more of its receptors.

In some embodiments, the reduced affinity or activity at the receptor is restorable by attachment with one or more of the targeting moieties as described herein (e.g., targeting moiety against Clec9A or any other targeting moiety described herein). In other embodiments, the reduced affinity or activity at the receptor is not substantially restorable by the activity of one or more of the targeting moieties.

In various embodiments, the chimeric proteins of the present invention reduce off-target effects because their signaling agents have mutations that weaken or ablate binding affinity or activity at a receptor. In various embodiments, this reduction in side effects is observed relative with, for example, the wild type signaling agents. In various embodiments, the signaling agent is active on target cells because the targeting moiety(ies) compensates for the missing/insufficient binding (e.g., without limitation and/or avidity) required for substantial activation. In various embodiments, the modified signaling agent is substantially inactive *en route* to the site of therapeutic activity and has its effect substantially on specifically targeted cell types which greatly reduces undesired side effects.

In some embodiments, the signaling agent may include one or more mutations that attenuate or reduce binding or affinity for one receptor (*i.e.*, a therapeutic receptor) and one or more mutations that substantially reduce or ablate binding or activity at a second receptor. In such embodiments, these mutations may be at the same or at

different positions (*i.e.*, the same mutation or multiple mutations). In some embodiments, the mutation(s) that reduce binding and/or activity at one receptor is different than the mutation(s) that substantially reduce or ablate at another receptor. In some embodiments, the mutation(s) that reduce binding and/or activity at one receptor is the same as the mutation(s) that substantially reduce or ablate at another receptor. In some embodiments, the present chimeric proteins have a modified signaling agent that has both mutations that attenuate binding and/or activity at a therapeutic receptor and therefore allow for a more controlled, on-target therapeutic effect (*e.g.* relative wild type signaling agent) and mutations that substantially reduce or ablate binding and/or activity at another receptor and therefore reduce side effects (*e.g.* relative to wild type signaling agent).

In some embodiments, the substantial reduction or ablation of binding or activity is not substantially restorable with a targeting moiety (*e.g.*, a targeting moiety against Clec9A or any other targeting moiety described herein). In some embodiments, the substantial reduction or ablation of binding or activity is restorable with a targeting moiety. In various embodiments, substantially reducing or ablating binding or activity at a second receptor also may prevent deleterious effects that are mediated by the other receptor. Alternatively, or in addition, substantially reducing or ablating binding or activity at the other receptor causes the therapeutic effect to improve as there is a reduced or eliminated sequestration of the therapeutic chimeric proteins away from the site of therapeutic action. For instance, in some embodiments, this obviates the need of high doses of the present chimeric proteins that compensate for loss at the other receptor. Such ability to reduce dose further provides a lower likelihood of side effects.

In various embodiments, the modified signaling agent comprises one or more mutations that cause the signaling agent to have reduced, substantially reduced, or ablated affinity, *e.g.* binding (*e.g.* K_D) and/or activation (for instance, when the modified signaling agent is an agonist of its receptor, measurable as, for example, K_A and/or EC_{50}) and/or inhibition (for instance, when the modified signaling agent is an antagonist of its receptor, measurable as, for example, K_i and/or IC_{50}), for one or more of its receptors. In various embodiments, the reduced affinity at the immunomodulating agent's receptor allows for attenuation of activity (inclusive of agonism or antagonism). In such embodiments, the modified signaling agent has about 1%, or about 3%, about 5%, about 10%, about 15%, about 20%, about 25%, about 30%, about 35%, about 40%, about 45%, about 50%, about 60%, about 65%, about 70%, about 75%, about 80%, about 85%, about 90%, about 95%, or about 10%-20%, about 20%-40%, about 50%, about 40%-60%, about 60%-80%, about 80%-100% of the affinity for the receptor relative to the wild type signaling agent. In some embodiments, the binding affinity is at least about 2-fold lower, about 3-fold lower, about 4-fold lower, about 5-fold lower, about 6-fold lower, about 7-fold lower, about 8-fold lower, about 9-fold lower, at least about 10-fold lower, at least about 15-fold lower, at least about 20-fold lower, at least about 25-fold lower, at least about 30-fold lower, at least about 35-fold lower, at least about 40-fold lower, at least about 45-fold lower, at least about 50-fold lower, at least about 100-fold lower, at least about 150-fold lower, or about 10-50-fold lower, about 50-100-fold lower, about 100-150-fold lower, about 150-200-fold lower, or more than 200-fold lower relative to the wild type signaling agent.

In embodiments wherein the chimeric protein has mutations that reduce binding at one receptor and substantially reduce or ablate binding at a second receptor, the attenuation or reduction in binding affinity of a modified signaling agent for one receptor is less than the substantial reduction or ablation in affinity for the other receptor. In some embodiments, the attenuation or reduction in binding affinity of a modified signaling agent for one receptor is less than the substantial reduction or ablation in affinity for the other receptor by about 1%, or about 3%, about 5%, about 10%, about 15%, about 20%, about 25%, about 30%, about 35%, about 40%, about 45%, about 50%, about 60%, about 65%, about 70%, about 75%, about 80%, about 85%, about 90%, or about 95%. In various embodiments, substantial reduction or ablation refers to a greater reduction in binding affinity and/or activity than attenuation or reduction.

In various embodiments, the modified signaling agent comprises one or more mutations that reduce the endogenous activity of the signaling agent to about 75%, or about 70%, or about 60%, or about 50%, or about 40%, or about 30%, or about 25%, or about 20%, or about 10%, or about 5%, or about 3%, or about 1%, e.g., relative to the wild type signaling agent.

In some embodiments, the modified signaling agent comprises one or more mutations that cause the signaling agent to have reduced affinity for its receptor that is lower than the binding affinity of the targeting moiety(ies) for its(their) receptor(s). In some embodiments, this binding affinity differential is between signaling agent/receptor and targeting moiety/receptor on the same cell. In some embodiments, this binding affinity differential allows for the signaling agent, e.g. mutated signaling agent, to have localized, on-target effects and to minimize off-target effects that underlie side effects that are observed with wild type signaling agent. In some embodiments, this binding affinity is at least about 2-fold, or at least about 5-fold, or at least about 10-fold, or at least about 15-fold lower, or at least about 25-fold, or at least about 50-fold lower, or at least about 100-fold, or at least about 150-fold.

Receptor binding activity may be measured using methods known in the art. For example, affinity and/or binding activity may be assessed by Scatchard plot analysis and computer-fitting of binding data (e.g. Scatchard, 1949) or by reflectometric interference spectroscopy under flow through conditions, as described by Brecht *et al.* (1993), the entire contents of all of which are hereby incorporated by reference.

In various embodiments, the signaling agent is an immune-modulating agent, e.g. one or more of an interleukin, interferon, and tumor necrosis factor.

In some embodiments, the signaling agent is an interleukin or a modified interleukin, including for example IL-1; IL-2; IL-3; IL-4; IL-5; IL-6; IL-7; IL-8; IL-9; IL-10; IL-11; IL-12; IL-13; IL-14; IL-15; IL-16; IL-17; IL-18; IL-19; IL-20; IL-21; IL-22; IL-23; IL-24; IL-25; IL-26; IL-27; IL-28; IL-29; IL-30; IL-31; IL-32; IL-33; IL-35; IL-36 or a fragment, variant, analogue, or family-member thereof. Interleukins are a group of multi- functional cytokines synthesized by lymphocytes, monocytes, and macrophages. Known functions include stimulating proliferation of immune cells (e.g., T helper cells, B cells, eosinophils, and lymphocytes), chemotaxis of neutrophils and T lymphocytes, and/or inhibition of interferons. Interleukin activity can be determined using assays known in the art: Matthews *et al.*, in

Lymphokines and Interferons: A Practical Approach, Clemens *et al.*, eds, IRL Press, Washington, D.C. 1987, pp. 221-225; and Orencole & Dinarello (1989) Cytokine 1, 14-20.

In some embodiments, the signaling agent is an interferon or a modified version of an interferon such as interferon types I, II, and III. Illustrative interferons, including for example, interferon- α -1, 2, 4, 5, 6, 7, 8, 10, 13, 14, 16, 17, and 21, interferon- β and interferon- γ , interferon κ , interferon ϵ , interferon τ , and interferon ω .

In some embodiments, the signaling agent is a tumor necrosis factor (TNF) or a modified version of a tumor necrosis factor (TNF) or a protein in the TNF family, including but not limited to, TNF- α , TNF- β , LT- β , CD40L, CD27L, CD30L, FASL, 4-1BBL, OX40L, and TRAIL.

The amino acid sequences of the wild type signaling agents described herein are well known in the art. Accordingly, in various embodiments the modified signaling agent comprises an amino acid sequence that has at least about 60%, or at least about 61%, or at least about 62%, or at least about 63%, or at least about 64%, or at least about 65%, or at least about 66%, or at least about 67%, or at least about 68%, or at least about 69%, or at least about 70%, or at least about 71%, or at least about 72%, or at least about 73%, or at least about 74%, or at least about 75%, or at least about 76%, or at least about 77%, or at least about 78%, or at least about 79%, or at least about 80%, or at least about 81%, or at least about 82%, or at least about 83%, or at least about 84%, or at least about 85%, or at least about 86%, or at least about 87%, or at least about 88%, or at least about 89%, or at least about 90%, or at least about 91%, or at least about 92%, or at least about 93%, or at least about 94%, or at least about 95%, or at least about 96%, or at least about 97%, or at least about 98%, or at least about 99% sequence identity with the known wild type amino acid sequences of the signaling agents described herein (e.g. about 60%, or about 61%, or about 62%, or about 63%, or about 64%, or about 65%, or about 66%, or about 67%, or about 68%, or about 69%, or about 70%, or about 71%, or about 72%, or about 73%, or about 74%, or about 75%, or about 76%, or about 77%, or about 78%, or about 79%, or about 80%, or about 81%, or about 82%, or about 83%, or about 84%, or about 85%, or about 86%, or about 87%, or about 88%, or about 89%, or about 90%, or about 91%, or about 92%, or about 93%, or about 94%, or about 95%, or about 96%, or about 97%, or about 98%, or about 99% sequence identity).

In various embodiments the modified signaling agent comprises an amino acid sequence that has at least about 60%, or at least about 61%, or at least about 62%, or at least about 63%, or at least about 64%, or at least about 65%, or at least about 66%, or at least about 67%, or at least about 68%, or at least about 69%, or at least about 70%, or at least about 71%, or at least about 72%, or at least about 73%, or at least about 74%, or at least about 75%, or at least about 76%, or at least about 77%, or at least about 78%, or at least about 79%, or at least about 80%, or at least about 81%, or at least about 82%, or at least about 83%, or at least about 84%, or at least about 85%, or at least about 86%, or at least about 87%, or at least about 88%, or at least about 89%, or at least about 90%, or at least about 91%, or at least about 92%, or at least about 93%, or at least about 94%, or at least about 95%, or at least about 96%, or at least about 97%, or at least about 98%, or at least about 99% sequence identity with any amino acid sequences of the signaling agents described herein (e.g. about 60%, or about 61%,

or about 62%, or about 63%, or about 64%, or about 65%, or about 66%, or about 67%, or about 68%, or about 69%, or about 70%, or about 71%, or about 72%, or about 73%, or about 74%, or about 75%, or about 76%, or about 77%, or about 78%, or about 79%, or about 80%, or about 81%, or about 82%, or about 83%, or about 84%, or about 85%, or about 86%, or about 87%, or about 88%, or about 89%, or about 90%, or about 91%, or about 92%, or about 93%, or about 94%, or about 95%, or about 96%, or about 97%, or about 98%, or about 99% sequence identity).

In various embodiments, the modified signaling agent comprises an amino acid sequence having one or more amino acid mutations. In some embodiments, the one or more amino acid mutations may be independently selected from substitutions, insertions, deletions, and truncations. In some embodiments, the amino acid mutations are amino acid substitutions, and may include conservative and/or non-conservative substitutions, as described elsewhere herein.

In various embodiments, the substitutions may also include non-classical amino acids as described elsewhere herein.

As described herein, the modified signaling agents bear mutations that affect affinity and/or activity at one or more receptors. The receptors of any signaling agents, as described herein, are known in the art.

Illustrative mutations which provide reduced affinity and/or activity (*e.g.* agonistic) at a receptor are found in WO 2013/107791 (*e.g.* with regard to interferons), WO 2015/007542 (*e.g.* with regard to interleukins), and WO 2015/007903 (*e.g.* with regard to TNF), the entire contents of each of which are hereby incorporated by reference. Illustrative mutations which provide reduced affinity and/or activity (*e.g.* antagonistic) at a receptor are found in WO 2015/007520, the entire contents of which are hereby incorporated by reference.

In an embodiment, the modified signaling agent is interferon α . In such embodiments, the modified IFN- α agent has reduced affinity and/or activity for the IFN- α/β receptor (IFNAR), *i.e.*, IFNAR1 and/or IFNAR2 chains. In some embodiments, the modified IFN- α agent has substantially reduced or ablated affinity and/or activity for the IFN- α/β receptor (IFNAR), *i.e.*, IFNAR1 and/or IFNAR2 chains.

Mutant forms of interferon α are known to the person skilled in the art. In an illustrative embodiment, the modified signaling agent is the allelic form IFN- α 2a having the amino acid sequence of:

IFN- α 2a:

CDLPQTHSLGSRRTLMLLAQMRKISLFSCLKDRHDFGFPQEEFGNQFQKAETIPVLH
EMIQQIFNLFSTKDSSAAWDETLLDKFYTELYQQLNDLEACVIQGVGVGTETPLMKED
SILAVRKYFQRITLYLKEKKYSPCAWEVVRAEIMRSFSLSTNLQESLRSKE (SEQ ID
NO:86).

In an illustrative embodiment, the modified signaling agent is the allelic form IFN- α 2b having the amino acid sequence of (which differs from IFN- α 2a at amino acid position 23):

IFN- α 2b:

CDLPQTHSLGSRRTLMLLAQMRRISLFSCLKDRHDFGFPQEEFGNQFQKAETIPVLH
 EMIQQIFNLFSTKDSSAAWDETLLDKFYTELYQQLNLEACVIQGVGVGTETPLMKED
 SILAVRKYFQRITLYLKEKKYSPCAWEVVRAEIMRSFSLSTNLQESLRSKE (SEQ ID
 NO:87).

In some embodiments, said IFN- α 2 mutant (IFN- α 2a or IFN- α 2b) is mutated at one or more amino acids at positions 144-154, such as amino acid positions 148, 149 and/or 153. In some embodiments, the IFN- α 2 mutant comprises one or more mutations selected from L153A, R149A, and M148A. Such mutants are described, for example, in WO2013/107791 and Piehler *et al.*, (2000) J. Biol. Chem, 275:40425-33, the entire contents of all of which are hereby incorporated by reference.

In some embodiments, the IFN- α 2 mutants have reduced affinity and/or activity for IFNAR1. In some embodiments, the IFN- α 2 mutant comprises one or more mutations selected from F64A, N65A, T69A, L80A, Y85A, and Y89A, as described in WO2010/030671, the entire contents of which is hereby incorporated by reference.

In some embodiments, the IFN- α 2 mutant comprises one or more mutations selected from K133A, R144A, R149A, and L153A as described in WO2008/124086, the entire contents of which is hereby incorporated by reference.

In some embodiments, the IFN- α 2 mutant comprises one or more mutations selected from R120E and R120E/K121E, as described in WO2015/007520 and WO2010/030671, the entire contents of which are hereby incorporated by reference. In such embodiments, said IFN- α 2 mutant antagonizes wildtype IFN- α 2 activity. In such embodiments, said mutant IFN- α 2 has reduced affinity and/or activity for IFNAR1 while affinity and/or activity of IFNR2 is retained.

In some embodiments, the human IFN- α 2 mutant comprises (1) one or more mutations selected from R120E and R120E/K121E, which, without wishing to be bound by theory, create an antagonistic effect and (2) one or more mutations selected from K133A, R144A, R149A, and L153A, which, without wishing to be bound by theory, allow for an attenuated effect at, for example, IFNAR2. In an embodiment, the human IFN- α 2 mutant comprises R120E and L153A.

In some embodiments, the human IFN- α 2 mutant comprises one or more mutations selected from, L15A, A19W, R22A, R23A, L26A, F27A, L30A, L30V, K31A, D32A, R33K, R33A, R33Q, H34A, D35A, Q40A, D114R, L117A, R120A, R125A, K134A, R144A, A145G, A145M, M148A, R149A, S152A, L153A, and N156A as disclosed in WO 2013/059885, the entire disclosures of which are hereby incorporated by reference. In some embodiments, the human IFN- α 2 mutant comprises the mutations H57Y, E58N, Q61S, and/or L30A as disclosed in WO 2013/059885. In some embodiments, the human IFN- α 2 mutant comprises the mutations H57Y, E58N, Q61S, and/or R33A as disclosed in WO 2013/059885. In some embodiments, the human IFN- α 2 mutant comprises the mutations H57Y, E58N, Q61S, and/or M148A as disclosed in WO 2013/059885. In some embodiments, the human IFN- α 2 mutant comprises the mutations H57Y, E58N, Q61S, and/or L153A as disclosed in WO

2013/059885. In some embodiments, the human IFN- α 2 mutant comprises the mutations N65A, L80A, Y85A, and/or Y89A as disclosed in WO 2013/059885. In some embodiments, the human IFN- α 2 mutant comprises the mutations N65A, L80A, Y85A, Y89A, and/or D114A as disclosed in WO 2013/059885.

In an embodiment, the modified signaling agent is interferon β . In such embodiments, the modified interferon β agent has reduced affinity and/or activity for the IFN- α/β receptor (IFNAR), *i.e.*, IFNAR1 and/or IFNAR2 chains. In some embodiments, the modified interferon β agent has substantially reduced or ablated affinity and/or activity for the IFN- α/β receptor (IFNAR), *i.e.*, IFNAR1 and/or IFNAR2 chains.

In an embodiment, the modified signaling agent is interferon γ . In such embodiments, the modified interferon γ agent has reduced affinity and/or activity for the interferon-gamma receptor (IFNGR), *i.e.*, IFNGR1 and IFNGR2 chains. In some embodiments, the modified interferon γ agent has substantially reduced or ablated affinity and/or activity for the interferon-gamma receptor (IFNGR), *i.e.*, IFNGR1 and/or IFNGR2 chains.

In an embodiment, the modified signaling agent is TNF- α . TNF is a pleiotropic cytokine with many diverse functions, including regulation of cell growth, differentiation, apoptosis, tumorigenesis, viral replication, autoimmunity, immune cell functions and trafficking, inflammation, and septic shock. It binds to two distinct membrane receptors on target cells: TNFR1 (p55) and TNFR2 (p75). TNFR1 exhibits a very broad expression pattern whereas TNFR2 is expressed preferentially on certain populations of lymphocytes, Tregs, endothelial cells, certain neurons, microglia, cardiac myocytes and mesenchymal stem cells. Very distinct biological pathways are activated in response to receptor activation, although there is also some overlap. As a general rule, without wishing to be bound by theory, TNFR1 signaling is associated with induction of apoptosis (cell death) and TNFR2 signaling is associated with activation of cell survival signals (*e.g.* activation of NF κ B pathway). Administration of TNF is systemically toxic, and this is largely due to TNFR1 engagement. However, it should be noted that activation of TNFR2 is also associated with a broad range of activities and, as with TNFR1, in the context of developing TNF based therapeutics, control over TNF targeting and activity is important.

In some embodiments, the modified signaling agent has reduced affinity and/or activity for TNFR1 and/or TNFR2. In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for TNFR1 and/or TNFR2. TNFR1 is expressed in most tissues, and is involved in cell death signaling while, by contrast, TNFR2 is involved in cell survival signaling. Accordingly in embodiments directed to methods of treating cancer, the modified signaling agent has reduced affinity and/or activity for TNFR1 and/or substantially reduced or ablated affinity and/or activity for TNFR2. In these embodiments, the chimeric proteins may be targeted to a cell for which apoptosis is desired, *e.g.* a tumor cell or a tumor vasculature endothelial cell. In embodiments directed to methods of promoting cell survival, for example, in neurogenesis for the treatment of neurodegenerative disorders, the modified signaling agent has reduced affinity and/or activity for TNFR2 and/or substantially reduced or ablated affinity and/or activity for TNFR1. Stated another way, the present chimeric proteins, in some embodiments, comprise modified TNF- α agent that allows of favoring either death or survival signals.

In some embodiments, the chimeric protein has a modified TNF having reduced affinity and/or activity for TNFR1 and/or substantially reduced or ablated affinity and/or activity for TNFR2. Such a chimera, in some embodiments, is a more potent inducer of apoptosis as compared to a wild type TNF and/or a chimera bearing only mutation(s) causing reduced affinity and/or activity for TNFR1. Such a chimera, in some embodiments, finds use in inducing tumor cell death or a tumor vasculature endothelial cell death (e.g. in the treatment of cancers). Also, in some embodiments, these chimeras avoid or reduce activation of T_{reg} cells via TNFR2, for example, thus further supporting TNFR1-mediated antitumor activity in vivo.

In some embodiments, the chimeric protein has a modified TNF having reduced affinity and/or activity for TNFR2 and/or substantially reduced or ablated affinity and/or activity for TNFR1. Such a chimera, in some embodiments, is a more potent activator of cell survival in some cell types, which may be a specific therapeutic objective in various disease settings, including without limitation, stimulation of neurogenesis. In addition, such a TNFR2-favoring chimeras also are useful in the treatment of autoimmune diseases (e.g. Crohn's, diabetes, MS, colitis etc. and many others described herein). In some embodiments, the chimera is targeted to auto-reactive T cells. In some embodiments, the chimera promotes T_{reg} cell activation and indirect suppression of cytotoxic T cells.

In some embodiments, the chimera causes the death of auto-reactive T cells, e.g. by activation of TNFR2 and/or avoidance TNFR1 (e.g. a modified TNF having reduced affinity and/or activity for TNFR2 and/or substantially reduced or ablated affinity and/or activity for TNFR1). Without wishing to be bound by theory these auto-reactive T cells, have their apoptosis/survival signals altered e.g. by NF- κ B pathway activity/signaling alterations.

In some embodiments, a TNFR-2 based chimera has additional therapeutic applications in diseases, including various autoimmune diseases, heart diseases, de-myelinating and neurodegenerative disorders, and infectious disease, among others.

In an embodiment, the wild type TNF- α has the amino acid sequence of:

TNF- α

VRSSSRTPSDKPVAVHVVANPQAEGQLQWLNRRANALLANGVELRDNQLV
VPSEGLYLIYSQVLFGQGCPSTHVLLTHTISRIASVYQTKVNLLSAIKSPCQ
RETPEGAEAKPWYEPIYLGGVFQLEKGDRLSAEINRPDYLDFAESGQVYF
GIAL (SEQ ID NO:88).

In such embodiments, the modified TNF- α agent has mutations at one or more amino acid positions 29, 31, 32, 84, 85, 86, 87, 88, 89, 145, 146 and 147 which produces a modified TNF- α with reduced receptor binding affinity. See, for example, U.S. Patent No. 7,993,636, the entire contents of which are hereby incorporated by reference.

In some embodiments, the modified TNF- α moiety has mutations at one or more amino acid positions R32, N34, Q67, H73, L75, T77, S86, Y87, V91, I97, T105, P106, A109, P113, Y115, E127, N137, D143, and A145, as described, for example, in WO/2015/007903, the entire contents of which is hereby incorporated by reference (numbering according to the human TNF sequence, Genbank accession number BAG70306, version

BAG70306.1 GI: 197692685). In some embodiments, the modified TNF- α moiety has substitution mutations selected from R32G, N34G, Q67G, H73G, L75G, L75A, L75S, T77A, S86G, Y87Q, Y87L, Y87A, Y87F, V91G, V91A, I97A, I97Q, I97S, T105G, P106G, A109Y, P113G, Y115G, Y115A, E127G, N137G, D143N, A145G and A145T. In an embodiment, the TNF- α moiety has a mutation selected from Y87Q, Y87L, Y87A, and Y87F. In another embodiment, the TNF- α moiety has a mutation selected from I97A, I97Q, and I97S. In a further embodiment, the TNF- α moiety has a mutation selected from Y115A and Y115G.

In some embodiments, the modified TNF- α agent has one or more mutations selected from N39Y, S147Y, and Y87H, as described in WO2008/124086, the entire contents of which is hereby incorporated by reference.

In some embodiments, the modified human TNF- α moiety has mutations that provide receptor selectivity as described in PCT/IB2016/001668, the entire contents of which are hereby incorporated by reference. In some embodiments, the mutations to TNF are TNF-R1 selective. In some embodiments, the mutations to TNF which are TNF-R1 selective are at one or more of positions R32, S86, and E146. In some embodiments, the mutations to TNF which are TNF-R1 selective are one or more of R32W, S86T, and E146K. In some embodiments, the mutations to TNF which are TNF-R1 selective are one or more of R32W, R32W/S86T, R32W/E146K and E146K. In some embodiments, the mutations to TNF are TNF-R2 selective. In some embodiments, the mutations to TNF which are TNF-R2 selective are at one or more of positions A145, E146, and S147. In some embodiments, the mutations to TNF which are TNF-R2 selective are one or more of A145T, A145R, E146D, and S147D. In some embodiments, the mutations to TNF which are TNF-R2 selective are one or more of A145R, A145T/S147D, and A145T/E146D/S147D.

In an embodiment, the modified signaling agent is TNF- β . TNF- β can form a homotrimer or a heterotrimer with LT- β (LT- α 1 β 2). In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for TNFR1 and/or TNFR2 and/or herpes virus entry mediator (HEVM) and/or LT- β R.

In an embodiment, the wild type TNF- β has the amino acid sequence of:

TNF-beta

LPGVGLTPSAAQTARQHHPKMHLSNLKPAAHLLIGDPSKQNSLLWRANTD
RAFLQDGFSLSNNSLLVPTSGIYFVYSQVVFSGKAYSPKATSSPLYLAHEV
QLFSSQYPFHVPLLSSQKMVYPGLQEPWLHSMYHGAAAFQLTQGDQLSTH
TDGIPHLVLPSTVFFGAFAL (SEQ ID NO:89).

In such embodiments, the modified TNF- β agent may comprise mutations at one or more amino acids at positions 106-113, which produce a modified TNF- β with reduced receptor binding affinity to TNFR2. In an embodiment, the modified signaling agent has one or more substitution mutations at amino acid positions 106-113. In illustrative embodiments, the substitution mutations are selected from Q107E, Q107D, S106E, S106D, Q107R, Q107N, Q107E/S106E, Q107E/S106D, Q107D/S106E, and Q107D/S106D. In another embodiment, the modified signaling agent has an insertion of about 1 to about 3 amino acids at positions 106-113.

In some embodiments, the modified agent is a TNF family member (e.g. TNF-alpha, TNF-beta) which can be a single chain trimeric version as described in WO 2015/007903, the entire contents of which are incorporated by reference.

In some embodiments, the modified agent is a TNF family member (e.g. TNF-alpha, TNF-beta) which has reduced affinity and/or activity, *i.e.* antagonistic activity (e.g. natural antagonistic activity or antagonistic activity that is the result of one or more mutations, see, e.g., WO 2015/007520, the entire contents of which are hereby incorporated by reference) at TNFR1. In these embodiments, the modified agent is a TNF family member (e.g. TNF-alpha, TNF-beta) which also, optionally, has substantially reduced or ablated affinity and/or activity for TNFR2. In some embodiments, the modified agent is a TNF family member (e.g. TNF-alpha, TNF-beta) which has reduced affinity and/or activity, *i.e.* antagonistic activity (e.g. natural antagonistic activity or antagonistic activity that is the result of one or more mutations, see, e.g., WO 2015/007520, the entire contents of which are hereby incorporated by reference) at TNFR2. In these embodiments, the modified agent is a TNF family member (e.g. TNF-alpha, TNF-beta) which also, optionally, has substantially reduced or ablated affinity and/or activity for TNFR1. The constructs of such embodiments find use in, for example, methods of dampening TNF response in a cell specific manner. In some embodiments, the antagonistic TNF family member (e.g. TNF-alpha, TNF-beta) is a single chain trimeric version as described in WO 2015/007903.

In an embodiment, the modified signaling agent is TRAIL. In some embodiments, the modified TRAIL agent has reduced affinity and/or activity for DR4 (TRAIL-RI) and/or DR5 (TRAIL-RII) and/or DcR1 and/or DcR2. In some embodiments, the modified TRAIL agent has substantially reduced or ablated affinity and/or activity for DR4 (TRAIL-RI) and/or DR5 (TRAIL-RII) and/or DcR1 and/or DcR2.

In an embodiment, the wild type TRAIL has the amino acid sequence of:

TRAIL

MAMMEVQGGPSLGQTCVLIVFTVLLQSLCAVTVYVYFTNELKQMMDKYSK
SGIACFLKEDDSYWDPNDEESMNSPCWQVKWQLRQLVRKMILRTSEETIS
TVQEKQQNISPLVRERGPQRVAAHITGTRGRSNTLSSPNSKNEKALGRKIN
SWESSRSGHSFLSNLHLRNGELVIHEKGFYYIYSQTYFRFQEEIKENTKND
KQMVQYIYKYTSYPDPILLMKSARNSCWSKDAEYGLYSIYQGGIFELKEND
RIFVSVTNEHLIDMDHEASFFGAFLVG (SEQ ID NO:90).

In such embodiments, the modified TRAIL agent may comprise a mutation at amino acid positions T127-R132, E144-R149, E155-H161, Y189-Y209, T214-1220, K224-A226, W231, E236-L239, E249-K251, T261-H264 and H270-E271 (Numbering based on the human sequence, Genbank accession number NP_003801, version 10 NP_003801.1, GI: 4507593; see above).

In an embodiment, the modified signaling agent is an interleukin. In an embodiment, the modified signaling agent is IL-1. In an embodiment, the modified signaling agent is IL-1 α or IL-1 β . In some embodiments, the modified

signaling agent has reduced affinity and/or activity for IL-1R1 and/or IL-1RAcP. In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for IL-1R1 and/or IL-1RAcP. In some embodiments, the modified signaling agent has reduced affinity and/or activity for IL-1R2. In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for IL-1R2. For instance, in some embodiments, the present modified IL-1 agents avoid interaction at IL-1R2 and therefore substantially reduce its function as a decoy and/or sink for therapeutic agents.

In an embodiment, the wild type IL-1 β has the amino acid sequence of:

IL-1 beta (mature form, wild type)

APVRSLNCTLRDSQQKSLVMSGPYELKALHLQGQDMEQQVVFSMSFVQG
EESNDKIPVALGLKEKNLYLSCVLKDDKPTLQLESVDPKNYPKKKMEKRFV
FNKIEINNKLFEESAQFPNWIYSTQAENMPVFLGGTKGGQDITDFTMQFV
SS (SEQ ID NO:91).

IL1 is a proinflammatory cytokine and an important immune system regulator. It is a potent activator of CD4 T cell responses, increases proportion of Th17 cells and expansion of IFN γ and IL-4 producing cells. IL-1 is also a potent regulator of CD8 $^{+}$ T cells, enhancing antigen-specific CD8 $^{+}$ T cell expansion, differentiation, migration to periphery and memory. IL-1 receptors comprise IL-1R1 and IL-1R2. Binding to and signaling through the IL-1R1 constitutes the mechanism whereby IL-1 mediates many of its biological (and pathological) activities. IL-1R2 can function as a decoy receptor, thereby reducing IL-1 availability for interaction and signaling through the IL-1R1.

In some embodiments, the modified IL-1 has reduced affinity and/or activity (e.g. agonistic activity) for IL-1R1. In some embodiments, the modified IL-1 has substantially reduced or ablated affinity and/or activity for IL-1R2. In such embodiments, there is restorable IL-1/ IL-1R1 signaling and prevention of loss of therapeutic chimeras at IL-1R2 and therefore a reduction in dose of IL-1 that is required (e.g. relative to wild type or a chimera bearing only an attenuation mutation for IL-1R1). Such constructs find use in, for example, methods of treating cancer, including, for example, stimulating the immune system to mount an anti-cancer response.

In some embodiments, the modified IL-1 has reduced affinity and/or activity (e.g. antagonistic activity, e.g. natural antagonistic activity or antagonistic activity that is the result of one or more mutations, see, e.g., WO 2015/007520, the entire contents of which are hereby incorporated by reference) for IL-1R1. In some embodiments, the modified IL-1 has substantially reduced or ablated affinity and/or activity for IL-1R2. In such embodiments, there is the IL-1/ IL-1R1 signaling is not restorable and prevention of loss of therapeutic chimeras at IL-1R2 and therefore a reduction in dose of IL-1 that is required (e.g. relative to wild type or a chimera bearing only an attenuation mutation for IL-1R1). Such constructs find use in, for example, methods of treating autoimmune diseases, including, for example, suppressing the immune system.

In such embodiments, the modified signaling agent has a deletion of amino acids 52-54 which produces a modified human IL-1 β with reduced binding affinity for type I IL-1R and reduced biological activity. See, for

example, WO 1994/000491, the entire contents of which are hereby incorporated by reference. In some embodiments, the modified human IL-1 β has one or more substitution mutations selected from A117G/P118G, R120X, L122A, T125G/L126G, R127G, Q130X, Q131G, K132A, S137G/Q138Y, L145G, H146X, L145A/L147A, Q148X, Q148G/Q150G, Q150G/D151A, M152G, F162A, F162A/Q164E, F166A, Q164E/E167K, N169G/D170G, I172A, V174A, K208E, K209X, K209A/K210A, K219X, E221X, E221 S/N224A, N224S/K225S, E244K, N245Q (where X can be any change in amino acid, e.g., a non-conservative change), which exhibit reduced binding to IL-1R, as described, for example, in WO2015/007542 and WO/2015/007536, the entire contents of which is hereby incorporated by reference (numbering base on the human IL-1 β sequence, Genbank accession number NP_000567, version NP-000567.1, GI: 10835145). In some embodiments, the modified human IL-1 β may have one or more mutations selected from R120A, R120G, Q130A, Q130W, H146A, H146G, H146E, H146N, H146R, Q148E, Q148G, Q148L, K209A, K209D, K219S, K219Q, E221S and E221K. In an embodiment, the modified human IL-1 β comprises the mutations Q131G and Q148G. In an embodiment, the modified human IL-1 β comprises the mutations Q148G and K208E. In an embodiment, the modified human IL-1 β comprises the mutations R120G and Q131G. In an embodiment, the modified human IL-1 β comprises the mutations R120G and H146A. In an embodiment, the modified human IL-1 β comprises the mutations R120G and H146N. In an embodiment, the modified human IL-1 β comprises the mutations R120G and H146R. In an embodiment, the modified human IL-1 β comprises the mutations R120G and H146E. In an embodiment, the modified human IL-1 β comprises the mutations R120G and H146G. In an embodiment, the modified human IL-1 β comprises the mutations R120G and K208E. In an embodiment, the modified human IL-1 β comprises the mutations R120G, F162A, and Q164E.

In an embodiment, the modified signaling agent is IL-2. In such an embodiment, the modified signaling agent has reduced affinity and/or activity for IL-2R α and/or IL-2R β and/or IL-2R γ . In some embodiments, the modified signaling agent has reduced affinity and/or activity for IL-2R β and/or IL-2R γ . In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for IL-2R α . Such embodiments may be relevant for treatment of cancer, for instance when the modified IL-2 is agonistic at IL-2R β and/or IL-2R γ . For instance, the present constructs may favor attenuated activation of CD8⁺ T cells (which can provide an anti-tumor effect), which have IL2 receptors β and γ and disfavor T_{regs} (which can provide an immune suppressive, pro-tumor effect), which have IL2 receptors α , β , and γ . Further, in some embodiments, the preferences for IL-2R β and/or IL-2R γ over IL-2R α avoid IL-2 side effects such as pulmonary edema. Also, IL-2-based chimeras are useful for the treatment of diseases (e.g., autoimmune diseases), for instance when the modified IL-2 is antagonistic (e.g. natural antagonistic activity or antagonistic activity that is the result of one or more mutations, see, e.g., WO 2015/007520, the entire contents of which are hereby incorporated by reference) at IL-2R β and/or IL-2R γ . For instance, the present constructs may favor attenuated suppression of CD8⁺ T cells (and therefore dampen the immune response), which have IL2 receptors β and γ and disfavor T_{regs} which have IL2 receptors α , β , and γ . Alternatively, in some embodiments, the chimeras bearing IL-2 favor the activation of T_{regs}, and therefore immune suppression, and activation of disfavor of CD8⁺ T cells. For instance, these constructs find use

in the treatment of diseases or diseases that would benefit from immune suppression, e.g., autoimmune diseases.

In some embodiments, the chimeric protein has targeting moieties as described herein directed to CD8⁺ T cells as well as a modified IL-2 agent having reduced affinity and/or activity for IL-2R β and/or IL-2R γ and/or substantially reduced or ablated affinity and/or activity for IL-2R α . In some embodiments, these constructs provide targeted CD8⁺ T cell activity and are generally inactive (or have substantially reduced activity) towards T_{reg} cells. In some embodiments, such constructs have enhanced immune stimulatory effect compared to wild type IL-2 (e.g., without wishing to be bound by theory, by not stimulating Tregs), whilst eliminating or reducing the systemic toxicity associated with IL-2.

In an embodiment, the wild type IL-2 has the amino acid sequence of:

IL-2 (mature form, wild type)

APTSSSTKKTQLQLEHLLDLQMILNGINNYKNPKLTRMLTFKFYMPKKATE
LKHLQCLEELKPLEEVLNLAQSKNFHLRPRDLISNINVIVLELKGSETTFMC
EYADETATIVEFLNRWITFCQSIISTLT (SEQ ID NO:92).

In such embodiments, the modified IL-2 agent has one or more mutations at amino acids L72 (L72G, L72A, L72S, L72T, L72Q, L72E, L72N, L72D, L72R, or L72K), F42 (F42A, F42G, F42S, F42T, F42Q, F42E, F42N, F42D, F42R, or F42K) and Y45 (Y45A, Y45G, Y45S, Y45T, Y45Q, Y45E, Y45N, Y45D, Y45R or Y45K). Without wishing to be bound by theory, it is believed that these modified IL-2 agents have reduced affinity for the high-affinity IL-2 receptor and preserves affinity to the intermediate-affinity IL-2 receptor, as compared to the wild-type IL-2. See, for example, US Patent Publication No. 2012/0244112, the entire contents of which are hereby incorporated by reference.

In an embodiment, the modified signaling agent is IL-3. In some embodiments, the modified signaling agent has reduced affinity and/or activity for the IL-3 receptor, which is a heterodimer with a unique alpha chain paired with the common beta (beta c or CD131) subunit. In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for the IL-3 receptor, which is a heterodimer with a unique alpha chain paired with the common beta (beta c or CD131) subunit.

In an embodiment, the modified signaling agent is IL-4. In such an embodiment, the modified signaling agent has reduced affinity and/or activity for type 1 and/or type 2 IL-4 receptors. In such an embodiment, the modified signaling agent has substantially reduced or ablated affinity and/or activity for type 1 and/or type 2 IL-4 receptors. Type 1 IL-4 receptors are composed of the IL-4R α subunit with a common γ chain and specifically bind IL-4. Type 2 IL-4 receptors include an IL-4R α subunit bound to a different subunit known as IL-13R α 1. In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity the type 2 IL-4 receptors.

In an embodiment, the wild type IL-4 has the amino acid sequence of:

IL-4 (mature form, wild type)

HKCDITLQEIIKTLNSLTEQKTLCTELTVTDIFAASKNTTEKETFCRAATVLRQ
FYSHHEKDTRCLGATAQQFHRHKQLIRFLKRLDRNLWGLAGLNSCPVKEA
NQSTLENFLERLKTIMREKYSKCSS (SEQ ID NO:93).

In such embodiments, the modified IL-4 agent has one or more mutations at amino acids R121 (R121A, R121D, R121E, R121F, R121H, R121I, R121K, R121N, R121P, R121T, R121W), E122 (E122F), Y124 (Y124A, Y124Q, Y124R, Y124S, Y124T) and S125 (S125A). Without wishing to be bound by theory, it is believed that these modified IL-4 agents maintain the activity mediated by the type I receptor, but significantly reduces the biological activity mediated by the other receptors. See, for example, US Patent No. 6,433,157, the entire contents of which are hereby incorporated by reference.

In an embodiment, the modified signaling agent is IL-6. IL-6 signals through a cell-surface type I cytokine receptor complex including the ligand-binding IL-6R chain (CD126), and the signal-transducing component gp130. IL-6 may also bind to a soluble form of IL-6R (sIL-6R), which is the extracellular portion of IL-6R. The sIL-6R/IL-6 complex may be involved in neurites outgrowth and survival of neurons and, hence, may be important in nerve regeneration through remyelination. Accordingly, in some embodiments, the modified signaling agent has reduced affinity and/or activity for IL-6R/gp130 and/or sIL-6R. In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for IL-6R/gp130 and/or sIL-6R.

In an embodiment, the wild type IL-6 has the amino acid sequence of:

IL-6 (mature form, wild type)

APVPPGEDSKDVAAPHRQPLTSSERIDKQIRYILDGISALRKETCNKSNMCE
SSKEALAENNLNLPKMAEKDGCQSGFNEETCLVKIITGLLEFEVYLEYLQN
RFESSEEQARAVQMSTKVLIQFLQKKAKNLDAITPDPTTNASLTTKLQAQN
QWLQDMTTHLILRSFKEFLQSSLRALRQM (SEQ ID NO:94).

In such embodiments, the modified signaling agent has one or more mutations at amino acids 58, 160, 163, 171 or 177. Without wishing to be bound by theory, it is believed that these modified IL-6 agents exhibit reduced binding affinity to IL-6R α and reduced biological activity. See, for example, WO 97/10338, the entire contents of which are hereby incorporated by reference.

In an embodiment, the modified signaling agent is IL-10. In such an embodiment, the modified signaling agent has reduced affinity and/or activity for IL-10 receptor-1 and IL-10 receptor-2. In some embodiments, the modified signaling agent has ablated or substantially reduced affinity and/or activity for IL-10 receptor-1 and IL-10 receptor-2.

In an embodiment, the modified signaling agent is IL-11. In such an embodiment, the modified signaling agent has reduced affinity and/or activity for IL-11R α and/or IL-11R β and/or gp130. In such an embodiment, the

modified signaling agent has ablated or substantially reduced affinity and/or activity for IL-11R α and/or IL-11R β and/or gp130.

In an embodiment, the modified signaling agent is IL-12. In such an embodiment, the modified signaling agent has reduced affinity and/or activity for IL-12R β 1 and/or IL-12R β 2. In such an embodiment, the modified signaling agent has substantially reduced or ablated affinity and/or activity for IL-12R β 1 and/or IL-12R β 2.

In an embodiment, the modified signaling agent is IL-13. In such an embodiment, the modified signaling agent has reduced affinity and/or activity for the IL-4 receptor (IL-4R α) and IL-13R α 1. In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for IL-4 receptor (IL-4R α) or IL-13R α 1.

In an embodiment, the wild type IL-13 has the amino acid sequence of:

IL-13 (mature form, wild type)

SPGPVPPSTALRELIEELVNITQNQKAPLCNGSMVWSINLTAGMYCAALES
LINVSGCSAIEKTQRMISGFCPHKVSAGQFSSLHVRDTKIEVAQFVKDLLLH
LKKLFREGRFN (SEQ ID NO:95).

In such embodiments, the modified IL-13 agent has one or more mutations at amino acids 13, 16, 17, 66, 69, 99, 102, 104, 105, 106, 107, 108, 109, 112, 113 and 114. Without wishing to be bound by theory, it is believed that these modified IL-13 agents exhibit reduced biological activity. See, for example, WO 2002/018422, the entire contents of which are hereby incorporated by reference.

In an embodiment, the modified signaling agent is IL-18. In some embodiments, the modified signaling agent has reduced affinity and/or activity for IL-18R α and/or IL-18R β . In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for IL-18R α and/or IL-18R β . In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for IL-18R α type II, which is an isoform of IL-18R α that lacks the TIR domain required for signaling.

In an embodiment, the wild type IL-18 has the amino acid sequence of:

IL-18 (wild type)

MAAEPVEDNCINFVAMKFIDNTLYFIAEDDENLESDFGKLESKLSVIRNLN
DQVLFIDQGNRPLFEDMTDSDCRDNAPRTIFIISMYKDSQPRGMAVTISVKC
EKISTLSCENKIISFKEMNPPDNKDTKSDIIFQRSVPGHDKMQFESSYE
GYFLACEKERDLFKLILKKEDELGDRSIMFTVQNEDL (SEQ ID NO:96).

In such embodiments, the modified IL-18 agent may comprise one or more mutations in amino acids or amino acid regions selected from Y37-K44, R49-Q54, D59-R63, E67-C74, R80, M87-A97, N 127-K129, Q139-M149, K165-K171, R183 and Q190-N191, as described in WO/2015/007542, the entire contents of which are hereby

incorporated by reference (numbering based on the human IL-18 sequence, Genbank accession number AAV38697, version AAV38697.1, GI: 54696650).

In an embodiment, the modified signaling agent is IL-33. In such an embodiment, the modified signaling agent has reduced affinity and/or activity for the ST-2 receptor and IL-1RAcP. In some embodiments, the modified signaling agent has substantially reduced or ablated affinity and/or activity for the ST-2 receptor and IL-1RAcP.

In an embodiment, the wild type IL-33 has the amino acid sequence of:

MKPKMKYSTNKISTAKWKNTASKALCFKLGKSQQKAKEVCPMYFMKLRSGLMIKKEACYFRRETTKRPSLKTGRKHKRHLVLAACQQQSTVECFAGISGVQKYTRALHDSSITGISPITEYLASLSTYNDQSITFALEDESYEIYVEDLKKDEKDKVLLSYYESQHPSNESGDGVDGKMLMVTLSPTKDFWLHANNKEHSVELHKCEKPLPDQAFFVLHNMHSNCVSFECKTDPGVFIGVKDNHLALIKVDSSENLCTENILFKLSET (SEQ ID NO:97).

In such embodiments, the modified IL-33 agent may comprise one or more mutations in amino acids or amino acid regions selected from I113-Y122, S127-E139, E144-D157, Y163-M183, E200, Q215, L220-C227 and T260-E269, as described in WO/2015/007542, the entire contents of which are hereby incorporated by reference (numbering based on the human sequence, Genbank accession number NP_254274, version NP_254274.1, GI:15559209).

In one embodiment, the present chimeric protein has (i) a targeting moiety against Clec9A and (ii) a targeting moiety which is directed against a tumor cell, along with any of the modified or mutant signaling agents described herein. In an embodiment, the present chimeric protein has a targeting moiety directed against Clec9A on dendritic cells and a second targeting moiety directed against PD-L1 or PD-L2 on tumor cells.

In one embodiment, the present chimeric protein has (i) a targeting moiety against Clec9A and (ii) a targeting moiety which is directed against a checkpoint inhibitor marker, along with any of the modified or mutant interferons described herein. In an embodiment, the present chimeric protein has a targeting moiety directed against Clec9A on dendritic cells and a second targeting moiety directed against PD-1.

In various embodiments, the signaling agent is a toxin or toxic enzyme. In some embodiments, the toxin or toxic enzyme is derived from plants and bacteria. Illustrative toxins or toxic enzymes include, but are not limited to, the diphtheria toxin, Pseudomonas toxin, anthrax toxin, ribosome-inactivating proteins (RIPs) such as ricin and saporin, modeccin, abrin, gelonin, and poke weed antiviral protein. Additional toxins include those disclosed in Mathew et al., (2009) Cancer Sci 100(8): 1359-65, the entire disclosures are hereby incorporated by reference. In such embodiments, the chimeric proteins of the invention may be utilized to induce cell death in cell-type specific manner. In such embodiments, the toxin may be modified, e.g. mutated, to reduce affinity and/or activity of the toxin for an attenuated effect, as described with other signaling agents herein.

Multi-Specific Chimeras and Fusions with Signaling Agents

In various embodiments, the Clec9A binding agent of the invention is part of a chimera or fusion with one or more signaling agents as described herein and/or one or more additional targeting moieties. Accordingly, the present invention provides for chimeric or fusion proteins that include one or more signaling agents and a targeting moiety against Clec9A and/or one or more additional targeting moieties. Accordingly, in various embodiments, the term "Clec9A binding agent" encompasses such chimeras or fusion proteins with one or more signaling agents and/or one or more additional targeting moieties.

In various embodiments, the chimeric proteins of the present invention have targeting moieties which target two different cells (e.g. to make a synapse) or the same cell (e.g. to get a more concentrated signaling agent effect).

In various embodiments, the Clec9A binding agent of the invention is multispecific, *i.e.*, the Clec9A binding agent comprises two or more targeting moieties having recognition domains (e.g. antigen recognition domains) that recognize and bind two or more targets (e.g. antigens, or receptors, or epitopes). In such embodiments, the Clec9A binding agent of the invention may comprises two more targeting moieties having recognition domains that recognize and bind two or more epitopes on the same antigen or on different antigens or on different receptors. In various embodiments, such multi-specific Clec9A binding agents exhibit advantageous properties such as increased avidity and/or improved selectivity. In an embodiment, the Clec9A binding agent of the invention comprises two targeting moieties and is bispecific, *i.e.*, binds and recognizes two epitopes on the same antigen or on different antigens or different receptors. Accordingly, in various embodiments, the term "Clec9A binding agent" encompasses such multi-specific Clec9A binding agents comprising two or more targeting moieties.

In various embodiments, the multispecific Clec9A binding agent of the invention comprises two or more targeting moieties with each targeting moiety being an antibody or an antibody derivative as described herein. In an embodiment, the multispecific Clec9A binding agent of the invention comprises at least one VHH comprising an antigen recognition domain against Clec9A and one antibody or antibody derivative comprising a recognition domain against a tumor antigen and/or an immune cell marker.

In various embodiments, the present multispecific Clec9A binding agents have two or more targeting moieties that target different antigens or receptors, and one targeting moiety may be attenuated for its antigen or receptor, e.g. the targeting moiety binds its antigen or receptor with a low affinity or avidity (including, for example, at an affinity or avidity that is less than the affinity or avidity the other targeting moiety has for its antigen or receptor, for instance the difference between the binding affinities may be about 10-fold, or 25-fold, or 50-fold, or 100-fold, or 300-fold, or 500-fold, or 1000-fold, or 5000-fold; for instance the lower affinity or avidity targeting moiety may bind its antigen or receptor at a K_D in the mid- to high-nM or low- to mid- μ M range while the higher affinity or avidity targeting moiety may bind its antigen or receptor at a K_D in the mid- to high-pM or low- to mid-nM range). For instance, in some embodiments, the present multispecific Clec9A binding agent comprises an attenuated targeting moiety that is directed against a promiscuous antigen or receptor, which may improve targeting to a cell of interest (e.g. via the other targeting moiety) and prevent effects across multiple types of

cells, including those not being targeted for therapy (e.g. by binding promiscuous antigen or receptor at a higher affinity than what is provided in these embodiments).

The multispecific Clec9A binding agent of the invention may be constructed using methods known in the art, see for example, U.S. Patent No. 9,067,991, U.S. Patent Publication No. 20110262348 and WO 2004/041862, the entire contents of which are hereby incorporated by reference. In an illustrative embodiment, the multispecific Clec9A binding agent of the invention comprising two or more targeting moieties may be constructed by chemical crosslinking, for example, by reacting amino acid residues with an organic derivatizing agent as described by Blattler *et al.*, Biochemistry 24,1517-1524 and EP294703, the entire contents of which are hereby incorporated by reference. In another illustrative embodiment, the multispecific Clec9A binding agent comprising two or more targeting moieties is constructed by genetic fusion, *i.e.*, constructing a single polypeptide which includes the polypeptides of the individual targeting moieties. For example, a single polypeptide construct may be formed which encodes a first VHH with an antigen recognition domain against Clec9A and a second antibody or antibody derivative with an antigen recognition domain against e.g., a tumor antigen or a checkpoint inhibitor. A method for producing bivalent or multivalent VHH polypeptide constructs is disclosed in PCT patent application WO 96/34103, the entire contents of which is hereby incorporated by reference. In a further illustrative embodiment, the multispecific Clec9A binding agent of the invention may be constructed by using linkers. For example, the carboxy-terminus of a first VHH with an antigen recognition domain against Clec9A may be linked to the amino-terminus of a second antibody or antibody derivative with an antigen recognition domain against e.g., a tumor antigen or a checkpoint inhibitor (or vice versa). Illustrative linkers that may be used are described herein. In some embodiments, the components of the multispecific Clec9A binding agent of the invention are directly linked to each other without the use of linkers.

In various embodiments, the multi-specific Clec9A binding agent of the invention recognizes and binds to Clec9A and one or more antigens found on one or more immune cells, which can include, without limitation, megakaryocytes, thrombocytes, erythrocytes, mast cells, basophils, neutrophils, eosinophils, monocytes, macrophages, natural killer cells, T lymphocytes (e.g., cytotoxic T lymphocytes, T helper cells, natural killer T cells), B lymphocytes, plasma cells, dendritic cells, or subsets thereof. In some embodiments, the CLEC9A binding agent specifically binds to an antigen of interest and effectively directly or indirectly recruits one or more immune cells.

In various embodiments, the multi-specific Clec9A binding agent of the invention recognizes and binds to Clec9A and one or more antigens found on tumor cells. In these embodiments, the present Clec9A binding agents may directly or indirectly recruit an immune cell to a tumor cell or the tumor microenvironment. In some embodiments, the present Clec9A binding agents may directly or indirectly recruit an immune cell, e.g. a dendritic cell, to a site of action (such as, by way of non-limiting example, the tumor microenvironment). In some embodiments, the present Clec9A binding agent enhances antigen presentation (e.g. tumor antigen presentation) by dendritic cells for the induction of a potent humoral and cytotoxic T cell response.

In some embodiments, the present Clec9A binding agents are capable of, or find use in methods involving, shifting the balance of immune cells in favor of immune attack of a tumor. For instance, the present Clec9A binding agents can shift the ratio of immune cells at a site of clinical importance in favor of cells that can kill and/or suppress a tumor (e.g. T cells, cytotoxic T lymphocytes, T helper cells, natural killer (NK) cells, natural killer T (NKT) cells, anti-tumor macrophages (e.g. M1 macrophages), B cells, and dendritic cells and in opposition to cells that protect tumors (e.g. myeloid-derived suppressor cells (MDSCs), regulatory T cells (Tregs); tumor associated neutrophils (TANs), M2 macrophages, tumor associated macrophages (TAMs), or subsets thereof). In some embodiments, the present Clec9A binding agent is capable of increasing a ratio of effector T cells to regulatory T cells.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. antigen or receptor) associated with tumor cells. In some embodiments, the targeting moiety directly or indirectly recruits tumor cells. For instance, in some embodiments, the recruitment of the tumor cell is to one or more effector cell (e.g. an immune cell as described herein) that can kill and/or suppress the tumor cell.

Tumor cells, or cancer cells refer to an uncontrolled growth of cells or tissues and/or an abnormal increased in cell survival and/or inhibition of apoptosis which interferes with the normal functioning of bodily organs and systems. For example, tumor cells include benign and malignant cancers, polyps, hyperplasia, as well as dormant tumors or micrometastases. Illustrative tumor cells include, but are not limited to cells of: basal cell carcinoma, biliary tract cancer; bladder cancer; bone cancer; brain and central nervous system cancer; breast cancer; cancer of the peritoneum; cervical cancer; choriocarcinoma; colon and rectum cancer; connective tissue cancer; cancer of the digestive system; endometrial cancer; esophageal cancer; eye cancer; cancer of the head and neck; gastric cancer (including gastrointestinal cancer); glioblastoma; hepatic carcinoma; hepatoma; intra-epithelial neoplasm; kidney or renal cancer; larynx cancer; leukemia; liver cancer; lung cancer (e.g., small-cell lung cancer, non-small cell lung cancer, adenocarcinoma of the lung, and squamous carcinoma of the lung); melanoma; myeloma; neuroblastoma; oral cavity cancer (lip, tongue, mouth, and pharynx); ovarian cancer; pancreatic cancer; prostate cancer; retinoblastoma; rhabdomyosarcoma; rectal cancer; cancer of the respiratory system; salivary gland carcinoma; sarcoma; skin cancer; squamous cell cancer; stomach cancer; testicular cancer; thyroid cancer; uterine or endometrial cancer; cancer of the urinary system; vulval cancer; lymphoma including Hodgkin's and non-Hodgkin's lymphoma, as well as B-cell lymphoma (including low grade/follicular non-Hodgkin's lymphoma (NHL); small lymphocytic (SL) NHL; intermediate grade/follicular NHL; intermediate grade diffuse NHL; high grade immunoblastic NHL; high grade lymphoblastic NHL; high grade small non-cleaved cell NHL; bulky disease NHL; mantle cell lymphoma; AIDS-related lymphoma; and Waldenstrom's Macroglobulinemia; chronic lymphocytic leukemia (CLL); acute lymphoblastic leukemia (ALL); Hairy cell leukemia; chronic myeloblastic leukemia; as well as other carcinomas and sarcomas; and post-transplant lymphoproliferative disorder (PTLD), as well as abnormal vascular proliferation associated with phakomatoses, edema (e.g. that associated with brain tumors), and Meigs' syndrome.

Tumor cells, or cancer cells also include, but are not limited to, carcinomas, *e.g.* various subtypes, including, for example, adenocarcinoma, basal cell carcinoma, squamous cell carcinoma, and transitional cell carcinoma), sarcomas (including, for example, bone and soft tissue), leukemias (including, for example, acute myeloid, acute lymphoblastic, chronic myeloid, chronic lymphocytic, and hairy cell), lymphomas and myelomas (including, for example, Hodgkin and non-Hodgkin lymphomas, light chain, non-secretory, MGUS, and plasmacytomas), and central nervous system cancers (including, for example, brain (*e.g.* gliomas (*e.g.* astrocytoma, oligodendroglioma, and ependymoma), meningioma, pituitary adenoma, and neuromas, and spinal cord tumors (*e.g.* meningiomas and neurofibroma).

Illustrative tumor antigens include, but are not limited to, MART-1/Melan-A, gp100, Dipeptidyl peptidase IV (DPP-IV), adenosine deaminase-binding protein (ADAbp), cyclophilin b, Colorectal associated antigen (CRC)-0017-1A/GA733, Carcinoembryonic Antigen (CEA) and its immunogenic epitopes CAP-1 and CAP-2, *etv6*, *aml1*, Prostate Specific Antigen (PSA) and its immunogenic epitopes PSA-1, PSA-2, and PSA-3, prostate-specific membrane antigen (PSMA), T-cell receptor/CD3-zeta chain, MAGE-family of tumor antigens (*e.g.*, MAGE-A1, MAGE-A2, MAGE-A3, MAGE-A4, MAGE-A5, MAGE-A6, MAGE-A7, MAGE-A8, MAGE-A9, MAGE-A10, MAGE-A11, MAGE-A12, MAGE-Xp2 (MAGE-B2), MAGE-Xp3 (MAGE-B3), MAGE-Xp4 (MAGE-B4), MAGE-C1, MAGE-C2, MAGE-C3, MAGE-C4, MAGE-C5), GAGE-family of tumor antigens (*e.g.*, GAGE-1, GAGE-2, GAGE-3, GAGE-4, GAGE-5, GAGE-6, GAGE-7, GAGE-8, GAGE-9), BAGE, RAGE, LAGE-1, NAG, GnT-V, MUM-1, CDK4, tyrosinase, p53, MUC family, HER2/neu, p21ras, RCAS1, α -fetoprotein, E-cadherin, α -catenin, β -catenin and γ -catenin, p120ctn, gp100 Pmel117, PRAME, NY-ESO-1, *cdc27*, adenomatous polyposis coli protein (APC), fodrin, Connexin 37, Ig-idiotype, p15, gp75, GM2 and GD2 gangliosides, viral products such as human papilloma virus proteins, Smad family of tumor antigens, *Imp-1*, NA, EBV-encoded nuclear antigen (EBNA)-1, brain glycogen phosphorylase, SSX-1, SSX-2 (HOM-MEL-40), SSX-1, SSX-4, SSX-5, SCP-1 CT-7, *c-erbB-2*, CD19, CD20, CD22, CD30, CD33, CD37, CD56, CD70, CD74, CD138, AGS16, MUC1, GPNMB, Ep-CAM, PD-L1, PD-L2, PMSA, and BCMA (TNFRSF17). In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these tumor antigens.

In some embodiments, the present multi-specific Clec9A binding agent recognizes and binds to Clec9A as well as an antigen on a tumor cell. In some embodiments, the multi-specific Clec9A binding agent directly or indirectly recruits dendritic cells to the tumor cell or tumor microenvironment.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (*e.g.* an antigen or receptor) associated with T cells. In some embodiments, the targeting moiety directly or indirectly recruits T cells. In an embodiment, the antigen recognition domains specifically bind to effector T cells. In some embodiments, the antigen recognition domain directly or indirectly recruits effector T cells, *e.g.*, in some embodiments, to a therapeutic site (*e.g.* a locus with one or more disease cell or cell to be modulated for a therapeutic effect). Illustrative effector T cells include cytotoxic T cells (*e.g.* $\alpha\beta$ TCR, CD3⁺, CD8⁺, CD45RO⁺); CD4⁺ effector T cells (*e.g.* $\alpha\beta$ TCR, CD3⁺, CD4⁺, CCR7⁺, CD62Lhi, IL-7R/CD127⁺); CD8⁺ effector T cells (*e.g.* $\alpha\beta$ TCR, CD3⁺, CD8⁺, CCR7⁺, CD62Lhi, IL-7R/CD127⁺);

effector memory T cells (e.g. CD62L^{low}, CD44⁺, TCR, CD3⁺, IL-7R/CD127⁺, IL-15R⁺, CCR7^{low}); central memory T cells (e.g. CCR7⁺, CD62L⁺, CD27⁺; or CCR7^{hi}, CD44⁺, CD62L^{hi}, TCR, CD3⁺, IL-7R/CD127⁺, IL-15R⁺); CD62L⁺ effector T cells; CD8⁺ effector memory T cells (TEM) including early effector memory T cells (CD27⁺ CD62L⁻) and late effector memory T cells (CD27⁻ CD62L⁻) (TemE and TemL, respectively); CD127⁽⁺⁾CD25^(low/-) effector T cells; CD127⁽⁻⁾CD25⁽⁻⁾ effector T cells; CD8⁺ stem cell memory effector cells (TSCM) (e.g. CD44^(low)CD62L^(high)CD122^(high)sca⁽⁺⁾); TH1 effector T-cells (e.g. CXCR3⁺, CXCR6⁺ and CCR5⁺; or $\alpha\beta$ TCR, CD3⁺, CD4⁺, IL-12R⁺, IFN γ R⁺, CXCR3⁺); TH2 effector T cells (e.g. CCR3⁺, CCR4⁺ and CCR8⁺; or $\alpha\beta$ TCR, CD3⁺, CD4⁺, IL-4R⁺, IL-33R⁺, CCR4⁺, IL-17RB⁺, CRTH2⁺); TH9 effector T cells (e.g. $\alpha\beta$ TCR, CD3⁺, CD4⁺); TH17 effector T cells (e.g. $\alpha\beta$ TCR, CD3⁺, CD4⁺, IL-23R⁺, CCR6⁺, IL-1R⁺); CD4⁺CD45RO⁺CCR7⁺ effector T cells, ICOS⁺ effector T cells; CD4⁺CD45RO⁺CCR7⁽⁻⁾ effector T cells; and effector T cells secreting IL-2, IL-4 and/or IFN- γ .

Illustrative T cell antigens of interest include, for example (and inclusive of the extracellular domains, where applicable): CD8, CD3, SLAMF4, IL-2R α , 4-1BB/TNFRSF9, IL-2 R β , ALCAM, B7-1, IL-4 R, B7-H3, BLAME/SLAMFS, CEACAM1, IL-6 R, CCR3, IL-7 R α , CCR4, CXCR1/IL-S RA, CCR5, CCR6, IL-10R α , CCR 7, IL-10 R β , CCR5, IL-12 R β 1, CCR9, IL-12 R β 2, CD2, IL-13 R α 1, IL-13, CD3, CD4, ILT2/CDS5j, ILT3/CDS5k, ILT4/CDS5d, ILT5/CDS5a, Luteal α 4/CD49d, CDS, Integrin α E/CD103, CD6, Integrin α M/CD 11 b, CDS, Integrin α X/CD11c, Integrin β 2/CDIS, KIR/CD15S, CD27/TNFRSF7, KIR2DL1, CD2S, KIR2DL3, CD30/TNFRSF5, KIR2DL4/CD15Sd, CD31/PECAM-1, KIR2DS4, CD40 Ligand/TNFSF5, LAG-3, CD43, LAIR1, CD45, LAIR2, CDS3, Leukotriene B4-R1, CDS4/SLAMF5, NCAM-L1, CD94, NKG2A, CD97, NKG2C, CD229/SLAMF3, NKG2D, CD2F-10/SLAMF9, NT-4, CD69, NTB-A/SLAMF6, Common γ Chain/IL-2 R γ , Osteopontin, CRACC/SLAMF7, PD-1, CRTAM, PSGL-1, CTLA-4, RANK/TNFRSF11A, CX3CR1, CX3CL1, L-Selectin, CXCR3, SIRP β 1, CXCR4, SLAM, CXCR6, TCCR/WSX-1, DNAM-1, Thymopoietin, EMMPRIN/CD147, TIM-1, EphB6, TIM-2, Fas/TNFRSF6, TIM-3, Fas Ligand/TNFSF6, TIM-4, Fc γ RIII/CD16, TIM-6, TNFR1/TNFRSF1A, Granulysin, TNF RIII/TNFRSF1B, TRAIL RI/TNFRSF10A, ICAM-1/CD54, TRAIL R2/TNFRSF10B, ICAM-2/CD102, TRAILR3/TNFRSF10C, IFN- γ R1, TRAILR4/TNFRSF10D, IFN- γ R2, TSLP, IL-1 R1 and TSLP R. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these illustrative T cell antigens.

By way of non-limiting example, in various embodiments, the present chimeric protein has a targeting moiety directed against a checkpoint marker expressed on a T cell, e.g. one or more of PD-1, CD28, CTLA4, ICOS, BTLA, KIR, LAG3, CD137, OX40, CD27, CD40L, TIM3, and A2aR.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with B cells. In some embodiments, the targeting moiety directly or indirectly recruits B cells, e.g., in some embodiments, to a therapeutic site (e.g. a locus with one or more disease cell or cell to be modulated for a therapeutic effect). Illustrative B cell antigens of interest include, for example, CD10, CD19, CD20, CD21, CD22, CD23, CD24, CD37, CD38, CD39, CD40, CD72, CD73, CD74, CDw75, CDw76, CD77, CD78, CD79a/b, CD80,

CD81, CD82, CD83, CD84, CD85, CD86, CD89, CD98, CD126, CD127, CDw130, CD138, CDw150, and B-cell maturation antigen (BCMA). In various embodiments, the Clec9A binding agent comprises a targeting moiety that binds one or more of these illustrative B cell antigens.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with Natural Killer cells. In some embodiments, the targeting moiety directly or indirectly recruits Natural Killer cells, e.g., in some embodiments, to a therapeutic site (e.g. a locus with one or more disease cell or cell to be modulated for a therapeutic effect). Illustrative Natural Killer cell antigens of interest include, for example TIGIT, 2B4/SLAMF4, KIR2DS4, CD155/PVR, KIR3DL1, CD94, LMIR1/CD300A, CD69, LMIR2/CD300c, CRACC/SLAMF7, LMIR3/CD300LF, Kir1alpha, DNAM-1, LMIR5/CD300LB, Fc-epsilon RII, LMIR6/CD300LE, Fc-gamma RI/CD64, MICA, Fc-gamma RIIB/CD32b, MICB, Fc-gamma RIIC/CD32c, MULT-1, Fc-gamma RIIA/CD32a, Nectin-2/CD112, Fc-gamma RIII/CD16, NKG2A, FcRH1/IRTA5, NKG2C, FcRH2/IRTA4, NKG2D, FcRH4/IRTA1, NKp30, FcRH5/IRTA2, NKp44, Fc-Receptor-like 3/CD16-2, NKp46/NCR1, NKp80/KLRF1, NTB-A/SLAMF6, Rae-1, Rae-1 alpha, Rae-1 beta, Rae-1 delta, H60, Rae-1 epsilon, ILT2/CD85j, Rae-1 gamma, ILT3/CD85k, TREM-1, ILT4/CD85d, TREM-2, ILT5/CD85a, TREM-3, KIR/CD158, TREML1/TLT-1, KIR2DL1, ULBP-1, KIR2DL3, ULBP-2, KIR2DL4/CD158d and ULBP-3. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these illustrative NK cell antigens.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with macrophages/monocytes. In some embodiments, the targeting moiety directly or indirectly recruits macrophages/monocytes, e.g., in some embodiments, to a therapeutic site (e.g. a locus with one or more disease cell or cell to be modulated for a therapeutic effect). Illustrative macrophages/monocyte antigens of interest include, for example SIRP1a, B7-1/CD80, ILT4/CD85d, B7-H1, ILT5/CD85a, Common beta Chain, Integrin alpha 4/CD49d, BLAME/SLAMF8, Integrin alpha X/CD11c, CCL6/C10, Integrin beta 2/CD18, CD155/PVR, Integrin beta 3/CD61, CD31/PECAM-1, Latexin, CD36/SR-B3, Leukotriene B4 R1, CD40/TNFRSF5, LIMP1/CD300A, CD45, LMIR2/CD300c, CD68, LMIR3/CD300LF, CD84/SLAMF5, LMIR5/CD300LB, CD97, LMIR6/CD300LE, CD163, LRP-1, CD2F-10/SLAMF9, MARCO, CRACC/SLAMF7, MD-1, ECF-L, MD-2, EMMPRIN/CD147, MGL2, Endoglin/CD105, Osteoactivin/GPNMB, Fc-gamma RI/CD64, Osteopontin, Fc-gamma RIIB/CD32b, PD-L2, Fc-gamma RIIC/CD32c, Siglec-3/CD33, Fc-gamma RIIA/CD32a, SIGNR1/CD209, Fc-gamma RIII/CD16, SLAM, GM-CSF R alpha, TCCR/WSX-1, ICAM-2/CD102, TLR3, IFN-gamma RI, TLR4, IFN-gamma R2, TREM-1, IL-1 RII, TREM-2, ILT2/CD85j, TREM-3, ILT3/CD85k, TREML1/TLT-1, 2B4/SLAMF 4, IL-10 R alpha, ALCAM, IL-10 R beta, AminopeptidaseN/ANPEP, ILT2/CD85j, Common beta Chain, ILT3/CD85k, Clq R1/CD93, ILT4/CD85d, CCR1, ILT5/CD85a, CCR2, CD206, Integrin alpha 4/CD49d, CCR5, Integrin alpha M/CD11b, CCR8, Integrin alpha X/CD11c, CD155/PVR, Integrin beta 2/CD18, CD14, Integrin beta 3/CD61, CD36/SR-B3, LAIR1, CD43, LAIR2, CD45, Leukotriene B4-R1, CD68, LIMP1/CD300A, CD97, LMIR2/CD300c, CD163, LMIR3/CD300LF, Coagulation Factor III/Tissue Factor, LMIR5/CD300LB, CX3CR1, CX3CL1, LMIR6/CD300LE,

CXCR4, LRP-1, CXCR6, M-CSF R, DEP-1/CD148, MD-1, DNAM-1, MD-2, EMMPRIN/CD147, MMR, Endoglin/CD105, NCAM-L1, Fc-γ RI/CD64, PSGL-1, Fc-γ RIICD16, RP105, G-CSF R, L-Selectin, GM-CSF R α, Siglec-3/CD33, HVEM/TNFRSF14, SLAM, ICAM-1/CD54, TCCR/WSX-1, ICAM-2/CD102, TREM-1, IL-6 R, TREM-2, CXCR1/IL-8 RA, TREM-3 and TREML1/TLT-1. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these illustrative macrophage/monocyte antigens.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with dendritic cells. In some embodiments, the targeting moiety directly or indirectly recruits dendritic cells, e.g., in some embodiments, to a therapeutic site (e.g. a locus with one or more disease cell or cell to be modulated for a therapeutic effect). Illustrative dendritic cell antigens of interest include, for example, CLEC9A, XCR1, RANK, CD36/SRB3, LOX-1/SR-E1, CD68, MARCO, CD163, SR-A1/MSR, CD5L, SREC-1, CL-PI/COLEC12, SREC-II, LIMP1/SRB2, RP105, TLR4, TLR1, TLR5, TLR2, TLR6, TLR3, TLR9, 4-IBB Ligand/TNFSF9, IL-12/IL-23 p40, 4-Amino-1,8-naphthalimide, ILT2/CD85j, CCL21/6CKine, ILT3/CD85k, 8-oxo-dG, ILT4/CD85d, 8D6A, ILT5/CD85a, A2B5, Integrin α 4/CD49d, Aαg, Integrin β 2/CD18, AMICA, Langerin, B7-2/CD86, Leukotriene B4 RI, B7-H3, LMIR1/CD300A, BLAME/SLAMF8, LMIR2/CD300c, Clq R1/CD93, LMIR3/CD300LF, CCR6, LMIR5/CD300LB, CCR7, LMIR6/CD300LE, CD40/TNFRSF5, MAG/Siglec-4-a, CD43, MCAM, CD45, MD-1, CD68, MD-2, CD83, MDL-1/CLEC5A, CD84/SLAMF5, MMR, CD97, NCAM1, CD2F-10/SLAMF9, Osteoactivin GPNMB, Chern 23, PD-L2, CLEC-1, RP105, CLEC-2, CLEC-8, Siglec-2/CD22, CRACC/SLAMF7, Siglec-3/CD33, DC-SIGN, DCE205, Siglec-5, DC-SIGNR/CD299, Siglec-6, DCAR, Siglec-7, DCIR/CLEC4A, Siglec-9, DEC-205, Siglec-10, Dectin-1/CLEC7A, Siglec-F, Dectin-2/CLEC6A, SIGNR1/CD209, DEP-1/CD148, SIGNR4, DLEC, SLAM, EMMPRIN/CD147, TCCR/WSX-1, Fc-γ R1/CD64, TLR3, Fc-γ RIIB/CD32b, TREM-1, Fc-γ RIIC/CD32c, TREM-2, Fc-γ RIIA/CD32a, TREM-3, Fc-γ RIIC/CD16, TREML1/TLT-1, ICAM-2/CD102 and Vanilloid R1. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these illustrative DC antigens.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with immune cells selected from, but not limited to, megakaryocytes, thrombocytes, erythrocytes, mast cells, basophils, neutrophils, eosinophils, or subsets thereof. In some embodiments, the antigen recognition domains directly or indirectly recruit megakaryocytes, thrombocytes, erythrocytes, mast cells, basophils, neutrophils, eosinophils, or subsets thereof, e.g., in some embodiments, to a therapeutic site (e.g. a locus with one or more disease cell or cell to be modulated for a therapeutic effect).

In some embodiments, the multi-specific CLEC9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with megakaryocytes and/or thrombocytes. Illustrative megakaryocyte and/or thrombocyte antigens of interest include, for example, GP IIb/IIIa, GPIb, vWF, PF4, and TSP. In various embodiments, the CLEC9A binding agent

comprises a targeting moiety that binds one or more of these illustrative megakaryocyte and/or thrombocyte antigens.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with erythrocytes. Illustrative erythrocyte antigens of interest include, for example, CD34, CD36, CD38, CD41a (platelet glycoprotein IIb/IIIa), CD41b (GPIIb), CD71 (transferrin receptor), CD105, glycophorin A, glycophorin C, c-kit, HLA-DR, H2 (MHC-II), and Rhesus antigens. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these illustrative erythrocyte antigens.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with mast cells. Illustrative mast cells antigens of interest include, for example, SCFR/CD117, Fc ϵ RI, CD2, CD25, CD35, CD88, CD203c, C5R1, CMAI, FCERIA, FCER2, TPSAB1. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these mast cell antigens.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with basophils. Illustrative basophils antigens of interest include, for example, Fc ϵ RI, CD203c, CD123, CD13, CD107a, CD107b, and CD164. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these basophil antigens.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with neutrophils. Illustrative neutrophils antigens of interest include, for example, 7D5, CD10/CALLA, CD13, CD16 (FcRIII), CD18 proteins (LFA-1, CR3, and p150, 95), CD45, CD67, and CD177. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these neutrophil antigens.

In some embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to a target (e.g. an antigen or receptor) associated with eosinophils. Illustrative eosinophils antigens of interest include, for example, CD35, CD44 and CD69. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these eosinophil antigens.

In various embodiments, the multi-specific Clec9A binding agent of the invention comprises a targeting moiety having a recognition domain that specifically binds to an appropriate antigen or cell surface marker known by the skilled artisan. In some embodiments, the antigen or cell surface marker is a tissue-specific marker. Illustrative tissue-specific markers include, but are not limited to, endothelial cell surface markers such as ACE, CD14, CD34, CDH5, ENG, ICAM2, MCAM, NOS3, PECAMI, PROCR, SELE, SELP, TEK, THBD, VCAMI, VWF; smooth muscle cell surface markers such as ACTA2, MYH10, MYH11, MYH9, MYOCD; fibroblast (stromal) cell surface markers such as ALCAM, CD34, COL1A1, COL1A2, COL3A1, FAP, PH-4; epithelial cell surface markers such as

CDID, K6IRS2, KRTIO, KRT13, KRT17, KRT18, KRT19, KRT4, KRT5, KRT8, MUCI, TACSTD1; neovasculature markers such as CD13, TFNA, Alpha-v beta-3 ($\alpha V\beta 3$), E-selectin; and adipocyte surface markers such as ADIPOQ, FABP4, and RETN. In various embodiments, the CLEC9A binding agent comprises a targeting moiety that binds one or more of these antigens. In various embodiments, a targeting moiety of the chimeric protein binds one or more of cells having these antigens.

In various embodiments, the multi-specific Clec9A binding agent of the invention has one or more targeting moieties directed against a checkpoint marker, e.g. one or more of PD-1/PD-L1 or PD-L2, CD28/CD80 or CD86, CTLA4/ CD80 or CD86, ICOS/ICOSL or B7RP1, BTLA/HVEM, KIR, LAG3, CD137/CD137L, OX40/OX40L, CD27, CD40L, TIM3/Gal9, and A2aR. In some embodiments, the multispecific Clec9A binding agent of the invention may comprise an antibody or antibody format, e.g. VHH, against a checkpoint inhibitor marker selected from one of CTLA-4, PD-L1, PD-L2, and PD-1.

By way of non-limiting example, in various embodiments, the present multispecific Clec9A binding agent has a targeting moiety directed against (i) a checkpoint marker expressed on a T cell, e.g. one or more of PD-1, CD28, CTLA4, ICOS, BTLA, KIR, LAG3, CD137, OX40, Cd27, CD40L, TIM3, and A2aR and (ii) a targeting moiety is directed against a tumor cell, along with any of the modified (e.g. mutant) signaling agents described herein.

In various embodiments, the present multi-specific Clec9A binding agent has one or more targeting moieties directed against PD-1. In some embodiments, the Clec9A binding agent has one or more targeting moieties which selectively bind a PD-1 polypeptide. In some embodiments, the Clec9A binding agent comprises one or more antibodies, antibody derivatives or formats, peptides or polypeptides, or fusion proteins that selectively bind a PD-1 polypeptide.

In an embodiment, the targeting moiety comprises the anti-PD-1 antibody pembrolizumab (aka MK-3475, KEYTRUDA), or fragments thereof. Pembrolizumab and other humanized anti-PD-1 antibodies are disclosed in Hamid, et al. (2013) New England Journal of Medicine 369 (2): 134-44, US 8,354,509, and WO 2009/114335, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, pembrolizumab or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising the amino acid sequence of:

QVQLVQSGVEVKKPGASVKVSCASGYTFTNYYMYWVRQAPGGLEWMGGINPSNGGTNF
NEKFKNRVTLTDSSTTTAYMELKSLQFDDTAVYYCARRDYRFDMGFDYWGQTTVTVSS
ASTKGPSVFPLAPCSRSTSESTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSS
GLYSLSSVVTVPSSSLGKTYTCNVDHKPSNTKVDKRVESKYGPCCPPCPAPEFLGGPSV
FLFPPKPKDTLMISRTEVTCVVVDVSQEDPEVQFNWYVDGVEVHNAKTKPREEQFNSTY
RVVSVLTVLHQDWLNGKEYKCKVSNKGLPSSIEKTIKAKGQPREPQVYTLPPSQEEMTK
NQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTTPVLDSDGSFFLYSRLTVDKSRWQEG
NVFSCSVMEALHNHYTQKSLSLSLGK (SEQ ID NO:98);

and/or a light chain comprising the amino acid sequence of:

EIVLTQSPATLSLSPGERATLSCRASKGVSTSGYSYLHWYQQKPGQAPRLLIYLAAYLES
GVPARFSGSGSGTDFTLTISSELPEDFAVYYCQHSRDLPLTFGGGTKVEIKRTVAAPSVF

IFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLS
STLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC (SEQ ID NO:99).

In an embodiment, the targeting moiety comprises the anti-PD-1 antibody, nivolumab (aka BMS-936558, MDX-1106, ONO-4538, OPDIVO), or fragments thereof. Nivolumab (clone 5C4) and other human monoclonal antibodies that specifically bind to PD-1 are disclosed in US 8,008,449 and WO 2006/121168, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, nivolumab or an antigen-binding fragment thereof comprises a heavy chain comprising the amino acid sequence of:

QVQLVESGGG VVQPGRSLRL DCKASGITFS NSGMHWVRQA PGKGLEWVAV IWYDGSKRYY
ADSVKGRFTI SRDNSKNTLF LQMNSLRAED TAVYYCATND DYWGQGTLT VSSASTKGPS
VFPLAPCSRS TSESTAALGC LVKDYFPEPV TVSWNSGALT SGVHTFPAVL QSSGLYSLS
VVTVPSSSLG TKTYTCNVDP KPSNTKVDKR VESKYGPCCP PCPAPEFLGG PSVFLFPPKP
KDTLMIS RTP EVTCVVVDVS QEDPEVQFNW YVDGVEVHNA KTKPREEQFN STYRVVSVLT
VLHQDWLNGK EYKCKVSNKG LPSSIEKTIS KAKGQPREPQ VYTLPPSQEE MTKNQVSLTC
LVKGFYPSDI AVEWESNGQP ENNYKTTTPV LDSGGSFFLY SRLTVDKSRW QEGNVFSCSV
MHEALHNHYT QKSLSLSLGK (SEQ ID NO:100);

and/or a light chain comprising the amino acid sequence of:

EIVLTQSPAT LSLSPGERAT LSCRASQSVS SYLAWYQQKP GQAPRLLIYD ASNRATGIPA
RFGSGSGTD FTLTISSLEP EDFAVYYCQQ SSNWPRTFGQ GTKVEIKRTV AAPSVFIFPP
SDEQLKSGTA SVVCLLNNFY PREAKVQWKV DNALQSGNSQ ESVTEQDSKD STYLSSTLT
LSKADYEKHK VYACEVTHQG LSSPVTKSFN RGEC (SEQ ID NO:101).

In an embodiment, the targeting moiety comprises the anti-PD-1 antibody pidilizumab (aka CT-011, hBAT or hBAT-1), or fragments thereof. Pidilizumab and other humanized anti-PD-1 monoclonal antibodies are disclosed in US 2008/0025980 and WO 2009/101611, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, the anti-PD-1 antibody or an antigen-binding fragment thereof for use in the methods provided herein comprises a light chain variable regions comprising an amino acid sequence selected from SEQ ID NOS: 15-18 of US 2008/0025980:

SEQ ID No: 15 of US 2008/0025980 (SEQ ID NO:102):

EIVLTQSPSSLSASVGDRVTITCSARSSVSVMHWYQQKPGKAPKLLIYRTSNLASGVPSR
FSGSGSGTDFTLTINS LQPEDFATYYCQQRSSFPLTFGGGTKLEIK;

SEQ ID No: 16 of US 2008/0025980 (SEQ ID NO:103):

EIVLTQSPSSLSASVGDRVTITCSARSSVSVMHWFQQKPGKAPKLWIYRTSNLASGVPSR
FSGSGSGTDYTLTINS LQPEDFATYYCQQRSSFPLTFGGGTKLEIK;

SEQ ID No: 17 of US 2008/0025980 (SEQ ID NO:104):

EIVLTQSPSSLSASVGDRVTITCSARSSVSVMHWFQQKPGKAPKLWIYRTSNLASGVPSR
FSGSGSGTDYCLTINS LQPEDFATYYCQQRSSFPLTFGGGTKLEIK;

SEQ ID No: 18 of US 2008/0025980 (SEQ ID NO:105):

EIVLTQSPSSLSASVGDRTITCSARSSVSYMHWFQQKPGKAPKLWIYRTSNLASGVPSR
FSGSGSGTSYCLTINSLQPEDFATYYCQQRSSFPLTFGGGTKLEIK;

and/or a heavy chain comprising an amino acid sequence selected from SEQ ID NOS: 20-24 of US 2008/0025980:

SEQ ID No: 20 of US 2008/0025980 (SEQ ID NO:106):

QVQLVQSGSELKKPGASVKISCKASGYFSFSNYGMNWVRQAPGQGLQWMGWINTDSGESTY
AEEFKGRFVFSLDTSVSTAYLQITSLTAEDTGMVFCYKVDALDYWGQGTLVTVSS;

SEQ ID No: 21 of US 2008/0025980 (SEQ ID NO:107):

QVQLVQSGSELKKPGASVKISCKASGYTFTNYGMNWVRQAPGQGLQWMGWINTDSGESTY
AEEFKGRFVFSLDTSVSTAYLQITSLTAEDTGMVFCYKVDALDYWGQGTLVTVSS;

SEQ ID No: 22 of US 2008/0025980 (SEQ ID NO:108):

QVQLVQSGSELKKPGASVKISCKASGYTFTNYGMNWVRQAPGQGLQWMGWINTDSGESTY
AEEFKGRFVFSLDTSVNTAYLQITSLTAEDTGMVFCVRYDALDYWGQGTLVTVSS;

SEQ ID No: 23 of US 2008/0025980 (SEQ ID NO:109):

QIQLVQSGSELKKPGASVKISCKASGYTFTNYGMNWVRQAPGQGLQWMGWINTDSGESTY
AEEFKGRFVFSLDTSVNTAYLQITSLTAEDTGMVFCVRYDALDYWGQGTLVTVSS;

SEQ ID No: 24 of US 2008/0025980 (SEQ ID NO:110):

QIQLVQSGSELKKPGASVKISCKASGYTFTNYGMNWVRQAPGQGLQWMGWINTDSGESTY
AEEFKGRFAFSLDTSVNTAYLQITSLNAEDTGMVFCVRYDALDYWGQGTLVTVSS.

In an embodiment, the targeting moiety comprises a light chain comprising SEQ ID NO:18 of US 2008/0025980 and a heavy chain comprising SEQ ID NO:22 of US 2008/0025980.

In an embodiment, the targeting moiety comprises AMP-514 (aka MEDI-0680).

In an embodiment, the targeting moiety comprises the PD-L2-Fc fusion protein AMP-224, which is disclosed in WO2010/027827 and WO 2011/066342, the entire disclosures of which are hereby incorporated by reference. In such an embodiment, the targeting moiety may include a targeting domain which comprises SEQ ID NO:4 of WO2010/027827 (SEQ ID NO:111):

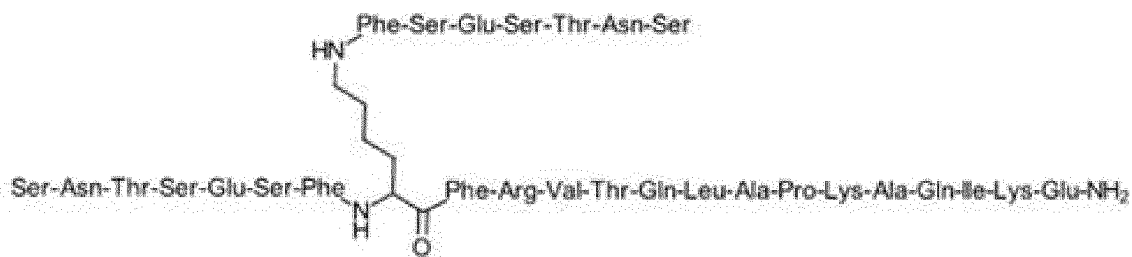
LFTVTVPKELYIIIEHGSNVTLECNFDTGSHVNLGAI TASLQKVENDTSPHRERATLLEEQ
LPLGKASFHIPQVQVRDEGQYQCIIYGVAWDYKYLTLKVKASYRKINTHILKVPETDEV
ELTCQATGYPLAEVSWPNVSVFANTSHSRTPEGLYQVTSVLRKPPPGRNFSVFWNTHV
RELTLASIDLQSQMEPRTHPTWLLHIFIPFCIIAFIFFIATVIALRKQLCQKLYSSKDTTK
RPVTTTKREVNSAI

and/or the B7-DC fusion protein which comprises SEQ ID NO:83 of WO2010/027827 (SEQ ID NO:112):

MIFLLMLSLLEQLHQIAALFTVTVPKELYIIIEHGSNVTLECNFDTGSHVNLGAITASLQ
KVENDTSPHRERATLLEEQLPLGKASFHIPQVQVRDEGQYQCIIIIYGVAWDYKYLTLKVK
ASYRKINTHILKVPETDEVELTCQATGYPLAEVSWPNVSV PANTSHSRTPEGLYQVTSVL
RLKPPPGRNFSCVFNTHVRELTLASIDLQSQMEPRTHPTWEPKSCDKTHTCPPCPAPEL
LGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREE
QYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPS
RDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTPPVLDSDGSFFLYSKLTVDK
SRWQQGNV FSCSV MHEALHNHYTQKSLSLSPGK

In an embodiment, the targeting moiety comprises the peptide AUNP 12 or any of the other peptides disclosed in US 2011/0318373 or 8,907,053. For example, the targeting moiety may comprise AUNP 12 (*i.e.*, Compound 8 or SEQ ID NO:49 of US 2011/0318373) which has the sequence of SEQ ID NO:113:

SNTSESEFK (SNTSESF) FRVTQLAPKAQIKE-NH₂



or: SNTSESF-NH
|
SNTSESEFKFRVTQLAPKAQIKE-NH₂

In an embodiment, the targeting moiety comprises the anti-PD-1 antibody 1E3, or fragments thereof, as disclosed in US 2014/0044738, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 1E3 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

EVQLQQSGPV LVKPGASVKM SCKASGYTFT DYIMNWVKQS HGKSLEWIGN
INPYNGGTTY NQKFKGKATL TVDKSSRTAY MEINSLTSED SAVYYCARGR
IYDGSLDYWG QGTALT VSS (SEQ ID NO:114);

and/or a light chain variable region comprising the amino acid sequence of:

DIQMTQFPSS LCASQGGKVT VTCKASQDIN NYMAWYQHKP GKGPRLLIHY
TSTLLSGIPS RFSGSGSGRD YSFSISNLEP EDIATYYCLQ YDNLWTFGGG
TKLEIK (SEQ ID NO:115).

In an embodiment, the targeting moiety comprises the anti-PD-1 antibody 1E8, or fragments thereof, as disclosed in US 2014/0044738, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 1E8 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

QVQLQQSGAE LAKPGASVRL SCKASGYTFT NYWMHWVKQR PGQGLEWIGH
INPSSGFTTY NQNFKDKATL TADKSSNTAY MQLSSLTYED SAVYFCARED
YDVDYWGGGT TLTVSS (SEQ ID NO:116);

and/or a light chain variable region comprising the amino acid sequence of:

DIVMTQSQKF MSTSVGDRVS VTCKASQSVD TNVAWYQQKP GQSPKALIFS
ASYRYSQVPD RFTGSGSGTD FTLTINSVQS EDLAEIFCQQ YNSYPYTFGS
GTKLEIK (SEQ ID NO:117).

In an embodiment, the targeting moiety comprises the anti-PD-1 antibody 1H3, or fragments thereof, as disclosed in US 2014/0044738, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 1H3 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

EVQLVESGGG LVKPGGSLKL SCAASGFTFS DYGMHWVRQA PEKGLEWVAY
ISSGSYTIYY TDTVKGRFTI SRDNAKNTLF LQMTSLRSED TAMYYCARRG
YGSFYEYYFD YWGQGTTLTV SS (SEQ ID NO:118);

and/or light chain variable region comprising the amino acid sequence of:

QIVLTQSPAL MSASPGEKVT MTCSASSSVS YMYWYQQKPR SSPKPWIYLT
SNLASGVPAR FSGSGSGTSY SLTISSMEAE DAATYVCQQW SSNPFTFGSG
TKLEIK (SEQ ID NO:119).

In an embodiment, the targeting moiety comprises a VHH directed against PD-1 as disclosed, for example, in US 8,907,065 and WO 2008/071447, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, the VHHs against PD-1 comprise SEQ ID NOS: 347-351 of US 8,907,065:

SEQ ID No: 347 of US 8,907,065 (SEQ ID NO:120):

EVQLVESGGGLVQAGKSLRLSCAASGSI FSIHAMGWFRQAPGKEREFVAA
ITWSSGITYYEDSVKGRFTISRDNKNTVYLQMNSLKPEDTAIYYCAADR
AESSWYDYWGQGTQVTVSS;

SEQ ID No: 348 of US 8,907,065 (SEQ ID NO:121):

EVQLVESGGGLVQAGGSLRLSCAASGSIASIHAMGWFRQAPGKEREFVAV
ITWSSGITYYADSVKGRFTISRDNKNTVYLQMNSLKPEDTAIYYCAGDK
HQSSWYDYWGQGTQVTVSS;

SEQ ID No: 349 of US 8,907,065 (SEQ ID NO:122):

EVQLVESGGGLVQAGGSLRLSCAASGSISSIHAMGWFRQAPGKEREFVAA
ITWSSGGITYYADSLKGRFTISRDNKNTGYLQMNSLKPEDTAIYYCAADR
AQSSWYDYWGQGTQVTVSS;

SEQ ID No: 350 of US 8,907,065 (SEQ ID NO:123):

EVQLVESGGGLVQAGGSLGLSCAASGSIFSINAMAWFRQAPGKEREFVAL
ISWSSGGSTYYEDSVKGRFTISRDNKNTVYLYQMNSLKPEDTAIYYCAADR
VDSNWYDYWGQGTQVTVSS;

SEQ ID No: 351 of US 8,907,065 (SEQ ID NO:124):

EVQLVESGGGLVQAGGSLRLSCAASGRAFSSTMGWFRRAPGKEREFVA
SIPWSSGGRIYYADSVKGRFTISRDNKNTVYLYQMNSLKPEDTAVYYCAVK
ERSTGWDFASWGQGTQVTVSS.

In an embodiment, the targeting moiety comprises any one of the anti-PD-1 antibodies, or fragments thereof, as disclosed in US2011/0271358 and WO2010/036959, the entire contents of which are hereby incorporated by reference. In illustrative embodiments, the antibody or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising an amino acid sequence selected from SEQ ID NOS: 25-29 of US2011/0271358:

SEQ ID No: 25 of US2011/0271358 (SEQ ID NO:125):

QVQLVQSGAELKQPGASVKMSCKASGYSFTSSWIHWVKQAPGGGLEWIGYIYPSTGFTEY
NQKFKDRATLTADKSTSTAYMELSSLRSEDSAVYYCARWRDSSGYHAMDYWGQGTSVTVS
S;

SEQ ID No: 26 of US2011/0271358 (SEQ ID NO:126):

QVQLVQSGAEVKQPGASVKMSCKASGYSFTSSWIHWVKQAPGGGLEWIGYIYPSTGFTEY
NQKFKDRATLTADKSTSTAYMELSSLRSEDTAVYY3/d10CARWRDSSGYHAMDYWGQGTSVTVS
S;

SEQ ID No: 27 of US2011/0271358 (SEQ ID NO:127):

QVQLVQSGHEVKQPGASVKMSCKASGYSFTSSWIHWVKQAPGGGLEWIGYIYPSTGFTEY
NQKFKDRATLTADKSTSTAYMELSSLRSEDTAVYYCARWRDSSGYHAMDYWGQGTSLVTVS
S;

SEQ ID No: 28 of US2011/0271358 (SEQ ID NO:128):

QVQLVQSGHEVKQPGASVKMSCKASGYSFTSSWIHWVRQAPGGGLEWIGYIYPSTGFTEY
NQKFKDRATLTADKSTSTAYMELSSLRSEDTAVYYCARWRDSSGYHAMDYWGQGTSLVTVS
S;

SEQ ID No: 29 of US2011/0271358 (SEQ ID NO:129):

QVQLVQSGHEVKQPGASVKVSCASGYSFTSSWIHWVRQAPGGGLEWIGYIYPSTGFTEY

NQKFKDRATITADKSTSTAYMELSSLRSED TAVYYCARWRDSSGYHAMDYWGQGLVTVS
S;

and/or a light chain comprising an amino acid sequence selected from SEQ ID NOS: 30-33 of US2011/0271358:

SEQ ID No: 30 of US2011/0271358 (SEQ ID NO:130):

DIVLTQSPASLTLSLSPGQRLTISCRASQSVSTSGYSYMHYQQKPDQSPKLLIKFGSNLES
GIPARFSGSGSGTDFTLTISSELEEDFATYYCQHSWEIPYTFGQGTKLEIK;

SEQ ID No: 31 of US2011/0271358 (SEQ ID NO:131):

DIVLTQSPATLSLSPGQRLTISCRASQSVSTSGYSYMHYQQKPDQSPKLLIKFGSNLES
GIPARFSGSGSGTDFTLTISSELEPEDFATYYCQHSWEIPYTFGQGTKLEIK;

SEQ ID No: 32 of US2011/0271358 (SEQ ID NO:132):

EIVLTQSPATLSLSPGQRLTISCRASQSVSTSGYSYMHYQQKPDQSPKLLIKFGSNLES
GIPARFSGSGSGTDFTLTISSELEPEDFATYYCQHSWEIPYTFGQGTKLEIK;

SEQ ID No: 33 of US2011/0271358 (SEQ ID NO:133):

DIVLTQSPATLSLSPGQRLTISCRASQSVSTSGYSYMHYQQKPDQSPKLLIKFGSNLES
GIPARFSGSGSGTDFTLTISSELEPEDFAVYYCQHSWEIPYTFGQGTKLEIK.

In various embodiments, the present multi-specific Clec9A binding agent comprises one or more antibodies directed against PD-1, or antibody fragments thereof, selected from TSR-042 (Tesar, Inc.), REGN2810 (Regeneron Pharmaceuticals, Inc.), PDR001 (Novartis Pharmaceuticals), and BGB-A317 (BeiGene Ltd.)

In an exemplary embodiment, the present multi-specific Clec9A binding agent comprises a targeting moiety directed against PD-1, such as SEQ ID NO:134:

EVQLVESGGGLVQAGKSLRLSCAASGSIHAMDGFRQAPGKEREFVAITWSGGITYYEDSVKGRFTISRDN
KNTVYLQMNSLKPEDTAIYYCAADRAESSWYDYWGQGTQVTVSS.

In various embodiments, the present multi-specific Clec9A binding agent has one or more targeting moieties directed against PD-L1. In some embodiments, the Clec9A binding agent has one or more targeting moieties which selectively bind a PD-L1 polypeptide. In some embodiments, the Clec9A binding agent comprises one or more antibodies, antibody derivatives or formats, peptides or polypeptides, or fusion proteins that selectively bind a PD-L1 polypeptide.

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody MEDI4736 (aka durvalumab), or fragments thereof. MEDI4736 is selective for PD-L1 and blocks the binding of PD-L1 to the PD-1 and CD80 receptors. MEDI4736 and antigen-binding fragments thereof for use in the methods provided herein comprises a heavy chain and a light chain or a heavy chain variable region and a light chain variable region. The sequence of MEDI4736 is disclosed in WO/2016/06272, the entire contents of which are hereby incorporated by reference. In

illustrative embodiments, MEDI4736 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising the amino acid sequence of:

EVQLVESGGG LVQPGGSLRL SCAASGFTFS RYWMSWVRQA PGKGLEWVAN
IKQDGSEKYY VDSVKGRFTI SRDNAKNSLY LQMNSLRAED TAVYYCAREG
GWFGELAFDY WQGTTLVTVS SASTKGPSVF PLAPSSKSTS GGTAALGCLV
KDYFPEPVTV SWNSGALTSG VHTFPAVLQS SGLYSLSSVV TVPSSSLGTQ
TYICNVNHKP SNTKVDKRV E PKSCDKTHTC PPCPAPEFEG GPSVFLFPPK
PKDTLMISRT PEVTCVVVDV SHEDPEVKFN WYVDGVEVHN AKTKPREEQY
NSTYRVVSVL TVLHQDWLNG KEYKCKVSNK ALPASIEKTI SKAKGQPREP
QVYTLPPSRE EMTKNQVSLT CLVKGFYPSD IAVEWESNGQ PENNYKTTPP
VLDSDGSFFL YSKLTVDKSR WQQGNVFSCS VMHEALHNHY TQKSLSLSPG
K (SEQ ID NO:135);

and/or a light chain comprising the amino acid sequence of:

EIVLTQSPGT LSLSPGERAT LSCRASQRVS SSYLAWYQQK PGQAPRLLIY
DASSRATGIP DRFSGSGSGT DFTLTISRLE PEDFAVYYCQ QYGSLPWTFG
QGTVKVEIKRT VAAPSVFIFP PSDEQLKSGT ASVVCLLNNF YPREAKVQWK
VDNALQSGNS QESVTEQDSK DSTYSLSSLT TLSKADYEKH KVVACEVTHQ
GLSSPVTKSF NRGEC (SEQ ID NO:136).

In illustrative embodiments, the MEDI4736 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of SEQ ID NO:4 of WO/2016/06272 (SEQ ID NO:137):

EVQLVESGGGLVQPGGSLRLSCAASGFTFSRYWMSWVRQAPGKGLEWVANIKQDGSEKYY
VDSVKGRFTISRDNANKNSLYLQMNSLRAEDTAVYYCAREGGWFGELAFDYWQGTTLVTVS
S;

and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO:3 of WO/2016/06272 (SEQ ID NO:138):

EIVLTQSPGTLSLSPGERATLSCRASQRVSSSYLAWYQQKPGQAPRLLIYDASSRATGIP
DRFSGSGSGTDFTLTISRLEPEDFAVYYCQYGSLPWTFGQGTKVEIK

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody atezolizumab (aka MPDL3280A, RG7446), or fragments thereof. In illustrative embodiments, atezolizumab or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising the amino acid sequence of:

EVQLVESGGGLVQPGGSLRLSCAASGFTFSDSWIHWVRQAPGKGLEWVAWISPYGGSTYYADSVKGRF
TISADTSKNTAYLQMNSLRAEDTAVYYCARRHWPGGFDYWGQGTTLVTVSSASTKGPSVFPLAPSSKST
SGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVTVTPSSSLGTQTYICNVN
HKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDP
EVKFNWYVDGVEVHNAKTKPREEQYASTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKA
KGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLY
SKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK (SEQ ID NO:139);

and/or a light chain comprising the amino acid sequence of:

DIQMTQSPSSLSASVGDRVTITCRASQDVSTAVAWYQQKPGKAPKLLIYSASFLYSGVPSRFSGSGSG
 TDFTLTISSLPEDFATYYCQQYLYHPATFGQGTKVEIKRTVAAPSVFIFPPSDEQLKSGTASVVCLL
 NNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSP
 VTKSFNRGEC (SEQ ID NO:140).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody avelumab (aka MSB0010718C), or fragments thereof. In illustrative embodiments, avelumab or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising the amino acid sequence of:

EVQLLES GGG LVQPGGSLRL SCAASGFTFS SYIMMWVRQA PGKGLEWVSS
 IYPSGGITFY ADTVKGRFTI SRDNSKNTLY LQMNSLRAED TAVYYCARIK
 LGTVTTVDYW GQGTLLTVSS ASTKGPSVFP LAPSSKSTSG GTAALGCLVK
 DYFPEPVTVS WNSGALTSGV HTFPAVLQSS GLYSLSSVVT VPSSSLGTQT
 YICNVNHKPS NTKVDKKVEP KSCDKHTTCP PCPAPELLGG PSVFLFPPKP
 KDTLMIS RTP EVTCVVVDVS HEDPEVKFNW YVDGVEVHNA KTKPREEQYN
 STYRVVSVLT VLHQDWLNGK EYKCKVSNKA LPAPIEKTIS KAKGQPREPQ
 VYTLPPSRDE LTKNQVSLTC LVKGFYPSDI AVEWESNGQP ENNYKTTTPV
 LDSDGSFFLY SKLTVDKSRW QQGNVFSCSV MHEALHNHYT QKSLSLSPGK (SEQ ID NO:141);

and/or a light chain comprising the amino acid sequence of:

QSALTQPASV SGSPGQSITI SCTGTSSDVG GYNYVSWYQQ HPGKAPKLMI
 YDVSNRPSGV SNRFGSKSG NTASLTISGL QAED EADYYC SSYTSSSTRV
 FGTGKTIVTL GQPKANPTVT LFPPSSEELQ ANKATLVCLI SDFYPGAVTV
 AWKADGSPVK AGVETTKPSK QSNNKYAASS YLSLTPEQWK SHRSYSCQVT
 HEGSTVEKTV APTECS (SEQ ID NO:142).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody BMS-936559 (aka 12A4, MDX-1105), or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, BMS-936559 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

QVQLVQSGAEVKKPGSSVKVCKTSGDTFSTYAI SWVRQAPGQGLEWMGGIIPIFGKAHY
 AQKFQGRVTITADESTSTAYMELSSLRSEDTAVYFCARKFHFVSGSPFGMDVWGQGT VTV
 VSS (SEQ ID NO:143);

and/or a light chain variable region comprising the amino acid sequence of:

EIVLTQSPATLSLSPGERATLSCRASQSVSSYLAWYQQKPGQAPRLLIYDASNRATGIPA
 RFSGSGSGTDFTLTISSLEPEDFAVYYCQQRSNWPTFGQGTKVEIK (SEQ ID NO:144).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 3G10, or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 3G10 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

QVQLVQSGAEVKKPGASVKVSCASGYTFTDYGFSWVRQAPGGLEWMGWITAYNGNTNY
AQLKQGRVTMTTDTSTSTVYMELRSLRSDDTAVYYCARDYFYGMDVWGQGTTVTVSS (SEQ ID
NO:145);

and/or a light chain variable region comprising the amino acid sequence of:

EIVLTQSPATLSLSPGERATLSCRASQSVSSYLVWYQQKPGQAPRLLIYDASNRATGIPA
RFSGSGSGTDFTLTISLLEPEDFAVYYCQQRSNWPRTFGQGTKVEIK (SEQ ID NO:146).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 10A5, or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 10A5 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

QVQLVQSGAEVKKPGASVKVSCASGYTFTSYDVHWVRQAPGQRLEWMGWLHADTGITKF
SQKFQGRVTITRDTASTAYMELSSLRSEDFAVYYCARERIQLWFDYWGQGTTLTVSS (SEQ ID
NO:147);

and/or a light chain variable region comprising the amino acid sequence of:

DIQMTQSPSSLSASVGDRTITCRASQGISSWLAWYQQKPEKAPKSLIYAASSLQSGVPS
RFSGSGSGTDFTLTISLQPEDFATYYCQQYNSYPYTFGQGTKLEIK (SEQ ID NO:148).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 5F8, or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 5F8 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

QVQLVQSGAEVKKPGSSVKVSCKVSGGIFSTYAINWVRQAPGGLEWMGGIIPFGTANH
AQKFQGRVTITADESTSTAYMELSSLRSEDFAVYYCARDQGI AALFDYWGQGTTLTVSS (SEQ ID
NO:149);

and/or a light chain variable region comprising the amino acid sequence of:

EIVLTQSPGTLTLSPGERATLSCRASQSVSSSYLAWYQQKPGQAPRLLIYGASSRATGIP
DRFSGSGSGTDFTLTISRLEPEDFAVYYCQQYGSSPWTFGQGTKVEIK (SEQ ID NO:150).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 10H10, or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 10H10 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

EVQLVESGGGLVQPGRSLRLSCAVSGFTFDDYVHWVRQAPGKGLEWVSGISGNSGNIGY
ADSVKGRFTISRDNKNSLYLQMNSLRAEDTALYYCAVPFDYWGQGTTLTVSS (SEQ ID NO:151);

and/or a light chain variable region comprising the amino acid sequence of:

DIQMTQSPSSLSASVGDRTITCRASQGISSWLAWYQQKPEKAPKSLIYAASSLQSGVPS
RFSGSGSGTDFTLTISLQPEDFATYYCQQYNSYPYTFGQGTKLEIK (SEQ ID NO:152).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 1B12, or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 1B12 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

QVQLVQSGAEVKKPGSSVKVSCKTSGDTFSSYAI SWVRQAPGQGLEWMGGIIPIFGRAHY
AQKFQGRVTITADESTSTAYMELSSLRSED TAVYFCARKFHFVSGSPFGMDVWGQGT TTVT
VSS (SEQ ID NO:153);

and/or a light chain variable region comprising the amino acid sequence of:

EIVLTQSPATLSLSPGERATLSCRASQSVSSYLAWYQQKPGQAPRLLIYDASNRATGIPA
RFSGSGSGTDFTLTISLLEPEDFAVYYCQQRSNWPTFGQGTKVEIK (SEQ ID NO:154).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 7H1, or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 7H1 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

QVQLVQSGAEVKKPGSSVKVSCKTSGGTFSSYAI SWVRQAPGQGLEWMGGIIPIFGKAHY
AQKFQGRVTITADESTTTAYMELSSLRSED TAVYYCARKYDYVSGSPFGMDVWGQGT TTVT
VSS (SEQ ID NO:155);

and/or a light chain variable region comprising the amino acid sequence of:

EIVLTQSPATLSLSPGERATLSCRASQSVSSYLAWYQQKPGQAPRLLIYDASNRATGIPA
RFSGSGSGTDFTLTISLLEPEDFAVYYCQQRSNWPTFGQGTKVEIK (SEQ ID NO:156).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 11E6, or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 11E6 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

QVQLVQSGAEVKKPGSSVKVSCKASGGTFSSYAINWVRQAPGQGLEWMGGIIPIFGSANY
AQKFQDRVTITADESTSAAYMELSSLRSED TAVYYCARDSSGWSRYYMDVWGQGT TTVTVS
S (SEQ ID NO:157);

and/or a light chain variable region comprising the amino acid sequence of:

EIVLTQSPGTLSPGERATLSCRASQSVSSYLAWYQQKPGQAPRLLIYGASSRATGIP
DRFSGSGSGTDFTLTISRLEPEDFAVYYCQQYGSSPFGGGTKVEIK (SEQ ID NO:158).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 12B7, or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by

reference. In illustrative embodiments, 12B7 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

QVQLVQSGAEVKEPGSSVKVSCKASGGTFNSYAI SWVRQAPGQGLEWMGGIIPLFGIAHY
AQKFQGRVTITADESTNTAYMDLSSLRSEDTAVYYCARKYSYVSGSPFGMDVWGQGTTVT
VSS (SEQ ID NO:159);

and/or a light chain variable region comprising the amino acid sequence of:

EIVLTQSPATLSLSPGERATLSCRASQSVSSYLAWYQQKPGQAPRLLIYDASNRATGIPA
RFGSGSGTDFTLTITSLLEPEDFAVYYCQQRSNWPTFGQGRLEIK (SEQ ID NO:160).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 13G4, or fragments thereof, as disclosed in US 2013/0309250 and WO2007/005874, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 13G4 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

EVQLVESGGGLVQPGRSLRLSCAASGITFDDYGMHWVRQAPGKGLEWVSGISWNRGRIEY
ADSVKGRFTISRDNALNSLYLQMNSLRAEDTALYYCAKGRFRYFDWFLDYWGQGLTLVTVS
S (SEQ ID NO:161);

and/or a light chain variable region comprising the amino acid sequence of:

AIQLTQSPSSLSASVGDRTITCRASQGISSALAWYQQKPGKAPKLLIYDASSLESQVPS
RFGSGSGTDFTLTITSLQPEDFATYYCQQFNSYPFTFGPGTKVDIK (SEQ ID NO:162).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 1E12, or fragments thereof, as disclosed in US 2014/0044738, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 1E12 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

EVKLQESGPS LVKPSQTLST TCSVTGYSIT SDYWNWIRKF PGNKLEYVGY
ISYTGSTYYN PSLKSRISIT RDTSKNQYYL QLNSVTSEDT ATYYCARYGG
WLSPFDYWGQ GTTLTVSS (SEQ ID NO:163);

and/or a light chain variable region comprising the amino acid sequence of:

DIVMTQSHKL MSTSVGDRVS ITCKASQDVG TAVAWYQQKP GQSPKLLIYW
ASTRHTGVDP RFTGSGSGTD FTLTISNVQS EDLADYFCQQ DSSYPLTFGA
GTKVELK (SEQ ID NO:164).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 1F4, or fragments thereof, as disclosed in US 2014/0044738, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 1F4 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

EVQLQESGPG LVAPSQSLSI TCTVSGFSLT TYSINWIRQP PGKGLEWLGV

MWAGGGTNSN SVLKSRLIIS KDNSKSQVFL KMNSLQTDDT ARYYCARYYG
NSPYAIDYW GQGTSTVTVSS (SEQ ID NO:165);

and/or a light chain variable region comprising the amino acid sequence of:

DIVTTQSHKL MSTSVGDRVS ITCKASQDVG TAVAWYQQKP GQSPKLLIYW
ASTRHTGVPD RFTGSGSGTD FTLTISNVQS EDLADYFCQQ DSSYPLTFGA
GTKVELK (SEQ ID NO:166).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 2G11, or fragments thereof, as disclosed in US 2014/0044738, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 2G11 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

EVKLQESGPS LVKPSQTLISL TCSVTGYSII SDYWNWIRKF PGNKLEYLGY
ISYTGSTYYN PSLKSRISIT RDTSKNQYYL QLNSVTTEDT ATYYCARRGG
WLLPFQYWGQ GTTLTVSS (SEQ ID NO:167);

and/or a light chain variable region comprising the amino acid sequence of:

DIVMTQSPSS LAVSVGEKVS MGCKSSQSLL YSSNQKNSLA WYQQKPGQSP
KLLIDWASTR ESGVPDRFTG SGSGTDFTLT ISSVKAEDLA VYYCQQYYGY
PLTFGAGTKL ELK (SEQ ID NO:168).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 3B6, or fragments thereof, as disclosed in US 2014/0044738, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 3B6 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

EVKLQESGPS LVKPGASVKL SCKASGYTFT SYDINWVKQR PGQGLEWIGW
IFPRDNNTKY NENFKGKATL TVDTSSTAY MELHSLTSED SAVYFCTKEN
WVGDFDYWGQ GTTLTLSS (SEQ ID NO:169);

and/or a light chain variable region comprising the amino acid sequence of:

DIVMTQSPAI MSASPGEKVT MTCSASSSIR YMHYQQKPG TSPKRWISDT
SKLTSGVPAR FSGSGSGTSY ALTISSMEAE DAATYYCHQR SSYPWTFGGG
TKLEIK (SEQ ID NO:170).

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 3D10, or fragments thereof, as disclosed in US 2014/0044738 and WO2012/145493, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 3D10 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

EVQLQQSGPD LVTSGASVRI SCQASGYTFP DYIMNWKQS HGKSLEWIGD
IDPNYGGTTY NQKFKGKAIL TVDRSSSTAY MELRSLTSED SAVYYCARGA
LTDWGQGTSL TVSS (SEQ ID NO:171);

and/or a light chain variable region comprising the amino acid sequence of:

QIVLSQSPAI LSASPGEKVT MTCRASSSVS YIYWFQQKPG SSPKPWIYAT
 FNLASGVPAR FSGSGSGTSY SLTISRVE TE DAATYYCQQW SNNPLTFGAG
 TKLELK (SEQ ID NO:172).

In an embodiment, the targeting moiety comprises any one of the anti-PD-L1 antibodies disclosed in US2011/0271358 and WO2010/036959, the entire contents of which are hereby incorporated by reference. In illustrative embodiments, the antibody or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising an amino acid sequence selected from SEQ ID Nos: 34-38 of US2011/0271358:

SEQ ID No: 34 of US2011/0271358 (SEQ ID NO:173):

EVQLVQSGPELK KPGASVKMSCKASGYTFTSYVMHWVKQAPGQRLEWIGYVNPFPNDGTTY
 NEMFKGRATLTSDKSTSTAYMELSSLRSEDSAVYYCARQAWGYPWGQGT LTVTVSS ;

SEQ ID No: 35 of US2011/0271358 (SEQ ID NO:174):

EVQLVQSGAEVKKPGASVKMSCKASGYTFTSYVMHWVKQAPGQRLEWIGYVNPFPNDGTTY
 NEMFKGRATLTSDKSTSTAYMELSSLRSEDTAVYYCARQAWGYPWGQGT LTVTVSS ;

SEQ ID No: 36 of US2011/0271358 (SEQ ID NO:175):

EVQLVQSGAEVKKPGASVKMSCKASGYTFTSYVMHWVRQAPGQRLEWIGYVNPFPNDGTTY
 NEMFKGRATLTSDKSTSTAYMELSSLRSEDTAVYYCARQAWGYPWGQGT LTVTVSS ;

SEQ ID No: 37 of US2011/0271358 (SEQ ID NO:176):

EVQLVQSGAEVKKPGASVKVSCASGYTFTSYVMHWVRQAPGQRLEWIGYVNPFPNDGTTY
 NEMFKGRATLTSDKSTSTAYMELSSLRSEDTAVYYCARQAWGYPWGQGT LTVTVSS ;

SEQ ID No: 38 of US2011/0271358 (SEQ ID NO:177):

EVQLVQSGAEVKKPGASVKVSCASGYTFTSYVMHWVRQAPGQRLEWIGYVNPFPNDGTTY
 NEMFKGRATITSDKSTSTAYMELSSLRSEDTAVYYCARQAWGYPWGQGT LTVTVSS ;

and/or a light chain comprising an amino acid sequence selected from SEQ ID Nos: 39-42 of US2011/0271358:

SEQ ID No: 39 of US2011/0271358 (SEQ ID NO:178):

DIVLTQSPASLALSPGERATLSCRATESVEYYGTSLVQWYQQKPGQPPKLLIYAASSVDS
 GVPSRFSGSGSGTDFTLTINSLEEEDAAMYFCQQSRRVPYTFGQGTKLEIK ;

SEQ ID No: 40 of US2011/0271358 (SEQ ID NO:179):

DIVLTQSPATLSLSPGERATLSCRATESVEYYGTSLVQWYQQKPGQPPKLLIYAASSVDS
 GVPSRFSGSGSGTDFTLTINSLEAEDAAMYFCQQSRRVPYTFGQGTKLEIK ;

SEQ ID No: 41 of US2011/0271358 (SEQ ID NO:180):

EIVLTQSPATLSLSPGERATLSCRATESVEYYGTSLVQWYQQKPGQPPKLLIYAASSVDS
GVPSRFSGSGSGTDFTLTINSLEAEDAAMYFCQQSRRVPYTFGQGTKLEIK;

SEQ ID No: 42 of US2011/0271358 (SEQ ID NO:181):

DIVLTQSPATLSLSPGERATLSCRATESVEYYGTSLVQWYQQKPGQPPKLLIYAASSVDS
GVPSRFSGSGSGTDFTLTINSLEAEDAATYFCQQSRRVPYTFGQGTKLEIK.

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 2.7A4, or fragments thereof, as disclosed in WO 2011/066389, US8,779,108, and US2014/0356353, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 2.7A4 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

SEQ ID No: 2 of WO 2011/066389 (SEQ ID NO:182):

EVQLVESGGGLVKPGGSLRLSCAASGFTFSTYSMNWVRQAPGKGLEWVSSISSGDYIYY
ADSVKGRFTISRDNKNSLFLQMNSLKAEDTAVYYCARDLVTSMVAFDYWGQGTLLVTVSS;

and/or a light chain variable region comprising the amino acid sequence of:

SEQ ID No: 7 of WO 2011/066389 (SEQ ID NO:183):

SYELTQPPSVSVSPGQAARITCSGDALPQKYVFWYQQKSGQAPVLVIYEDSKRPSGIPER
FSGSSSGTMATLTISGAQVEDEADYYCYSTDRSGNHRVFGGTRLTVL.

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 2.9D10, or fragments thereof, as disclosed in WO 2011/066389, US8,779,108, and US2014/0356353, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 2.9D10 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

SEQ ID No: 12 of WO 2011/066389 (SEQ ID NO:184):

EVQLVESGGGLVQPGGSLRLSCAASGFTFSSYWMSWVRQAPGKGLEWVANIKQDGGEQYY
VDSVKGRFTISRDNKNSLYLQMNSLRAEDTAVYYCARDWNYGYDMDVWGQGTITVTVSS;

and/or a light chain variable region comprising the amino acid sequence of:

SEQ ID No: 17 of WO 2011/066389 (SEQ ID NO:185):

EIVLTQSPGTLSPGERATLSCRASQSVSSNYLAWFQQKPGQAPRLLIFGTSSRATGIP
DRFSGSGSGTDFTLTISRLEPEDFAVYYCQQYGSSIFTFGPGTKVDIK.

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 2.14H9, or fragments thereof, as disclosed in WO 2011/066389, US8,779,108, and US2014/0356353, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 2.14H9 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

SEQ ID No: 22 of WO 2011/066389 (SEQ ID NO:186):

EVQLVESGGGLVQPGGSLRLSCAASGFTFSRYWMSWVRQAPGKGLEWVANIKQDGSEKYY
VDSVKGRFTISRDNANKNSLYLQMNSLRAEDTAVYYCAREGGWFGELAFDYWGQGLTVTVS
S;

and/or a light chain variable region comprising the amino acid sequence of:

SEQ ID No: 27 of WO 2011/066389 (SEQ ID NO:187):

EIVLTQSPGTLISLSPGERATLSCRASQRVSSSYLAWYQQKPGQAPRLLIYDASSRATGIP
DRFSGSGSGTDFTLTISRLEPEDFAVYYCQQYGSFLPWTFGQGTEVEIK.

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 2.20A8, or fragments thereof, as disclosed in WO 2011/066389, US8,779,108, and US2014/0356353, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 2.20A8 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

SEQ ID No: 32 of WO 2011/066389 (SEQ ID NO:188):

EVQLLES GGGLVQPGGSLRLSCAASGFTFSNYAMSWVRQAPGKGLEWVSAIRGSGGSTYY
ADSVKGRFTISRDN SKNTLYLQMNSLRAEDTAVYYCAKDLHYDSSGYLDYWGQGLTVTVS
S;

and/or a light chain variable region comprising the amino acid sequence of:

SEQ ID No: 37 of WO 2011/066389 (SEQ ID NO:189):

DIQMTQSPSSVSASVGDRVITITCRASQGIRSWLAWYQQKPGKAPKLLIYAI SRLQSGVPS
RFSGSGSGTDFTLTIS SLQPEDFATYYCQ QANSFPLTFGGGTKVEIK.

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 3.15G8, or fragments thereof, as disclosed in WO 2011/066389, US8,779,108, and US2014/0356353, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 3.15G8 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

SEQ ID No: 42 of WO 2011/066389 (SEQ ID NO:190):

EVQLVESGGGLVQPGGSLRLSCAASGFTFSSYWMSWVRQAPGKGLEWVANIKQDGGEKYY
VDSVKGRFTISRDNANKNSLFLQMNSLRAEDTAVYYCARVQLYSDYFDYWGQGLTVTVSS;

and/or a light chain variable region comprising the amino acid sequence of:

SEQ ID No: 47 of WO 2011/066389 (SEQ ID NO:191):

DIQMTQSPSSVSASVGDRVITITCRASQGISSWLAWYQQKSGKAPKLLIYAASGLQSGVPS
RFSGSGSGTDFTLTIS SLQPEDLATYYCQ QSHSLPPTFGQGTKVEIK.

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 3.18G1, or fragments thereof, as disclosed in WO 2011/066389, US8,779,108, and US2014/0356353, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 3.18G1 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

SEQ ID No: 52 of WO 2011/066389 (SEQ ID NO:192):

EVQLLES GGD LVQ PGGSLRLSCAASGFTFNSYAMSWVRQAPGKGLEWVSTISGSGGFTFS
ADSVKGRFTISRDN SKNTLFLQMNSLRVEDSAVYSCAKVLVGFNNGCWDYWGQGTILVTVS
S;

and/or a light chain variable region comprising the amino acid sequence of:

SEQ ID No: 57 of WO 2011/066389 (SEQ ID NO:193):

SYVLTQPPSVSVAPGQTARITCGGNNIGSKSVHWYQQKPGQAPVLVYDDSDRPSGIPER
FSGSNSGNTATLTISRVEAGDEADYYCQVWDSSNDHVVFSGGTKLTVL.

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 2.7A4OPT, or fragments thereof, as disclosed in WO 2011/066389, US8,779,108, and US2014/0356353, and US2014/0356353, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 2.7A4OPT or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

SEQ ID No: 62 of WO 2011/066389 (SEQ ID NO:194):

EVQLVESGGGLVKPGGSLRLSCAASGFTFSTYSMNWVRQAPGKGLEWVSSISSSGDYIYY
ADSVKGRFTISRDN AKNSLYLQMNSLRAEDTAVYYCARDLVTSMVAFDYWGQGTILVTVSS;

and/or a light chain variable region comprising the amino acid sequence of:

SEQ ID No: 67 of WO 2011/066389 (SEQ ID NO:195):

SYELTQPPSVSVSPGQTARITCSGDALPQKYVFWYQQKSGQAPVLVIYEDSKRPSGIPER
FSGSSSGTMTATLTISGAQVEDEADYYCYSTRSGNHRVFGGTKLTVL.

In an embodiment, the targeting moiety comprises the anti-PD-L1 antibody 2.14H9OPT, or fragments thereof, as disclosed in WO 2011/066389, US8,779,108, and US2014/0356353, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, 2.14H9OPT or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region comprising the amino acid sequence of:

SEQ ID No: 72 of WO 2011/066389 (SEQ ID NO:196):

EVQLVESGGGLVKPGGSLRLSCAASGFTFSRYWMSWVRQAPGKGLEWVANIKQDGSEKYY
VDSVKGRFTISRDN AKNSLYLQMNSLRAEDTAVYYCAREGGWFGELAFDYWGQGTILVTVS

S;

and/or a light chain variable region comprising the amino acid sequence of:

SEQ ID No: 77 of WO 2011/066389 (SEQ ID NO:197):

EIVLTQSPGTLISLSPGERATLSCRASQRVSSSYLAWYQQKPGQAPRLLIYDASSRATGIP
DRFSGSGSGTDFTLTISRLEPEDFAVYYCQQYGSLPWTFGQGTKVEIK.

In an embodiment, the targeting moiety comprises any one of the anti-PD-L1 antibodies disclosed in WO2016/061142, the entire contents of which are hereby incorporated by reference. In illustrative embodiments, the antibody or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising an amino acid sequence selected from SEQ ID Nos: 18, 30, 38, 46, 50, 54, 62, 70, and 78 of WO2016/061142:

SEQ ID No: 18 of WO2016/061142 (SEQ ID NO:198):

QVQLVQSGAEVKKPGASVKVSCKASGYTFTSYWYWVRQATGQGLEWMGRIDPNSGSTKY
NEKFKNRFTISRDDSKNTAYLQMNSLKTEDTAVYYCARDYRKGLYAMDYWGQGT TVTVSS;

SEQ ID No: 30 of WO2016/061142 (SEQ ID NO:199):

EVQLVQSGAEVKKPGATVKISCKVSGYTFTSYWYWVRQATGQGLEWMGRIDPNSGSTKY
NEKFKNRVTITADKSTSTAYMELSSLRSED TAVYYCARDYRKGLYAMDYWGQGT TVTVSS;

SEQ ID No: 38 of WO2016/061142 (SEQ ID NO:200):

EVQLVQSGAEVKKPGESLRISCKGSGYTFTSYWYWVRQAPGQGLEWMGRIDPNSGSTKY
NEKFKNRVTISVDTSKNQFSLKLSSVTAADTAVYYCARDYRKGLYAMDYWGQGT TVTVSS;

SEQ ID No: 46 of WO2016/061142 (SEQ ID NO:201):

EVQLVQSGAEVKKPGATVKISCKVSGYTFTSYWYWIRQSPSRGLEWLGRIDPNSGSTKY
NEKFKNRLTISKDTSKNQVVL TMTNMDPVDTATYYCARDYRKGLYAMDYWGQGT TVTVSS;

SEQ ID No: 50 of WO2016/061142 (SEQ ID NO:202):

EVQLVQSGAEVKKPGESLRISCKGSGYTFTSYWYWIRQPPGKLEWIGRIDPNSGSTKY
NEKFKNRVTITADKSTSTAYMELSSLRSED TAVYYCARDYRKGLYAMDYWGQGT TVTVSS;

SEQ ID No: 54 of WO2016/061142 (SEQ ID NO:203):

QVQLVQSGAEVKKPGASVKVSCKASGYTFTSYWYWIRQSPSRGLEWLGRIDPNSGSTKY
NEKFKNRFTISRDDSKNTAYLQMNSLKTEDTAVYYCARDYRKGLYAMDYWGQGT TVTVSS;

SEQ ID No: 62 of WO2016/061142 (SEQ ID NO:204):

EVQLVQSGAEVKKPGESLRISCKGSGYTFTSYWYWVRQARGQRLWIGRIDPNSGSTKY
NEKFKNRLTISKDTSKNQVVL TMTNMDPVDTATYYCARDYRKGLYAMDYWGQGT TVTVSS;

SEQ ID No: 70 of WO2016/061142 (SEQ ID NO:205):

QITLKESGPTLVKPTQTLTLTCTFSGYTFTSYWMYWVRQAPGKGLEWVSRIDPNSGSTKY
NEKFKNRVTITADKSTSTAYMELSSLRSED TAVYYCARDYRKGLYAMDYWGQGT TTVTVSS;

SEQ ID No: 78 of WO2016/061142 (SEQ ID NO:206):

EVQLVQSGAEVKKPGATVKISCKVSGYTFTSYWMYWVRQARGQRLEWIGRIDPNSGSTKY
NEKFKNRFTISRDN SKNTLYLQMNSLRAED TAVYYCARDYRKGLYAMDYWGQGT TTVTVSS;

and/or a light chain comprising an amino acid sequence selected from SEQ ID Nos: 22, 26, 34, 42, 58, 66, 74, 82, and 86 of WO2016/061142:

SEQ ID No: 22 of WO2016/061142 (SEQ ID NO:207):

DIVMTQTPLSLPVTGPGEPA SISKASQDVGTAVAWYLQKPGQSPQLLIYWASTRHTGIPA
RFGSGSGTFTLTISLQSEDFAVYYCQQYNSYPLTFGQGTKVEIK;

SEQ ID No: 26 of WO2016/061142 (SEQ ID NO:208):

DIQMTQSPSSLSASVGDRV TITCKASQDVGTAVAWYLQKPGQSPQLLIYWASTRHTGVPS
RFGSGSGTDFTLTISLQPEDFATYYCQQYNSYPLTFGQGTKVEIK;

SEQ ID No: 34 of WO2016/061142 (SEQ ID NO:209):

EIVLTQSPDFQSVTPKEKVTITCKASQDVGTAVAWYLQKPGQSPQLLIYWASTRHTGVDP
RFGSGSGTDFTLKISRVEAEDVGYYCQQYNSYPLTFGQGTKVEIK;

SEQ ID No: 42 of WO2016/061142 (SEQ ID NO:210):

EIVLTQSPDFQSVTPKEKVTITCKASQDVGTAVAWYLQKPGQSPQLLIYWASTRHTGVPS
RFGSGSGTDFTF TISLQPEDATYYCQQYNSYPLTFGQGTKVEIK.

SEQ ID No: 58 of WO2016/061142 (SEQ ID NO:211):

EIVLTQSPATLSLSPGERATLSCKASQDVGTAVAWYLQKPGQSPQLLIYWASTRHTGIPP
RFGSGGYGTDFTLTINNIESEDAAYYFCQQYNSYPLTFGQGTKVEIK;

SEQ ID No: 66 of WO2016/061142 (SEQ ID NO:212):

DVVM TQSP LSLPVT LGQPASISKASQDVGTAVAWYQQKPGQAPRL LIYWASTRHTGVPS
RFGSGSGTFTLTISLQPD DFATYYCQQYNSYPLTFGQGTKVEIK;

SEQ ID No: 74 of WO2016/061142 (SEQ ID NO:213):

DIQMTQSPSSLSASVGDRV TITCKASQDVGTAVAWYQQKPGQAPRL LIYWASTRHTGVPS
RFGSGSGTDFTF TISLQPEDATYYCQQYNSYPLTFGQGTKVEIK;

SEQ ID No: 82 of WO2016/061142 (SEQ ID NO:214):

AIQLTQSPSSLSASVGDRVTTITCKASQDVGTAVAWYLQKPGQSPQLLIYWASTRHTGVPS
RFSGSGSGTDFTFTISSLEAEDAATYYCQQYNSYPLTFGQGTKVEIK;

SEQ ID No: 86 of WO2016/061142 (SEQ ID NO:215):

EIVLTQSPDFQSVTPKEKVTITCKASQDVGTAVAWYQQKPGQAPRLLIYWASTRHTGVPS
RFSGSGSGTEFTLTISLQPDDEFATYYCQQYNSYPLTFGQGTKVEIK.

In an embodiment, the targeting moiety comprises any one of the anti-PD-L1 antibodies disclosed in WO2016/022630, the entire contents of which are hereby incorporated by reference. In illustrative embodiments, the antibody or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising an amino acid sequence selected from SEQ ID Nos: 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, and 46 of WO2016/022630:

SEQ ID No: 2 of WO2016/022630 (SEQ ID NO:216):

EVKLVESGGGLVQPGGSLKLSKAASGFI FR SYGMSWVRQTPEKRLEWVASISSGGSTYYP
DSVKGRFTISRDNARNILYLQMSSLRSED TAMYDCARGYDSGFAYWGQGT LVT VSE;

SEQ ID No: 6 of WO2016/022630 (SEQ ID NO:217):

EVKLVESGGGLVQPGGSLKLSKAASGFTFR SYGMSWVRQTPEKRLEWVASISSGGTYYP
DSVKGRFTISRDNARNILYLQMSSLRSED TAMYCAKGYDSGFAYWGQGT LVI VSA;

SEQ ID No: 10 of WO2016/022630 (SEQ ID NO:218):

QVQLKQSGPGLVQPSQSL SITCTVSGFSLT TYGVHWVRQSPGKGLEWLGVIWRGVT TDYN
AAFM SRLTITKDNSKSQVFFKMNSLQANDTAIYYCARLGFYAMDYWGQGT SVTVSS;

SEQ ID No: 14 of WO2016/022630 (SEQ ID NO:219):

QVQLKQSGPGLVQPSQSL SITCTVSGFSLT SYGVHWVRQSPGKGLEWLGVIWSSGGVT DYN
AAFI SRLSISKDNSKSQVFFKMNSLQANDTAIYYCARLGFYAMDYWGQGT SVTVSS;

SEQ ID No: 18 of WO2016/022630 (SEQ ID NO:220):

EVKLFESGGGLVQPGGSLKLSKVASGFDFSTYWMHWVRQAPQG LEWIGQINPDSTTINY
APSLKDRFTISRDN AKNTLFLQMSKVRSED TALYYCAKPGDYGYDFDCWGQGT TLTVSS;

SEQ ID No: 22 of WO2016/022630 (SEQ ID NO:221):

EVQLQESGPSLVKPSQTL SLTCSVTGDSITSGYWNWIRKFPGNKLEYMGYISYSGSTYYN
PSLKSRI SITRDT SKNQYYLQLNSVTTEDTATYYCARSL LWFSTGFAYWGQGT LVT VSA;

SEQ ID No: 26 of WO2016/022630 (SEQ ID NO:222):

QVQLKQSGPGLVQPSQSL SITCTVSGFSLT SYGVHWVRQSPGKGLEWLGVIWSSGGIT DYN
AAFKSRLSISKDNSKSQVFFKMNSLQANDTAIYFCARLGFYAMDYWGQGT SVTVSS;

SEQ ID No: 30 of WO2016/022630 (SEQ ID NO:223):

EVKLVESGGGLVKPGGSLKLSCAASGFTFRSYGMSWARQIPEKRLEWVASISSGGTTYL
GSVQGRFTISRDNARNILYLQMSSLRSEDAMYCARGYDAGFAYWGQGLTVSVSE;

SEQ ID No: 34 of WO2016/022630 (SEQ ID NO:224):

EVQLQESGPSLVKPSQTLTLTCSVTGDSITSGYWTWIRKFPGNKLEYMGYISYTGSTYYN
PSLKSRLISIRDTSKSQYYLQLNSVTTEDTATYYCARQRDWLGFAYWGQGLTVTASA;

SEQ ID No: 38 of WO2016/022630 (SEQ ID NO:225):

EEKLVESGGGLVKPGGSLKLSCAASGFSSSYGMSWVRQTPEKRLEWVASISSGGSIYYP
DSVKGRFTISRDNARNILYLQMSSLRSEDAMYCARGYDAGFAFWGQGLTVTASA;

SEQ ID No: 42 of WO2016/022630 (SEQ ID NO:226):

QITLKESGPTLVKPTQTLTLTCTVSGFSLSTYGVHWIRQPPGKALEWLGVWIRGVTTDYN
AAFMSRLTITKDNSKNQVVLTMNNMDPVDATYYCARLGFYAMDYWGQGLTVTVSS;

SEQ ID No: 46 of WO2016/022630 (SEQ ID NO:227):

EVQLVESGGGLVKPGGSLRLSCAASGFIERSYGMSWVRQAPGKLEWVASISSGGSTYYP
DSVKGRFTISRDNANKSLYLQMNLSRAEDTAVYDCARGYDSGFAYWGQGLTVTVSS;

and/or a light chain comprising an amino acid sequence selected from SEQ ID Nos: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, and 48 of WO2016/022630:

SEQ ID No: 4 of WO2016/022630 (SEQ ID NO:228):

DIVLTQSPASLAVSLGQRATISCRASQSVSTSSSSFMHWYQQKPGQPPKLLIKYASNLES
GVPARFSGSGSGTDFTLNIHPVEEEDTATYYCQHSWEIPYTFGGGTKLEIK;

SEQ ID No: 8 of WO2016/022630 (SEQ ID NO:229):

DIVLTQSPPSLAVSLGQRATISCRASQSVSTSSSSYMHYQQKPGQPPKLLIKYASNLES
GVPARFSGSGSGTDFTLNIHPVEEEDTATYYCQHSWEIPYTFGGGTKLEIK;

SEQ ID No: 12 of WO2016/022630 (SEQ ID NO:230):

SIVMTQTPKFLVLSAGDRVITITCKASQSVSNDVAWYQQKPGQSPKLLIYYAANRYTGVPD
RFTGSGYGTDFTTISIVQAEDLAVYFCQQDYTSPTYTFGGGTKLEIK;

SEQ ID No: 16 of WO2016/022630 (SEQ ID NO:231):

SIVMTQTPKFLVLSAGDRVITITCKASQSVSNDVGWYQQKPGQSPKLLIYYASNRYSGVPD
RFTGSGYGTDFTTISTVQAEDLAVYFCQQDYTSPTYTFGGGTKLEIK;

SEQ ID No: 20 of WO2016/022630 (SEQ ID NO:232):

DVLMTQTPLYLPVSLGDQASISCRSSQIIVHSNANTYLEWFLQKPGQSPKLLIYKVSNR
SGVPDRFSGSGSGTDFTLTKISRVEAEDLGYYCFQGSHPYTFGGGTKLEIK;

SEQ ID No: 24 of WO2016/022630 (SEQ ID NO:233):

QIVLTQSPAIMASASPGEKVTLTCSASSSVSSSYLYWNQQKPGSSPKVWIYNTSNLASGVP
ARFSGSGSGTSSYSLTISSMEAEDAASYFCHQWRSYPPTLGAGTKLELK;

SEQ ID No: 28 of WO2016/022630 (SEQ ID NO:234):

QIVLTQSPAIMASASPGEKVTMTCSANSSVSVMHWYQQKSGTSPKRWIYDTSKLGASGVPAR
FSGSGSGTSSYSLTISSMGAEDAATYYCQWSSNPWTFGGGTKLEIK;

SEQ ID No: 32 of WO2016/022630 (SEQ ID NO:235):

DIVLTQSPASLAVSLGQRATISCRASQSVSTSSYSYMHYQQKPGQPPKLLIKYASNLES
GVPARFSGSGSGTDFTLNIHPVEEEDTATYYCQNSWEIPYTFGGGTKLEIK;

SEQ ID No: 36 of WO2016/022630 (SEQ ID NO:236):

DIVMTQTSPSSLAVSLGEKVTMSCKSSQSLLYSSNQKNSLAWYQQKPGQSPKLLIYWASNR
ESGVPDRFTGSSSGTDFTLTISSVKAEDLAVYYCQYYSYPLTFGAGTKLELK;

SEQ ID No: 40 of WO2016/022630 (SEQ ID NO:237):

DIVLTQSPASLAVSLGQRATISCRASQSVSTSSYSYVHWYQQKPGQPPKLLIKYASNLES
GVPARFSGSGSGTDFTLNIHPVEEEDTATYYCQHSWEIPYTFGGGTKLEIK;

SEQ ID No: 44 of WO2016/022630 (SEQ ID NO:238):

DIQMTQSPSSLSASVGDRTITCKASQSVSNDAWYQQKPGKAPKLLIYYAANRYTGVPD
RFSGSGYGTDFTFITISLQPEDATYFCQQDYTSPTYFGQGTKLEIK;

SEQ ID No: 48 of WO2016/022630 (SEQ ID NO:239):

DIVLTQSPASLAVSPGQRATITCRASQSVSTSSSSFMHWYQQKPGQPPKLLIKYASNLES
GVPARFSGSGSGTDFTLTINPVEANDTANYYCQHSWEIPYTFGQGTKLEIK.

In an embodiment, the targeting moiety comprises any one of the anti-PD-L1 antibodies disclosed in WO2015/112900, the entire contents of which are hereby incorporated by reference. In illustrative embodiments, the antibody or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising an amino acid sequence selected from SEQ ID Nos: 38, 50, 82, and 86 of WO 2015/112900:

SEQ ID No: 38 of WO2015/112900 (SEQ ID NO:240):

EVQLVQSGAEVKKPGESLRISCKGSGYTFTTYWMHWVRQATGQGLEWMGNIYPGTGGSNF
DEKFKNRVTITADKSTSTAYMELSSLRSEDTAVYYCTRWTGTGAYWGQGTITVTVSS;

SEQ ID No: 50 of WO 2015/112900 (SEQ ID NO:241):

EVQLVQSGAEVKKPGESLRISCKGSGYTFTTYWMHWIRQSPSRGLEWLGNIYPGTGGSNF

DEKFKNRFTISRDN SKNTLYLQMNSLRAEDTAVYYCTRWTGTGAYWGQGTTVTVSS;

SEQ ID No: 82 of WO 2015/112900 (SEQ ID NO:242):

QVQLVQSGAEVKKPGASVKVSCKASGYTFTTYWMHWIRQSPSRGLEWLGNIYPGTGGSNF
DEKFKNRFTISRDN SKNTLYLQMNSLRAEDTAVYYCTRWTGTGAYWGQGTTVTVSS;

SEQ ID No: 86 of WO 2015/112900 (SEQ ID NO:243):

EVQLVQSGAEVKKPGESLRISCKGSGYTFTTYWMHWVRQAPGGLEWMGNIYPGTGGSNF
DEKFKNRFTISRDN SKNTLYLQMNSLRAEDTAVYYCTRWTGTGAYWGQGTTVTVSS;

and/or a light chain comprising an amino acid sequence selected from SEQ ID Nos: 42, 46, 54, 58, 62, 66, 70, 74, and 78 of WO 2015/112900:

SEQ ID No: 42 of WO2015/112900 (SEQ ID NO:244):

EIVLTQSPATLSLSPGERATLSCCKSSQSLD SGNQKNFLT WYQQKPGQAPRLLIYWASTR
ESGVPSRFS GSGSGTEFTLTIS SLQPD DFATYYCQNDYSYPYTFGQGTKVEIK;

SEQ ID No: 46 of WO 2015/112900 (SEQ ID NO:245):

DIQMTQSPSSLSASVGDRVTITCKSSQSLD SGNQKNFLT WYQQKPGQAPRLLIYWASTR
ESGIPPRFS GSGSGYGTDFLT INNIESEDAAYFCQNDYSYPYTFGQGTKVEIK;

SEQ ID No: 54 of WO 2015/112900 (SEQ ID NO:246):

EIVLTQSPATLSLSPGERATLSCCKSSQSLD SGNQKNFLT WYQQKPGKAPKLLIYWASTR
ESGVPSRFS GSGSGTDFTFTIS SLQPE DIATYYCQNDYSYPYTFGQGTKVEIK;

SEQ ID No: 58 of WO 2015/112900 (SEQ ID NO:247):

DIVMTQTPLSLPVTPGEPASISCKSSQSLD SGNQKNFLT WYQQKPGQAPRLLIYWASTR
ESGVPSRFS GSGSGTDFTFTIS SLAEADAATYYCQNDYSYPYTFGQGTKVEIK;

SEQ ID No: 62 of WO 2015/112900 (SEQ ID NO:248):

EIVLTQSPATLSLSPGERATLSCCKSSQSLD SGNQKNFLT WYQQKPGKAPKLLIYWASTR
ESGVPSRFS GSGSGTDFTFTIS SLAEADAATYYCQNDYSYPYTFGQGTKVEIK;

SEQ ID No: 66 of WO 2015/112900 (SEQ ID NO:249):

EIVLTQSPDFQSVTPKEKVTITCKSSQSLD SGNQKNFLT WYQQKPGQAPRLLIYWASTR
ESGVPSRFS GSGSGTDFTFTIS SLAEADAATYYCQNDYSYPYTFGQGTKVEIK;

SEQ ID No: 70 of WO 2015/112900 (SEQ ID NO:250):

EIVLTQSPATLSLSPGERATLSCCKSSQSLD SGNQKNFLT WYQQKPGQAPRLLIYWASTR
ESGVPSRFS GSGSGTDFTFTIS SLAEADAATYYCQNDYSYPYTFGQGTKVEIK;

SEQ ID No: 74 of WO 2015/112900 (SEQ ID NO:251):

DIQMTQSPSSLSASVGDRVITITCKSSQSLLDSGNQKNFLTWYLQKPGQSPQLLIYWASTR
ESGVPSRFSGSGSGTDFTFITISSLEAEDAATYYCQNDYSYPYTFGQGTKVEIK;

SEQ ID No: 78 of WO 2015/112900 (SEQ ID NO:252):

DVVMTQSPLSLPVTILGQPASISCKSSQSLLDSGNQKNFLTWYQQKPGKAPKLLIYWASTR
ESGVPSRFSGSGSGTDFTFITISSLEAEDAATYYCQNDYSYPYTFGQGTKVEIK.

In an embodiment, the targeting moiety comprises any one of the anti-PD-L1 antibodies disclosed in WO 2010/077634 and US 8,217,149, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, the anti-PD-L1 antibody or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain region comprising the amino acid sequence of:

SEQ ID No: 20 of WO 2010/077634 (SEQ ID NO:253):

EVQLVESGGGLVQPGGSLRLSCAASGFTFSDSWIHWVRQAPGKGLEWVAWISPYGGSTYY
ADSVKGRFTISADTSKNTAYLQMNSLRAEDTAVYYCARRHWPGGFDYWGQGTLVTVSA;

and/or a light chain variable region comprising the amino acid sequence of:

SEQ ID No: 21 of WO 2010/077634 (SEQ ID NO:254):

DIQMTQSPSSLSASVGDRVITITCRASQDVSTAVAWYQQKPGKAPKLLIYSASFLYSGVPS
RFSGSGSGTDFTLTITSSLPEDFATYYCQQYLYHPATFGQGTKVEIKR.

In an embodiment, the targeting moiety comprises any one of the anti-PD-L1 antibodies obtainable from the hybridoma accessible under CNCM deposit numbers CNCM I-4122, CNCM I-4080 and CNCM I-4081 as disclosed in US 20120039906, the entire disclosures of which are hereby incorporated by reference.

In an embodiment, the targeting moiety comprises a VHH directed against PD-L1 as disclosed, for example, in US 8,907,065 and WO 2008/071447, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, the VHHs against PD-L1 comprise SEQ ID NOS: 394-399 of US 8,907,065:

SEQ ID No: 394 of US 8,907,065 (SEQ ID NO:255):

EVQLVESGGGLVQPGGSLRLSCAASGFTLDYYAIGWFRQAPGKEREWASS
ISSSDGSTYYADSVKGRFTISRDNKNTVFLQMNSLKPEDTAVYSCAASQ
APITITATMMKPFYDYWGQGTQVTVSS;

SEQ ID No: 395 of US 8,907,065 (SEQ ID NO:256):

EVQLVESGGGLVQPGGSLRLSCAASGFTLDYYAKCWFRQAPGKEREWVSC
ISSSDGSTYYADSVKGRFTISRDNKNTVYLQMNSLKPEDTAVYFCAARH
GGPLTVEYFFDYWGQGTQVTVSS;

SEQ ID No: 396 of US 8,907,065 (SEQ ID NO:257):

EVQLVESGGGLVQPGGSLRLSCAASGFTFDYYAIGWFRQAPGKAREGVSC
ISGGDNSTYYADSVKGRFTISRDNKNTVYLMNSLKPEDTAVYYCATGG
WKYCSGYDPEYIYWGGGTQVTVSS;

SEQ ID No: 397 of US 8,907,065 (SEQ ID NO:258):

EVQLVESGGGLVQAGGSLRLSCAASGSTFSQYDVGWYRQAPGKQRELVA
FSSSGGRTIYPDSVKGRFTFSRDNTKNTVYLMNTSLKPEDTAVYYCKIDW
YLNSYWGQGTQVTVSS;

SEQ ID No: 398 of US 8,907,065 (SEQ ID NO:259):

EVQLVESGGGLVQAGGSLRLSCAASGVDASNSAMGWYRQAPGKQREWVAR
ITGGGLIAYTDSVKGRFTISRDNKSTVYLMNSLEPEDTAVYYCNTINS
RDGWGQGTQVTVSS;

SEQ ID No: 399 of US 8,907,065 (SEQ ID NO:260):

EVQLVESGGGLVQAGGSLTISCAASGITFSDSIVSWYRRARGKQREWVAG
ISNGGTTKYAESVLGRFTISRDNKNNVYLMNGLNPEDTAVYLCKVRQY
WGQGTQVTVSS.

In an exemplary embodiment, the present multi-specific Clec9A binding agent comprises a targeting moiety directed against PDL-1, such as SEQ ID NO:261:

EVQLVESGGGLVQPGGSLRLSCAASGFTLDYYAKCWFRQAPGKEREWVSCISSSDGSTYYADSVKGRFTISR
NAKNTVYLMNSLKPEDTAVYFCAARHGGPLTVEYFFDYWGQGTQVTVSS

In various embodiments, the present multi-specific Clec9A binding agent has one or more targeting moieties directed against PD-L2. In some embodiments, the Clec9A binding agent has one or more targeting moieties which selectively bind a PD-L2 polypeptide. In some embodiments, the Clec9A binding agent comprises one or more antibodies, antibody derivatives or formats, peptides or polypeptides, or fusion proteins that selectively bind a PD-L2 polypeptide.

In an embodiment, the targeting moiety comprises a VHH directed against PD-L2 as disclosed, for example, in US 8,907,065 and WO 2008/071447, the entire disclosures of which are hereby incorporated by reference. In illustrative embodiments, the VHHs against PD-1 comprise SEQ ID Nos: 449-455 of US 8,907,065:

SEQ ID No: 449 of US 8,907,065 (SEQ ID NO:262):

EVQLVESGGGLVQAGGSLRLSCAASESTVLINAMGWYRQAPGKQRELVAS
ISSGGSTNYADSVKGRFTISRDNKNTVYLMNSLKPEDTAVYYCNADV
PQDYGLGYVEGKVYYGHDYWGWTGTLVTVSS;

SEQ ID No: 450 of US 8,907,065 (SEQ ID NO:263):

EVQLVESGGGLVQAGGSLRLSCAASGSTFSNYVSNYAMGWGRQAPGTQ
RELVASISNGDTTNYADSVKGRFTISRDNKNTVYLQMNSLKPEDTAVYY
CFEHQVAGLTWGQGTQVTVSS;

SEQ ID No: 451 of US 8,907,065 (SEQ ID NO:264):

EVQLVESGGGLVQAGGSLRLSCVASGXALKIXVMGWYRQAPGKQREL
AAITSGGRNTYSDSVKGRFTISGDNAXNTVYLQMNSLKSED
TAVYYCRE
WNSGYPPVDYWGQGTQVTVSS;

SEQ ID No: 452 of US 8,907,065 (SEQ ID NO:265):

EVQLVESGGGLVQAGGSLRLSCAASGRTFSSGTMGWFRRAPGKEREFV
ASIPWSSGRTYYADSVKDRFTISRDNQNTVFLQMNSLKPEDTAVYYCAF
KERSTGWDFASWGQGIQVTVSS;

SEQ ID No: 453 of US 8,907,065 (SEQ ID NO:266):

EVQLVESGGGLVQTGGSLRLSCAASGFTLDYYGIGWFRQAPGKEREGVS
FISGSDGSTYYAESVKGRFTISRDKAKNTVYLQMNSLKPEDTAVYYCAAD
PWGPPSIATMTSYEYKHWGQGTQVTVSS;

SEQ ID No: 454 of US 8,907,065 (SEQ ID NO:267):

EVQLVESGGGLVQPGGSLRLSCAASGFTFSTYTMWLRRAPGKGFEWV
STIDKDGNTNYVDSVKGRFAVSRDNTKNTLYLQMNSLKPEDTAMYYCTK
HGSSARGQGTQVTVSS;

SEQ ID No: 455 of US 8,907,065 (SEQ ID NO:268):

EVQLVESGGGLVEPGGSLRLSCVASGFTFSSYDMSWVRQAPGKGLE
WVSTINSGGGITYRGSVKGRFTISRDNKNTLYLQMNSLKPEDTAVYY
CENGSSYRRGQGTQVTVSS.

In an embodiment, the targeting moiety comprises any one of the anti-PD-L2 antibodies disclosed in US2011/0271358 and WO2010/036959, the entire contents of which are hereby incorporated by reference. In illustrative embodiments, the antibody or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain comprising an amino acid sequence selected from SEQ ID Nos: 43-47 of US2011/0271358:

SEQ ID No: 43 of US2011/0271358 (SEQ ID NO:269):

QVQLVQSGAELKKPGASVKMSCKASGYTFTGYTMHWVKQAPGQGLEWIGYINPRSGYTEY
NQKFKDRITLTADKSTSTAYMELSSLRSEDSAVYYCARPWFAYWGQGLTVTVSS;

SEQ ID No: 44 of US2011/0271358 (SEQ ID NO:270):

QVQLVQSGAEVKKPGASVKMSCKASGYTFTGYTMHWVKQAPGQGLEWIGYINPRSGYTEY
NQKFKDRITLTADKSTSTAYMELSSLRSEDTAVYYCARPWFAYWGQGLTVTVSS;

SEQ ID No: 45 of US2011/0271358 (SEQ ID NO:271):

QVQLVQSGAEVKKPGASVKMSCKASGYTFTGYTMHWVRQAPGGLEWIGYINPRSGYTEY
NQKFKDRITTLTADKSTSTAYMELSSLRSEDTAVYYCARPWFAYWGQGTLLTVSS;

SEQ ID No: 46 of US2011/0271358 (SEQ ID NO:272):

QVQLVQSGAEVKKPGASVKVSCCKASGYTFTGYTMHWVRQAPGGLEWIGYINPRSGYTEY
NQKFKDRITTLTADKSTSTAYMELSSLRSEDTAVYYCARPWFAYWGQGTLLTVSS;

SEQ ID No: 47 of US2011/0271358 (SEQ ID NO:273):

QVQLVQSGAEVKKPGASVKVSCCKASGYTFTGYTMHWVRQAPGGLEWIGYINPRSGYTEY
NQKFKDRITITADKSTSTAYMELSSLRSEDTAVYYCARPWFAYWGQGTLLTVSS;

and/or a light chain comprising an amino acid sequence selected from SEQ ID Nos: 48-51 of US2011/0271358:

SEQ ID No: 48 of US2011/0271358 (SEQ ID NO:274):

DIVMTQSPASLTVPGEKVTITCKSSQSLNSGNQKNYLTWYQQKPGQPPKLLIYWASTR
ESGVPDRFTGSGSGTDFTLTISSLQAEDVAVYYCQNDYSYPLTFGQGTKLEIK;

SEQ ID No: 49 of US2011/0271358 (SEQ ID NO:275):

DIVMTQSPASLSVTPGEKVTITCKSSQSLNSGNQKNYLTWYQQKPGQPPKLLIYWASTR
ESGVPDRFTGSGSGTDFTLTISSLQAEDVAVYYCQNDYSYPLTFGQGTKLEIK;

SEQ ID No: 50 of US2011/0271358 (SEQ ID NO:276):

DIVMTQSPAFLSVTPGEKVTITCKSSQSLNSGNQKNYLTWYQQKPGQPPKLLIYWASTR
ESGVPDRFTGSGSGTDFTLTISSLQAEDVAVYYCQNDYSYPLTFGQGTKLEIK;

SEQ ID No: 51 of US2011/0271358 (SEQ ID NO:277):

DIVMTQSPAFLSVTPGEKVTITCKSSQSLNSGNQKNYLTWYQQKPGQPPKLLIYWASTR
ESGVPDRFSGSGSGTDFTLTISSLQAEDVAVYYCQNDYSYPLTFGQGTKLEIK.

In various embodiments, the targeting moieties of the invention may comprise a sequence that targets PD-1, PD-L1, and/or PD-L2, or any other targets described herein, which is at least about 60%, at least about 61%, at least about 62%, at least about 63%, at least about 64%, at least about 65%, at least about 66%, at least about 67%, at least about 68%, at least about 69%, at least about 70%, at least about 71%, at least about 72%, at least about 73%, at least about 74%, at least about 75%, at least about 76%, at least about 77%, at least about 78%, at least about 79%, at least about 80%, at least about 81%, at least about 82%, at least about 83%, at least about 84%, at least about 85%, at least about 86%, at least about 87%, at least about 88%, at least about 89%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identical to

any of the sequences disclosed herein (e.g. about 60%, or about 61%, or about 62%, or about 63%, or about 64%, or about 65%, or about 66%, or about 67%, or about 68%, or about 69%, or about 70%, or about 71%, or about 72%, or about 73%, or about 74%, or about 75%, or about 76%, or about 77%, or about 78%, or about 79%, or about 80%, or about 81%, or about 82%, or about 83%, or about 84%, or about 85%, or about 86%, or about 87%, or about 88%, or about 89%, or about 90%, or about 91%, or about 92%, or about 93%, or about 94%, or about 95%, or about 96%, or about 97%, or about 98%, about 99% or about 100% sequence identity with any of the sequences disclosed herein).

In various embodiments, the targeting moieties of the invention may comprise any combination of heavy chain, light chain, heavy chain variable region, light chain variable region, complementarity determining region (CDR), and framework region sequences that target PD-1, PD-L1, and/or PD-L2 as disclosed herein.

Additional antibodies, antibody derivatives or formats, peptides or polypeptides, or fusion proteins that selectively bind or target PD-1, PD-L1 and/or PD-L2 are disclosed in WO 2011/066389, US 2008/0025980, US 2013/0034559, US 8,779,108, US 2014/0356353, US 8,609,089, US 2010/028330, US 2012/0114649, WO 2010/027827, WO 2011/066342, US 8,907,065, WO 2016/062722, WO 2009/101611, WO2010/027827, WO 2011/066342, WO 2007/005874, WO 2001/014556, US2011/0271358, WO 2010/036959, WO 2010/077634, US 8,217,149, US 2012/0039906, WO 2012/145493, US 2011/0318373, U.S. Patent No. 8,779,108, US 20140044738, WO 2009/089149, WO 2007/00587, WO 2016061142, WO 2016,02263, WO 2010/077634, and WO 2015/112900, the entire disclosures of which are hereby incorporated by reference.

In various embodiments, the multi-specific Clec9A binding agent of the invention has one or more targeting moieties directed against XCR1 e.g. on dendritic cells. For instance, the targeting moiety, in some embodiments comprises all or part of XCL1 or an anti-XCR1 agent that does not functionally modulate (e.g. a non-neutralizing) XCR1.

In various embodiments, the multi-specific Clec9A binding agents have targeting moieties having recognition domains which specifically bind to a target (e.g. antigen, receptor) which is part of a non-cellular structure. In some embodiments, the antigen or receptor is not an integral component of an intact cell or cellular structure. In some embodiments, the antigen or receptor is an extracellular antigen or receptor. In some embodiments, the target is a non-proteinaceous, non-cellular marker, including, without limitation, nucleic acids, inclusive of DNA or RNA, such as, for example, DNA released from necrotic tumor cells or extracellular deposits such as cholesterol.

In some embodiments, the target (e.g. antigen, receptor) of interest is part of the non-cellular component of the stroma or the extracellular matrix (ECM) or the markers associated therewith. As used herein, stroma refers to the connective and supportive framework of a tissue or organ. Stroma may include a compilation of cells such as fibroblasts/myofibroblasts, glial, epithelia, fat, immune, vascular, smooth muscle, and immune cells along with the extracellular matrix (ECM) and extracellular molecules. In various embodiments, the target (e.g. antigen, receptor) of interest is part of the non-cellular component of the stroma such as the extracellular matrix and

extracellular molecules. As used herein, the ECM refers to the non-cellular components present within all tissues and organs. The ECM is composed of a large collection of biochemically distinct components including, without limitation, proteins, glycoproteins, proteoglycans, and polysaccharides. These components of the ECM are usually produced by adjacent cells and secreted into the ECM via exocytosis. Once secreted, the ECM components often aggregate to form a complex network of macromolecules. In various embodiments, the chimeric protein of the invention comprises a targeting moiety that recognizes a target (e.g., an antigen or receptor or non-proteinaceous molecule) located on any component of the ECM. Illustrative components of the ECM include, without limitation, the proteoglycans, the non-proteoglycan polysaccharides, fibers, and other ECM proteins or ECM non-proteins, e.g. polysaccharides and/or lipids, or ECM associated molecules (e.g. proteins or non-proteins, e.g. polysaccharides, nucleic acids and/or lipids).

In some embodiments, the targeting moiety recognizes a target (e.g. antigen, receptor) on ECM proteoglycans. Proteoglycans are glycosylated proteins. The basic proteoglycan unit includes a core protein with one or more covalently attached glycosaminoglycan (GAG) chains. Proteoglycans have a net negative charge that attracts positively charged sodium ions (Na⁺), which attracts water molecules via osmosis, keeping the ECM and resident cells hydrated. Proteoglycans may also help to trap and store growth factors within the ECM. Illustrative proteoglycans that may be targeted by the chimeric proteins of the invention include, but are not limited to, heparan sulfate, chondroitin sulfate, and keratan sulfate. In an embodiment, the targeting moiety recognizes a target (e.g. antigen, receptor) on non-proteoglycan polysaccharides such as hyaluronic acid.

In some embodiments, the targeting moiety recognizes a target (e.g. antigen, receptor) on ECM fibers. ECM fibers include collagen fibers and elastin fibers. In some embodiments, the targeting moiety recognizes one or more epitopes on collagens or collagen fibers. Collagens are the most abundant proteins in the ECM. Collagens are present in the ECM as fibrillar proteins and provide structural support to resident cells. In one or more embodiments, the targeting moiety recognizes and binds to various types of collagens present within the ECM including, without limitation, fibrillar collagens (types I, II, III, V, XI), facit collagens (types IX, XII, XIV), short chain collagens (types VIII, X), basement membrane collagens (type IV), and/or collagen types VI, VII, or XIII. Elastin fibers provide elasticity to tissues, allowing them to stretch when needed and then return to their original state. In some embodiments, the target moiety recognizes one or more epitopes on elastins or elastin fibers.

In some embodiments, the targeting moiety recognizes one or more ECM proteins including, but not limited to, a tenascin, a fibronectin, a fibrin, a laminin, or a nidogen/entactin.

In an embodiment, the targeting moiety recognizes and binds to tenascin. The tenascin (TN) family of glycoproteins includes at least four members, tenascin-C, tenascin-R, tenascin-X, and tenascin W. The primary structures of tenascin proteins include several common motifs ordered in the same consecutive sequence: amino-terminal heptad repeats, epidermal growth factor (EGF)-like repeats, fibronectin type III domain repeats, and a carboxyl-terminal fibrinogen-like globular domain. Each protein member is associated with typical variations in the number and nature of EGF-like and fibronectin type III repeats. Isoform variants also exist

particularly with respect to tenascin-C. Over 27 splice variants and/or isoforms of tenascin-C are known. In a particular embodiment, the targeting moiety recognizes and binds to tenascin-CA1. Similarly, tenascin-R also has various splice variants and isoforms. Tenascin-R usually exists as dimers or trimers. Tenascin-X is the largest member of the tenascin family and is known to exist as trimers. Tenascin-W exists as trimers. In some embodiments, the targeting moiety recognizes one or more epitopes on a tenascin protein. In some embodiments, the targeting moiety recognizes the monomeric and/or the dimeric and/or the trimeric and/or the hexameric forms of a tenascin protein.

In an embodiment, the targeting moieties recognize and bind to fibronectin. Fibronectins are glycoproteins that connect cells with collagen fibers in the ECM, allowing cells to move through the ECM. Upon binding to integrins, fibronectins unfolds to form functional dimers. In some embodiments, the targeting moiety recognizes the monomeric and/or the dimeric forms of fibronectin. In some embodiments, the targeting moiety recognizes one or more epitopes on fibronectin. In illustrative embodiments, the targeting moiety recognizes fibronectin extracellular domain A (EDA) or fibronectin extracellular domain B (EDB). Elevated levels of EDA are associated with various diseases and disorders including psoriasis, rheumatoid arthritis, diabetes, and cancer. In some embodiments, the targeting moiety recognizes fibronectin that contains the EDA isoform and may be utilized to target the chimeric protein to diseased cells including cancer cells. In some embodiments, the targeting moiety recognizes fibronectin that contains the EDB isoform. In various embodiments, such targeting moieties may be utilized to target the chimeric protein to tumor cells including the tumor neovasculature.

In an embodiment, the targeting moiety recognizes and binds to fibrin. Fibrin is another protein substance often found in the matrix network of the ECM. Fibrin is formed by the action of the protease thrombin on fibrinogen which causes the fibrin to polymerize. In some embodiments, the targeting moiety recognizes one or more epitopes on fibrin. In some embodiments, the targeting moiety recognizes the monomeric as well as the polymerized forms of fibrin.

In an embodiment, the targeting moiety recognizes and binds to laminin. Laminin is a major component of the basal lamina, which is a protein network foundation for cells and organs. Laminins are heterotrimeric proteins that contain an α -chain, a β -chain, and a γ -chain. In some embodiments, the targeting moiety recognizes one or more epitopes on laminin. In some embodiments, the targeting moiety recognizes the monomeric, the dimeric as well as the trimeric forms of laminin.

In an embodiment, the targeting moiety recognizes and binds to a nidogen or entactin. Nidogens/entactins are a family of highly conserved, sulfated glycoproteins. They make up the major structural component of the basement membranes and function to link laminin and collagen IV networks in basement membranes. Members of this family include nidogen-1 and nidogen-2. In various embodiments, the targeting moiety recognizes an epitope on nidogen-1 and/or nidogen-2.

In various embodiments, the targeting moiety comprises an antigen recognition domain that recognizes an epitope present on any of the targets (e.g., ECM proteins) described herein. In an embodiment, the antigen-

recognition domain recognizes one or more linear epitopes present on the protein. As used herein, a linear epitope refers to any continuous sequence of amino acids present on the protein. In another embodiment, the antigen-recognition domain recognizes one or more conformational epitopes present on the protein. As used herein, a conformation epitope refers to one or more sections of amino acids (which may be discontinuous) which form a three-dimensional surface with features and/or shapes and/or tertiary structures capable of being recognized by an antigen recognition domain.

In various embodiments, the targeting moiety may bind to the full-length and/or mature forms and/or isoforms and/or splice variants and/or fragments and/or any other naturally occurring or synthetic analogs, variants, or mutants of any of the targets (e.g., ECM proteins) described herein. In various embodiments, the targeting moiety may bind to any forms of the proteins described herein, including monomeric, dimeric, trimeric, tetrameric, heterodimeric, multimeric and associated forms. In various embodiments, the targeting moiety may bind to any post-translationally modified forms of the proteins described herein, such as glycosylated and/or phosphorylated forms.

In various embodiments, the targeting moiety comprises an antigen recognition domain that recognizes extracellular molecules such as DNA. In some embodiments, the targeting moiety comprises an antigen recognition domain that recognizes DNA. In an embodiment, the DNA is shed into the extracellular space from necrotic or apoptotic tumor cells or other diseased cells.

In various embodiments, the targeting moiety comprises an antigen recognition domain that recognizes one or more non-cellular structures associated with atherosclerotic plaques. Two types of atherosclerotic plaques are known. The fibro-lipid (fibro-fatty) plaque is characterized by an accumulation of lipid-laden cells underneath the intima of the arteries. Beneath the endothelium there is a fibrous cap covering the atheromatous core of the plaque. The core includes lipid-laden cells (macrophages and smooth muscle cells) with elevated tissue cholesterol and cholesterol ester content, fibrin, proteoglycans, collagen, elastin, and cellular debris. In advanced plaques, the central core of the plaque usually contains extracellular cholesterol deposits (released from dead cells), which form areas of cholesterol crystals with empty, needle-like clefts. At the periphery of the plaque are younger foamy cells and capillaries. A fibrous plaque is also localized under the intima, within the wall of the artery resulting in thickening and expansion of the wall and, sometimes, spotty localized narrowing of the lumen with some atrophy of the muscular layer. The fibrous plaque contains collagen fibers (eosinophilic), precipitates of calcium (hematoxylinophilic) and lipid-laden cells. In some embodiments, the targeting moiety recognizes and binds to one or more of the non-cellular components of these plaques such as the fibrin, proteoglycans, collagen, elastin, cellular debris, and calcium or other mineral deposits or precipitates. In some embodiments, the cellular debris is a nucleic acid, e.g. DNA or RNA, released from dead cells.

In various embodiments, the targeting moiety comprises an antigen recognition domain that recognizes one or more non-cellular structures found in the brain plaques associated with neurodegenerative diseases. In some embodiments, the targeting moiety recognizes and binds to one or more non-cellular structures located in the

amyloid plaques found in the brains of patients with Alzheimer's disease. For example, the targeting moiety may recognize and bind to the peptide amyloid beta, which is a major component of the amyloid plaques. In some embodiments, the targeting moiety recognizes and binds to one or more non-cellular structures located in the brains plaques found in patients with Huntington's disease. In various embodiments, the targeting moiety recognizes and binds to one or more non-cellular structures found in plaques associated with other neurodegenerative or musculoskeletal diseases such as Lewy body dementia and inclusion body myositis.

Linkers and Functional Groups

In various embodiments, the Clec9A binding agent may include one or more functional groups, residues, or moieties. In various embodiments, the one or more functional groups, residues, or moieties are attached or genetically fused to any of the signaling agents or targeting moieties described herein. In some embodiments, such functional groups, residues or moieties confer one or more desired properties or functionalities to the Clec9A binding agent of the invention. Examples of such functional groups and of techniques for introducing them into the Clec9A binding agent are known in the art, for example, see *Remington's Pharmaceutical Sciences*, 16th ed., Mack Publishing Co., Easton, Pa. (1980).

In various embodiments, the Clec9A binding agent may be conjugated and/or fused with another agent to extend half-life or otherwise improve pharmacodynamic and pharmacokinetic properties. In some embodiments, the CD8 binding agent may be fused or conjugated with one or more of PEG, XTEN (e.g., as rPEG), polysialic acid (POLYXEN), albumin (e.g., human serum albumin or HAS), elastin-like protein (ELP), PAS, HAP, GLK, CTP, transferrin, and the like. In some embodiments, the CD8 binding agent may be fused or conjugated with an antibody or an antibody fragment such as an Fc fragment. For example, the chimeric protein may be fused to either the N-terminus or the C-terminus of the Fc domain of human immunoglobulin (Ig) G. In various embodiments, each of the individual chimeric proteins is fused to one or more of the agents described in BioDrugs (2015) 29:215–239, the entire contents of which are hereby incorporated by reference.

In some embodiments, the functional groups, residues, or moieties comprise a suitable pharmacologically acceptable polymer, such as poly(ethyleneglycol) (PEG) or derivatives thereof (such as methoxypoly(ethyleneglycol) or mPEG). In some embodiments, attachment of the PEG moiety increases the half-life and/or reduces the immunogenicity of the Clec9A binding protein. Generally, any suitable form of pegylation can be used, such as the pegylation used in the art for antibodies and antibody fragments (including but not limited to single domain antibodies such as VHHs); see, for example, Chapman, *Nat. Biotechnol.*, 54, 531-545 (2002); by Veronese and Harris, *Adv. Drug Deliv. Rev.* 54, 453-456 (2003), by Harris and Chess, *Nat. Rev. Drug. Discov.*, 2, (2003) and in WO04060965, the entire contents of which are hereby incorporated by reference. Various reagents for pegylation of proteins are also commercially available, for example, from Nektar Therapeutics, USA. In some embodiments, site-directed pegylation is used, in particular via a cysteine-residue (see, for example, Yang *et al.*, *Protein Engineering*, 16, 10, 761-770 (2003), the entire contents of which is hereby incorporated by reference). For example, for this purpose, PEG may be attached to a cysteine residue

that naturally occurs in the Clec9A binding agent of the invention. In some embodiments, the Clec9A binding agent of the invention is modified so as to suitably introduce one or more cysteine residues for attachment of PEG, or an amino acid sequence comprising one or more cysteine residues for attachment of PEG may be fused to the amino- and/or carboxy-terminus of the Clec9A binding agent, using techniques known in the art.

In some embodiments, the functional groups, residues, or moieties comprise N-linked or O-linked glycosylation. In some embodiments, the N-linked or O-linked glycosylation is introduced as part of a co-translational and/or post-translational modification.

In some embodiments, the functional groups, residues, or moieties comprise one or more detectable labels or other signal-generating groups or moieties. Suitable labels and techniques for attaching, using and detecting them are known in the art and, include, but are not limited to, fluorescent labels (such as fluorescein, isothiocyanate, rhodamine, phycoerythrin, phycocyanin, allophycocyanin, o-phthaldehyde, and fluorescamine and fluorescent metals such as Eu or others metals from the lanthanide series), phosphorescent labels, chemiluminescent labels or bioluminescent labels (such as luminal, isoluminol, therronic acridinium ester, imidazole, acridinium salts, oxalate ester, dioxetane or GFP and its analogs), radio-isotopes, metals, metals chelates or metallic cations or other metals or metallic cations that are particularly suited for use in in vivo, in vitro or in situ diagnosis and imaging, as well as chromophores and enzymes (such as malate dehydrogenase, staphylococcal nuclease, delta- V-steroid isomerase, yeast alcohol dehydrogenase, alpha-glycerophosphate dehydrogenase, triose phosphate isomerase, biotinavidin peroxidase, horseradish peroxidase, alkaline phosphatase, asparaginase, glucose oxidase, beta-galactosidase, ribonuclease, urease, catalase, glucose-VI-phosphate dehydrogenase, glucoamylase and acetylcholine esterase). Other suitable labels include moieties that can be detected using NMR or ESR spectroscopy. Such labeled VHHs and polypeptides of the invention may, for example, be used for in vitro, in vivo or in situ assays (including immunoassays known per se such as ELISA, RIA, EIA and other "sandwich assays," etc.) as well as in vivo diagnostic and imaging purposes, depending on the choice of the specific label.

In some embodiments, the functional groups, residues, or moieties comprise a tag that is attached or genetically fused to the Clec9A binding agent. In some embodiments, the Clec9A binding agent may include a single tag or multiple tags. The tag for example is a peptide, sugar, or DNA molecule that does not inhibit or prevent binding of the Clec9A binding agent to Clec9A or any other antigen of interest such as tumor antigens. In various embodiments, the tag is at least about: three to five amino acids long, five to eight amino acids long, eight to twelve amino acids long, twelve to fifteen amino acids long, or fifteen to twenty amino acids long. Illustrative tags are described for example, in U.S. Patent Publication No. US2013/0058962. In some embodiment, the tag is an affinity tag such as glutathione-S-transferase (GST) and histidine (His) tag. In an embodiment, the Clec9A binding agent comprises a His tag.

In some embodiments, the functional groups, residues, or moieties comprise a chelating group, for example, to chelate one of the metals or metallic cations. Suitable chelating groups, for example, include, without limitation, diethyl-enetriaminepentaacetic acid (DTPA) or ethylenediaminetetraacetic acid (EDTA).

In some embodiments, the functional groups, residues, or moieties comprise a functional group that is one part of a specific binding pair, such as the biotin-(strept)avidin binding pair. Such a functional group may be used to link the Clec9A binding agent of the invention to another protein, polypeptide or chemical compound that is bound to the other half of the binding pair, *i.e.*, through formation of the binding pair. For example, a Clec9A binding agent of the invention may be conjugated to biotin, and linked to another protein, polypeptide, compound or carrier conjugated to avidin or streptavidin. For example, such a conjugated Clec9A binding agent may be used as a reporter, for example, in a diagnostic system where a detectable signal-producing agent is conjugated to avidin or streptavidin. Such binding pairs may, for example, also be used to bind the Clec9A binding agent to a carrier, including carriers suitable for pharmaceutical purposes. One non-limiting example are the liposomal formulations described by Cao and Suresh, *Journal of Drug Targeting*, 8, 4, 257 (2000). Such binding pairs may also be used to link a therapeutically active agent to the Clec9A binding agent of the invention.

In some embodiments, the present Clec9A binding agent optionally comprises one or more linkers. In some embodiments, the Clec9A binding agent includes a linker that connects each binding region and/or targeting moieties. In some embodiments, the Clec9A binding agent includes a linker that connects each signaling agent and targeting moiety (or, if more than one targeting moiety, a signaling agent to one of the targeting moieties). In some embodiments, the linker may be utilized to link various functional groups, residues, or moieties as described herein to the Clec9A binding agent. In some embodiments, the linker is a single amino acid or a plurality of amino acids that does not affect or reduce the stability, orientation, binding, neutralization, and/or clearance characteristics of the binding regions and the binding protein. In various embodiments, the linker is selected from a peptide, a protein, a sugar, or a nucleic acid.

In some embodiments, the present Clec9A binding agent comprises a linker connecting the targeting moiety and the signaling agent. In some embodiments, the present chimeric protein comprises a linker within the signaling agent (*e.g.* in the case of single chain TNF, which can comprise two linkers to yield a trimer).

The invention contemplates the use of a variety of linker sequences. In various embodiments, the linker may be derived from naturally-occurring multi-domain proteins or are empirical linkers as described, for example, in Chichili *et al.*, (2013), *Protein Sci.* 22(2):153-167, Chen *et al.*, (2013), *Adv Drug Deliv Rev.* 65(10):1357-1369, the entire contents of which are hereby incorporated by reference. In some embodiments, the linker may be designed using linker designing databases and computer programs such as those described in Chen *et al.*, (2013), *Adv Drug Deliv Rev.* 65(10):1357-1369 and Crasto *et al.*, (2000), *Protein Eng.* 13(5):309-312, the entire contents of which are hereby incorporated by reference. In various embodiments, the linker may be functional. For example, without limitation, the linker may function to improve the folding and/or stability, improve the expression, improve the pharmacokinetics, and/or improve the bioactivity of the present Clec9A binding agent.

In some embodiments, the linker is a polypeptide. In some embodiments, the linker is less than about 100 amino acids long. For example, the linker may be less than about 100, about 95, about 90, about 85, about 80, about 75, about 70, about 65, about 60, about 55, about 50, about 45, about 40, about 35, about 30, about 25, about 20, about 19, about 18, about 17, about 16, about 15, about 14, about 13, about 12, about 11, about 10, about 9, about 8, about 7, about 6, about 5, about 4, about 3, or about 2 amino acids long. In some embodiments, the linker is a polypeptide. In some embodiments, the linker is greater than about 100 amino acids long. For example, the linker may be greater than about 100, about 95, about 90, about 85, about 80, about 75, about 70, about 65, about 60, about 55, about 50, about 45, about 40, about 35, about 30, about 25, about 20, about 19, about 18, about 17, about 16, about 15, about 14, about 13, about 12, about 11, about 10, about 9, about 8, about 7, about 6, about 5, about 4, about 3, or about 2 amino acids long. In some embodiments, the linker is flexible. In another embodiment, the linker is rigid.

In some embodiments, the linker length allows for efficient binding of a targeting moiety and the signaling agent to their receptors. For instance, in some embodiments, the linker length allows for efficient binding of one of the targeting moieties and the signaling agent to receptors on the same cell as well as the efficient binding of the other targeting moiety to another cell. Illustrative pairs of cells are provided elsewhere herein.

In some embodiments the linker length is at least equal to the minimum distance between the binding sites of one of the targeting moieties and the signaling agent to receptors on the same cell. In some embodiments the linker length is at least twice, or three times, or four times, or five times, or ten times, or twenty times, or 25 times, or 50 times, or one hundred times, or more the minimum distance between the binding sites of one of the targeting moieties and the signaling agent to receptors on the same cell.

In some embodiments, a linker connects the two targeting moieties to each other and this linker has a short length and a linker connects a targeting moiety and a signaling agent this linker is longer than the linker connecting the two targeting moieties. For example, the difference in amino acid length between the linker connecting the two targeting moieties and the linker connecting a targeting moiety and a signaling agent may be about 100, about 95, about 90, about 85, about 80, about 75, about 70, about 65, about 60, about 55, about 50, about 45, about 40, about 35, about 30, about 25, about 20, about 19, about 18, about 17, about 16, about 15, about 14, about 13, about 12, about 11, about 10, about 9, about 8, about 7, about 6, about 5, about 4, about 3, or about 2 amino acids. In some embodiments, the linker is flexible. In another embodiment, the linker is rigid.

In various embodiments, the linker is substantially comprised of glycine and serine residues (e.g. about 30%, or about 40%, or about 50%, or about 60%, or about 70%, or about 80%, or about 90%, or about 95%, or about 97% glycines and serines). For example, in some embodiments, the linker is $(\text{Gly}_4\text{Ser})_n$, where n is from about 1 to about 8, e.g. 1, 2, 3, 4, 5, 6, 7, or 8. In an embodiment, the linker sequence is GSGSGSGSGSGSGSGGS (SEQ ID NO:278). Additional illustrative linkers include, but are not limited to, linkers having the sequence LE, GGGGS (SEQ ID NO:279), $(\text{GGGGS})_n$ ($n=1-4$) (SEQ ID NO:280), $(\text{Gly})_8$ (SEQ ID NO:281), $(\text{Gly})_6$ (SEQ ID NO:282), $(\text{EAAAK})_n$ ($n=1-3$) (SEQ ID NO:283);, $\text{A}(\text{EAAAK})_n\text{A}$ ($n = 2-5$) (SEQ ID NO:284), AEAAAKEAAKA

(SEQ ID NO:285), A(EAAAK)₄ALEA(EAAAK)₄A (SEQ ID NO:286), PAPAP (SEQ ID NO:287), KESGSVSSEQLAQFRSLD (SEQ ID NO:288), EGKSSGSGSESKST (SEQ ID NO:289), GSAGSAAGSGEF (SEQ ID NO:290), and (XP)_n, with X designating any amino acid, *e.g.*, Ala, Lys, or Glu. In various embodiments, the linker is GGS.

In some embodiments, the linker is a hinge region of an antibody (*e.g.*, of IgG, IgA, IgD, and IgE, inclusive of subclasses (*e.g.* IgG1, IgG2, IgG3, and IgG4, and IgA1 and IgA2)). In various embodiments, the linker is a hinge region of an antibody (*e.g.*, of IgG, IgA, IgD, and IgE, inclusive of subclasses (*e.g.* IgG1, IgG2, IgG3, and IgG4, and IgA1 and IgA2)). The hinge region, found in IgG, IgA, IgD, and IgE class antibodies, acts as a flexible spacer, allowing the Fab portion to move freely in space. In contrast to the constant regions, the hinge domains are structurally diverse, varying in both sequence and length among immunoglobulin classes and subclasses. For example, the length and flexibility of the hinge region varies among the IgG subclasses. The hinge region of IgG1 encompasses amino acids 216-231 and, because it is freely flexible, the Fab fragments can rotate about their axes of symmetry and move within a sphere centered at the first of two inter-heavy chain disulfide bridges. IgG2 has a shorter hinge than IgG1, with 12 amino acid residues and four disulfide bridges. The hinge region of IgG2 lacks a glycine residue, is relatively short, and contains a rigid poly-proline double helix, stabilized by extra inter-heavy chain disulfide bridges. These properties restrict the flexibility of the IgG2 molecule. IgG3 differs from the other subclasses by its unique extended hinge region (about four times as long as the IgG1 hinge), containing 62 amino acids (including 21 prolines and 11 cysteines), forming an inflexible poly-proline double helix. In IgG3, the Fab fragments are relatively far away from the Fc fragment, giving the molecule a greater flexibility. The elongated hinge in IgG3 is also responsible for its higher molecular weight compared to the other subclasses. The hinge region of IgG4 is shorter than that of IgG1 and its flexibility is intermediate between that of IgG1 and IgG2. The flexibility of the hinge regions reportedly decreases in the order IgG3>IgG1>IgG4>IgG2.

According to crystallographic studies, the immunoglobulin hinge region can be further subdivided functionally into three regions: the upper hinge region, the core region, and the lower hinge region. See Shin *et al.*, 1992 *Immunological Reviews* 130:87. The upper hinge region includes amino acids from the carboxyl end of C_{H1} to the first residue in the hinge that restricts motion, generally the first cysteine residue that forms an interchain disulfide bond between the two heavy chains. The length of the upper hinge region correlates with the segmental flexibility of the antibody. The core hinge region contains the inter-heavy chain disulfide bridges, and the lower hinge region joins the amino terminal end of the C_{H2} domain and includes residues in C_{H2}. *Id.* The core hinge region of wild-type human IgG1 contains the sequence Cys-Pro-Pro-Cys which, when dimerized by disulfide bond formation, results in a cyclic octapeptide believed to act as a pivot, thus conferring flexibility. In various embodiments, the present linker comprises, one, or two, or three of the upper hinge region, the core region, and the lower hinge region of any antibody (*e.g.*, of IgG, IgA, IgD, and IgE, inclusive of subclasses (*e.g.* IgG1, IgG2, IgG3, and IgG4, and IgA1 and IgA2)). The hinge region may also contain one or more glycosylation sites, which include a number of structurally distinct types of sites for carbohydrate attachment. For example, IgA1 contains five glycosylation sites within a 17-amino-acid segment of the hinge region, conferring resistance of the hinge

region polypeptide to intestinal proteases, considered an advantageous property for a secretory immunoglobulin. In various embodiments, the linker of the present invention comprises one or more glycosylation sites. In various embodiments, the linker is a hinge-CH2-CH3 domain of a human IgG4 antibody.

If desired, the present Clec9A binding agent can be linked to an antibody Fc region, comprising one or both of C_H2 and C_H3 domains, and optionally a hinge region. For example, vectors encoding the present Clec9A binding agents linked as a single nucleotide sequence to an Fc region can be used to prepare such polypeptides.

In some embodiments, the linker is a synthetic linker such as PEG.

In various embodiments, the linker may be functional. For example, without limitation, the linker may function to improve the folding and/or stability, improve the expression, improve the pharmacokinetics, and/or improve the bioactivity of the present Clec9A binding agent. In another example, the linker may function to target the Clec9A binding agent to a particular cell type or location.

Modifications and Production of Clec9A binding agents

In various embodiments, the Clec9A binding agent comprises a targeting moiety that is a VHH. In various embodiments, the VHH is not limited to a specific biological source or to a specific method of preparation. For example, the VHH can generally be obtained: (1) by isolating the V_HH domain of a naturally occurring heavy chain antibody; (2) by expression of a nucleotide sequence encoding a naturally occurring V_HH domain; (3) by "humanization" of a naturally occurring V_HH domain or by expression of a nucleic acid encoding a such humanized V_HH domain; (4) by "camelization" of a naturally occurring VH domain from any animal species, such as from a mammalian species, such as from a human being, or by expression of a nucleic acid encoding such a camelized VH domain; (5) by "camelization" of a "domain antibody" or "Dab" as described in the art, or by expression of a nucleic acid encoding such a camelized VH domain; (6) by using synthetic or semi-synthetic techniques for preparing proteins, polypeptides or other amino acid sequences known in the art; (7) by preparing a nucleic acid encoding a VHH using techniques for nucleic acid synthesis known in the art, followed by expression of the nucleic acid thus obtained; and/or (8) by any combination of one or more of the foregoing.

In an embodiment, the Clec9A binding agent comprises a VHH that corresponds to the V_HH domains of naturally occurring heavy chain antibodies directed against human Clec9A. In some embodiments, such V_HH sequences can generally be generated or obtained by suitably immunizing a species of Camelid with a Clec9A molecule, (*i.e.*, so as to raise an immune response and/or heavy chain antibodies directed against Clec9A), by obtaining a suitable biological sample from the Camelid (such as a blood sample, or any sample of B-cells), and by generating V_HH sequences directed against Clec9A, starting from the sample, using any suitable known techniques. In some embodiments, naturally occurring V_HH domains against Clec9A can be obtained from naive libraries of Camelid V_HH sequences, for example, by screening such a library using Clec9A or at least one part, fragment, antigenic determinant or epitope thereof using one or more screening techniques known in the art. Such libraries and techniques are, for example, described in WO9937681, WO0190190, WO03025020 and WO03035694, the entire contents of which are hereby incorporated by reference. In some embodiments,

improved synthetic or semi-synthetic libraries derived from naive V_HH libraries may be used, such as V_HH libraries obtained from naive V_HH libraries by techniques such as random mutagenesis and/or CDR shuffling, as for example, described in WO0043507, the entire contents of which are hereby incorporated by reference. In some embodiments, another technique for obtaining V_HH sequences directed against a Clec9A involves suitably immunizing a transgenic mammal that is capable of expressing heavy chain antibodies (*i.e.*, so as to raise an immune response and/or heavy chain antibodies directed against Clec9A), obtaining a suitable biological sample from the transgenic mammal (such as a blood sample, or any sample of B-cells), and then generating V_HH sequences directed against Clec9A starting from the sample, using any suitable known techniques. For example, for this purpose, the heavy chain antibody-expressing mice and the further methods and techniques described in WO02085945 and in WO04049794 (the entire contents of which are hereby incorporated by reference) can be used.

In an embodiment, the Clec9A binding agent comprises a VHH that has been “humanized” *i.e.*, by replacing one or more amino acid residues in the amino acid sequence of the naturally occurring V_HH sequence (and in particular in the framework sequences) by one or more of the amino acid residues that occur at the corresponding position(s) in a VH domain from a conventional 4-chain antibody from a human being. This can be performed using humanization techniques known in the art. In some embodiments, possible humanizing substitutions or combinations of humanizing substitutions may be determined by methods known in the art, for example, by a comparison between the sequence of a VHH and the sequence of a naturally occurring human VH domain. In some embodiments, the humanizing substitutions are chosen such that the resulting humanized VHHs still retain advantageous functional properties. Generally, as a result of humanization, the VHHs of the invention may become more “human-like,” while still retaining favorable properties such as a reduced immunogenicity, compared to the corresponding naturally occurring V_HH domains. In various embodiments, the humanized VHHs of the invention can be obtained in any suitable manner known in the art and thus are not strictly limited to polypeptides that have been obtained using a polypeptide that comprises a naturally occurring V_HH domain as a starting material.

In an embodiment, the Clec9A binding agent comprises a VHH that has been “camelized,” *i.e.*, by replacing one or more amino acid residues in the amino acid sequence of a naturally occurring VH domain from a conventional 4-chain antibody by one or more of the amino acid residues that occur at the corresponding position(s) in a V_HH domain of a heavy chain antibody of a camelid. In some embodiments, such “camelizing” substitutions are inserted at amino acid positions that form and/or are present at the VH-VL interface, and/or at the so-called Camelidae hallmark residues (see, for example, WO9404678, the entire contents of which are hereby incorporated by reference). In some embodiments, the VH sequence that is used as a starting material or starting point for generating or designing the camelized VHH is a VH sequence from a mammal, for example, the VH sequence of a human being, such as a VH3 sequence. In various embodiments, the camelized VHHs can be obtained in any suitable manner known in the art (*i.e.*, as indicated under points (1)-(8) above) and thus are not

strictly limited to polypeptides that have been obtained using a polypeptide that comprises a naturally occurring VH domain as a starting material.

In various embodiments, both "humanization" and "camelization" can be performed by providing a nucleotide sequence that encodes a naturally occurring V_HH domain or VH domain, respectively, and then changing, in a manner known in the art, one or more codons in the nucleotide sequence in such a way that the new nucleotide sequence encodes a "humanized" or "camelized" VHH, respectively. This nucleic acid can then be expressed in a manner known in the art, so as to provide the desired VHH of the invention. Alternatively, based on the amino acid sequence of a naturally occurring V_HH domain or VH domain, respectively, the amino acid sequence of the desired humanized or camelized VHH of the invention, respectively, can be designed and then synthesized de novo using techniques for peptide synthesis known in the art. Also, based on the amino acid sequence or nucleotide sequence of a naturally occurring V_HH domain or VH domain, respectively, a nucleotide sequence encoding the desired humanized or camelized VHH, respectively, can be designed and then synthesized de novo using techniques for nucleic acid synthesis known in the art, after which the nucleic acid thus obtained can be expressed in a manner known in the art, so as to provide the desired VHH of the invention. Other suitable methods and techniques for obtaining the VHHs of the invention and/or nucleic acids encoding the same, starting from naturally occurring VH sequences or V_HH sequences, are known in the art, and may, for example, comprise combining one or more parts of one or more naturally occurring VH sequences (such as one or more FR sequences and/or CDR sequences), one or more parts of one or more naturally occurring V_HH sequences (such as one or more FR sequences or CDR sequences), and/or one or more synthetic or semi-synthetic sequences, in a suitable manner, so as to provide a VHH of the invention or a nucleotide sequence or nucleic acid encoding the same.

Methods for producing the Clec9A binding agents of the invention are described herein. For example, DNA sequences encoding the Clec9A binding agents of the invention can be chemically synthesized using methods known in the art. Synthetic DNA sequences can be ligated to other appropriate nucleotide sequences, including, e.g., expression control sequences, to produce gene expression constructs encoding the desired Clec9A binding agents. Accordingly, in various embodiments, the present invention provides for isolated nucleic acids comprising a nucleotide sequence encoding the Clec9A binding agent of the invention.

Nucleic acids encoding the Clec9A binding agent of the invention can be incorporated (ligated) into expression vectors, which can be introduced into host cells through transfection, transformation, or transduction techniques. For example, nucleic acids encoding the Clec9A binding agent of the invention can be introduced into host cells by retroviral transduction. Illustrative host cells are *E.coli* cells, Chinese hamster ovary (CHO) cells, human embryonic kidney 293 (HEK 293) cells, HeLa cells, baby hamster kidney (BHK) cells, monkey kidney cells (COS), human hepatocellular carcinoma cells (e.g., Hep G2), and myeloma cells. Transformed host cells can be grown under conditions that permit the host cells to express the genes that encode the Clec9A binding agent of the invention. Accordingly, in various embodiments, the present invention provides expression vectors

comprising nucleic acids that encode the Clec9A binding agent of the invention. In various embodiments, the present invention additionally provides host cells comprising such expression vectors.

Specific expression and purification conditions will vary depending upon the expression system employed. For example, if a gene is to be expressed in *E. coli*, it is first cloned into an expression vector by positioning the engineered gene downstream from a suitable bacterial promoter, e.g., Trp or Tac, and a prokaryotic signal sequence. In another example, if the engineered gene is to be expressed in eukaryotic host cells, e.g., CHO cells, it is first inserted into an expression vector containing for example, a suitable eukaryotic promoter, a secretion signal, enhancers, and various introns. The gene construct can be introduced into the host cells using transfection, transformation, or transduction techniques.

The Clec9A binding agent of the invention can be produced by growing a host cell transfected with an expression vector encoding the Clec9A binding agent under conditions that permit expression of the protein. Following expression, the protein can be harvested and purified using techniques well known in the art, e.g., affinity tags such as glutathione-S-transferase (GST) and histidine (His) tags or by chromatography. In an embodiment, the Clec9A binding agent comprises a His tag. In an embodiment, the Clec9A binding agent comprises a His tag and a proteolytic site to allow cleavage of the His tag.

Accordingly, in various embodiments, the present invention provides for a nucleic acid encoding a Clec9A binding agent of the present invention. In various embodiments, the present invention provides for a host cell comprising a nucleic acid encoding a Clec9A binding agent of the present invention.

In various embodiments, the methods of modifying and producing the Clec9A binding agents as described herein can be easily adapted for the modification and production of any multi-specific binding agents or chimeras comprising two or more targeting moieties and/or signaling agents. For example, the methods may be adapted for production of a multi-specific Clec9A binding agent comprising a targeting moiety against a checkpoint inhibitor antigen.

Pharmaceutically Acceptable Salts and Excipients

The Clec9A binding agents (and/or any other therapeutic agents) described herein can possess a sufficiently basic functional group, which can react with an inorganic or organic acid, or a carboxyl group, which can react with an inorganic or organic base, to form a pharmaceutically acceptable salt. A pharmaceutically acceptable acid addition salt is formed from a pharmaceutically acceptable acid, as is well known in the art. Such salts include the pharmaceutically acceptable salts listed in, for example, *Journal of Pharmaceutical Science*, 66, 2-19 (1977) and *The Handbook of Pharmaceutical Salts; Properties, Selection, and Use*. P. H. Stahl and C. G. Wermuth (eds.), Verlag, Zurich (Switzerland) 2002, which are hereby incorporated by reference in their entirety.

Pharmaceutically acceptable salts include, by way of non-limiting example, sulfate, citrate, acetate, oxalate, chloride, bromide, iodide, nitrate, bisulfate, phosphate, acid phosphate, isonicotinate, lactate, salicylate, acid citrate, tartrate, oleate, tannate, pantothenate, bitartrate, ascorbate, succinate, maleate, gentisinate, fumarate,

gluconate, glucaronate, saccharate, formate, benzoate, glutamate, methanesulfonate, ethanesulfonate, benzenesulfonate, p-toluenesulfonate, camphorsulfonate, pamoate, phenylacetate, trifluoroacetate, acrylate, chlorobenzoate, dinitrobenzoate, hydroxybenzoate, methoxybenzoate, methylbenzoate, o-acetoxybenzoate, naphthalene-2-benzoate, isobutyrate, phenylbutyrate, α -hydroxybutyrate, butyne-1,4-dicarboxylate, hexyne-1,4-dicarboxylate, caprate, caprylate, cinnamate, glycollate, heptanoate, hippurate, malate, hydroxymaleate, malonate, mandelate, mesylate, nicotinate, phthalate, teraphthalate, propiolate, propionate, phenylpropionate, sebacate, suberate, p-bromobenzenesulfonate, chlorobenzenesulfonate, ethylsulfonate, 2-hydroxyethylsulfonate, methylsulfonate, naphthalene-1-sulfonate, naphthalene-2-sulfonate, naphthalene-1,5-sulfonate, xylenesulfonate, and tartarate salts.

The term "pharmaceutically acceptable salt" also refers to a salt of the compositions of the present invention having an acidic functional group, such as a carboxylic acid functional group, and a base. Suitable bases include, but are not limited to, hydroxides of alkali metals such as sodium, potassium, and lithium; hydroxides of alkaline earth metal such as calcium and magnesium; hydroxides of other metals, such as aluminum and zinc; ammonia, and organic amines, such as unsubstituted or hydroxy-substituted mono-, di-, or tri-alkylamines, dicyclohexylamine; tributyl amine; pyridine; N-methyl, N-ethylamine; diethylamine; triethylamine; mono-, bis-, or tris-(2-OH-lower alkylamines), such as mono-, bis-, or tris-(2-hydroxyethyl)amine, 2-hydroxy-tert-butylamine, or tris-(hydroxymethyl)methylamine, N,N-di-lower alkyl-N-(hydroxyl-lower alkyl)-amines, such as N,N-dimethyl-N-(2-hydroxyethyl)amine or tri-(2-hydroxyethyl)amine; N-methyl-D-glucamine; and amino acids such as arginine, lysine, and the like.

In some embodiments, the compositions described herein are in the form of a pharmaceutically acceptable salt.

Pharmaceutical Compositions and Formulations

In various embodiments, the present invention pertains to pharmaceutical compositions comprising the Clec9A binding agents (and/or any other therapeutic agents) described herein and a pharmaceutically acceptable carrier or excipient. In some embodiments, the present invention pertains to pharmaceutical compositions comprising the present Clec9A binding agents. In another embodiment, the present invention pertains to pharmaceutical compositions comprising any other therapeutic agents described herein. In a further embodiment, the present invention pertains to pharmaceutical compositions comprising a combination of the present Clec9A binding agents and any other therapeutic agents described herein. Any pharmaceutical compositions described herein can be administered to a subject as a component of a composition that comprises a pharmaceutically acceptable carrier or vehicle. Such compositions can optionally comprise a suitable amount of a pharmaceutically acceptable excipient so as to provide the form for proper administration.

In various embodiments, pharmaceutical excipients can be liquids, such as water and oils, including those of petroleum, animal, vegetable, or synthetic origin, such as peanut oil, soybean oil, mineral oil, sesame oil and the like. The pharmaceutical excipients can be, for example, saline, gum acacia, gelatin, starch paste, talc, keratin, colloidal silica, urea and the like. In addition, auxiliary, stabilizing, thickening, lubricating, and coloring agents can

be used. In one embodiment, the pharmaceutically acceptable excipients are sterile when administered to a subject. Water is a useful excipient when any agent described herein is administered intravenously. Saline solutions and aqueous dextrose and glycerol solutions can also be employed as liquid excipients, specifically for injectable solutions. Suitable pharmaceutical excipients also include starch, glucose, lactose, sucrose, gelatin, malt, rice, flour, chalk, silica gel, sodium stearate, glycerol monostearate, talc, sodium chloride, dried skim milk, glycerol, propylene, glycol, water, ethanol and the like. Any agent described herein, if desired, can also comprise minor amounts of wetting or emulsifying agents, or pH buffering agents. Other examples of suitable pharmaceutical excipients are described in *Remington's Pharmaceutical Sciences* 1447-1676 (Alfonso R. Gennaro eds., 19th ed. 1995), incorporated herein by reference.

The present invention includes the described pharmaceutical compositions (and/or additional therapeutic agents) in various formulations. Any inventive pharmaceutical composition (and/or additional therapeutic agents) described herein can take the form of solutions, suspensions, emulsion, drops, tablets, pills, pellets, capsules, capsules containing liquids, gelatin capsules, powders, sustained-release formulations, suppositories, emulsions, aerosols, sprays, suspensions, lyophilized powder, frozen suspension, desiccated powder, or any other form suitable for use. In one embodiment, the composition is in the form of a capsule. In another embodiment, the composition is in the form of a tablet. In yet another embodiment, the pharmaceutical composition is formulated in the form of a soft-gel capsule. In a further embodiment, the pharmaceutical composition is formulated in the form of a gelatin capsule. In yet another embodiment, the pharmaceutical composition is formulated as a liquid.

Where necessary, the inventive pharmaceutical compositions (and/or additional agents) can also include a solubilizing agent. Also, the agents can be delivered with a suitable vehicle or delivery device as known in the art. Combination therapies outlined herein can be co-delivered in a single delivery vehicle or delivery device.

The formulations comprising the inventive pharmaceutical compositions (and/or additional agents) of the present invention may conveniently be presented in unit dosage forms and may be prepared by any of the methods well known in the art of pharmacy. Such methods generally include the step of bringing the therapeutic agents into association with a carrier, which constitutes one or more accessory ingredients. Typically, the formulations are prepared by uniformly and intimately bringing the therapeutic agent into association with a liquid carrier, a finely divided solid carrier, or both, and then, if necessary, shaping the product into dosage forms of the desired formulation (e.g., wet or dry granulation, powder blends, etc., followed by tableting using conventional methods known in the art).

In various embodiments, any pharmaceutical compositions (and/or additional agents) described herein is formulated in accordance with routine procedures as a composition adapted for a mode of administration described herein.

Routes of administration include, for example: oral, intradermal, intramuscular, intraperitoneal, intravenous, subcutaneous, intranasal, epidural, sublingual, intranasal, intracerebral, intravaginal, transdermal, rectally, by inhalation, or topically. Administration can be local or systemic. In some embodiments, the administering is

effected orally. In another embodiment, the administration is by parenteral injection. The mode of administration can be left to the discretion of the practitioner, and depends in-part upon the site of the medical condition. In most instances, administration results in the release of any agent described herein into the bloodstream.

In one embodiment, the Clec9A binding agent described herein is formulated in accordance with routine procedures as a composition adapted for oral administration. Compositions for oral delivery can be in the form of tablets, lozenges, aqueous or oily suspensions, granules, powders, emulsions, capsules, syrups, or elixirs, for example. Orally administered compositions can comprise one or more agents, for example, sweetening agents such as fructose, aspartame or saccharin; flavoring agents such as peppermint, oil of wintergreen, or cherry; coloring agents; and preserving agents, to provide a pharmaceutically palatable preparation. Moreover, where in tablet or pill form, the compositions can be coated to delay disintegration and absorption in the gastrointestinal tract thereby providing a sustained action over an extended period of time. Selectively permeable membranes surrounding an osmotically active driving any Clec9A binding agents described herein are also suitable for orally administered compositions. In these latter platforms, fluid from the environment surrounding the capsule is imbibed by the driving compound, which swells to displace the agent or agent composition through an aperture. These delivery platforms can provide an essentially zero order delivery profile as opposed to the spiked profiles of immediate release formulations. A time-delay material such as glycerol monostearate or glycerol stearate can also be useful. Oral compositions can include standard excipients such as mannitol, lactose, starch, magnesium stearate, sodium saccharin, cellulose, and magnesium carbonate. In one embodiment, the excipients are of pharmaceutical grade. Suspensions, in addition to the active compounds, may contain suspending agents such as, for example, ethoxylated isostearyl alcohols, polyoxyethylene sorbitol and sorbitan esters, microcrystalline cellulose, aluminum metahydroxide, bentonite, agar-agar, tragacanth, *etc.*, and mixtures thereof.

Dosage forms suitable for parenteral administration (*e.g.* intravenous, intramuscular, intraperitoneal, subcutaneous and intra-articular injection and infusion) include, for example, solutions, suspensions, dispersions, emulsions, and the like. They may also be manufactured in the form of sterile solid compositions (*e.g.* lyophilized composition), which can be dissolved or suspended in sterile injectable medium immediately before use. They may contain, for example, suspending or dispersing agents known in the art. Formulation components suitable for parenteral administration include a sterile diluent such as water for injection, saline solution, fixed oils, polyethylene glycols, glycerine, propylene glycol or other synthetic solvents; antibacterial agents such as benzyl alcohol or methyl paraben; antioxidants such as ascorbic acid or sodium bisulfite; chelating agents such as EDTA; buffers such as acetates, citrates or phosphates; and agents for the adjustment of tonicity such as sodium chloride or dextrose.

For intravenous administration, suitable carriers include physiological saline, bacteriostatic water, Cremophor ELTM (BASF, Parsippany, NJ) or phosphate buffered saline (PBS). The carrier should be stable under the conditions of manufacture and storage, and should be preserved against microorganisms. The carrier can be a solvent or dispersion medium containing, for example, water, ethanol, polyol (for example, glycerol, propylene glycol, and liquid polyethylene glycol), and suitable mixtures thereof.

The compositions provided herein, alone or in combination with other suitable components, can be made into aerosol formulations (*i.e.*, “nebulized”) to be administered via inhalation. Aerosol formulations can be placed into pressurized acceptable propellants, such as dichlorodifluoromethane, propane, nitrogen, and the like.

Any inventive pharmaceutical compositions (and/or additional agents) described herein can be administered by controlled-release or sustained-release means or by delivery devices that are well known to those of ordinary skill in the art. Examples include, but are not limited to, those described in U.S. Patent Nos. 3,845,770; 3,916,899; 3,536,809; 3,598,123; 4,008,719; 5,674,533; 5,059,595; 5,591,767; 5,120,548; 5,073,543; 5,639,476; 5,354,556; and 5,733,556, each of which is incorporated herein by reference in its entirety. Such dosage forms can be useful for providing controlled- or sustained-release of one or more active ingredients using, for example, hydropropyl cellulose, hydropropylmethyl cellulose, polyvinylpyrrolidone, other polymer matrices, gels, permeable membranes, osmotic systems, multilayer coatings, microparticles, liposomes, microspheres, or a combination thereof to provide the desired release profile in varying proportions. Suitable controlled- or sustained-release formulations known to those skilled in the art, including those described herein, can be readily selected for use with the active ingredients of the agents described herein. The invention thus provides single unit dosage forms suitable for oral administration such as, but not limited to, tablets, capsules, gelcaps, and caplets that are adapted for controlled- or sustained-release.

Controlled- or sustained-release of an active ingredient can be stimulated by various conditions, including but not limited to, changes in pH, changes in temperature, stimulation by an appropriate wavelength of light, concentration or availability of enzymes, concentration or availability of water, or other physiological conditions or compounds.

In another embodiment, a controlled-release system can be placed in proximity of the target area to be treated, thus requiring only a fraction of the systemic dose (*see, e.g.*, Goodson, in *Medical Applications of Controlled Release*, *supra*, vol. 2, pp. 115-138 (1984)). Other controlled-release systems discussed in the review by Langer, 1990, *Science* 249:1527-1533) may be used.

Pharmaceutical formulations preferably are sterile. Sterilization can be accomplished, for example, by filtration through sterile filtration membranes. Where the composition is lyophilized, filter sterilization can be conducted prior to or following lyophilization and reconstitution.

Administration and Dosage

It will be appreciated that the actual dose of the Clec9A binding agent and/or any therapeutic agents described herein to be administered according to the present invention will vary according to the particular dosage form, and the mode of administration. Many factors that may modify the action of the Clec9A binding agent (*e.g.*, body weight, gender, diet, time of administration, route of administration, rate of excretion, condition of the subject, drug combinations, genetic disposition and reaction sensitivities) can be taken into account by those skilled in the art. Administration can be carried out continuously or in one or more discrete doses within the maximum

tolerated dose. Optimal administration rates for a given set of conditions can be ascertained by those skilled in the art using conventional dosage administration tests.

In some embodiments, a suitable dosage of the Clec9A binding agent and/or any therapeutic agents described herein is in a range of about 0.01 mg/kg to about 10 g/kg of body weight of the subject, about 0.01 mg/kg to about 1 g/kg of body weight of the subject, about 0.01 mg/kg to about 100 mg/kg of body weight of the subject, about 0.01 mg/kg to about 10 mg/kg of body weight of the subject, for example, about 0.01 mg/kg, about 0.02 mg/kg, about 0.03 mg/kg, about 0.04 mg/kg, about 0.05 mg/kg, about 0.06 mg/kg, about 0.07 mg/kg, about 0.08 mg/kg, about 0.09 mg/kg, about 0.1 mg/kg, about 0.2 mg/kg, about 0.3 mg/kg, about 0.4 mg/kg, about 0.5 mg/kg, about 0.6 mg/kg, about 0.7 mg/kg, about 0.8 mg/kg, about 0.9 mg/kg, about 1 mg/kg, about 1.1 mg/kg, about 1.2 mg/kg, about 1.3 mg/kg, about 1.4 mg/kg, about 1.5 mg/kg, about 1.6 mg/kg, about 1.7 mg/kg, about 1.8 mg/kg, 1.9 mg/kg, about 2 mg/kg, about 3 mg/kg, about 4 mg/kg, about 5 mg/kg, about 6 mg/kg, about 7 mg/kg, about 8 mg/kg, about 9 mg/kg, about 10 mg/kg body weight, about 100 mg/kg body weight, about 1 g/kg of body weight, about 10 g/kg of body weight, inclusive of all values and ranges therebetween.

Individual doses of the Clec9A binding agent and/or any therapeutic agents described herein can be administered in unit dosage forms containing, for example, from about 0.01 mg to about 100 g, from about 0.01 mg to about 75 g, from about 0.01 mg to about 50 g, from about 0.01 mg to about 25 g, about 0.01 mg to about 10 g, about 0.01 mg to about 7.5 g, about 0.01 mg to about 5 g, about 0.01 mg to about 2.5 g, about 0.01 mg to about 1 g, about 0.01 mg to about 100 mg, from about 0.1 mg to about 100 mg, from about 0.1 mg to about 90 mg, from about 0.1 mg to about 80 mg, from about 0.1 mg to about 70 mg, from about 0.1 mg to about 60 mg, from about 0.1 mg to about 50 mg, from about 0.1 mg to about 40 mg active ingredient, from about 0.1 mg to about 30 mg, from about 0.1 mg to about 20 mg, from about 0.1 mg to about 10 mg, from about 0.1 mg to about 5 mg, from about 0.1 mg to about 3 mg, from about 0.1 mg to about 1 mg per unit dosage form, or from about 5 mg to about 80 mg per unit dosage form. For example, a unit dosage form can be about 0.01 mg, about 0.02 mg, about 0.03 mg, about 0.04 mg, about 0.05 mg, about 0.06 mg, about 0.07 mg, about 0.08 mg, about 0.09 mg, about 0.1 mg, about 0.2 mg, about 0.3 mg, about 0.4 mg, about 0.5 mg, about 0.6 mg, about 0.7 mg, about 0.8 mg, about 0.9 mg, about 1 mg, about 2 mg, about 3 mg, about 4 mg, about 5 mg, about 6 mg, about 7 mg, about 8 mg, about 9 mg about 10 mg, about 15 mg, about 20 mg, about 25 mg, about 30 mg, about 35 mg, about 40 mg, about 45 mg, about 50 mg, about 55 mg, about 60 mg, about 65 mg, about 70 mg, about 75 mg, about 80 mg, about 85 mg, about 90 mg, about 95 mg, about 100 mg, about 200 mg, about 500 mg, about 1 g, about 2.5 g, about 5 g, about 10 g, about 25 g, about 50 g, about 75 g, about 100 g, inclusive of all values and ranges therebetween.

In one embodiment, the Clec9A binding agent and/or any therapeutic agents described herein are administered at an amount of from about 0.01 mg to about 100 g daily, from about 0.01 mg to about 75 g daily, from about 0.01 mg to about 50 g daily, from about 0.01 mg to about 25 g daily, from about 0.01 mg to about 10 g daily, from about 0.01 mg to about 7.5 g daily, from about 0.01 mg to about 5 g daily, from about 0.01 mg to about 2.5 g

daily, from about 0.01 mg to about 1 g daily, from about 0.01 mg to about 100 mg daily, from about 0.1 mg to about 100 mg daily, from about 0.1 mg to about 95 mg daily, from about 0.1 mg to about 90 mg daily, from about 0.1 mg to about 85 mg daily, from about 0.1 mg to about 80 mg daily, from about 0.1 mg to about 75 mg daily, from about 0.1 mg to about 70 mg daily, from about 0.1 mg to about 65 mg daily, from about 0.1 mg to about 60 mg daily, from about 0.1 mg to about 55 mg daily, from about 0.1 mg to about 50 mg daily, from about 0.1 mg to about 45 mg daily, from about 0.1 mg to about 40 mg daily, from about 0.1 mg to about 35 mg daily, from about 0.1 mg to about 30 mg daily, from about 0.1 mg to about 25 mg daily, from about 0.1 mg to about 20 mg daily, from about 0.1 mg to about 15 mg daily, from about 0.1 mg to about 10 mg daily, from about 0.1 mg to about 5 mg daily, from about 0.1 mg to about 3 mg daily, from about 0.1 mg to about 1 mg daily, or from about 5 mg to about 80 mg daily. In various embodiments, the Clec9A binding agent is administered at a daily dose of about 0.01 mg, about 0.02 mg, about 0.03 mg, about 0.04 mg, about 0.05 mg, about 0.06 mg, about 0.07 mg, about 0.08 mg, about 0.09 mg, about 0.1 mg, about 0.2 mg, about 0.3 mg, about 0.4 mg, about 0.5 mg, about 0.6 mg, about 0.7 mg, about 0.8 mg, about 0.9 mg, about 1 mg, about 2 mg, about 3 mg, about 4 mg, about 5 mg, about 6 mg, about 7 mg, about 8 mg, about 9 mg, about 10 mg, about 15 mg, about 20 mg, about 25 mg, about 30 mg, about 35 mg, about 40 mg, about 45 mg, about 50 mg, about 55 mg, about 60 mg, about 65 mg, about 70 mg, about 75 mg, about 80 mg, about 85 mg, about 90 mg, about 95 mg, about 100 mg, about 200 mg, about 500 mg, about 1 g, about 2.5 g, about 5 g, about 7.5 g, about 10 g, about 25 g, about 50 g, about 75 g, about 100 g, inclusive of all values and ranges therebetween.

In accordance with certain embodiments of the invention, the pharmaceutical composition comprising the Clec9A binding agent and/or any therapeutic agents described herein may be administered, for example, more than once daily (e.g., about two times, about three times, about four times, about five times, about six times, about seven times, about eight times, about nine times, or about ten times daily), about once per day, about every other day, about every third day, about once a week, about once every two weeks, about once every month, about once every two months, about once every three months, about once every six months, or about once every year.

Combination Therapy and Additional Therapeutic Agents

In various embodiments, the pharmaceutical composition of the present invention is co-administered in conjunction with additional therapeutic agent(s). Co-administration can be simultaneous or sequential.

In one embodiment, the additional therapeutic agent and the Clec9A binding agent of the present invention are administered to a subject simultaneously. The term "simultaneously" as used herein, means that the additional therapeutic agent and the Clec9A binding agent are administered with a time separation of no more than about 60 minutes, such as no more than about 30 minutes, no more than about 20 minutes, no more than about 10 minutes, no more than about 5 minutes, or no more than about 1 minute. Administration of the additional therapeutic agent and the Clec9A binding agent can be by simultaneous administration of a single formulation (e.g., a formulation comprising the additional therapeutic agent and the Clec9A binding agent) or of separate

formulations (e.g., a first formulation including the additional therapeutic agent and a second formulation including the Clec9A binding agent).

Co-administration does not require the therapeutic agents to be administered simultaneously, if the timing of their administration is such that the pharmacological activities of the additional therapeutic agent and the Clec9A binding agent overlap in time, thereby exerting a combined therapeutic effect. For example, the additional therapeutic agent and the Clec9A binding agent can be administered sequentially. The term "sequentially" as used herein means that the additional therapeutic agent and the Clec9A binding agent are administered with a time separation of more than about 60 minutes. For example, the time between the sequential administration of the additional therapeutic agent and the Clec9A binding agent can be more than about 60 minutes, more than about 2 hours, more than about 5 hours, more than about 10 hours, more than about 1 day, more than about 2 days, more than about 3 days, more than about 1 week, or more than about 2 weeks, or more than about one month apart. The optimal administration times will depend on the rates of metabolism, excretion, and/or the pharmacodynamic activity of the additional therapeutic agent and the Clec9A binding agent being administered. Either the additional therapeutic agent or the Clec9A binding agent cell may be administered first.

Co-administration also does not require the therapeutic agents to be administered to the subject by the same route of administration. Rather, each therapeutic agent can be administered by any appropriate route, for example, parenterally or non-parenterally.

In some embodiments, the Clec9A binding agent described herein acts synergistically when co-administered with another therapeutic agent. In such embodiments, the Clec9A binding agent and the additional therapeutic agent may be administered at doses that are lower than the doses employed when the agents are used in the context of monotherapy.

In some embodiments, the present invention pertains to chemotherapeutic agents as additional therapeutic agents. For example, without limitation, such combination of the present Clec9A binding agents and chemotherapeutic agent find use in the treatment of cancers, as described elsewhere herein. Examples of chemotherapeutic agents include, but are not limited to, alkylating agents such as thiotepa and CYTOXAN cyclophosphamide; alkyl sulfonates such as busulfan, improsulfan and piposulfan; aziridines such as benzodopa, carboquone, meturedopa, and uredopa; ethylenimines and methylamelamines including altretamine, triethylenemelamine, triethylenephosphoramide, triethylenethiophosphoramide and trimethylolomelamine; acetogenins (e.g., bullatacin and bullatacinone); a camptothecin (including the synthetic analogue topotecan); bryostatin; cally statin; CC-1065 (including its adozelesin, carzelesin and bizelesin synthetic analogues); cryptophycins (e.g., cryptophycin 1 and cryptophycin 8); dolastatin; duocarmycin (including the synthetic analogues, KW-2189 and CB 1-TM1); eleutherobin; pancratistatin; a sarcodictyin; spongistatin; nitrogen mustards such as chlorambucil, chlornaphazine, cholophosphamide, estramustine, ifosfamide, mechlorethamine, mechlorethamine oxide hydrochloride, melphalan, novembichin, phenesterine, prednimustine, trofosfamide, uracil mustard; nitrosureas such as carmustine, chlorozotocin, fotemustine, lomustine, nimustine, and

ranimustine; antibiotics such as the enediyne antibiotics (e.g., calicheamicin, especially calicheamicin gammall and calicheamicin omegall (see, e.g., Agnew, Chem. Intl. Ed. Engl., 33: 183-186 (1994)); dynemicin, including dynemicin A; bisphosphonates, such as clodronate; an esperamicin; as well as neocarzinostatin chromophore and related chromoprotein enediyne antibiotic chromophores), aclacinomysins, actinomycin, authramycin, azaserine, bleomycins, cactinomycin, carabycin, caminomycin, carzinophilin, chromomycinis, dactinomycin, daunorubicin, detorubicin, 6-diazo-5-oxo-L-norleucine, ADRIAMYCIN doxorubicin (including morpholino-doxorubicin, cyanomorpholino-doxorubicin, 2-pyrrolino-doxorubicin and deoxy doxorubicin), epirubicin, esorubicin, idarubicin, marcellomycin, mitomycins such as mitomycin C, mycophenolic acid, nogalamycin, olivomycins, peplomycin, potfiromycin, puromycin, quelamycin, rodorubicin, streptonigrin, streptozocin, tubercidin, ubenimex, zinostatin, zorubicin; anti-metabolites such as methotrexate and 5-fluorouracil (5-FU); folic acid analogues such as denopterin, methotrexate, pteropterin, trimetrexate; purine analogs such as fludarabine, 6-mercaptopurine, thiamiprine, thioguanine; pyrimidine analogs such as ancitabine, azacitidine, 6-azauridine, carmofur, cytarabine, dideoxyuridine, doxifluridine, enocitabine, floxuridine; androgens such as calusterone, dromostanolone propionate, epitio stanol, mepitio stanane, testolactone; anti-adrenals such as minogluthethimide, mitotane, trilostane; folic acid replenisher such as frolinic acid; aceglatone; aldophosphamide glycoside; aminolevulinic acid; eniluracil; amsacrine; bestrabucil; bisantrene; edatraxate; demecolcine; diaziquone; elformithine; elliptinium acetate; an epothilone; etoglucid; gallium nitrate; hydroxyurea; lentinan; lonidainine; maytansinoids such as maytansine and ansamitocins; mitoguazone; mitoxantrone; mopidanmol; nitraerine; pentostatin; phenamet; pirarubicin; losoxantrone; podophyllinic acid; 2-ethylhydrazide; procarbazine; PSK polysaccharide complex (JHS Natural Products, Eugene, Oreg.); razoxane; rhizoxin; sizofuran; spirogermanium; tenuazonic acid; triaziquone; 2,2',2''-trichlorotriethylamine; trichothecenes (e.g., T-2 toxin, verracurin A, roridin A and anguidine); urethan; vindesine; dacarbazine; mannomustine; mitobronitol; mitolactol; pipobroman; gacytosine; arabinoside ("Ara-C"); cyclophosphamide; thiotepa; taxoids, e.g., TAXOL paclitaxel (Bristol-Myers Squibb Oncology, Princeton, N.J.), ABRAXANE Cremophor-free, albumin-engineered nanoparticle formulation of paclitaxel (American Pharmaceutical Partners, Schaumburg, 111.), and TAXOTERE doxetaxel (Rhone-Poulenc Rorer, Antony, France); chloranbucil; GEMZAR gemcitabine; 6-thioguanine; mercaptopurine; methotrexate; platinum analogs such as cisplatin, oxaliplatin and carboplatin; vinblastine; platinum; etoposide (VP-16); ifosfamide; mitoxantrone; vincristine; NAVELBINE. vinorelbine; novantrone; teniposide; edatrexate; daunomycin; aminopterin; xeloda; ibandronate; irinotecan (Camptosar, CPT-11) (including the treatment regimen of irinotecan with 5-FU and leucovorin); topoisomerase inhibitor RFS 2000; difluoromethylornithine (DMFO); retinoids such as retinoic acid; capecitabine; combretastatin; leucovorin (LV); oxaliplatin, including the oxaliplatin treatment regimen (FOLFOX); lapatinib (Tykerb); inhibitors of PKC- α , Raf, H-Ras, EGFR (e.g., erlotinib (Tarceva)) and VEGF-A that reduce cell proliferation and pharmaceutically acceptable salts, acids or derivatives of any of the above. In addition, the methods of treatment can further include the use of radiation. In addition, the methods of treatment can further include the use of photodynamic therapy.

Accordingly, in some embodiments, the present invention relates to combination therapies using the Clec9A binding agent and a chemotherapeutic agent. In some embodiments, the present invention relates to administration of the Clec9A binding agent to a patient undergoing treatment with a chemotherapeutic agent. In some embodiments, the chemotherapeutic agent is a DNA-intercalating agent such as, without limitation, doxorubicin, cisplatin, daunorubicin, and epirubicin. In an embodiment, the DNA-intercalating agent is doxorubicin.

In illustrative embodiments, the Clec9A binding agent acts synergistically when co-administered with doxorubicin. In an illustrative embodiment, the Clec9A binding agent acts synergistically when co-administered with doxorubicin for use in treating tumor or cancer. For example, co-administration of the Clec9A binding agent and doxorubicin may act synergistically to reduce or eliminate the tumor or cancer, or slow the growth and/or progression and/or metastasis of the tumor or cancer. In illustrative embodiments, the combination of the Clec9A binding agent and doxorubicin may exhibit improved safety profiles when compared to the agents used alone in the context of monotherapy. In illustrative embodiments, the Clec9A binding agent and doxorubicin may be administered at doses that are lower than the doses employed when the agents are used in the context of monotherapy. In some embodiments, the Clec9A binding agent comprises a mutated interferon such as a mutated IFN α . In illustrative embodiments, the mutated IFN α comprises one or more mutations at positions 148, 149, and 153 with reference to SEQ ID NO: 86 or SEQ ID NO: 87, such as the substitutions M148A, R149A, and L153A.

In some embodiments, the present invention relates to combination therapy with one or more immune-modulating agents, for example, without limitation, agents that modulate immune checkpoint. In various embodiments, the immune-modulating agent targets one or more of PD-1, PD-L1, and PD-L2. In various embodiments, the immune-modulating agent is PD-1 inhibitor. In various embodiments, the immune-modulating agent is an antibody specific for one or more of PD-1, PD-L1, and PD-L2. For instance, in some embodiments, the immune-modulating agent is an antibody such as, by way of non-limitation, nivolumab, (ONO-4538/BMS-936558, MDX1106, OPDIVO, BRISTOL MYERS SQUIBB), pembrolizumab (KEYTRUDA, MERCK), pidilizumab (CT-011, CURE TECH), MK-3475 (MERCK), BMS 936559 (BRISTOL MYERS SQUIBB), MPDL3280A (ROCHE). In some embodiments, the immune-modulating agent targets one or more of CD137 or CD137L. In various embodiments, the immune-modulating agent is an antibody specific for one or more of CD137 or CD137L. For instance, in some embodiments, the immune-modulating agent is an antibody such as, by way of non-limitation, urelumab (also known as BMS-663513 and anti-4-1BB antibody). In some embodiments, the present chimeric protein is combined with urelumab (optionally with one or more of nivolumab, lirilumab, and urelumab) for the treatment of solid tumors and/or B-cell non-Hodgkins lymphoma and/or head and neck cancer and/or multiple myeloma. In some embodiments, the immune-modulating agent is an agent that targets one or more of CTLA-4, AP2M1, CD80, CD86, SHP-2, and PPP2R5A. In various embodiments, the immune-modulating agent is an antibody specific for one or more of CTLA-4, AP2M1, CD80, CD86, SHP-2, and PPP2R5A. For instance, in some embodiments, the immune-modulating agent is an antibody such as, by way of non-limitation,

ipilimumab (MDX-010, MDX-101, Yervoy, BMS) and/or tremelimumab (Pfizer). In some embodiments, the present chimeric protein is combined with ipilimumab (optionally with bavituximab) for the treatment of one or more of melanoma, prostate cancer, and lung cancer. In various embodiments, the immune-modulating agent targets CD20. In various embodiments, the immune-modulating agent is an antibody specific CD20. For instance, in some embodiments, the immune-modulating agent is an antibody such as, by way of non-limitation, Ofatumumab (GENMAB), obinutuzumab (GAZYVA), AME-133v (APPLIED MOLECULAR EVOLUTION), Ocrelizumab (GENENTECH), TRU-015 (TRUBION/EMERGENT), veltuzumab (IMMU-106).

In some embodiments, the present invention relates to combination therapy using the Clec9A binding agent and a checkpoint inhibitor. In some embodiments, the present invention relates to administration of the Clec9A binding agent to a patient undergoing treatment with a checkpoint inhibitor. In some embodiments, the checkpoint inhibitor is an agent that targets one or more of PD-1, PD-L1, PD-L2, and CTLA-4 (including any of the anti-PD-1, anti-PD-L1, anti-PD-L2, and anti-CTLA-4 agents described herein). In some embodiment, the checkpoint inhibitor is one or more of nivolumab, (ONO-4538/BMS-936558, MDX1106, OPDIVO, BRISTOL MYERS SQUIBB), pembrolizumab (KEYTRUDA, MERCK), pidilizumab (CT-011, CURE TECH), MK-3475 (MERCK), BMS 936559 (BRISTOL MYERS SQUIBB), MPDL3280A (ROCHE), ipilimumab (MDX-010, MDX-101, Yervoy, BMS) and tremelimumab (Pfizer). In an embodiment, the checkpoint inhibitor is an antibody against PD-L1.

In illustrative embodiments, the Clec9A binding agent acts synergistically when co-administered with the anti-PD-L1 antibody. In an illustrative embodiment, the Clec9A binding agent acts synergistically when co-administered with the anti-PD-L1 antibody for use in treating tumor or cancer. For example, co-administration of the Clec9A binding agent and the anti-PD-L1 antibody may act synergistically to reduce or eliminate the tumor or cancer, or slow the growth and/or progression and/or metastasis of the tumor or cancer. In some embodiments, the combination of the Clec9A binding agent and the anti-PD-L1 antibody may exhibit improved safety profiles when compared to the agents used alone in the context of monotherapy. In some embodiments, the Clec9A binding agent and the anti-PD-L1 antibody may be administered at doses that are lower than the doses employed when the agents are used in the context of monotherapy. In some embodiments, the Clec9A binding agent comprises a mutated interferon such as a mutated IFN α . In illustrative embodiments, the mutated IFN α comprises one or more mutations at positions 148, 149, and 153 with reference to SEQ ID NO: 86 or SEQ ID NO: 87, such as the substitutions M148A, R149A, and L153A.

In some embodiments, the present invention relates to combination therapies using the Clec9A binding agent and an immunosuppressive agent. In some embodiments, the present invention relates to administration of the Clec9A binding agent to a patient undergoing treatment with an immunosuppressive agent. In an embodiment, the immunosuppressive agent is TNF.

In illustrative embodiments, the Clec9A binding agent acts synergistically when co-administered with TNF. In an illustrative embodiment, the Clec9A binding agent acts synergistically when co-administered with TNF for use in

treating tumor or cancer. For example, co-administration of the Clec9A binding agent and TNF may act synergistically to reduce or eliminate the tumor or cancer, or slow the growth and/or progression and/or metastasis of the tumor or cancer. In some embodiments, the combination of the Clec9A binding agent and TNF may exhibit improved safety profiles when compared to the agents used alone in the context of monotherapy. In some embodiments, the Clec9A binding agent and TNF may be administered at doses that are lower than the doses employed when the agents are used in the context of monotherapy. In some embodiments, the Clec9A binding agent comprises a mutated interferon such as a mutated IFN α . In illustrative embodiments, the mutated IFN α comprises one or more mutations at positions 148, 149, and 153 with reference to SEQ ID NO: 86 or SEQ ID NO: 87, such as the substitutions M148A, R149A, and L153A.

In some embodiments, the Clec9A binding agent acts synergistically when used in combination with Chimeric Antigen Receptor (CAR) T-cell therapy. In an illustrative embodiment, the Clec9A binding agent acts synergistically when used in combination with CAR T-cell therapy in treating tumor or cancer. In an embodiment, the Clec9A binding agent acts synergistically when used in combination with CAR T-cell therapy in treating blood-based tumors. In an embodiment, the Clec9A binding agent acts synergistically when used in combination with CAR T-cell therapy in treating solid tumors. For example, use of the Clec9A binding agent and CAR T-cells may act synergistically to reduce or eliminate the tumor or cancer, or slow the growth and/or progression and/or metastasis of the tumor or cancer. In various embodiments, the Clec9A binding agent of the invention induces CAR T-cell division. In various embodiments, the Clec9A binding agent of the invention induces CAR T-cell proliferation. In various embodiments, the Clec9A binding agent of the invention prevents anergy of the CAR T cells.

In various embodiments, the CAR T-cell therapy comprises CAR T cells that target antigens (e.g., tumor antigens) such as, but not limited to, carbonic anhydrase IX (CAIX), 5T4, CD19, CD20, CD22, CD30, CD33, CD38, CD47, CS1, CD138, Lewis-Y, L1-CAM, MUC16, ROR-1, IL13R α 2, gp100, prostate stem cell antigen (PSCA), prostate-specific membrane antigen (PSMA), B-cell maturation antigen (BCMA), human papillomavirus type 16 E6 (HPV-16 E6), CD171, folate receptor alpha (FR α), GD2, human epidermal growth factor receptor 2 (HER2), mesothelin, EGFRvIII, fibroblast activation protein (FAP), carcinoembryonic antigen (CEA), and vascular endothelial growth factor receptor 2 (VEGF-R2), as well as other tumor antigens well known in the art. Additional illustrative tumor antigens include, but are not limited to MART-1/Melan-A, gp100, Dipeptidyl peptidase IV (DPPIV), adenosine deaminase-binding protein (ADAbp), cyclophilin b, Colorectal associated antigen (CRC)-0017-1A/GA733, Carcinoembryonic Antigen (CEA) and its immunogenic epitopes CAP-1 and CAP-2, etv6, aml1, Prostate Specific Antigen (PSA) and its immunogenic epitopes PSA-1, PSA-2, and PSA-3, T-cell receptor/CD3-zeta chain, MAGE-family of tumor antigens (e.g., MAGE-A1, MAGE-A2, MAGE-A3, MAGE-A4, MAGE-A5, MAGE-A6, MAGE-A7, MAGE-A8, MAGE-A9, MAGE-A10, MAGE-A11, MAGE-A12, MAGE-Xp2 (MAGE-B2), MAGE-Xp3 (MAGE-B3), MAGE-Xp4 (MAGE-B4), MAGE-C1, MAGE-C2, MAGE-C3, MAGE-C4, MAGE-C5), GAGE-family of tumor antigens (e.g., GAGE-1, GAGE-2, GAGE-3, GAGE-4, GAGE-5, GAGE-6, GAGE-7, GAGE-8, GAGE-9), BAGE, RAGE, LAGE-1, NAG, GnT-V, MUM-1, CDK4, tyrosinase, p53, MUC family,

HER2/neu, p21ras, RCAS1, α -fetoprotein, E-cadherin, α -catenin, β -catenin and γ -catenin, p120ctn, gp100 Pmel117, PRAME, NY-ESO-1, cdc27, adenomatous polyposis coli protein (APC), fodrin, Connexin 37, Ig-idiotype, p15, gp75, GM2 and GD2 gangliosides, viral products such as human papilloma virus proteins, Smad family of tumor antigens, Imp-1, NA, EBV-encoded nuclear antigen (EBNA)-1, brain glycogen phosphorylase, SSX-1, SSX-2 (HOM-MEL-40), SSX-1, SSX-4, SSX-5, SCP-1 CT-7, c-erbB-2, CD19, CD37, CD56, CD70, CD74, CD138, AGS16, MUC1, GPNMB, Ep-CAM, PD-L1, and PD-L2.

Exemplary CAR T-cell therapy include, but are not limited to, JCAR014 (Juno Therapeutics), JCAR015 (Juno Therapeutics), JCAR017 (Juno Therapeutics), JCAR018 (Juno Therapeutics), JCAR020 (Juno Therapeutics), JCAR023 (Juno Therapeutics), JCAR024 (Juno Therapeutics), CTL019 (Novartis), KTE-C19 (Kite Pharma), BPX-401 (Bellicum Pharmaceuticals), BPX-501 (Bellicum Pharmaceuticals), BPX-601 (Bellicum Pharmaceuticals), bb2121 (Bluebird Bio), CD-19 Sleeping Beauty cells (Ziopharm Oncology), UCART19 (Collectis), UCART123 (Collectis), UCART38 (Collectis), UCARTCS1 (Collectis), OXB-302 (Oxford BioMedica, MB-101 (Mustang Bio) and CAR T-cells developed by Innovative Cellular Therapeutics.

In some embodiments, the Clec9A binding agent is used in a method of treating multiple sclerosis (MS) in combination with one or more MS therapeutics including, but not limited to, 3-interferons, glatiramer acetate, T-interferon, IFN- β -2 (U. S. Patent Publication No. 2002/0025304), spirogermaniums (e.g., N-(3-dimethylaminopropyl)-2-aza-8,8-dimethyl-8-germanspiro [4:5] decane, N-(3-dimethylaminopropyl)-2-aza-8,8-diethyl-8-germaspiro [4:5] decane, N-(3-dimethylaminopropyl)-2-aza-8,8-dipropyl-8-germaspiro [4:5] decane, and N-(3-dimethylaminopropyl)-2-aza-8,8-dibutyl-8-germaspiro [4:5] decane), vitamin D analogs (e.g., 1,25 (OH) 2D3, (see, e.g., U.S. Patent No. 5,716,946)), prostaglandins (e.g., latanoprost, brimonidine, PGE1, PGE2 and PGE3, see, e.g., U. S. Patent Publication No. 2002/0004525), tetracycline and derivatives (e.g., minocycline and doxycycline, see, e.g., U.S. Patent Publication No. 20020022608), a VLA-4 binding antibody (see, e.g., U.S. Patent Publication No. 2009/0202527), adrenocorticotrophic hormone, corticosteroid, prednisone, methylprednisone, 2-chlorodeoxyadenosine, mitoxantrone, sulphasalazine, methotrexate, azathioprine, cyclophosphamide, cyclosporin, fumarate, anti-CD20 antibody (e.g., rituximab), and tizanidine hydrochloride.

In some embodiments, the Clec9A binding agent is used in combination with one or more therapeutic agents that treat one or more symptoms or side effects of MS. Such agents include, but are not limited to, amantadine, baclofen, papaverine, meclizine, hydroxyzine, sulfamethoxazole, ciprofloxacin, docusate, pemoline, dantrolene, desmopressin, dexamethasone, tolterodine, phenytoin, oxybutynin, bisacodyl, venlafaxine, amitriptyline, methenamine, clonazepam, isoniazid, vardenafil, nitrofurantoin, psyllium hydrophilic mucilloid, alprostadil, gabapentin, nortriptyline, paroxetine, propantheline bromide, modafinil, fluoxetine, phenazopyridine, methylprednisolone, carbamazepine, imipramine, diazepam, sildenafil, bupropion, and sertraline.

In some embodiments, the Clec9A binding agent is used in a method of treating multiple sclerosis in combination with one or more of the disease modifying therapies (DMTs) described herein (e.g. the agents of Table A). In some embodiments, the present invention provides an improved therapeutic effect as compared to use of one or

more of the DMTs described herein (e.g. the agents listed in the Table below) without the one or more disclosed binding agent. In an embodiment, the combination of the Clec9A binding agent and the one or more DMTs produces synergistic therapeutic effects.

Illustrative Disease Modifying Therapies

Generic Name	Branded Name/Company	Frequency/Route of Delivery/Usual Dose
teriflunomide	AUBAGIO (GENZYME)	Every day; pill taken orally; 7 mg or 14 mg.
interferon beta-1a	AVONEX (BIOGEN IDEC)	Once a week; intramuscular (into the muscle) injection; 30 mcg
interferon beta-1b	BETASERON (BAYER HEALTHCARE PHARMACEUTICALS, INC.)	Every other day; subcutaneous (under the skin) injection; 250 mcg.
glatiramer acetate	COPAXONE (TEVA NEUROSCIENCE)	Every day; subcutaneous (under the skin) injection; 20 mg (20,000 mcg) OR Three times a week; subcutaneous (under the skin) injection; 40 mg (40,000 mcg)
interferon beta-1b	EXTAVIA (NOVARTIS PHARMACEUTICALS CORP.)	Every other day; subcutaneous (under the skin) injection; 250 mcg.
fingolimod	GILENYA (NOVARTIS PHARMACEUTICALS CORP.)	Every day; capsule taken orally; 0.5 mg.
Alemtuzumab (anti-CD52 monoclonal antibody)	LEMTADA (GENZYME)	Intravenous infusion on five consecutive days, followed by intravenous infusion on three consecutive days one year later (12 mg)
mitoxantrone	NOVANTRONE (EMD SERONO)	Four times a year by IV infusion in a medical facility. Lifetime cumulative dose limit of approximately 8–12 doses over 2–3 years (140 mg/m ²).
pegylated interferon beta-1a	PLEGRIDY (BIOGEN IDEC)	Every 14 days; subcutaneous (under the skin) injection; 125 mcg
interferon beta-1a	REBIF (EMD SERONO, INC.)	Three times a week; subcutaneous (under the skin) injection; 44 mcg
dimethyl fumarate (BG-12)	TECFIDERA (BIOGEN IDEC)	Twice a day; capsule taken orally; 120 mg for one week and 240 mg thereafter
Natalizumab (humanized monoclonal antibody VLA-4 antagonist)	TYSABRI (BIOGEN IDEC)	Every four weeks by IV infusion in a registered infusion facility; 300 mg
DMTs in Development		
Amiloride (targets Acid-sensing ion channel-1 Epithelial sodium channel Na ⁺ /H ⁺ exchanger)	PAR PHARMACEUTICAL, PERRIGO COMPANY, SIGMAPHARM LABORATORIES	Oral
ATX-MS-1467 (targets Major histocompatibility complex class II T cell responses to myelin basic protein)	APIPOPE / MERCK SERONO	Intradermal Subcutaneous
BAF312 (targets Sphingosine 1-phosphate (S1P) receptor subtypes S1P1 and S1P5 B cell distribution T cell distribution)	NOVARTIS PHARMA	Oral
BGC20-0134 (targets	BTG PLC	Oral

Generic Name	Branded Name/Company	Frequency/Route of Delivery/Usual Dose
Proinflammatory and anti-inflammatory cytokines)		
BIIB033 (targets LINGO-1 ("leucine-rich repeat and immunoglobulin-like domain-containing, Nogo receptor-interacting protein"))	BIOGEN	Intravenous infusion used in Phase I and Phase II trials Subcutaneous injection used in Phase I trial
Cladribine (targets CD4+ T cells DNA synthesis and repair E-selectin Intracellular adhesion molecule-1 Pro-inflammatory cytokines interleukin 2 and interleukin 2R Pro-inflammatory cytokines interleukin 8 and RANTES Cytokine secretion Monocyte and lymphocyte migration)	MERCK SERONO	Oral
Cyclophosphamide (targets T cells, particularly CD4+ helper T cells B cells)	BAXTER HEALTHCARE CORPORATION	Oral, monthly intravenous pulses
Daclizumab (humanized monoclonal antibody targeting CD25 Immune modulator of T cells)	BIOGEN IDEC/ABBVIE BIOTHERAPEUTICS	Projected to be IM injection once monthly
Dalfampridine (targets Voltage-gated potassium channels Degenerin/epithelial sodium channels L-type calcium channels that contain subunit Cavbeta3)	ACORDA THERAPEUTICS / BIOGEN IDEC	One tablet every 12 hours (extended release), 10 mg twice a day
Dronabinol (targets Cannabinoid receptor CB1 Cannabinoid receptor CB2)	ABBVIE INC.	Oral
Firategrast (targets Alpha4beta1 integrin)	GLAXOSMITHKLINE	Oral
GNbAC1MSRV-Env (targets envelope protein of the MS-associated retrovirus)	GENEURO SA / SERVIER	Intravenous infusion
Idebenone (targets Reactive oxygen species)	SANTHERA PHARMACEUTICALS	Oral Dose in clinical trial for PPMS is 2250 mg per day (750 mg dose, 3 times per day)
Imilecleucel-T (targets Myelin-specific, autoreactive T cells)	OPEXA THERAPEUTICS / MERCK SERONO	Subcutaneous Given 5 times per year, according to information from the manufacturer
Laquinimod	TEVA	Projected to be 0.6 mg or 1.2 mg oral tablet taken daily
Masitinib (targets KIT (a stem cell factor, also called c-KIT) receptor as well as select other tyrosine kinases Mast cells)	AB SCIENCE	Oral
MEDI-551 (targets CD19, a	MEDIMMUNE	Intravenous Subcutaneous

Generic Name	Branded Name/Company	Frequency/Route of Delivery/Usual Dose
B cell-specific antigen that is part of the B cell receptor complex and that functions in determining the threshold for B cell activation B cells Plasmablasts, B cells that express CD19 (but not CD20) and that secrete large quantities of antibodies; depletion of plasmablasts may be useful in autoimmune diseases involving pathogenic autoantibodies)		
Minocycline (targets T cells Microglia Leukocyte migration Matrix metalloproteinases)	VARIOUS	Oral Available as pellet-filled capsules and an oral suspension
MIS416 (targets Innate immune system Pathogen-associated molecular pattern recognition receptors of the innate immune system Myeloid cells of the innate immune system, which might be able to remodel the deregulated immune system activity that occurs in SPMS)	INNATE IMMUNOTHERAPEUTICS	Intravenous
Mycophenolate mofetil (targets Purine synthesis)	MANUFACTURED BY GENENTECH	Oral
Naltrexone (targets Opioid receptors Toll-like receptor 4)	VARIOUS	Given at low doses (3 to 4.5 mg per day) in oral form as "Low-dose naltrexone" (or "LDN")
Ocrelizumab and Ofatumumab (humanized monoclonal antibodies targeting CD20 B cell suppression	ROCHE / GSK	Projected to be IV infusion
ONO-4641 (targets Sphingosine 1-phosphate receptor)	ONO PHARMACEUTICAL CO.	Oral
Phenytoin (targets Sodium channels)	PFIZER	Intravenous Intramuscular (less favored option) Oral
Ponesimod	ACTELION	To be determined
Raltegravir (targets Retroviral integrase Herpesvirus DNA packaging terminase)	MERCK	Oral 400 mg tablet twice daily, according to information from the manufacturer
RHB-104	REDHILL BIOPHARMA LIMITED	95 mg clarithromycin, 45 mg rifabutin, and 10 mg clofazimine
Riluzole (targets Glutamatergic neurotransmission	COVIS PHARMA / SANOFI	Oral

Generic Name	Branded Name/Company	Frequency/Route of Delivery/Usual Dose
Glutamate uptake and release Voltage-gated sodium channels Protein kinase C)		

MS disease progression may be most intensive, and most damaging, at the earliest stages of disease progression. Accordingly, counter to many reimbursement policies and physician practice in light of, for example, costs and side effect mitigation, it may be most beneficial for a patient's long term disease status to begin treatment with the most intensive DMTs, for instance so-called second-line therapies. In some embodiments, a patient is treated with a regimen of the Clec9A binding agent in combination with a second-line therapy. Such a combination is used to reduce the side effect profile of one or more second-line therapies. In some embodiments, the combination is used to reduce dose of frequency of administration of one or more second-line therapies. For example, the doses of agents listed in the Table provided above may be reduced by about 50%, or about 40%, or about 30%, or about 25% in the context of the combination and the/or the frequency of dosing may be decreased to be half as often, or a third as often or may be reduced from, for example, daily to every other day or weekly, every other day to weekly or bi-weekly, weekly to bi-weekly or monthly, *etc.* Accordingly, in some embodiments, the Clec9A binding agent increase patient adherence by allowing for more convenient treatment regimens. Further, some DMTs have a suggested lifetime dose limitation e.g. for mitoxantrone, the lifetime cumulative dose should be strictly limited to 140 mg/m², or 2 to 3 years of therapy. In some embodiments, supplementation with the Clec9A binding agent preserves patient's access to mitoxantrone by allowing for lower or less frequent dosing with this DMT.

In some embodiments, the patient is a naive patient, who has not received treatment with one or more DMTs, and the Clec9A binding agent is used to buffer the side effects of a second-line therapy. Accordingly, the naive patient is able to benefit from the long-term benefits of a second-line therapy at disease outset. In some embodiments, the Clec9A binding agent is used as an entry therapy that precedes the use of a second-line therapy. For example, the Clec9A binding agent may be administered for an initial treatment period of about 3 months to stabilize disease and then the patient may be transitioned to a maintenance therapy of a second line agent.

It is generally believed that naive patients are more likely to respond to therapy as compared to patients that have received, and perhaps failed one or more DMT. In some embodiments, the Clec9a binding agent finds use in patients that have received, and perhaps failed one or more DMT. For example, in some embodiments, the Clec9A binding agent increases the therapeutic effect in patients that have received, and perhaps failed one or more DMT and may allow these patients to respond like naive patients.

In some embodiments, the patient has received or is receiving treatment with one or more DMTs and is not responding well. For example, the patient may be refractory or poorly responsive to one or more DMTs. In some embodiments, the patient is refractory, or poorly responsive to one or more of teriflunomide (AUBAGIO (GENZYME)); interferon beta-1a (AVONEX (BIAGEN IDEC)); interferon beta-1b (BETASERON (BAYER

HEALTHCARE PHARMACEUTICALS, INC.); glatiramer acetate (COPAXONE (TEVA NEUROSCIENCE)); interferon beta-1b (EXTAVIA (NOVARTIS PHARMACEUTICALS CORP.)); fingolimod (GILENYA (NOVARTIS PHARMACEUTICALS CORP.)); alemtuzumab (LEMTADA (GENZYME)); mitoxantrone (NOVANTRONE (EMD SERONO)); pegylated interferon beta-1a (PLEGRIDY (BIOGEN IDEC)); interferon beta-1a (REBIF (EMD SERONO, INC.)); dimethyl fumarate (BG-12) (TECFIDERA (BIOGEN IDEC)); and natalizumab (TYSABRI (BIOGEN IDEC)). In some embodiments, the one or more disclosed binding agent results in a therapeutic benefit of one or more DMTs in the patient and therefore reduces or eliminates the non-responsiveness to the DMT. For instance, this may spare the patient therapy with one or more DMTs at a higher dosing or frequency.

In patients with more aggressive disease, one approach is an induction treatment model, where a therapy with strong efficacy but strong safety concerns would be given first, followed by a maintenance therapy. An example of such a model might include initial treatment with alemtuzumab, followed by IFN- β , GA, or BG-12. In some embodiments, the one or more disclosed binding agent is used to prevent the need to switch therapies for maintenance. In some embodiments, the one or more disclosed binding agent is used to as maintenance therapy to one or more DMTs, including second line therapies. In some embodiments, the one or more disclosed binding agent is used to as first therapy in an induction, followed by another DMT as a maintenance therapy- such as, for example, a first line therapy.

In some embodiments, the one or more disclosed binding agent may be administered for an initial treatment period of about 3 months to stabilize disease and then the patient may be transitioned to a maintenance therapy of a first line agent.

In various embodiments, the one or more disclosed binding agent is used to reduce one or more side effects of a DMT, including without limitation any agent disclosed herein. For example, the one or more disclosed binding agent may be used in a regimen that allows dose sparing for one or more DMTs and therefore results in fewer side effects. For example, in some embodiments, the one or more disclosed binding agent may reduce one or more side effects of AUBAGIO or related agents, which may include hair thinning, diarrhea, flu, nausea, abnormal liver tests and unusual numbness or tingling in the hands or feet (paresthesias), levels of white blood cells, which can increase the risk of infections; increase in blood pressure; and severe liver damage. In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of AVONEX or related agents which include flu-like symptoms following injection, depression, mild anemia, liver abnormalities, allergic reactions, and heart problems. In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of BETASERON or related agents which include flu-like symptoms following injection, injection site reactions, allergic reactions, depression, liver abnormalities, and low white blood cell counts. In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of COPAXONE or related agents which include injection site reactions, vasodilation (dilation of blood vessels); chest pain; a reaction immediately after injection, which includes anxiety, chest pain, palpitations, shortness of breath, and flushing. In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of EXTAVIA or related agents which include flu-like symptoms following injection, injection site

reactions, allergic reactions, depression, liver abnormalities, and low white blood cell counts. In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of GILENYA or related agents which include headache, flu, diarrhea, back pain, liver enzyme elevations, cough, slowed heart rate following first dose, infections, and swelling in the eye. In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of LEMTRADA or related agents which include rash, headache, fever, nasal congestion, nausea, urinary tract infection, fatigue, insomnia, upper respiratory tract infection, hives, itching, thyroid gland disorders, fungal Infection, pain in joints, extremities and back, diarrhea, vomiting, flushing, and infusion reactions (including nausea, hives, itching, insomnia, chills, flushing, fatigue, shortness of breath, changes in the sense of taste, indigestion, dizziness, pain). In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of NOVANTRONE or related agents which include blue-green urine 24 hours after administration; infections, bone marrow suppression (fatigue, bruising, low blood cell counts), nausea, hair thinning, bladder infections, mouth sores, and serious liver and heart damage. In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of PLEGRIDY or related agents which include flu-like symptoms following injection, injection site reactions, depression, mild anemia, liver abnormalities, allergic reactions, and heart problems. In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of REBIF or related agents which include flu-like symptoms following injection, injection site reactions, liver abnormalities, depression, allergic reactions, and low red or white blood cell counts. In some embodiments, one or more disclosed binding agent may reduce one or more side effects of TECFIDERA or related agents which include flushing (sensation of heat or itching and a blush on the skin), gastrointestinal issues (nausea, diarrhea, abdominal pain), rash, protein in the urine, elevated liver enzymes; and reduction in blood lymphocyte (white blood cell) counts. In some embodiments, the one or more disclosed binding agent may reduce one or more side effects of TYSABRI or related agents which include headache, fatigue, urinary tract infections, depression, respiratory tract infections, joint pain, upset stomach, abdominal discomfort, diarrhea, vaginitis, pain in the arms or legs, rash, allergic or hypersensitivity reactions within two hours of infusion (dizziness, fever, rash, itching, nausea, flushing, low blood pressure, difficulty breathing, chest pain).

In some embodiments, the present invention relates to combination therapy with one or more chimeric agents described in WO 2013/10779, WO 2015/007536, WO 2015/007520, WO 2015/007542, and WO 2015/007903, the entire contents of which are hereby incorporated by reference in their entireties.

In some embodiments, inclusive of, without limitation, infectious disease applications, the present invention pertains to anti-infectives as additional therapeutic agents. In some embodiments, the anti-infective is an anti-viral agent including, but not limited to, Abacavir, Acyclovir, Adefovir, Amprenavir, Atazanavir, Cidofovir, Darunavir, Delavirdine, Didanosine, Docosanol, Efavirenz, Elvitegravir, Emtricitabine, Enfuvirtide, Etravirine, Famciclovir, and Foscarnet. In some embodiments, the anti-infective is an anti-bacterial agent including, but not limited to, cephalosporin antibiotics (cephalexin, cefuroxime, cefadroxil, cefazolin, cephalothin, cefaclor, cefamandole, cefoxitin, cefprozil, and ceftobiprole); fluoroquinolone antibiotics (cipro, Levaquin, floxin, tequin,

avelox, and norflox); tetracycline antibiotics (tetracycline, minocycline, oxytetracycline, and doxycycline); penicillin antibiotics (amoxicillin, ampicillin, penicillin V, dicloxacillin, carbenicillin, vancomycin, and methicillin); monobactam antibiotics (aztreonam); and carbapenem antibiotics (ertapenem, doripenem, imipenem/cilastatin, and meropenem). In some embodiments, the anti-infectives include anti-malarial agents (e.g., chloroquine, quinine, mefloquine, primaquine, doxycycline, artemether/lumefantrine, atovaquone/proguanil and sulfadoxine/pyrimethamine), metronidazole, tinidazole, ivermectin, pyrantel pamoate, and albendazole.

In some embodiments, inclusive, without limitation, of autoimmune applications, the additional therapeutic agent is an immunosuppressive agent. In some embodiments, the immunosuppressive agent is an anti-inflammatory agent such as a steroidal anti-inflammatory agent or a non-steroidal anti-inflammatory agent (NSAID). Steroids, particularly the adrenal corticosteroids and their synthetic analogues, are well known in the art. Examples of corticosteroids useful in the present invention include, without limitation, hydrocortisone, alpha-methyl dexamethasone, beta-methyl betamethasone, beclomethasone dipropionate, betamethasone benzoate, betamethasone dipropionate, betamethasone valerate, clobetasol valerate, desonide, desoxymethasone, dexamethasone, diflorasone diacetate, diflucortolone valerate, fluadrenolone, flucorolone acetonide, flumethasone pivalate, fluosinolone acetonide, fluocinonide, flucortine butylester, fluocortolone, fluprednidene (fluprednylidene) acetate, flurandrenolone, halcinonide, hydrocortisone acetate, hydrocortisone butyrate, methylprednisolone, triamcinolone acetonide, cortisone, cortodoxone, flucetonide, fludrocortisone, difluorosone diacetate, fluradrenolone acetonide, medrysone, amcinafel, amcinafide, betamethasone and the balance of its esters, chloroprednisone, clocortelone, clescinolone, dichlorisone, difluprednate, flucorolone, flunisolide, fluoromethalone, fluperolone, fluprednisolone, hydrocortisone, meprednisone, paramethasone, prednisolone, prednisone, beclomethasone dipropionate. (NSAIDS) that may be used in the present invention, include but are not limited to, salicylic acid, acetyl salicylic acid, methyl salicylate, glycol salicylate, salicylides, benzyl-2,5-diacetoxybenzoic acid, ibuprofen, flurbiprofen, naproxen, ketoprofen, etofenamate, phenylbutazone, and indomethacin. In some embodiments, the immunosuppressive agent may be cytostatics such as alkylating agents, antimetabolites (e.g., azathioprine, methotrexate), cytotoxic antibiotics, antibodies (e.g., basiliximab, daclizumab, and muromonab), anti-immunophilins (e.g., cyclosporine, tacrolimus, sirolimus), interferons, opioids, TNF binding proteins, mycophenolates, and small biological agents (e.g., fingolimod, myriocin). Additional anti-inflammatory agents are described, for example, in U.S. Patent No. 4,537,776, the entire contents of which is incorporated by reference herein.

In some embodiments, the Clec9A binding agent described herein, include derivatives that are modified, *i.e.*, by the covalent attachment of any type of molecule to the composition such that covalent attachment does not prevent the activity of the composition. For example, but not by way of limitation, derivatives include composition that have been modified by, *inter alia*, glycosylation, lipidation, acetylation, pegylation, phosphorylation, amidation, derivatization by known protecting/blocking groups, proteolytic cleavage, linkage to a cellular ligand or other protein, *etc.* Any of numerous chemical modifications can be carried out by known techniques, including, but not limited to specific chemical cleavage, acetylation, formylation, metabolic synthesis of tunicamycin, *etc.*

In still other embodiments, the Clec9A binding agent described herein further comprise a cytotoxic agent, comprising, in illustrative embodiments, a toxin, a chemotherapeutic agent, a radioisotope, and an agent that causes apoptosis or cell death. Such agents may be conjugated to a composition described herein.

The Clec9A binding agent described herein may thus be modified post-translationally to add effector moieties such as chemical linkers, detectable moieties such as for example fluorescent dyes, enzymes, substrates, bioluminescent materials, radioactive materials, and chemiluminescent moieties, or functional moieties such as for example streptavidin, avidin, biotin, a cytotoxin, a cytotoxic agent, and radioactive materials.

Illustrative cytotoxic agents include, but are not limited to, methotrexate, aminopterin, 6-mercaptopurine, 6-thioguanine, cytarabine, 5-fluorouracil decarbazine; alkylating agents such as mechlorethamine, thioepa chlorambucil, melphalan, carmustine (BSNU), mitomycin C, lomustine (CCNU), 1-methylnitrosourea, cyclophosphamide, mechlorethamine, busulfan, dibromomannitol, streptozotocin, mitomycin C, cis-dichlorodiamine platinum (II) (DDP) cisplatin and carboplatin (paraplatin); anthracyclines include daunorubicin (formerly daunomycin), doxorubicin (adriamycin), detorubicin, carminomycin, idarubicin, epirubicin, mitoxantrone and bisantrene; antibiotics include dactinomycin (actinomycin D), bleomycin, calicheamicin, mithramycin, and anthramycin (AMC); and antimetabolic agents such as the vinca alkaloids, vincristine and vinblastine. Other cytotoxic agents include paclitaxel (taxol), ricin, pseudomonas exotoxin, gemcitabine, cytochalasin B, gramicidin D, ethidium bromide, emetine, etoposide, teniposide, colchicin, dihydroxy anthracin dione, 1-dehydrotestosterone, glucocorticoids, procaine, tetracaine, lidocaine, propranolol, puromycin, procarbazine, hydroxyurea, asparaginase, corticosteroids, mytostane (O,P'-(DDD)), interferons, and mixtures of these cytotoxic agents.

Further cytotoxic agents include, but are not limited to, chemotherapeutic agents such as carboplatin, cisplatin, paclitaxel, gemcitabine, calicheamicin, doxorubicin, 5-fluorouracil, mitomycin C, actinomycin D, cyclophosphamide, vincristine, bleomycin, VEGF antagonists, EGFR antagonists, platins, taxols, irinotecan, 5-fluorouracil, gemcitabine, leucovorine, steroids, cyclophosphamide, melphalan, vinca alkaloids (e.g., vinblastine, vincristine, vindesine and vinorelbine), mustines, tyrosine kinase inhibitors, radiotherapy, sex hormone antagonists, selective androgen receptor modulators, selective estrogen receptor modulators, PDGF antagonists, TNF antagonists, IL-1 antagonists, interleukins (e.g. IL-12 or IL-2), IL-12R antagonists, Toxin conjugated monoclonal antibodies, tumor antigen specific monoclonal antibodies, Erbitux, Avastin, Pertuzumab, anti-CD20 antibodies, Rituxan, ocrelizumab, ofatumumab, DXL625, HERCEPTIN®, or any combination thereof. Toxic enzymes from plants and bacteria such as ricin, diphtheria toxin and Pseudomonas toxin may be conjugated to the therapeutic agents (e.g. antibodies) to generate cell-type-specific-killing reagents (Youle, *et al.*, Proc. Nat'l Acad. Sci. USA 77:5483 (1980); Gilliland, *et al.*, Proc. Nat'l Acad. Sci. USA 77:4539 (1980); Krolick, *et al.*, Proc. Nat'l Acad. Sci. USA 77:5419 (1980)).

Other cytotoxic agents include cytotoxic ribonucleases as described by Goldenberg in U.S. Pat. No. 6,653,104. Embodiments of the invention also relate to radioimmunoconjugates where a radionuclide that emits alpha or

beta particles is stably coupled to the Clec9A binding agent, with or without the use of a complex-forming agent. Such radionuclides include beta-emitters such as Phosphorus-32, Scandium-47, Copper-67, Gallium-67, Yttrium-88, Yttrium-90, Iodine-125, Iodine-131, Samarium-153, Lutetium-177, Rhenium-186 or Rhenium-188, and alpha-emitters such as Astatine-211, Lead-212, Bismuth-212, Bismuth-213 or Actinium-225.

Illustrative detectable moieties further include, but are not limited to, horseradish peroxidase, acetylcholinesterase, alkaline phosphatase, beta-galactosidase and luciferase. Further illustrative fluorescent materials include, but are not limited to, rhodamine, fluorescein, fluorescein isothiocyanate, umbelliferone, dichlorotriazinylamine, phycoerythrin and dansyl chloride. Further illustrative chemiluminescent moieties include, but are not limited to, luminol. Further illustrative bioluminescent materials include, but are not limited to, luciferin and aequorin. Further illustrative radioactive materials include, but are not limited to, Iodine-125, Carbon-14, Sulfur-35, Tritium and Phosphorus-32.

Methods of Treatment

Methods and compositions described herein have application to treating various diseases and disorders, including, but not limited to cancer, infections, immune disorders, and inflammatory diseases or conditions.

Further, any of the present agents may be for use in the treating, or the manufacture of a medicament for treating, various diseases and disorders, including, but not limited to cancer, infections, immune disorders, inflammatory diseases or conditions, and autoimmune diseases.

In some embodiments, the present invention relates to the treatment of, or a patient having cancer. As used herein, cancer refers to any uncontrolled growth of cells that may interfere with the normal functioning of the bodily organs and systems, and includes both primary and metastatic tumors. Primary tumors or cancers that migrate from their original location and seed vital organs can eventually lead to the death of the subject through the functional deterioration of the affected organs. A metastasis is a cancer cell or group of cancer cells, distinct from the primary tumor location, resulting from the dissemination of cancer cells from the primary tumor to other parts of the body. Metastases may eventually result in death of a subject. For example, cancers can include benign and malignant cancers, polyps, hyperplasia, as well as dormant tumors or micrometastases.

Illustrative cancers that may be treated include, but are not limited to, basal cell carcinoma, biliary tract cancer; bladder cancer; bone cancer; brain and central nervous system cancer; breast cancer; cancer of the peritoneum; cervical cancer; choriocarcinoma; colon and rectum cancer; connective tissue cancer; cancer of the digestive system; endometrial cancer; esophageal cancer; eye cancer; cancer of the head and neck; gastric cancer (including gastrointestinal cancer); glioblastoma; hepatic carcinoma; hepatoma; intra-epithelial neoplasm; kidney or renal cancer; larynx cancer; leukemia; liver cancer; lung cancer (e.g., small-cell lung cancer, non-small cell lung cancer, adenocarcinoma of the lung, and squamous carcinoma of the lung); melanoma; myeloma; neuroblastoma; oral cavity cancer (lip, tongue, mouth, and pharynx); ovarian cancer; pancreatic cancer; prostate cancer; retinoblastoma; rhabdomyosarcoma; rectal cancer; cancer of the respiratory system; salivary gland carcinoma; sarcoma; skin cancer; squamous cell cancer; stomach cancer; testicular cancer; thyroid cancer;

uterine or endometrial cancer; cancer of the urinary system; vulval cancer; lymphoma including Hodgkin's and non-Hodgkin's lymphoma, as well as B-cell lymphoma (including low grade/follicular non-Hodgkin's lymphoma (NHL); small lymphocytic (SL) NHL; intermediate grade/follicular NHL; intermediate grade diffuse NHL; high grade immunoblastic NHL; high grade lymphoblastic NHL; high grade small non-cleaved cell NHL; bulky disease NHL; mantle cell lymphoma; AIDS-related lymphoma; and Waldenstrom's Macroglobulinemia; chronic lymphocytic leukemia (CLL); acute lymphoblastic leukemia (ALL); acute myeloid leukemia (AML); Hairy cell leukemia; chronic myeloblastic leukemia; as well as other carcinomas and sarcomas; and post-transplant lymphoproliferative disorder (PTLD), as well as abnormal vascular proliferation associated with phakomatoses, edema (e.g. that associated with brain tumors), and Meigs' syndrome.

In various embodiments, the present invention provides Clec9A binding agents which are part of a chimera that further comprises modified signaling agents for the treatment of cancer. In some embodiments, the Clec9A binding agents of the invention significantly reduce and/or eliminate tumors. In some embodiments, the present Clec9A binding agents significantly reduce and/or eliminate tumors when administered to a subject in combination with other anti-cancer agents such as chemotherapeutic agents, checkpoint inhibitors, and immunosuppressive agents. In various embodiments, the combination of Clec9A binding agents and other anti-cancer agents synergistically reduced tumor size and/or eliminated tumor cells.

In various embodiments, the present invention relates to cancer combination therapies with a Clec9A binding agent that is part of a chimera comprising one or more targeting moieties and one or more modified signaling agents. Accordingly, the present invention provides for chimeric or fusion proteins that include, for example, a targeting moiety against Clec9A and one or more signaling agents and uses thereof in combination with anti-cancer agents.

For instance, in various embodiments, the present invention pertains to combination therapies for cancer involving chimeras of a Clec9A binding agent described herein and a modified signaling agent, including, without limitation a mutated human interferon, such as IFN alpha, including human interferon alpha 2.

In other embodiments, the present Clec9A binding agent is part of a chimera that comprises multiple targeting moieties and therefore be present in bispecific or trispecific formats. For instance, in various embodiments, the present invention pertains to combination therapies for cancer involving chimeras of a Clec9A binding agent and a checkpoint inhibitor binding agent (e.g. anti-PD-L1, anti-PD-1, anti-PD-L2, or anti-CTLA) described herein and a modified signaling agent, including, without limitation a mutated human interferon, such as IFN alpha, including human interferon alpha 2.

In various embodiments, the signaling agent is modified to have reduced affinity or activity for one or more of its receptors, which allows for attenuation of activity (inclusive of agonism or antagonism) and/or prevents non-specific signaling or undesirable sequestration of the chimeric protein. In some embodiments, the reduced affinity or activity at the receptor is restorable by attachment with one or more of the targeting moieties described herein.

In some embodiments, the present invention relates to the treatment of, or a patient having a microbial infection and/or chronic infection. Illustrative infections include, but are not limited to, HIV/AIDS, tuberculosis, osteomyelitis, hepatitis B, hepatitis C, Epstein-Barr virus or parvovirus, T cell leukemia virus, bacterial overgrowth syndrome, fungal or parasitic infections.

In various embodiments, the present compositions are used to treat or prevent one or more inflammatory diseases or conditions, such as inflammation, acute inflammation, chronic inflammation, respiratory disease, atherosclerosis, restenosis, asthma, allergic rhinitis, atopic dermatitis, septic shock, rheumatoid arthritis, inflammatory bowel disease, inflammatory pelvic disease, pain, ocular inflammatory disease, celiac disease, Leigh Syndrome, Glycerol Kinase Deficiency, Familial eosinophilia (FE), autosomal recessive spastic ataxia, laryngeal inflammatory disease; Tuberculosis, Chronic cholecystitis, Bronchiectasis, Silicosis and other pneumoconioses.

In various embodiments, the present invention has application to treating autoimmune and/or neurodegenerative diseases.

In various embodiments, the present compositions are used to treat or prevent one or more conditions characterized by undesirable CTL activity, and/or a conditions characterized by high levels of cell death. For instance, in various embodiments, the present compositions are used to treat or prevent one or more conditions associated with uncontrolled or overactive immune response.

In various embodiments, the present compositions are used to treat or prevent one or more autoimmune and/or neurodegenerative diseases or conditions, such as MS, diabetes mellitus, lupus, celiac disease, Crohn's disease, ulcerative colitis, Guillain-Barre syndrome, scleroderms, Goodpasture's syndrome, Wegener's granulomatosis, autoimmune epilepsy, Rasmussen's encephalitis, Primary biliary sclerosis, Sclerosing cholangitis, Autoimmune hepatitis, Addison's disease, Hashimoto's thyroiditis, Fibromyalgia, Menier's syndrome; transplantation rejection (e.g., prevention of allograft rejection) pernicious anemia, rheumatoid arthritis, systemic lupus erythematosus, dermatomyositis, Sjogren's syndrome, lupus erythematosus, myasthenia gravis, Reiter's syndrome, Grave's disease, and other autoimmune diseases.

In various embodiments, the present invention is used to treat or prevent various autoimmune and/or neurodegenerative diseases. In some embodiments, the autoimmune and/or neurodegenerative diseases selected from MS (including without limitation the subtypes described herein), Alzheimer's disease (including, without limitation, Early-onset Alzheimer's, Late-onset Alzheimer's, and Familial Alzheimer's disease (FAD), Parkinson's disease and parkinsonism (including, without limitation, Idiopathic Parkinson's disease, Vascular parkinsonism, Drug-induced parkinsonism, Dementia with Lewy bodies, Inherited Parkinson's, Juvenile Parkinson's), Huntington's disease, Amyotrophic lateral sclerosis (ALS, including, without limitation, Sporadic ALS, Familial ALS, Western Pacific ALS, Juvenile ALS, Hirayama Disease).

In various embodiments, the present invention is used to treat or prevent MS. In various embodiments, the Clec9a binding agents as described herein are used to eliminate and reduce multiple MS symptoms. Illustrative

symptoms associated with multiple sclerosis, which can be prevented or treated with the compositions and methods described herein, include: optic neuritis, diplopia, nystagmus, ocular dysmetria, internuclear ophthalmoplegia, movement and sound phosphenes, afferent pupillary defect, paresis, monoparesis, paraparesis, hemiparesis, quadraparesis, plegia, paraplegia, hemiplegia, tetraplegia, quadraplegia, spasticity, dysarthria, muscle atrophy, spasms, cramps, hypotonia, clonus, myoclonus, myokymia, restless leg syndrome, footdrop, dysfunctional reflexes, paraesthesia, anaesthesia, neuralgia, neuropathic and neurogenic pain, l'hermitte's sign, proprioceptive dysfunction, trigeminal neuralgia, ataxia, intention tremor, dysmetria, vestibular ataxia, vertigo, speech ataxia, dystonia, dysidiadochokinesia, frequent micturation, bladder spasticity, flaccid bladder, detrusor-sphincter dyssynergia, erectile dysfunction, anorgasmy, frigidity, constipation, fecal urgency, fecal incontinence, depression, cognitive dysfunction, dementia, mood swings, emotional lability, euphoria, bipolar syndrome, anxiety, aphasia, dysphasia, fatigue, Uhthoff's symptom, gastroesophageal reflux, and sleeping disorders. Mitigation or amelioration or one more of these symptoms in a subject can be achieved by the one or more agent as described herein.

In various embodiments, the Clec9A binding agents as described herein is used to treat or prevent clinically isolated syndrome (CIS). A clinically isolated syndrome (CIS) is a single monosymptomatic attack compatible with MS, such as optic neuritis, brain stem symptoms, and partial myelitis. Patients with CIS that experience a second clinical attack are generally considered to have clinically definite multiple sclerosis (CDMS). Over 80 percent of patients with CIS and MRI lesions go on to develop MS, while approximately 20 percent have a self-limited process. Patients who experience a single clinical attack consistent with MS may have at least one lesion consistent with multiple sclerosis prior to the development of clinically definite multiple sclerosis. In various embodiments, the presently described Clec9a binding agents is used to treat CIS so it does not develop into MS, including, for example RRMS.

In various embodiments, the Clec9A binding agents as described herein are used to treat or prevent radiologically isolated syndrome (RIS). In RIS, incidental imaging findings suggest inflammatory demyelination in the absence of clinical signs or symptoms. In various embodiments, the Clec9A binding agent is used to treat RIS so it does not develop into MS, including, for example RRMS.

In various embodiments, the Clec9A binding agents as described herein are used to treat one or more of benign multiple sclerosis; relapsing-remitting multiple sclerosis (RRMS); secondary progressive multiple sclerosis (SPMS); progressive relapsing multiple sclerosis (PRMS); and primary progressive multiple sclerosis (PPMS).

Benign multiple sclerosis is a retrospective diagnosis which is characterized by 1-2 exacerbations with complete recovery, no lasting disability and no disease progression for 10-15 years after the initial onset. Benign multiple sclerosis may, however, progress into other forms of multiple sclerosis. In various embodiments, the Clec9a binding agent is used to treat benign multiple sclerosis so it does not develop into MS.

Patients suffering from RRMS experience sporadic exacerbations or relapses, as well as periods of remission. Lesions and evidence of axonal loss may or may not be visible on MRI for patients with RRMS. In various

embodiments, the Clec9a binding agents as described herein are used to treat RRMS. In some embodiments, RRMS includes patients with RRMS; patients with SPMS and superimposed relapses; and patients with CIS who show lesion dissemination on subsequent MRI scans according to McDonald's criteria. A clinical relapse, which may also be used herein as "relapse," "confirmed relapse," or "clinically defined relapse," is the appearance of one or more new neurological abnormalities or the reappearance of one or more previously observed neurological abnormalities. This change in clinical state must last at least 48 hours and be immediately preceded by a relatively stable or improving neurological state of at least 30 days. In some embodiments, an event is counted as a relapse when the subject's symptoms are accompanied by observed objective neurological changes, consistent with an increase of at least 1.00 in the Expanded Disability Status Scale (EDSS) score or one grade in the score of two or more of the seven FS or two grades in the score of one of FS as compared to the previous evaluation.

SPMS may evolve from RRMS. Patients afflicted with SPMS have relapses, a diminishing degree of recovery during remissions, less frequent remissions and more pronounced neurological deficits than RRMS patients. Enlarged ventricles, which are markers for atrophy of the corpus callosum, midline center and spinal cord, are visible on MRI of patients with SPMS. In various embodiments, the Clec9a binding agents as described herein is used to treat RRMS so it does not develop into SPMS.

PPMS is characterized by a steady progression of increasing neurological deficits without distinct attacks or remissions. Cerebral lesions, diffuse spinal cord damage and evidence of axonal loss are evident on the MRI of patients with PPMS. PPMS has periods of acute exacerbations while proceeding along a course of increasing neurological deficits without remissions. Lesions are evident on MRI of patients suffering from PRMS. In various embodiments, the Clec9A binding agent as described herein is used to treat RRMS and/or SPMS so it does not develop into PPMS.

In some embodiments, the Clec9A binding agents as described herein are used in a method of treatment of relapsing forms of MS. In some embodiments, the Clec9A binding agent is used in a method of treatment of relapsing forms of MS to slow the accumulation of physical disability and/or reduce the frequency of clinical exacerbations, and, optionally, for patients who have experienced a first clinical episode and have MRI features consistent with MS. In some embodiments, the Clec9a binding agents as described herein are used in a method of treatment of worsening relapsing-remitting MS, progressive-relapsing MS or secondary-progressive MS to reduce neurologic disability and/or the frequency of clinical exacerbations. In some embodiments, the Clec9A binding agents reduce the frequency and/or severity of relapses.

In some embodiments, the Clec9A binding agents are used in a method of treatment of relapsing forms of MS in patients who have had an inadequate response to (or are refractory to) one, or two, or three, or four, or five, or six, or seven, or eight, or nine, or ten or more disease modifying therapies (DMTs).

In various embodiments, the subject's symptoms may be assessed quantitatively, such as by EDSS, or decrease in the frequency of relapses, or increase in the time to sustained progression, or improvement in the magnetic

resonance imaging (MRI) behavior in frequent, serial MRI studies and compare the patient's status measurement before and after treatment. In a successful treatment, the patient status will have improved (e.g., the EDSS measurement number or frequency of relapses will have decreased, or the time to sustained progression will have increased, or the MRI scans will show less pathology).

In some embodiments, the patient can be evaluated, e.g., before, during or after receiving the Clec9a binding agents e.g., for indicia of responsiveness. Various clinical or other indicia of effectiveness of treatment, e.g., EDSS score; MRI scan; relapse number, rate, or severity; multiple sclerosis functional composite (MSFC); multiple sclerosis quality of life inventory (MSQLI); Paced Serial Addition Test (PASAT); symbol digit modalities test (SDMT); 25-foot walk test; 9-hole peg test; low contrast visual acuity; Modified Fatigue Impact Scale; expanded disability status score (EDSS); multiple sclerosis functional composite (MSFC); Beck Depression Inventory; and 7/24 Spatial Recall Test can be used. In various embodiments, the Clec9A binding agents cause an improvement in one or more of these measures. Further, the patient can be monitored at various times during a regimen. In some embodiments, the Clec9a binding agents cause a disease improvement as assessed by MacDonald dissemination in space and time. For example, for dissemination in space, lesion imaging, such as, by way of illustration, Barkhof-Tintore MR imaging criteria, may be used, including at least one gadolinium-enhancing lesion or 9 T2 hyperintense lesions; at least one infratentorial lesion; at least one juxtacortical lesion; at least about three periventricular lesions; and a spinal cord lesion. For dissemination in time, MRI can also be used; for example, if an MRI scan of the brain performed at ≥ 3 months after an initial clinical event demonstrates a new gadolinium-enhancing lesion, this may indicate a new CNS inflammatory event, because the duration of gadolinium enhancement in MS is usually less than 6 weeks. If there are no gadolinium-enhancing lesions but a new T2 lesion (presuming an MRI at the time of the initial event), a repeat MR imaging scan after another 3 months may be needed with demonstration of a new T2 lesion or gadolinium-enhancing lesion.

In some embodiments, disease effects are assessed using any of the measures described in Lavery, *et al.* Multiple Sclerosis International, Vol 2014 (2014), Article ID 262350, the entire contents of which are hereby incorporated by reference.

In some embodiments, the Clec9A binding agent results in one or more of: (a) prevention of worsening in disability defined as deterioration by 1.0 point on EDSS, (b) increase in time to relapse, (c) reduction or stabilization of number and/or volume of gadolinium enhancing lesions, (d) decreased annualized relapse rate, (e) increased relapse duration and severity by NRS score, (f) decrease in disease activity as measured by MRI (annual rate of new or enlarging lesions), (g) lower average number of relapses at 1 year, or 2 years, (h) sustained disease progression as measured by the EDSS at 3 months, (i) prevention of conversion to CDMS, (j) no or few new or enhancing T2 lesions, (k) minimal change in hyperintense T2 lesion volume, (l) increased time to McDonald defined MS, (m) prevention of progression of disability as measured by sustained worsening of EDSS at 12 weeks, (n) reduction in time to relapse at 96 weeks, and (o) reduction or stabilization of brain atrophy (e.g. percentage change from baseline).

In one embodiment, the Clec9A binding agents are administered and is effective to result in a decreased rate of relapse (e.g., at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80% or greater reduction in rate of relapse) compared to the rate of relapse before administration (e.g., compared to the rate of relapse following administration for 12 months or for less than 12 months, e.g., about 10, or about 8, or about 4, or about 2 or less months) of treatment, or before commencement of treatment, when measured between 3-24 months (e.g., between 6-18 months, e.g., 12 months) after a previous relapse.

In one embodiment, the Clec9A binding agents are administered and are effective to result in a prevention of an increase in EDSS score from a pre-treatment state. The Kurtzke Expanded Disability Status Scale (EDSS) is a method of quantifying disability in multiple sclerosis. The EDSS replaced the previous Disability Status Scales which used to bunch people with MS in the lower brackets. The EDSS quantifies disability in eight Functional Systems (FS) and allows neurologists to assign a Functional System Score (FSS) in each of these. The Functional Systems are: pyramidal, cerebellar, brainstem, sensory, bowel and bladder, visual and cerebral.

In one embodiment, the Clec9A binding agents are administered and is effective to result in a decreased EDSS score (e.g., a decrease of 1, 1.5, 2, 2.5, 3 points or more, e.g., over at least three months, six months, one year, or longer) compared to the EDSS score following administration of the Clec9a binding agents (e.g. for 12 months or for less than 12 months, e.g., less than 10, 8, 4 or less months, or before the commencement of treatment).

In one embodiment, the Clec9A binding agents are administered and is effective to result in a decreased number of new lesions overall or of any one type (e.g., at least 10%, 20%, 30%, 40% decrease), compared to the number of new lesions following administration of the Clec9A binding agents for 12 months or for less than 12 months, e.g., less than 10, 8, 4 or less months, or before commencement of treatment;

In one embodiment, the Clec9A binding agents are administered and is effective to result in a decreased number of lesions overall or of any one type (e.g., at least 10%, 20%, 30%, 40% decrease), compared to the number of lesions following administration of the Clec9a binding agents for 12 months or for less than 12 months, e.g., less than 10, 8, 4 or less months, or before commencement of treatment;

In one embodiment, the Clec9A binding agents are administered and is effective to result in a reduced rate of appearance of new lesions overall or of any one type (e.g., at least 10%, 20%, 30%, 40% reduced rate), compared to the rate of appearance of new lesions following administration for 12 months or for less than 12 months, e.g., less than 10, 8, 4 or less months, or before commencement of treatment;

In one embodiment, the Clec9A binding agents are administered and is effective to result in a reduced increase in lesion area overall or of any one type (e.g., at least 10%, 20%, 30%, 40% decreased increase), compared to an increase in lesion area following administration for 12 months or less than 12 months, e.g., less than 10, 8, 4 or less months, or before commencement of treatment.

In one embodiment, the Clec9A binding agents are administered and is effective to result in a reduced incidence or symptom of optic neuritis (e.g., improved vision), compared to the incidence or symptom of optic neuritis

following administration for 12 months or for less than 12 months, e.g., less than 10, 8, 4 or less months, or before commencement of treatment.

In various embodiments, methods of the invention are useful in treatment a human subject. In some embodiments, the human is a pediatric human. In other embodiments, the human is an adult human. In other embodiments, the human is a geriatric human. In other embodiments, the human may be referred to as a patient. In some embodiments, the human is a female. In some embodiments, the human is a male.

In certain embodiments, the human has an age in a range of from about 1 to about 18 months old, from about 18 to about 36 months old, from about 1 to about 5 years old, from about 5 to about 10 years old, from about 10 to about 15 years old, from about 15 to about 20 years old, from about 20 to about 25 years old, from about 25 to about 30 years old, from about 30 to about 35 years old, from about 35 to about 40 years old, from about 40 to about 45 years old, from about 45 to about 50 years old, from about 50 to about 55 years old, from about 55 to about 60 years old, from about 60 to about 65 years old, from about 65 to about 70 years old, from about 70 to about 75 years old, from about 75 to about 80 years old, from about 80 to about 85 years old, from about 85 to about 90 years old, from about 90 to about 95 years old or from about 95 to about 100 years old. In various embodiments, the human has an age of more than 30 years old.

Immune Modulation

In various embodiments, the present compositions are capable of, or find use in methods of, immune modulation. For instance, in various embodiments, the present methods of treatment may involve the immune modulation described herein. In some embodiments, the immune modulation involves IFN signaling, including modified IFN signaling, in the context of a dendritic cell (DC).

In various embodiments, a multi-specific Clec9a binding agent is provided. In some embodiments, such multi-specific Clec9a binding agent of the invention recognizes and binds to Clec9A and one or more antigens found on one or more immune cells, which can include, without limitation, megakaryocytes, thrombocytes, erythrocytes, mast cells, basophils, neutrophils, eosinophils, monocytes, macrophages, natural killer cells, T lymphocytes (e.g., cytotoxic T lymphocytes, T helper cells, natural killer T cells), B lymphocytes, plasma cells, dendritic cells, or subsets thereof. In some embodiments, the Clec9A binding agent specifically binds to an antigen of interest and effectively directly or indirectly recruits one or more immune cells.

In some embodiments, the Clec9a binding agent specifically binds to an antigen of interest and effectively directly or indirectly recruits one or more immune cells to cause an immunosuppressive effect, e.g. the Clec9a binding agent directly or indirectly recruits an immunosuppressive immune cell. In some embodiments, the immunosuppressive immune cell is a regulatory T cell (or "Tregs" which, as used herein, refers to a subpopulation of T cells which modulate the immune system, abrogate autoimmune disease, maintain tolerance to self-antigens and thwart anti-tumor immune responses). Other immunosuppressive immune cells include myeloid suppressor cells (or "MSC," which, as used herein, refers to a heterogeneous population of cells, defined by their myeloid origin, immature state, and ability to potently suppress T cell responses); tumor associated

neutrophils (or “TANs” which, as used herein, refers to a subset of neutrophils that are capable of suppressing immune responses); tumor associated macrophages (or “TAMs” which, as used herein, refers to a subset of macrophages that may reduce an immune response), M2 macrophages, and/or tumor-inducing mast cells (which as used herein, refers to a subset of bone marrow-derived, long-lived, heterogeneous cellular population). Also, immunosuppressive immune cells include Th2 cells and Th17 cells. Additionally, immunosuppressive immune cells include immune cells, e.g., CD4+ and/or CD8+ T cells, expressing one or more checkpoint inhibitory receptors (e.g. receptors, including CTLA-4, B7-H3, B7-H4, TIM-3, expressed on immune cells that prevent or inhibit uncontrolled immune responses). See Stagg, J. *et. al.*, Immunotherapeutic approach in triple-negative breast cancer. *Ther Adv Med Oncol.* (2013) 5(3):169-181).

In some embodiments, the Clec9a binding agent stimulates regulatory T cell (Treg) proliferation. Treg cells are characterized by the expression of the Foxp3 (Forkhead box p3) transcription factor. Most Treg cells are CD4+ and CD25+, and can be regarded as a subset of helper T cells, although a small population may be CD8+. Thus the immune response which is to be modulated by a method of the invention may comprise inducing proliferation of Treg cells, optionally in response to an antigen. Thus the method may comprise administering to the subject a composition comprising the antigen, wherein the antigen is associated with a binding agent having affinity for Clec9A. The antigen may be administered with an adjuvant which promotes proliferation of Treg cells.

Insofar as this method involves stimulating proliferation and differentiation of Treg cells in response to a specific antigen, it can be considered to be a method of stimulating an immune response. However, given that Treg cells may be capable of modulating the response of other cells of the immune system against an antigen in other ways, e.g. inhibiting or suppressing their activity, the effect on the immune system as a whole may be to modulate (e.g. suppress or inhibit) the response against that antigen. Thus the methods of this aspect of the invention can equally be referred to as methods of modulating (e.g. inhibiting or suppressing) an immune response against an antigen.

In some embodiments, the methods therapeutically or prophylactically inhibit or suppress an undesirable immune response against a particular antigen, even in a subject with pre-existing immunity or an on-going immune response to that antigen. This may be particularly useful, for example, in the treatment of autoimmune disease.

Under certain conditions, it may also be possible to tolerize a subject against a particular antigen by targeting the antigen to an antigen presenting cell expressing Clec9A. The invention thus provides a method for inducing tolerance in a subject towards an antigen, comprising administering to the subject a composition comprising the antigen, wherein the antigen is associated with a binding agent having affinity for Clec9A and wherein the antigen is administered in the absence of an adjuvant. Tolerance in this context typically involves depletion of immune cells which would otherwise be capable of responding to that antigen, or inducing a lasting reduction in responsiveness to an antigen in such immune cells.

It may be particularly desirable to raise a Treg response against an antigen to which the subject exhibits, or is at risk of developing, an undesirable immune response. For example, it may be a self-antigen against which an

immune response occurs in an autoimmune disease. Examples of autoimmune diseases in which specific antigens have been identified as potentially pathogenically significant include multiple sclerosis (myelin basic protein), insulin-dependent diabetes mellitus (glutamic acid decarboxylase), insulin-resistant diabetes mellitus (insulin receptor), celiac disease (gliadin), bullous pemphigoid (collagen type XVII), auto-immune haemolytic anaemia (Rh protein), auto-immune thrombocytopenia (GpIIb/IIIa), myasthenia gravis (acetylcholine receptor), Graves' disease (thyroid-stimulating hormone receptor), glomerulonephritis, such as Goodpasture's disease (alpha3(IV)NC1 collagen), and pernicious anaemia (intrinsic factor). Alternatively the target antigen may be an exogenous antigen which stimulates a response which also causes damage to host tissues. For example, acute rheumatic fever is caused by an antibody response to a Streptococcal antigen which cross-reacts with a cardiac muscle cell antigen. Thus these antigens, or particular fragments or epitopes thereof, may be suitable antigens for use in the present invention.

In some embodiments, the present agents, or methods using these agents, disrupt Clec9A signaling (e.g. via neutralization of Clec9A), e.g. by reducing or inhibiting Clec9A binding to its ligand. Some autoimmune diseases are characterized by unusually high levels of cell death and it is believed that immune responses against self antigens associated with these cells may contribute to the pathogenesis of these conditions. Clec9A antagonists may therefore be used to prevent Clec9A from binding to the ligand exposed in dead and dying cells (e.g. those undergoing immunogenic cell death) and may thus inhibit or prevent stimulation of immune responses against these antigens.

In various embodiments, the present agents, or methods using these agents, reduce or suppress autoreactive T cells. In some embodiments, the multi-specific Clec9a binding agent, optionally through an interferon signaling in the context of a chimera, causes this immunosuppression. In some embodiments, the multi-specific Clec9a binding agent stimulates PD-L1 or PD-L2 signaling and/or expression which may suppress autoreactive T cells. In some embodiments, the Clec9A binding agent, optionally through an interferon signaling in the context of a chimera, causes this immunosuppression. In some embodiments, the Clec9A binding agent stimulates PD-L1 or PD-L2 signaling and/or expression which may suppress autoreactive T cells.

In various embodiments, the present methods comprise modulating the ratio of regulatory T cells to effector T cells in favor of immunosuppression, for instance, to treat autoimmune diseases. For instance, the present methods, in some embodiments, reduce and/or suppress one or more of cytotoxic T cells; effector memory T cells; central memory T cells; CD8⁺ stem cell memory effector cells; TH1 effector T-cells; TH2 effector T cells; TH9 effector T cells; TH17 effector T cells. For instance, the present methods, in some embodiments, increase and/or stimulate one or more of CD4⁺CD25⁺FOXP3⁺ regulatory T cells, CD4⁺CD25⁺ regulatory T cells, CD4⁺CD25⁻ regulatory T cells, CD4⁺CD25^{high} regulatory T cells, TIM-3⁺PD-1⁺ regulatory T cells, lymphocyte activation gene-3 (LAG-3)⁺ regulatory T cells, CTLA-4/CD152⁺ regulatory T cells, neuropilin-1 (Nrp-1)⁺ regulatory T cells, CCR4⁺CCR8⁺ regulatory T cells, CD62L (L-selectin)⁺ regulatory T cells, CD45RB^{low} regulatory T cells, CD127^{low} regulatory T cells, LRRC32/GARP⁺ regulatory T cells, CD39⁺ regulatory T cells, GITR⁺ regulatory T cells, LAP⁺ regulatory T cells, 1B11⁺ regulatory T cells, BTLA⁺ regulatory T cells, type 1 regulatory T cells (Tr1

cells), T helper type 3 (Th3) cells, regulatory cell of natural killer T cell phenotype (NKTregs), CD8⁺ regulatory T cells, CD8⁺CD28⁻ regulatory T cells and/or regulatory T-cells secreting IL-10, IL-35, TGF- β , TNF- α , Galectin-1, IFN- γ and/or MCP1.

In some embodiments, the present methods favor immune inhibitory signals over immune stimulatory signals. In some embodiments, the present methods allow for reversing or suppressing immune activating or co-stimulatory signals. In some embodiments, the present methods allow for providing immune inhibitory signals. For instance, in some embodiments, the present agents and methods reduce the effects of an immune stimulatory signal, which, without limitation, is one or more of 4-1BB, OX-40, HVEM, GITR, CD27, CD28, CD30, CD40, ICOS ligand; OX-40 ligand, LIGHT (CD258), GITR ligand, CD70, B7-1, B7-2, CD30 ligand, CD40 ligand, ICOS, ICOS ligand, CD137 ligand and TL1A. Further, in some embodiments, the present agents and methods increase the effects of an immune inhibitory signal, which, without limitation, is one or more of CTLA-4, PD-L1, PD-L2, PD-1, BTLA, HVEM, TIM3, GAL9, LAG3, VISTA, KIR, 2B4, CD160 (also referred to as BY55), CGEN-15049, CHK 1 and CHK2 kinases, A2aR, CEACAM (e.g., CEACAM-1, CEACAM-3 and/or CEACAM-5), and various B-7 family ligands (including, but are not limited to, B7-1, B7-2, B7-DC, B7-H1, B7-H2, B7-H3, B7-H4, B7-H5, B7-H6 and B7-H7. Kits

The present invention also provides kits for the administration of any Clec9A binding agent described herein (e.g. with or without additional therapeutic agents). The kit is an assemblage of materials or components, including at least one of the inventive pharmaceutical compositions described herein. Thus, in some embodiments, the kit contains at least one of the pharmaceutical compositions described herein.

The exact nature of the components configured in the kit depends on its intended purpose. In one embodiment, the kit is configured for the purpose of treating human subjects.

Instructions for use may be included in the kit. Instructions for use typically include a tangible expression describing the technique to be employed in using the components of the kit to effect a desired therapeutic outcome, such as to treat cancer. Optionally, the kit also contains other useful components, such as, diluents, buffers, pharmaceutically acceptable carriers, syringes, catheters, applicators, pipetting or measuring tools, bandaging materials or other useful paraphernalia as will be readily recognized by those of skill in the art.

The materials and components assembled in the kit can be provided to the practitioner stored in any convenience and suitable ways that preserve their operability and utility. For example, the components can be provided at room, refrigerated or frozen temperatures. The components are typically contained in suitable packaging materials. In various embodiments, the packaging material is constructed by well-known methods, preferably to provide a sterile, contaminant-free environment. The packaging material may have an external label which indicates the contents and/or purpose of the kit and/or its components.

Definitions

As used herein, “a,” “an,” or “the” can mean one or more than one.

Further, the term “about” when used in connection with a referenced numeric indication means the referenced numeric indication plus or minus up to 10% of that referenced numeric indication. For example, the language “about 50” covers the range of 45 to 55.

An “effective amount,” when used in connection with medical uses is an amount that is effective for providing a measurable treatment, prevention, or reduction in the rate of pathogenesis of a disease of interest.

As used herein, something is “decreased” if a read-out of activity and/or effect is reduced by a significant amount, such as by at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 95%, at least about 97%, at least about 98%, or more, up to and including at least about 100%, in the presence of an agent or stimulus relative to the absence of such modulation. As will be understood by one of ordinary skill in the art, in some embodiments, activity is decreased and some downstream read-outs will decrease but others can increase.

Conversely, activity is “increased” if a read-out of activity and/or effect is increased by a significant amount, for example by at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 95%, at least about 97%, at least about 98%, or more, up to and including at least about 100% or more, at least about 2-fold, at least about 3-fold, at least about 4-fold, at least about 5-fold, at least about 6-fold, at least about 7-fold, at least about 8-fold, at least about 9-fold, at least about 10-fold, at least about 50-fold, at least about 100-fold, in the presence of an agent or stimulus, relative to the absence of such agent or stimulus.

As referred to herein, all compositional percentages are by weight of the total composition, unless otherwise specified. As used herein, the word “include,” and its variants, is intended to be non-limiting, such that recitation of items in a list is not to the exclusion of other like items that may also be useful in the compositions and methods of this technology. Similarly, the terms “can” and “may” and their variants are intended to be non-limiting, such that recitation that an embodiment can or may comprise certain elements or features does not exclude other embodiments of the present technology that do not contain those elements or features.

Although the open-ended term “comprising,” as a synonym of terms such as including, containing, or having, is used herein to describe and claim the invention, the present invention, or embodiments thereof, may alternatively be described using alternative terms such as “consisting of” or “consisting essentially of.”

As used herein, the words “preferred” and “preferably” refer to embodiments of the technology that afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful, and is not intended to exclude other embodiments from the scope of the technology.

The amount of compositions described herein needed for achieving a therapeutic effect may be determined empirically in accordance with conventional procedures for the particular purpose. Generally, for administering therapeutic agents for therapeutic purposes, the therapeutic agents are given at a pharmacologically effective dose. A “pharmacologically effective amount,” “pharmacologically effective dose,” “therapeutically effective amount,” or “effective amount” refers to an amount sufficient to produce the desired physiological effect or amount capable of achieving the desired result, particularly for treating the disorder or disease. An effective amount as used herein would include an amount sufficient to, for example, delay the development of a symptom of the disorder or disease, alter the course of a symptom of the disorder or disease (e.g., slow the progression of a symptom of the disease), reduce or eliminate one or more symptoms or manifestations of the disorder or disease, and reverse a symptom of a disorder or disease. Therapeutic benefit also includes halting or slowing the progression of the underlying disease or disorder, regardless of whether improvement is realized.

Effective amounts, toxicity, and therapeutic efficacy can be determined by standard pharmaceutical procedures in cell cultures or experimental animals, e.g., for determining the LD₅₀ (the dose lethal to about 50% of the population) and the ED₅₀ (the dose therapeutically effective in about 50% of the population). The dosage can vary depending upon the dosage form employed and the route of administration utilized. The dose ratio between toxic and therapeutic effects is the therapeutic index and can be expressed as the ratio LD₅₀/ED₅₀. In some embodiments, compositions and methods that exhibit large therapeutic indices are preferred. A therapeutically effective dose can be estimated initially from in vitro assays, including, for example, cell culture assays. Also, a dose can be formulated in animal models to achieve a circulating plasma concentration range that includes the IC₅₀ as determined in cell culture, or in an appropriate animal model. Levels of the described compositions in plasma can be measured, for example, by high performance liquid chromatography. The effects of any particular dosage can be monitored by a suitable bioassay. The dosage can be determined by a physician and adjusted, as necessary, to suit observed effects of the treatment.

In certain embodiments, the effect will result in a quantifiable change of at least about 10%, at least about 20%, at least about 30%, at least about 50%, at least about 70%, or at least about 90%. In some embodiments, the effect will result in a quantifiable change of about 10%, about 20%, about 30%, about 50%, about 70%, or even about 90% or more. Therapeutic benefit also includes halting or slowing the progression of the underlying disease or disorder, regardless of whether improvement is realized.

As used herein, “methods of treatment” are equally applicable to use of a composition for treating the diseases or disorders described herein and/or compositions for use and/or uses in the manufacture of a medicaments for treating the diseases or disorders described herein.

EXAMPLES

The term “AcTaferon” is occasionally used herein to reference an interferon-based chimera.

In the following examples, unless noted, mutations to IFN are relative to human IFN- α 2: SEQ ID NO: 86.

The Q124R mutant is representative of an attenuated human IFN alpha 2 mutant that can be assayed *in vivo* in a murine model. Specifically, Q124R is a human IFN mutation that is suitable for use in the mouse (*i.e.* it is a human mutant IFN that functions in mouse). See *Nat. Comm.* 2014;5:3016. doi: 10.1038/ncomms4016, the entire contents of which are hereby incorporated by reference.

The R33A/E120R mutant is representative of human IFN alpha 2 mutant that is non-functional (and is used as a control)

Anti-human PD-L1 VHH used in these Examples is SEQ ID NO: 256.

Anti-Bcl10 VHH is used in these Examples as a control (targeting an irrelevant antigen, *i.e.* “untargeted”).

Example 1. Construction and Evaluation of VHHs Specific for Mouse Clec9A

Isolation of antigen-specific VHHs

A VHH library was subject to 3 consecutive rounds of panning (in solution), performed on stably transfected CHO-K1 cells expressing mouse Clec9A. The enrichment for antigen-specific phages was assessed after each round of panning by comparing the number of phagemid particles eluted from transfected cells after panning (output) with the number of phagemid particles used for panning (input). The phage output increased about 50- and 30-fold in 2nd and 3rd rounds, respectively, as compared to the output from 1st round. The input phage was always about 10¹¹ and the output from first round was about 10⁹ phage particles suggesting that there was already enrichment for target-specific phages in the first round. A total of 285 colonies (95 and 190 from 1st & 2nd rounds, respectively) were randomly selected and their crude periplasmic extracts (including soluble VHHs) were analyzed by cell ELISA for specific binding to transfected CHO-K1, as compared to parental CHO-K1 cells. None of these colonies scored positive in cell ELISA suggesting that either the ELISA is not sensitive enough in this case or the antigen is affected by cell fixation in ELISA. We therefore switched to FACS for the identification of antigen specific VHHs. Here, we sequenced 190 randomly selected colonies from 1st and 2nd panning rounds (95 from each round) and then grouped VHHs based on CDR3 sequences. These experiments resulted in the identification of 28 different VHHs belonging to 7 different groups. Table 1 below provides a description of 28 clones representing the 28 different anti-mouse Clec9A VHH genes. *E. coli* TG1 harboring recombinant phagemid pHEN4 containing anti-mouse Clec9A VHH sequences was generated and stored at -80°C. The vector pHEN4 codes for ampicillin resistance.

Table 1.

<i>E. coli</i> strain + Vector	VHH (Nb)	NSF Reference No. (Glycerol stock)
TG1, pHEN4	R1MCL 3	1727
TG1, pHEN4	R1MCL 7	1728
TG1, pHEN4	R1MCL 9	1729
TG1, pHEN4	R1MCL 12	1730
TG1, pHEN4	R1MCL 13	1731
TG1, pHEN4	R1MCL 33	1732
TG1, pHEN4	R1MCL 41	1733
TG1, pHEN4	R1MCL 71	1734

TG1, pHEN4	R1MCL 85	1735
TG1, pHEN4	R1MCL 95	1736
TG1, pHEN4	R2MCL 5	1737
TG1, pHEN4	R2MCL 15	1738
TG1, pHEN4	R2MCL 17	1739
TG1, pHEN4	R2MCL 18	1740
TG1, pHEN4	R2MCL 20	1741
TG1, pHEN4	R2MCL 28	1742
TG1, pHEN4	R2MCL 36	1743
TG1, pHEN4	R2MCL 41	1744
TG1, pHEN4	R2MCL 43	1745
TG1, pHEN4	R2MCL 47	1746
TG1, pHEN4	R2MCL 49	1747
TG1, pHEN4	R2MCL 57	1748
TG1, pHEN4	R2MCL 65	1749
TG1, pHEN4	R2MCL 66	1750
TG1, pHEN4	R2MCL 74	1751
TG1, pHEN4	R2MCL 85	1752
TG1, pHEN4	R2MCL 86	1753
TG1, pHEN4	R2MCL 93	1754

Using crude periplasmic extracts including VHHs, representative(s) of each group was (were) analyzed by FACS for specificity to mouse Clec9A using CHO-K1 cells transfected with mouse Clec9A. The parental non-transfected CHO-K1 cells served as negative control cell. The representative VHHs tested for their specificity towards mouse Clec9A were as follows: R1MCL3, R1MCL7, R1MCL9, R1MCL12, R1MCL13, R1MCL33, R1MCL71, R1MCL95, R2MCL15, R2MCL18, R2MCL20, R2MCL28, R2MCL36, R2MCL41, R2MCL43, R2MCL47, R2MCL57, R2MCL74, R2MCL86, R2MCL93. All representatives tested were positive for CHO-K1 cells transfected with mouse Clec9A showing that all 28 VHHs bound mouse Clec9A specifically. Next, a representative of each group was analyzed by FACS for specificity to mouse and human Clec9A using CHO-K1 cells transfected with either mouse Clec9A or human Clec9A. Here also, the parental non-transfected CHO-K1 cells served as negative control cell. The representative VHHs tested for cross-species reactivity were as follows: R1MCL3, R1MCL7, R1MCL9, R1MCL12, R1MCL33, R2MCL18, R2MCL43. None of these VHHs showed any specific binding to human Clec9A suggesting that these VHHs recognize epitopes unique to mouse Clec9A.

Expression and purification of VHHs

The VHH genes were recloned from pHEN4 to pHEN6c vectors. Specifically, the VHH gene was amplified by PCR using recombinant pHEN4 harboring the VHH gene as template and primers A6E and 38. Primers A6E and 38 were framework 1 and framework 4 primers, respectively. The primer sequences were as follows:

- Primer A6E (5' GAT GTG CAG CTG CAG GAG TCT GGR* GGA GG 3') (SEQ ID NO:291).
- Primer 38 (5' GGA CTA GTG CGG CCG CTG GAG ACG GTG ACC TGG GT 3') (SEQ ID NO:292).
- Universal reverse primer (5' TCA CAC AGG AAA CAG CTA TGA C 3') (SEQ ID NO:293).

- Universal forward primer (5' CGC CAG GGT TTT CCC AGT CAC GAC 3') (SEQ ID NO:294).

*R stands for A or G.

The amplification protocol included about 30 cycles of PCR, each cycle included 30 seconds at 94°C, 30 seconds at 55°C and 45 seconds at 72°C, followed by 10 minutes extension at 72°C at the end of PCR. A fragment of about 400 bp was amplified. All resulting VHHs produced using the protocol described herein start with the following sequence: QVQLQESGGG (SEQ ID NO:295).

The PCR product was purified (e.g. by Qiaquick PCR purification kit from Qiagen) and digested overnight with PstI. The purified PCR product was digested with BstEII overnight (or with Eco91I from Fermentas). The temperature used for digestion varied. For example, digestion with BstEII was done at 50°C or 60°C depending on the supplier of the enzyme.

For ligation, the PCR product was purified. The pHEN6c vector was digested with PstI for 3 hours, purified as described above, and then digested with BstEII for 2 to 3 hours. Alternatively, digestion was carried out using Eco91I from Fermentas. The digested vector was ran on 1% agarose gel, with the vector band excised out of the gel and purified (e.g. by Qiaquick gel extraction kit from Qiagen). The PCR fragment was subsequently ligated to the vector.

Electrocompetent WK6 cells were transformed with the ligation reaction, and transformants were selected using LB/agar/ampicillin (100 µg/ml)/glucose (1%) plates. Positive clones were screened by PCR using universal reverse and universal forward primers. A fragment of about 550 bp was amplified, if the insert was present. To verify the identity of the clones, at least 2 clones per each VHH were sequenced using universal reverse primers. Antigen binding capacity was retested by ELISA or any other appropriate assay.

Following the above protocol, the VHH gene cloned in pHEN6c vector was generated which contained PelB signal sequence at the N-terminus and His₆-tail at the C-terminus. The PelB leader sequence directed the VHH to the periplasmic space of the *E.coli*, and the His-tag was used for the purification and detection of VHH (e.g. in ELISA, Western Blot, etc.).

Expression and purification of the VHHs were carried out. Specifically, on day 1, 10-20 ml of LB + ampicillin (100 µg/ml) + glucose (1%) were inoculated with a freshly transformed WK6 colony. This pre-culture was incubated at 37°C overnight with shaking at 200-250 rpm. On day 2, a TB medium was used for expressing the VHHs. The TB medium included, per liter: 2.3 g KH₂PO₄, 16.4 g K₂HPO₄·3H₂O, 12 g Tryptone (Duchefa Biochemie), 24 g Yeast (Duchefa Biochemie), and 4 ml 100% glycerol (Duchefa Biochemie).

A baffled shaker flask of 1 liter was filled with 330 ml TB and autoclaved. KH₂PO₄ and K₂HPO₄·3H₂O were not autoclaved. Instead, KH₂PO₄ and K₂HPO₄·3H₂O were prepared, filter sterilized, and then added to the rest of the medium that was already autoclaved. About 1 ml of the pre-culture was added to 330 ml of TB supplemented with 100 µg/ml Ampicillin, 2 mM MgCl₂ and 0.1% glucose and subsequently grew at 37°C with shaking (200-250 rpm) until an OD₆₀₀ of 0.6-0.9 was reached. IPTG (final concentration of 1 mM) was added to induce VHH

expression. The culture was incubated at 28°C with shaking overnight (about 16-18 hours). The OD₆₀₀ after overnight induction was usually between 25 and 30. At least 1 liter of culture (3 bottles) per clone was prepared with an average yield of between 1 and 15 mg/l.

Extraction of the VHHs from the periplasm of *E. coli* was carried out on day 3. The solutions used included: TES: 0.2 M Tris pH 8.0, 0.5 mM EDTA, 0.5 M sucrose, and TES/4: TES diluted 4 times in water.

The overnight induced cultures were centrifuged for 8 minutes at 8000 rpm. The cell pellets from 1 liter culture were resuspended in 12 ml TES by pipetting up and down and shaken for 1 hour on ice. Per each 12 ml TES used, about 18 ml TES/4 were added and incubated on ice for an additional hour with shaking followed by centrifugation for 30 minutes at 8000 rpm at 4°C. The supernatant which contained proteins extracted from the periplasmic space was transferred to fresh falcon tubes.

The VHHs were subsequently purified by IMAC which utilized the following solution: HIS-select (SIGMA), PBS, and 50 mM NaAcetate pH 4.6.

His-select was equilibrated with PBS. Specifically, per periplasmic extract derived from 1 liter culture, 1 ml of Resin (about 2 ml His-select solution) was added to a 50 ml falcon tube. PBS was also added to final volume of 50 ml and mixed. Centrifugation was carried out at 2000 rpm for 2 minutes, and the supernatant was discarded. The resin was washed with PBS twice as described above. The periplasmic extract was added to the resin, incubated for 30 minutes to 1 hour at room temperature with gentle shaking. The samples were loaded on PD-10 columns with a filter at the bottom (GE healthcare, cat. No. 17-0435-01) and washed with 50 to 100 ml PBS (50-100 ml PBS per 1 ml resin used). Elution was carried out for 3 times, each time with 1 ml PBS/0.5 M imidazole per 1 ml resin used (for efficient elution, resuspend the beads and leave overnight at 4°C with the bottom of the column closed). Dialysis was performed overnight at 4°C against PBS (cutoff 3500 Daltons) to remove imidazole. For efficient dialysis, the dialysis buffer (PBS) was changed 2-3 times. Alternatively, instead of elution with imidazole, the bound VHHs could be eluted with 10 ml 50 mM Na-acetate pH 4.6. If 50 mM Na-acetate pH 4.6 was used to elute VHHs, the eluted VHHs was immediately neutralized with 1 M Tris pH 8.0, and no dialysis was required.

The amount of protein was estimated by OD₂₈₀ measurement of eluted sample. Extinction coefficient of each clone was determined by protParam tool under primary structure analysis at the ExPASy proteomics server. Further purification of VHHs could be achieved by different methods. For example, the samples could be concentrated (Vivaspin 5000 MW cutoff, Vivascience) by centrifuging at 2000 rpm at 4°C until an appropriate volume for loading on a Superdex 75 16/60 was obtained (max. 4 ml). The concentrated sample was loaded on a Superdex 75 16/60 column equilibrated with PBS. Peak fractions were pooled, and OD₂₈₀ measurements were performed for quantification. In general, VHHs eluted after 85-95 minutes when run at 1 ml/min. Aliquots of concentrated VHH samples were stored at -20°C at a concentration of about 1 mg/ml.

Functional analysis of VHHs

The VHHs were tested for binding to Clec9A. **Figure 1** shows binding of the various VHHs to CHO cells stably expressing Clec9A. In all experiments, the VHHs were labeled as follows:

mClec9A VHHs MBU-I-number	single cells/single cells Geometric Mean (FL1-H)	group
20140226 CHO mClec9A.control	3.74	
20140226 CHO mClec9A.10487	6.44	1
20140226 CHO mClec9A.10488	5.97	3
20140226 CHO mClec9A.10489	7.36	2
20140226 CHO mClec9A.10490	6.01	7
20140226 CHO mClec9A.10491	5.8	3
20140226 CHO mClec9A.10492	6.09	4
20140226 CHO mClec9A.10493	5.45	1
20140226 CHO mClec9A.10494	6.26	4
20140226 CHO mClec9A.10495	8.49	6
20140226 CHO mClec9A.10496	6.04	4
20140226 CHO mClec9A.10497	12.7	1
20140226 CHO mClec9A.10498	6.07	1
20140226 CHO mClec9A.10499	7.74	1
20140226 CHO mClec9A.10501	7.31	6
20140226 CHO mClec9A.10502	6.03	3
20140226 CHO mClec9A.10503	7.14	6
20140226 CHO mClec9A.10504	8.36	1
20140226 CHO mClec9A.10505	6.46	5
20140226 CHO mClec9A.10507	5.32	1
20140226 CHO mClec9A.10508	8.99	2
20140226 CHO mClec9A.10509	6.08	1
20140226 CHO mClec9A.10510	5.9	3
20140226 CHO mClec9A.10511	10.5	1
20140226 CHO mClec9A.10512	5.61	3
20140226 CHO mClec9A.10513	6.01	3
20140226 CHO mClec9A.10514	7.59	6

Experiments were carried out to characterize the activity of the VHHs in treating tumors. In the experiments of **Figure 2**, female C57BL/6J mice were injected s.c. with 6×10^5 B16Bl6-mCD20 cells in 50 μ l PBS. Seven days later, perilesional (= s.c. at the edge of the tumor) treatments were started. WT mIFN was injected in a dose of 8×10^6 IU, while 5500 IU of the chimeric protein were injected. Treatments were given at days 8, 9, 10, 11, 12, 14, 16 and 17 after tumor cell inoculation. Control mice were injected with 100 μ l PBS. Tumor growth was monitored using a digital caliper. Plotted are means \pm SEM (n=5) of tumor sizes (**Figure 2** panel A) and body weight changes (**Figure 2** panel B). One day after the last treatment (day 18), EDTA-blood was collected from the tail vein for analysis of hematological parameters (**Figure 2** panel C) using a Hemavet 950FS Analyzer (Drew Scientific).

As shown in **Figure 2**, panel A, administration of VHHs against Clec9A effectively reduced tumor size. **Figure 2**, panels B and C, demonstrate that treatment with the VHHs did not result in weight loss or hematological toxicity,

respectively. Importantly, panels B and C show improved safety parameters (body weight, blood count parameters) of the chimeras relative to wild type interferon.

Example 2. Construction and Evaluation of VHHs Specific for Human Clec9A

Isolation of antigen-specific VHHs

A VHH library was subject to 2 consecutive rounds of panning (in solution), performed on stably transfected CHO-K1 cells expressing human Clec9A. The enrichment for antigen-specific phages was assessed after each round of panning by comparing the number of phagemid particles eluted from transfected cells after panning (output) with the number of phagemid particles used for panning (input). The phage output increased about 10^2 -fold in the 2nd round, as compared to the output from 1st round. The input phage was about 10^{11} and the output from first round was about 2×10^8 phage particles. 95 colonies from round were randomly selected and their crude periplasmic extracts (including soluble VHHs) were analyzed by cell ELISA for specific binding to transfected CHO-K1, as compared to parental CHO-K1 cells. None of these colonies scored positive in cell ELISA suggesting that either the ELISA was not sensitive enough in this case or the antigen was affected by cell fixation in ELISA. FACS analysis was therefore used for the identification of antigen-specific VHHs. Here, 190 randomly selected colonies from 1st and 2nd panning rounds (95 from each round) were sequenced and then the VHHs were grouped based on CDR3 sequences. These experiments resulted in the identification of 27 different VHHs belonging to 11 different groups (**Figure 5**). The nucleotide and amino acid sequences of the 27 anti-human Clec9A VHHs are shown in **Figures 3** and **4**, respectively. Table 2 below provides a description of 27 clones representing the 27 different anti-human Clec9A VHH genes. *E. coli* TG1 harboring recombinant phagemid pHEN4 containing anti-human Clec9A VHH sequences was generated and stored at -80°C. The vector pHEN4 codes for ampicillin resistance.

Table 2.

<i>E. coli</i> strain + Vector	VHH (Nb)	NSF Reference No. (Glycerol stock)
TG1, pHEN4	R1CHCL 16	1755
TG1, pHEN4	R1CHCL 21	1756
TG1, pHEN4	R1CHCL 23	1757
TG1, pHEN4	R1CHCL 27	1758
TG1, pHEN4	R1CHCL 34	1759
TG1, pHEN4	R1CHCL 50	1760
TG1, pHEN4	R1CHCL 56	1761
TG1, pHEN4	R1CHCL 82	1762
TG1, pHEN4	R2CHCL 3	1763
TG1, pHEN4	R2CHCL 8	1764
TG1, pHEN4	R2CHCL 10	1765
TG1, pHEN4	R2CHCL 13	1766
TG1, pHEN4	R2CHCL 14	1767
TG1, pHEN4	R2CHCL 18	1768
TG1, pHEN4	R2CHCL 22	1769
TG1, pHEN4	R2CHCL 24	1770
TG1, pHEN4	R2CHCL 25	1771
TG1, pHEN4	R2CHCL 27	1772

TG1, pHEN4	R2CHCL 32	1773
TG1, pHEN4	R2CHCL 38	1774
TG1, pHEN4	R2CHCL 41	1775
TG1, pHEN4	R2CHCL 42	1776
TG1, pHEN4	R2CHCL 49	1777
TG1, pHEN4	R2CHCL 53	1778
TG1, pHEN4	R2CHCL 69	1779
TG1, pHEN4	R2CHCL 87	1780
TG1, pHEN4	R2CHCL 94	1781

Using crude periplasmic extracts including VHHs, representative(s) of each group was (were) analyzed by FACS for specificity to human and mouse Clec9A using CHO-K1 cells transfected with either mouse Clec9A or human Clec9A. The parental non-transfected CHO-K1 cells served as negative control cell. The representative VHHs tested were as follows: R1CHCL16, R1CHCL27, R1CHCL34, R1CHCL50, R2CHCL3, R2CHCL10, R2CHCL13, R2CHCL24, R2CHCL25, R2CHCL27, R2CHCL32, R2CHCL38, R2CHCL49, R2CHCL69 and R2CHCL87. All representatives tested were positive for CHO-K1 cells transfected with human Clec9A showing that all 27 VHHs bound human Clec9A specifically. Moreover, VHH R2CHCL10 from group 5 also reacted strongly with mouse Clec9A in FACS. VHH R1CHCL34, also from group 5, reacted with mouse Clec9A but very weakly. VHH R1CHCL82 from group 5 was not tested in FACS. Additionally, VHH R2CHCL32 from group 7 weakly reacted with mouse Clec9A in FACS. The other 2 members of the group 7 (VHHs R1CHCL56 and R2CHCL69) were not tested in FACS.

Expression and purification of VHHs

The VHH genes were recloned from pHEN4 to pHEN6c vectors. Specifically, the VHH gene was amplified by PCR using recombinant pHEN4 harboring the VHH gene as template and primers A6E and 38. Primers A6E and 38 were framework1 and framework4 primers, respectively. The primer sequences were as follows:

- Primer A6E (5' GAT GTG CAG CTG CAG GAG TCT GGR* GGA GG 3') (SEQ ID NO:291).
- Primer 38 (5' GGA CTA GTG CGG CCG CTG GAG ACG GTG ACC TGG GT 3') (SEQ ID NO:292).
- Universal reverse primer (5' TCA CAC AGG AAA CAG CTA TGA C 3') (SEQ ID NO:293).
- Universal forward primer (5' CGC CAG GGT TTT CCC AGT CAC GAC 3') (SEQ ID NO:294).

*R stands for A or G.

The amplification protocol included about 30 cycles of PCR, each cycle included 30 seconds at 94°C, 30 seconds at 55°C and 45 seconds at 72°C, followed by 10 minutes extension at 72°C at the end of PCR. A fragment of about 400 bp was amplified.

The PCR product was purified (e.g. by Qiaquick PCR purification kit from Qiagen) and digested overnight with PstI. The purified PCR product was digested with BstEII overnight (or with Eco91I from Fermentas). The

temperature used for digestion varied. For example, digestion with BstEII was done at 50°C or 60°C depending on the supplier of the enzyme.

For ligation, the PCR product was purified. The pHEN6c vector was digested with PstI for 3 hours, purified as described above, and then digested with BstEII for 2 to 3 hours. Alternatively, digestion was carried out using Eco91I from Fermentas. The digested vector was ran on 1% agarose gel, with the vector band excised out of the gel and purified (e.g. by Qiaquick gel extraction kit from Qiagen). The PCR fragment was subsequently ligated to the vector.

Electrocompetent WK6 cells were transformed with the ligation reaction, and transformants were selected using LB/agar/ampicillin (100 µg/ml)/glucose (1%) plates. Positive clones were screened by PCR using universal reverse and universal forward primers. A fragment of about 550 bp was amplified, if the insert was present. To verify the identity of the clones, at least 2 clones per each VHH were sequenced using universal reverse primers. Antigen binding capacity was retested by ELISA or any other appropriate assay.

Following the above protocol, the VHH gene cloned in pHEN6c vector was generated which contained PelB signal sequence at the N-terminus and His₆-tail at the C-terminus. The PelB leader sequence directed the VHH to the periplasmic space of the *E.coli*, and the His-tag was used for the purification and detection of VHH (e.g. in ELISA, Western Blot, etc.).

Expression and purification of the VHHs were carried out. Specifically, on day 1, 10-20 ml of LB + ampicillin (100 µg/ml) + glucose (1%) were inoculated with a freshly transformed WK6 colony. This pre-culture was incubated at 37°C overnight with shaking at 200-250 rpm. On day 2, a TB medium was used for expressing the VHHs. The TB medium included, per liter: 2.3 g KH₂PO₄, 16.4 g K₂HPO₄·3H₂O, 12 g Tryptone (Duchefa Biochemie), 24 g Yeast (Duchefa Biochemie), and 4 ml 100% glycerol (Duchefa Biochemie)

A baffled shaker flask of 1 liter was filled with 330 ml TB and autoclaved. KH₂PO₄ and K₂HPO₄·3H₂O were not autoclaved. Instead, KH₂PO₄ and K₂HPO₄·3H₂O were prepared, filter sterilized, and then added to the rest of the medium that was already autoclaved. About 1 ml of the pre-culture was added to 330 ml of TB supplemented with 100 µg/ml Ampicillin, 2 mM MgCl₂ and 0.1% glucose and subsequently grew at 37°C with shaking (200-250 rpm) until an OD₆₀₀ of 0.6-0.9 was reached. IPTG (final concentration of 1 mM) was added to induce VHH expression. The culture was incubated at 28°C with shaking overnight (about 16-18 hours). The OD₆₀₀ after overnight induction was usually between 25 and 30. At least 1 liter of culture (3 bottles) per clone was prepared with an average yield of between 1 and 15 mg/l.

Extraction of the VHHs from the periplasm of *E. coli* was carried out on day 3. The solutions used included: TES: 0.2 M Tris pH 8.0, 0.5 mM EDTA, 0.5 M sucrose, and TES/4: TES diluted 4 times in water.

The overnight induced cultures were centrifuged for 8 minutes at 8000 rpm. The cell pellets from 1 liter culture were resuspended in 12 ml TES by pipetting up and down and shaken for 1 hour on ice. Per each 12 ml TES used, about 18 ml TES/4 were added and incubated on ice for an additional hour with shaking followed by

centrifugation for 30 minutes at 8000 rpm at 4°C. The supernatant which contained proteins extracted from the periplasmic space was transferred to fresh falcon tubes.

The VHHs were subsequently purified by IMAC which utilized the following solution: HIS-select (SIGMA), PBS, and 50 mM NaAcetate pH 4.6.

His-select was equilibrated with PBS. Specifically, per periplasmic extract derived from 1 liter culture, 1 ml of Resin (about 2 ml His-select solution) was added to a 50 ml falcon tube. PBS was also added to final volume of 50 ml and mixed. Centrifugation was carried out at 2000 rpm for 2 minutes, and the supernatant was discarded. The resin was washed with PBS twice as described above. The periplasmic extract was added to the resin, incubated for 30 minutes to 1 hour at room temperature with gentle shaking. The samples were loaded on PD-10 columns with a filter at the bottom (GE healthcare, cat. No. 17-0435-01) and washed with 50 to 100 ml PBS (50-100 ml PBS per 1 ml resin used). Elution was carried out for 3 times, each time with 1 ml PBS/0.5 M imidazole per 1 ml resin used (for efficient elution, resuspend the beads and leave overnight at 4°C with the bottom of the column closed). Dialysis was performed overnight at 4°C against PBS (cutoff 3500 daltons) to remove imidazole. For efficient dialysis, the dialysis buffer (PBS) was changed 2-3 times. Alternatively, instead of elution with imidazole, the bound VHHs could be eluted with 10 ml of 50 mM Na-acetate pH 4.6. If 50 mM Na-acetate pH 4.6 was used to elute VHHs, the eluted VHHs was immediately neutralized with 1 M Tris pH 8.0, and no dialysis was required.

The amount of protein was estimated by OD₂₈₀ measurement of eluted samples. Extinction coefficient of each clone was determined by protParam tool under primary structure analysis at the ExPASy proteomics server. Further purification of VHHs could be achieved by different methods. For example, the samples could be concentrated (Vivaspin 5000 MW cutoff, Vivascience) by centrifuging at 2000 rpm at 4°C until an appropriate volume for loading on a Superdex 75 16/60 was obtained (max. 4 ml). The concentrated sample was loaded on a Superdex 75 16/60 column equilibrated with PBS. Peak fractions were pooled, and OD₂₈₀ measurements were performed for quantification. In general, VHHs eluted after 85-95 minutes when run at 1 ml/min. Aliquots of concentrated VHH samples were stored at -20°C at a concentration of about 1 mg/ml.

The sequences of **Figure 3** and **Figure 4** are assigned sequence identifiers as shown in the table below. Further, binding characteristics of the anti-human Clec9A VHHs, after purification, was assayed by binding to HEK-293T cells transfected with Clec9A is shown in the table below. Briefly, Hek293T cells were transfected a human Clec9A expression-plasmid using a standard calcium phosphate procedure. Two days after transfection, cells were resuspended in FACS buffer (PBS supplemented with 2% FBS and 0.5 mM EDTA) and incubated with a serial dilution VHH (1000 ng/ml; 1 over 3) for two hours at 4°C. Unbound VHHs were washed away with FACS buffer. Samples were further stained with a FITC-coupled anti-His Ab for 45 minutes at 4°C and analysed with a FACSCalibur (BD Biosciences) and the CellQuest Pro Version 4.0.2 software (BD Biosciences).

Clone	Sequence Identifier	Binding
R1CHCL23	SEQ ID NO:78	ND

Clone	Sequence Identifier	Binding
R2CHCL18	SEQ ID NO:77	ND
R2CHCL22	SEQ ID NO:75	++
R2CHCL49	SEQ ID NO:73	ND
R2CHCL53	SEQ ID NO:74	ND
R2CHCL25	SEQ ID NO:76	+
R1CHCL27	SEQ ID NO:79	—
R1CHCL82	SEQ ID NO:68	++
R2CHCL10	SEQ ID NO:66	+++
R1CHCL34	SEQ ID NO:67	+
R2CHCL3	SEQ ID NO:69	+
R1CHCL50	SEQ ID NO:60	+++
R2CHCL8	SEQ ID NO:59	+++
R1CHCL21	SEQ ID NO:61	—
R2CHCL87	SEQ ID NO:62	+++
R2CHCL24	SEQ ID NO:63	+++
R2CHCL38	SEQ ID NO:64	—
R1CHCL16	SEQ ID NO:65	++
R1CHCL56	SEQ ID NO:71	ND
R2CHCL69	SEQ ID NO:70	—
R2CHCL32	SEQ ID NO:72	—
R2CHCL14	SEQ ID NO:81	ND
R2CHCL42	SEQ ID NO:82	ND
R2CHCL13	SEQ ID NO:80	ND
R2CHCL41	SEQ ID NO:83	—
R2CHCL94	SEQ ID NO:84	++
R2CHCL27	SEQ ID NO:85	ND

Example 3. Combination Therapy Using Clec9A Chimeras and Tumor Necrosis Factor

The anti-tumor effects of a combination therapy using VHHs specific for mouse Clec9A and Tumor Necrosis Factor (TNF) were tested. Mice were inoculated subcutaneously with B16 (a mouse melanoma cell line) to induce tumors. The mice were subsequently given perilesional (= s.c. at the edge of the tumor) treatments with a chimeric Clec9A VHH specific for mouse Clec9A fused with a modified human interferon alpha 2 (Q124R mutant, “AcTa Clec9A”) with or without TNF. Control mice were treated with PBS or either the chimeric Clec9A VHH alone or TNF alone. Tumor growth was monitored using a digital caliper. EDTA-blood was also collected from the tail vein for analysis of hematological parameters using a Hemavet 950FS Analyzer (Drew Scientific).

As shown in **Figure 6**, panel A, combined treatment using the chimeric Clec9A VHH and TNF elicited potent anti-tumor effects with no tumor recurrence by day 38 compared to treatment with either agent alone. **Figure 6**, panel B, shows that the combination treatment was well tolerated and induced no hematological toxicity compared to treatment with wildtype IFN alone or wildtype IFN with TNF. Altogether these data suggests a synergistic effect for combination therapy using chimeric Clec9A VHHs and TNF.

The Q124R mutant is representative of an attenuated human IFN alpha 2 mutant that can be assayed in vivo in a murine model. Specifically, Q124R is a human IFN mutation that is suitable for use in the mouse (*i.e.* it is a human mutant IFN that functions in mouse). See *Nat. Comm.* 2014;5:3016. doi: 10.1038/ncomms4016, the entire contents of which are hereby incorporated by reference.

Example 4. Combination Therapy Using Clec9A Chimeras and anti-PD-L1 Antibodies

Figure 7 shows the combined effect of a chimera of a VHH specific for mouse Clec9A fused to a modified human IFN alpha 2 (Q124R mutant) and an anti-PD-L1 antibody ("Clec9A-AcTaferon + anti-PD-L1") in comparison to PBS (negative control), chimera of a VHH specific for mouse Clec9A fused to a modified human IFN (Q124R mutant, "Clec9A-AcTaferon") alone, and anti-PD-L1 antibody ("anti-PD-L1") alone.

As demonstrated by the in vivo experiment of **Figure 7**, the combination of a chimera of Clec9A fused to a modified human IFN and an anti-PD-L1 antibody provides synergy with regard to tumor progression. Specifically, the combined treatment provided not only stasis but also tumor shrinkage. This is particularly notable in comparison to, for example, anti-PD-L1 antibody alone, as the mice treated with such were displaying growing tumors at the end of the experiment.

The Q124R mutant is representative of an attenuated human IFN alpha 2 mutant that can be assayed in vivo in a murine model. Specifically, Q124R is a human IFN mutation that is suitable for use in the mouse (*i.e.* it is a human mutant IFN that functions in mouse). See *Nat. Comm.* 2014;5:3016. doi: 10.1038/ncomms4016, the entire contents of which are hereby incorporated by reference.

Example 5. Combination Therapy Using Clec9A Chimeras and Chemotherapy

Figure 8 shows the combined effect of a chimera of a VHH specific for mouse Clec9A fused to a modified human IFN (Q124R) and fused to an anti-PD-L1 VHH, and doxorubicin ("Clec9A-Q124R-PD-L1 + doxo"), compared to a chimera of a VHH specific for mouse Clec9A fused to a modified human IFN ("Q124R") and fused to an anti-PD-L1 VHH ("Clec9A-Q124R-PD-L1"), doxorubicin ("doxo"), and PBS (negative control).

As demonstrated by the in vivo experiment of **Figure 8**, the combination of a chimera of a VHH specific for mouse Clec9A fused to a modified human interferon (Q124R) and fused to an anti-PD-L1 VHH and doxorubicin provides synergy with regard to tumor progression. Importantly, 5 out of 6 mice in the combination therapy group showed a complete tumor regression.

The Q124R mutant is representative of an attenuated human IFN alpha 2 mutant that can be assayed in vivo in a murine model. Specifically, Q124R is a human IFN mutation that is suitable for use in the mouse (*i.e.* it is a human mutant IFN that functions in mouse). See *Nat. Comm.* 2014;5:3016. doi: 10.1038/ncomms4016, the entire contents of which are hereby incorporated by reference.

Example 6. Stimulation of T Cell Proliferation by Mouse Clec9A Chimeras

Chimeric Antigen Receptor (CAR) T-cell therapy is often compromised by the extremely inhospitable solid tumor microenvironment which imposes an immunosuppressive effect on the CAR T cells. For examples, various

immunosuppressive cytokines, regulatory modulators, and co-inhibitory receptors are present in the tumor microenvironment which can induce anergy of the CAR T cells. One mechanism for enhancing the efficacy of CAR T-cell therapy entails an induction of the T cells to divide and proliferate within the tumor microenvironment.

Experiments were conducted to evaluate whether a VHH specific for mouse Clec9A fused to a modified human IFN (Q124R) could induce proliferation of CAR T cells in vivo. Specifically, carboxyfluorescein succinimidyl ester (CFSE)-labeled T cell receptor transgenic CD8⁺ T cells (pmel-1) which recognize the melanocyte differentiation antigen gp100 present on tumor cells were adoptively transferred to mice bearing B16 melanoma tumors. The mice were subsequently treated with either PBS (control) or a VHH specific for mouse Clec9A fused to a modified human IFN (Q124R). T cell proliferation was assessed by evaluating the extent of CFSE-labeled T cells present in the tumor draining lymph nodes using FACS analysis.

As shown in **Figure 9**, treating the mice with the VHH substantially induced T cell division and proliferation as compared to treatment with PBS. Without wishing to be bound by theory, it is believed that T cell division and proliferation was mediated via dendritic cell activation. Altogether these results suggest that the use of VHHs specific for Clec9A fused to IFN synergistically enhances CAR T-cell therapy.

Example 7. VHHs Specific for Human Clec9A are Effective in an Experimental Autoimmune Encephalomyelitis (EAE) Model

This Example shows the therapeutic effects of VHHs specific for mouse Clec9A in an EAE mouse model which mimics human multiple sclerosis (MS). In short, 4 in 5 mice treated with a fusion of Clec9A-IFNQ124R never developed MS symptoms. A single treated mouse got sick, but recovered quickly. Three out of 5 animals treated with a high dose of wild type IFN, that suppressed disease development, died. Mice treated with low-dose wt IFN showed loss of weight. This is in stark contrast with Clec9A-IFNQ124R AcTaferon (*i.e.* fusion protein) treated animals which actually gained weight.

For **Figures 10-12**: various AcTaferons were used. In this context, these refer to attenuated interferon, *i.e.* hIFN Q124R ("Q") which was linked to various targeting domains that included VHHs against Bcl10, mCD20, CD8, or Clec9A at 5000 IU. For comparison, wild type interferon was used ("WT mIFN" at either 5000 IU or 1,000,000 IU as noted. PBS buffer is a mock control (*i.e.* negative).

The treatment schedule for this study was as follows:

- d0 = sc injection MOG + CFA/mtb, + ip PT
- d2 = ip PT
- d7 = start daily treatments ip, and

clinical scoring was as follows:

- 0-1 varying degrees of less horizontal tail if mouse held by the neck
- 1.5 limp tail (totally vertical) but with still a tiny bit tension in it

- 2 totally limp tail
- 2.5 + hind paws closed (toes no longer spread open)
- 3 + waddled walk (but still using both hind paws)
- 3.5 one hind paw no longer used when walking
- 4 both hind paws ...
- 4.5 + no longer able to turn if put on the back
- 5 moribund
- 6 dead.

In **Figure 10**, Panel A, male C57Bl/6J mice (8 wks old) were immunized s.c. with 2x100 μ l of an emulsion of myelin-specific peptide (Mouse Oligodendrocyte Glycoprotein amino acids 35-55 MEVGWYRSPFSRVVHLYRNGK, (SEQ ID NO:296), 1 mg/ml) and Complete Freund's Adjuvant (5mg/ml) at day 0, followed by an i.p. injection of 50 ng pertussis toxin. At day 2, a second pertussis toxin dose was inoculated i.p. Starting at day 7, mice were treated daily (i.p.) with 5000 IU of AcTaferon linked to a VHH binding to either Bcll10 (*i.e.* an irrelevant target, thus the untargeted control), mCD8, mCD20 or mClec9A (n=5, except for mCD8-targeted AcTaferon, where n=4). As positive controls, untargeted wild type mIFN (linked to the Bcll10 VHH) was injected either at 5,000 IU or 1,000,000 IU. Control mice received PBS treatments. Mice were scored daily for progressive paresis and paralysis. Scores between 0 and 2 were given for varying degrees of decreased tail tone, score 2 for a completely paralyzed tail; score 3 for hind limb weakness and starting paraplegia; score 4 for full paraplegia; score 5 for quadriplegia (at which stage the mice should be euthanized) and score 6 if the mouse died. Of note, if mice suddenly died with a score of less than 1, their death was attributed to toxicity of the treatment. These mice were not included for calculation of the mean clinical score (this was only the case for mice treated with high-dose wild type IFN). **Figure 10**, Panel B, shows body weight change. Body weights were also measured daily. Mean weight was calculated including that of mice that died.

Figure 11 shows the mean (\pm S.E.M.) cumulative clinical scores of days 10 to 28 after treatment. First signs of paralysis were visible from day 13 on (n=5, n=4 for mCD8-targeted AcTaferon). **Figure 12** shows an evaluation of the toxic side effects of daily treatments with the various AcTaferons. Shown are mortality during the course of the experiment (panel A) and leukocyte counts at day 25. Specifically, EDTA-treated blood was collected from the tail vein of mice 3 hours after the last treatment, and lymphocytes (panel B), monocytes (panel C), neutrophils (panel D), platelets (panel E) and red blood cells (panel F) were counted using a HEMAVET950FS hematological analyzer (Drew Scientific). Plotted are means \pm S.E.M. (n=5, n=4 for mCD8-targeted AcTaferon, n=2 for wild type mIFN 1.000.000 IU).

Example 8. Dendritic Cell Signaling Induced by Anti-human Clec9A VHH Chimeras

A dendritic cell pSTAT signaling assay was undertaken. Chimeras studied were anti-human Clec9A VHH/ /human IFN R149A and anti-human Clec9A VHH/human IFN R33A/E120R. Two doses of the agents were studied: 100 ng/ml and 500 ng/ml.

The anti-human Clec9A VHH used in this Example was R2CHCL24 (SEQ ID NO:63).

Briefly, human PBMCs were isolated from blood obtained from healthy donors. Approximately 120 ml of blood was collected from each donor using heparin coated tubes (12 tubes). The blood was kept at room temperature and processed immediately. Briefly, blood was diluted 1:1 with DPBS and 25 ml was gently layered onto 15 ml of Lympholyte H. After centrifugation, the mononuclear cell rings were collected and cells were washed three times with DPBS (PBS Dulbecco's Phosphate Buffered Saline, Wisent, catalog #311-425-LL) and counted. Dendritic cells were enriched from the PBMC population using "DC- enrichment kit" containing a combination of lineage specific monoclonal antibodies in PBS and a suspension of magnetic particles (STEMCELL Technologies Catalogue number 19251), according to manufacturer's instructions.

Dendritic cells (DC) were stimulated for 15 minutes in the presence or absence of test items and controls (PBS) and the level of phosphorylated-STAT1 (pSTAT1, specifically pY701-STAT1) was determined in isolated DC cell populations (Lin-(CD14/CD16/CD20/CD56/CD3)/HLA-DR+) by flow cytometry. Post stimulation, cells were fixed (BD Cytofix fixation buffer, BD Bioscience, catalog #554655), then permeabilized with Perm buffer II (BD PhosFlow Perm Buffer, BD Bioscience, catalog #558052). Cells were then stained for phosphoSTAT1 and for DC surface markers (Lin-/HLA-DR+) (see table below). Both intra-cellular and surface staining were performed at the same time. Flow cytometry and data acquisition was performed after cell washing with DPBS.

Table showing list of antibodies for flow cytometry staining

Marker/Product Name	Fluorochrome	Clone	Purpose	Supplier-Catalog Number
pSTAT1	AlexaFluor647	4a	phospho-STAT1	BD-562070
Anti-human CD3	PE	UCHT1	T cells marker Lineage depletion	BD-561809
Anti-human CD14	PE	M5E2	Monocytes markers Lineage depletion	BD-555398
anti-human CD16	PE	B73.1	NK, Neutrophils, Monocytes marker Lineage depletion	BD-561313
anti-human CD19	PE	H1B19	B cells marker Lineage depletion	BD-555413
anti-human CD56	PE	B159	NK cells marker Lineage depletion	BD-555516
Anti-human HLA-DR	FITC	TU36	MHC II marker DC discrimination	BD-555560
Anti-human CD11c	BV421	B-Ly6	DC discrimination	BD-562561
LIVE/DEAD Fixable Aqua Dead Cell Stain	Aqua	N/Ap	Viability dye	ThermoFisher- L34957
Normal mouse IgG	N/Ap	N/Ap	Fc receptor blocker Blocking agent	ThermoFisher- 10400C

Figure 13 shows the data, expressed as a fold change of the percentage of pSTAT⁺ dendritic cells.

This study clearly shows that a human CLEC9A antigen-targeting construct comprising an IFN signaling agent whose activity is recoverable upon cell targeting (IFN R149A) promotes IFN signaling in human dendritic cells (as determined by pSTAT1 induction). In contrast, no IFN signaling activation is observed with a CLEC9A-targeting construct that incorporates an IFN signaling agent whose activity is not recoverable (IFN R33A/E120R). Thus, as observed for comparable IFN fusion constructs targeting mouse CLEC9A, targeting IFN to human dendritic cells using a targeting moiety directed at human CLEC9A antigen results in triggering of a pronounced IFN signal transduction.

Example 9. Modeled Human Anti-Tumor Effects

The anti-human Clec9A VHH used in this Example was R2CHCL24 (SEQ ID NO:63).

Selection of human cord blood

Stem cells were HLA-type matched with the expression of HLA-A2 by the tumor cells used during the experiments. To that end, only HLA-A2 positive cord bloods were selected to proceed with CD34 stem cell purification. Cells were stained with HLA-A2-FITC (BD Pharmingen) or HLA-ABC-PE (BD Pharmingen), the latter as a positive control. Samples were acquired on an Attune Nxt Acoustic Focusing Cytometer (Life Technologies).

Purification of CD34⁺ stem cells from human cord blood

Viable mononuclear cells from human cord bloods were isolated using Fycoll (Lymphoprep, Stemcell technologies) gradient separation prior to CD34⁺ MACS isolation using a direct CD34⁺ progenitor cell isolation kit (Miltenyi). Flow cytometric staining using human CD3-PE (BD Pharmingen)/human-CD34-APC (BD Pharmingen) was used to evaluate purity of the isolated stem cells. Samples were acquired on an Attune Nxt Acoustic Focusing Cytometer (Life Technologies). Purity of injected cells reached 95-98%.

Generation of humanized mice

Newborn NSG mice (1-2 days of age) were sublethally irradiated with 100 cGy prior to intrahepatic delivery of 10⁵ CD34⁺ human stem cells. At 6 weeks after cell transfer, peripheral blood was analyzed for the presence of both human and mouse CD45 (both BD) cells to analyze the effect of engraftment. Samples were acquired on a LSR flow cytometer (BD) and analyzed by FACS Diva software (BD).

The antitumor potential of chimeras was assessed in tumor-bearing humanized mice models. Newborn NSG mice (1-2 days of age) were sublethally irradiated with 100 cGy prior to intrahepatic delivery of 10⁵ CD34⁺ human stem cells (from HLA-A2 positive cord bloods). At week 13 after stem cell transfer mice were s.c. inoculated with 2.5 x 10⁶ human RL follicular lymphoma cells. Mice were treated i.p. daily starting at day 6 after tumor inoculation with 30 µl of Flt3L protein. Daily perilesional chimera delivery (30 µg) was started at day 10 after tumor inoculation, when a palpable tumor was reached. Treatment with the anti-human Clec9a VHH/anti-human PD-L1 VHH/human IFN-R149A bi-specific chimera resulted in stabilization of the tumor growth, which was even more pronounced when combined with Flt3L injections in contrast to injection of PBS. The graph shows tumor growth as mean ± SEM.

Accordingly, the anti-human Clec9a VHH/anti-human PD-L1 VHH/human IFN-R149A bi-specific chimera showed clear antitumor effects on a human tumor (RL) grown in humanized mice (mice with a reconstituted human immune system). See **Figure 14**.

EQUIVALENTS

While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modifications and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice within the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth and as follows in the scope of the appended claims.

Those skilled in the art will recognize, or be able to ascertain, using no more than routine experimentation, numerous equivalents to the specific embodiments described specifically herein. Such equivalents are intended to be encompassed in the scope of the following claims.

INCORPORATION BY REFERENCE

All patents and publications referenced herein are hereby incorporated by reference in their entireties.

The publications discussed herein are provided solely for their disclosure prior to the filing date of the present application. Nothing herein is to be construed as an admission that the present invention is not entitled to antedate such publication by virtue of prior invention.

As used herein, all headings are simply for organization and are not intended to limit the disclosure in any manner. The content of any individual section may be equally applicable to all sections.

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CLAIMS

What is claimed is:

1. A chimeric protein comprising:
 - (a) a first targeting moiety comprising a recognition domain which recognizes and binds to Clec9A; and
 - (b) a modified signaling agent, said modified signaling agent having one or more mutations that confer improved safety as compared to a wild type signaling agent, andwherein the targeting moieties and modified signaling agent are optionally connected with one or more linkers.
2. The chimeric protein of claim 1, further comprising one or more additional targeting moieties.
3. The chimeric protein of claim 2, wherein the one or more additional targeting moieties comprise a recognition domain that recognizes and binds an antigen or receptor on a tumor cell.
4. The chimeric protein of claim 2, wherein the one or more additional targeting moieties comprise a recognition domain that recognizes and binds an antigen or receptor on an immune cell.
5. The chimeric protein of claim 4, wherein the immune cell is selected from a T cell, a B cell, a dendritic cell, a macrophage, a neutrophil, and a NK cell.
6. The chimeric protein of any one of the above claims, wherein the recognition domain comprises a full-length antibody, a single-domain antibody, a recombinant heavy-chain-only antibody (VHH), a single-chain antibody (scFv), a shark heavy-chain-only antibody (VNAR), a microprotein, a darpin, an anticalin, an adnectin, an aptamer, a Fv, a Fab, a Fab', a F(ab')₂, a peptide mimetic molecule, a natural ligand for a receptor, or a synthetic molecule.
7. The chimeric protein of any one of the above claims, wherein the recognition domain comprises a VHH.
8. The chimeric protein of any one of the above claims, wherein the modified signaling agent comprises one or more mutations conferring reduced affinity or activity for a receptor relative to a wild type signaling agent.
9. The chimeric protein of claim 8, wherein the one or more mutations allow for attenuation of activity.
10. The chimeric protein of claim 9, wherein agonistic or antagonistic activity is attenuated.
11. The chimeric protein of claim 8, wherein the mutation confers reduced affinity or activity that is restorable by attachment to one or more targeting moiety.
12. The chimeric protein of claim 8, wherein the mutation confers substantially reduced or ablated affinity or activity that is not substantially restorable by attachment to one or more targeting moiety.

13. The chimeric protein of any one of the above claims, wherein the modified signaling agent is selected from one or more of an interferon, an interleukin, and a tumor necrosis factor, any of which are optionally mutated.
14. The chimeric protein of any one of the above claims, wherein the modified signaling agent is IFN α 2a, optionally having one or more mutations at positions L153, R149, and M148 (SEQ ID NO: 86 or SEQ ID NO:87).
15. The chimeric protein of any one of the above claims, wherein the recognition domain comprises three complementarity determining regions (CDR1, CDR2, and CDR3), wherein:
 - (a) CDR1 comprises an amino acid sequence selected from any one of SEQ ID NOs: 2-21;
 - (b) CDR2 comprises an amino acid sequence selected from any one of SEQ ID NO: 22-43; and
 - (c) CDR3 comprises an amino acid sequence selected from any one of SEQ ID NO: 44-58, LGR, and VIK.
16. A Clec9A binding agent comprising at least one targeting moiety comprising three complementarity determining regions (CDR1, CDR2, and CDR3), wherein:
 - (a) CDR1 comprises an amino acid sequence selected from any one of SEQ ID NOs: 2-21;
 - (b) CDR2 comprises an amino acid sequence selected from any one of SEQ ID NO: 22-43; and
 - (c) CDR3 comprises an amino acid sequence selected from any one of SEQ ID NO: 44-58, LGR, and VIK.
17. The Clec9A binding agent of claim 16, wherein the targeting moiety is a full-length antibody, a single-domain antibody, a recombinant heavy-chain-only antibody (VHH), a single-chain antibody (scFv), a shark heavy-chain-only antibody (VNAR), a microprotein, a darpin, an anticalin, an adnectin, an aptamer, a Fv, a Fab, a Fab', a F(ab')₂, a peptide mimetic molecule, a natural ligand for a receptor, or a synthetic molecule.
18. The Clec9A binding agent of claim 16 or 17, wherein the targeting moiety is a single-domain antibody.
19. The Clec9A binding agent of claim 18, wherein the targeting moiety comprises a V_HH, a humanized V_HH, or a camelized V_HH.
20. The Clec9A binding agent of any one of claims 16-19, wherein the targeting moiety comprises a CDR1 comprising the amino acid sequence of SEQ ID NO:2, a CDR2 comprising the amino acid sequence of SEQ ID NO:22, and a CDR3 comprising the amino acid sequence of SEQ ID NO:44.
21. The Clec9A binding agent of any one of claims 16-20, wherein the targeting moiety comprises one or more of :
 - a CDR1 comprising the amino acid sequence of SEQ ID NO:3, a CDR2 comprising the amino acid sequence of SEQ ID NO:23, and a CDR3 comprising the amino acid sequence of SEQ ID NO:45,

CDR1 comprising the amino acid sequence of SEQ ID NO:16, a CDR2 comprising the amino acid sequence of SEQ ID NO:37, and a CDR3 comprising the amino acid sequence of SEQ ID NO:57;

CDR1 comprising the amino acid sequence of SEQ ID NO:17, a CDR2 comprising the amino acid sequence of SEQ ID NO:37, and a CDR3 comprising the amino acid sequence of SEQ ID NO:57;

CDR1 comprising the amino acid sequence of SEQ ID NO:18, a CDR2 comprising the amino acid sequence of SEQ ID NO:38, and a CDR3 comprising the amino acid sequence of SEQ ID NO:58;

CDR1 comprising the amino acid sequence of SEQ ID NO:19, a CDR2 comprising the amino acid sequence of SEQ ID NO:39, and a CDR3 comprising the amino acid sequence of LGR;

CDR1 comprising the amino acid sequence of SEQ ID NO:19, a CDR2 comprising the amino acid sequence of SEQ ID NO:40, and a CDR3 comprising the amino acid sequence of LGR;

CDR1 comprising the amino acid sequence of SEQ ID NO:19, a CDR2 comprising the amino acid sequence of SEQ ID NO:41, and a CDR3 comprising the amino acid sequence of LGR;

CDR1 comprising the amino acid sequence of SEQ ID NO:20, a CDR2 comprising the amino acid sequence of SEQ ID NO:42, and a CDR3 comprising the amino acid sequence of LGR; and

CDR1 comprising the amino acid sequence of SEQ ID NO:21, a CDR2 comprising the amino acid sequence of SEQ ID NO:43, and a CDR3 comprising the amino acid sequence of VIK.

22. The Clec9A binding agent of any one of claims 16-21, comprising an amino acid sequence having at least 90% similarity with any one of SEQ ID NOs:59-85.
23. The Clec9A binding agent of any one of claims 16-22, comprising an amino acid sequence of one of more of SEQ ID NOs:59-85.
24. The Clec9A binding agent of any one of claims 16-23, wherein the Clec9A binding agent comprises one or more signaling agents.
25. The Clec9A binding agent of claim 24, wherein the signaling agent is selected from one or more of an interferon, an interleukin, and a tumor necrosis factor, any of which are optionally modified.
26. The Clec9A binding agent of any one of claims 16-25, wherein the Clec9A binding agent comprises one or more additional targeting moieties.
27. The Clec9A binding agent of claim 26, wherein the one or more additional targeting moieties recognize and optionally functionally modulate a tumor antigen.
28. The Clec9A binding agent of claim 27, wherein the one or more additional targeting moieties recognize and optionally functionally modulate an antigen on an immune cell, optionally selected from a T cell, a B cell, a dendritic cell, a macrophage, a neutrophil, and a NK cell.

29. The Clec9A binding agent of any one of claims 16-28, wherein the Clec9A binding agent recognizes and binds Clec9A without substantially neutralizing its activity.
30. The Clec9A binding agent of any one of claims 16-29, wherein the Clec9A binding agent directly or indirectly recruits dendritic cells to tumor cells or to the tumor environment.
31. The Clec9A binding agent of any one of claims 16-30, wherein the Clec9A agent enhances antigen presentation by dendritic cells.
32. The Clec9A binding agent of claim 31, wherein the Clec9A agent enhances tumor antigen presentation by dendritic cells.
33. A recombinant nucleic acid composition encoding the Clec9A binding agents of any one of claims 16-32.
34. A host cell comprising a nucleic acid of claim 33.
35. The Clec9A binding agent of any one of claims 16-34, wherein the Clec9A binding agent is suitable for use in a patient having one or more of: cancers, infections, immune disorders, autoimmune disorders, and/or neurodegenerative diseases.
36. A method for treating or preventing cancer, comprising administering to a patient in need thereof an effective amount of a chimera comprising:
- a targeting moiety comprising a recognition domain which recognizes and binds to Clec9A, and
 - a signaling agent, optionally selected from one or more of an interferon, an interleukin, and a tumor necrosis factor.
37. The method of claim 36, wherein the cancer is selected from one or more of basal cell carcinoma, biliary tract cancer; bladder cancer; bone cancer; brain and central nervous system cancer; breast cancer; cancer of the peritoneum; cervical cancer; choriocarcinoma; colon and rectum cancer; connective tissue cancer; cancer of the digestive system; endometrial cancer; esophageal cancer; eye cancer; cancer of the head and neck; gastric cancer (including gastrointestinal cancer); glioblastoma; hepatic carcinoma; hepatoma; intra-epithelial neoplasm; kidney or renal cancer; larynx cancer; leukemia; liver cancer; lung cancer (e.g., small-cell lung cancer, non-small cell lung cancer, adenocarcinoma of the lung, and squamous carcinoma of the lung); melanoma; myeloma; neuroblastoma; oral cavity cancer (lip, tongue, mouth, and pharynx); ovarian cancer; pancreatic cancer; prostate cancer; retinoblastoma; rhabdomyosarcoma; rectal cancer; cancer of the respiratory system; salivary gland carcinoma; sarcoma; skin cancer; squamous cell cancer; stomach cancer; testicular cancer; thyroid cancer; uterine or endometrial cancer; cancer of the urinary system; vulval cancer; lymphoma including Hodgkin's and non-Hodgkin's lymphoma, as well as B-cell lymphoma (including low grade/follicular non-Hodgkin's lymphoma (NHL); small lymphocytic (SL) NHL; intermediate grade/follicular NHL; intermediate grade diffuse NHL; high grade immunoblastic NHL; high grade lymphoblastic NHL; high grade small non-cleaved cell NHL; bulky disease NHL; mantle cell lymphoma; AIDS-related lymphoma; and Waldenstrom's Macroglobulinemia; chronic

lymphocytic leukemia (CLL); acute lymphoblastic leukemia (ALL); Hairy cell leukemia; chronic myeloblastic leukemia; as well as other carcinomas and sarcomas; and post-transplant lymphoproliferative disorder (PTLD), as well as abnormal vascular proliferation associated with phakomatoses, edema (e.g. that associated with brain tumors), and Meigs' syndrome.

38. The method of claim 36 or 37, wherein the targeting moiety comprising a recognition domain which recognizes and binds to Clec9A is a Clec9A binding agent of any of the above claims.

39. The method of any one of claims 36-38, wherein the signaling agent is modified.

40. The method of claim 39, wherein the modified signaling agent is a mutated interferon.

41. The method of claim 40, wherein the mutated interferon is a mutated human IFN α 2.

42. The method of claim 41, wherein the mutated IFN α 2 comprises one or more mutations at positions 148, 149, and 153 with reference to SEQ ID NO: 86 or SEQ ID NO:87.

43. The method of claim 42, wherein the mutation is one or more of M148A, R149A, and L153A, or functional equivalents thereof.

44. The method of any one of claims 36-43, further comprising administering an effective amount of a chemotherapeutic agent to a patient in need thereof.

45. The method of claim 44, wherein the chemotherapeutic agent is a DNA-intercalating agent.

46. The method of claim 45, wherein the DNA-intercalating agent is selected from doxorubicin, cisplatin, daunorubicin, and epirubicin.

47. The method of claim 46, wherein the DNA-intercalating agent is doxorubicin.

48. The method of any one of claims 36-47, wherein the method provides synergistic effects compared to a therapeutic response with the chimera or the chemotherapeutic agent alone.

49. The method any one of claims 36-48, further comprising administering an effective amount of a checkpoint inhibitor to a patient in need thereof.

50. The method of claim 49, wherein the checkpoint inhibitor is an agent that targets one or more of PD-1, PD-L1, PD-L2, and CTLA-4.

51. The method of claim 50, wherein the checkpoint inhibitor is one or more of nivolumab, (ONO-4538/BMS-936558, MDX1106, OPDIVO, BRISTOL MYERS SQUIBB), pembrolizumab (KEYTRUDA, MERCK), pidilizumab (CT-011, CURE TECH), MK-3475 (MERCK), BMS 936559 (BRISTOL MYERS SQUIBB), MPDL3280A (ROCHE), ipilimumab (MDX-010, MDX-101, Yervoy, BMS) and tremelimumab (Pfizer).

52. The method of claim 51, wherein the checkpoint inhibitor is an antibody against PD-L1.

53. The method of any one of claims 49-52, wherein the method provides synergistic effects compared to a therapeutic response with the chimera or the checkpoint inhibitor alone.

54. The method of any one of claims 36-53, further comprising administering an effective amount of an immunosuppressive agent to a patient in need thereof.
55. The method of claim 54, wherein the immunosuppressive agent is TNF.
56. The method of claim 54 or 55, wherein the method provides synergistic effects compared to a therapeutic response with the chimera or the immunosuppressive agent alone.
57. The method of any one of claims 36-56, further comprising administering an effective amount of T cells expressing a chimeric antigen receptor (CAR) to a patient in need thereof.
58. The method of claim 57, wherein the T cells expressing CAR targets one or more antigens selected from carbonic anhydrase IX (CAIX), 5T4, CD19, CD20, CD22, CD30, CD33, CD38, CD47, CS1, CD138, Lewis-Y, L1-CAM, MUC16, ROR-1, IL13R α 2, gp100, prostate stem cell antigen (PSCA), prostate-specific membrane antigen (PSMA), B-cell maturation antigen (BCMA), human papillomavirus type 16 E6 (HPV-16 E6), CD171, folate receptor alpha (FR- α), GD2, human epidermal growth factor receptor 2 (HER2), mesothelin, EGFRvIII, fibroblast activation protein (FAP), carcinoembryonic antigen (CEA), and vascular endothelial growth factor receptor 2 (VEGF-R2).
59. The method of claim 58, wherein the T cells expressing CAR is selected from JCAR014 (Juno Therapeutics), JCAR015 (Juno Therapeutics), JCAR017 (Juno Therapeutics), JCAR018 (Juno Therapeutics), JCAR020 (Juno Therapeutics), JCAR023 (Juno Therapeutics), JCAR024 (Juno Therapeutics), CTL019 (Novartis), KTE-C19 (Kite Pharma), BPX-401 (Bellicum Pharmaceuticals), BPX-501 (Bellicum Pharmaceuticals), BPX-601 (Bellicum Pharmaceuticals), bb2121 (Bluebird Bio), CD-19 Sleeping Beauty cells (Ziopharm Oncology), UCART19 (Cellestis), UCART123 (Cellestis), UCART38 (Cellestis), UCARTCS1 (Cellestis), OXB-302 (Oxford BioMedica), MB-101 (Mustang Bio) and CAR T-cells developed by Innovative Cellular Therapeutics.
60. The method of any one of claims 57-59, wherein the method provides synergistic effects compared to a therapeutic response with the chimera or the CAR T cells alone.
61. The method of any one of 36-60, wherein the method provides improved safety compared to a chimeric protein comprising an unmodified signaling agent.
62. A method for treating or preventing an autoimmune and/or neurodegenerative disease, comprising administering to a patient in need thereof an effective amount of a chimera comprising:
- a targeting moiety comprising a recognition domain which recognizes and binds to Clec9A, and
 - a signaling agent selected from one or more of an interferon, an interleukin, and a tumor necrosis factor.
63. The method of claim 62, wherein the autoimmune and/or neurodegenerative disease is selected from multiple sclerosis, diabetes mellitus, lupus, celiac disease, Crohn's disease, ulcerative colitis, Guillain-Barre syndrome, scleroderms, Goodpasture's syndrome, Wegener's granulomatosis, autoimmune epilepsy, Rasmussen's encephalitis, Primary biliary sclerosis, Sclerosing cholangitis, Autoimmune hepatitis, Addison's

disease, Hashimoto's thyroiditis, Fibromyalgia, Menier's syndrome; transplantation rejection (e.g., prevention of allograft rejection) pernicious anemia, rheumatoid arthritis, systemic lupus erythematosus, dermatomyositis, Sjogren's syndrome, lupus erythematosus, myasthenia gravis, Reiter's syndrome, Grave's disease,

64. The method of claim 63, wherein the autoimmune and/or neurodegenerative disease is multiple sclerosis.

65. The method of any one of claims 62-64, wherein the targeting moiety comprising a recognition domain which recognizes and binds to Clec9A is a Clec9A binding agent of any of the above claims.

66. The method of any one of claims 62-65, wherein the signaling agent is modified.

67. The method of any one of claims 62-66, wherein the chimera comprises one or more additional targeting moieties.

68. The method of claim 67, wherein the one or more additional targeting moieties recognize and optionally neutralize an immune stimulatory signal.

69. The method of claim 67, wherein the one or more additional targeting moieties recognize and optionally neutralize an antigen on an immune cell.

70. The method of claim 69, wherein the immune cell is selected from a T cell, a B cell, a dendritic cell, a macrophage, a neutrophil, and a NK cell.

71. The method of any one of claims 65-70, wherein the Clec9A binding agent recognizes and binds Clec9A and substantially modulate its activity.

72. The method of any one of claims 65-71, wherein the Clec9A binding agent leads to immunosuppression in the patient.

FIGURE 1

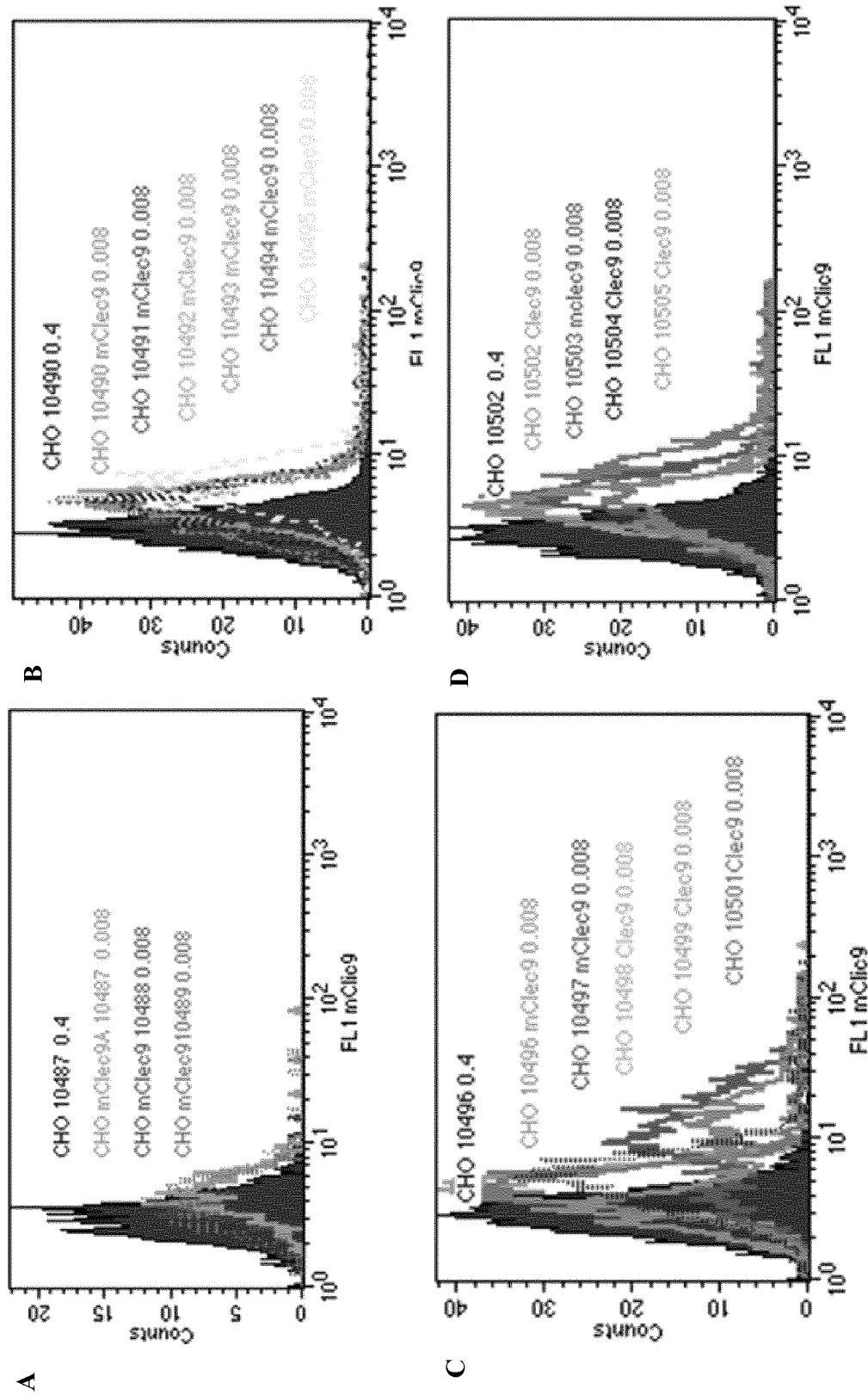


FIGURE 1 (CONTINUED)

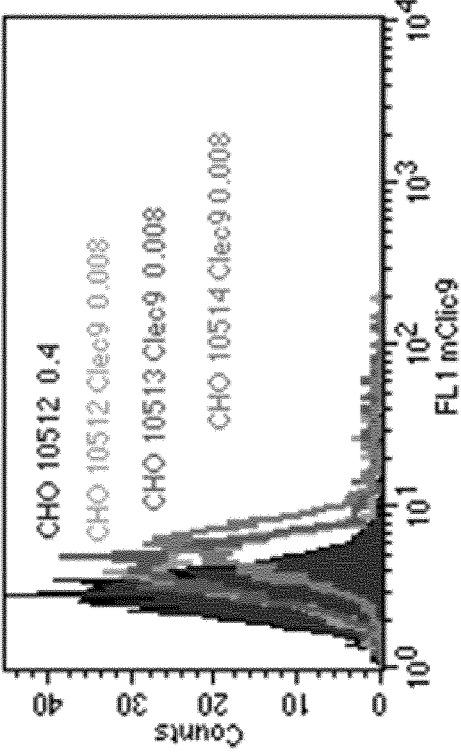
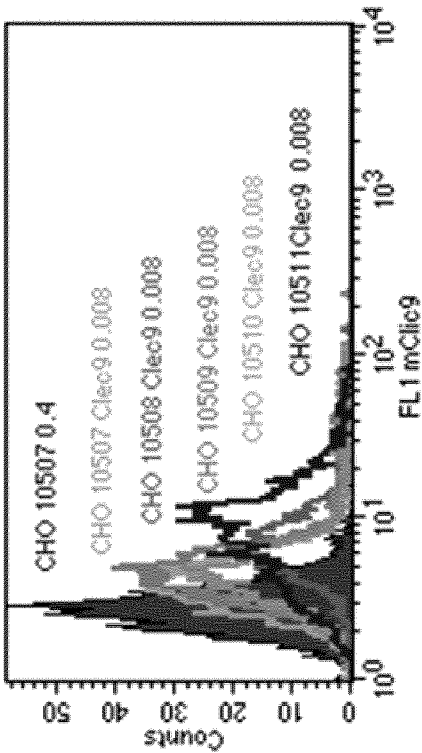


FIGURE 2

A.

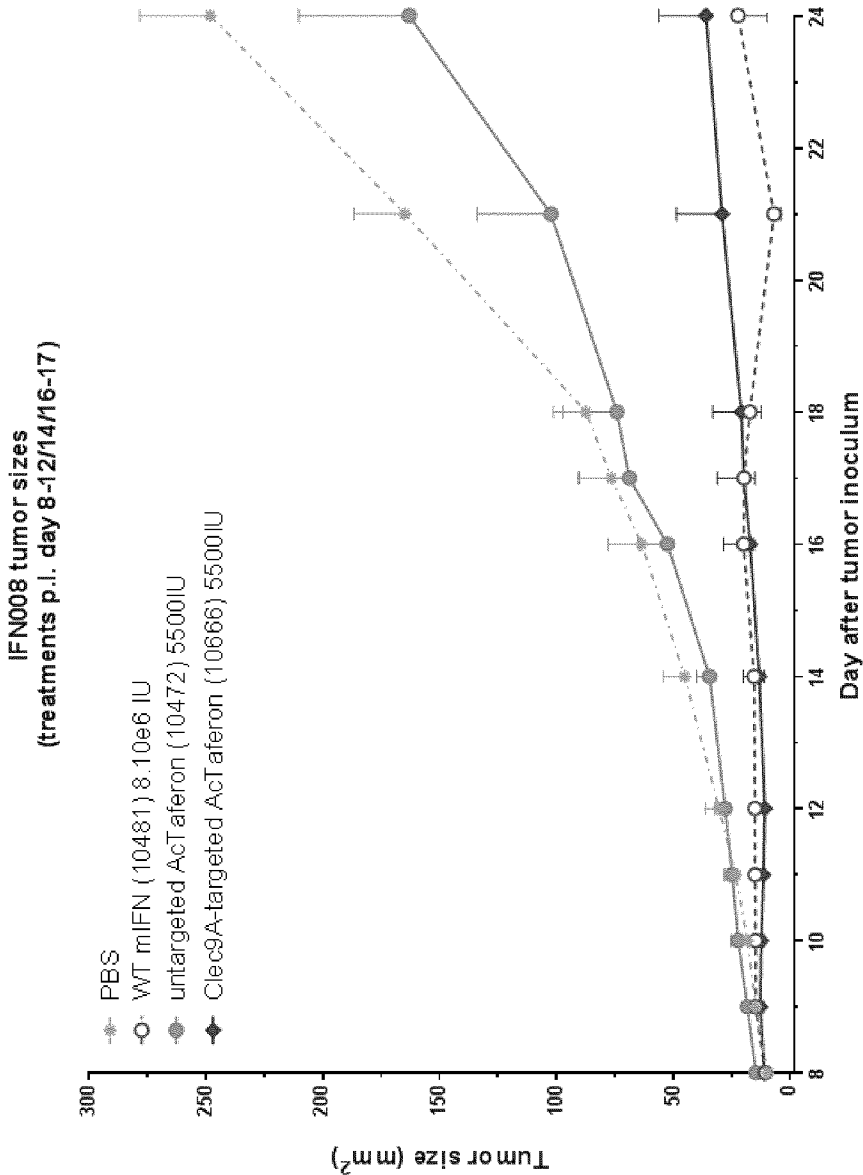


FIGURE 2 (CONTINUED)

B.

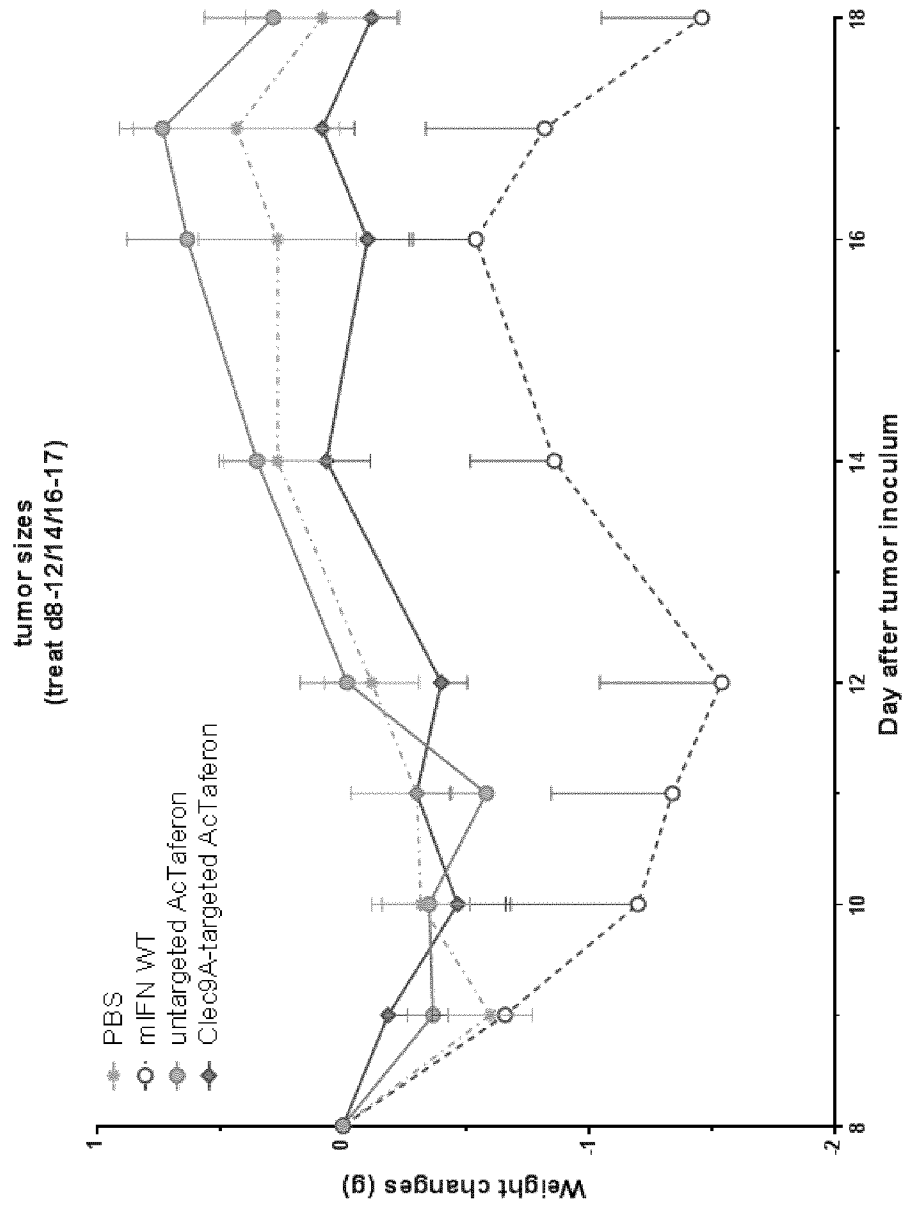
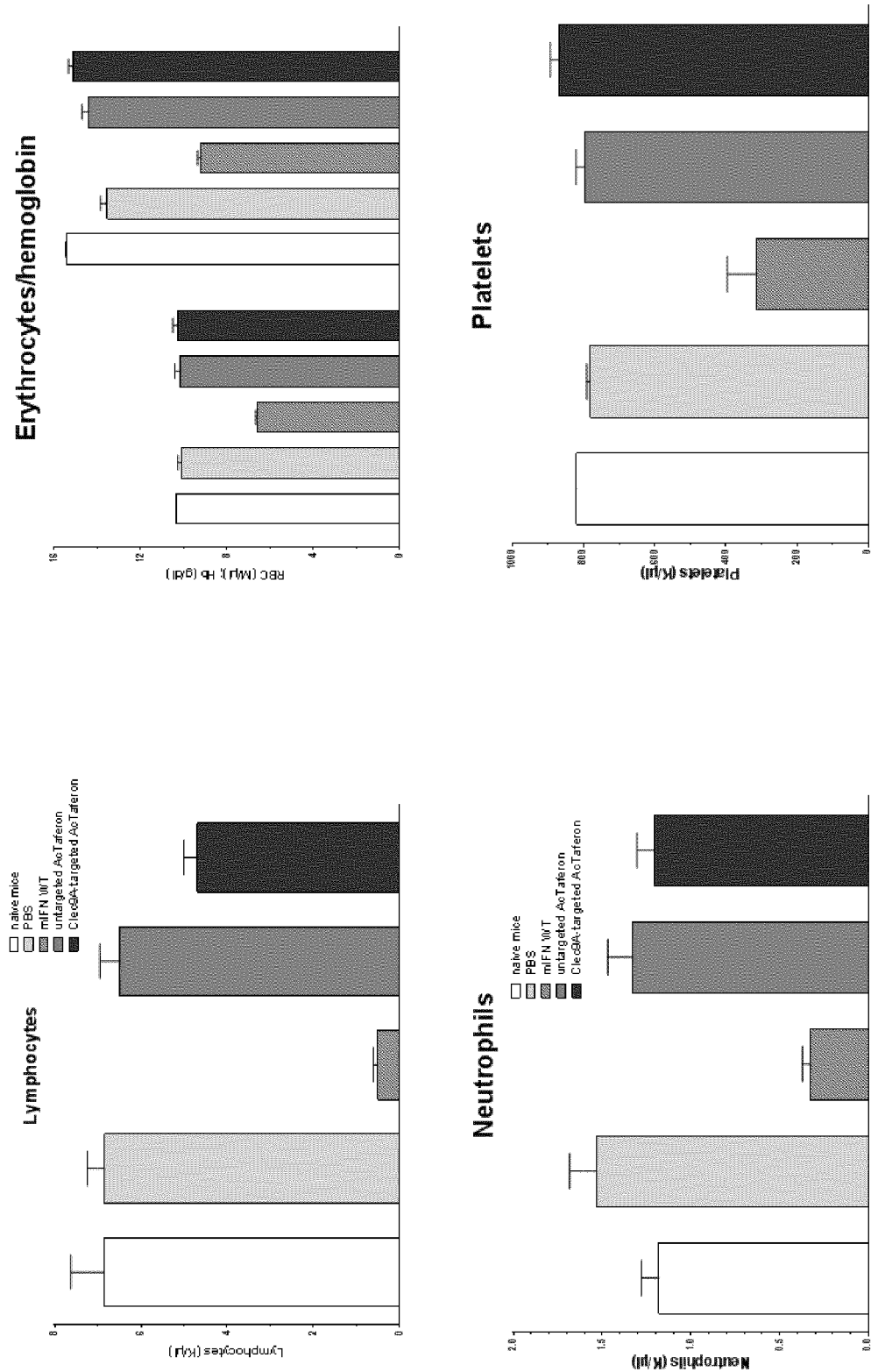


FIGURE 2 (CONTINUED)

C.



[illegible]

[illegible]

FIGURE 3 (CONTINUED)

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R1CHL23 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 399
R2CHL18 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 399
R2CHL22 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 399
R2CHL49 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 399
R2CHL53 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 399
R2CHL53 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 399
R2CHL25 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 399
R1CHL27 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 393
R1CHL82 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 399
R2CHL10 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 399
R1CHL34 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 396
R2CHL3 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 396
R1CHL50 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 393
R2CHL8 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 393
R1CHL21 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 393
R2CHL87 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 393
R2CHL24 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 411
R2CHL38 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 393
R1CHL16 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 393
R1CHL56 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 396
R2CHL69 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 396
R2CHL32 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 396
R2CHL14 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 384
R2CHL42 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 384
R2CHL13 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 384
R2CHL41 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 384
R2CHL94 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 384
R2CHL27 : GTACCGTCTCCAGCGGCCGCTACCGGTACGCGTTCGGACTACGGTTCCGGCCGACATAG : 384

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[illegible]

CDR1

FIGURE 4 (CONTINUED)

	120
R2CHCL8	: VTSS
R1CHCL50	: VTSS
R1CHCL21	: VTSS
R2CHCL87	: VTSS
R2CHCL24	: VTSS
R2CHCL38	: VTSS
R1CHCL16	: VTSS
R2CHCL10	: VTSS
R1CHCL34	: VTSS
R1CHCL82	: VTSS
R2CHCL3	: VTSS
R2CHCL69	: VTSS
R1CHCL56	: VTSS
R2CHCL32	: VTSS
R2CHCL49	: VTSS
R2CHCL53	: VTSS
R2CHCL22	: VTSS
R2CHCL25	: VTSS
R2CHCL18	: VTSS
R1CHCL23	: VTSS
R1CHCL27	: VTSS
R2CHCL13	: VTSS
R2CHCL14	: VTSS
R2CHCL42	: VTSS
R2CHCL41	: VTSS
R2CHCL94	: VTSS
R2CHCL27	: VTSS

FIGURE 5

Group	Member(s)
1	R1CHCL21, R1CHCL50, R2CHCL8, R2CHCL87
2	R2CHCL24
3	R2CHCL38
4	R1CHCL16
5	R1CHCL34, R1CHCL82, R2CHCL10
6	R2CHCL3
7	R1CHCL56, R2CHCL32, R2CHCL69
8	R1CHCL23, R2CHCL18, R2CHCL22, R2CHCL25, R2CHCL49, R2CHCL53
9	R1CHCL27
10	R2CHCL13, R2CHCL14, R2CHCL41, R2CHCL42, R2CHCL94
11	R2CHCL27

FIGURE 6

A.

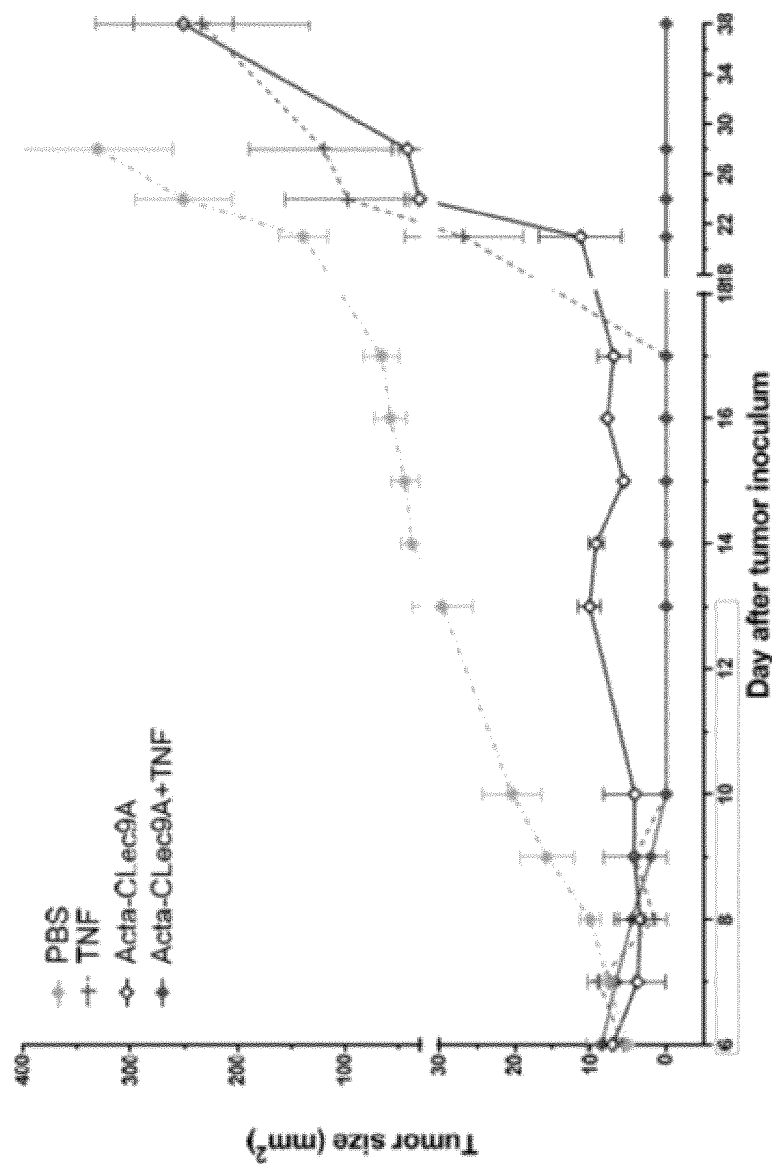


FIGURE 6 (Continued)
B.

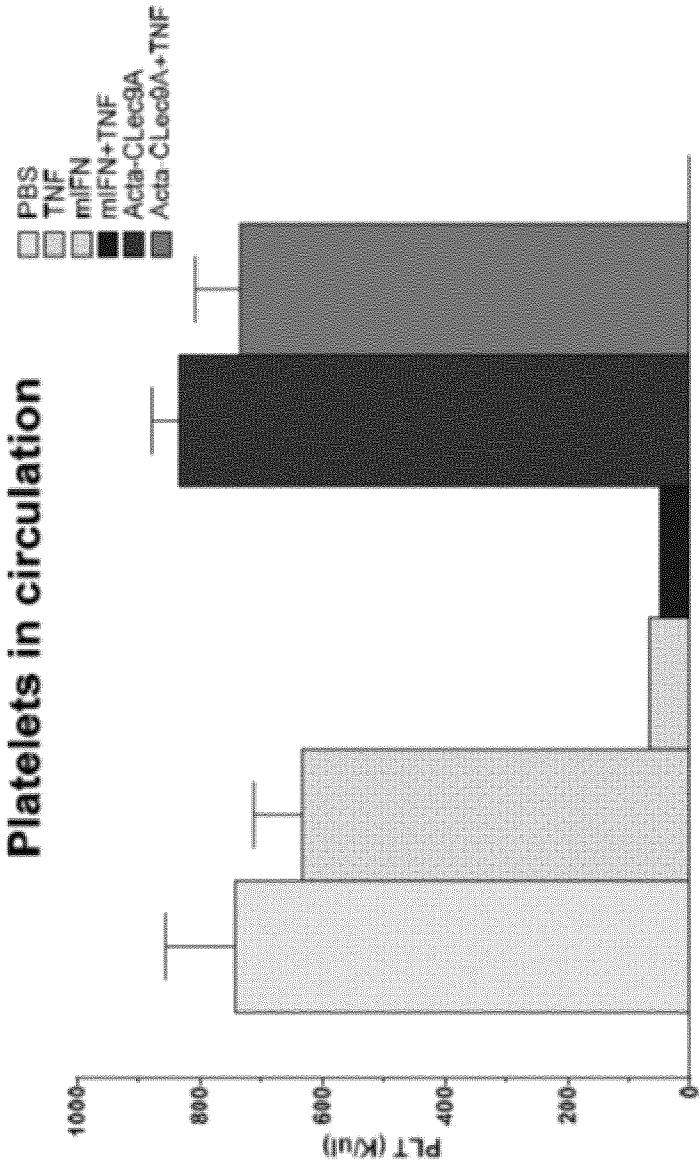


FIGURE 7

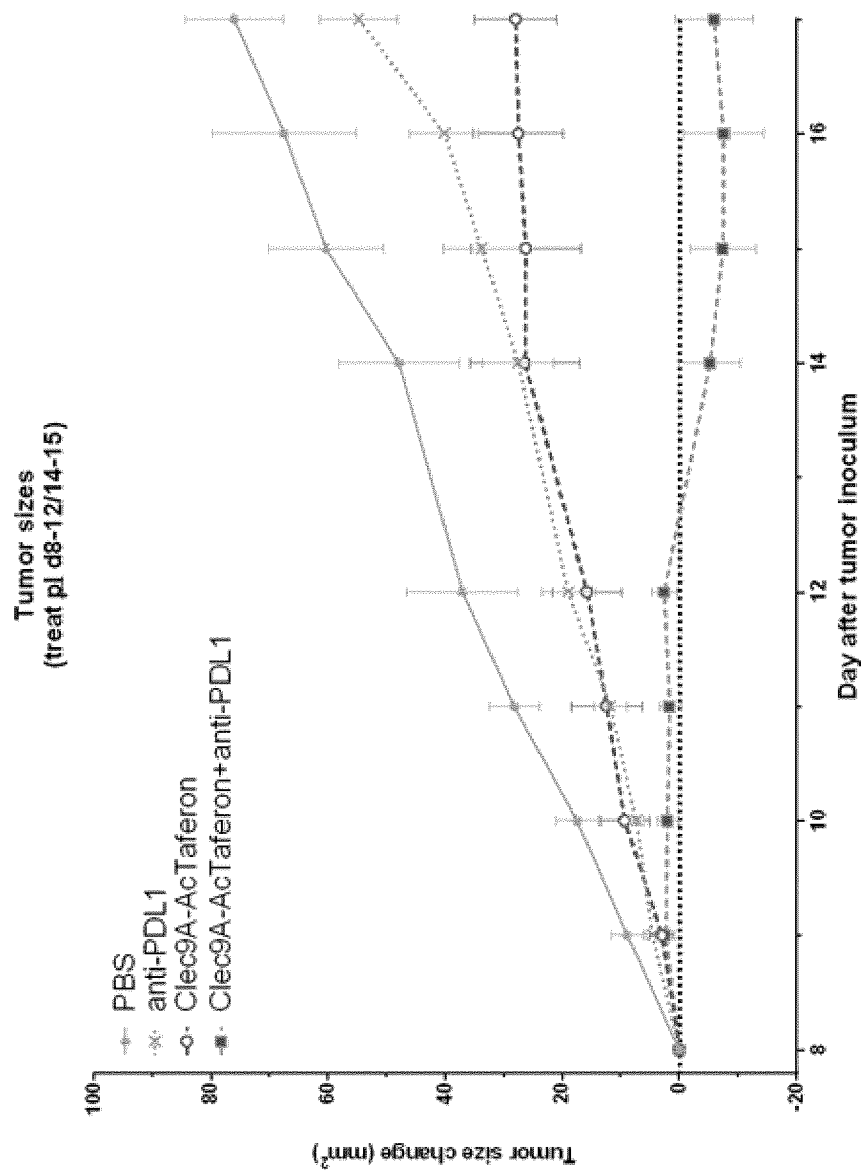
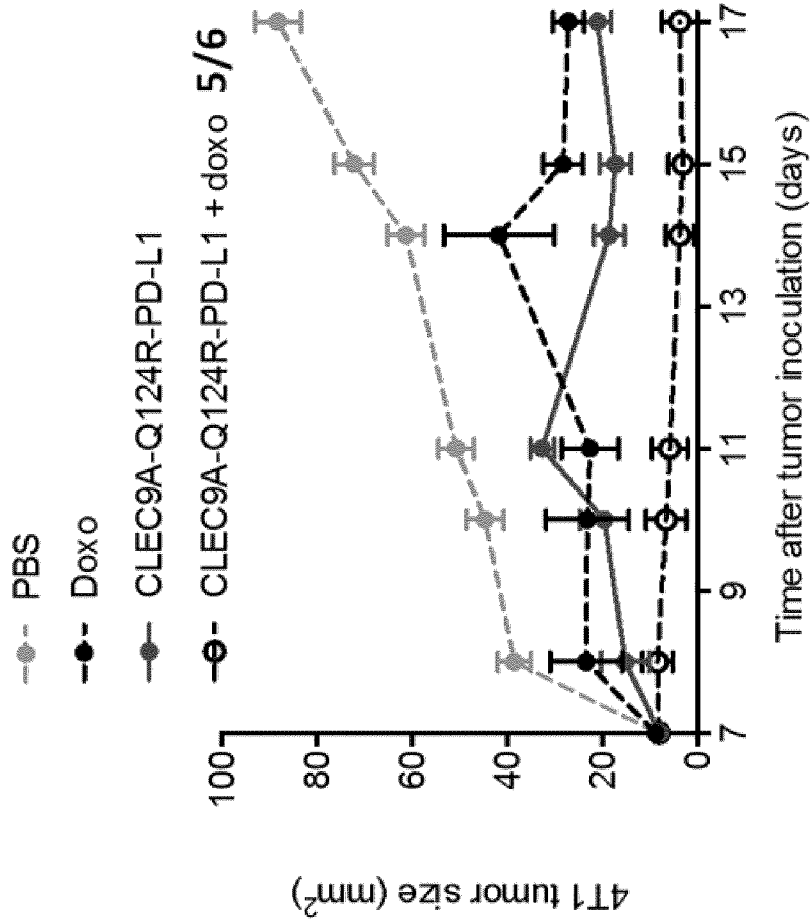


FIGURE 8



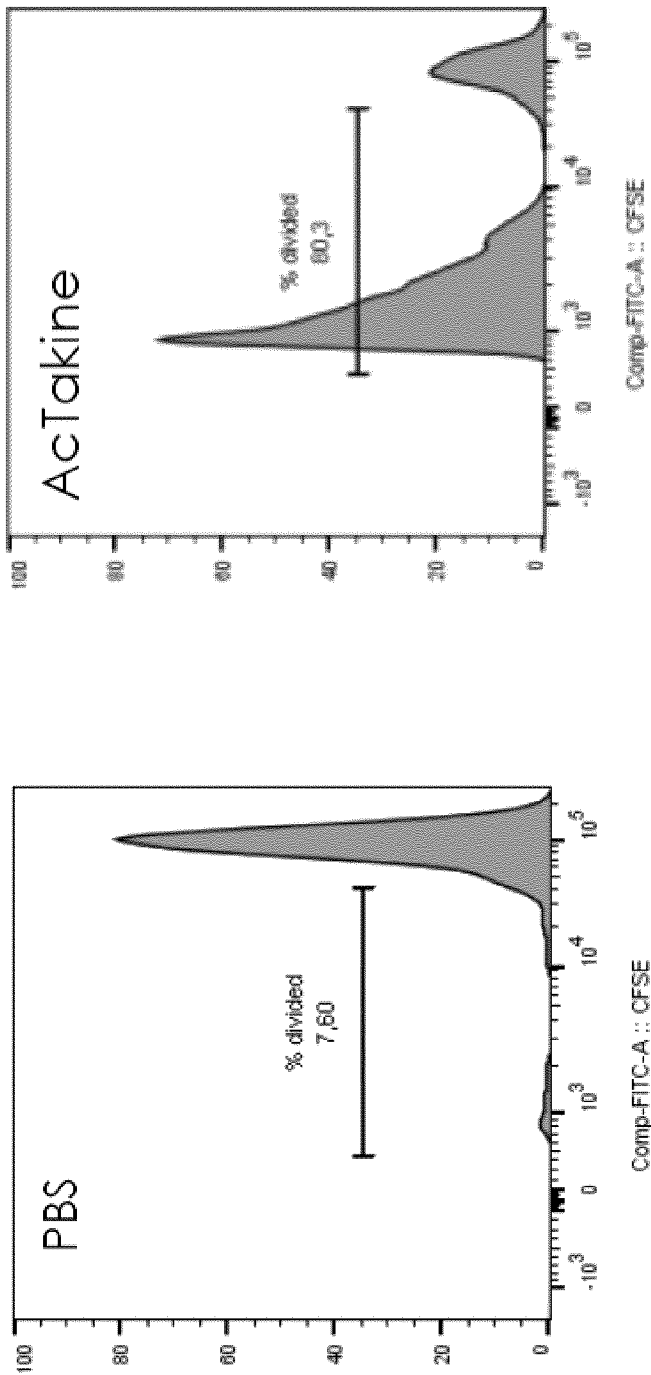


FIGURE 9

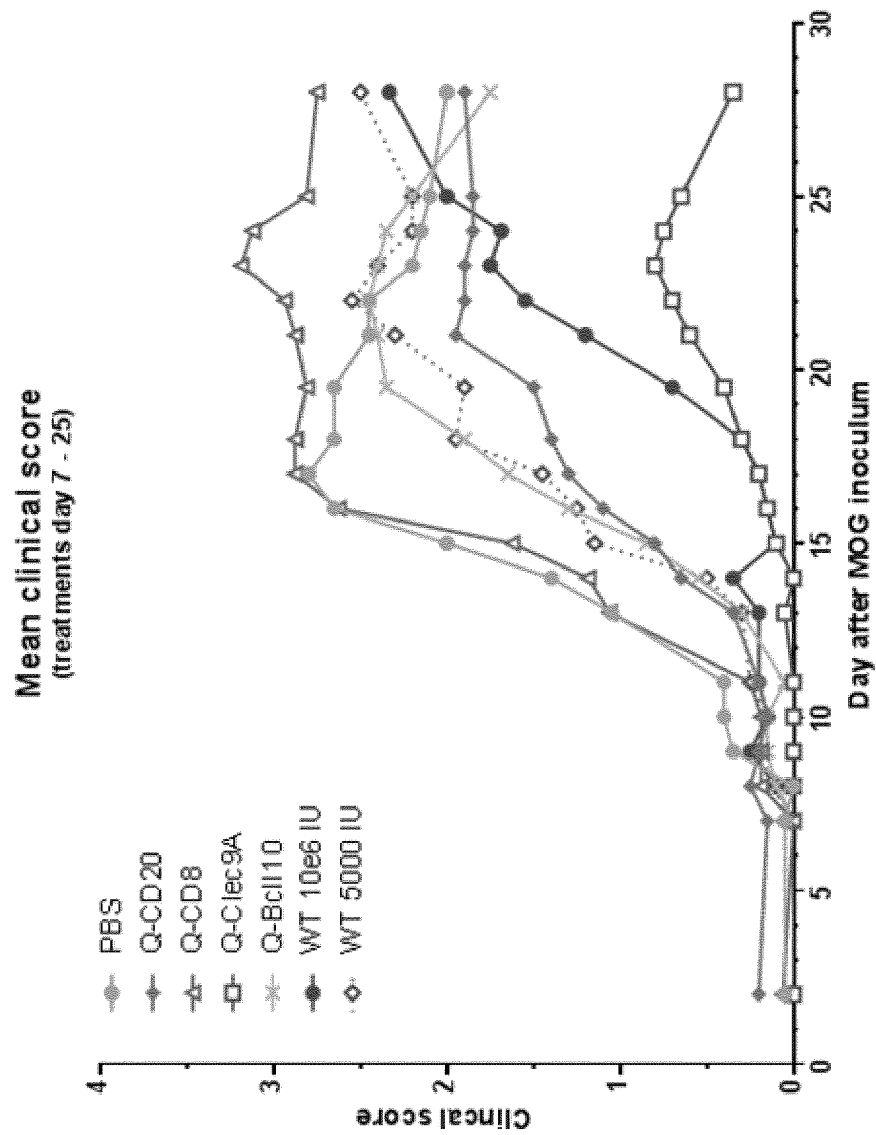
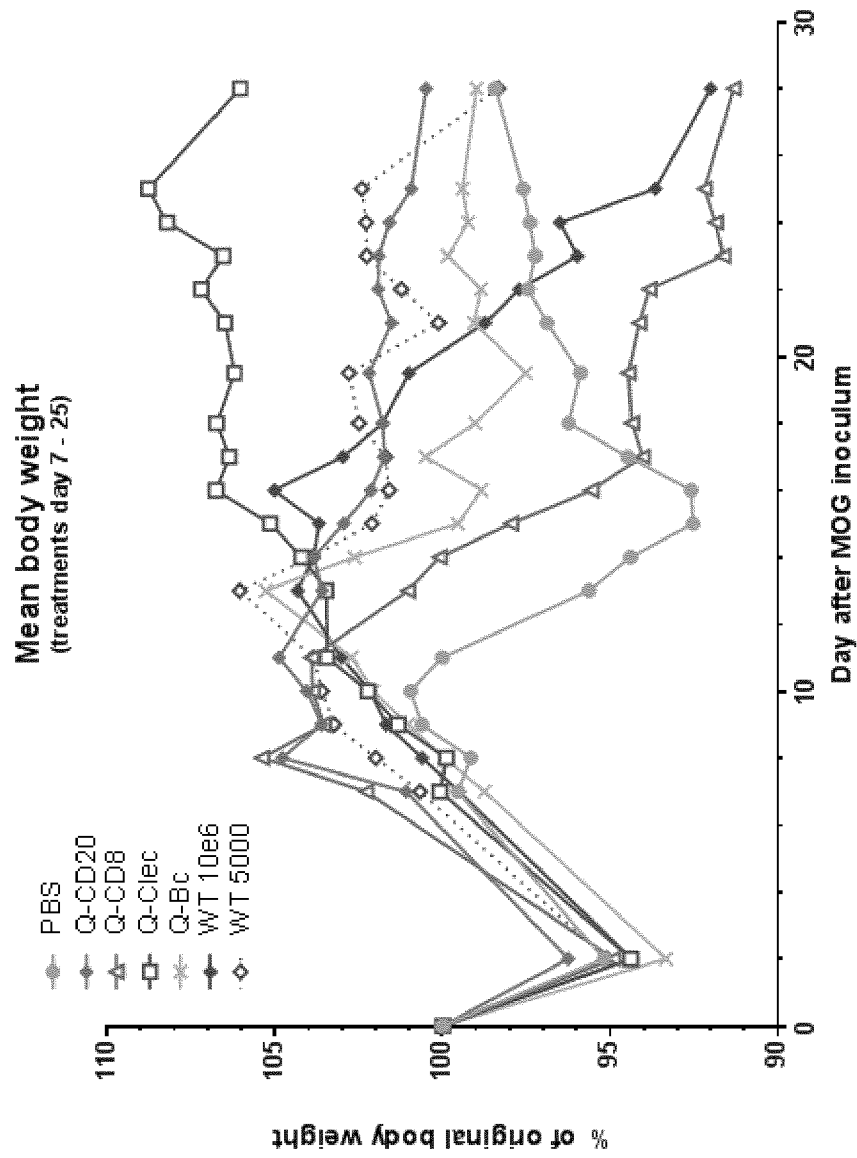


FIGURE 10

A.

FIGURE 10 (Continued)

B.



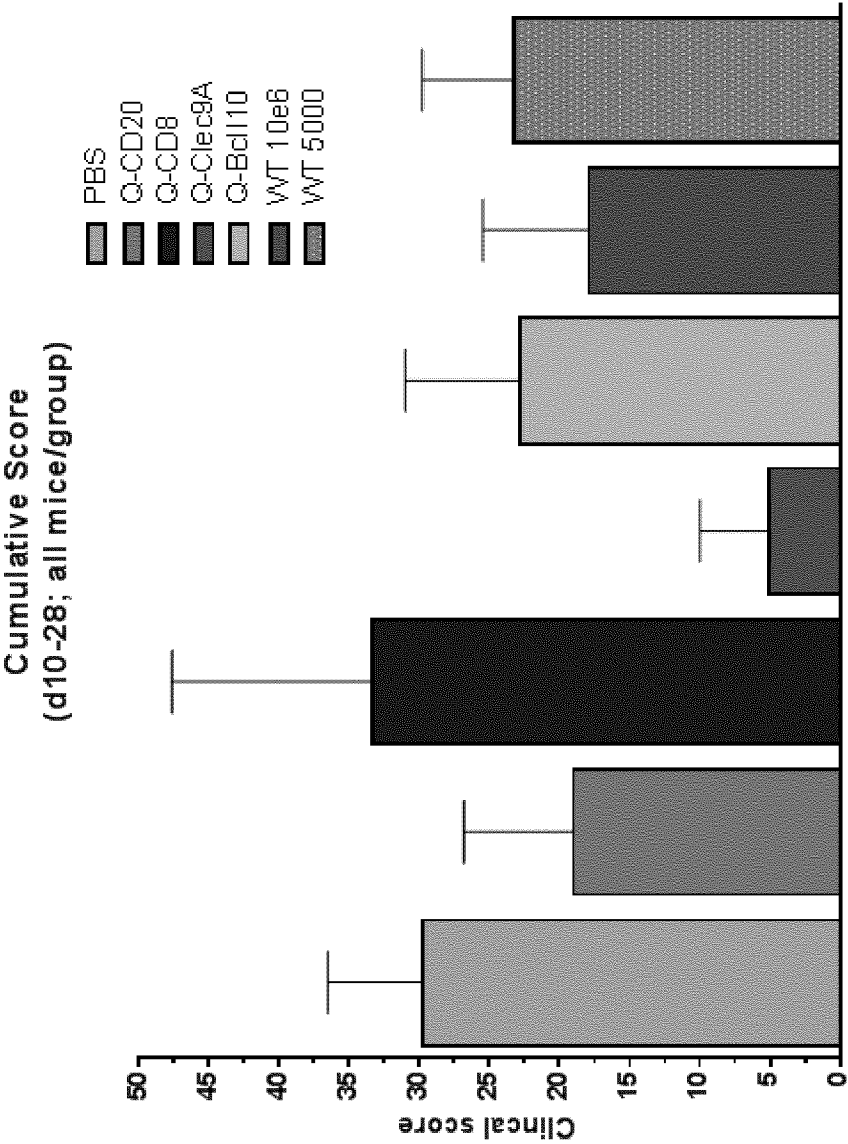


FIGURE 11

FIGURE 12

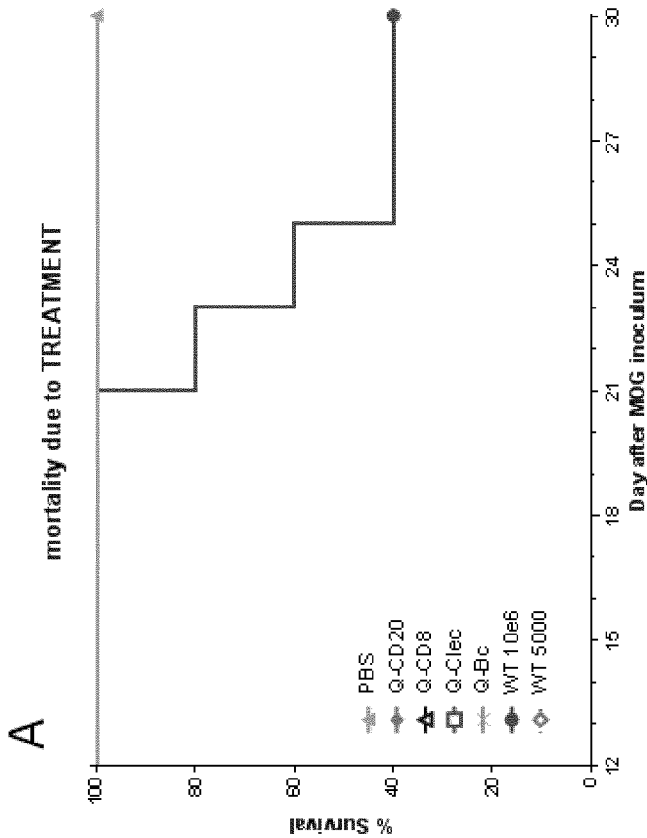
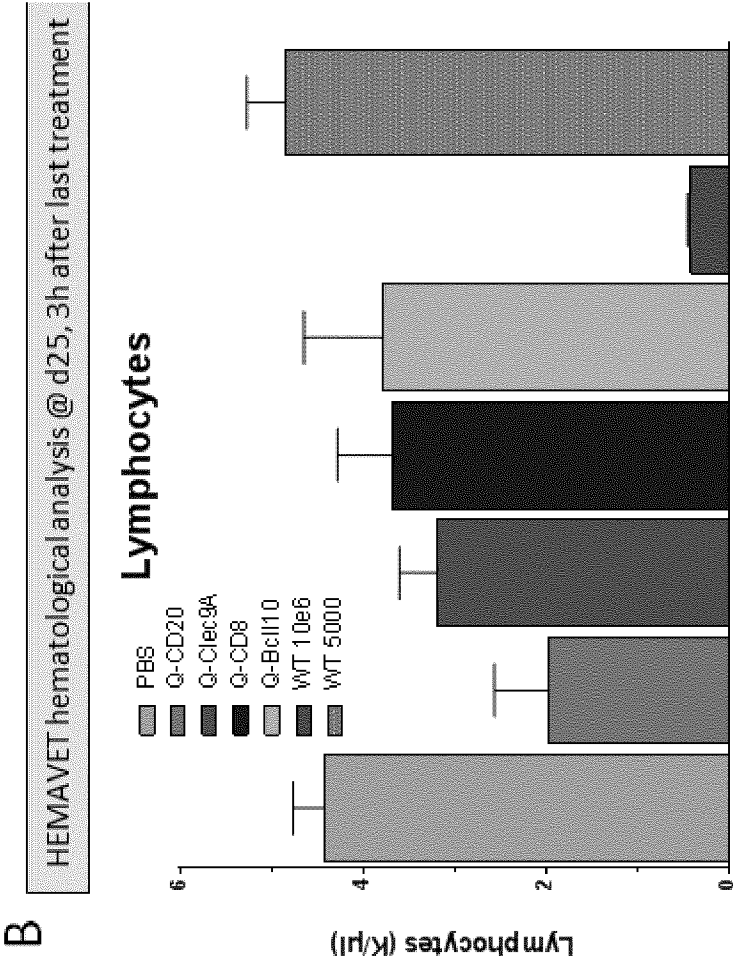


FIGURE 12 (Continued)



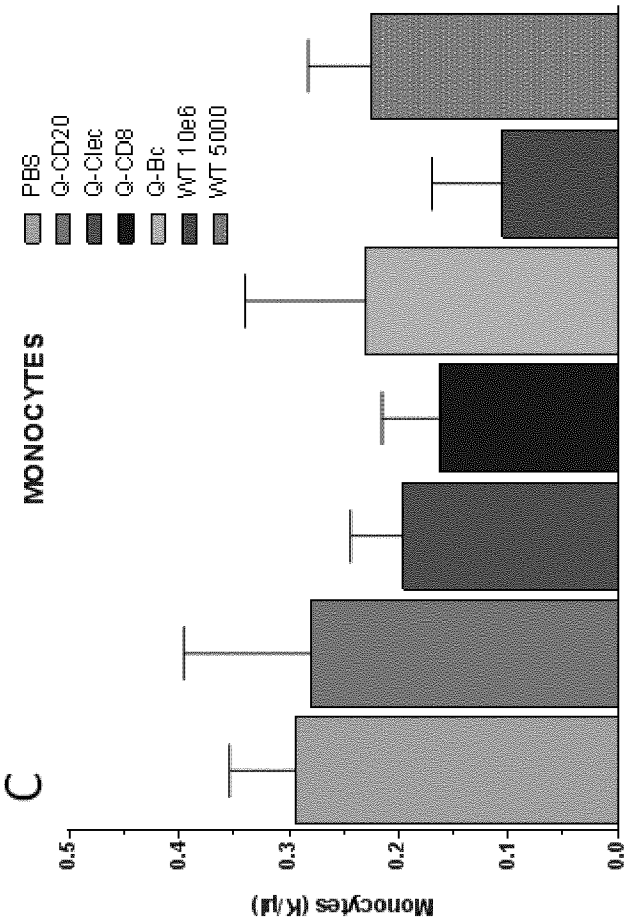


FIGURE 12 (Continued)

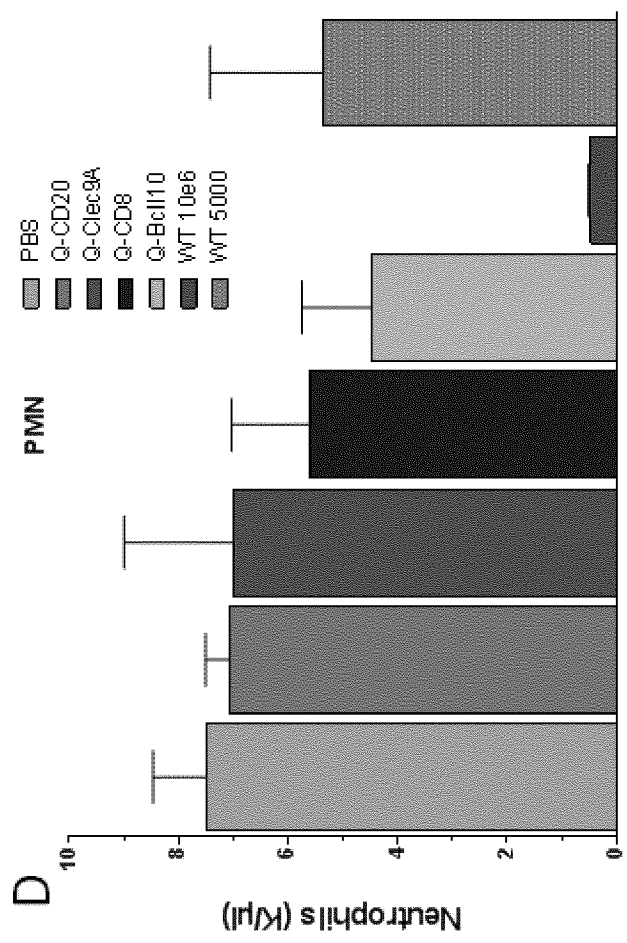


FIGURE 12 (Continued)

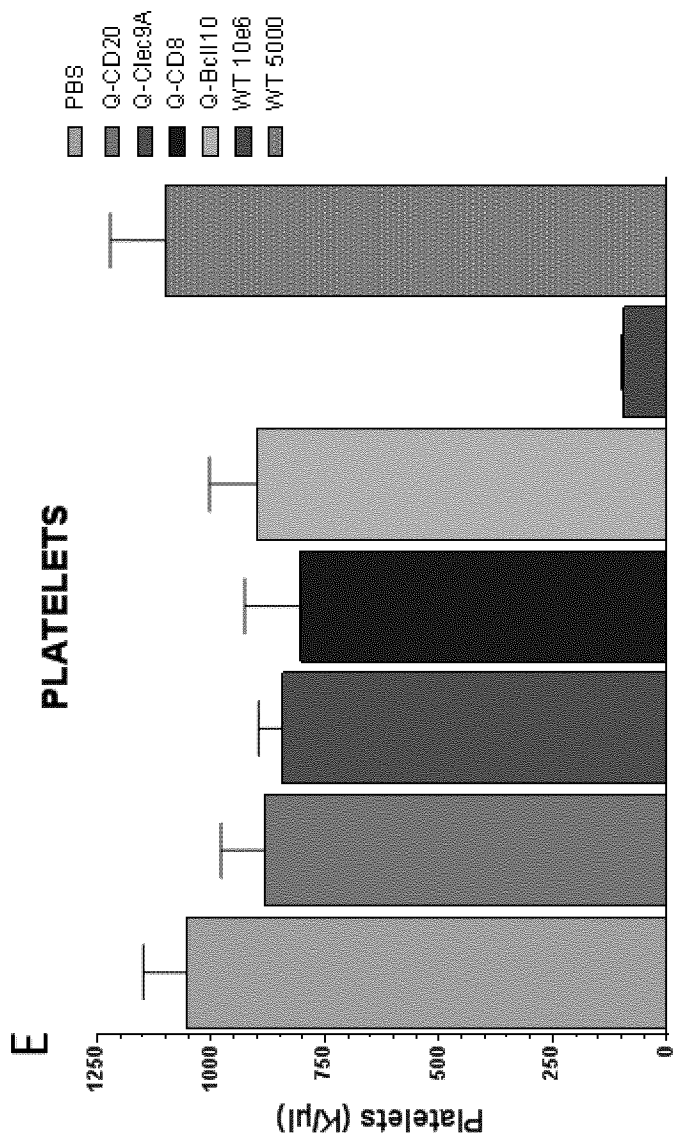


FIGURE 12 (Continued)

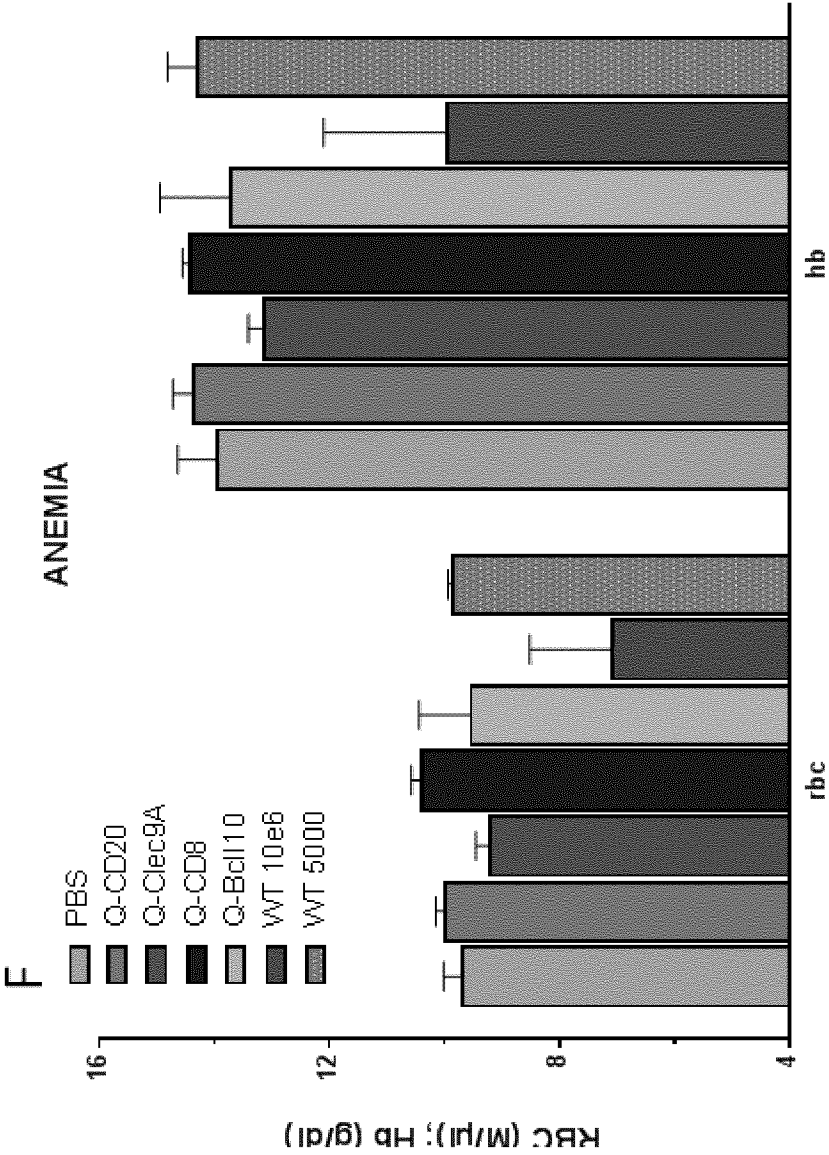


FIGURE 12 (Continued)

FIGURE 13

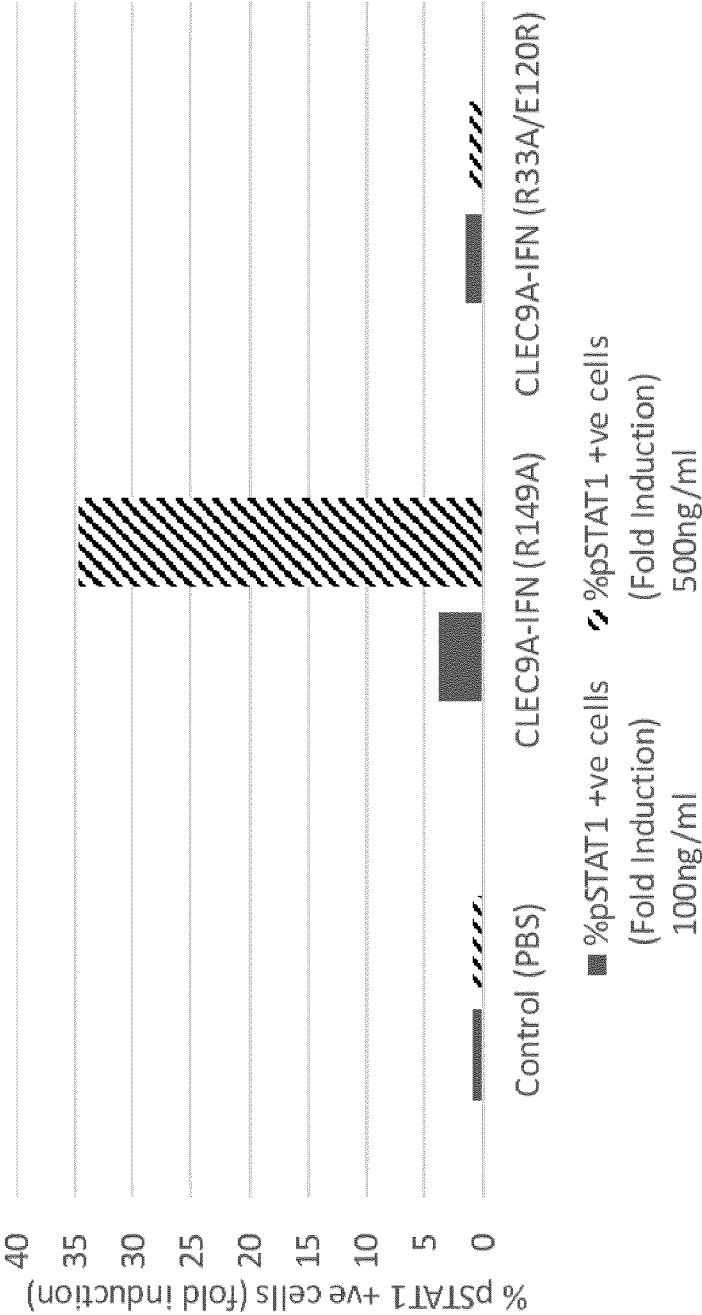
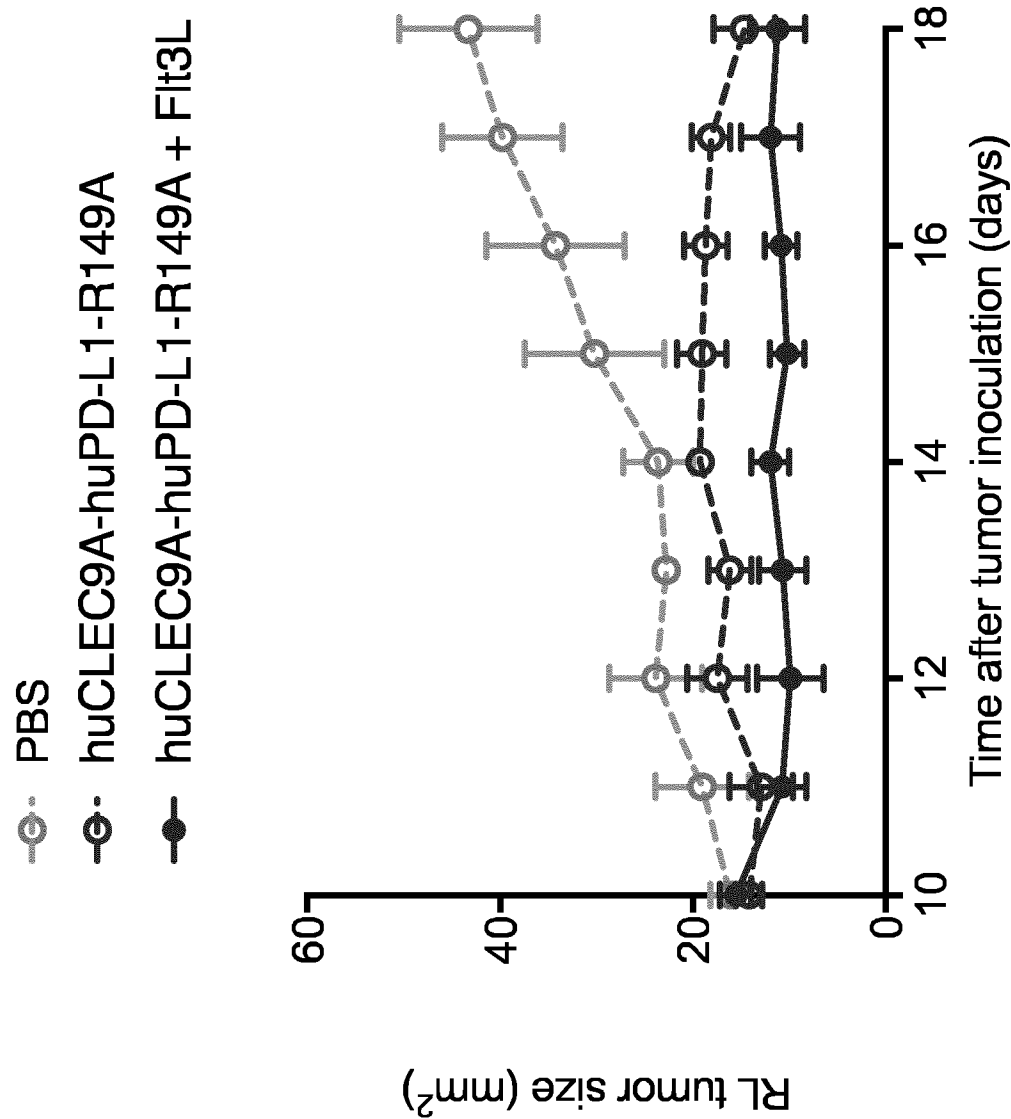


FIGURE 14



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/052544

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61K39/395 A61K38/00 A61K39/40 A61K39/42 C07K16/00
C07K16/28 C07K14/00

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 C07K

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

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

EP0-Internal, BIOSIS, Sequence Search, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2015/313965 A1 (POGUE SARAH L [US] ET AL) 5 November 2015 (2015-11-05) paragraph [0020] - paragraph [0067] -----	1-15
Y	MIREILLE H LAHOUD ET AL: "Targeting Antigen to Mouse Dendritic Cells via Clec9A Induces Potent CD4 T Cell Responses Biased toward a Follicular Helper Phenotype", THE JOURNAL OF IMMUNOLOGY, THE AMERICAN ASSOCIATION OF IMMUNOLOGISTS, US, vol. 187, no. 2, 15 July 2011 (2011-07-15), pages 842-850, XP002693448, ISSN: 0022-1767, DOI: 10.4049/JIMMUNOL.1101176 [retrieved on 2011-06-15] page 842 - page 843 ----- -/--	1-15



Further documents are listed in the continuation of Box C.



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

6 April 2017

Date of mailing of the international search report

06/06/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
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Fax: (+31-70) 340-3016

Authorized officer

Scheffzyk, Irmgard

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/052544

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2009/013484 A1 (SANCHO-MADRID DAVID [GB]; SCHULZ OLIVER [GB]; ROGERS NEIL CHARLES [GB]) 29 January 2009 (2009-01-29) example all -----	1-15
Y	WO 2013/053008 A2 (INST MEDICAL W & E HALL [AU]) 18 April 2013 (2013-04-18) example 2 -----	1-15
Y	J. IDOYAGA ET AL: "Comparable T helper 1 (Th1) and CD8 T-cell immunity by targeting HIV gag p24 to CD8 dendritic cells within antibodies to Langerin, DEC205, and Clec9A", PROCEEDINGS NATIONAL ACADEMY OF SCIENCES PNAS, vol. 108, no. 6, 24 January 2011 (2011-01-24), pages 2384-2389, XP055294773, US ISSN: 0027-8424, DOI: 10.1073/pnas.1019547108 section "Materials and Methods" -----	1-15
Y	GIANFRANCO PICCO ET AL: "Targeting DNCR-1 (CLEC9A) with antibody/MUC1 peptide conjugates as a vaccine for carcinomas", EUROPEAN JOURNAL OF IMMUNOLOGY, vol. 44, no. 7, 17 April 2014 (2014-04-17) , pages 1947-1955, XP055359398, ISSN: 0014-2980, DOI: 10.1002/eji.201344076 the whole document -----	1-15
A	SANCHO D ET AL: "Identification of a dendritic cell receptor that couples sensing of necrosis to immunity", NATURE, NATURE PUBLISHING GROUP, UNITED KINGDOM, vol. 458, no. 7240, 16 April 2009 (2009-04-16), pages 899-903, XP002693445, ISSN: 0028-0836, DOI: 10.1038/NATURE07750 the whole document -----	1-15
X	US 2013/230517 A1 (GREWAL IQBAL [US] ET AL) 5 September 2013 (2013-09-05) table 1 -----	1-15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2017/052544

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-15

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-15

provision of a chimeric protein as defined in claim 1 having a modified signaling agent

2. claims: 16-35

provision of a Clec9A binding agent as defined in claim 16

3. claims: 36-72

use of a chimera comprising a targeting agent having a domain which recognizes and binds to Clec9A and a (non-modified) signaling agent in a method of treatment as defined in claims 36 and 62

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/052544

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015313965 A1	05-11-2015	AU 2015265624 A1 CA 2945902 A1 CN 106536562 A EA 201692200 A1 EP 3137505 A2 KR 20160146770 A PE 13922016 A1 US 2015313965 A1 WO 2015181641 A2	10-11-2016 03-12-2015 22-03-2017 31-03-2017 08-03-2017 21-12-2016 04-01-2017 05-11-2015 03-12-2015
WO 2009013484 A1	29-01-2009	AU 2008278831 A1 CA 2693277 A1 CN 101896500 A DK 2185586 T3 EP 2185586 A1 ES 2557935 T3 HR P20160033 T1 HU E026387 T2 JP 5577246 B2 JP 2010534200 A SI 2185586 T1 US 2010221265 A1 US 2014328865 A1 WO 2009013484 A1	29-01-2009 29-01-2009 24-11-2010 18-01-2016 19-05-2010 29-01-2016 26-02-2016 30-05-2016 20-08-2014 04-11-2010 29-02-2016 02-09-2010 06-11-2014 29-01-2009
WO 2013053008 A2	18-04-2013	NONE	
US 2013230517 A1	05-09-2013	AU 2013230484 A1 CA 2866126 A1 CN 104470536 A EP 2822575 A1 JP 2015515453 A US 2013230517 A1 US 2015139951 A1 US 2017073388 A1 WO 2013134138 A1	12-02-2015 12-09-2013 25-03-2015 14-01-2015 28-05-2015 05-09-2013 21-05-2015 16-03-2017 12-09-2013