COMBINATION

Sequence Listing

The present application is being filed along with a Sequence Listing in electronic format. The Sequence Listing is provided as a file entitled 200252_ST25PCT.txt created 19 Oct 2015, which is 65 kb in size. The information in the electronic format of the sequence listing is incorporated herein by reference in its entirety.

Field

In certain embodiments, methods, compounds, and compositions for treating cancer, for example B-cell lymphoma, in an animal, by administering an agent capable of inhibiting expression of STAT3 mRNA or protein and an immunomudulatory agent, are provided herein. In particular embodiments, the agent capable of inhibiting expression of STAT3 mRNA or protein is selective for inhibiting expression of STAT3 mRNA or protein. In particular embodiments, the combination therapy involves administration to a patient in need thereof an antisense compound targeted to STAT3 and an agent (such as an antibody) capable of inhibiting binding of PD-L1 ligand to its receptor. Such methods, compounds, and compositions are useful to treat, prevent, or ameliorate B-cell lymphoma and other cancers that are susceptible to response with an immune checkpoint inhibitor.

BACKGROUND OF THE INVENTION

The role of the immune system, in particular T cell-mediated cytotoxicity, in tumor control is well recognized. There is mounting evidence that T cells control tumor growth and survival in cancer patients, both in early and late stages of the disease. However, tumor-specific T-cell responses are difficult to mount and sustain in cancer patients.

T cell pathways receiving significant attention to date signal through cytotoxic T lymphocyte antigen-4 (CTLA-4, CD152), programmed death ligand 1 (PD-L1, also known as B7-H1 or CD274), and OX40 (CD134; TNFRSF4).

CTLA-4 is expressed on activated T cells and serves as a co-inhibitor to keep T cell responses in check following CD28-mediated T cell activation. CTLA-4 is believed to regulate the amplitude of the early activation of naïve and memory T cells following TCR engagement and to be part of a central inhibitory pathway that affects both antitumor immunity and autoimmunity. CTLA-4 is expressed exclusively on T cells, and the expression of its ligands CD80 (B7.1) and CD86 (B7.2), is largely restricted to antigen-presenting cells, T cells, and other immune

mediating cells. CTLA-4 belongs to a class of molecules known as immune checkpoint proteins. Antagonistic anti-CTLA-4 antibodies that block the CTLA-4 signaling pathway have been reported to enhance T cell activation. One such antibody, ipilimumab, was approved by the FDA in 2011 for the treatment of metastatic melanoma. Another anti-CTLA-4 antibody, tremelimumab, was tested in phase III trials for the treatment of advanced melanoma, but did not significantly increase the overall survival of patients compared to the standard of care (temozolomide or dacarbazine) at that time.

PD-L1 and PD1 belong to a class of molecules known as immune checkpoint proteins. These proteins are cell surface-bound ligand-receptor pairs that, in healthy individuals, dampen immune responses to prevent an over-reaction of the immune system. Cancer cells often hijack the normal PD-L1-PD1 immune checkpoint mechanism by overexpressing the ligand PD-L1, which binds to PD1 on effector CD8 T cells, thereby preventing the T cells from mounting an immune response to the tumor. PD-L1 is expressed in a broad range of cancers with a high frequency. Tumor PD-L1 over expression correlates with poor prognosis in a number of cancers (see e.g. Hamid and Carvajal. Expert Opin. Biol. Ther. 13(6):847-861, 2013).

Antibodies that block the interaction between PD-L1 and its receptors are able to relieve PD-L1 -dependent immunosuppressive effects and enhance the cytotoxic activity of antitumor T cells *in vitro*. MEDI4736 (also known as durvalumab) is a human monoclonal antibody directed against human PD-L1 that is capable of blocking the binding of PD-L1 to both the PD-1 and CD80 receptors.

Anti-PD-L1 and anti-PD1 therapeutic blocking antibodies are being trialled and have shown clinical benefit in a number of tumor types including lung cancer, melanoma, renal cell carcinoma, bladder cancer, gastric cancer, head and neck cancer, etc; but only a minority of patients respond to these therapies (e.g. see, Brahmer et al., New Engl. J. Med. 366(26):2455-2465, 2012; Harvey. Clinical Pharmacology & Therapeutics **96**(2): 214–223, 2014). This lack of response has been attributed to other modes of immunosuppression that override PD1/PD-L1 effects and combination approaches that involve immunosuppression are being considered (Dolan et al., Cancer Control 21(3)231-237).

OX40 is a tumor necrosis factor receptor (TNFR) found primarily on activated CD4+ and CD8+ T cells, regulatory T cells (Treg), and natural killer (NK) cells. Signaling through OX40 on activated CD4+ and CD8+ T cells leads to enhanced cytokine production, granzyme and perforin release, and expansion of effector and memory T-cell pools. In addition, OX40 signaling on Treg

cells inhibits expansion of Tregs, shuts down the induction of Tregs, and blocks Treg-suppressive function.

Despite the potential of immunomodulators or immune checkpoint inhibitors for the treatment of cancers, there is a need in the art for improving upon responses to these agents for treating cancers.

SUMMARY OF THE INVENTION

As described below, the present invention features methods of treating cancer (e.g., lymphoma) with an immunomodulator, such as an immune checkpoint inhibitor, and an antisense compound targeted to STAT3 in a subject in need thereof. Particular immunomodulators include an anti-PD-L1 antibody (or an antigen-binding fragment thereof), an anti-PD1 antibody (or an antigen-binding fragment thereof), an anti-CTLA-4 antibody (or an antigen-binding fragment thereof) and an OX40 agonist ((*e.g.*, an OX40 ligand fusion protein, or an OX40 agonist antibody or antigen-binding fragment thereof). The subject can be any mammal. In one embodiment the subject is a human. Also provided are combination products and kits, each comprising an immunomodulator and an antisense compound targeted to STAT3, for use in treating one or more types of cancer. In particular embodiments the antisense compound targeted to STAT3 is a single-stranded antisense oligonucleotide (ASO).

Antibodies that selectively bind CTLA-4, PD-L1 or PD-1, or inhibit the binding or activation of CTLA-4, PD-L1 or PD-1 are useful in the methods of the invention. Antibodies that selectively bind and activate OX40 are useful in the methods of the invention.

Anti-PD-L1 antibodies are known in the art. Exemplary anti-PD-L1 antibodies include: MEDI4736 (durvalumab), MPDL3280A, BMS936559, 2.7A4, AMP-714 and MDX-1105.

Anti-PD-1 antibodies are known in the art. Exemplary anti-PD-1 antibodies include: nivolumab, pembrolizumab, pidilizumab and MPDL3280A.

Anti-CTLA-4 antibodies are known in the art. Exemplary anti-CTLA-4 antibodies include: tremelimumab and ipilimumab, also termed MDX-010 (or BMS-734016).

OX-40 agonists are known in the art. Exemplary OX-40 agonists include: OX40L FP.

AZD9150 is an antisense oligonucleotide and an example of an antisense compound targeted to STAT3.

In one embodiment the combination involves the antisense oligonucleotide AZD9150 and at least one immunomodulator selected from the group consisting of: MEDI4736, MPDL3280A,

BMS936559, 2.7A4, AMP-714, MDX-1105, nivolumab, pembrolizumab, pidilizumab, MPDL3280A, tremelimumab, ipilimumab and OX40L FP.

In one embodiment the combination involves the anti-PD-L1 antibody MEDI4736 and the antisense oligonucleotide AZD9150.

In one embodiment the combination involves the antisense oligonucleotide AZD9150, the anti-PD-L1 antibody MEDI4736 (durvalumab) and the anti-CTLA-4 antibody tremelimumab.

PDL-1 has been implicated in helping a variety of cancers evade immune surveillance by the body. As such, the present invention is predicted to be of benefit in treating any cancer.

Examples of types of cancer that the combination treatment is proposed for include: lung cancer, including non small cell lung cancer (NSCLC), breast cancer, including triple negative, ovarian cancer, including serous, pancreatic cancer, colorectal cancer, hepatocellular carcinoma (HCC), head and neck cancer, including head and neck squamous cell carcinoma (HNSCC), and lymphoma, including diffuse large B-cell carcinoma (DLBCL).

Definitions

Unless defined otherwise, all technical and scientific terms used herein have the meaning commonly understood by a person skilled in the art to which this invention belongs. The following references provide one of skill with a general definition of many of the terms used in this invention: Singleton et al., Dictionary of Microbiology and Molecular Biology (2nd ed. 1994); The Cambridge Dictionary of Science and Technology (Walker ed., 1988); The Glossary of Genetics, 5th Ed., R. Rieger et al. (eds.), Springer Verlag (1991); and Hale & Marham, The Harper Collins Dictionary of Biology (1991). Standard techniques may be used for chemical synthesis, and chemical analysis. Where permitted, all patents, applications, published applications and other publications, GENBANK Accession Numbers and associated sequence information obtainable through databases such as National Center for Biotechnology Information (NCBI) and other data referred to throughout in the disclosure herein are incorporated by reference for the portions of the document discussed herein, as well as in their entirety.

Unless otherwise indicated, the following terms have the following meanings:

"2'-deoxynucleoside" means a nucleoside comprising 2'-H furanosyl sugar moiety, as found naturally occurring in deoxyribonucleosides (DNA). In certain embodiments, a 2'-deoxynucleoside may comprise a modified nucleobase or may comprise an RNA nucleobase (e.g., uracil).

"2'-substituted nucleoside" means a nucleoside comprising a substituent at the 2'-position other than H or OH. Unless otherwise indicated, a 2'-substituted nucleoside is not a bicyclic nucleoside.

"5'-methylcytosine" means a cytosine modified with a methyl group attached to the 5' position. A 5-methylcytosine is a modified nucleobase.

As used herein, the term "About" is understood as within a range of normal tolerance in the art, and generally means within ±10%, such as within 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2%, 1%, 0.5%, 0.1%, 0.05%, or 0.01% of the stated value. For example, if it is stated, "the compounds affected at least about 70% inhibition of STAT3", it is implied that the STAT3 levels are inhibited within a range of 63% and 77%. If it is stated that the compound is used at about 20mg/kg, it covers the range 18-22mg/kg inclusive. Unless otherwise clear from context, all numerical values provided herein are modified by the term about.

"Administered concomitantly" refers to the co-administration of two agents in any manner in which the pharmacological effects of both are manifest in the patient at the same time. Concomitant administration does not require that both agents be administered in a single pharmaceutical composition, in the same dosage form, or by the same route of administration. The effects of both agents need not manifest themselves at the same time. The effects need only be overlapping for a period of time and need not be coextensive.

"Agent" refers to a substance, such as a compound, antisense oligonucleotide or antibody (and the like) that is capable of producting an effect.

"Animal" refers to a human or non-human animal, including, but not limited to, mice, rats, rabbits, dogs, cats, pigs, and non-human primates, including, but not limited to, monkeys and chimpanzees.

The term "antibody," as used in this disclosure, refers to an immunoglobulin or a fragment or a derivative thereof, and encompasses any polypeptide comprising an antigen-binding site, regardless whether it is produced *in vitro* or *in vivo*. The term includes, but is not limited to, polyclonal, monoclonal, monospecific, polyspecific, non-specific, humanized, single-chain, chimeric, synthetic, recombinant, hybrid, mutated, and grafted antibodies. Unless otherwise modified by the term "intact," as in "intact antibodies," for the purposes of this disclosure, the term "antibody" also includes antibody fragments such as Fab, $F(ab')_2$, Fv, scFv, Fd, dAb, and other antibody fragments that retain antigen-binding function, *i.e.*, the ability to bind, for example, CTLA-4, PD-L1 specifically. Typically, such fragments would comprise an antigen-binding domain.

By "anti-CTLA-4 antibody" is meant an antibody that selectively binds a CTLA-4 polypeptide. Exemplary anti- CTLA-4 antibodies are described for example at US Patent Nos. 6,682,736; 7,109,003; 7,123,281; 7,411,057; 7,824,679; 8,143,379; 7,807,797; and 8,491,895 (Tremelimumab is 11.2.1, therein), which are herein incorporated by reference. Tremelimumab (U.S. Patent No. 6,682,736) is an exemplary anti-CTLA-4 antibody.

Tremelimumab sequences:

VL - SEQ ID NO: 13.

VH - SEQ ID NO: 14.

VH CDR1 - SEQ ID NO: 15; VH CDR2 - SEQ ID NO: 16; VH CDR3 - SEQ ID NO: 17.

VL CDR1 - SEQ ID NO: 18; VL CDR2 - SEQ ID NO: 19; VL CDR3 - SEQ ID NO: 20.

By "anti-PD-L1 antibody" is meant an antibody that selectively binds a PD-L1 polypeptide. Exemplary anti-PD-L1 antibodies are described for example at WO 2011/066389, US20130034559 / US8779108 and US20140356353which are herein incorporated by reference. MEDI4736 is an exemplary anti-PD-L1 antibody. The sequences are provided in the sequence listing below (e.g., SEQ ID NOs. 3-10). Other anti-PD-L1 antibodies include BMS-936559 (Bristol-Myers Squibb) and MPDL3280A (Roche).

The terms "antigen-binding domain," "antigen-binding fragment," and "binding fragment" refer to a part of an antibody molecule that comprises amino acids responsible for the specific binding between the antibody and the antigen. In instances, where an antigen is large, the antigen-binding domain may only bind to a part of the antigen. A portion of the antigen molecule that is responsible for specific interactions with the antigen-binding domain is referred to as "epitope" or "antigenic determinant." An antigen-binding domain typically comprises an antibody light chain variable region (V_L) and an antibody heavy chain variable region (V_H), however, it does not necessarily have to comprise both. For example, a so-called Fd antibody fragment consists only of a V_H domain, but still retains some antigen-binding function of the intact antibody.

Binding fragments of an antibody are produced by recombinant DNA techniques, or by enzymatic or chemical cleavage of intact antibodies. Binding fragments include Fab, Fab', F(ab')2, Fv, and single-chain antibodies. An antibody other than a "bispecific" or "bifunctional" antibody is understood to have each of its binding sites identical. Digestion of antibodies with the enzyme, papain, results in two identical antigen-binding fragments, known also as "Fab" fragments, and a "Fc" fragment, having no antigen-binding activity but having the ability to crystallize. Digestion of antibodies with the enzyme, pepsin, results in the a F(ab')2 fragment in which the two arms of the

antibody molecule remain linked and comprise two-antigen binding sites. The F(ab')2 fragment has the ability to crosslink antigen. "Fv" when used herein refers to the minimum fragment of an antibody that retains both antigen-recognition and antigen-binding sites. "Fab" when used herein refers to a fragment of an antibody that comprises the constant domain of the light chain and the CHI domain of the heavy chain.

The term "mAb" refers to monoclonal antibody. Antibodies of the invention comprise without limitation whole native antibodies, bispecific antibodies; chimeric antibodies; Fab, Fab', single chain V region fragments (scFv), fusion polypeptides, and unconventional antibodies.

"Antisense compound" means an oligomeric compound that is is capable of undergoing hybridization to a target nucleic acid through hydrogen bonding. Examples of antisense compounds include single-stranded and double-stranded compounds, such as, antisense oligonucleotides, siRNAs, shRNAs, snoRNAs, miRNAs, meroduplex (mdRNA) and satellite repeats.

"An antisense compound targeted to STAT3" means an oligomeric compound that is is capable of undergoing hybridization to STAT3 target nucleic acid through hydrogen bonding

"Antisense oligonucleotide" means a single-stranded oligonucleotide having a nucleobase sequence that permits hybridization to a corresponding region or segment of a target nucleic acid.

"Anti-tumor activity" means any biological activity that reduces or stabilizes the proliferation or survival of a tumor cell. In one embodiment, the anti-tumor activity is an anti-tumor immune response.

"Bicyclic sugar" means a furosyl ring modified by the bridging of two atoms. A bicyclic sugar is a modified sugar.

By "cancer" is meant a disease or disorder characterized by excess proliferation or reduced apoptosis. Illustrative cancers for which the invention can be used include, but are not limited to leukemias (e.g., acute leukemia, acute lymphocytic leukemia, acute myelocytic leukemia, acute myeloblastic leukemia, acute promyelocytic leukemia, acute myelomonocytic leukemia, acute monocytic leukemia, acute erythroleukemia, chronic leukemia, chronic myelocytic leukemia, chronic lymphocytic leukemia), polycythemia vera, lymphoma (Hodgkin's disease, non-Hodgkin's disease, DLBCL), Waldenstrom's macroglobulinemia, heavy chain disease, and solid tumors such as sarcomas and carcinomas (e.g., fibrosarcoma, myxosarcoma, liposarcoma, chondrosarcoma, osteogenic sarcoma, chordoma, angiosarcoma, endotheliosarcoma, lymphangiosarcoma, lymphangioendotheliosarcoma, synovioma, mesothelioma, Ewing's tumor, leiomyosarcoma, rhabdomyosarcoma, colon carcinoma, pancreatic cancer, breast cancer, ovarian cancer, prostate

cancer, squamous cell carcinoma, basal cell carcinoma, adenocarcinoma, sweat gland carcinoma, sebaceous gland carcinoma, papillary carcinoma, papillary adenocarcinomas, cystadenocarcinoma, medullary carcinoma, bronchogenic carcinoma, renal cell carcinoma, hepatoma, nile duct carcinoma, choriocarcinoma, seminoma, embryonal carcinoma, Wilm's tumor, cervical cancer, uterine cancer, testicular cancer, lung carcinoma, small cell lung carcinoma, bladder carcinoma, epithelial carcinoma, glioma, glioblastoma multiforme, astrocytoma, medulloblastoma, craniopharyngioma, ependymoma, pinealoma, hemangioblastoma, acoustic neuroma, oligodenroglioma, schwannoma, meningioma, melanoma, neuroblastoma, and retinoblastoma).

"Chimeric antisense compound" means an antisense compound that has at least two chemically distinct regions.

"Co-administration" means administration of two or more pharmaceutical agents to an individual. The two or more pharmaceutical agents may be in a single pharmaceutical composition, or may be in separate pharmaceutical compositions. Each of the two or more pharmaceutical agents may be administered through the same or different routes of administration. Co-administration encompasses parallel or sequential administration. In one embodiment, the co-administration is carried out so as to result in exposure of the patient to both drugs at the same time based on the pharmacokinetics of the drugs.

"Constrained ethyl nucleoside" (also cEt nucleoside) means a nucleoside comprising a bicyclic sugar moiety comprising a 4'-$CH(CH_3)$-O-2' bridge.

"Contiguous nucleobases" means nucleobases immediately adjacent to each other.

By "Disease" is meant any condition or disorder that damages, interferes with or dysregulates the normal function of a cell, tissue, or organ. In a disease such as cancer (e.g., lung cancer) the normal function of a cell tissue or organ is subverted to enable immune evasion and/or escape.

By "CTLA-4 polypeptide" is meant a polypeptide having at least 85% amino acid sequence identity to GenBank Accession No. AAL07473.1 or a fragment thereof, having T cell inhibitory activity. The sequence of AAL07473.1 is disclosed in SEQ ID NO: 21, herein.

By "CTLA-4 nucleic acid molecule" is meant a polynucleotide encoding a CTLA-4 polypeptide. An exemplary CTLA-4 polynucleotide is provided at GenBank Accession No. AAL07473.

"Diluent" means an ingredient in a composition that lacks pharmacological activity, but is pharmaceutically necessary or desirable. For example, the diluent in an injected composition may be a liquid, e.g. saline solution.

"Dose" means a specified quantity of a pharmaceutical agent provided in a single administration, or in a specified time period. In certain embodiments, a dose may be administered in one, two, or more boluses, tablets, or injections. For example, in certain embodiments where subcutaneous administration is desired, the desired dose requires a volume not easily accommodated by a single injection, therefore, two or more injections may be used to achieve the desired dose. In certain embodiments, the pharmaceutical agent is administered by infusion over an extended period of time or continuously. Doses may be stated as the amount of pharmaceutical agent per hour, day, week, or month.

"Effective amount" means the amount of active pharmaceutical agent sufficient to effectuate a desired physiological outcome in an individual in need of the agent. The effective amount may vary among individuals depending on the health and physical condition of the individual to be treated, the taxonomic group of the individuals to be treated, the formulation of the composition, assessment of the individual's medical condition, and other relevant factors.

"Gapmer" means a chimeric antisense compound in which an internal region having a plurality of nucleosides that support RNase H cleavage is positioned between external regions having one or more nucleosides, wherein the nucleosides comprising the internal region are chemically distinct from the nucleoside or nucleosides comprising the external regions. The internal region may be referred to as the "gap" and the external regions may be referred to as the "wings."

"Hybridization" means the annealing of complementary nucleic acid molecules. In certain embodiments, complementary nucleic acid molecules include an antisense compound and a target nucleic acid.

"Immune checkpoint inhibitor" means an agent that inhibits the CTLA-4 or PD-1 pathways, particular checkpoint inhibitors include antibodies that inhibit PD-1, PD-L1 or CTLA-4.

"Immunomodulatory agent" means an agent that enhances an immune response (e.g., anti-tumor immune response). Exemplary immunomodulatory agents of the invention include antibodies, such as an anti-CTLA-4 antibody, an anti-PD-L1 antibody, an anti-PD-1 antibody and antigenic fragments of any of these, and OX-40 agonists, including proteins, such as OX40 ligand fusion protein, or fragments thereof. In one embodiment, the immunomodulatory agent is an immune checkpoint inhibitor.

"Inhibiting STAT3" means reducing expression of STAT3 mRNA and/or protein levels in the presence of a STAT3 antisense compound, including a STAT3 antisense oligonucleotide, as compared to expression of STAT3 mRNA and/or protein levels in the absence of a STAT3 antisense compound, such as an antisense oligonucleotide.

"Individual" means a human or non-human animal selected for treatment or therapy.

"Internucleoside linkage" refers to the chemical bond between nucleosides.

"Linked nucleosides" means adjacent nucleosides which are bonded together.

"Modified internucleoside linkage" refers to a substitution or any change from a naturally occurring internucleoside bond (i.e. a phosphodiester internucleoside bond).

"Modified nucleobase" refers to any nucleobase other than adenine, cytosine, guanine, thymidine, or uracil. An "unmodified nucleobase" means the purine bases adenine (A) and guanine (G), and the pyrimidine bases thymine (T), cytosine (C), and uracil (U).

"Modified nucleotide" means a nucleotide having, independently, a modified sugar moiety, modified internucleoside linkage, or modified nucleobase. A "modified nucleoside" means a nucleoside having, independently, a modified sugar moiety or modified nucleobase.

"Modified oligonucleotide" means an oligonucleotide comprising a modified intemucleoside linkage, a modified sugar, and/or a modified nucleobase.

"Modified sugar" refers to a substitution or change from a natural sugar.

"Naturally occurring internucleoside linkage" means a 3' to 5' phosphodiester linkage.

"Nucleic acid" refers to molecules composed of monomeric nucleotides. A nucleic acid includes ribonucleic acids (RNA), deoxyribonucleic acids (DNA), single-stranded nucleic acids, double-stranded nucleic acids, small interfering ribonucleic acids (siRNA), and microRNAs (miRNA).

"Nucleobase" means a heterocyclic moiety capable of pairing with a base of another nucleic acid.

"Nucleobase sequence" means the order of contiguous nucleobases independent of any sugar, linkage, or nucleobase modification.

"Nucleoside" means a nucleobase linked to a sugar.

"Nucleotide" means a nucleoside having a phosphate group covalently linked to the sugar portion of the nucleoside.

"Oligomeric compound" or "oligomer" means a polymer of linked monomeric subunits which is capable of hybridizing to at least a region of a nucleic acid molecule.

"Oligonucleotide" means a polymer of linked nucleosides each of which can be modified or unmodified, independent one from another.

"Overall survival" means the length of time from the start of treatment for a disease, such as cancer, that patients diagnosed with the disease are still alive. The overall survival figure is typically determined as an average from an appropriately sized clinical trial.

"OX40 polypeptide" means a polypeptide or fragment thereof having at least about 85% amino acid identity to NCBI Accession No. NP_003318. OX40 is a member of the TNFR-superfamily of receptors that is expressed on the surface of antigen-activated mammalian CD4+ and CD8+ T lymphocytes. See, for example, Paterson et al., Mol Immunol 24, 1281-1290 (1987); Mallett et al., EMBO J 9, 1063-1068 (1990); and Calderhead et al., J Immunol 151, 5261-5271 (1993)). OX40 is also referred to as CD134, ACT-4, and ACT35. OX40 receptor sequences are known in the art and are provided, for example, at GenBank Accession Numbers: AAB33944 or CAE11757. An exemplary human OX40 amino acid sequence is disclosed in SEQ ID NO: 22, herein.

"OX40 ligand" means a polypeptide or fragment thereof having at least about 85% amino acid identity to NCBI Accession No. NP_003317 and that specifically binds the OX40 receptor. See, for example, Baum P.R., *et al. EMBO J. 13*:3992-4001(1994)). The term OX40L includes the entire OX40 ligand, soluble OX40 ligand, and fusion proteins comprising a functionally active portion of OX40 ligand covalently linked to a second moiety, *e.g.*, a protein domain. Also included within the definition of OX40L are variants which vary in amino acid sequence from naturally occurring OX4L but which retain the ability to specifically bind to the OX40 receptor. Further included within the definition of OX40L are variants which enhance the biological activity of OX40. OX40 ligand sequences are known in the art and are provided, for example, at GenBank Accession Numbers: NP_003318. An exemplary human OX40 ligand amino acid sequence is disclosed in SEQ ID NO: 23, herein.

"OX40 agonist" means an OX40 ligand that specifically interacts with and increases the biological activity of the OX40 receptor. Desirably, the biological activity is increased by at least about 10%, 20%, 30%, 50%, 70%, 80%, 90%, 95%, or even 100%. In certain aspects, OX40 agonists as disclosed herein include OX40 binding polypeptides, such as anti-OX40 antibodies (e.g., OX40 agonist antibodies), OX40 ligands, or fragments or derivatives of these molecules.

"OX40 antibody" means an antibody that specifically binds OX40. OX40 antibodies include monoclonal and polyclonal antibodies that are specific for OX40 and antigen-binding fragments

thereof. In certain aspects, anti-OX40 antibodies as described herein are monoclonal antibodies (or antigen-binding fragments thereof), e.g., murine, humanized, or fully human monoclonal antibodies. In one particular embodiment, the OX40 antibody is an OX40 receptor agonist, such as the mouse anti-human OX40 monoclonal antibody (9B12) described by Weinberg et al., J Immunother 29, 575-585 (2006). In other embodiments, the antibody which specifically binds to OX40, or an antigen-binding fragment thereof, binds to the same OX40 epitope as mAb 9B12.

"OX40 ligand fusion protein" means a protein that specifically binds the OX40 receptor and increases an immune response. In one embodiment, binding of an OX40 ligand fusion protein to the OX40 receptor enhances a tumor antigen specific immune response by boosting T-cell recognition. Exemplary OX40 ligand fusion proteins are described in U.S. Patent 7,959,925, entitled, "Trimeric OX40 Immunoglobulin Fusion Protein and Methods of Use." See, for example, U.S. Patent 7,959,925, SEQ ID NO. 8. This sequence is reproduced herein as SEQ ID NO: 24. Other OX40 ligand fusion proteins are described, for example, in US Patent 6,312,700. In one embodiment, an OX40 ligand fusion protein enhances tumor-specific T-cell immunity. In particular embodiments, the OX40 ligand fusion protein has an amino acid sequence disclosed in SEQ ID NO: 32, 34 or 36 (such variants are termed herein as OX40L FP)

"Parenteral administration" means administration through injection (e.g., bolus injection) or infusion. Parenteral administration includes subcutaneous administration, intravenous administration, intramuscular administration, intraarterial administration, intraperitoneal administration, or intracranial administration, e.g., intrathecal or intracerebroventricular administration.

"PD-L1 polypeptide" means a polypeptide or fragment thereof having at least about 85% amino acid identity to NCBI Accession No. NP_001254635, and having PD-1 and CD80 binding activity.

"PD-L1 nucleic acid molecule" means a polynucleotide encoding a PD-L1 polypeptide. An exemplary PD-L1 nucleic acid molecule sequence is provided at NCBI Accession No. NM_001267706.

"PD-L1 positive" means, in the context of immunohistochemistry, cells in a cancer sample exhibit staining for PD-L1. The level of positivity that is biologically significant can vary, based on tumor type, and on the immune status of the tumor environment.

"Peptide" means a molecule formed by linking at least two amino acids by amide bonds. Peptide refers to polypeptides and proteins.

"Pharmaceutical composition" means a mixture of substances suitable for administering to an individual. For example, a pharmaceutical composition may comprise one or more active pharmaceutical agents and a sterile aqueous solution. In certain embodiments, a pharmaceutical composition shows activity in free uptake assay in certain cell lines.

"Phosphorothioate linkage" means a linkage between nucleosides where the phosphodiester bond is modified by replacing one of the non-bridging oxygen atoms with a sulfur atom. A phosphorothioate linkage (P=S) is a modified internucleoside linkage.

"Portion" means a defined number of contiguous (i.e., linked) nucleobases of a nucleic acid. In certain embodiments, a portion is a defined number of contiguous nucleobases of a target nucleic acid. In certain embodiments, a portion is a defined number of contiguous nucleobases of an antisense compound.

"Prevent" refers to delaying or forestalling the onset or development of a disease, disorder, or condition for a period of time from minutes to indefinitely. Prevent also means reducing risk of developing a disease, disorder, or condition.

"Progression free survival" means the length of time during and after the treatment of a disease, such as cancer, that a patient lives with the disease but it does not get worse. The progression free survival figure is typically determined as an average from an appropriately sized clinical trial.

Ranges provided herein are understood to be shorthand for all of the values within the range. For example, a range of 1 to 50 is understood to include any number, combination of numbers, or sub-range from the group consisting 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, or 50.

By "reference" is meant a standard of comparison.

By "responsive" in the context of therapy is meant susceptible to treatment.

"Signal Transducer and Activator of Transcription 3 nucleic acid" or "STAT3 nucleic acid" means any nucleic acid encoding STAT3. For example, in certain embodiments, a STAT3 nucleic acid includes a DNA sequence encoding STAT3, an RNA sequence transcribed from DNA encoding STAT3 (including genomic DNA comprising introns and exons), and an mRNA sequence encoding STAT3. "STAT3 mRNA" means an mRNA encoding a STAT3 protein.

"Single-stranded oligonucleotide" means an oligonucleotide which is not hybridized to a complementary strand.

By "specifically binds" is meant a compound (*e.g.*, antibody) that recognizes and binds a molecule (*e.g.*, polypeptide), but which does not substantially recognize and bind other molecules in a sample, for example, a biological sample. For example, two molecules that specifically bind form a complex that is relatively stable under physiologic conditions. Specific binding is characterized by a high affinity and a low to moderate capacity as distinguished from nonspecific binding which usually has a low affinity with a moderate to high capacity. Typically, binding is considered specific when the affinity constant K_A is higher than $10^6\,M^{-1}$, or more preferably higher than $10^8\,M^{-1}$. If necessary, non-specific binding can be reduced without substantially affecting specific binding by varying the binding conditions. The appropriate binding conditions such as concentration of antibodies, ionic strength of the solution, temperature, time allowed for binding, concentration of a blocking agent (*e.g.*, serum albumin, milk casein), *etc.*, may be optimized by a skilled artisan using routine techniques.

"Specifically hybridizable" refers to an antisense compound having a sufficient degree of complementarity (pairing between nucleobases) between an antisense oligonucleotide and a target nucleic acid to induce a desired effect, while exhibiting minimal or no effects on non-target nucleic acids under conditions in which specific binding is desired, i.e., under physiological conditions in the case of *in vivo* assays and therapeutic treatments.

By "Subject" is meant a mammal, including, but not limited to, a human or non-human mammal, such as a bovine, equine, canine, ovine, or feline.

"Targeting" or "targeted" means directed at. With respect to an antibody it refers to the ability to bind to the reference protein. With respect to an antisense compound it refers to they ability to specifically hybridize to a target nucleic acid and induce a desired effect.

"Target nucleic acid," "target RNA," "target mRNA," and "target RNA transcript" all refer to a nucleic acid capable of being targeted by antisense compounds.

"Target segment" means the sequence of nucleotides of a target nucleic acid to which an antisense compound is targeted. "5' target site" refers to the 5'-most nucleotide of a target segment. "3' target site" refers to the 3'-most nucleotide of a target segment.

"Therapeutically effective amount" means an amount of a pharmaceutical agent that provides a therapeutic benefit to an individual.

"Treat", "treating," "treatment," and the like, refers to administering a pharmaceutical composition to reduce or ameliorate a disease, disorder, or condition and/or any symptom associated therewith. It will be appreciated that, although not precluded, treating a disorder or condition does not require that the disorder, condition or symptoms associated therewith be completely eliminated.

"Unmodified nucleotide" means a nucleotide composed of naturally occuring nucleobases, sugar moieties, and internucleoside linkages. In certain embodiments, an unmodified nucleotide is an RNA nucleotide (i.e. β-D-ribonucleosides) or a DNA nucleotide (i.e. β-D-deoxyribonucleoside).

Unless specifically stated, or obvious from context, as used herein, the term "or" is understood to be inclusive. Unless specifically stated or obvious from context, as used herein, the terms "a", "an", and "the" are understood to be singular or plural.

In this disclosure, "comprises," "comprising," "containing" and "having" and the like can have the meaning ascribed to them in U.S. Patent law and can mean " includes," "including," and the like; "consisting essentially of" or "consists essentially" likewise has the meaning ascribed in U.S. Patent law and the term is open-ended, allowing for the presence of more than that which is recited so long as basic or novel characteristics of that which is recited is not changed by the presence of more than that which is recited, but excludes prior art embodiments.

As used herein, the terms "determining", "assessing", "assaying", "measuring" and "detecting" refer to both quantitative and qualitative determinations, and as such, the term "determining" is used interchangeably herein with "assaying," "measuring," and the like. Where a quantitative determination is intended, the phrase "determining an amount" of an analyte and the like is used. Where a qualitative and/or quantitative determination is intended, the phrase "determining a level" of an analyte or "detecting" an analyte is used.

The terms "isolated", "purified," or "biologically pure" refer to material that is free to varying degrees from components which normally accompany it as found in its native state. "Isolate" denotes a degree of separation from original source or surroundings. "Purify" denotes a degree of separation that is higher than isolation. A "purified" or "biologically pure" protein is sufficiently free of other materials such that any impurities do not materially affect the biological properties of the protein or cause other adverse consequences. That is, a nucleic acid or peptide of this invention is purified if it is substantially free of cellular material, viral material, or culture medium when produced by recombinant DNA techniques, or chemical precursors or other chemicals when chemically synthesized. Purity and homogeneity are typically determined using analytical chemistry techniques, for example, polyacrylamide gel electrophoresis or high performance liquid

chromatography. The term "purified" can denote that a nucleic acid or protein gives rise to essentially one band in an electrophoretic gel. For a protein that can be subjected to modifications, for example, phosphorylation or glycosylation, different modifications may give rise to different isolated proteins, which can be separately purified.

DETAILED DESCRIPTION OF THE INVENTION

As described below, the present invention features methods of treating cancer (e.g., lung cancer, such as non-small cell lung cancer (NSCLC); breast cancer, including triple negative; ovarian cancer, including serous; pancreatic cancer; colorectal cancer; lymphoma, such as diffuse large B-cell lung cancer (DLBCL) or Hodgkin's lymphoma; or head and neck cancer, such as head and neck squamous cell carcinoma (HNSCC)) with an immunomodulatory agent, such as an anti-PD-L1 antibody like MEDI4736, and an antisense compound targeted to STAT3, such as AZD9150, in a subject in need thereof.

Anti-PD-L1 Antibodies

Antibodies that specifically bind and inhibit PD-L1 are useful in the present invention.

MEDI4736 is an exemplary anti-PD-L1 antibody that is selective for a PD-L1 polypeptide and blocks the binding of PD-L1 to the PD-1 and CD80 receptors. MEDI4736 can relieve PD-L1 -mediated suppression of human T-cell activation *in vitro* and inhibits tumor growth in a xenograft model via a T-cell dependent mechanism.

Information regarding MEDI4736 (or fragments thereof) for use in the methods provided herein can be found in U.S. Patent No. 8,779,108, the disclosure of which is incorporated herein by reference in its entirety. The fragment crystallizable (Fc) domain of MEDI4736 contains a triple mutation in the constant domain of the IgG1 heavy chain that reduces binding to the complement component C1q and the Fcγ receptors responsible for mediating antibody-dependent cell-mediated cytotoxicity (ADCC).

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. In a specific aspect, MEDI4736 or an antigen-binding fragment thereof for use in the methods provided herein comprises a light chain variable region comprising the amino acid sequence of SEQ ID NO:3 and a heavy chain variable region comprising the amino acid sequence of SEQ ID NO:4. In a specific aspect, MEDI4736 or an antigen-binding fragment thereof for use in the methods provided herein comprises a heavy chain variable region and a light chain variable region, wherein the heavy chain variable region comprises the Kabat-defined CDR1, CDR2, and

CDR3 sequences of SEQ ID NOs: 5-7, and wherein the light chain variable region comprises the Kabat-defined CDR1, CDR2, and CDR3 sequences of SEQ ID NOs: 8-10. Those of ordinary skill in the art would easily be able to identify Chothia-defined, Abm-defined or other CDR definitions known to those of ordinary skill in the art. In a specific aspect, MEDI4736 or an antigen-binding fragment thereof for use in the methods provided herein comprises the variable heavy chain and variable light chain CDR sequences of the 2.14H9OPT antibody as disclosed in WO 2011/066389 A1, which is herein incorporated by reference in its entirety.

There are numerous anti-PDL-1 antibodies in the published literature that could feature in the present invention, including compounds in development and/or in clinical trials such as: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714 and MDX-1105. Patent specifications disclosing anti-PDL-1 antibodies that may be useful in the present invention include: WO2007/005874 (BMS/Medarex), WO01/14556 (Dana Farber), US2011/0271358 (Dana Farber), WO2010/036959 (Dana Farber), WO2010/077634 (Genentech), including issued U.S. Patent No. 8,217,149, US2012/0039906 (INSERM), WO2012/145493 (Amplimmune), U.S. Patent No. 8,779,108 (MedImmune - for MEDI4726 and 2.7A4), US20140044738 (Ampimmune - for AMP-714) and WO2009/089149 (John's Hopkins University). Each of these disclosures is herein incorporated by reference in its entirety.

Anti-CTLA-4 Antibodies

Antibodies that specifically bind CTLA-4 and inhibit CTLA-4 activity are useful for enhancing an anti-tumor immune response. Information regarding tremelimumab (or antigen-binding fragments thereof) for use in the methods provided herein can be found in US 6,682,736 (where it is referred to as 11.2.1), the disclosure of which is incorporated herein by reference in its entirety. Tremelimumab (also known as CP-675,206, CP-675, CP-675206, and ticilimumab) is a human IgG_2 monoclonal antibody that is highly selective for CTLA-4 and blocks binding of CTLA-4 to CD80 (B7.1) and CD86 (B7.2). It has been shown to result in immune activation *in vitro* and some patients treated with tremelimumab have shown tumor regression.

Tremelimumab 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. In a specific aspect, tremelimumab or an antigen-binding fragment thereof for use in the methods provided herein comprises a light chain variable region comprising the amino acid sequences shown herein above and a heavy chain variable region comprising the amino acid sequence shown herein above. In a specific aspect, tremelimumab or an antigen-binding fragment thereof for use in the methods

provided herein comprises a heavy chain variable region and a light chain variable region, wherein the heavy chain variable region comprises the Kabat-defined CDR1, CDR2, and CDR3 sequences shown herein above, and wherein the light chain variable region comprises the Kabat-defined CDR1, CDR2, and CDR3 sequences shown herein above. Those of ordinary skill in the art would easily be able to identify Chothia-defined, Abm-defined or other CDR definitions known to those of ordinary skill in the art. In a specific aspect, tremelimumab or an antigen-binding fragment thereof for use in the methods provided herein comprises the variable heavy chain and variable light chain CDR sequences of the 11.2.1 antibody as disclosed in US 6,682,736, which is herein incorporated by reference in its entirety.

Other anti-CTLA-4 antibodies are described, for example, in US 20070243184. In one embodiment, the anti-CTLA-4 antibody is Ipilimumab, also termed MDX-010; BMS-734016.

OX40 Agonists

OX40 agonists interact with the OX40 receptor on $CD4^+$ T-cells during, or shortly after, priming by an antigen resulting in an increased response of the $CD4^+$ T-cells to the antigen. An OX40 agonist interacting with the OX40 receptor on antigen specific $CD4^+$ T-cells can increase T cell proliferation as compared to the response to antigen alone. The elevated response to the antigen can be maintained for a period of time substantially longer than in the absence of an OX40 agonist. Thus, stimulation via an OX40 agonist enhances the antigen specific immune response by boosting T-cell recognition of antigens, *e.g.*, tumor cells. OX40 agonists are described, for example, in U.S. Patent Nos. 6,312,700, 7,504,101, 7,622,444, and 7,959,925, which are incorporated herein by reference in their entireties. Methods of using such agonists in cancer treatment are described, for example, in WO/2013/119202 and in WO/2013/130102, each of which are incorporated herein by reference in its entirety.

OX40 agonists include, but are not limited to OX40 binding molecules, *e.g.*, binding polypeptides, *e.g.*, OX40 ligand ("OX40L") or an OX40-binding fragment, variant, or derivative thereof, such as soluble extracellular ligand domains and OX40L fusion proteins, and anti-OX40 antibodies (for example, monoclonal antibodies such as humanized monoclonal antibodies), or an antigen-binding fragment, variant or derivative thereof. Examples of anti-OX40 monoclonal antibodies are described, for example, in U.S. Patent Nos. 5,821,332 and 6,156,878, the disclosures of which are incorporated herein by reference in their entireties. In certain embodiments, the anti-OX40 monoclonal antibody is 9B12, or an antigen-binding fragment, variant, or derivative thereof,

as described in Weinberg, A.D., *et al. J Immunother* 29, 575-585 (2006), which is incorporated herein by reference in its entirety.

In certain embodiments of the various aspects disclosed herein, the OX40 agonist is a humanized anti-OX40 antibody or an antigen-binding fragment thereof comprising an antibody VH and an antibody VL, wherein the VL comprises an amino acid sequence at least 70%, 75%, 80%, 85%, 90%, 95%, or 100% identical to the reference amino acid sequence: DIQMTQSPSSLSASVGDRVTITCRASQDISNYLNWYQQKPGKAPKLLIYYTSKLHSGVPSRF SGSGSGTDYTLTISSLQPEDFATYYCQQGSALPWTFGQGTKVEIK (SEQ ID NO: 25) or DIQMTQSPSSLSASVGDRVTITCRASQDISNYLNWYQQKPGKAVKLLIYYTSKLHSGVPSRF SGSGSRTDYTLTISSLQPEDFATYYCQQGSALPWTFGQGTKVEIK (SEQ ID NO: 26).

In one embodiment, the humanized anti-OX40 antibody or an antigen-binding fragment thereof comprising an antibody VH and an antibody VL, where the VL comprises the amino acid sequence DIQMTQSPSSLSASVGDRVTITCRASQDISNYLNWYQQKPGKAPKLLIYYTSKLHSGVPSRF SGSGSGTDYTLTISSLQPEDFATYYCQQGSALPWTFGQGTKVEIK (SEQ ID NO: 25) and the VH comprises the amino acid sequence QVQLQESGPGLVKPSQTLSLTCAVYGGSFSSGYWNWIRKHPGKGLEYIGYISYNGITYHNPS LKSRITINRDTSKNQYSLQLNSVTPEDTAVYYCARYKYDYDGGHAMDYWGQGTLVTVSS (SEQ ID NO: 27).

In certain other embodiments the humanized anti-OX40 antibody or an antigen-binding fragment thereof comprises an antibody heavy chain or fragment thereof and an antibody light chain or fragment thereof, where the heavy chain comprises the amino acid sequence disclosed in SEQ ID NO: 28, herein, and the light chain comprises the amino acid sequence disclosed in SEQ ID NO: 29, herein.

In other embodiments, the antibody which specifically binds to OX40, or an antigen-binding fragment thereof binds to the same OX40 epitope as mAb 9B12.

An exemplary humanized OX40 antibody is described by Morris et al., Mol Immunol. May 2007; 44(12): 3112–3121, and has the sequence disclosed in SEQ ID NO: 30, herein.

9B12 is a murine IgG1, anti-OX40 mAb directed against the extracellular domain of human OX40 (CD134) (Weinberg, A.D., *et al. J Immunother* 29, 575-585 (2006)). It was selected from a panel of anti-OX40 monoclonal antibodies because of its ability to elicit an agonist response for OX40 signaling, stability, and for its high level of production by the hybridoma. For use in clinical

applications, 9B12 mAb is equilibrated with phosphate buffered saline, pH 7.0, and its concentration is adjusted to 5.0 mg/ml by diafiltration.

"OX40 ligand" ("OX40L") (also variously termed tumor necrosis factor ligand superfamily member 4, gp34, TAX transcriptionally-activated glycoprotein-1, and CD252) is found largely on antigen presenting cells (APCs), and can be induced on activated B cells, dendritic cells (DCs), Langerhans cells, plamacytoid DCs, and macrophages (Croft, M., (2010) *Ann Rev Immunol 28*:57-78). Other cells, including activated T cells, NK cells, mast cells, endothelial cells, and smooth muscle cells can express OX40L in response to inflammatory cytokines (Id.). OX40L specifically binds to the OX40 receptor. The human protein is described in U.S. Patent 6,156,878. The mouse OX40L is described in U.S. Patent 5,457,035. OX40L is expressed on the surface of cells and includes an intracellular, a transmembrane and an extracellular receptor-binding domain. A functionally active soluble form of OX40L can be produced by deleting the intracellular and transmembrane domains as described, *e.g.*, in U.S. Pat. Nos. 5,457,035; 6,312,700; 6,156,878; 6,242,566; 6,528,055; 6,528,623; 7,098,184; and 7,125,670, the disclosures of which are incorporated herein for all purposes. A functionally active form of OX40L is a form that retains the capacity to bind specifically to OX40, that is, that possesses an OX40 "receptor binding domain." An example is amino acids 51 to 183 of human OX40L. Methods of determining the ability of an OX40L molecule or derivative to bind specifically to OX40 are discussed below. Methods of making and using OX40L and its derivatives (such as derivatives that include an OX40 binding domain) are described in U.S. Pat. Nos. 6,156,878; 6,242,566; 6,528,055; 6,528,623; 7,098,184; and 7,125,670, which also describe proteins comprising the soluble form of OX40L linked to other peptides, such as human immunoglobulin ("Ig") Fc regions, that can be produced to facilitate purification of OX40 ligand from cultured cells, or to enhance the stability of the molecule after *in vivo* administration to a mammal (see also, U.S. Pat. Nos. 5,457,035 and 7,959,925, both of which are incorporated by reference herein in their entireties).

As used herein, the term "OX40L" includes the entire OX40 ligand, soluble OX40 ligand, and functionally active portions of the OX40 ligand. Also included within the definition of OX40L are OX40 ligand variants which vary in amino acid sequence from naturally occurring OX40 ligand molecules but which retain the ability to specifically bind to an OX40 receptor. Such variants are described in U.S. Pat. Nos. 5,457,035; 6,156,878; 6,242,566; 6,528,055; 6,528,623; 7,098,184; and 7,125,670. In a related embodiment, a mutant of OX40L which has lost the ability to specifically

bind to OX40, for example amino acids 51 to 183, in which the phenylalanine at position 180 of the receptor-binding domain of human OX40L has been replaced with alanine (F180A) is used.

OX40 agonists include a fusion protein in which one or more domains of OX40L is covalently linked to one or more additional protein domains. Exemplary OX40L fusion proteins that can be used as OX40 agonists are described in U.S. Pat. No. 6,312,700, the disclosure of which is incorporated herein by reference in its entirety. In one embodiment, an OX40 agonist includes an OX40L fusion polypeptide that self-assembles into a multimeric (*e.g.*, trimeric or hexameric) OX40L fusion protein. Such fusion proteins are described, *e.g.*, in U.S. Patent No. 7,959,925, which is incorporated by reference herein in its entirety. The multimeric OX40L fusion protein exhibits increased efficacy in enhancing antigen specific immune response in a subject, particularly a human subject, due to its ability to spontaneously assemble into highly stable trimers and hexamers.

In another embodiment, an OX40 agonist capable of assembling into a multimeric form includes a fusion polypeptide comprising in an N-terminal to C-terminal direction: an immunoglobulin domain, wherein the immunoglobulin domain includes an Fc domain, a trimerization domain, wherein the trimerization domain includes a coiled coil trimerization domain, and a receptor binding domain, wherein the receptor binding domain is an OX40 receptor binding domain, *e.g.*, an OX40L or an OX40-binding fragment, variant, or derivative thereof, where the fusion polypeptide can self-assemble into a trimeric fusion protein. In one aspect, an OX40 agonist capable of assembling into a multimeric form is capable of binding to the OX40 receptor and stimulating at least one OX40 mediated activity. In certain aspects, the OX40 agonist includes an extracellular domain of OX40 ligand.

The trimerization domain of an OX40 agonist capable of assembling into a multimeric form serves to promote self-assembly of individual OX40L fusion polypeptide molecules into a trimeric protein. Thus, an OX40L fusion polypeptide with a trimerization domain self-assembles into a trimeric OX40L fusion protein. In one aspect, the trimerization domain is an isoleucine zipper domain or other coiled coli polypeptide structure. Exemplary coiled coil trimerization domains include: TRAF2 (GENBANK® Accession No. Q12933, amino acids 299-348; Thrombospondin 1 (Accession No. PO7996, amino acids 291-314; Matrilin-4 (Accession No. O95460, amino acids 594-618; CMP (matrilin-1) (Accession No. NP—002370, amino acids 463-496; HSF1 (Accession No. AAX42211, amino acids 165-191; and Cubilin (Accession No. NP—001072 , amino acids 104-138. In certain specific aspects, the trimerization domain includes a TRAF2 trimerization domain, a Matrilin-4 trimerization domain, or a combination thereof.

OX40L FP is a human OX40 ligand IgG4P fusion protein that specifically binds to, and triggers signaling by, the human OX40 receptor, a member of the TNFR superfamily. OX40L FP can have the nucleic acid disclosed in any of SEQ ID NOs: 31, 33 and 35 and the correspondingly encoded amino acid sequence disclosed in SEQ ID NO: 32, 34 and 36, respectively. OX40L FP is also disclosed in PCT/US2015/032598, incorporated herein by reference in its entirety. OX40L FP is composed of three distinct domains: (1) human OX40 ligand extracellular receptor binding domains (RBDs) that form homotrimers and bind the OX40 receptor; (2) isoleucine zipper trimerization domains derived from TNFR-associated factor 2 that stabilize the homotrimeric structure of the OX40 ligand RBDs; and (3) human IgG4 fragment crystallizable gamma (Fcγ) domains that facilitate Fcγ receptor clustering of the fusion protein when bound to OX40 receptors, and contain a serine to proline substitution at position 228 (according to EU numbering) in the hinge regions (IgG4P) to promote stability of two sets of OX40 ligand RBD homotrimers. The IgG4P Fc domain is fused directly to an isoleucine zipper trimerization domain derived from amino acid residues 310-349 of human tumor necrosis factor 2 (TRAF2). Fused to the c-terminus of the TRAF2 domain are amino acid residues 51-183 of the extracellular receptor binding domain (RBD) of human OX40L (gene name TNFSF4). The TRAF2 domain stabilizes the homotrimeric structure of OX40L RBDs to enable OX40 binding and activation, while the IgG4P Fc domain confers serum stability, dimerization of OX40L trimers, and facilitates Fcγ receptor clustering of the hexameric fusion protein. One such OX40L FP has the sequences disclosed in SEQ ID NO: 31 and 32. One OX40L FP variant possesses a phenylalanine (F) to alanine (A) mutation at the amino acid corresponding to position 180 in OX40L (SEQ ID NO:33 and 34). Another OX40L FP variant has the IgG4P Fc domain replaced with a human IgG1 Fc domain (SEQ ID NO: 35 and 36). In particular embodiments, the OX40 agonist for use in the present invention is one of the OX40L FP variants.

In particular embodiments, the OX40 agonist for use in the present invention has been modified to increase its serum half-life. For example, the serum half-life of an OX40 agonist can be increased by conjugation to a heterologous molecule such as serum albumin, an antibody Fc region, or PEG. In certain embodiments, OX40 agonists can be conjugated to other therapeutic agents or toxins to form immunoconjugates and/or fusion proteins. In certain embodiments, the OX40 agonist can be formulated so as to facilitate administration and promote stability of the active agent.

Derivatives

Antibodies for use in the invention (*e.g.*, anti-CTLA-4, anti-PD-L1, anti-PD-1, anti-OX40) may include variants of these sequences that retain the ability to specifically bind their targets. Such variants may be derived from the sequence of these antibodies by a skilled artisan using techniques well known in the art. For example, amino acid substitutions, deletions, or additions, can be made in the FRs and/or in the CDRs. While changes in the FRs are usually designed to improve stability and immunogenicity of the antibody, changes in the CDRs are typically designed to increase affinity of the antibody for its target. Variants of FRs also include naturally occurring immunoglobulin allotypes. Such affinity-increasing changes may be determined empirically by routine techniques that involve altering the CDR and testing the affinity antibody for its target. For example, conservative amino acid substitutions can be made within any one of the disclosed CDRs. Various alterations can be made according to the methods described in Antibody Engineering, 2nd ed., Oxford University Press, ed. Borrebaeck, 1995. These include but are not limited to nucleotide sequences that are altered by the substitution of different codons that encode a functionally equivalent amino acid residue within the sequence, thus producing a "silent" change. For example, the nonpolar amino acids include alanine, leucine, isoleucine, valine, proline, phenylalanine, tryptophan, and methionine. The polar neutral amino acids include glycine, serine, threonine, cysteine, tyrosine, asparagine, and glutamine. The positively charged (basic) amino acids include arginine, lysine, and histidine. The negatively charged (acidic) amino acids include aspartic acid and glutamic acid.

Derivatives and analogs of antibodies of the invention can be produced by various techniques well known in the art, including recombinant and synthetic methods (Maniatis (1990) Molecular Cloning, A Laboratory Manual, 2nd ed., Cold Spring Harbor Laboratory, Cold Spring Harbor, N.Y., and Bodansky *et al.* (1995) The Practice of Peptide Synthesis, 2nd ed., Spring Verlag, Berlin, Germany). Analogous shuffling or combinatorial techniques are also disclosed by Stemmer (Nature (1994) 370: 389-391), who describes the technique in relation to a β-lactamase gene but observes that the approach may be used for the generation of antibodies.

One may generate novel VH or VL regions carrying one or more sequences derived from the sequences disclosed herein using random mutagenesis of one or more selected VH and/or VL genes. One such technique, error-prone PCR, is described by Gram *et al.* (Proc. Nat. Acad. Sci. U.S.A. (1992) 89: 3576-3580).

Another method that may be used is to direct mutagenesis to CDRs of VH or VL genes. Such techniques are disclosed by Barbas *et al.* (Proc. Nat. Acad. Sci. U.S.A. (1994) 91: 3809-3813) and Schier *et al.* (J. Mol. Biol. (1996) 263: 551-567).

Similarly, one or more, or all three CDRs may be grafted into a repertoire of VH or VL domains, which are then screened for an antigen-binding fragment specific for CTLA-4 or PD-L1.

A portion of an immunoglobulin variable domain will comprise at least one of the CDRs substantially as set out herein and, optionally, intervening framework regions from the scFv fragments as set out herein. The portion may include at least about 50% of either or both of FR1 and FR4, the 50% being the C-terminal 50% of FR1 and the N-terminal 50% of FR4. Additional residues at the N-terminal or C-terminal end of the substantial part of the variable domain may be those not normally associated with naturally occurring variable domain regions. For example, construction of antibodies by recombinant DNA techniques may result in the introduction of N- or C-terminal residues encoded by linkers introduced to facilitate cloning or other manipulation steps. Other manipulation steps include the introduction of linkers to join variable domains to further protein sequences including immunoglobulin heavy chain constant regions, other variable domains (for example, in the production of diabodies), or proteinaceous labels as discussed in further detail below.

A skilled artisan will recognize that antibodies for use in the invention may comprise antigen-binding fragments containing only a single CDR from either VL or VH domain. Either one of the single chain specific binding domains can be used to screen for complementary domains capable of forming a two-domain specific antigen-binding fragment capable of, for example, binding to CTLA-4 and PD-L1.

Antibodies for use in the invention described herein can be linked to another functional molecule, *e.g.*, another peptide or protein (albumin, another antibody, *etc.*). For example, the antibodies can be linked by chemical cross-linking or by recombinant methods. The antibodies may also be linked to one of a variety of nonproteinaceous polymers, *e.g.*, polyethylene glycol, polypropylene glycol, or polyoxyalkylenes, in the manner set forth in U.S. Pat. Nos. 4,640,835; 4,496,689; 4,301,144; 4,670,417; 4,791,192; or 4,179,337. The antibodies can be chemically modified by covalent conjugation to a polymer, for example, to increase their circulating half-life. Exemplary polymers and methods to attach them are also shown in U.S. Pat. Nos. 4,766,106; 4,179,337; 4,495,285, and 4,609,546.

The antibodies may also be altered to have a glycosylation pattern that differs from the native pattern. For example, one or more carbohydrate moieties can be deleted and/or one or more glycosylation sites added to the original antibody. Addition of glycosylation sites to the presently disclosed antibodies may be accomplished by altering the amino acid sequence to contain glycosylation site consensus sequences known in the art. Another means of increasing the number of carbohydrate moieties on the antibodies is by chemical or enzymatic coupling of glycosides to the amino acid residues of the antibody. Such methods are described in WO 87/05330, and in Aplin *et al.* (1981) CRC Crit. Rev. Biochem., 22: 259-306. Removal of any carbohydrate moieties from the antibodies may be accomplished chemically or enzymatically, for example, as described by Hakimuddin *et al.* (1987) Arch. Biochem. Biophys., 259: 52; and Edge *et al.* (1981) Anal. Biochem., 118: 131 and by Thotakura *et al.* (1987) Meth. Enzymol., 138: 350. The antibodies may also be tagged with a detectable, or functional, label. Detectable labels include radiolabels such as 131I or 99Tc, which may also be attached to antibodies using conventional chemistry. Detectable labels also include enzyme labels such as horseradish peroxidase or alkaline phosphatase. Detectable labels further include chemical moieties such as biotin, which may be detected via binding to a specific cognate detectable moiety, *e.g.*, labeled avidin.

Antibodies, in which CDR sequences differ only insubstantially from those set forth herein are encompassed within the scope of this invention. Typically, an amino acid is substituted by a related amino acid having similar charge, hydrophobic, or stereochemical characteristics. Such substitutions would be within the ordinary skills of an artisan. Unlike in CDRs, more substantial changes can be made in FRs without adversely affecting the binding properties of an antibody. Changes to FRs include, but are not limited to, humanizing a non-human derived or engineering certain framework residues that are important for antigen contact or for stabilizing the binding site, *e.g.*, changing the class or subclass of the constant region, changing specific amino acid residues which might alter the effector function such as Fc receptor binding, *e.g.*, as described in U.S. Pat. Nos. 5,624,821 and 5,648,260 and Lund *et al.* (1991) J. Immun. 147: 2657-2662 and Morgan *et al.* (1995) Immunology 86: 319-324, or changing the species from which the constant region is derived.

One of skill in the art will appreciate that the modifications described above are not all-exhaustive, and that many other modifications would be obvious to a skilled artisan in light of the teachings of the present disclosure.

STAT3 antisense compounds, including antisense oligonucleotides

Antisense compound targeted to STAT3, including antisense oligonucleotides, that specifically bind to and inhibit STAT3 mRNA or protein expression are useful in the present invention.

STAT3 inhibitory antisense oligonucleotides are known in the art.

WO2000/061602 and WO2005/083124 (both Isis Pharmaceuticals Inc.) disclose numerous STAT3 inhibitory antisense oligonucleotides that could feature in the present invention.

WO2012/135736 (Isis Pharmaceuticals Inc.) also discloses numerous STAT3 inhibitory antisense oligonucleotides that could feature in the present invention. Antisense oligonucleotides suitable for use in the embodiments provided herein include, but are not limited to, SEQ ID NOs: 9-426, 430-442, 445-464, 471-498, 500-1034, and 1036-1512 described in WO2012/135736. One of these, identified therein as ISIS 481464, is the molecule also known as AZD9150. It is a gapmer molecule with 3-10-3 configuration, the central gap segment comprising ten 2'-deoxynucleosides, flanked on both sides (in the 5' and 3' directions) by wings comprising three nucleosides each. Each nucleoside in the 5' wing segment and each nucleoside in the 3' wing segment has a cET sugar modification. The internucleotide linkages throughout each gapmer are phosphorothioate (P=S) linkages. All cytosine residues in the gapmer are 5'-methylcytosines. The complete 16-mer nucleobase sequence of AZD9150/ISIS481464 is CTATTTGGATGTCAGC (disclosed herein as SEQ ID NO: 2). Wing segments are underlined. AZD9150 is complementary to nucleobases 3016-3031 in STAT3 sequence of GENBANK Accession No. NM 139276.2, incorporated herein as SEQ ID NO:1.

WO 2014/070868 (Isis Pharmaceuticals Inc.) discloses particular dosages of AZD9150 and methods of treating particular cancers therewith.

AZD9150 is currently being tested in Phase I clinical trials and has shown clinical responses in DLBCL and HCC at tolerated doses.

Other antisense compounds targeted to STAT3 are disclosed in, for example, WO2008109494, which discloses STAT3 meroduplex ribonucleic acid molecules (mdRNAs), and US20100298409, which discloses STAT3 siRNA molecules.

Each of these disclosures is herein incorporated by reference in its entirety.

Certain embodiments.

In one aspect, the invention provides a method comprising administering to a patient in need thereof an immunomodulatory agent and an antisense compound targeted to STAT3. In one

embodiment, the agents ((i) the anti-PD-L1 antibody or antigen-binding fragment thereof; and (ii) the antisense compound targeted to STAT3)) are administered simultaneously, separately or sequentially.

In one aspect, the invention provides a method of treatment that involves administering: (i) at least one immunomodulatory agent; and (ii) an antisense compound targeted to STAT3; to a patient in need thereof. In one embodiment, the agents are administered simultaneously, separately or sequentially.

In one aspect, the invention provides an immunomodulatory agent, and an antisense compound targeted to STAT3, for use in the treatment of a patient in need thereof. In one embodiment, the two agents are administered simultaneously, separately or sequentially.

In one aspect, the invention provides at least one immunomodulatory agent, and an antisense compound targeted to STAT3, for use in the treatment of a patient in need thereof. In one embodiment, the agents are administered simultaneously, separately or sequentially.

In one aspect, the invention provides an immunomodulatory agent for use in the treatment of a patient in need thereof, wherein said patient is also being treated with an antisense compound targeted to STAT3. In one embodiment, the agents are administered simultaneously, separately or sequentially.

In one aspect, the invention provides an antisense compound targeted to STAT3 for use in the treatment of a patient in need thereof, wherein said patient is also being treated with an immunomodulatory agent. In one embodiment, the agents are administered simultaneously, separately or sequentially.

In one aspect, the invention provides the use of an immunomodulatory agent, in the manufacture of a medicament for the treatment of a patient suffering from cancer, which patient is also being treated with an antisense compound targeted to STAT3.

In one aspect, the invention provides the use of an immunomodulatory agent, in the manufacture of a medicament for treating a patient suffering from cancer, wherein the immunomodulatory agent, is administered simultaneously, separately or sequentially with an antisense compound targeted to STAT3, to a patient in need thereof.

In one aspect, the invention provides the use of an antisense compound targeted to STAT3 in the manufacture of a medicament for the treatment of a patient suffering from cancer, which patient is also being treated with an immunomodulatory agent.

In one aspect, the invention provides the use of an antisense compound targeted to STAT3 in the manufacture of a medicament for treating a patient suffering from cancer, wherein the antisense compound targeted to STAT3 is administered simultaneously, separately or sequentially with an immunomodulatory agent.

In one aspect, the invention provides the use of (i) an immunomodulatory agent; and (ii) an antisense compound targeted to STAT3, in the manufacture of a medicament for the treatment of a patient suffering from cancer. In one embodiment, the two agents (antisense compound and immunomodulatory) are administered simultaneously, separately or sequentially.

In one aspect, the invention provides an immunomodulatory agent, for use in the treatment of a patient suffering from cancer, which patient is also being treated with an antisense compound targeted to STAT3.

In one aspect, the invention provides an immunomodulatory agent, for use in the treatment of a patient suffering from cancer, wherein the immunomodulatory agent, is administered simultaneously, separately or sequentially with an antisense compound targeted to STAT3.

In one aspect, the invention provides an antisense compound targeted to STAT3, for use in the treatment of a patient suffering from cancer, which patient is also being treated with an immunomodulatory agent.

In one aspect, the invention provides an antisense compound targeted to STAT3, for use in the treatment of a patient suffering from cancer, wherein the antisense compound targeted to STAT3 is administered simultaneously, separately or sequentially with an immunomodulatory agent.

In one aspect, the invention provides: (i) an immunomodulatory agent; and (ii) an antisense compound targeted to STAT3; for use in the treatment of a patient suffering from cancer, wherein each of the immunomodulatory agent and the antisense compound targeted to STAT3 is administered simultaneously, separately or sequentially to the patient.

In the various aspects disclosed herein, when we refer to treatment of a patient with an immunomodulatory agent it also embraces treatment with more than one immunomodulatory agent.

In particular embodiments of any of the aspects disclosed herein, the immunomodulatory agent is an immune checkpoint inhibitor.

In particular embodiments of any of the aspects disclosed herein, the immunomodulatory agent is: anti-PD-L1 antibody or an antigen-binding fragment thereof.

In particular embodiments of any of the aspects disclosed herein, the immunomodulatory agent is: anti-PD-1 antibody or an antigen-binding fragment thereof.

In particular embodiments of any of the aspects disclosed herein, the immunomodulatory agent is: anti-CTLA-4 antibody or an antigen-binding fragment thereof.

In particular embodiments of any of the aspects disclosed herein, the immunomodulatory agent is: an OX-40 agonist. In particular embodiments the OX-40 agonist is selected from: an anti-OX40 agonist antibody or an antigen-binding fragment thereof, an OX40 ligand or a fragment or derivatives thereof, or an OX40 ligand fusion protein.

In particular embodiments of any of the aspects disclosed herein, the immunomodulatory agent is selected from the group consisting of: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714, MDX-1105, nivolumab, pembrolizumab, pidilizumab, MPDL3280A, tremelimumab, ipilimumab and OX40L FP.

In one embodiment of any of the aspects disclosed herein the STAT3 is human STAT3, thus the combinations and methods of treatment and the like, utilize an antisense compound targeted to human STAT3.

Certain aspects are drawn to a combination of an antisense compound targeted to STAT3 and one or more immunomodulatory agents. In certain embodiments, such a combination of an antisense compound targeted to STAT3 and one or more immunomodulatory agents comprises AZD9150 and one or more agents selected from: an anti-PD-L1 antibody, an anti-PD1 antibody, and anti-CTLA-4 antibody and an OX-40 agonist. In certain embodiments, such a combination comprises AZD9150 as the antisense compound targeted to STAT3 and one or more immunomodulatory agents selected from the group consisting of: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714, MDX-1105, nivolumab, pembrolizumab, pidilizumab, MPDL3280A, tremelimumab, ipilimumab and OX40L FP.

In particular embodiments of any of the first or second medical uses, or method of treatment aspects disclosed herein, two or more immunomodulatory agents can be administered in combination with the antisense compound targeted to STAT3. For example, the combination treatment may involve a STAT3 ASO, an anti-PDL-1 antibody and an anti-CTLA-4 antibody, such as AZD9150, MEDI4736 and tremelimumab. One alternative would involve a STAT3 ASO, an anti-PDL-1 antibody and an OX40 agonist, such as AZD9150, MEDI4736 and OX40L FP. Another alternative would involve a STAT3 ASO, an anti-PDL-1 antibody and an anti-CTLA-4 antibody, such as AZD9150, MEDI4736 and tremelimumab.

In particular embodiments of any of the first or second medical uses, or method of treatment aspects disclosed herein, the immunomodulatory agent is an anti-PD-L1 antibody or antigen-binding

fragment thereof, selected from: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714 and MDX-1105, or an antigen-binding fragment of any of these.

In particular embodiments of any of the first or second medical uses, or method of treatment aspects above involving an anti-PD-L1 antibody or antigen-binding fragment thereof, the anti-PD-L1 antibody is MEDI4376, or an antigen binding fragment thereof.

In particular embodiments of any of the first or second medical uses, or method of treatment aspects above involving an anti-PD-L1 antibody or antigen-binding fragment thereof, the anti-PD-L1 antibody or antigen binding fragment thereof, blocks the binding of PD-L1 to the PD-1 and CD80 receptors.

In particular embodiments of any of the first or second medical uses, or method of treatment aspects above, the antisense compound targeted to STAT3 is administered to the patient before the immunomodulatory agent. In particular embodiments, the duration between administration of the antisense compound targeted to STAT3 and the immunomodulatory agent, is at least: 10 minutes, 1 hour, 2 hours, 6 hours, 12 hours, 18 hours, 24 hours, 36 hours, 48 hours, 5 days, 7 days 10 days or 14 days. In a particular embodiment, the antisense compound targeted to STAT3 is administered to the patient first and then the immunomodulatory agent is administered later on at a different time point and at a different visitation. A different visitation in this context can mean that the health care provider supplying or administering the immunomodulator drug to the patient does so at a different visit than the visit when the antisense compound targeted to STAT3 was provided/administered. Clearly, the location of the visit is unimportant. The patient could be visiting the healthcare provider or vice versa.

In particular embodiments of any of the first or second medical uses, or method of treatment aspects above, the immunomodulatory agent is administered to the patient before the antisense compound targeted to STAT3.

In particular embodiments, the duration between administration of: (i) the immunomodulatory agent; and, (ii) the antisense compound targeted to STAT3, is at least: 10 minutes, 1 hour, 2 hours, 6 hours, 12 hours, 18 hours, 24 hours, 36 hours, 48 hours, 5 days, 7 days 10 days or 14 days.

In each of the various first or second medical uses, or method of treatment aspects above, the antisense compound targeted to STAT3 can be an antisense oligonucleotide.

In particular embodiments of any of the first or second medical uses, or method of treatment aspects above, the antisense compound targeted to STAT3 can be AZD9150.

In certain embodiments the antisense compound targeted to STAT3 does not inhibit STAT1, STAT4, or STAT6.

In certain embodiments, the patient has cancer. In one embodiment, the patient has a cancer selected from: head and neck cancer (including squamous cell carcinoma (HNSCC)), lymphoma (including diffuse large B-cell carcinoma (DLBCL) or Hodgkin's lymphoma), breast cancer (including triple negative), ovarian cancer (including serous), pancreatic cancer, colorectal cancer, lung cancer (including non small cell lung cancer (NSCLC)), and hepatocellular carcinoma (HCC).

In certain embodiments the cancer cells express PD-L1.

In certain embodiments the patient in need thereof was identified as having a cancer that is PD-L1 positive. In particular embodiments, at least: 20%, 25%, 30%, 40%, 50%, 60%, 70%, 80% or more of the cells in the tumor cells of the patient are PD-L1 positive when assessed using immunochemistry.

In one embodiment, the lung cancer is small cell lung cancer or non-small cell lung cancer (e.g., squamous cell carcinoma, adenocarcinoma, large cell carcinoma, adenosquamous carcinoma and sarcomatoid carcinoma).

In one embodiment, the head and neck cancer is HNSCC.

In one embodiment the lymphoma is DLBCL.

In another aspect, the invention provides a method of treatment involving administering MEDI4736 or an antigen binding fragments thereof, and AZD9150 to a patient identified as having a cancer. In one embodiment of this specific aspect the cancer is selected from: HNSCC, DLBCL, pancreatic cancer, breast cancer, ovarian cancer, NSCLC and HCC.

In another aspect, the invention provides a method of treatment involving administering between about 0.5 - 20 mg/kg/wk of MEDI4736 or an antigen binding fragment thereof, and between about 0.3-5 mg/kg/wk AZD9150, to a patient identified as having cancer. In a particular embodiment, in addition to the AZD9150 and MEDI4736, between about 1-10mg/kg/wk tremelimumab is also administered to the patient. In certain embodiments, the subject's body weight is calculated as the ideal body weight using the Devine formula (Pai, M.P. and Paloucek, F.P. Ann. Pharmacol. 2000. 34: 1066-1069): for men (in kg) = 50 + 2.3 kg/inch over 5 feet; for women (in kg) = 45.5 + 2.3 kg/inch over 5 feet.

In certain embodiments, because of the treatment effects observed, the immunomodulatory agent and/or the antisense compounds targeting STAT3 may be administered at a dose that is lower than the same agent when used as monotherapy. In certain embodiments, the antisense compound

targeting STAT3 provided herein is administered to a subject in the range of about 0.3 to 5 milligrams of the antisense compound per kilogram of the subject's body weight per week (0.3-5 mg/kg/wk). Such dose ranges are unexpectedly low for treating cancer. By comparison, a Phase 1 study of LY2275796, an antisense oligonucleotide targeted to cap-binding protein eukaryotic initiation factor 4E (eIF-4E), concluded that the maximum tolerable dose (MTD) and biologically effective dose (BED) of LY2275796 is 1,000 mg under a loading and maintenance dose regimen, but even at a 1,000 mg dose, no tumor response was observed. (Hong D.S. et al., Clin Cancer Res. 2011 17(20):6582-91). In certain embodiments, the immunomodulatory agent is administered to a subject in the range of about 1 to 20 milligrams of the antibody compound per kilogram of the subject's body weight per week (1-20 mg/kg/wk).

In various embodiments of any of the above aspects or any aspect of the invention delineated herein involving an anti-PD-L1 antibody or antigen-binding fragment thereof, the anti-PD-L1 antibody or antigen-binding fragment thereof is selected from: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714 and MDX-1105, or an antigen-binding fragment of any of these.

In various embodiments of any of the above aspects or any aspect of the invention delineated herein involving an anti-PD1 antibody or antigen-binding fragment thereof, the anti-PD1 antibody or antigen-binding fragment thereof is selected from: nivolumab, pembrolizumab, pidilizumab and MPDL3280A.

In various embodiments of any of the above aspects or any aspect of the invention delineated herein involving an anti-CTLA-4 antibody or antigen-binding fragment thereof, the CTLA-4 antibody or antigen-binding fragment thereof is selected from: tremelimumab and ipilimumab.

In various embodiments of any of the above aspects or any aspect of the invention delineated herein involving an OX040 agonist, the OX-40 agonist is: OX40L FP.

In various embodiments of any of the above aspects or any aspect of the invention delineated herein the antisense compound targeted to STAT3 is AZD9150.

In certain embodiments, the STAT3 nucleic acid that the antisense compounds can hybridise to is any of the sequences set forth in GENBANK Accession No. NM_139276.2 (incorporated herein as SEQ ID NO: 1) or the complement of GENBANK Accession No. NT_010755.14 truncated from nucleotides 4185000 to 4264000 (referred to as SEQ ID NO:2 in WO2012/135736). In certain embodiments, the antisense oligonucleotide suitable for use herein include, but are not limited to, SEQ ID NOs: 9-426, 430-442, 445-464, 471-498, 500-1034, and 1036-1512 described in WO2012/135736. In certain embodiments the antisense oligonucleotide for use in the present

invention comprises a modified oligonucleotide consisting of 12 to 30 linked nucleosides having a nucleobase sequence comprising a portion of at least 12 contiguous nucleobases complementary to an equal length portion of nucleobases 3008 to 3033 of SEQ ID NO: 1, and wherein the nucleobase sequence is complementary to SEQ ID NO: 1. In certain embodiments the antisense oligonucleotide is AZD9150.

Information regarding AZD9150 (aka ISIS 481464), for use in the methods provided herein can be found in WO2012/135736, such as in Example 1, the disclosure of which is incorporated herein by reference in its entirety. AZD9150 is a single stranded modified oligonucleotide comprising ten linked deoxynucleosides (the gap segment), a 5' wing segment consisting of 3 linked nucleosides; and a 3' wing segment consisting of 3 linked nucleosides. The gap segment is positioned between the 5' wing segment and the 3' wing segment and each nucleoside of each wing segment comprises a constrained ethyl nucleoside. Each internucleoside linkage of the oligonucleotide is a phosphorothioate linkage and each cytosine of the oligonucleotide is a 5'-methylcytosine. The complete 16-mer nucleobase sequence of AZD9150 is CTATTTGGATGTCAGC (disclosed herein as SEQ ID NO: 2), wing segments underlined. In certain embodiments, the antisense compound targeted to STAT3 is a compound comprising a modified oligonucleotide consisting of 12 to 30 linked nucleosides and having a nucleobase sequence comprising at least 12 contiguous nucleobases of the nucleobase sequence of SEQ ID NO: 2.

In certain embodiments, the modified oligonucleotide targeting STAT3 consists of a single-stranded modified oligonucleotide.

In certain embodiments, at least one internucleoside linkage of the modified oligonucleotide targeting STAT3 is a modified internucleoside linkage.

In certain embodiments, each internucleoside linkage of the modified oligonucleotide targeting STAT3 is a phosphorothioate internucleoside linkage.

In certain embodiments, at least one nucleoside of the modified oligonucleotide targeting STAT3 comprises a modified sugar.

In certain embodiments, at least one modified sugar of the modified oligonucleotide targeting STAT3 is a bicyclic sugar.

In certain embodiments, the bicyclic sugar of the modified oligonucleotide targeting STAT3 comprises a 4'-CH_2-O-2' bridge or a 4'-$CH(CH_3)$-O-2' bridge.

In certain embodiments, the modified sugar of the modified oligonucleotide targeting STAT3 comprises a 2'-O$(CH_2)_2$-OCH_3 group or a 2'-O-CH_3 group.

In certain embodiments, at least one nucleoside of the modified oligonucleotide targeting STAT3 comprises a modified nucleobase. In certain embodiments, the said modified nucleobase is a 5'-methylcytosine.

In certain embodiments, the modified oligonucleotide targeting STAT3 comprises:

a 5'-wing consisting of 1 to 5 linked nucleosides;

a 3'-wing consisting of 1 to 5 linked nucleosides;

a gap between the 5'-wing and the 3'-wing consisting of 8 to 12 linked 2'-deoxynucleosides; and

wherein at least one of the 5'-wing and the 3'-wing comprises at least one bicyclic nucleoside or 2'-substituted nucleoside.

In certain embodiments, the antisense compound targeting STAT3 has a nucleobase sequence that, when written in the 5' to 3' direction, comprises the reverse complement of the target segment of a target nucleic acid to which it is targeted.

It is understood that the sequence set forth in each SEQ ID NO contained herein and as applied to an antisense molecule/compound is independent of any modification to a sugar moiety, an internucleoside linkage, or a nucleobase. As such, antisense compounds defined by a SEQ ID NO may comprise, independently, one or more modifications to a sugar moiety, an internucleoside linkage, or a nucleobase.

Modifications

A nucleoside is a base-sugar combination. The nucleobase (also known as base) portion of the nucleoside is normally a heterocyclic base moiety. Nucleotides are nucleosides that further include a phosphate group covalently linked to the sugar portion of the nucleoside. For those nucleosides that include a pentofuranosyl sugar, the phosphate group can be linked to the 2', 3' or 5' hydroxyl moiety of the sugar. Oligonucleotides are formed through the covalent linkage of adjacent nucleosides to one another, to form a linear polymeric oligonucleotide. Within the oligonucleotide structure, the phosphate groups are commonly referred to as forming the internucleoside linkages of the oligonucleotide.

Modifications to antisense compounds encompass substitutions or changes to internucleoside linkages, sugar moieties, or nucleobases. Modified antisense compounds are often preferred over native forms because of desirable properties such as, for example, enhanced cellular

uptake, enhanced affinity for nucleic acid target, increased stability in the presence of nucleases, or increased inhibitory activity.

Chemically modified nucleosides may also be employed to increase the binding affinity of a shortened or truncated antisense oligonucleotide for its target nucleic acid. Consequently, comparable results can often be obtained with shorter antisense compounds that have such chemically modified nucleosides.

Modified Internucleoside Linkages

The naturally occuring internucleoside linkage of RNA and DNA is a 3' to 5' phosphodiester linkage. Antisense compounds having one or more modified, i.e. non-naturally occurring, internucleoside linkages are often selected over antisense compounds having naturally occurring internucleoside linkages because of desirable properties such as, for example, enhanced cellular uptake, enhanced affinity for target nucleic acids, and increased stability in the presence of nucleases.

Oligonucleotides having modified internucleoside linkages include internucleoside linkages that retain a phosphorus atom as well as internucleoside linkages that do not have a phosphorus atom. Representative phosphorus containing internucleoside linkages include, but are not limited to, phosphodiesters, phosphotriesters, methylphosphonates, phosphoramidate, and phosphorothioates. Methods of preparation of phosphorous-containing and non-phosphorous-containing linkages are well known.

In certain embodiments, antisense compounds targeted to a STAT3 nucleic acid comprise one or more modified internucleoside linkages. In certain embodiments, the modified internucleoside linkages are phosphorothioate linkages. In certain embodiments, each internucleoside linkage of an antisense compound is a phosphorothioate internucleoside linkage.

Modified Sugar Moieties

Antisense compounds provided herein can optionally contain one or more nucleosides wherein the sugar group has been modified. Such sugar modified nucleosides may impart enhanced nuclease stability, increased binding affinity, or some other beneficial biological property to the antisense compounds. In certain embodiments, nucleosides comprise a chemically modified ribofuranose ring moiety. Examples of chemically modified ribofuranose rings include, without limitation, addition of substitutent groups (including 5' and 2' substituent groups); bridging of non-geminal ring atoms to form bicyclic nucleic acids (BNA); replacement of the ribosyl ring oxygen atom with S, N(R), or C(R1)(R)2 (R = H, C_1-C_{12} alkyl or a protecting group); and combinations

thereof. Examples of chemically modified sugars include, 2'-F-5'-methyl substituted nucleoside (*see*, PCT International Application WO 2008/101157 for other disclosed 5', 2'-bis substituted nucleosides), replacement of the ribosyl ring oxygen atom with S with further substitution at the 2'-position (*see*, published U.S. Patent Application US2005/0130923), or, alternatively, 5'-substitution of a BNA (*see*, PCT International Application WO 2007/134181, wherein LNA is substituted with, for example, a 5'-methyl or a 5'-vinyl group).

Examples of nucleosides having modified sugar moieties include, without limitation, nucleosides comprising 5'-vinyl, 5'-methyl (R or S), 4'-S, 2'-F, 2'-OCH_3, and 2'-$O(CH_2)2OCH_3$ substituent groups. The substituent at the 2' position can also be selected from allyl, amino, azido, thio, O-allyl, O-C_1-C_{10} alkyl, OCF_3, $O(CH_2)2SCH_3$, $O(CH_2)2$-O-N(Rm)(Rn), and O-CH_2-C(=O)-N(Rm)(Rn), where each Rm and Rn is, independently, H or substituted or unsubstituted C_1-C_{10} alkyl.

Conjugated Antisense compounds

Antisense compounds may be covalently linked to one or more moieties or conjugates which enhance the activity, cellular distribution or cellular uptake of the resulting antisense oligonucleotides. Typical conjugate groups include cholesterol moieties and lipid moieties. Additional conjugate groups include carbohydrates, phospholipids, biotin, phenazine, folate, phenanthridine, anthraquinone, acridine, fluoresceins, rhodamines, coumarins, and dyes.

Formulations

The immunomodulatory agent(s) and the antisense compound targeted to a STAT3 nucleic acid can be utilized in pharmaceutical compositions by combining the compound(s) with a suitable pharmaceutically acceptable diluent or carrier. A pharmaceutically acceptable diluent includes phosphate-buffered saline (PBS). Suitable examples of carriers include physiological saline, polyethylene glycol, ethanol, vegetable oils, isopropyl myristate, etc., but are not limited to them.

Acceptable carriers or diluents for therapeutic use are well known in the pharmaceutical art, and are described, for example, in *Remington's Pharmaceutical Sciences*, Mack Publishing Co., A.R Gennaro edit., 1985.

Pharmaceutical compositions comprising the immunomodulatory agent and/or the antisense compounds encompass any pharmaceutically acceptable salts, esters, or salts of such esters which, upon administration to an animal, including a human, is capable of providing (directly or indirectly) the biologically active metabolite or residue thereof.

In certain embodiments the two agents (immunomodulatory agent and the STAT3 antisense compound) are formulated separately.

According to one aspect there is provided a pharmaceutical composition comprising an immunomodulatory agent and an antisense compound targeted to STAT3 and one or more pharmaceutically acceptable carriers or diluent.

The agents of the present invention may be formulated for parenteral administration (e.g., by injection, for example bolus injection or continuous infusion) and may be presented in unit dose form in ampoules, pre-filled syringes, small volume infusion or in multi-dose containers with an added preservative. The compositions may take such forms as solutions, suspensions, or emulsions in oily or aqueous vehicles, for example solutions in aqueous polyethylene glycol. Examples of oily or nonaqueous carriers, diluents, or vehicles include propylene glycol, polyethylene glycol, vegetable oils (e.g., olive oil), and injectable organic esters (e.g. , ethyl oleate). The compositions may also contain other formulatory agents such as wetting, emulsifying or suspending, preserving, stabilizing and/or dispersing agents. Alternatively, the active ingredient may be in powder form, obtained by aseptic isolation of sterile solid or by lyophilization from solution for constitution before use with a suitable vehicle, e.g., sterile, pyrogen-free water.

In one embodiment, the anti-PD-L1 antibody MEDI4736 is formulated at 50 mg/mL in 26 mM histidine/histidine-HCl, 275 mM trehalose dihydrate, 0.02% (weight/volume [w/v]) polysorbate 80, pH 6.0. The product can then be supplied as a white to off-white lyophilized powder in clear glass vials (e.g. 10R vial), e.g. closed with an elastomeric stopper and a flip-off cap overseal. Each vial contains 200 mg (nominal) of active product. MEDI4736 is then reconstituted using aseptic techniques with 4.0 mL sterile water for injection (WFI) to give a final concentration of 50 mg/mL. The reconstituted solution is then diluted with 0.9% (w/v) saline for IV infusion using, for example, syringes or bags.

Treatment regimes.

In various embodiments of any of the above aspects, the treatment is administered every 1, 2, 3 or 4 weeks. In various embodiments, the patient is first administered one or a series of loading dose(s) of the immunomodulatory agent (e.g. anti-PD-L1 antibody MEDI4736). This could entail dosing the agent multiple times in the early stage of treatment (loading phase), e.g. on days 1, 3 and 5 in week 1.

The inventors have found that treating the patient with the STAT3 inhibitor first followed later by the immunomudulator yield better anti-cancer results. In various embodiments, the patient

is first administered one or a series of loading dose(s) of the antisense compound targeted to a STAT3 nucleic acid (e.g. AZD9150). This could entail dosing the agent multiple times in the early stage of treatment, e.g. on days 1, 3 and 5 in week 1.

The purpose of a loading dose phase is to reach steady state or efficacious level of agent (as measured in blood) more quickly, before the "maintenance" phase of treatment, e.g. once a week.

Pretreatment with the STAT3 selective inhibitor may also serve to provide an increase in tumor infiltrating CD45+ cells, and possibly also a decrease in tumor infiltrating macrophages, providing a tumor environment that is more susceptible to effective treatment with an immunomodulatory agent.

In various embodiments of any of the above aspects between about 1mg/kg and 20mg/kg, inclusive, of an immunomodulatory agent, and between about 1mg/kg and 15mg/kg, inclusive, of an antisense compound targeted to a STAT3 nucleic acid is administered to a patient.

In various embodiments of any of the above aspects involving MEDI4736 or an antigen-binding fragment thereof, between about 2mg/kg and 10mg/kg, inclusive, of MEDI4736 or an antigen-binding fragment thereof, and between about 1mg/kg and 3mg/kg, inclusive, AZD9150 is administered. In various embodiments of any of the above aspects involving MEDI4736 or an antigen-binding fragment thereof, about 1 mg/kg MEDI4736 and about 1 mg/kg AZD9150 is administered, about 1 mg/kg MEDI4736 and about 2 mg/kg AZD9150 is administered, about 1 mg/kg MEDI4736 and about 3 mg/kg AZD9150 is administered; about 1 mg/kg MEDI4736 and about 10 mg/kg AZD9150 is administered, about 3 mg/kg MEDI4736 and about 1 mg/kg AZD9150 is administered; about 3 mg/kg MEDI4736 and about 2 mg/kg AZD9150 is administered; about 3 mg/kg MEDI4736 and about 3 mg/kg AZD9150 is administered; about 3 mg/kg MEDI4736 and about 10 mg/kg AZD9150 is administered; about 10 mg/kg MEDI4736 and about 1 mg/kg AZD9150 is administered; about 10 mg/kg MEDI4736 and about 2 mg/kg AZD9150 is administered; about 10 mg/kg MEDI4736 and about 3 mg/kg AZD9150 is administered; about 10 mg/kg MEDI4736 and about 10 mg/kg AZD9150 is administered, about 15 mg/kg MEDI4736 and about 1 mg/kg AZD9150 is administered; about 15 mg/kg MEDI4736 and about 2 mg/kg AZD9150 is administered; about 15 mg/kg MEDI4736 and about 3 mg/kg AZD9150 is administered or about 15 mg/kg MEDI4736 and about 10 mg/kg AZD9150 is administered. In certain embodiments, the subject's body weight is calculated as the ideal body weight using the Devine formula.

In various embodiments of any of the above aspects, the method results in an increase in overall survival (e.g., an increase of weeks, months or years) as compared to the administration of

either the immunomodulatory agent (e.g. MEDI4736 or an antigen-binding fragment thereof) or the AZD9150 alone. In particular, the increase in survival is more than about 4-6 weeks, 1-2 months, 3-4 months, 5-7 months, 6-8 months, or 9-12 months. In various embodiments of any of the above aspects, the administration of the immunomodulatory agent (e.g. MEDI4736 or an antigen-binding fragment thereof) is repeated about every 4 weeks. In various embodiments of any of the above aspects, the administration of AZD9150 is repeated about every 4 weeks. In various embodiments of any of the above aspects, the administration of AZD9150 is repeated about every 12 weeks. In various embodiments of any of the above aspects, the administration of AZD9150 is administered about every 4 weeks for seven administrations and then every 12 weeks. In various embodiments of any of the above aspects, the administration of the immunomodulatory agent (e.g. MEDI4736 or an antigen-binding fragment thereof), is by intravenous infusion. In various embodiments of any of the above aspects, the administration of AZD9150 is by intravenous infusion. In various embodiments of any of the above aspects, AZD9150 and MEDI4736 or an antigen-binding fragment thereof, are administered concurrently or at different times. In various embodiments of any of the above aspects, AZD9150 and MEDI4736 or an antigen-binding fragment thereof, are administered twenty-four, forty-eight or seventy-two hours apart, 1, 2, or 3 weeks apart, or between 1, 2, and 3 months apart.

Combinations involving three agents are also contemplated. In particular embodiments of any of the aspects disclosed herein, AZD9150, MEDI4736 and tremelimumab are used in the combination and/or treatments. Particular dosage for these agents include, AZD9150 at 2mg/kg or 3mg/kg, MEDI4736 at 5mg/kg, 10mg/kg or 20mg/kg and tremelimumab at 1mg/kg or 2mg/kg.

Other features and advantages of the invention will be apparent from the detailed description, and from the claims.

In certain aspects, a patient presenting with a cancer/tumor is administered: (i) at least one immunomodulatory agent; and, (ii) an antisense compound targeted to STAT3; in pharmaceutically effective amounts.

In certain aspects, a patient presenting with a cancer/tumor is administered: (i) MEDI4736 or an antigen-binding fragment thereof; and, (ii) AZD9150; in pharmaceutically effective amounts. In a particular embodiment of this aspect, the patient is also administered tremelimumab, or an antigen binding fragment thereof. MEDI4736 or an antigen-binding fragment thereof, and AZD9150 can be administered only once or infrequently while still providing benefit to the patient. In further aspects the patient is administered additional follow-on doses. Follow-on doses can be administered at

various time intervals depending on the patient's age, weight, clinical assessment, tumor burden, and/or other factors, including the judgment of the attending physician.

The intervals between doses of the immunomodulatory agent (e.g. MEDI4736 or an antigen-binding fragment thereof and/or tremelimumab or an antigen-binding fragment thereof), and of the antisense compound targeted to STAT3 (e.g. AZD9150) can be every one, two, three, four, five or six weeks. The intervals between doses of MEDI4736, or an antigen-binding fragment thereof, and AZD9150 can be every four weeks for six cycles and then every twelve weeks. In certain aspects, MEDI4736 or an antigen-binding fragment thereof, is administered about twice as frequently as AZD9150. In certain aspects, MEDI4736 or an antigen-binding fragment thereof, is administered about six times as frequently as AZD9150. In certain aspects, AZD9150 is administered about twice as frequently as MEDI4736 or an antigen-binding fragment thereof. In certain aspects, AZD9150 is administered about six times as frequently as MEDI4736 or an antigen-binding fragment thereof.

In some embodiments, at least three doses, at least four doses, at least five doses, at least six doses, at least seven doses, at least eight doses, at least nine doses, at least ten doses, or at least fifteen doses or more of each agent can be administered to the patient. In some embodiments, the immunomodulatory agent (e.g. MEDI4736 or an antigen-binding fragment thereof), is administered over a two-week treatment period, over a four-week treatment period, over a six-week treatment period, over an eight-week treatment period, over a twelve-week treatment period, over a twenty-four-week treatment period, or over a one-year or more treatment period. In some embodiments, AZD9150 is administered over a two-week treatment period, a four-week treatment period, over an eight-week treatment period, over a twelve-week treatment period, over a twenty-four-week treatment period, or over a one-year or more treatment period

The amount of (i) immunomodulatory agent, and (ii) antisense compound targeted to STAT3 to be administered to an individual patient may depend on various parameters such as the patient's age, weight, clinical assessment, tumor burden and/or other factors, including the judgment of the attending physician. The amount of the immunomodulatory agent (e.g. anti-PD-L1 antibody or antigen-binding fragment thereof), and antisense compound targeted to a STAT3 nucleic acid (e.g. AZD9150) to be administered to the patient may be determined from comprehensive clinical trials of the agents in the patient population.

In certain embodiments involving the anti-PD-L1 antibody MEDI4736, the patient is administered one or more doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 0.3 mg/kg. In certain embodiments the patient is administered one or more doses of

MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 1 mg/kg. In certain embodiments the patient is administered one or more doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 3 mg/kg. In certain embodiments the patient is administered one or more doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 10 mg/kg. In certain embodiments the patient is administered one or more doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 15 mg/kg. In certain embodiments the patient is administered one or more doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 20 mg/kg. In certain embodiments each of the doses of MEDI4736 or an antigen-binding fragment thereof, are administered at least one week apart, such as qw, 2qw, 3qw, 4qw, 8qw and 12qw. In certain embodiments, the subject's body weight is calculated as the ideal body weight using the Devine formula.

In certain embodiments involving the antisense compound targeted to STAT3 known as AZD9150, the patient is administered one or more doses of AZD9150 wherein the dose is about 0.3 mg/kg. In certain embodiments the patient is administered one or more doses of AZD9150 wherein the dose is about 1 mg/kg. In certain embodiments the patient is administered one or more doses of AZD9150 wherein the dose is about 3 mg/kg. In certain embodiments the patient is administered one or more doses of AZD9150 wherein the dose is about 10 mg/kg. In certain embodiments the patient is administered one or more doses of AZD9150 wherein the dose is about 15 mg/kg. In certain embodiments the patient is administered one or more doses of AZD9150 wherein the dose is about 20 mg/kg. In certain embodiments each of the doses of AZD9150 are administered at least one week apart. In certain embodiments each of the doses of AZD9150 are administered 2 week apart (2QW). In certain embodiments each of the doses of AZD9150 are administered 3 week apart (3QW). In certain embodiments each of the doses of AZD9150 are administered 4 week apart (4QW). In certain embodiments each of the doses of AZD9150 are administered 8 week apart (8QW). In certain embodiments each of the doses of AZD9150 are administered 12 week apart (12QW).

In certain embodiments involving the anti-CTLA-4 antibody tremelimumab or ipilimumab, or an antigen-binding fragment of either, the patient is administered one or more doses of the anti-CTLA-4 antibody or an antigen-binding fragment thereof wherein the dose is about 1 mg/kg. In certain embodiments the patient is administered one or more doses of the anti-CTLA-4 antibody or an antigen-binding fragment thereof wherein the dose is about 3 mg/kg. In certain embodiments the

patient is administered one or more doses of the anti-CTLA-4 antibody or an antigen-binding fragment thereof wherein the dose is about 10 mg/kg.

In certain embodiments the patient is administered at least two doses of the anti-CTLA-4 antibody or an antigen-binding fragment thereof wherein the dose is about 1 mg/kg. In certain embodiments the patient is administered at least two doses of the anti-CTLA-4 antibody or an antigen-binding fragment thereof wherein the dose is about 3 mg/kg. In certain embodiments the patient is administered at least two doses of the anti-CTLA-4 antibody or an antigen-binding fragment thereof wherein the dose is about 10 mg/kg. In some embodiments, the at least two doses are administered about four weeks apart. In some embodiments, the at least two doses are administered about twelve weeks apart.

In certain embodiments the patient is administered at least three doses of the anti-CTLA-4 antibody or an antigen-binding fragment thereof wherein the dose is about 1 mg/kg. In certain embodiments the patient is administered at least three doses of the anti-CTLA-4 antibody or an antigen-binding fragment thereof wherein the dose is about 3 mg/kg. In certain embodiments the patient is administered at least three doses of the anti-CTLA-4 antibody or an antigen-binding fragment thereof wherein the dose is about 10 mg/kg. In some embodiments, the at least three doses are administered about four weeks apart. In some embodiments, the at least three doses are administered about twelve weeks apart.

In certain embodiments the patient is administered at least two doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 1 mg/kg. In certain embodiments the patient is administered at least two doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 3 mg/kg. In certain embodiments the patient is administered at least two doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 10 mg/kg. In certain embodiments the patient is administered at least two doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 15 mg/kg. In certain embodiments the patient is administered at least two doses of MEDI4736 or an antigen-binding fragment thereof, wherein the dose is about 20 mg/kg. In certain embodiments the patient is administered at least two doses of AZD9150 wherein the dose is about 1 mg/kg. In certain embodiments the patient is administered at least two doses of AZD9150 wherein the dose is about 2 mg/kg. In certain embodiments the patient is administered at least two doses of AZD9150 wherein the dose is about 3 mg/kg. In certain embodiments, the subject's body weight is calculated as the ideal body weight using the Devine formula.

In some embodiments, the at least two doses are administered about four weeks apart. In some embodiments, the at least two doses are administered about twelve weeks apart.

In certain embodiments, administration of the agents, such as MEDI4736 or an antigen-binding fragment thereof, and/or AZD9150, according to the methods provided herein is through parenteral administration. For example, one or both agents can be administered by intravenous infusion or by subcutaneous injection. In some embodiments, the administration is by intravenous infusion.

Effective treatment with a combination of an immunomodulator (such as anti-CTLA-4 antibody, anti-PD-L1 antibody, anti-PD-1 antibody, and OX40 agonist) and an antisense compound targeted to STAT3 (such as AZD9150) includes, for example, reducing the rate of progression of the cancer, retardation or stabilization of tumor or metastatic growth, tumor shrinkage, and/or tumor regression, either at the site of a primary tumor, or in one or more metastases. In some aspects the reduction or retardation of tumor growth can be statistically significant. A reduction in tumor growth can be measured by comparison to the growth of patient's tumor at baseline, against an expected tumor growth, against an expected tumor growth based on a large patient population, or against the tumor growth of a control population. In other embodiments, the methods of the invention increase survival.

Clinical response to administration of an immunomodulator (such as anti-CTLA-4 antibody, anti-PD-L1 antibody, anti-PD-1 antibody, and OX40 agonist) and an antisense compound targeted to STAT3 (such as AZD9150) can be assessed using diagnostic techniques known to clinicians, including but not limited to magnetic resonance imaging (MRI) scan, x-radiographic imaging, computed tomographic (CT) scan, flow cytometry or fluorescence-activated cell sorter (FACS) analysis, histology, gross pathology, and blood chemistry, including but not limited to changes detectable by ELISA, RIA, and chromatography.

The methods provided herein can decrease or retard cancer tumor growth. In some cases the reduction or retardation can be statistically significant. A reduction in tumor growth can be measured by comparison to the growth of patient's tumor at baseline, against an expected tumor growth, against an expected tumor growth based on a large patient population, or against the tumor growth of a control population.

In certain embodiments, administering the dose of an antisense compound targeted to STAT3 and an immunomodulatory agent reduces tumor size or tumor volume in the subject. In certain embodiments, administering the dose of the antisense compound and the immunomodulatory

agent prolongs survival of the subject. In certain embodiments, administering the dose of the antisense compound targeted to a STAT3 and the immunomodulatory agent, treats cancer, such as B-cell lymphoma, in the subject. In certain embodiments, the method is effective to treat cancer and acceptably tolerable in a subject.

In certain embodiments, a tumor response is measured using the Immune-related Response Criteria (irRc). In certain embodiments, a tumor response is measured using the Response Evaluation Critera in Solid Tumors (RECIST).

In certain embodiments, a tumor response is detectable at week 7 or thereafter, such as at week 13, at week 25, at week 41, at week 52.

In certain embodiments, a patient achieves disease control (DC). Disease control can be a complete response (CR), partial response (PR), or stable disease (SD).

A "complete response" (CR) refers to the disappearance of all lesions, whether measurable or not, and no new lesions. Confirmation can be obtained using a repeat, consecutive assessment no less than four weeks from the date of first documentation. New, non-measurable lesions preclude CR.

A "partial response" (PR) refers to a decrease in tumor burden $\geq$ 30% relative to baseline. Confirmation can be obtained using a consecutive repeat assessment at least 4 weeks from the date of first documentation.

"Stable disease" (SD) indicates a decrease in tumor burden of less than about 30% relative to baseline cannot be established and a 20% or greater increase compared to nadir cannot be established.

In certain embodiments, administration of the immunomodulatory agent and the antisense compound targeted to STAT3 can increase progression-free survival (PFS).

In certain embodiments, administration of the immunomodulatory agent and the antisense compound targeted to STAT3 can increase overall survival (OS).

In certain embodiments, administration of MEDI4736 or an antigen-binding fragment thereof, and AZD9150 can increase progression-free survival (PFS).

In certain embodiments, administration of MEDI4736 or an antigen-binding fragment thereof, and AZD9150 can increase overall survival (OS).

In some embodiments, the patient has previously received treatment with at least one chemotherapeutic agent. In some embodiments, the patient has previously received treatment with

at least two chemotherapeutic agents. The chemotherapeutic agent can be, for example, and without limitation, Vemurafenib, Gefitinib, Erlotinib, Afatinib, Cetuximab, Carboplatin, Bevacizumab, and/or Pemetrexed.

In some embodiments, the cancer is refractory or resistant to at least one chemotherapeutic agent. In some embodiments, the cancer is refractory or resistant to at least two chemotherapeutic agents. The cancer can be refractory or resistant to one or more of, for example, and without limitation, Vemurafenib, Gefitinib, Erlotinib, Afatinib, Cetuximab, Carboplatin, Bevacizumab, and/or Pemetrexed.

In some embodiments, the patient has an Eastern Cooperative Oncology Group (ECOG) (Oken MM, *et al. Am. J. Clin. Oncol. 5*: 649–55 (1982)) performance status of 0, 1, or 2 prior to the administration of MEDI4736 or an antigen-binding fragment thereof, and AZD9150.

As provided herein, MEDI4736 or an antigen-binding fragment thereof, can also decrease free (soluble) PD-L1 levels. Free (soluble) PD-L1 refers to PD-L1 that is not bound (e.g., by MEDI4736). In some embodiments, sPD-L1 levels are reduced and/or undetectable following administration of MEDI4736 or an antigen-binding fragment thereof, and AZD9150. In some embodiments, administration of MEDI4736 or an antigen-binding fragment thereof, and AZD9150 reduces the rate of increase of free (soluble) PD-L1 levels as compared, e.g., to the rate of increase of free (soluble) PD-L1 levels prior to the administrations.

Treatment of a patient with a cancer using both (i) an immunomodulatory agent , such as MEDI4736, or an antigen-binding fragment thereof; and, (ii) an antisense compound targeted to STAT3, such as AZD9150, (i.e., co-therapy) as provided herein can result in an additive and/or synergistic effect. As used herein, the term "synergistic" refers to a combination of therapies (*e.g.*, a combination of MEDI4736 or an antigen-binding fragment thereof, and AZD9150) which is more effective than the additive effects of the single therapies.

A synergistic effect of a combination of therapies (*e.g.*, a combination of a MEDI4736 or an antigen-binding fragment thereof, and AZD9150) may permit the use of lower dosages of one or more of the therapeutic agents and/or less frequent administration of said therapeutic agents to a patient with cancer. The ability to utilize lower dosages of therapeutic agents and/or to administer said therapies less frequently reduces the toxicity associated with the administration of said therapies to a subject without reducing the efficacy of said therapies in the treatment of a cancer. In addition, a synergistic effect can result in improved efficacy of therapeutic agents in the management, treatment, or amelioration of a cancer. The synergistic effect of a combination of therapeutic agents

can avoid or reduce adverse or unwanted side effects associated with the use of either single therapy. The synergistic effect of a combination of therapeutic agents may also manifest itself as a reduction in tumor mass (or tumor regression). The synergistic effect of a combination of therapeutic agents may also manifest itself as a sustained reduction in tumor growth rate.

In co-therapy, the immunomodulatory agent (such as MEDI4736 or an antigen-binding fragment thereof), can be optionally included in the same pharmaceutical composition as the antisense compound targeted to STAT3 (such as AZD9150), or may be included in a separate pharmaceutical composition. In this latter case, the pharmaceutical composition comprising the immunomodulatory agent, is suitable for administration prior to, simultaneously with, or following administration of the pharmaceutical composition comprising the antisense compound targeted to STAT3. In certain instances, the the immunomodulatory agent, is administered at overlapping times as the antisense compound targeted to STAT3 in a separate composition.

Kits

In another aspect, the invention provides kits for treating cancer comprising: (i) an antisense compound targeted to STAT3 (such as AZD9150); and, (ii) an immunomodulatory agent (such as an anti-PD-L1 antibody or an antigen-binding fragment thereof). In one embodiment, the kit includes a therapeutic composition comprising the immunomodulatory agent (such as an anti-PD-L1 antibody or an antigen-binding fragment thereof), and the antisense compound targeted to STAT3 (such as AZD9150), each in unit dosage form. In certain embodiments the antisense compound targeted to STAT3 can be AZD9150 and/or the immunomodulatory agent, can be selected from the group consisting of: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714, MDX-1105, nivolumab, pembrolizumab, pidilizumab, MPDL3280A, tremelimumab, ipilimumab and OX40L FP.

When the immunomodulatory agent is an anti-PD-L1 antibody, it can be selected from: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714 and MDX-1105, or an antigen-binding fragment of any of these.

In some embodiments, the kit comprises a sterile container which contains one or more therapeutic compositions; such containers can be boxes, ampoules, bottles, vials, tubes, bags, pouches, blister-packs, or other suitable container forms known in the art. Such containers can be made of plastic, glass, laminated paper, metal foil, or other materials suitable for holding medicaments.

If desired, the kit further comprises instructions for administering the immunomodulatory agent (e.g. anti-PD-L1 antibody or an antigen-binding fragment thereof), and the antisense

compound targeted to STAT3 (e.g. AZD9150) to a subject having a cancer. In particular embodiments, the instructions include at least one of the following: description of the therapeutic agent(s); dosage schedule and administration for treatment or prevention of cancer or symptoms thereof; precautions; warnings; indications; counter-indications; over dosage information; adverse reactions; animal pharmacology; clinical studies; and/or references. The instructions may be printed directly on the container (when present), or as a label applied to the container, or as a separate sheet, pamphlet, card, or folder supplied in or with the container.

In another aspect, there is provided a product containing an antisense compound targeted to STAT3 and an immunomodulatory agent, as a combined preparation for simultaneous, separate or sequential use in treating cancer.

In such a product the antisense compound targeted to STAT3 is or can be AZD9150 and/or the immunomodulatory agent is or can be selected from: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714, MDX-1105, nivolumab, pembrolizumab, pidilizumab, MPDL3280A, tremelimumab, ipilimumab and OX40L FP.

In other embodiment, in such a product the antisense compound targeted to STAT3 is or can be AZD9150 and/or the anti-PD-L1 antibody or an antigen-binding fragment thereof, is or can be selected from: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714 and MDX-1105, or an antigen-binding fragment of any of these.

The practice of the present invention employs, unless otherwise indicated, conventional techniques of molecular biology (including recombinant techniques), microbiology, cell biology, biochemistry immunohistochemistry and immunology, which are well within the purview of the skilled artisan. Such techniques are explained fully in the literature, such as, “Molecular Cloning: A Laboratory Manual”, second edition (Sambrook, 1989); “Oligonucleotide Synthesis” (Gait, 1984); “Animal Cell Culture” (Freshney, 1987); “Methods in Enzymology” “Handbook of Experimental Immunology” (Weir, 1996); “Gene Transfer Vectors for Mammalian Cells” (Miller and Calos, 1987); “Current Protocols in Molecular Biology” (Ausubel, 1987); “PCR: The Polymerase Chain Reaction”, (Mullis, 1994); “Current Protocols in Immunology” (Coligan et al., 1991). These techniques are applicable to the production of the polynucleotides and polypeptides of the invention, and, as such, may be considered in making and practicing the invention. Particularly useful techniques for particular embodiments will be discussed in the sections that follow.

The following examples and figures are put forth so as to provide those of ordinary skill in the art with a complete disclosure and description of how to make and use the various aspects of the invention, and are not intended to limit the scope of what the inventors regard as their invention.

Figure Legend

Figure 1 Tumor infiltrating leukocytes in CT-26 tumors from mice treated with muSTAT3 ASO (% of total live cells, relative to vehicle control).

Figure 2 CT-26 tumor volumes (mean +/- SEM (2a) and individual mice (2b) and (2c)) after treatment with mouse STAT3 ASO as a single agent and in combination with an antibody targeting PD-L1.

Figure 3 CT-26 tumor volumes after treatment with mouse STAT3 ASO as a single agent and in combination with PD-L1 Ab, CTLA-4 Ab, or OX4- ligand fusion protein.

Figure 4 CT-26 tumor volumes after treatment with AZD9150, PD-L1 Ab, or isotype control Ab as single agents, or a combination of AZD9150 plus PD-L1 Ab.

Figure 5 Tumor infiltrating lymphocytes in CT-26 tumors from mice treated with a JAK1 selective inhibitor (% of total live cells, relative to vehicle control).

Figure 6 CT-26 tumor volumes after treatment with AZ-JAK1, anti-PD-L1 Ab, or combination of the two treatments. Mean ± SEM.

Figure 7 STAT3 mRNA levels in tumor and blood samples from CT-26 tumor bearing mice after treatment with STAT3 ASO, anti-PD-L1 Ab, or a combination of the two treatments. Mean +/- SEM of 4 samples from each treatment group.

Examples:

Example 1. Preclinical studies showing that STAT3 inhibition using ASO in mouse bolsters the immune system.

Antisense oligos used:

Both ASOs used are 3-10-3 gapmers with cET chemistry and phosphorothioate linkages, all bases are 2'-deoxynucleosides. Wing portions are underlined.

Mouse STAT3 ASO: *GAA*ATTCATTCTT*CCA* [SEQ ID NO: 11)

Control ASO: *GGC*TACTACGCCG*TCA* (SEQ ID NO: 12)

Oligos can be synthesized according to standard techniques, such as that described in Seth et al., (J Med Chem. 52(1): 10-13, 2009).

CT-26 mouse colon tumor cells (5 x 10^5 / mouse) were implanted subcutaneously in female BALB/c mice. The mice were randomized into groups of 8 (based on body weight), and treated with either PBS vehicle, non-targeting control antisense oligonucleotide (ASO) SEQ ID NO: 12], or mouse STAT3 targeted ASO (SEQ ID NO: 11) at 50 mg/kg. All ASOs were formulated in PBS and dosed subcutaneously at 50 mg/kg, QD, on a 5 days on / 2 days off schedule, beginning 2 days after tumor implantation. At 12 and 26 days after initiation of dosing, 4 mice from each group were selected and tumors harvested and processed for flow cytometry analysis. Cells from the tumors harvested at day 12 (week 2) were pooled prior to analysis, due to small tumor size, while tumors harvested at day 26 (week 4) were analysed individually. CD45+ cells were quantified at weeks 2 and 4. Macrophages were quantified at week 4. The various cells were identified and quantified by immunostaining and flow cytometry analysis using a BD FACS Canto II flow cytometer and FlowJo software.

The practice of the present invention employs, unless otherwise indicated, conventional techniques in cell biology, immunohistochemistry and immunology, which are well within the purview of the skilled artisan. Such techniques are explained fully in the literature, such as "Handbook of Experimental Immunology" (Weir, 1996) and "Current Protocols in Immunology" (Coligan et al., 1991).

Treatment with the STAT3 ASO resulted in changes in the tumor immune infiltrate, relative to vehicle and control ASO treated mice (Figure 1). An increase in total immune infiltrate (CD45+ leukocytes) in the mouse STAT3 ASO treated group, relative to the vehicle and control ASO treated groups, was observed at weeks 2 (149%) and 4 (353%). Macrophages (CD45+F4/80+) were lower (65% decrease) in tumors at week 4.

The elevation in tumor infiltrating CD45+ cells, along with the decrease in tumor infiltrating macrophages, indicate immune modulation and enhanced antitumor immune response associated with STAT3 ASO treatment.

Example 2. Pretreatment vs. concurrent treatment with mouse STAT3 ASO in combination with anti-PD-L1 antibody treatment provides enhanced antitumor activity.

CT-26 mouse colon tumor cells (5 x 10^5 / mouse) were implanted subcutaneously in female BALB/c mice. Mice were treated with either PBS vehicle, mouse STAT3 ASO (same as used in Example 1), an anti-PD-L1 antibody (anti-mouse PD-L1, clone 10F.9G2, rat IgG2b isotype, purchased from BioXCell, West Lebanon, NH), an isotype control Ab (rat IgG2b, product LTF-2, purchased from BioXCell, West Lebanon NH), or a combination of mouse STAT3 ASO + PD-L1 antibody. ASO treatments began either before randomization into treatment groups (day 2 after implant), or at the time of randomization (day 9 after implant). At the time of randomization, the tumor volume in mice receiving ASO treatment was not significantly different than the tumor volume in mice that had not received ASO treatment. There were ten mice in each treatment group. The ASOs were formulated in PBS and dosed subcutaneously. The Abs were also formulated in PBS, and dosed intraperitoneally. During the course of the experiment, tumor length and width were measured by caliper, and tumor volume calculated using the formula volume = (length x width^2)* $\pi/6$.

As shown in Figure 2a, treatment with the control Ab had no significant effect on tumor growth. Treatment with the mouse STAT3 ASO and anti-PD-L1 Ab as single agents had a modest effect on tumor growth. Treatment with STAT3 ASO + anti-PD-L1 Ab combination had greater antitumor activity than single agent treatments.

When treatment with STAT3 ASO began prior to treatment with anti-PD-L1 Ab (ASO treatment beginning day 2 and Ab treatment beginning day 9), tumor regression was observed in 6/10 mice (60%), while tumor regression was observed in only 1/10 mice (10%) when both treatments began on day 9. Figure 2a shows mean +/- SEM. Figure 2b shows individual animals for combination when dosed concurrently. Figure 2c shows individual animals for combination when predosed with ASO.

These results indicate that starting STAT3 ASO treatment prior to checkpoint inhibitor treatment provides greater antitumor activity. Thus, it seems that enabling the immune stimulatory effects of STAT3 ASO treatment to be already in progress at the time of checkpoint inhibitor treatment is beneficial.

Example 3. Addition of mouse STAT3 ASO treatment enhances the antitumor activity of antibodies targeting PD-L1 and CTLA-4, and an OX40 ligand fusion protein, in mouse syngeneic tumor models

Checkpoint inhibitors or immune stimulators used:

Anti-mouse CTLA-4: Clone 9D9, Mouse IgG2b isotype. Purchased from BioXCell, West Lebanon, NH

Anti-mouse PD-L1: Clone 10F.9G2, Rat IgG2b isotype. Purchased from BioXCell, West Lebanon, NH

Mouse OX40 ligand fusion protein (mIgG1FcmTF2mOX40L or OX40FP), was generated in house. The DNA and amino acid sequences are presented as SEQ ID NO: 37 and SEQ ID NO: 38, respectively.

The antitumor efficacy of mouse STAT3 ASO in combination with antibodies targeting PD-L1 or CTLA-4, or with an OX40 ligand fusion protein, were evaluated in three mouse syngeneic tumor models: CT-26 (colorectal), 4T1 (mammary) and A20 (lymphoma). Details of tumor implantation and treatment schedules for each model are in the table below. The QDx5/wk dosing schedule for the STAT3 ASO (same ASO as used in Example 1) was 5 days of treatment followed by 2 days without treatment. The 2X/wk dosing schedule for antibodies was 2 treatments/wk evenly spaced over the course of the week (e.g., Monday and Thursday, or Tuesday and Friday, etc.). ASO treatments began before randomization into treatment groups. At the time of randomization, the tumor volume in mice receiving ASO treatment was not significantly different than the tumor volume in mice that had not received ASO treatment. There were ten mice in each treatment group.

	CT-26	4T1	A20
Implantation	0.5 million cells, subcutaneously in right flank	0.4 million cells in mammary fat pad	1 million cells, subcutaneously in right flank
Tumor volume at randomization	Mean: 147 mm^3 Range: 58-248 mm^3	Mean: 123 mm^3 Range: 70-182 mm^3	Mean: 218 mm^3 Range: 122-277 mm^3
Schedule of ASO treatment	Beginning 7 days before Ab or FP treatment, QDx5/wk for 4 weeks, dosed SC	Beginning 5 days before Ab or FP treatment, QDx7/wk for 1 week followed	Beginning 4 days before Ab or FP treatment, QDx5/wk for 3 weeks, dosed SC

		by QDx5/wk for 3 weeks, dosed SC	
Randomization (days after implant	7	5	13
Dosing schedule for PD-L1 and CTLA-4 antibodies (beginning one day after randomization	2X/wk for 3 weeks, dosed IP	2X/wk for 1 week, dosed IP	2X/wk for 2 weeks, dosed IP
Dosing schedule for OX40 fusion protein (beginning one day after randomization)	2X/wk for 1 week, dosed IP	2X/wk for 1 week, dosed IP	2X/wk for 1 week, dosed IP

The mouse STAT3 ASO was formulated in PBS and dosed subcutaneously. The Abs and FP were also formulated in PBS, and dosed intraperitoneally. During the course of the experiment, tumor length and width were measured by caliper, and tumor volume calculated using the formula volume = (length x width^2)* $\pi/6$.

Results are shown in Figure 3. At the doses and schedules administered in this experiment, the anti-PD-L1 and anti-CTLA-4 Abs, OX40 ligand FP, and mouse STAT3 targeted ASO had weak to modest single agent antitumor activity. The addition of mouse STAT3 ASO treatment significantly enhanced the antitumor activity of antibody and FP treatment in many cases. In certain instances the effect appeared synergistic. Addition of mouse STAT3 ASO to PD-L1 Ab, CTLA-4 Ab, or OX40 ligand FP led to mean tumor stasis or regression in the CT-26 and A20 models. In the 4T1 model, the combination of mouse STAT3 ASO plus CTLA-4 antibody led to tumor regressions. In addition, the combination treatments led to long term complete responses (no measurable tumor several weeks after the end of treatment) in some individual mice, including 30% (3/10) of mice with the mouse STAT3 ASO + CTLA-4 Ab combination in the CT-26, 4T1 and A20 models; 20% (2/10) with the PD-L1 combination in the A20 model, and 50% (5/10) with the OX40 combination in the A20 model.

The enhanced antitumor activity of combination treatment vs. single agents in these models indicates the potential for treatment with a STAT3 targeted antisense molecule to enhance the activity of the checkpoint inhibitor or immune stimulators used, including agents targeting PD-L1, CTLA-4, and OX40, in multiple tumor types. The combination activity is consistent with a mechanism whereby treatment with the STAT3 ASO results in an increase in antitumor immune infiltrates in the tumor (Example 1), which enables enhanced inhibition of tumor growth when immune checkpoints are blocked by treatment with therapeutics targeting PD-L1 and CTLA-4, or when immune stimulators such as OX40 agonists are used.

Example 4. No antitumor activity observed with a control ASO and control antibodies in mice bearing CT-26 tumors

The CT-26 experiment in Example 3 included treatment with a control ASO (AZD9150) and an isotype control antibody (rat IgG2b, product LTF-2, purchased from BioXCell, West Lebanon NH) as negative controls. The human STAT3 targeted ASO molecule AZD9150 can be used as a control in murine tumor models, as it does not cross react with mouse STAT3 sequences. As shown in Figure 4, and in contrast to the activity with mouse targeted STAT3 ASO described in Examples 2 and 3, treatment with the control ASO resulted in no enhancement of the activity of the anti-PD-L1 antibody. These results are consistent with the activities of the mouse STAT3 ASO and anti-PD-L1 antibodies being due to the on target activities of these agents.

Example 5. STAT3 inhibition using a small molecule JAK1 inhibitor suppresses the immune system

CT-26 mouse colon tumor cells (5×10^5 / mouse) were implanted subcutaneously in female BALB/c mice. Ten days after implant, the mice were randomized into groups of 4, with an average tumor volume of $122mm^3$, and treated with either a JAK1 selective small molecule inhibitor (AZ-3; Woessner et al., Proc. Am. Assoc. Cancer Res. 54: 931, 2013), or vehicle. AZ-3 is herein after referred to as AZ-JAK1. AZ-JAK1 was formulated in water and dosed orally at 100 mg/kg, BID, for 11 days. On day 11, tumors were harvested and processed for flow cytometry analysis. Tumors from each group were pooled prior to analysis, to enable detection of low percentage cell

populations by flow cytometry. CD45+ leukocytes, CD4+ and CD8+ T-cells, CD11c+MHCII+ dendritic cells, and CD11b+Gr1+ myeloid suppressor cells were quantified.

Treatment with the JAK1 selective inhibitor resulted in a decrease in T-cells, dendritic cells, and myeloid suppressor cells (Figure 5), indicating that the treatment was broadly immune suppressive, in contrast to the treatment with STAT3 ASO (Figure 1). The data indicate that selective inhibition of STAT3 with a STAT3 targeted antisense oligonucleotide can enhance antitumor immune response, while inhibition of JAK1, which inhibits signaling through several STATs including STAT3 but also STATs 1, 4 and 6, is broadly immune suppressive.

Example 6. JAK1 inhibition antagonizes the anti-tumor activity of anti-PD-L1 and anti-CTLA-4 Abs in mice bearing established CT-26 tumors

CT-26 mouse colon tumor cells (5 x 10^5 / mouse) were implanted subcutaneously in female BALB/c mice. On day 14 after implantation, the mice were randomized into groups of 10 (based on tumor volume), and treated with either PBS vehicle, a JAK1 selective small molecule (AZ-JAK1) at 100 mg/kg BID, anti-PD-L1 antibody (clone 10F.9G2) at 2.5 mg/kg twice a week, anti-CTLA-4 antibody (clone 9D9) at 1 mg/kg twice a week, or combinations of AZ-JAK1 + anti-PD-L1 Ab or AZ-JAK1 + anti-CTLA-4 Ab. AZ-JAK1 was formulated in water and dosed orally. The antibodies were formulated in PBS, and dosed intraperitoneally. The average tumor size at the start of treatment was ~140mm^3. During the course of the experiment, tumor length and width were measured by caliper, and tumor volume calculated using the formula volume = (length x $width^2$)* $\pi/6$.

Results are shown in Figure 6. Treatment with the anti-PD-L1 and anti-CTLA-4 antibodies as a single agents resulted in inhibition of tumor growth. Treatment with AZ-JAK1 resulted in a modest increase in average tumor growth rate relative to vehicle control. Addition of AZ-JAK1 to anti-PD-L1 Ab or to anti-CTLA-4 Ab antagonized the antitumor activity of the antibodies, resulting in a tumor growth rate similar to that of single agent AZ-JAK1. All treatments were well tolerated, with no significant outward signs over the course of treatment. Average mouse weight at the end of treatment was greater than the weight at the start of treatment in all groups.

The enhancement of anti-PD-L1 or anti-CTLA-4 Ab activity by addition of a STAT3 ASO (Figures 2 and 3), vs. antagonism of antibody activity by addition of the JAK1 inhibitor (Figure 6), indicates a differential effect that is dependent on the mechanism of STAT3 inhibition (selective

reduction of STAT3 protein by STAT3 ASO treatment, vs. inhibition of signaling mediated by multiple STATs, including STATs 1, 3, 4 and 6, by JAK1 inhibitor treatment).

The immune stimulation and anti-tumor activity of STAT3 ASO treatment (Figures 1 – 3), vs. the immune suppression and antagonism of anti-PD-L1 and anti-CTLA-4 Ab activities with AZ-JAK1 (Figures 5 and 6), indicate that the combination activity of STAT3 ASO + anti-PD-L1 Ab treatment is dependent on a direct, selective STAT3 inhibition, and cannot be replicated (and is in fact antagonised) by other approaches to inhibition of JAK/STAT signaling such as JAK1 inhibition.

Example 7. Data showing STAT3 knockdown in CT-26 tumors and blood with STAT3 ASO treatment

To confirm knockdown of STAT3 mRNA by the STAT3 targeted ASO, mice bearing subcutaneous CT-26 tumors were treated with vehicle, mouse STAT3 ASO (same ASO as used in Example 1; QD, 50 mg/kg for 3.5 weeks), anti-PD-L1 Ab (anti-mouse PD-L1: Clone 10F.9G2, Rat IgG2b isotype; 2X/wk, 2.5 mg/kg for 3.5 weeks) or a combination of STAT3 ASO plus antiPD-L1 Ab, and blood and tumor samples collected at the end of the experiment and analyzed for the level of STAT3 mRNA. Samples from 4 mice in each treatment group were collected and processed for qRT-PCR analysis. Blood was collected in Paxgene reagent and RNA prepared according to kit directions (Qiagen, catalog number 762164). Tumors were collected in RNAlater (Qiagen) and processed to RNA according to kit directions (Qiagen, catalog number 74104) for qRT-PCR analysis. The STAT3 mRNA level measured by qRT-PCR was normalized to the amount of GAPDH mRNA in each sample. Primer/probe sets were purchased from ABI: catalog #4331182 for mouse STAT3, catalog #4352339E for mouse GAPDH.

STAT3 mRNA knockdown in blood and tumor, after STAT3 ASO treatment was 53% and 70%, respectively (Figure 7). STAT3 mRNA knockdown mice treated with PD-L1 Ab + STAT3 ASO was not significantly different than in mice treated with STAT3 ASO alone.

Example 8. Gene expression changes in DLBCL patients treated with AZD9150

Tumor biopsies were collected in a Phase I clinical trial from cancer patients treated with AZD9150 before treatment started and at 4-6 weeks after treatment commenced. Patients received three loading doses 2 or 3 mg/kg AZD9150 during the first week on days 1, 3, and 5, followed by weekly doses thereafter. Nine of the sets of biopsies were from patients with Diffuse Large B Cell

Lymphoma, two were from patients with follicular lymphoma, and one was from a patient with non-small cell lung cancer. The biopsies were formalin fixed and paraffin embedded and sectioned. RNA was isolated from six five-micron sections of each biopsy and subjected to Nanostring gene expression profiling analysis using the nCounter Human Immunology Codeset representing 594 immune-related genes. Raw data were calibrated according to Veldman-Jones et al., (Cancer Research. 75:2587, 2015) and analyzed for changes on-treatment compared to the baseline pre-treatment samples. A heatmap representing unsupervised clustering of the largest and most statistically relevant gene expression changes in DLBCL was generated. Among the AZD9150-upregulated genes are five of six genes comprising an "interferon gamma gene signature" reported to correlate with clinical benefit of pembrolizumab, a PD1-targeting therapeutic antibody (Plimack et al, J Clin Oncol 33, 2015 (suppl; abstr 4502). These five AZD9150-upregulated "interferon gamma gene signature" genes were: STAT1, IFN-gamma, CXCL9, CXCL10, and IDO. These data indicate immune modulation in the tumor microenvironment after AZD9150 treatment of patients, and suggest that AZD9150 treatment may make patients' tumors more responsive to PD(L)1 axis therapy.

Example 9. Prospective combination trials

Clinical trials of the MEDI4736 and AZD9150 combination are planned in squamous cell carcinoma of the head or neck (SCCHN) and diffuse large B cell lymphoma (DLBCL) to establish safe doses for the combination and test for superior clinical response rates vs. either therapy alone. The indications were chosen based on demonstration of clinical responses in previous clinical trials to monotherapy MEDI4736 in SCCHN and to AZD9150 or anti-PD1 therapy in DLBCL.

AZD9150 will be formulated in saline and administered via infusion on days 1, 3, 5 of treatment and weekly thereafter. MEDI4736 will be formulated in saline and administered via intravenous infusion once every two weeks, either starting at the same time as first AZD9150 administration, or after 1, 2, or more weeks of AZD9150 administration, to allow for AZD9150 loading dose phase.

Example 9a: Squamous Cell Carcinoma of the Head or Neck (SCCHN) trial

Subjects in this study are required to be 18 years of age or older and have histologically- or cytologically-confirmed SCCHN with at least one measurable lesion according to Response Evaluation Criteria in Solid Tumors (RECIST) guidelines v1.1.

Design of the SCCHN trial

The study is an open-label Phase 1/2 study of the combination of anti-PD-L1 antibody (MEDI4736) and STAT3 ASO (AZD9150) vs. AZD9150 alone to establish doses, safety, and superior efficacy of the combination vs. monotherapy using RECIST criteria.

Phase 1a: To establish safety and the Phase 1b doses, a small cohort of subjects (e.g. 6) will receive combinations of up to 3 mg/kg AZD9150 (starting at 3 mg/kg and lowering if there are safety issues) and 3 or 10 mg/kg MEDI4736.

Phase 1b: Up to fifty patients will receive the doses of AZD9150 + MEDI4736 established in Phase 1a and up to fifty patients will receive AZD9150 alone at the same dose as that used in the combination. The MEDI4736 monotherapy response rate from a previous clinical trial of MEDI4736 in SCCHN will be used as another comparator to the combination therapy.

Baseline levels of PDL-1 tumor expression will be obtained for all subjects to correlate to clinical responses. In addition, some circulating leukocyte populations (e.g. myeloid derived suppressor cells, MDSCs) will be monitored by immunophenotyping to assess correlation to clinical response.

Success is defined as a superior response rate or survival benefit for AZD9150 and MEDI4736 combination vs. either drug at its recommended monotherapy dose in the entire patient population or a biomarker-defined subset.

Example 9b: Diffuse Large B Cell Lymphoma (DLBCL) trial

Subjects in this study are required to be 18 years of age or older and have histologically- or cytologically-confirmed DLBCL with at least one measurable lesion according to the International Working Group (IWG) criteria. Eligible patients must have failed Autologous Stem Cell Transplant (ASCT) or have had at least two prior multi-agent chemotherapy regimens and not be candidates for ASCT.

Design of the DLBCL trial

The study is an open-label Phase 1/2 study of the combination of anti-PD-L1 antibody (MEDI4736) and AZD9150 vs. MEDI4736 alone to establish doses, safety, and superior efficacy of the combination vs. monotherapy using IWG criteria.

Phase 1a: To establish safety and the Phase 1b doses, a small cohort of subjects (e.g. 6) will receive combinations of up to 3 mg/kg AZD9150 (starting at 3 mg/kg and lowering if there are safety issues) and 3 or 10 mg/kg MEDI4736.

Phase 1b: Up to fifty patients will receive the doses of AZD9150 + MEDI4736 established in Phase 1a and up to fifty patients will receive MEDI4736 alone at the same dose as that used in the combination. The AZD9150 monotherapy response rate from a previous clinical trial of AZD9150 in DLBCL will be used as another comparator to the combination therapy.

Baseline levels of PDL-1 tumor expression will be obtained for all subjects to correlate to clinical responses. In addition, some circulating leukocyte populations (e.g. myeloid derived suppressor cells, MDSCs) will be monitored by immunophenotyping to assess correlation to clinical response.

Success is defined as a superior response rate or survival benefit for AZD9150 and MEDI4736 combination vs. either drug at its recommended monotherapy dose in the entire patient population or a biomarker-defined subset.

Other Embodiments

From the foregoing description, it will be apparent that variations and modifications may be made to the invention described herein to adopt it to various usages and conditions. Such embodiments are also within the scope of the following claims.

The recitation of a listing of elements in any definition of a variable herein includes definitions of that variable as any single element or combination (or subcombination) of listed elements. The recitation of an embodiment herein includes that embodiment as any single embodiment or in combination with any other embodiments or portions thereof.

All patents and publications mentioned in this specification are herein incorporated by reference to the same extent as if each independent patent and publication was specifically and individually indicated to be incorporated by reference.

The following further aspects are provide:

1. A method of treatment comprising administering: (i) an anti-PD-L1 antibody or an antigen-binding fragment thereof; and (ii) an antisense compound targeted to STAT3; to a patient in need thereof.

2. The method of aspect 1, wherein the anti-PD-L1 antibody is selected from: MEDI4736, MPDL3280A, BMS936559, 2.7A4, AMP-714 and MDX-1105.

3. The method of aspect 2, wherein the anti-PD-L1 antibody, is MEDI4736.

4. The method of aspect 1, wherein the antisense compound targeted to STAT3 does not inhibit STAT1, STAT4, or STAT6.

5. The method of aspect 1, wherein the antisense compound targeted to STAT3 is an antisense oligonucleotide.

6. The method of aspect 1 or aspect 5, wherein the antisense compound targeted to STAT3 is AZD9150.

7. The method of aspect 1, wherein the patient has cancer.

8. The method of aspect 7, wherein the cancer is selected from: lung cancer; including non small cell lung cancer (NSCLC); breast cancer, including triple negative; ovarian cancer, including serous; pancreatic cancer; colorectal cancer; hepatocellular carcinoma (HCC); head and neck cancer, including head and neck squamous cell carcinoma (HNSCC); and, lymphoma, including diffuse large B-cell carcinoma (DLBCL).

9. The method of aspect 8, wherein the cancer cells express PD-L1.

10. The method of aspect 1, wherein the patient in need thereof was identified as having a cancer that is PD-L1 positive.

11. The method according to any of the preceding aspect wherein the anti-PD-L1 antibody is MEDI4736 and the antisense compound targeted to STAT3 is AZD9150.

12. The method according to aspect 11, wherein between about 1 mg/kg and 20 mg/kg MEDI4736 or an antigen-binding fragment thereof, and between about 1 mg/kg and 10 mg/kg AZD9150 is administered to a patient in need thereof.

13. The method of aspect 12, wherein the treatment is administered every week, every 2 weeks, every 3 weeks, or every 4 weeks.

14. The method of any one of aspects 1-13, wherein about 1 mg/kg MEDI4736 or an antigen-binding fragment thereof, and about 3 mg/kg AZD9150 is administered per dose.

15. The method of any one of aspects 1-14, wherein the method results in an increase in progression free survival and/or overall survival as compared to the administration of either the MEDI4736 or the AZD9150 alone.

16. The method of any one of aspects 2-15, wherein the administration of MEDI4736 or an antigen-binding fragment thereof, is by intravenous infusion.

17. The method of any one of aspects 4-16, wherein the administration of AZD9150 is by intravenous infusion.

18. The method of any one of aspects 2-15, wherein AZD9150 and MEDI4736, or an antigen-binding fragment thereof, are administered concurrently or at different times.

19. A kit for treating cancer, the kit comprising MEDI4736 or an antigen-binding fragment thereof, and AZD9150.

20. A pharmaceutical composition which comprises MEDI4736 or an antigen-binding fragment thereof, and AZD9150 in association with a pharmaceutically acceptable diluent or carrier.

21. The pharmaceutical composition of aspect 20, wherein the pharmaceutical composition is formulated to provide a dose of about 1mg/kg to about 20mg/kg of MEDI4736 or an antigen-binding fragment thereof, and a dose of about 1mg/kg to about 10mg/kg of AZD9150.

22. The pharmaceutical composition of aspect 21, wherein the pharmaceutical composition is formulated to provide a dose of about 1mg/kg of MEDI4736 or an antigen-binding fragment thereof, and a dose of about 3mg/kg of AZD9150.

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23. A method for modulating immune infiltrate cells in a warm-blooded animal such as a human, which comprises administering to said animal an effective amount of MEDI4736 or an antigen binding fragment thereof, before, after or simultaneously with an effective amount of AZD9150.

CLAIMS

1. A combination comprising an immune checkpoint inhibitor and a single-stranded antisense oligonucleotide targeted to STAT3 for use in the treatment of cancer, wherein the combination is to be administered to a patient in need thereof.

2. A combination for use according to claim 1, wherein the immune checkpoint inhibitor is selected from: an anti-PD-L1 antibody or an antigen-binding fragment thereof; an anti-PD1 antibody or an antigen-binding fragment thereof; and, an anti-CTLA-4 antibody or an antigen-binding fragment thereof.

3. A combination for use according to claim 1 or claim 2, wherein the immune checkpoint inhibitor is selected from: MEDI4736, MPDL3280A, 2.7A4, AMP-714, MDX-1105, nivolumab, pembrolizumab, pidilizumab, BMS936559, MPDL3280A, tremelimumab and ipilimumab.

4. A combination for use according to any one of claims 1 - 3, wherein the immune checkpoint inhibitor is MEDI4736.

5. A combination for use according to any of the previous claims wherein the single-stranded antisense oligonucleotide targeted to STAT3 does not inhibit STAT1, STAT4, or STAT6.

6. A combination for use according to any of the previous claims, wherein the single-stranded antisense oligonucleotide targeted to STAT3 is AZD9150.

7. A combination for use according to any of the previous claims, wherein the cancer is selected from: lung cancer, including non small cell lung cancer (NSCLC), pancreatic cancer, colorectal cancer, hepatocellular carcinoma (HCC), head and neck cancer, including head and neck squamous cell carcinoma (HNSCC), and lymphoma, including diffuse large B-cell carcinoma (DLBCL).

8. A combination for use according to claim 7, wherein the cancer cells express PD-L1.

9. A combination for use according to any of the previous claims, wherein the cancer is PD-L1 positive.

10. A combination for use according to any of the previous claims wherein the immune checkpoint inhibitor is MEDI4736 and the single-stranded antisense oligonucleotide targeted to STAT3 is AZD9150.

11. A combination for use according to claim 10, wherein between about 1 mg/kg and 20 mg/kg MEDI4736, and between about 1 mg/kg and 10 mg/kg AZD9150 is to be administered to the patient.

12. A combination for use according to claim 11, wherein the treatment is to be administered every week, every 2 weeks, every 3 weeks, or every 4 weeks.

13. A combination for use according to any of the previous claims wherein the single-stranded antisense oligonucleotide targeted to STAT3 is to be administered to the patient before the immune checkpoint inhibitor.

14. A combination for use according to claim 13, wherein the single-stranded antisense oligonucleotide targeted to STAT3 is to be administered to the patient at least one day before the immune checkpoint inhibitor is to be administered to the patient.

15. A combination for use according to any one of claims 1 - 14, wherein the single-stranded antisense oligonucleotide targeted to STAT3 is AZD9150 and the immune checkpoint inhibitor is MEDI4736, and wherein AZD9150 and MEDI4736 are to be administered concurrently or at different times.

16. A combination for use according to any of the claims 1 - 15, wherein (i) two immune checkpoint inhibitors and (ii) a single-stranded antisense oligonucleotide targeted to STAT3 are to be administered to a patient in need thereof; wherein the two immune checkpoint inhibitors are MEDI4736 and tremelimumab, and the single-stranded antisense oligonucleotide targeted to STAT3 is AZD9150.

17. A pharmaceutical composition which comprises an immune checkpoint inhibitor and a single-stranded antisense oligonucleotide targeted to STAT3 in association with a pharmaceutically acceptable diluent or carrier for use in the treatment of cancer, wherein the pharmaceutical composition is to be administered to a patient in need thereof, wherein the patient has cancer.

18. Use of a combination comprising an immune checkpoint inhibitor and a single-stranded antisense oligonucleotide targeted to STAT3 in the manuafacture of a medicament for the treatment of cancer, wherein the medicament is to be administered to a patient in need thereof, wherein the patient has cancer.

19. The use according to claim 18, wherein the immune checkpoint inhibitor is selected from: an anti-PD-L1 antibody or an antigen-binding fragment thereof; an anti-PD1 antibody or an antigen-binding fragment thereof; and, an anti-CTLA-4 antibody or an antigen-binding fragment thereof.

20. The use according to claim 18 or claim 19, wherein the immune checkpoint inhibitor is selected from: MEDI4736, MPDL3280A, 2.7A4, AMP-714, MDX-1105, nivolumab, pembrolizumab, pidilizumab, BMS936559, MPDL3280A, tremelimumab and ipilimumab.

21. The use according to any one of claims 18 - 20, wherein the immune checkpoint inhibitor is MEDI4736.

22. The use according to any one of claims 18 - 21, wherein the single-stranded antisense oligonucleotide targeted to STAT3 does not inhibit STAT1, STAT4, or STAT6.

23. The use according to any one of claims 18 - 22, wherein the single-stranded antisense oligonucleotide targeted to STAT3 is AZD9150.

24. The use according to any one of claims 18 - 23, wherein the cancer is selected from: lung cancer, including non small cell lung cancer (NSCLC), pancreatic cancer, colorectal cancer, hepatocellular carcinoma (HCC), head and neck cancer, including head and neck squamous cell carcinoma (HNSCC), and lymphoma, including diffuse large B-cell carcinoma (DLBCL).

25. The use according to claim 24, wherein the cancer cells express PD-L1.

26. The use according to any one of claims 18 - 25, wherein the cancer is PD-L1 positive.

27. The use according to any one of claims 18 – 26, wherein the immune checkpoint inhibitor is MEDI4736 and the single-stranded antisense oligonucleotide targeted to STAT3 is AZD9150.

28. The use according to claim 27, wherein between about 1 mg/kg and 20 mg/kg MEDI4736, and between about 1 mg/kg and 10 mg/kg AZD9150 is to be administered to the patient.

29. The use according to claim 28, wherein the treatment is to be administered every week, every 2 weeks, every 3 weeks, or every 4 weeks.

30. The use according to any one of claims 18 – 29, wherein the single-stranded antisense oligonucleotide targeted to STAT3 is to be administered to the patient before the immune checkpoint inhibitor.

31. The use according to claim 30, wherein the single-stranded antisense oligonucleotide targeted to STAT3 is to be administered to the patient at least one day before the immune checkpoint inhibitor is to be administered to the patient.

32. The use according to any one of claims 18 – 31, wherein the single-stranded antisense oligonucleotide targeted to STAT3 is AZD9150 and the immune checkpoint inhibitor is MEDI4736, and wherein AZD9150 and MEDI4736 are to be administered concurrently or at different times.

33. The use according to any one of claims 18 – 32, wherein (i) two immune checkpoint inhibitors and (ii) a single-stranded antisense oligonucleotide targeted to STAT3 are to be administered to a patient in need thereof; wherein the two immune checkpoint inhibitors are MEDI4736 and tremelimumab, and the single-stranded antisense oligonucleotide targeted to STAT3 is AZD9150.

34. Use of a pharmaceutical composition which comprises an immune checkpoint inhibitor and a single-stranded antisense oligonucleotide targeted to STAT3 in association with a pharmaceutically acceptable diluent or carrier in the manuafacture of a medicament for the treatment of cancer, wherein the medicament is to be administered to a patient in need thereof, wherein the patient has cancer.