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(54) **Title:** USE OF IL-20 ANTAGONISTS FOR TREATING EYE DISEASES

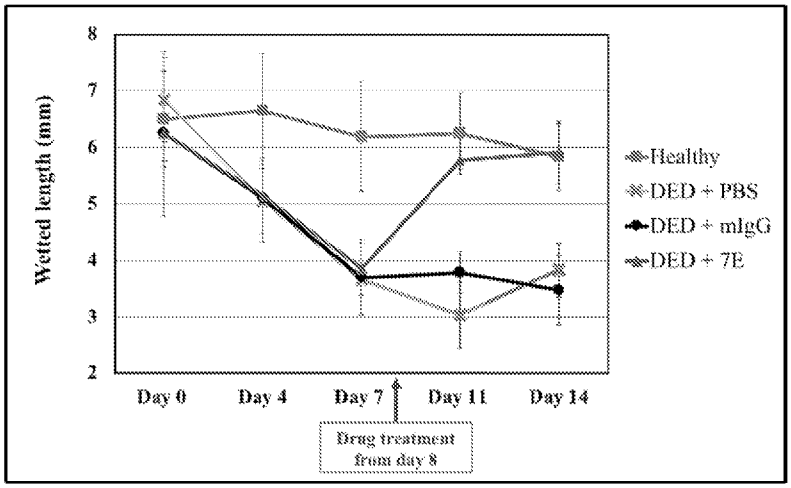

Fig. 1

(57) **Abstract:** Methods for treating eye diseases such as dry eye disease (DED) and age-related macular degeneration (AMD) using an IL-20 antagonist that blocks the signaling pathway mediated by IL-20, for example, an antibody that binds IL-20 or an IL-20 receptor.

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USE OF IL-20 ANTAGONISTS FOR TREATING EYE DISEASES

RELATED APPLICATIONS

This application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application No.62/489,611, filed April 25, 2017, the contents of which are incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

Ophthalmologic diseases affect millions of people around the world, particularly older adults. For example, dry eye disease (DED; also known as keratoconjunctivitis sicca) is a common ophthalmologic disease. It is a multifactorial disorder of the tear film and ocular surface characterized by symptoms of dryness and irritation. Dews, Ocul Surf. 2007, 5:75-92. DED can negatively impact the performance of daily activities and would result in an overall decrease in quality of life.

As another example, age-related macular degeneration (AMD) is a retinal condition which happens when macula, a part of the retina, is damaged. Macular degeneration is the leading cause of vision loss affecting more than 10 million patients in the US.

Accordingly, it is of great interest to develop novel compositions and methods for treating ophthalmic conditions such as dry eye disease and AMD.

SUMMARY OF THE INVENTION

The present disclosure is based on the unexpected results that antibodies capable of interfering with the IL-20 signaling pathway (*e.g.*, anti-IL-20 antibody such as mAb7E) successfully increased tear volume and inhibited corneal damage in a mice suffering from dry eye syndrome and also showed superior therapeutic effects in a mouse model of age-related macular degeneration.

Accordingly, one aspect of the present disclosure relates to a method for treating an eye disease or delaying the onset of the eye disease in a subject, comprising administering to a subject in need of the treatment an effective amount of a pharmaceutical composition comprising an IL-20 antagonist, which inhibits a signaling pathway mediated by IL-20. In some embodiments, the IL-20 antagonist can be an antibody that binds to IL-20 or an IL-20 receptor, thereby inhibiting a signaling pathway mediated by IL-20. For example, such an antibody may bind to an IL-20 protein (*e.g.*, human IL-20) or may bind to an IL-20 receptor

(*e.g.*, a human IL-20 receptor such as the R1 subunit of the IL-20 receptor). Any of the antibodies used in the method described herein can be a full-length antibody or an antigen-binding fragment thereof. Alternatively, the antibody can be a human antibody, a humanized antibody, a chimeric antibody, or a single-chain antibody.

When an antibody that binds human IL-20 is used in the method described herein, it can be the monoclonal antibody mAb7E, an antigen-binding fragment thereof, or a functional variant thereof. In some embodiments, the anti-IL-20 antibody may bind to the same epitope of human IL-20 as mAb7E or competes against mAb7E from binding to human IL-20. In one example, the anti-IL-20 antibody described herein may comprise the same heavy chain and light chain complementary determining regions (CDRs) as mAb7E. In another example, the anti-IL-20 antibody is a humanized antibody of mAb7E. Such a humanized antibody can comprises a heavy chain variable region (V_H), which comprises the amino acid sequence of SEQ ID NO:8, and a light chain variable region (V_L), which comprises the amino acid sequence of SEQ ID NO:12 or SEQ ID NO:13.

Alternatively, an antibody that binds a human IL-20 receptor or a subunit thereof, can be used in the method described herein. Such an anti-IL20 receptor antibody may bind the IL-20R1 subunit, the IL-20R2 subunit, the IL-20R1/R2 complex, the IL-22R1 subunit, or the IL-22R1/IL-20R2 complex. In some embodiments, the antibody binds subunit R1 of human IL-20 receptor. In one example, the antibody that binds subunit R1 of the human IL-20 receptor is an antibody comprising the same V_H and V_L as monoclonal antibody mAb51D or mAb7GW, or a functional variant of mAb51D or mAb7GW. In some instances, the anti-IL-20R antibody may bind to the same epitope of the subunit R1 of human IL-20R as mAb7GW or mAb51D, or competes against mAb7GW or mAb51D from binding to the subunit R1. The anti-IL-20R antibody described herein may comprise the same heavy chain and light chain complementary determining regions (CDRs) as mAb51D or mAb7GW. In some examples, the anti-IL-20R antibody may be a humanized antibody of mAb51D or mAb7GW.

The subject to be treated in the method described herein (*e.g.*, a method in which an antibody that inhibits the IL-20 signaling pathway is used) can be a patient (*e.g.*, a human patient) who has or is suspected of having an eye disease, which can be dry eye disease (DED) or age-related macular degeneration (AMD), for example, wet AMD. In some examples, the DED is aqueous tear-deficient dry eye. In other examples, the DED is evaporative dry eye. In some embodiments, the eye disease can be diabetic macular edema

(DME), diabetic retinopathy (DR) in DME, or macular edema following retinal vein occlusion (RVO).

Also within the scope of this disclosure are (a) pharmaceutical compositions for use in treating an eye disease (*e.g.*, DED, AMD, or others described herein) or delaying the onset of the eye disease in a subject, the pharmaceutical composition comprising one or more of the IL-20 antagonists described herein (*e.g.*, an antibody that inhibits the IL-20 signaling pathway such as an antibody that binds human IL-20 or human IL-20 receptor (R1, R2, or a complex thereof); and (b) uses of any of the IL-20 antagonists described herein (*e.g.*, anti-IL-20 or anti-IL-20 receptor antibodies) in manufacturing a medicament for treating or delaying the onset of eye disease.

The details of one or more embodiments of the invention are set forth in the description below. Other features or advantages of the present invention will be apparent from the following drawings and detailed description of several embodiments, and also from the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a chart showing therapeutic effect of anti-IL-20 antibody mAb7E on tear volume in mice having dry eye disease (DED) induced by topical administration of benzalkonium chloride (BAC). DED group mice were treated with PBS, mouse immunoglobulin G (mIgG), or mAb7E. ***: healthy versus DED, $p<0.001$. ***: mIgG versus 7E, $p<0.001$

Figure 2 is a photo including representative images of corneal fluorescein staining showing the inhibitory effects of mAb7E on corneal damage.

Figure 3 is a chart showing that treatment with mAb7E causes a significant decrease in corneal fluorescein staining score. ***: mIgG versus 7E, $p<0.001$.

Figure 4A is a chart showing fluorescent intensity of choroidal neovascularization (CNV) lesions measured 7 days after laser photocoagulation in mice treated with PBS (a blank control), EYLEA®, mIgG (a control), or mAb7E.

Figure 4B is a chart showing fluorescent intensity of choroidal neovascularization (CNV) lesions measured 14 days after laser photocoagulation in mice treated with PBS (a blank control), EYLEA®, mIgG (a control), or mAb7E.

Figure 4C is a chart showing fluorescent intensity of choroidal neovascularization (CNV) lesions measured 21 days after laser photocoagulation in mice treated with PBS (a

blank control), EYLEA®, mIgG (a control), or mAb7E.

Figure 4D is a chart showing fluorescent intensity of choroidal neovascularization (CNV) lesions measured 28 days after laser photocoagulation in mice treated with PBS (a blank control), EYLEA®, mIgG (a control), or mAb7E.

BRIEF DESCRIPTION OF THE SEQUENCES

SEQ ID NO:1 is the nucleotide sequence encoding the heavy chain variable region of monoclonal antibody mAb7E.

SEQ ID NO:2 is the amino acid sequence of the heavy chain variable region of monoclonal antibody mAb7E.

SEQ ID NO:3 is the nucleotide sequence encoding the light chain variable region of monoclonal antibody mAb7E.

SEQ ID NO:4 is the amino acid sequence of the light chain variable region of monoclonal antibody mAb7E.

SEQ ID NO:5 is the nucleotide sequence encoding the heavy chain variable region of humanized antibodies HL1 and HL2 derived from mAb7E (precursor form, which includes a signal peptide).

SEQ ID NO:6 is the amino acid sequence of the heavy chain variable region of humanized antibodies HL1 and HL2 derived from mAb7E (precursor form, which includes a signal peptide).

SEQ ID NO:7 is the nucleotide sequence encoding the heavy chain variable region of humanized antibodies HL1 and HL2 derived from mAb7E (mature form, lacking the signal peptide).

SEQ ID NO:8 is the amino acid sequence of the heavy chain variable region of humanized antibodies HL1 and HL2 derived from mAb7E (mature form, lacing the signal peptide).

SEQ ID NO:9 is the nucleotide sequence encoding the light chain variable region of humanized antibody HL2 (precursor form, which includes a signal peptide).

SEQ ID NO:10 is the amino acid sequence of the light chain variable region of humanized antibody HL2 (precursor form, which includes a signal peptide).

SEQ ID NO:11 is the nucleotide sequence encoding the light chain variable region of humanized antibody HL2 (mature form, lacking the signal peptide).

SEQ ID NO:12 is the amino acid sequence of the light chain variable region of humanized antibody HL2 (mature form, lacking the signal peptide).

SEQ ID NO:13 is the amino acid sequence of the light chain variable region of humanized antibody HL1 (mature form, lacking the signal peptide).

SEQ ID NO:14 is the amino acid sequence of the heavy chain of monoclonal antibody mAb7GW.

SEQ ID NO:15 is the nucleotide sequence encoding the heavy chain of monoclonal antibody mAb7GW.

SEQ ID NO:16 is the amino acid sequence of the light chain of monoclonal antibody mAb7GW.

SEQ ID NO:17 is the nucleotide sequence encoding the light chain of monoclonal antibody mAb7GW.

SEQ ID NO:18 is the amino acid sequence of the heavy chain of monoclonal antibody mAb51D.

SEQ ID NO:19 is the nucleotide sequence encoding the heavy chain of monoclonal antibody mAb51D.

SEQ ID NO:20 is the amino acid sequence of the light chain of monoclonal antibody mAb51D.

SEQ ID NO:21 is the nucleotide sequence encoding the light chain of monoclonal antibody mAb51D.

DETAILED DESCRIPTION OF THE INVENTION

The present disclosure reports the unexpected results that antibodies capable of interfering with the IL-20 signaling pathway (*e.g.*, anti-IL-20 antibody such as mAb7E) successfully increased tear volume and inhibited corneal damage in a well-established dry eye syndrome mouse model (the BAC-induced dry eye mouse model). Accordingly, the present disclosure relates to methods of treating eye diseases such as dry eye disease (*e.g.*, alleviating eye disease or delaying the onset of eye diseases) in a subject using an effective amount of an IL-20 antagonist, which can be an antibody capable of interfering with the IL-20 signaling pathway.

General Techniques

The practice of the present invention will employ, unless otherwise indicated,

conventional techniques of molecular biology (including recombinant techniques), microbiology, cell biology, biochemistry and immunology, which are within the skill of the art. Such techniques are explained fully in the literature, such as, Molecular Cloning: A Laboratory Manual, second edition (Sambrook, et al., 1989) Cold Spring Harbor Press; Oligonucleotide Synthesis (M. J. Gait, ed., 1984); Methods in Molecular Biology, Humana Press; Cell Biology: A Laboratory Notebook (J. E. Cellis, ed., 1998) Academic Press; Animal Cell Culture (R. I. Freshney, ed., 1987); Introduction to Cell and Tissue Culture (J. P. Mather and P. E. Roberts, 1998) Plenum Press; Cell and Tissue Culture: Laboratory Procedures (A. Doyle, J. B. Griffiths, and D. G. Newell, eds., 1993-8) J. Wiley and Sons; Methods in Enzymology (Academic Press, Inc.); Handbook of Experimental Immunology (D. M. Weir and C. C. Blackwell, eds.); Gene Transfer Vectors for Mammalian Cells (J. M. Miller and M. P. Calos, eds., 1987); Current Protocols in Molecular Biology (F. M. Ausubel, et al., eds., 1987); PCR: The Polymerase Chain Reaction, (Mullis, et al., eds., 1994); Current Protocols in Immunology (J. E. Coligan et al., eds., 1991); Short Protocols in Molecular Biology (Wiley and Sons, 1999); Immunobiology (C. A. Janeway and P. Travers, 1997); Antibodies (P. Finch, 1997); Antibodies: a practical approach (D. Catty., ed., IRL Press, 1988-1989); Monoclonal antibodies: a practical approach (P. Shepherd and C. Dean, eds., Oxford University Press, 2000); Using antibodies: a laboratory manual (E. Harlow and D. Lane (Cold Spring Harbor Laboratory Press, 1999); The Antibodies (M. Zanetti and J. D. Capra, eds., Harwood Academic Publishers, 1995).

IL-20 antagonists and Pharmaceutical Compositions Comprising Such

Interleukin IL-20 (IL-20) is a member of the IL-10 family, which includes IL-10, IL-19, IL-20, IL-22, IL-24, and IL-26. Blumberg, et al., 2001, Cell 104:9-19; Pestka et al., 2004, Annu Rev Immunol 22:929-979. IL-20 is expressed in monocytes, epithelial cells, and endothelial cells and acts on multiple cell types by activating a heterodimer receptor complex of either IL-20R1/IL-20R2 or IL-22R1/IL-20R2. Dumoutier, et al., 2001, J Immunol 167:3545-3549). IL-20 was found to be involved in various inflammatory diseases, such as psoriasis (Blumberg et al., 2001; Sa et al., 2007, J Immunol 178:2229-2240; and Wei et al., 2005, Clin Immunol 117:65-72), rheumatoid arthritis (Hsu, et al., 2006, Arthritis Rheum 54:2722-2733), atherosclerosis (Caligiuri, et al. 2006, Arterioscler Thromb Vasc Biol 26:1929-1930; and Chen et al., 2006, Arterioscler Thromb Vasc Biol 26:2090-2095), ischemic stroke (Chen et al., 2009, J Immunol 182:5003-5012), and renal failure (Li et al.,

2008, Genes Immun 9:395-404). See also Wei et al., 2006, J Biomed Sci 13:601-612.

The IL-20 described herein refers to interleukin-20 and variants thereof that retain at least part of the activity of IL-20. As used herein, IL-20 includes all mammalian species of native sequence IL-20, including human, canine, feline, equine, or bovine. In one example, the IL-20 is a human IL-20 (GenBank accession no. NP_061194.2).

IL-20 activates the IL-20 signaling pathway via binding to IL-20 receptor, which is a dimeric complex contains subunits IL-20R1 and IL-20R2 (also known as RA and RB). Such an IL-20 receptor is shared by three functionally different cytokines, *i.e.*, IL-19, IL-20, and IL-24, suggesting that this receptor mediates different signaling pathways dependent upon its binding to a specific cytokine. IL-20 is also capable of binding to a dimeric complex containing IL-20R2 and IL-22R1. The IL-20 receptor disclosed herein refers to one or more polypeptides that are capable of binding to and being activated by IL-20. IL-20 receptors disclosed herein include IL-20R1, IL-20R2 and IL-22R1 of any mammalian species, including, but are not limited to, human, canine, feline, equine, primate, or bovine. Examples of human IL-20 receptors include hIL-20R1 (GenBank Accession No. NM_014432.2), hIL-20R2 (GenBank Accession No. NM_144717.2) and hIL-22R1 (NM_181309.1). Sequences of human IL-20 receptors have been described; for example, in U.S. Pat. Nos. 6,610,286; 7,122,632; 7,393,684; and 7,537,761; and U.S. Pat. App. Pub. Nos. 2006/0263850 A1; 2006/0263851 A1; 2008/0247945 A1, and 2009/0074661 A1.

The IL-20 antagonist to be used in the methods described herein is a molecule that blocks, suppresses, or reduces (including significantly) the biological activity of IL-20, including downstream pathways mediated by IL-20 signaling, such as receptor binding and/or elicitation of a cellular response to IL-20. See US2011/0064731, which is incorporated by reference herein in its entirety. The term "antagonist" implies no specific mechanism of biological action whatsoever, and is deemed to expressly include and encompass all possible pharmacological, physiological, and biochemical interactions with IL-20 whether direct or indirect. For purpose of the present disclosure, it will be explicitly understood that the term "antagonist" encompass all the previously identified terms, titles, and functional states and characteristics whereby the IL-20 itself (*e.g.*, human IL-20), an IL-20 biological activity (including but not limited to its ability to mediate any aspect of eye disease), or the consequences of the biological activity, are substantially nullified, decreased, or neutralized in any meaningful degree, *e.g.*, by at least 20%, 50%, 70%, 85%, 90%, 100%, 150%, 200%,

300%,or 500%, or by 10-fold, 20-fold, 50-fold, 100-fold, 1000-fold, or 10^4-fold.

Exemplary IL-20 antagonists include, but are not limited to, an anti-IL-20 antibody, an anti-sense nucleic acid molecule directed to an IL-20 (including an anti-sense nucleic acid directed to a nucleic acid encoding IL-20), a small interfering RNA (siRNA) directed toward an IL-20 nucleic acid, a microRNA directed toward an IL-20 nucleic acid, an IL-20 inhibitory compound, an anti-IL-20R antibody (*e.g.*, an antibody specifically binds IL-20R1, IL-20R2, or the dimeric complex formed thereby), an antisense nucleic acid molecule directed to a subunit of an IL-20 receptor, an siRNA or a microRNA directed to a nucleic acid encoding a subunit of an IL-20 receptor, or an IL-20R inhibitory compound. In some embodiments, an IL-20 antagonist binds IL-20 or IL-20 receptor and prevents the formation of IL-20-IL-20R complex, thereby inhibiting the IL-20 signaling pathway. In other embodiments, an IL-20 antagonist inhibits or reduces IL-20 synthesis and/or production (release). Such antagonists include antisense molecules, siRNAs and microRNAs.

Antibodies capable of interfering with the IL-20 signaling pathway

An antibody (interchangeably used in plural form) is an immunoglobulin molecule capable of specific binding to a target, such as a carbohydrate, polynucleotide, lipid, polypeptide, etc., through at least one antigen recognition site, located in the variable region of the immunoglobulin molecule. As used herein, the term "antibody" encompasses not only intact (*i.e.*, full-length) polyclonal or monoclonal antibodies, but also antigen-binding fragments thereof (such as Fab, Fab', $F(ab')_2$, Fv), single chain (scFv), mutants thereof, fusion proteins comprising an antibody portion, humanized antibodies, chimeric antibodies, diabodies, linear antibodies, single chain antibodies, multispecific antibodies (e.g., bispecific antibodies) and any other modified configuration of the immunoglobulin molecule that comprises an antigen recognition site of the required specificity, including glycosylation variants of antibodies, amino acid sequence variants of antibodies, and covalently modified antibodies. An antibody includes an antibody of any class, such as IgD, IgE, IgG, IgA, or IgM (or sub-class thereof), and the antibody need not be of any particular class. Depending on the antibody amino acid sequence of the constant domain of its heavy chains, immunoglobulins can be assigned to different classes. There are five major classes of immunoglobulins: IgA, IgD, IgE, IgG, and IgM, and several of these may be further divided into subclasses (isotypes), *e.g.*, IgG1, IgG2, IgG3, IgG4, IgA1 and IgA2. The heavy-chain constant domains that correspond to the different classes of immunoglobulins are called

alpha, delta, epsilon, gamma, and mu, respectively. The subunit structures and three-dimensional configurations of different classes of immunoglobulins are well known.

The antibodies to be used in the methods described herein can be murine, rat, human, or any other origin (including chimeric or humanized antibodies). In some examples, the antibody comprises a modified constant region, such as a constant region that is immunologically inert, *e.g.*, does not trigger complement mediated lysis, or does not stimulate antibody-dependent cell mediated cytotoxicity (ADCC). ADCC activity can be assessed using methods disclosed in U.S. Pat. No. 5,500,362. In other embodiments, the constant region is modified as described in Eur. J. Immunol. (1999) 29:2613-2624; PCT Application No. PCT/GB99/01441; and/or UK Patent Application No. 9809951.8.

Any of the antibodies described herein can be either monoclonal or polyclonal. A "monoclonal antibody" refers to a homogenous antibody population and a "polyclonal antibody" refers to a heterogenous antibody population. These two terms do not limit the source of an antibody or the manner in which it is made.

In one example, the antibody used in the methods described herein is a humanized antibody. Humanized antibodies refer to forms of non-human (*e.g.*, murine) antibodies that are specific chimeric immunoglobulins, immunoglobulin chains, or antigen-binding fragments thereof that contain minimal sequence derived from non-human immunoglobulin. For the most part, humanized antibodies are human immunoglobulins (recipient antibody) in which residues from a complementary determining region (CDR) of the recipient are replaced by residues from a CDR of a non-human species (donor antibody) such as mouse, rat, or rabbit having the desired specificity, affinity, and capacity. In some instances, Fv framework region (FR) residues of the human immunoglobulin are replaced by corresponding non-human residues. Furthermore, the humanized antibody may comprise residues that are found neither in the recipient antibody nor in the imported CDR or framework sequences, but are included to further refine and optimize antibody performance. In general, the humanized antibody will comprise substantially all of at least one, and typically two, variable domains, in which all or substantially all of the CDR regions correspond to those of a non-human immunoglobulin and all or substantially all of the FR regions are those of a human immunoglobulin consensus sequence. The humanized antibody optimally also will comprise at least a portion of an immunoglobulin constant region or domain (Fc), typically that of a human immunoglobulin. Antibodies may have Fc regions modified as described in WO

99/58572. Other forms of humanized antibodies have one or more CDRs (one, two, three, four, five, six) which are altered with respect to the original antibody, which are also termed one or more CDRs "derived from" one or more CDRs from the original antibody. Humanized antibodies may also involve affinity maturation.

In another example, the antibody described herein is a chimeric antibody, which can include a heavy constant region and a light constant region from a human antibody. Chimeric antibodies refer to antibodies having a variable region or part of variable region from a first species and a constant region from a second species. Typically, in these chimeric antibodies, the variable region of both light and heavy chains mimics the variable regions of antibodies derived from one species of mammals (*e.g.*, a non-human mammal such as mouse, rabbit, and rat), while the constant portions are homologous to the sequences in antibodies derived from another mammal such as human. In some embodiments, amino acid modifications can be made in the variable region and/or the constant region.

In some examples, the antibody disclosed herein specifically binds a target antigen, such as human IL-20 or one of the two subunits of a human IL-20 receptor (*e.g.*, IL-20R1). An antibody that "specifically binds" (used interchangeably herein) to a target or an epitope is a term well understood in the art, and methods to determine such specific binding are also well known in the art. A molecule is said to exhibit "specific binding" if it reacts or associates more frequently, more rapidly, with greater duration and/or with greater affinity with a particular target antigen than it does with alternative targets. An antibody "specifically binds" to a target antigen if it binds with greater affinity, avidity, more readily, and/or with greater duration than it binds to other substances. For example, an antibody that specifically (or preferentially) binds to an IL-20 epitope is an antibody that binds this IL-20 epitope with greater affinity, avidity, more readily, and/or with greater duration than it binds to other IL-20 epitopes or non-IL-20 epitopes. It is also understood by reading this definition that, for example, an antibody that specifically binds to a first target antigen may or may not specifically or preferentially bind to a second target antigen. As such, "specific binding" or "preferential binding" does not necessarily require (although it can include) exclusive binding. Generally, but not necessarily, reference to binding means preferential binding.

Antibodies capable of interfering with the IL-20 signaling pathway can be an antibody that binds an IL-20 (*e.g.*, a human IL-20) and inhibits IL-20 biological activity and/or

downstream pathways mediated by IL-20. Alternatively, such antibodies can be antibodies that bind an IL-20 receptor (IL-20R), *e.g.*, bind to one or both of the subunits of the IL-20 receptor, and suppress the downstream signaling pathways mediated by the receptor triggered by IL-20.

(i) Anti-IL-20 antibodies

An anti-IL-20 antibody is an antibody capable of binding to IL-20 and inhibits IL-20 biological activity and/or downstream pathway(s) mediated by IL-20 signaling. In some examples, an anti-IL-20 antibody used in the methods described herein suppresses the IL-20 signaling pathway by at least 20%, at least 40%, at least 50%, at least 75%, at least 90%, at least 100%, or by at least 2-fold, at least 5-fold, at least 10-fold, at least 20-fold, at least 50-fold, at least 100-fold, or at least 1000-fold. Examples of anti-IL-20 antibodies include, but are not limited to, those disclosed in U.S. Pat. Nos. 7,435,800; 7,115,714; 7,119,175; 7,151,166; and 7,393,684; and PCT publications WO 2007/081465; WO 99/27103; WO 2004/085475; and WO 2005052000.

The binding affinity of an anti-IL-20 antibody to IL-20 (such as human IL-20) can be less than any of about 100 nM, about 50 nM, about 10 nM, about 1 nM, about 500 pM, about 100 pM, or about 50 pM to any of about 2 pM. Binding affinity can be expressed K_D or dissociation constant, and an increased binding affinity corresponds to a decreased K_D. One way of determining binding affinity of antibodies to IL-20 is by measuring binding affinity of monofunctional Fab fragments of the antibody. To obtain monofunctional Fab fragments, an antibody (for example, IgG) can be cleaved with papain or expressed recombinantly. The affinity of an anti-IL-20 Fab fragment of an antibody can be determined by surface plasmon resonance (BIAcore3000^{TM} surface plasmon resonance (SPR) system, BIAcore, INC, Piscaway N.J.). Kinetic association rates (k_{on}) and dissociation rates (k_{off}) (generally measured at 25 ºC.) are obtained; and equilibrium dissociation constant (K_D) values are calculated as k_{off}/k_{on}.

In some embodiments, the antibody binds human IL-20, and does not significantly bind an IL-20 from another mammalian species. In some embodiments, the antibody binds human IL-20 as well as one or more IL-20 from another mammalian species. In still other embodiments, the antibody binds IL-20 and does not significantly cross-react with other cytokines (such as the related cytokines IL-10, IL-17A, IL-19, IL-22, IL-24 and IL-26). The

epitope(s) bound by the antibody can be continuous or discontinuous.

In some embodiments, the anti-IL-20 antibody described herein is anti-IL-20 antibody 7E, which refers to monoclonal antibody mAb 7E and its functional variants. MAb 7E is produced by the hybridoma cell line deposited at the American Type Culture Collection, 10801 University Boulevard, Manassas, Va. 20110-2209, U.S.A. and assigned a deposit number PTA-8687. This hybridoma cell line will be released to the public irrevocably and without restriction/condition upon granting a US patent on this application, and will be maintained in the ATCC for a period of at least 30 years from the date of the deposit for the enforceable life of the patent or for a period of 5 years after the date of the most recent. See also U.S. Patent Nos. 8,206,712 and 7,611,705, the relevant disclosures of each of which are incorporated by reference herein.

The amino acid sequences and encoding nucleotide sequences of the heavy chain variable region (V_H) and light chain variable region (V_L) of mAb7E are produced below:

Nucleotide sequence (SEQ ID NO:1) and amino acid sequence (SEQ ID NO:2) of mAb 7E heavy chain variable region

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gaa ttg aag ctt gag gag tct gga gga ggc ttg gtg cag cct gga 45
 E   L   K   L   E   E   S   G   G   G   L   V   Q   P   G  15

gga tcc atg aaa ctc tct tgt gct gcc tct gga ttc act ttt agt 90
 G   S   M   K   L   S   C   A   A   S   G   F   T   F   S  30

gac gcc tgg atg gac tgg gtc cgc cag tct cca gag aag ggg ctt 135
 D   A   W   M   D   W   V   R   Q   S   P   E   K   G   L   45

gag tgg att gct gaa att aga agc aaa gct aat aat tat gca aca 180
 E   W   I   A   E   I   R   S   K   A   N   N   Y   A   T   60

tac ttt gct gag tct gtg aaa ggg agg ttc acc atc tca aga gat 215
 Y   F   A   E   S   V   K   G   R   F   T   I   S   R   D   75

gat tcc aaa agt ggt gtc tac ctg caa atg aac aac tta aga gct 270
 D   S   K   S   G   V   Y   L   Q   M   N   N   L   R   A   90

gag gac act ggc att tat ttc tgt acc aag tta tca cta cgt tac 315
 E   D   T   G   I   Y   F   C   T   K   L   S   L   R   Y  105

tgg ttc ttc gat gtc tgg ggc gca ggg acc acg gtc acc gtc tcc 360
 W   F   F   D   V   W   G   A   G   T   T   V   T   V   S  120

tca 363
 S  121
```

Nucleotide sequence (SEQ ID NO:3) and amino acid sequence (SEQ ID NO:4) of mAb 7E light chain variable region

```
gat ttt gtg atg acc cag act cca ctc act ttg tcg gtt acc att 45
```

```
 D   F   V   M   T   Q   T   P   L   T   L   S   V   T   I  15

gga caa cca gcc tcc atc tct tgc aag tca agt cag agc ctc ttg 90
 G   Q   P   A   S   I   S   C   K   S   S   Q   S   L   L  30

gat agt gat gga aag aca tat ttg aat tgg ttg tta cag agg cca 135
 D   S   D   G   K   T   Y   L   N   W   L   L   Q   R   P  45

ggc cag tct cca aag cac ctc atc tat ctg gtg tct aaa ctg gac 180
 G   Q   S   P   K   H   L   I   Y   L   V   S   K   L   D  60

tct gga gtc cct gac agg ttc act ggc agt gga tca ggg acc gat 215
 S   G   V   P   D   R   F   T   G   S   G   S   G   T   D  75
ttc aca ctg aga atc agc aga gtg gag gct gag gat ttg gga gtt 270
 F   T   L   R   I   S   R   V   E   A   E   D   L   G   V  90

tat tat tgc tgg caa agt aca cat ttt ccg tgg acg ttc ggt gga 315
 Y   Y   C   W   Q   S   T   H   F   P   W   T   F   G   G 105

ggc acc aag ctg gaa atc aaa cgg 339
 G   T   K   L   E   I   K   R 113
```

A functional variant (equivalent) of mAb7E has essentially the same epitope-binding specificity as mAb7E and exhibits at least 20% (*e.g.*, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or greater) of the activity of neutralizing a signaling pathway mediated by IL-20 as relative to mAb7E. In some embodiments, a functional variant of mAb7E contains the same regions/residues responsible for antigen-binding as mAb7E, such as the same specificity-determining residues in the CDRs or the whole CDRs. The regions/residues that are responsible for antigen-binding can be identified from amino acid sequences of the heavy chain/light chain sequences of mAb7E (shown above) by methods known in the art. See, *e.g.*, www.bioinf.org.uk/abs;, Almagro, J. Mol. Recognit. 17:132-143 (2004); and Chothia et al., J. Mol. Biol. 227:799-817 (1987).

In addition, determination of CDR regions in an antibody is well within the skill of the art. There are at least two techniques for determining CDRs: (1) an approach based on cross-species sequence variability (i.e., Kabat et al. Sequences of Proteins of Immunological Interest, (5th ed., 1991, National Institutes of Health, Bethesda Md.)); and (2) an approach based on crystallographic studies of antigen-antibody complexes (Chothia et al. (1989) Nature 342:877; Al-lazikani et al (1997) J. Molec. Biol. 273:927-948)). Additional approaches include the "IMGT" numbering scheme (Lefranc M P et al., Dev Comp Immunol, 2003 January; 27(1):55-77), and the "AHo" numbering scheme (Honegger A and Pluckthun A, J Mol Biol, 2001 Jun. 8; 309(3):657-70). As used herein, a CDR may refer to CDRs defined by either approach or by a combination of both approaches.

Two heavy chain variable regions (or two light chain variable regions) having the

same CDRs means that the CDRs in the two heavy chain variable regions (or light chain variable regions) as determined by the same numbering scheme are identical.

In some examples, an anti-IL-20 antibody described herein can be a functional variant of mAb7E that comprises a V_H chain that includes a V_H CDR1, V_H CDR2, and V_H CDR3 at least 75% (*e.g.*, 80%, 85%, 90%, 95%, or 98%) identical to the corresponding V_H CDRs of mAb7E, and a V_L chain that includes a V_L CDR1, V_L CDR2, and V_L CDR3 at least 75% (*e.g.*, 80%, 85%, 90%, 95%, or 98%) identical to the corresponding V_H CDRs of mAb7E.

Alternatively, the functional variant of mAb7E comprises a V_H chain at least 75% (*e.g.*, 80%, 85%, 90%, 95%, or 98%) identical to the V_H chain (mature or precursor) of mAb7E and a V_L chain at least 75% (*e.g.*, 80%, 85%, 90%, 95%, or 98%) identical to the V_L chain (mature of precursor) of mAb7E.

The "percent identity" of two amino acid sequences is determined using the algorithm of Karlin and Altschul *Proc. Natl. Acad. Sci.* USA 87:2264-68, 1990, modified as in Karlin and Altschul *Proc. Natl. Acad. Sci.* USA 90:5873-77, 1993. Such an algorithm is incorporated into the NBLAST and XBLAST programs (version 2.0) of Altschul, *et al. J. Mol. Biol.* 215:403-10, 1990. BLAST protein searches can be performed with the XBLAST program, score=50, wordlength=3 to obtain amino acid sequences homologous to the protein molecules of interest. Where gaps exist between two sequences, Gapped BLAST can be utilized as described in Altschul *et al.*, *Nucleic Acids Res.* 25(17):3389-3402, 1997. When utilizing BLAST and Gapped BLAST programs, the default parameters of the respective programs (*e.g.*, XBLAST and NBLAST) can be used.

In other examples, a functional variant of mAb7E comprises a V_H chain that includes up to 5 (*e.g.*, 1, 2, 3, 4, or 5) amino acid residue variations in the V_H CDR regions (V_H CDR1, CDR2, and/or CDR3) as compared to the V_H CDRs of mAb7E, and/or a V_L chain that includes up to 5 (*e.g.*, 1, 2, 3, 4, or 5) amino acid residue variations in the V_L CDR regions (V_L CDR1, CDR2, and/or CDR3) as compared to the V_H CDRs of mAb7E.

Functional variants of mAb7E are also disclosed in US Patent No. 7,611,705 and US2011/0064731, both of which are incorporated by reference herein.

In one example, a functional variant of mAb7E is a humanized antibody derived from mAb7E. Provided below are exemplary humanized mAb7E antibodies HL1 and HL2; see also US Patent No. 8,597,647, the relevant disclosures therein are incorporated by reference.

Amino acid sequence and encoding nucleotide sequence of the V_H chain of humanized

anti-IL-20 antibodies HL1 and HL2:

```
                    ATG TAC TTG GGA CTG AAC TAT GTT TTC ATC GTT TTT CTC CTG AAT
                     M   Y   L   G   L   N   Y   V   F   I   V   F   L   L   N

GGT GTC CAG AGT GAA GTG CAG CTT GTG GAG TCT GGA GGA GGC TTG GTG CAG CCT GGA
 G   V   Q   S   E   V   Q   L   V   E   S   G   G   G   L   V   Q   P   G

GGA TCC CTG AAA CTC TCT TGT GCT GCC TCT GGA TTC ACT TTT AGT GAC GCC TGG ATG
 G   S   L   K   L   S   C   A   A   S   G   F   T   F   S  D  A  W  M

GAC TGG GTC CGC CAG GCT TCC GGG AAG GGG CTT GAG TGG ATT GCT GAA ATT AGA AGC
 D   W   V   R   Q   A   S   G   K   G   L   E   W   I   A  E  I  R  S

AAA GCT AAT AAT TAT GCA ACA TAC TTT GCT GAG TCT GTG AAA GGG AGG TTC ACC ATC
 K  A  N  N  Y  A  T  Y  F  A  E  S  V  K  G   R   F   T   I

TCA AGA GAT GAT TCC AAA AAC ACC GCC TAC CTG CAA ATG AAC AGC TTA AAA ACC GAG
 S   R   D   D   S   K   N   T   A   Y   L   Q   M   N   S   L   K   T   E

GAC ACT GCC GTT TAT TAC TGT ACC AAG TTA TCA CTG CGT TAC TGG TTC TTC GAT GTC
 D   T   A   V   Y   Y   C   T   K  L  S  L  R  Y  W  F  F  D  V

TGG GGC CAG GGG ACC CTG GTC ACC GTC TCC TCA (SEQ ID NO:5)
 W   G   Q   G   T   L   V   T   V   S   S  (SEQ ID NO:6)
```

The underlined region refers to the signal peptide and the boldfaced/italic regions are the CDRs. SEQ ID NOs: 8 and 7 represent the mature V_H amino acid sequence (lacking the signal peptide) and its encoding nucleotide sequence, respectively.

Amino acid sequence and encoding nucleotide sequence of the V_L chain (VL2) of a humanized anti-IL-20 antibody HL2:

```
                ATG ATG AGT CCT GCC CAG TTC CTG TTT CTG TTG GTG CTC TGG ATT
                 M   M   S   P   A   Q   F   L   F   L   L   V   L   W   I

CGG GAA ACC AAC GGT GAT ATC GTG ATG ACC CAG ACT CCA CTC TCT TTG TCC GTT
 R   E   T   N   G   D  I  V   M   T   Q   T   P   L   S   L   S   V

ACC CCT GGA CAA CCA GCC TCC ATC TCT TGC AAG TCA AGT CAG AGC CTC TTG GAT
 T   P   G   Q   P   A   S   I   S   C  K  S  S  Q  S  L  L  D

AGT GAT GGA AAG ACA TAT TTG AAT TGG TTG TTA CAG AAG CCA GGC CAG TCT CCA
 S  D  G  K  T  Y  L  N  W   L   L   Q   K   P   G   Q   S   P

CAG CAC CTC ATC TAT CTG GTG TCT AAA CTG GAC TCT GGA GTC CCT GAC AGG TTC
 Q   H   L   I   Y  L  V  S  K  L  D  S  G   V   P   D   R   F

AGT GGC AGT GGA TCA GGG ACC GAT TTC ACA CTG AAA ATC AGC AGA GTG GAG GCT
 S   G   S   G   S   G   T   D   F   T   L   K   I   S   R   V   E   A

GAG GAT GTT GGA GTT TAT TAT TGC TGG CAA AGT ACA CAT TTT CCC TGG ACC TTC
 E   D   V   G   V   Y   Y   C  W  Q  S  T  H  F  P  W  T  F
```

```
GGT GGA GGC ACC AAG GTG GAA ATC AAA  (SEQ ID NO:9)
G   G   G   T   K   V   E   I   K    (SEQ ID NO:10)
```

The underlined region refers to the signal peptide and the boldfaced/italic regions are the CDRs. SEQ ID NOs: 12 and 11 represent the mature V_L amino acid sequence (lacking the signal peptide) and its encoding nucleotide sequence, respectively.

Humanized antibody HL1 comprises the same V_H chain as HL2 and a V_L chain (SEQ ID NO:13; mature form) that is otherwise identical to the V_L of HL2 except that the I residue at position 2 of mature V_L of HL2 is replaced with F.

Also disclosed herein are functional variants of the above-noted humanized antibodies HL1 and HL2. Such functional variants can comprise a V_H chain that comprises an amino acid sequence at least 85% (e.g., 90%, 92%, 94%, 95%, 96%, 97%, 98%, or 99%) identical to that of the V_H of HL1 and HL2 (precursor or mature form; SEQ ID NO:6 and SEQ ID NO:8, respectively) and a V_L chain that has an amino acid sequence at least 85% (e.g., 90%, 92%, 94%, 95%, 96%, 97%, 98%, or 99%) identical to that of the V_L of HL2 (precursor or mature form; SEQ ID NO:10 and SEQ ID NO:12, respectively). These variants are capable of binding to an IL-20 molecule, particularly a human IL-20 molecule. In some examples, the variants possess similar antigen-binding affinity relative to the exemplary humanized antibody described above (*e.g.*, having a $K_d < 4 \times 10^{-9}$).

In some embodiments, the anti-IL-20 antibody described herein may bind to the same epitope of human IL-20 as mAb7E or competes against mAb7E from binding to human IL-20. An "epitope" refers to the site on a target antigen that is recognized and bound by an antibody. The site can be entirely composed of amino acid components, entirely composed of chemical modifications of amino acids of the protein (*e.g.*, glycosyl moieties), or composed of combinations thereof. Overlapping epitopes include at least one common amino acid residue. An epitope can be linear, which is typically 6-15 amino acids in length. Alternatively, the epitope can be conformational. The epitope to which an antibody binds can be determined by routine technology, for example, the epitope mapping method (see, *e.g.*, descriptions below). An antibody that binds the same epitope as a reference antibody described herein may bind to exactly the same epitope or a substantially overlapping epitope (*e.g.*, containing less than 3 non-overlapping amino acid residue, less than 2 non-overlapping amino acid residues, or only 1 non-overlapping amino acid residue) as the exemplary

antibody. Whether two antibodies compete against each other from binding to the cognate antigen can be determined by a competition assay, which is well known in the art.

(ii) Anti-IL-20R antibodies

An anti-IL-20R antibody is an antibody capable of binding to an IL-20R (e.g., binding to either one of its two subunits or binding to the dimeric complex) and inhibits the biological activity of the IL-20R and/or its downstream pathway(s) mediated by IL-20. In some examples, an anti-IL-20 antibody used in the methods described herein suppresses the IL-20 signaling pathway by at least 20%, at least 40%, at least 50%, at least 75%, at least 90%, at least 100%, or by at least 2-fold, at least 5-fold, at least 10-fold, at least 20-fold, at least 50-fold, at least 100-fold, or at least 1000-fold. In some examples, the anti-IL-20R antibody specifically binds IL-20R1, such as human IL-20R1. Such an antibody may have low affinity to IL-20R2 or the IL-20R1/IL-20R2 complex or does not bind IL-20R2 or the IL-20R1/IL-20R2 complex. In other examples, the anti-IL-20R antibody specifically binds IL-20R2, such as human IL-20R2. Such an antibody may have low affinity to IL-20R1 or the IL-20R1/IL-20R2 complex or does not bind IL-20R1 or the IL-20R1/IL-20R2 complex. In yet other examples, the anti-IL-20R antibody described herein specifically binds the IL-20R1/IL-20R2 complex.

The binding affinity of an anti-IL-20R antibody to IL-20R or a subunit thereof (such as human IL-20R or human IL-20R1) can be less than any of about 100 nM, about 50 nM, about 10 nM, about 1 nM, about 500 pM, about 100 pM, or about 50 pM to any of about 2 pM. Binding affinity can be expressed K_D or dissociation constant, and an increased binding affinity corresponds to a decreased K_D. One way of determining binding affinity of antibodies to IL-20R is by measuring binding affinity of monofunctional Fab fragments of the antibody. To obtain monofunctional Fab fragments, an antibody (for example, IgG) can be cleaved with papain or expressed recombinantly. The affinity of an anti-IL-20R Fab fragment of an antibody can be determined by surface plasmon resonance (BIAcore3000™ surface plasmon resonance (SPR) system, BIAcore, INC, Piscaway N.J.). Kinetic association rates (k_{on}) and dissociation rates (k_{off}) (generally measured at 25ºC.) are obtained; and equilibrium dissociation constant (K_D) values are calculated as k_{off}/k_{on}.

In some embodiments, the antibody binds human IL-20R or a subunit thereof (*e.g.*, human IL-20R1), and does not significantly bind an IL-20R from another mammalian

species. In some embodiments, the antibody binds human IL-20R as well as one or more IL-20R from another mammalian species. In still other embodiments, the antibody binds IL-20R and does not significantly cross-react with other cytokine receptors. The epitope(s) bound by the antibody can be continuous or discontinuous.

In some embodiments, the antibody used in the methods described herein is an antibody having the same heavy chain and light chain variable regions (V_H and V_L) as those of monoclonal antibody mAb7GW or mAb51D, the monoclonal antibodies, an antigen-binding fragment thereof, or a functional equivalent of either mAb7GW or mAb51D. US2011/0256093, which is herein incorporated by reference in its entirety. Shown below are the amino acid sequences of the heavy chains and light chains of mAb7GW and mAb51D, as well as their encoding nucleotide sequences.

Heavy Chain of mAb7GW:

Amino Acid Sequence (SEQ ID NO:14)

M R V L I L L W L F T A F P G I L S V V Q L Q E S G P G L V K P S Q S L S L T C T V T G Y S I
Signal peptide

T **S D Y A W N** W I R Q F P G N R L E W M **G Y I D Y S G S T K Y N P S L K S** R I S V T R D
CDR1 *CDR2*

T S K N Q F F L Q L N S V T T E D T A T Y Y C A R **D F G D A Y** W G Q G T L V T V S A *A K*
CDR3

T T P P S V Y P L A P G S A A Q T N S M V T L G C L V K G Y F P E P V T V T W N S G S L S S G V
H T F P A V L Q S D L Y T L S S S V T V P S S T W P S E T V T C N V A H P A S S T K V D K K I V
P R D C G C K P C I C T V P E V S S V F I F P P K P K D V L T I T L T P K V T C V V V D I S K D
D P E V Q F S W F V D D V E V H T A Q T Q P R E E Q F N S T F R S V S E L P I M H Q D W L N
G K E F K C R V N S A A F P A P I E K T I S K T K G R P K A P Q V Y T I P P P K E Q M A K D K
V S L T C M I T D F F P E D I T V E W Q W N G Q P A E N Y K N T Q P I M D T D G S Y F V Y S K
L N V Q K S N W E A G N T F T C S V L H E G L H N H H T E K S L S H S P G K
(The italic region refers to the heavy chain constant region.)

Nucleotide Sequence (SEQ ID NO:15)

ATGAGAGTGCTGATTCTTTTGTGGCTGTTCACAGCCTTTCCTGGTATCCTGTCTGTTGTGCAGC
Signal peptide

TTCAGGAGTCGGGACCTGGCCTGGTGAAACCTTCTCAGTCTCTGTCCCTCACCTGCACTG
TCACTGGCTACTCAATCACC**AGTGATTATGCCTGGAAC**TGGATCCGGCAGTTTCCAGGA
CDR1

AACAGACTGGAGTGGATGGGC**TACATAGACTACAGTGGTAGCACTAAATACAACCCC**
CDR2

TCTCTCAAAAGTCGAATCTCTGTCACTCGAGACACATCCAAGAACCAGTTCTTCCTGCA
GTTGAATTCTGTGACTACTGAGGACACAGCCACATATTACTGTGCAAGA**GACTTTGGTG**

CDR3

ATGCTTACTGGGGCCAGGGGACTCTGGTCACTGTCTCTGCA*GCCAAAACGACACCCCCAT*
CTGTCTATCCACTGGCCCCTGGATCTGCTGCCCAAACTAACTCCATGGTGACCCTGGGATGCC
TGGTCAAGGGCTATTTCCCTGAGCCAGTGACAGTGACCTGGAACTCTGGATCCCTGTCCAGCG
GTGTGCACACCTTCCCAGCTGTCCTGCAGTCTGACCTCTACACTCTGAGCAGCTCAGTGACTGT
CCCCTCCAGCACCTGGCCCAGCGAGACCGTCACCTGCAACGTTGCCCACCCGGCCAGCAGCA
CCAAGGTGGACAAGAAAATTGTGCCCAGGGATTGTGGTTGTAAGCCTTGCATATGTACAGTCCC
AGAAGTATCATCTGTCTTCATCTTCCCCCCAAAGCCCAAGGATGTGCTCACCATTACTCTGACTC
CTAAGGTCACGTGTGTTGTGGTAGACATCAGCAAGGATGATCCCGAGGTCCAGTTCAGCTGGT
TTGTAGATGATGTGGAGGTGCACACAGCTCAAACGCAACCCCGGGAGGAGCAGTTCAACAGCA
CTTTCCGCTCAGTCAGTGAACTTCCCATCATGCACCAGGACTGGCTCAATGGCAAGGAGTTCAA
ATGCAGGGTCAACAGTGCAGCTTTCCCTGCCCCCATCGAGAAAACCATCTCCAAAACCAAAGG
CAGACCGAAGGCTCCACAGGTGTACACCATTCCACCTCCCAAGGAGCAAATGGCCAAGGATAA
AGTCAGTCTGACCTGCATGATAACAGACTTCTTCCCTGAAGACATTACTGTGGAGTGGCAGTGG
AATGGGCAGCCAGCGGAGAACTACAAGAACACTCAGCCCATCATGGACACAGATGGCTCTTAC
TTCGTCTACAGCAAGCTCAATGTGCAGAAGAGCAACTGGGAGGCAGGAAATACTTTCACCTGCT
CTGTGTTACATGAGGGCCTGCACAACCACCATACTGAGAAGAGCCTCTCCCACTCTCCTGGTAA
ATGA (The italic region encodes the heavy chain constant region.)

Light Chain of mAb7GW:

Amino Acid Sequence (SEQ ID NO:16)

M D S Q A Q V L M L L L L W V S G S C G D I V M S Q S P S S L A V S V G E K V T M S C **K S S**
Signal peptide

Q S L L Y S R N Q K N Y L A W Y Q L K P G Q S P K L L I Y **W A S T R E S** G V P D R F T G
CDR1 *CDR2*

S G S G T D F T L T I S S V K A E D L A V Y Y C **Q Q Y Y S Y P** L T F G A G T K L E L K R *A*
CDR3

D A A P T V S I F P P S S E Q L T S G G A S V V C F L N N F Y P K D I N V K W K I D G S E R Q N
G V L N S W T D Q D S K D S T Y S M S S T L T L T K D E Y E R H N S Y T C E A T H K T S T S P I
V K S F N R N E C (The italic region refers to the light chain constant region.)

Nucleotide Sequence (SEQ ID NO:17)

ATGGATTCACAGGCCCAGGTTCTTATGTTACTGCTGCTATGGGTATCTGGTTCCTGTGGGGACA
Signal peptide

TTGTGATGTCACAGTCTCCATCCTCCCTAGCTGTGTCAGTTGGAGAGAAGGTTACTATGA
GCTGC**AAGTCCAGTCAGAGCCTTTTATATAGTAGGAATCAAAAGAACTACTTGGCC**T
CDR1

GGTACCAGCTGAAGCCAGGGCAGTCTCCTAAACTGCTGATTTAC**TGGGCATCCACTAGG**
CDR2

GAATCTGGGGTCCCTGATCGCTTCACAGGCAGTGGATCTGGGACAGATTTCACTCTCACC
ATCAGCAGTGTGAAGGCTGAAGACCTGGCAGTTTATTACTGT**CAGCAATATTATAGCTA**
CDR3

TCCGCTCACGTTCGGTGCTGGGACCAAGCTGGAGCTGAAACGG*GCTGATGCTGCACCAAC*
TGTATCCATCTTCCCACCATCCAGTGAGCAGTTAACATCTGGAGGTGCCTCAGTCGTGTGCTTC

TTGAACAACTTCTACCCCAAAGACATCAATGTCAAGTGGAAGATTGATGGCAGTGAACGACAAA
ATGGCGTCCTGAACAGTTGGACTGATCAGGACAGCAAAGACAGCACCTACAGCATGAGCAGCA
CCCTCACGTTGACCAAGGACGAGTATGAACGACATAACAGCTATACCTGTGAGGCCACTCACAA
GACATCAACTTCACCCATTGTCAAGAGCTTCAACAGGAATGAGTGTTAG
(The italic region encodes the light chain constant region.)

Heavy Chain of mAb51D:

Amino Acid Sequence (SEQ ID NO:18)

MNFGLSLIFLALILKGVQCEVQLVEAGGDLVKPGGSLKLSCAASGFSLS**NYGMS**WVRQTPDK
Signal peptide *CDR1*

RLEWVA**SISSGGRFTSYPDSVRG**RFTISRDNAKNTLYLQMSGLKSEDTAMYYCAR**HDGNG**
CDR2 *CDR3*

GDYWGQGTSVTVSS*AKTTPPSVYPLAPGSAAQTNSMVTLGCLVKGYFPEPVTVTWNSGSLSSGVH*
TFPAVLQSDLYTLSSSVTVPSSTWPSETVTCNVAHPASSTKVDKKIVPRDCGCKPCICTVPEVSSVFIF
PPKPKDVLTITLTPKVTCVVVDISKDDPEVQFSWFVDDVEVHTAQTQPREEQFNSTFRSVSELPIM
HQDWLNGKEFKCRVNSAAFPAPIEKTISKTKGRPKAPQVYTIPPPKEQMAKDKVSLTCMITDFFPE
DITVEWQWNGQPAENYKNTQPIMDTDGSYFVYSKLNVQKSNWEAGNTFTCSVLHEGLHNHHTEK
SLSHSPGK
(The italic region refers to the heavy chain constant region.)

Nucleotide Sequence (SEQ ID NO:19)

ATGAACTTCGGGCTCAGCCTGATTTTCCTTGCCCTCATTTTAAAAGGTGTCCAGTGTGAGGTGC
Signal peptide

AGCTGGTGGAGGCTGGGGGAGACTTAGTGAAGCCTGGAGGGTCCCTGAAACTCTCCTGT
GCGGCCTCTGGATTCAGTTTGAGT**AACTATGGCATGTCC**TGGGTTCGCCAGACTCCAGA
CDR1

CAAGAGGCTGGAGTGGGTCGCA**AGCATTAGTAGTGGTGGTCGTTTCACCTCCTATCC**
CDR2
AGACAGTGTGAGGGGGCGATTCACCATCTCCAGAGACAATGCCAAGAACACCCTGTAC
CTGCAAATGAGCGGTCTGAAGTCTGAGGACACAGCCATGTATTACTGTGCAAGA**CACGA**
CGGCAACGGTGGGGACTACTGGGGTCAAGGAACCTCAGTCACCGTCTCCTCA*GCCAAA*
CDR3

ACGACACCCCCATCTGTCTATCCACTGGCCCCTGGATCTGCTGCCCAAACTAACTCCATGGTGA
CCCTGGGATGCCTGGTCAAGGGCTATTTCCCTGAGCCAGTGACAGTGACCTGGAACTCTGGAT
CCCTGTCCAGCGGTGTGCACACCTTCCCAGCTGTCCTGCAGTCTGACCTCTACACTCTGAGCA
GCTCAGTGACTGTCCCCTCCAGCACCTGGCCCAGCGAGACCGTCACCTGCAACGTTGCCCAC
CCGGCCAGCAGCACCAAGGTGGACAAGAAAATTGTGCCCAGGGATTGTGGTTGTAAGCCTTGC
ATATGTACAGTCCCAGAAGTATCATCTGTCTTCATCTTCCCCCCAAAGCCCAAGGATGTGCTCA
CCATTACTCTGACTCCTAAGGTCACGTGTGTTGTGGTAGACATCAGCAAGGATGATCCCGAGGT
CCAGTTCAGCTGGTTTGTAGATGATGTGGAGGTGCACACAGCTCAGACGCAACCCCGGGAGGA
GCAGTTCAACAGCACTTTCCGCTCAGTCAGTGAACTTCCCATCATGCACCAGGACTGGCTCAAT
GGCAAGGAGTTCAAATGCAGGGTCAACAGTGCAGCTTTCCCTGCCCCCATCGAGAAAACCATC
TCCAAAACCAAAGGCAGACCGAAGGCTCCACAGGTGTACACCATTCCACCTCCCAAGGAGCAG
ATGGCCAAGGATAAAGTCAGTCTGACCTGCATGATAACAGACTTCTTCCCTGAAGACATTACTG
TGGAGTGGCAGTGGAATGGGCAGCCAGCGGAGAACTACAAGAACACTCAGCCCATCATGGAC
ACAGATGGCTCTTACTTCGTCTACAGCAAGCTCAATGTGCAGAAGAGCAACTGGGAGGCAGGA
AATACTTTCACCTGCTCTGTGTTACATGAGGGCCTGCACAACCACCATACTGAGAAGAGCCTCT

CCCACTCTCCTGGTAAATGA
(The italic region encodes the heavy chain constant region.)

Light Chain of mAb51D:

Amino Acid Sequence (SEQ ID NO:20)

MDFQVQIFSFLLISASVIMSRGQIVLSQFPAILSASPGEKVTMTC**RARSSVSFMH**WYQQKPGS
Signal peptide *CDR1*

SPKPWIY**ATSNLAS**GVPPRFSGSGSGTSYSLTISRVEAEDAATYYC**QQWSSNP**YTFGGGTKLE
CDR2 *CDR3*

IKR*ADAAPTVSIFPPSSEQLTSGGASVVCFLNNFYPKDINVKWKIDGSERQNGVLNSWTDQDSKDST YSMSSTLTLTKDEYERHNSYTCEATHKTSTSPIVKSFNRNEC*
(The italic region refers to the light chain constant region)

Nucleotide Sequence (SEQ ID NO:21)

ATGGATTTTCAAGTGCAGATTTTCAGCTTCCTGCTAATCAGTGCTTCAGTCATAATGTCCA
Signal peptide

GAGGACAAATTGTTCTCTCCCAGTTTCCAGCAATCCTGTCTGCATCTCCAGGGGAGAAGG
TCACAATGACTTGCA**GGGCCAGGTCAAGTGTAAGTTTCATGCAC**TGGTACCAGCAGAA
CDR1

GCCAGGATCCTCCCCCAAACCCTGGATTTAT**GCCACATCCAACCTGGCTTCT**GGAGTCC
CDR2

CTCCTCGCTTCAGTGGCAGTGGGTCTGGGACCTCTTACTCTCTCACAATCAGCAGAGTGG
AGGCTGAAGATGCTGCCACTTATTACTGC**CAGCAGTGGAGTAGTAACCCA**TACACGTTC
CDR3

GGAGGGGGGACTAAGCTGGAAATAAAACGG*GCTGATGCTGCACCAACTGTATCCATCTTCC CACCATCCAGTGAGCAGTTAACATCTGGAGGTGCCTCAGTCGTGTGCTTCTTGAACAACTTCTA CCCCAAAGACATCAATGTCAAGTGGAAGATTGATGGCAGTGAACGACAAAATGGCGTCCTGAA CAGTTGGACTGATCAGGACAGCAAAGACAGCACCTACAGCATGAGCAGCACCCTCACGTTGAC CAAGGACGAGTATGAACGACATAACAGCTATACCTGTGAGGCCACTCACAAGACATCAACTTCA CCCATTGTCAAGAGCTTCAACAGGAATGAGTGTTAG* (The italic region encodes the light chain constant region.)

A functional equivalent of mAb7GW or mAb51D has the same epitope-binding specificity as mAb7GW or mAb51D and exhibits at least 20% (*e.g.*, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or greater) of the activity of neutralizing a signaling pathway mediated by IL-20R1 as relative to mAb7GW or mAb51D. In some embodiments, a functional equivalent of mAb7GW or mAb51D contains the same regions/residues responsible for antigen-binding as mAb7GW or mAb51D, such as the same specificity-determining residues in the CDRs or the whole CDRs. The regions/residues that are responsible for antigen-binding can be identified from amino acid sequences of the heavy chain/light chain sequences

of mAb7GW or mAb51D (shown above) by methods known in the art. See, *e.g.*, www.bioinf.org.uk/abs;, Almagro, J. Mol. Recognit. 17:132-143 (2004); and Chothia et al., J. Mol. Biol. 227:799-817 (1987).

In some examples, a functional equivalent (variant) of mAb7GW or mAb51D comprises a V_H chain that includes a V_H CDR1, V_H CDR2, and V_H CDR3 at least 75% (e.g., 80%, 85%, 90%, 95%, or 98%) identical to the corresponding V_H CDRs of mAb7GW or mAb51D, and a V_L chain that includes a V_L CDR1, V_L CDR2, and V_L CDR3 at least 75% (e.g., 80%, 85%, 90%, 95%, or 98%) identical to the corresponding V_H CDRs of mAb7GW or mAb51D.

Alternatively, the functional equivalent of mAb7GW or mAb51D comprises a V_H chain at least 75% (e.g., 80%, 85%, 90%, 95%, or 98%) identical to the V_H chain (mature or precursor) of mAb7GW or mAb51D and a V_L chain at least 75% (e.g., 80%, 85%, 90%, 95%, or 98%) identical to the V_L chain (mature of precursor) of mAb7GW or mAb51D.

In other examples, a functional equivalent of mAb7GW or mAb51D comprises a V_H chain that includes up to 5 (e.g., 1, 2, 3, 4, or 5) amino acid residue variations in the V_H CDR regions (V_H CDR1, CDR2, and/or CDR3) as compared to the V_H CDRs of mAb7GW or mAb51D, and/or a V_L chain that includes up to 5 (e.g., 1, 2, 3, 4, or 5) amino acid residue variations in the V_L CDR regions (V_L CDR1, CDR2, and/or CDR3) as compared to the V_H CDRs of mAb7GW or mAb51D.

In some embodiments, the anti-IL-20R antibody described herein may bind to the same epitope of the subunit R1 of human IL-20 R as either mAb7GW or mAb51D, or competes against mAb7GW or mAb51D from binding to the subunit R1 of human IL-20.

(iii) Antibody Preparation

Antibodies capable of interfering with the IL-20 signaling pathway as described herein can be made by any method known in the art. See, for example, Harlow and Lane, (1988) Antibodies: A Laboratory Manual, Cold Spring Harbor Laboratory, New York.

In some embodiments, antibodies specific to a target antigen (*e.g.*, human IL-20 or IL-20R1) can be made by the conventional hybridoma technology. The full-length target antigen or a fragment thereof, optionally coupled to a carrier protein such as KLH, can be used to immunize a host animal for generating antibodies binding to that antigen. The route and schedule of immunization of the host animal are generally in keeping with established and conventional techniques for antibody stimulation and production, as further described

herein. General techniques for production of mouse, humanized, and human antibodies are known in the art and are described herein. It is contemplated that any mammalian subject including humans or antibody producing cells therefrom can be manipulated to serve as the basis for production of mammalian, including human hybridoma cell lines. Typically, the host animal is inoculated intraperitoneally, intramuscularly, orally, subcutaneously, intraplantar, and/or intradermally with an amount of immunogen, including as described herein.

Hybridomas can be prepared from the lymphocytes and immortalized myeloma cells using the general somatic cell hybridization technique of Kohler, B. and Milstein, C. (1975) Nature 256:495-497 or as modified by Buck, D. W., et al., In Vitro, 18:377-381 (1982). Available myeloma lines, including but not limited to X63-Ag8.653 and those from the Salk Institute, Cell Distribution Center, San Diego, Calif., USA, may be used in the hybridization. Generally, the technique involves fusing myeloma cells and lymphoid cells using a fusogen such as polyethylene glycol, or by electrical means well known to those skilled in the art. After the fusion, the cells are separated from the fusion medium and grown in a selective growth medium, such as hypoxanthine-aminopterin-thymidine (HAT) medium, to eliminate unhybridized parent cells. Any of the media described herein, supplemented with or without serum, can be used for culturing hybridomas that secrete monoclonal antibodies. As another alternative to the cell fusion technique, EBV immortalized B cells may be used to produce the anti-IL-20 monoclonal antibodies of the subject invention. The hybridomas are expanded and subcloned, if desired, and supernatants are assayed for anti-immunogen activity by conventional immunoassay procedures (*e.g.*, radioimmunoassay, enzyme immunoassay, or fluorescence immunoassay).

Hybridomas that may be used as source of antibodies encompass all derivatives, progeny cells of the parent hybridomas that produce monoclonal antibodies capable of interfering with the IL-20 signaling pathway. Hybridomas that produce such antibodies may be grown in vitro or in vivo using known procedures. The monoclonal antibodies may be isolated from the culture media or body fluids, by conventional immunoglobulin purification procedures such as ammonium sulfate precipitation, gel electrophoresis, dialysis, chromatography, and ultrafiltration, if desired. Undesired activity if present, can be removed, for example, by running the preparation over adsorbents made of the immunogen attached to a solid phase and eluting or releasing the desired antibodies off the immunogen.

Immunization of a host animal with a target antigen or a fragment containing the target amino acid sequence conjugated to a protein that is immunogenic in the species to be immunized, *e.g.*, keyhole limpet hemocyanin, serum albumin, bovine thyroglobulin, or soybean trypsin inhibitor using a bifunctional or derivatizing agent, for example maleimidobenzoyl sulfosuccinimide ester (conjugation through cysteine residues), N-hydroxysuccinimide (through lysine residues), glutaraldehyde, succinic anhydride, SOCl, or R1N=C=NR, where R and R1 are different alkyl groups, can yield a population of antibodies (*e.g.*, monoclonal antibodies).

If desired, an antibody (monoclonal or polyclonal) of interest (*e.g.*, produced by a hybridoma) may be sequenced and the polynucleotide sequence may then be cloned into a vector for expression or propagation. The sequence encoding the antibody of interest may be maintained in vector in a host cell and the host cell can then be expanded and frozen for future use. In an alternative, the polynucleotide sequence may be used for genetic manipulation to "humanize" the antibody or to improve the affinity (affinity maturation), or other characteristics of the antibody. For example, the constant region may be engineered to more resemble human constant regions to avoid immune response if the antibody is used in clinical trials and treatments in humans. It may be desirable to genetically manipulate the antibody sequence to obtain greater affinity to the target antigen and greater efficacy in inhibiting the signaling pathway mediated by IL-20. It will be apparent to one of skill in the art that one or more polynucleotide changes can be made to the antibody and still maintain its binding specificity to the target antigen.

In other embodiments, fully human antibodies can be obtained by using commercially available mice that have been engineered to express specific human immunoglobulin proteins. Transgenic animals that are designed to produce a more desirable (*e.g.*, fully human antibodies) or more robust immune response may also be used for generation of humanized or human antibodies. Examples of such technology are Xenomouse^{RTM} from Amgen, Inc. (Fremont, Calif.) and HuMAb-Mouse^{RTM} and TC Mouse^{TM} from Medarex, Inc. (Princeton, N.J.). In another alternative, antibodies may be made recombinantly by phage display technology. See, for example, U.S. Pat. Nos. 5,565,332; 5,580,717; 5,733,743; and 6,265,150; and Winter et al., (1994) Annu. Rev. Immunol. 12:433-455. Alternatively, the phage display technology (McCafferty et al., (1990) Nature 348:552-553) can be used to produce human antibodies and antibody fragments in vitro, from immunoglobulin variable

(V) domain gene repertoires from unimmunized donors.

Antigen-binding fragments of an intact antibody (full-length antibody) can be prepared via routine methods. For example, F(ab')2 fragments can be produced by pepsin digestion of an antibody molecule, and Fab fragments that can be generated by reducing the disulfide bridges of F(ab')2 fragments.

Genetically engineered antibodies, such as humanized antibodies, chimeric antibodies, single-chain antibodies, and bi-specific antibodies, can be produced via, e.g., conventional recombinant technology. In one example, DNA encoding a monoclonal antibodies specific to a target antigen can be readily isolated and sequenced using conventional procedures (*e.g.*, by using oligonucleotide probes that are capable of binding specifically to genes encoding the heavy and light chains of the monoclonal antibodies). The hybridoma cells serve as a preferred source of such DNA. Once isolated, the DNA may be placed into one or more expression vectors, which are then transfected into host cells such as *E. coli* cells, simian COS cells, Chinese hamster ovary (CHO) cells, or myeloma cells that do not otherwise produce immunoglobulin protein, to obtain the synthesis of monoclonal antibodies in the recombinant host cells. See, *e.g.*, PCT Publication No. WO 87/04462. The DNA can then be modified, for example, by substituting the coding sequence for human heavy and light chain constant domains in place of the homologous murine sequences, Morrison et al., (1984) Proc. Nat. Acad. Sci. 81:6851, or by covalently joining to the immunoglobulin coding sequence all or part of the coding sequence for a non-immunoglobulin polypeptide. In that manner, genetically engineered antibodies, such as "chimeric" or "hybrid" antibodies; can be prepared that have the binding specificity of a target antigen.

Techniques developed for the production of "chimeric antibodies" are well known in the art. See, *e.g.*, Morrison et al. (1984) Proc. Natl. Acad. Sci. USA 81, 6851; Neuberger et al. (1984) Nature 312, 604; and Takeda et al. (1984) Nature 314:452.

Methods for constructing humanized antibodies are also well known in the art. See, *e.g.*, Queen et al., *Proc. Natl. Acad. Sci. USA*, 86:10029-10033 (1989). In one example, variable regions of V_H and V_L of a parent non-human antibody are subjected to three-dimensional molecular modeling analysis following methods known in the art. Next, framework amino acid residues predicted to be important for the formation of the correct CDR structures are identified using the same molecular modeling analysis. In parallel,

human V_H and V_L chains having amino acid sequences that are homologous to those of the parent non-human antibody are identified from any antibody gene database using the parent V_H and V_L sequences as search queries. Human V_H and V_L acceptor genes are then selected.

The CDR regions within the selected human acceptor genes can be replaced with the CDR regions from the parent non-human antibody or functional variants thereof. When necessary, residues within the framework regions of the parent chain that are predicted to be important in interacting with the CDR regions (see above description) can be used to substitute for the corresponding residues in the human acceptor genes.

A single-chain antibody can be prepared via recombinant technology by linking a nucleotide sequence coding for a heavy chain variable region and a nucleotide sequence coding for a light chain variable region. Preferably, a flexible linker is incorporated between the two variable regions. Alternatively, techniques described for the production of single chain antibodies (U.S. Patent Nos. 4,946,778 and 4,704,692) can be adapted to produce a phage scFv library and scFv clones specific to IL-20R1 or IL-20R2 can be identified from the library following routine procedures. Positive clones can be subjected to further screening to identify those that suppress IL-20 receptor activity.

Antibodies obtained following a method known in the art and described herein can be characterized using methods well known in the art. For example, one method is to identify the epitope to which the antigen binds, or "epitope mapping." There are many methods known in the art for mapping and characterizing the location of epitopes on proteins, including solving the crystal structure of an antibody-antigen complex, competition assays, gene fragment expression assays, and synthetic peptide-based assays, as described, for example, in Chapter 11 of Harlow and Lane, Using Antibodies, a Laboratory Manual, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., 1999. In an additional example, epitope mapping can be used to determine the sequence to which an antibody binds. The epitope can be a linear epitope, *i.e.*, contained in a single stretch of amino acids, or a conformational epitope formed by a three-dimensional interaction of amino acids that may not necessarily be contained in a single stretch (primary structure linear sequence). Peptides of varying lengths (*e.g.*, at least 4-6 amino acids long) can be isolated or synthesized (*e.g.*, recombinantly) and used for binding assays with an antibody. In another example, the epitope to which the antibody binds can be determined in a systematic screening by using overlapping peptides derived from the target antigen sequence and determining binding by

the antibody. According to the gene fragment expression assays, the open reading frame encoding the target antigen is fragmented either randomly or by specific genetic constructions and the reactivity of the expressed fragments of the antigen with the antibody to be tested is determined. The gene fragments may, for example, be produced by PCR and then transcribed and translated into protein in vitro, in the presence of radioactive amino acids. The binding of the antibody to the radioactively labeled antigen fragments is then determined by immunoprecipitation and gel electrophoresis. Certain epitopes can also be identified by using large libraries of random peptide sequences displayed on the surface of phage particles (phage libraries). Alternatively, a defined library of overlapping peptide fragments can be tested for binding to the test antibody in simple binding assays. In an additional example, mutagenesis of an antigen binding domain, domain swapping experiments and alanine scanning mutagenesis can be performed to identify residues required, sufficient, and/or necessary for epitope binding. For example, domain swapping experiments can be performed using a mutant of a target antigen in which various fragments of the IL-20 polypeptide have been replaced (swapped) with sequences from a closely related, but antigenically distinct protein (such as another member of the neurotrophin protein family). By assessing binding of the antibody to the mutant IL-20, the importance of the particular antigen fragment to antibody binding can be assessed.

Alternatively, competition assays can be performed using other antibodies known to bind to the same antigen to determine whether an antibody binds to the same epitope as the other antibodies. Competition assays are well known to those of skill in the art.

Other IL-20 antagonists

IL-20 antagonists other than antibodies capable of interfering with the IL-20 signaling pathway as described above can be used in the methods described herein.

In some embodiments of the invention, the IL-20 antagonist comprises at least one antisense nucleic acid molecule capable of blocking or decreasing the expression of a functional IL-20 (*e.g.*, a human IL-20) or a subunit of an IL-20 receptor (*e.g.*, IL-20R1). Nucleotide sequences of the IL-20 and IL-20 receptor subunits are known and are readily available from publicly available databases. See above disclosures. It is routine to prepare antisense oligonucleotide molecules that will specifically bind a target mRNA without cross-reacting with other polynucleotides. Exemplary sites of targeting include, but are not limited

to, the initiation codon, the 5' regulatory regions, the coding sequence and the 3' untranslated region. In some embodiments, the oligonucleotides are about 10 to 100 nucleotides in length, about 15 to 50 nucleotides in length, about 18 to 25 nucleotides in length, or more. The oligonucleotides can comprise backbone modifications such as, for example, phosphorothioate linkages, and 2'-0 sugar modifications well known in the art.

Alternatively, IL-20/IL-20R expression and/or release can be decreased using gene knockdown, morpholino oligonucleotides, small interfering RNA (siRNA or RNAi), microRNA or ribozymes, methods that are well-known in the art. RNA interference (RNAi) is a process in which a dsRNA directs homologous sequence-specific degradation of messenger RNA. In mammalian cells, RNAi can be triggered by 21-nucleotide duplexes of small interfering RNA (siRNA) without activating the host interferon response. The dsRNA used in the methods disclosed herein can be a siRNA (containing two separate and complementary RNA chains) or a short hairpin RNA (*i.e.*, a RNA chain forming a tight hairpin structure), both of which can be designed based on the sequence of the target gene. Alternatively, it can be a microRNA.

Optionally, a nucleic acid molecule to be used in the method described herein (*e.g.*, an antisense nucleic acid, a small interfering RNA, or a microRNA) as described above contains non-naturally-occurring nucleobases, sugars, or covalent internucleoside linkages (backbones). Such a modified oligonucleotide confers desirable properties such as enhanced cellular uptake, improved affinity to the target nucleic acid, and increased *in vivo* stability.

In one example, the nucleic acid has a modified backbone, including those that retain a phosphorus atom (see, *e.g.*, U.S. Patents 3,687,808; 4,469,863; 5,321,131; 5,399,676; and 5,625,050) and those that do not have a phosphorus atom (see, *e.g.*, US Patents 5,034,506; 5,166,315; and 5,792,608). Examples of phosphorus-containing modified backbones include, but are not limited to, phosphorothioates, chiral phosphorothioates, phosphorodithioates, phosphotriesters, aminoalkyl-phosphotriesters, methyl and other alkyl phosphonates including 3'-alkylene phosphonates, 5'-alkylene phosphonates and chiral phosphonates, phosphinates, phosphoramidates including 3'-amino phosphoramidate and aminoalkylphosphoramidates, thionophosphoramidates, thionoalkylphosphonates, thionoalkylphosphotriesters, selenophosphates and boranophosphates having 3'-5' linkages, or 2'-5' linkages. Such backbones also include those having inverted polarity, *i.e.*, 3' to 3', 5' to 5' or 2' to 2' linkage. Modified backbones that do not include a phosphorus atom are formed

by short chain alkyl or cycloalkyl internucleoside linkages, mixed heteroatom and alkyl or cycloalkyl internucleoside linkages, or one or more short chain heteroatomic or heterocyclic internucleoside linkages. Such backbones include those having morpholino linkages (formed in part from the sugar portion of a nucleoside); siloxane backbones; sulfide, sulfoxide and sulfone backbones; formacetyl and thioformacetyl backbones; methylene formacetyl and thioformacetyl backbones; riboacetyl backbones; alkene containing backbones; sulfamate backbones; methyleneimino and methylenehydrazino backbones; sulfonate and sulfonamide backbones; amide backbones; and others having mixed N, O, S and CH_2 component parts.

In another example, the nucleic acid used in the disclosed methods includes one or more substituted sugar moieties. Such substituted sugar moieties can include one of the following groups at their 2' position: OH; F; O-alkyl, S-alkyl, N-alkyl, O-alkenyl, S-alkenyl, N-alkenyl; O- alkynyl, S-alkynyl, N-alkynyl, and O-alkyl-O-alkyl. In these groups, the alkyl, alkenyl and alkynyl can be substituted or unsubstituted C_1 to C_{10} alkyl or C_2 to C_{10} alkenyl and alkynyl. They may also include at their 2' position heterocycloalkyl, heterocycloalkaryl, aminoalkylamino, polyalkylamino, substituted silyl, an RNA cleaving group, a reporter group, an intercalator, a group for improving the pharmacokinetic properties of an oligonucleotide, or a group for improving the pharmacodynamic properties of an oligonucleotide. Preferred substituted sugar moieties include those having 2'-methoxyethoxy, 2'-dimethylaminooxyethoxy, and 2'-dimethylaminoethoxyethoxy. See Martin et al., Helv. Chim. Acta, 1995, 78, 486-504.

In yet another example, the nucleic acid includes one or more modified native nucleobases (*i.e.*, adenine, guanine, thymine, cytosine and uracil). Modified nucleobases include those described in U.S. Patent 3,687,808, The Concise Encyclopedia Of Polymer Science And Engineering, pages 858-859, Kroschwitz, J. I., ed. John Wiley & Sons, 1990, Englisch et al., Angewandte Chemie, International Edition, 1991, 30, 613, and Sanghvi, Y. S., Chapter 15, Antisense Research and Applications, pages 289-302, CRC Press, 1993. Certain of these nucleobases are particularly useful for increasing the binding affinity of the antisense oligonucleotide to its target nucleic acid. These include 5-substituted pyrimidines, 6-azapyrimidines and N-2, N-6 and O-6 substituted purines (*e.g.*, 2-aminopropyl-adenine, 5-propynyluracil and 5-propynylcytosine). See Sanghvi, et al., eds., Antisense Research and Applications, CRC Press, Boca Raton, 1993, pp. 276-278).

Any of the nucleic acids can be synthesized by methods known in the art. See, e.g.,

Caruthers et al., 1992, Methods in Enzymology 211, 3-19, Wincott et al., 1995, Nucleic Acids Res. 23, 2677-2684, Wincott et al., 1997, Methods Mol. Bio. 74, 59, Brennan et al., 1998, Biotechnol Bioeng., 61, 33-45, and Brennan, U.S. Pat. No. 6,001,311. It can also be transcribed from an expression vector and isolated using standard techniques.

In other embodiments, the IL-20 antagonist comprises at least one IL-20 or IL-20R inhibitory compound. As used herein, "IL-20 inhibitory compound" or "IL-20R inhibitory compound" refers to a compound other than an anti-IL-20 or anti-IL-20R antibody that directly or indirectly reduces, inhibits, neutralizes, or abolishes IL-20/IL-20R biological activity. An IL-20/IL-20R inhibitory compound should exhibit any one or more of the following characteristics: (a) binds to IL-20 or IL-20R and inhibits its biological activity and/or downstream pathways mediated by IL-20 signaling function; (b) prevents, ameliorates, or treats any aspect of eye disease; (c) blocks or decreases IL-20 receptor activation; (d) increases clearance of IL-20 or IL-20R; (e) inhibits (reduces) IL-20 or IL-20R synthesis, production or release. One skilled in the art can prepare other small molecules inhibitory compounds.

In some embodiments, an IL-20 or IL-20R inhibitory compound is an IL-20 mutant, an IL-19 mutant, or an IL-24 mutant, which can bind to an IL-20 receptor but cannot elicit signal transduction. Such a mutant may block binding of wild type IL-20 to an IL-20 receptor thus preventing IL-20 signal transduction.

In other embodiments, the IL-20 or IL-20R inhibitory compounds described herein are small molecules, which can have a molecular weight of about any of 100 to 20,000 daltons, 500 to 15,000 daltons, or 1000 to 10,000 daltons. Libraries of small molecules are commercially available. The small molecules can be administered using any means known in the art, including inhalation, intraperitoneally, intravenously, intramuscularly, subcutaneously, intrathecally, intraventricularly, orally, enterally, parenterally, intranasally, or dermally. In general, when the IL-20-antagonist according to the invention is a small molecule, it will be administered at the rate of 0.1 to 300 mg/kg of the weight of the patient divided into one to three or more doses. For an adult patient of normal weight, doses ranging from 1 mg to 5 g per dose can be administered.

The above-mentioned small molecules can be obtained from compound libraries. The libraries can be spatially addressable parallel solid phase or solution phase libraries. See, *e.g.*, Zuckermann et al. J. Med .Chem. 37, 2678-2685, 1994; and Lam Anticancer Drug Des.

12:145, 1997. Methods for the synthesis of compound libraries are well known in the art, e.g., DeWitt et al. PNAS USA 90:6909, 1993; Erb et al. PNAS USA 91:11422, 1994; Zuckermann et al. J. Med. Chem. 37:2678, 1994; Cho et al. Science 261:1303, 1993; Carrell et al. Angew Chem. Int. Ed. Engl. 33:2059, 1994; Carell et al. Angew Chem. Int. Ed. Engl. 33:2061, 1994; and Gallop et al. J. Med. Chem. 37:1233, 1994. Libraries of compounds may be presented in solution (e.g., Houghten Biotechniques 13:412-421, 1992), or on beads (Lam Nature 354:82-84, 1991), chips (Fodor Nature 364:555-556, 1993), bacteria (U.S. Patent No. 5,223,409), spores (U.S. Patent No. 5,223,409), plasmids (Cull et al. PNAS USA 89:1865-1869, 1992), or phages (Scott and Smith Science 249:386-390, 1990; Devlin Science 249:404-406, 1990; Cwirla et al. PNAS USA 87:6378-6382, 1990; Felici J. Mol. Biol. 222:301-310, 1991; and U.S. Patent No. 5,223,409).

In other embodiments, the IL-20 antagonists can be a polypeptide comprising an extracellular portion of an IL-20 receptor (such as IL-20 R1, IL-20R2, or IL-22R1), wherein the polypeptide specifically binds to 11-20 and blocks its interaction with one or more IL-20 receptors. In some embodiments, the extracellular portion of the IL-20 receptor is fused to a Fc domain of antibody. Examples of the soluble receptors are described in PCT WO 01/46232.

Identification of IL-20 Antagonists

IL-20 antagonists can be identified or characterized using methods known in the art, whereby reduction, amelioration, or neutralization of an IL-20 biological activity is detected and/or measured. For example, an ELISA-type assay may be suitable for qualitative or quantitative measurement of IL-20 mediated kinase activation by measuring the phosphorylation of proteins activated through an IL-20 cascade. Examples include JNK, ERK, AKT, p38, STAT3 and TRAF6.

The IL-20 antagonists can also be identified by incubating a candidate agent with IL-20 or IL-20R and monitoring any one or more of the following characteristics: (a) binding to IL-20 or IL-20R and inhibiting its biological activity and/or downstream pathways mediated by IL-20 signaling function; (b) preventing, ameliorating, or treating any aspect of eye disease; (c) blocking or decreasing IL-20 receptor activation; (d) increasing clearance of IL-20 or IL-20R; (e) inhibiting (reducing) IL-20 synthesis, production or release. In some embodiments, an IL-20 antagonist is identified by incubating a candidate agent with IL-20 or IL-20R and monitoring binding and attendant reduction or neutralization of a biological

activity of IL-20 or IL-20R. The binding assay may be performed with purified IL-20 or IL-20R polypeptide(s), or with cells naturally expressing, or transfected to express, IL-20 or IL-20R polypeptide(s). In one embodiment, the binding assay is a competitive binding assay, where the ability of a candidate antibody to compete with a known IL-20 antagonist for IL-20 or IL-20R binding is evaluated. The assay may be performed in various formats, including the ELISA format. In other embodiments, an IL-20 antagonist is identified by incubating a candidate agent with IL-20 or IL-20R (*e.g.*, IL-20R1) and monitoring attendant inhibition of IL-20R1/IL-20R2 complex formation or IL-20R2/IL-22R1 complex formation. Following initial identification, the activity of a candidate IL-20 antagonist can be further confirmed and refined by bioassays, known to test the targeted biological activities. Alternatively, bioassays can be used to screen candidates directly.

The examples provided below provide a number of assays that can be used to screen candidate IL-20 antagonists. Bioassays include but are not limited to flow cytometry of determine competitive binding of IL-20 to cells in the presence of candidate IL-20 antagonists; and inhibition of IL-20-induced apoptosis in renal epithelial cells. In addition, RT-PCR or Real-time PCR which can be used to directly measure IL-20 expression or to measure expression of genes upregulated by IL-20 such as TNFα MCP-1, IL-1β, IL-6 and VEGF.

Pharmaceutical Compositions

One or more of the above-described IL-20 antagonist can be mixed with a pharmaceutically acceptable carrier (excipient), including buffer, to form a pharmaceutical composition for use in alleviating eye disease. "Acceptable" means that the carrier must be compatible with the active ingredient of the composition (and preferably, capable of stabilizing the active ingredient) and not deleterious to the subject to be treated. Pharmaceutically acceptable excipients (carriers) including buffers, which are well known in the art. See, *e.g.*, Remington: The Science and Practice of Pharmacy 20th Ed. (2000) Lippincott Williams and Wilkins, Ed. K. E. Hoover. In one example, a pharmaceutical composition described herein contains more than one anti-IL-20 or anti-IL-20R antibodies that recognize different epitopes of the target antigen. In another example, the pharmaceutical composition comprises at least two different-typed IL-20 antagonists (e.g., one antibody and one small molecule).

The pharmaceutical compositions to be used in the present methods can comprise

pharmaceutically acceptable carriers, excipients, or stabilizers in the form of lyophilized formulations or aqueous solutions. (Remington: The Science and Practice of Pharmacy 20th Ed. (2000) Lippincott Williams and Wilkins, Ed. K. E. Hoover). Acceptable carriers, excipients, or stabilizers are nontoxic to recipients at the dosages and concentrations used, and may comprise buffers such as phosphate, citrate, and other organic acids; antioxidants including ascorbic acid and methionine; preservatives (such as octadecyldimethylbenzyl ammonium chloride; hexamethonium chloride; benzalkonium chloride, benzethonium chloride; phenol, butyl or benzyl alcohol; alkyl parabens such as methyl or propyl paraben; catechol; resorcinol; cyclohexanol; 3-pentanol; and m-cresol); low molecular weight (less than about 10 residues) polypeptides; proteins, such as serum albumin, gelatin, or immunoglobulins; hydrophilic polymers such as polyvinylpyrrolidone; amino acids such as glycine, glutamine, asparagine, histidine, arginine, or lysine; monosaccharides, disaccharides, and other carbohydrates including glucose, mannose, or dextrans; chelating agents such as EDTA; sugars such as sucrose, mannitol, trehalose or sorbitol; salt-forming counter-ions such as sodium; metal complexes (*e.g.*, Zn-protein complexes); and/or non-ionic surfactants such as TWEEN™, PLURONICS™ or polyethylene glycol (PEG). Pharmaceutically acceptable excipients are further described herein.

In some examples, the pharmaceutical composition described herein comprises liposomes containing the IL-20 antagonist (such as an antibody), which can be prepared by methods known in the art, such as described in Epstein, et al., Proc. Natl. Acad. Sci. USA 82:3688 (1985); Hwang, et al., Proc. Natl. Acad. Sci. USA 77:4030 (1980); and U.S. Pat. Nos. 4,485,045 and 4,544,545. Liposomes with enhanced circulation time are disclosed in U.S. Pat. No. 5,013,556. Particularly useful liposomes can be generated by the reverse phase evaporation method with a lipid composition comprising phosphatidylcholine, cholesterol and PEG-derivatized phosphatidylethanolamine (PEG-PE). Liposomes are extruded through filters of defined pore size to yield liposomes with the desired diameter.

The active ingredients (*e.g.*, an IL-20 antagonist) may also be entrapped in microcapsules prepared, for example, by coacervation techniques or by interfacial polymerization, for example, hydroxymethylcellulose or gelatin-microcapsules and poly-(methylmethacylate) microcapsules, respectively, in colloidal drug delivery systems (for example, liposomes, albumin microspheres, microemulsions, nano-particles and nanocapsules) or in macroemulsions. Such techniques are known in the art, see, *e.g.*,

Remington, The Science and Practice of Pharmacy 20th Ed. Mack Publishing (2000).

In other examples, the pharmaceutical composition described herein can be formulated in sustained-release format. Suitable examples of sustained-release preparations include semipermeable matrices of solid hydrophobic polymers containing the antibody, which matrices are in the form of shaped articles, *e.g.*, films, or microcapsules. Examples of sustained-release matrices include polyesters, hydrogels (for example, poly(2-hydroxyethyl-methacrylate), or poly(vinylalcohol), polylactides (U.S. Pat. No. 3,773,919), copolymers of L-glutamic acid and 7 ethyl-L-glutamate, non-degradable ethylene-vinyl acetate, degradable lactic acid-glycolic acid copolymers such as the LUPRON DEPOT™ (injectable microspheres composed of lactic acid-glycolic acid copolymer and leuprolide acetate), sucrose acetate isobutyrate, and poly-D-(-)-3-hydroxybutyric acid.

The pharmaceutical compositions to be used for *in vivo* administration must be sterile. This is readily accomplished by, for example, filtration through sterile filtration membranes. Therapeutic antibody compositions are generally placed into a container having a sterile access port, for example, an intravenous solution bag or vial having a stopper pierceable by a hypodermic injection needle.

The pharmaceutical compositions described herein can be in unit dosage forms such as tablets, pills, capsules, powders, granules, solutions or suspensions, or suppositories, for oral, parenteral or rectal administration, or administration by inhalation or insufflation.

For preparing solid compositions such as tablets, the principal active ingredient can be mixed with a pharmaceutical carrier, *e.g.*, conventional tableting ingredients such as corn starch, lactose, sucrose, sorbitol, talc, stearic acid, magnesium stearate, dicalcium phosphate or gums, and other pharmaceutical diluents, *e.g.*, water, to form a solid preformulation composition containing a homogeneous mixture of a compound of the present invention, or a non-toxic pharmaceutically acceptable salt thereof. When referring to these preformulation compositions as homogeneous, it is meant that the active ingredient is dispersed evenly throughout the composition so that the composition may be readily subdivided into equally effective unit dosage forms such as tablets, pills and capsules. This solid preformulation composition is then subdivided into unit dosage forms of the type described above containing from 0.1 to about 500 mg of the active ingredient of the present invention. The tablets or pills of the novel composition can be coated or otherwise compounded to provide a dosage form affording the advantage of prolonged action. For example, the tablet or pill can comprise an

inner dosage and an outer dosage component, the latter being in the form of an envelope over the former. The two components can be separated by an enteric layer that serves to resist disintegration in the stomach and permits the inner component to pass intact into the duodenum or to be delayed in release. A variety of materials can be used for such enteric layers or coatings, such materials including a number of polymeric acids and mixtures of polymeric acids with such materials as shellac, cetyl alcohol and cellulose acetate.

Suitable surface-active agents include, in particular, non-ionic agents, such as polyoxyethylenesorbitans (*e.g.*, Tween™ 20, 40, 60, 80 or 85) and other sorbitans (*e.g.*, Span™ 20, 40, 60, 80 or 85). Compositions with a surface-active agent will conveniently comprise between 0.05 and 5% surface-active agent, and can be between 0.1 and 2.5%. It will be appreciated that other ingredients may be added, for example mannitol or other pharmaceutically acceptable vehicles, if necessary.

Suitable emulsions may be prepared using commercially available fat emulsions, such as Intralipid™, Liposyn™, Infonutrol™, Lipofundin™ and Lipiphysan™. The active ingredient may be either dissolved in a pre-mixed emulsion composition or alternatively it may be dissolved in an oil (*e.g.*, soybean oil, safflower oil, cottonseed oil, sesame oil, corn oil or almond oil) and an emulsion formed upon mixing with a phospholipid (*e.g.*, egg phospholipids, soybean phospholipids or soybean lecithin) and water. It will be appreciated that other ingredients may be added, for example glycerol or glucose, to adjust the tonicity of the emulsion. Suitable emulsions will typically contain up to 20% oil, for example, between 5 and 20%. The fat emulsion can comprise fat droplets between 0.1 and 1.0 μm, particularly 0.1 and 0.5 μm, and have a pH in the range of 5.5 to 8.0.

The emulsion compositions can be those prepared by mixing an IL-20 antagonist with Intralipid™ or the components thereof (soybean oil, egg phospholipids, glycerol and water).

Pharmaceutical compositions for inhalation or insufflation include solutions and suspensions in pharmaceutically acceptable, aqueous or organic solvents, or mixtures thereof, and powders. The liquid or solid compositions may contain suitable pharmaceutically acceptable excipients as set out above. In some embodiments, the compositions are administered by the oral or nasal respiratory route for local or systemic effect.

Compositions in preferably sterile pharmaceutically acceptable solvents may be nebulised by use of gases. Nebulised solutions may be breathed directly from the nebulising

device or the nebulising device may be attached to a face mask, tent or intermittent positive pressure breathing machine. Solution, suspension or powder compositions may be administered, preferably orally or nasally, from devices which deliver the formulation in an appropriate manner.

Use of IL-20 Antagonists for Treating Eye Diseases

To practice the method disclosed herein, an effective amount of the pharmaceutical composition described above can be administered to a subject (*e.g.*, a human) in need of the treatment via a suitable route, such as intravenous administration, *e.g.*, as a bolus or by continuous infusion over a period of time, by intraocular injection, intravitreal injection, intrastromal injection, subretinal injection or by topical routes.

The subject to be treated by the methods described herein can be a mammal, more preferably a human. Mammals include, but are not limited to, farm animals, sport animals, pets, primates, horses, dogs, cats, mice and rats. A human subject who needs the treatment may be a human patient having, at risk for, or suspected of having an eye disease, for example, dry eye disease (DED), which may be aqueous tear-deficient dry eye or evaporative dry eye, and age-related macular degeneration (ADM), including wet ADM or dry ADM. Additional retinal conditions include, but are not limited to, diabetic macular edema (DME) and diabetic retinopathy (DR) in DME, and macular edema following retinal vein occlusion (RVO). A subject having an eye disease such as those described herein can be identified by routine medical examination, *e.g.*, comprehensive eye exam, measuring the volume of tears, determining the quality of tears, visual acuity test, dilated eye exam, Amsler grid test, fluorescein angiography, or optical coherence tomography (OCT). A subject suspected of having an eye disease might show one or more symptoms of the disorder, *e.g.*, burning sensation in the eyes, mucus in or around the eyes, sensitivity to light, eye redness, blurred vision, eye fatigue, watery eyes, visual distortions, reduced central vision, decreased intensity or brightness of colors, or hazy vision. A subject at risk for eye disease can be a subject having one or more of the risk factors for that disorder. For example, risk factors associated with eye disease include (a) age (eye disease is more frequent in people over 40), (b) smoking, (c) gender, (d) family history, (e) medications, and (f) medical conditions such as chronic inflammation.

"An effective amount" as used herein refers to the amount of each active agent

required to confer therapeutic effect on the subject, either alone or in combination with one or more other active agents. Effective amounts vary, as recognized by those skilled in the art, depending on the particular condition being treated, the severity of the condition, the individual patient parameters including age, physical condition, size, gender and weight, the duration of the treatment, the nature of concurrent therapy (if any), the specific route of administration and like factors within the knowledge and expertise of the health practitioner. These factors are well known to those of ordinary skill in the art and can be addressed with no more than routine experimentation. It is generally preferred that a maximum dose of the individual components or combinations thereof be used, that is, the highest safe dose according to sound medical judgment. It will be understood by those of ordinary skill in the art, however, that a patient may insist upon a lower dose or tolerable dose for medical reasons, psychological reasons or for virtually any other reasons.

Empirical considerations, such as the half-life, generally will contribute to the determination of the dosage. For example, antibodies that are compatible with the human immune system, such as humanized antibodies or fully human antibodies, may be used to prolong half-life of the antibody and to prevent the antibody being attacked by the host's immune system. Frequency of administration may be determined and adjusted over the course of therapy, and is generally, but not necessarily, based on treatment and/or suppression and/or amelioration and/or delay of eye disease. Alternatively, sustained continuous release formulations of an IL-20 antagonist may be appropriate. Various formulations and devices for achieving sustained release are known in the art.

In one example, dosages for an IL-20 antagonist as described herein may be determined empirically in individuals who have been given one or more administration(s) of IL-20 antagonist. Individuals are given incremental dosages of the antagonist. To assess efficacy of the antagonist, an indicator of eye disease (such as levels of tears) can be followed.

Generally, for administration of any of the antibodies described herein, an initial candidate dosage can be about 2 mg/kg. For the purpose of the present disclosure, a typical daily dosage might range from about any of 0.1 μg/kg to 3 μg/kg to 30 μg/kg to 300 μg/kg to 3 mg/kg, to 30 mg/kg to 100 mg/kg or more, depending on the factors mentioned above. For repeated administrations over several days or longer, depending on the condition, the treatment is sustained until a desired suppression of symptoms occurs or until sufficient

therapeutic levels are achieved to alleviate eye disease, or a symptom thereof. An exemplary dosing regimen comprises administering an initial dose of about 2 mg/kg, followed by a weekly maintenance dose of about 1 mg/kg of the antibody, or followed by a maintenance dose of about 1 mg/kg every other week. However, other dosage regimens may be useful, depending on the pattern of pharmacokinetic decay that the practitioner wishes to achieve. For example, dosing from one-four times a week is contemplated. In some embodiments, dosing ranging from about 3 μg/mg to about 2 mg/kg (such as about 3 μg/mg, about 10 μg/mg, about 30 μg/mg, about 100 μg/mg, about 300 μg/mg, about 1 mg/kg, and about 2 mg/kg) may be used. In some embodiments, dosing frequency is once every week, every 2 weeks, every 4 weeks, every 5 weeks, every 6 weeks, every 7 weeks, every 8 weeks, every 9 weeks, or every 10 weeks; or once every month, every 2 months, or every 3 months, or longer. The progress of this therapy is easily monitored by conventional techniques and assays. The dosing regimen (including the antibody used) can vary over time.

When the IL-20 antagonist is not an antibody, it may be administered at the rate of about 0.1 to 300 mg/kg of the weight of the patient divided into one to three doses, or as disclosed herein. In some embodiments, for an adult patient of normal weight, doses ranging from about 0.3 to 5.00 mg/kg may be administered. The particular dosage regimen, *i.e.*, dose, timing and repetition, will depend on the particular individual and that individual's medical history, as well as the properties of the individual agents (such as the half-life of the agent, and other considerations well known in the art).

For the purpose of the present disclosure, the appropriate dosage of an IL-20 antagonist will depend on the specific IL-20 antagonist(s) (or compositions thereof) employed, the type and severity of eye disease, whether the antagonist is administered for preventive or therapeutic purposes, previous therapy, the patient's clinical history and response to the antagonist, and the discretion of the attending physician. Typically the clinician will administer an IL-20 antagonist, such as an anti-IL-20 or anti-IL-20R antibody, until a dosage is reached that achieves the desired result. Administration of an IL-20 antagonist can be continuous or intermittent, depending, for example, upon the recipient's physiological condition, whether the purpose of the administration is therapeutic or prophylactic, and other factors known to skilled practitioners. The administration of an IL-20 antagonist (for example if the IL-20 antagonist is an anti-IL-20 antibody) may be essentially continuous over a preselected period of time or may be in a series of spaced dose, *e.g.*, either

before, during, or after developing eye disease.

As used herein, the term “treating” refers to the application or administration of a composition including one or more active agents to a subject, who has eye disease, a symptom of eye disease, or a predisposition toward the disease, with the purpose to cure, heal, alleviate, relieve, alter, remedy, ameliorate, improve, or affect the disorder, the symptom of the disease, or the predisposition toward the disease.

Alleviating eye disease includes delaying the development or progression of the disease, or reducing disease severity. Alleviating the disease does not necessarily require curative results. As used therein, "delaying" the development of a disease (such as eye disease) means to defer, hinder, slow, retard, stabilize, and/or postpone progression of the disease. This delay can be of varying lengths of time, depending on the history of the disease and/or individuals being treated. A method that "delays" or alleviates the development of a disease, or delays the onset of the disease, is a method that reduces probability of developing one or more symptoms of the disease in a given time frame and/or reduces extent of the symptoms in a given time frame, when compared to not using the method. Such comparisons are typically based on clinical studies, using a number of subjects sufficient to give a statistically significant result.

"Development" or "progression" of a disease means initial manifestations and/or ensuing progression of the disease. Development of the disease can be detectable and assessed using standard clinical techniques as well known in the art. However, development also refers to progression that may be undetectable. For purpose of this disclosure, development or progression refers to the biological course of the symptoms. "Development" includes occurrence, recurrence, and onset. As used herein "onset" or "occurrence" of eye disease includes initial onset and/or recurrence.

In some embodiments, the IL-20 antagonist (*e.g.*, an anti-IL-20 antibody or anti-IL-20R antibody such as anti-IL-20R1 antibody) described herein is administered to a subject in need of the treatment at an amount sufficient to reduce the level of the IL-20 receptor/IL-20-mediated signaling by at least 20% (*e.g.*, 30%, 40%, 50%, 60%, 70%, 80%, 90% or greater). In other embodiments, the antagonist is administered in an amount effective in reducing at least on symptom of eye disease.

Conventional methods, known to those of ordinary skill in the art of medicine, can be used to administer the pharmaceutical composition to the subject, depending upon the type of

eye disease to be treated (*e.g.*, DED or AMD). This composition can also be administered via other conventional routes, *e.g.*, administered orally, parenterally, by inhalation spray, topically, rectally, nasally, buccally, vaginally or via an implanted reservoir. The term "parenteral" as used herein includes subcutaneous, intracutaneous, intravenous, intramuscular, intraarticular, intraarterial, intrasynovial, intrasternal, intrathecal, intralesional, and intracranial injection or infusion techniques. In addition, it can be administered to the subject via injectable depot routes of administration such as using 1-, 3-, or 6-month depot injectable or biodegradable materials and methods.

Injectable compositions may contain various carriers such as vegetable oils, dimethylactamide, dimethyformamide, ethyl lactate, ethyl carbonate, isopropyl myristate, ethanol, and polyols (glycerol, propylene glycol, liquid polyethylene glycol, and the like). For intravenous injection, water soluble antibodies can be administered by the drip method, whereby a pharmaceutical formulation containing the antibody and a physiologically acceptable excipients is infused. Physiologically acceptable excipients may include, for example, 5% dextrose, 0.9% saline, Ringer's solution or other suitable excipients. Intramuscular preparations, e.g., a sterile formulation of a suitable soluble salt form of the antibody, can be dissolved and administered in a pharmaceutical excipient such as Water-for-Injection, 0.9% saline, or 5% glucose solution.

In one embodiment, an IL-20 antagonist is administered via site-specific or targeted local delivery techniques. In some examples, an aqueous formulation containing an IL-20 antagonist such as anti-IL-20 antibody may be applied topically to an eye that needs treatment. Other examples of site-specific or targeted local delivery techniques include various implantable depot sources of the IL-20 antagonist (*e.g.*, ocular implants). Ocular implants may be biodegradable or non-biodegradable. In some embodiments, the non-biodegradable ocular implant comprises polymers such as polyvinyl alcohol (PVA), ethylene vinyl acetate (EVA), and polysulfone capillary fiber (PCF). In some embodiments, the biodegradable ocular implant comprises polymers such as polylactic acid (PLA), polyglycolic acid (PGA), poly (lactide-co-glycolide) (PLGA), and polycaprolactones. In some embodiments, the IL-20 antagonist is administered via a contact lens loaded with an IL-20 antagonist.

In some embodiments, an IL-20 antagonist is administered via intraocular injection. Intraocular injection includes, but is not limited to, intrastromal injection, subconjunctival

injection, intravitreal injection, or periocular injections. In some embodiments, the IL-20 antagonist is administered using a microneedle.

Targeted delivery of therapeutic compositions containing an antisense polynucleotide, expression vector, or subgenomic polynucleotides can also be used. Receptor-mediated DNA delivery techniques are described in, for example, Findeis et al., Trends Biotechnol. (1993) 11:202; Chiou et al., Gene Therapeutics: Methods And Applications Of Direct Gene Transfer (J. A. Wolff, ed.) (1994); Wu et al., J. Biol. Chem. (1988) 263:621; Wu et al., J. Biol. Chem. (1994) 269:542; Zenke et al., Proc. Natl. Acad. Sci. USA (1990) 87:3655; Wu et al., J. Biol. Chem. (1991) 266:338. Therapeutic compositions containing a polynucleotide are administered in a range of about 100 ng to about 200 mg of DNA for local administration in a gene therapy protocol. In some embodiments, concentration ranges of about 500 ng to about 50 mg, about 1 μg to about 2 mg, about 5 μg to about 500 μg, and about 20 μg to about 100 μg of DNA or more can also be used during a gene therapy protocol.

The therapeutic polynucleotides and polypeptides described herein can be delivered using gene delivery vehicles. The gene delivery vehicle can be of viral or non-viral origin (see generally, Jolly, Cancer Gene Therapy (1994) 1:51; Kimura, Human Gene Therapy (1994) 5:845; Connelly, Human Gene Therapy (1995) 1:185; and Kaplitt, Nature Genetics (1994) 6:148). Expression of such coding sequences can be induced using endogenous mammalian or heterologous promoters and/or enhancers. Expression of the coding sequence can be either constitutive or regulated.

Viral-based vectors for delivery of a desired polynucleotide and expression in a desired cell are well known in the art. Exemplary viral-based vehicles include, but are not limited to, recombinant retroviruses (see, *e.g.*, PCT Publication Nos. WO 90/07936; WO 94/03622; WO 93/25698; WO 93/25234; WO 93/11230; WO 93/10218; WO 91/02805; U.S. Pat. Nos. 5,219,740 and 4,777,127; GB Patent No. 2,200,651; and EP Patent No. 0 345 242), alphavirus-based vectors (*e.g.*, Sindbis virus vectors, Semliki forest virus (ATCC VR-67; ATCC VR-1247), Ross River virus (ATCC VR-373; ATCC VR-1246) and Venezuelan equine encephalitis virus (ATCC VR-923; ATCC VR-1250; ATCC VR 1249; ATCC VR-532)), and adeno-associated virus (AAV) vectors (see, *e.g.*, PCT Publication Nos. WO 94/12649, WO 93/03769; WO 93/19191; WO 94/28938; WO 95/11984 and WO 95/00655). Administration of DNA linked to killed adenovirus as described in Curiel, Hum. Gene Ther. (1992) 3:147 can also be employed.

Non-viral delivery vehicles and methods can also be employed, including, but not limited to, polycationic condensed DNA linked or unlinked to killed adenovirus alone (see, e.g., Curiel, Hum. Gene Ther. (1992) 3:147); ligand-linked DNA (see, *e.g.*, Wu, J. Biol. Chem. (1989) 264:16985); eukaryotic cell delivery vehicles cells (see, *e.g.*, U.S. Pat. No. 5,814,482; PCT Publication Nos. WO 95/07994; WO 96/17072; WO 95/30763; and WO 97/42338) and nucleic charge neutralization or fusion with cell membranes. Naked DNA can also be employed. Exemplary naked DNA introduction methods are described in PCT Publication No. WO 90/11092 and U.S. Pat. No. 5,580,859. Liposomes that can act as gene delivery vehicles are described in U.S. Pat. No. 5,422,120; PCT Publication Nos. WO 95/13796; WO 94/23697; WO 91/14445; and EP Patent No. 0524968. Additional approaches are described in Philip, Mol. Cell. Biol. (1994) 14:2411, and in Woffendin, Proc. Natl. Acad. Sci. (1994) 91:1581.

It is also apparent that an expression vector can be used to direct expression of any of the protein-based IL-20 antagonists described herein (*e.g.*, anti-IL-20 antibody, or anti-IL-20R antibody). For example, other IL-20 receptor fragments that are capable of blocking (from partial to complete blocking) IL-20 and/or an IL-20 biological activity are known in the art.

The particular dosage regimen, *i.e.*, dose, timing and repetition, used in the method described herein will depend on the particular subject and that subject's medical history.

In some embodiments, more than one IL-20 antagonist, such as an antibody and a small molecule IL-20 inhibitory compound, may be administered to a subject in need of the treatment. The antagonist can be the same type or different from each other. At least one, at least two, at least three, at least four, at least five different IL-20 antagonists can be co-administered. Generally, those IL-20 antagonists have complementary activities that do not adversely affect each other. IL-20 antagonists can also be used in conjunction with other agents that serve to enhance and/or complement the effectiveness of the agents.

Treatment efficacy can be assessed by methods well-known in the art.

Kits For Use in Treating Eye Disease

The present disclosure also provides kits for use in alleviating eye disease. Such kits can include one or more containers comprising an IL-20 antagonist (such as an antibody, *e.g.*,

mAb7E or its functional variant, mAb7GW or its functional variant, or mAb51D or its functional variant). In some embodiments, the IL-20 antagonist is any antibody capable of interfering with the IL-20 signaling pathway as described herein. In other embodiments, the kit comprises an IL-20 antagonist that is other than the just-noted antibody.

In some embodiments, the kit can comprise instructions for use in accordance with any of the methods described herein. The included instructions can comprise a description of administration of the IL-20 antagonist to treat, delay the onset, or alleviate eye disease according to any of the methods described herein. The kit may further comprise a description of selecting an individual suitable for treatment based on identifying whether that individual has eye disease. In still other embodiments, the instructions comprise a description of administering an IL-20 antagonist to an individual at risk of eye disease.

The instructions relating to the use of an IL-20 antagonist generally include information as to dosage, dosing schedule, and route of administration for the intended treatment. The containers may be unit doses, bulk packages (*e.g.*, multi-dose packages) or sub-unit doses. Instructions supplied in the kits of the invention are typically written instructions on a label or package insert (*e.g.*, a paper sheet included in the kit), but machine-readable instructions (*e.g.*, instructions carried on a magnetic or optical storage disk) are also acceptable.

The label or package insert indicates that the composition is used for treating, delaying the onset and/or alleviating eye disease. Instructions may be provided for practicing any of the methods described herein.

The kits of this invention are in suitable packaging. Suitable packaging includes, but is not limited to, vials, bottles, jars, flexible packaging (*e.g.*, sealed Mylar or plastic bags), and the like. Also contemplated are packages for use in combination with a specific device, such as an inhaler, nasal administration device (*e.g.*, an atomizer) or an infusion device such as a minipump. A kit may have a sterile access port (for example the container may be an intravenous solution bag or a vial having a stopper pierceable by a hypodermic injection needle). The container may also have a sterile access port (for example the container may be an intravenous solution bag or a vial having a stopper pierceable by a hypodermic injection needle). At least one active agent in the composition is an IL-20 antagonist, such as an anti-IL-20 antibody.

Kits may optionally provide additional components such as buffers and interpretive

information. Normally, the kit comprises a container and a label or package insert(s) on or associated with the container. In some embodiments, the invention provides articles of manufacture comprising contents of the kits described above.

Without further elaboration, it is believed that one skilled in the art can, based on the above description, utilize the present invention to its fullest extent. The following specific embodiments are, therefore, to be construed as merely illustrative, and not limitative of the remainder of the disclosure in any way whatsoever. All publications cited herein are incorporated by reference for the purposes or subject matter referenced herein.

EXAMPLES

In order that the present disclosures herein may be more fully understood, the following examples are set forth. The examples described in this application are offered to illustrate the methods, compositions, and systems provided herein and are not to be construed in any way as limiting their scope.

EXAMPLE 1: Anti-IL-20 antibodies protected mice from benzalkonium chloride (BAC)-induced dry eye syndrome

MATERIALS AND METHODS

BAC-induced dry eye syndrome

Thirty six female BALB/c mice (18-20 grams, 6-8 weeks) were obtained from the Laboratory Animal Center (National Cheng Kung University, Tainan, Taiwan) and fed with standard laboratory chow and drinking water. They were handled according to the guidelines set forth by the Council for International Organization of Medical Sciences on Animal Experimentation (World Health Organization, Geneva, Switzerland) and the guidelines set forth by National Cheng Kung University. DED group mice were treated twice a day (8 AM and 8 PM) for 7 days by topical administration of 0.2% BAC dissolved in PBS. BAC treatment was administered for the duration of the treatment regimen, and BAC was administered 4 hours prior to administration of the therapeutic agents (PBS, IgG, 7E).

Measurement of tear volume

Tear volume was measured using SMTube® (Echo Electricity Co.) on days 0, 4, 7, 11, 14, at similar time point in the standard environment. Mice were kept immobile by

intraperitoneal injection of pentobarbital. The SM Tube was inserted into the conjunctival sac location around the junction of the lower lid. The wetted length (millimeter) of the paper tube was read after one minute.

Analysis of corneal damage

Both eyes of mice were stained with fluorescein (Sigma-Aldrich) to visualize damage of the corneal epithelium on days 0, 4, 7, and 14 at similar time points. In brief, 1 µl of 0.1% liquid fluorescein was dropped into the conjunctival sac of mice. After ninety seconds, corneal epithelial damage was visualized with a cobalt blue filter under a slit-lamp microscope (Topcon DC-4; Topcon Medical Systems, Inc.). The fluorescein score was analyzed as follows: 0, no fluorescein staining ; 0.5, slight fluorescein dotted stained; 1, diffuse dot-like fluorescein staining ; 2, fluorescein stained area less than one-third of the corneas ; 3, fluorescein stained area more than one-third of the corneas ; 4, fluorescein stained area more than two-third of the corneas. Scoring was performed blindly by four individuals. Scores for each group were determined by averaging the scores determined by the four individuals.

RESULTS

Benzalkonium chloride (BAC)-induced dry eye syndrome has been used as an animal model for studying dry eye disease (DED). BAC treatment in animal models produces pathological changes accordant with human dry eye syndrome, including inflammation, epithelial apoptosis, and squamous metaplasia. Despite its known damaging effects, BAC is the most frequently used preservative in ophthalmic solutions.

The effect of IL-20 inhibition on eye disease was analyzed in BAC-induced mouse model of dry eye syndrome. Female BALB/c mice (18-20 grams/ 6-8 weeks) were used in the experiment. Both eyes of mice in the DED group (n=27) were treated twice daily for seven days with topical administration of 0.2% BAC. Healthy control mice (n=9) were treated with PBS alone. After induction of dry eye syndrome by administration of BAC, mice were then randomly assigned to 3 treatment groups (n = 9 in each group), and treated with phosphate-buffered saline (PBS), an anti-IL-20 monoclonal antibody, mAb7E (800 µg/mL in 5 µL), or mouse immunoglobulin G (800 µg/mL in 5 µL) daily for the duration of the treatment regimen. Tear volume was measured on days 0, 4, 7, 11, and 14. Corneal epithelial damage was analyzed by fluorescein staining on days 0, 4, 7, and 14.

Compared to healthy control mice, DED group mice showed significant decreases in tear production (Fig. 1) and increases in fluorescein staining (Fig. 2). DED mice treated with mAb7E showed a significant increase in tear volume compared to DED mice treated with IgG or PBS (Fig 1.). Also, DED mice treated with mAb7E showed decreased fluorescein staining compared to DED mice treated with IgG or PBS (Figs. 2-3). Representative images of corneal fluorescein staining is shown in Fig. 2, and fluorescein staining score determined as described herein is shown in Fig. 3.

The above results clearly show that anti-IL-20 antibody protected against BAC-induced dry eye syndrome as indicated by increased tear volume and decreased corneal damage, indicating that anti-IL-20 therapies would be effective in treating DED.

Example 2: Anti-IL-20 antibody provided therapeutic effects in a mouse model of age-related macular degeneration (AMD)

Age-related macular degeneration (AMD) is the leading cause of blindness among elderly people in developed countries. Most of the severe vision loss that can be attributed to AMD results from its exudative form, which is characterized by choroidal neovascularization (CNV). CNV is defined as the penetration of immature new blood vessels into the Bruch's membrane from choriocapillaries and their extension into the sub-retinal and/or sub-retinal pigment epithelium (RPE) space. This is associated with manifestations such as RPE detachment, subretinal hemorrhages, and fibrovascular disciform scarring.

This study confirms the superior therapeutic effects of anti-IL-20 antibodies, exemplified by mAb 7E, in an animal model of AMD, as relative to EYLEA® (aflibercept), an approved Fc-fusion protein for treating certain retinal diseases, including wet AMD, diabetic macular edema (e.g., diabetic retinopathy in DME), and macular edema following retinal vein occlusion (RVO).

MATERIALS AND METHODS

Animals

Eight-week-old C57BL/6J male mice were kept on a 12-hour light-dark cycle at 22 ± 2°C. All animal experiments were conducted according to the conventional protocols and guidelines for the care and use of experimental animals. For all procedures, anesthesia was achieved by intraperitoneal injection of standard dosages of a mixture of Zoletil and Rompun, and pupils were dilated with topical 0.5% tropicamide.

Laser-induced choroidal neovascularization (CNV)

Mice were anesthetized with a mixture of Zoletil and Rompun, and pupils were dilated with topical drops of 0.5% tropicamide. Two minutes after pupil dilation, lubricating eye drops (Alcon Laboratories) were applied to the cornea. The fundus was viewed with an imaging camera, and laser photocoagulation was induced using the image-guided laser system (Micron IV, Phoenix Research Laboratories, Pleasanton, CA). The fundus image as well as the aiming beam can be observed on the monitor screen. Four laser burns at equal distance from the optic nerve were induced one by one on right eye by a green Argon laser with wavelength of 532 nm, duration of 170 ms and 80 mW power levels.

Treatment

After laser photocoagulation, the eyes were gently rinsed with sterile saline to remove the lubricating eye drops. Mice were divided into four groups and intravitreal injection with PBS (2 μl/mice, n=5), anti-IL-20 mAb (7E) (50μg/2μl/mice, n=5), mouse IgG isotype control (50μg/2μl/mice, n=5), EYLEA® (aflibercept, 80μg/2μl/mice, n=5). The animals were treated with an antibiotic ointment containing tetracycline. Mice were then placed on a pre-warmed warming plate at 35°C until they awakened.

Fundus fluorescein angiography (FFA)

FFA to determine leakage was performed with the retinal imaging microscope (Micron IV, Phoenix Research Laboratories) 7, 14, 21, and 28 days after laser photocoagulation. Mice were anesthetized, pupils dilated, and intraperitoneally injected with fluorescein AK-FLUOR® (Akorn, Lake Forest, IL) at 5 μg/g body weight. Fluorescent fundus images were taken with the retinal imaging microscope at 5 and 10 minutes after fluorescein injection. The fluorescent intensity of CNV lesions was graded using Image J (National Institutes of Health, Bethesda, MD) by masked researchers, and the difference of fluorescent intensity between 5 and 10 minute images were recorded as an indicator of CNV vascular leakage.

RESULTS

The therapeutic effects of IL-20 inhibition on eye disease were analyzed in a mouse model of age-related macular degeneration (AMD), in which CNV was induced by laser

photocoagulation. After induction of CNV, mice were then randomly divided into four treatment groups, and treated with either phosphate-buffered saline (PBS), an anti-IL-20 monoclonal antibody (mAb7E), mouse immunoglobulin G, or EYLEA® (a commercially available anti-VEGF drug also known as aflibercept). Fluorescent intensity of CNV lesions was measured at day 7, day 14, day 21, and day 28 following laser photocoagulation. The results are shown in Fig. 4A, Fig. 4B, Fig. 4C, and Fig. 4D, respectively.

Anti-IL-20 mAb7E treatment significantly decreased the fluorescent intensity of CNV lesions at days 7, 14, and 21 after laser burn compared with mIgG isotype control group (*** $p < 0.001$, *** $p < 0.001$, and *** $p < 0.001$, respectively) (Figs. 4A-4D). The fluorescent intensity of CNV lesions in mAb7E -treated group was lower than in EYLEA®-treated group (56% v.s. 71%) at day 7, and day 21 (50% v.s. 56%) after laser burn (Figs. 4A and 4C). The therapeutic efficacy persisted for a longer period of time in the anti-IL-20 mAb7E-treated group as compared with the EYLEA®-treated control group, suggested that anti-IL-20 mAb7E was more effective than EYLEA® as shown in the animal model of AMD. Figs. 4A-4D.

The above results clearly shows that anti-IL-20 antibody provided therapeutic effects against age-related macular degeneration (AMD) and choroidal neovascularization (CNV) as indicated by decreased fluorescence leakage, indicating that anti-IL-20 therapies would be therapeutically effective in treating AMD and other retinal diseases.

OTHER EMBODIMENTS

All of the features disclosed in this specification may be combined in any combination. Each feature disclosed in this specification may be replaced by an alternative feature serving the same, equivalent, or similar purpose. Thus, unless expressly stated otherwise, each feature disclosed is only an example of a generic series of equivalent or similar features.

From the above description, one skilled in the art can easily ascertain the essential characteristics of the present invention, and without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions. Thus, other embodiments are also within the claims.

EQUIVALENTS AND SCOPE

In the claims, articles such as "a," "an," and "the" may mean one or more than one unless indicated to the contrary or otherwise evident from the context. Claims or descriptions that include "or" between one or more members of a group are considered satisfied if one, more than one, or all of the group members are present in, employed in, or otherwise relevant to a given product or process unless indicated to the contrary or otherwise evident from the context. The invention includes embodiments in which exactly one member of the group is present in, employed in, or otherwise relevant to a given product or process. The invention includes embodiments in which more than one, or all of the group members are present in, employed in, or otherwise relevant to a given product or process.

Furthermore, the invention encompasses all variations, combinations, and permutations in which one or more limitations, elements, clauses, and descriptive terms from one or more of the listed claims is introduced into another claim. For example, any claim that is dependent on another claim can be modified to include one or more limitations found in any other claim that is dependent on the same base claim. Where elements are presented as lists, *e.g.*, in Markush group format, each subgroup of the elements is also disclosed, and any element(s) can be removed from the group. It should it be understood that, in general, where the invention, or aspects of the invention, is/are referred to as comprising particular elements and/or features, certain embodiments of the invention or aspects of the invention consist, or consist essentially of, such elements and/or features. For purposes of simplicity, those embodiments have not been specifically set forth *in haec verba* herein. It is also noted that the terms "comprising" and "containing" are intended to be open and permits the inclusion of additional elements or steps. Where ranges are given, endpoints are included. Furthermore, unless otherwise indicated or otherwise evident from the context and understanding of one of ordinary skill in the art, values that are expressed as ranges can assume any specific value or sub–range within the stated ranges in different embodiments of the invention, to the tenth of the unit of the lower limit of the range, unless the context clearly dictates otherwise.

This application refers to various issued patents, published patent applications, journal articles, and other publications, all of which are incorporated herein by reference. If there is a conflict between any of the incorporated references and the instant specification, the specification shall control. In addition, any particular embodiment of the present invention that falls within the prior art may be explicitly excluded from any one or more of the claims.

Because such embodiments are deemed to be known to one of ordinary skill in the art, they may be excluded even if the exclusion is not set forth explicitly herein. Any particular embodiment of the invention can be excluded from any claim, for any reason, whether or not related to the existence of prior art.

Those skilled in the art will recognize or be able to ascertain using no more than routine experimentation many equivalents to the specific embodiments described herein. The scope of the present embodiments described herein is not intended to be limited to the above Description, but rather is as set forth in the appended claims. Those of ordinary skill in the art will appreciate that various changes and modifications to this description may be made without departing from the spirit or scope of the present invention, as defined in the following claims.

What Is Claimed Is:

1. A method for treating or delaying the onset of an eye disease in a subject, the method comprising administering to a subject in need thereof an effective amount of a pharmaceutical composition comprising an IL-20 antagonist.

2. The method of claim 1, wherein the IL-20 antagonist is an antibody that binds either IL-20 or an IL-20 receptor, thereby inhibiting a signaling pathway mediated by IL-20.

3. The method of claim 2, wherein the antibody is an antibody that binds human IL-20.

4. The method of claim 3, wherein the antibody is a full-length antibody or an antigen-binding fragment thereof.

5. The method of claim 3 or claim 4, wherein the antibody is a human antibody, a humanized antibody, a chimeric antibody, or a single-chain antibody.

6. The method of claim 3, wherein the anti-IL-20 antibody binds to the same epitope of human IL-20 as monoclonal antibody mAb7E or competes against mAb7E from binding to human IL-20.

7. The method of claim 6, wherein the antibody comprises the same heavy chain complementary determining regions (CDRs) as mAb7E and the same light chain CDRs as mAb7E.

8. The method of claim 7, wherein the antibody is a humanized antibody of mAb7E.

9. The method of claim 8, wherein the humanized antibody comprises a heavy chain variable region (V_H), which comprises the amino acid sequence of SEQ ID NO:8, and a light chain variable region (V_L), which comprises the amino acid sequence of SEQ ID NO:12 or SEQ ID NO:13.

10. The method of claim 2, wherein the antibody is an antibody that binds a human IL-20 receptor.

11. The method of claim 10, wherein the antibody binds subunit R1 of the human IL-20 receptor.

12. The method of claim 10 or claim 11, wherein the antibody is a full-length antibody or an antigen-binding fragment thereof.

13. The method of any one of claims 10-12, wherein the antibody is a human antibody, a humanized antibody, a chimeric antibody, or a single-chain antibody.

14. The method of claim 11, wherein the antibody that binds subunit R1 of the human IL-20 receptor is an antibody that binds the same epitope of the subunit R1 as monoclonal antibody mAb51D or mAb7GW, or compete against mAb51D or mAb7GW from binding to the subunit R1.

15. The method of claim 14, wherein the antibody comprises the same heavy chain complementary determining regions (CDRs) as mAb51D or mAb7GW, and the same light chain CDRs as mAb51D or mAb7GW.

16. The method of claim 15, wherein the antibody is a humanized antibody of mAb51D or mAb7GW.

17. The method of any one of claims 1-16, wherein the subject is a human patient having or being suspected of having the eye disease.

18. The method of claim 17, wherein the eye disease is dry eye disease (DED).

19. The method of claim 18, wherein the DED is aqueous tear-deficient dry eye or evaporative dry eye.

20. The method of claim 17, wherein the eye disease is age-related macular degeneration (AMD), diabetic macular edema (DME), diabetic retinopathy (DR) in DME, or macular edema following retinal vein occlusion (RVO).

21. The method of claim 20, wherein the eye disease is AMD, which is wet AMD.

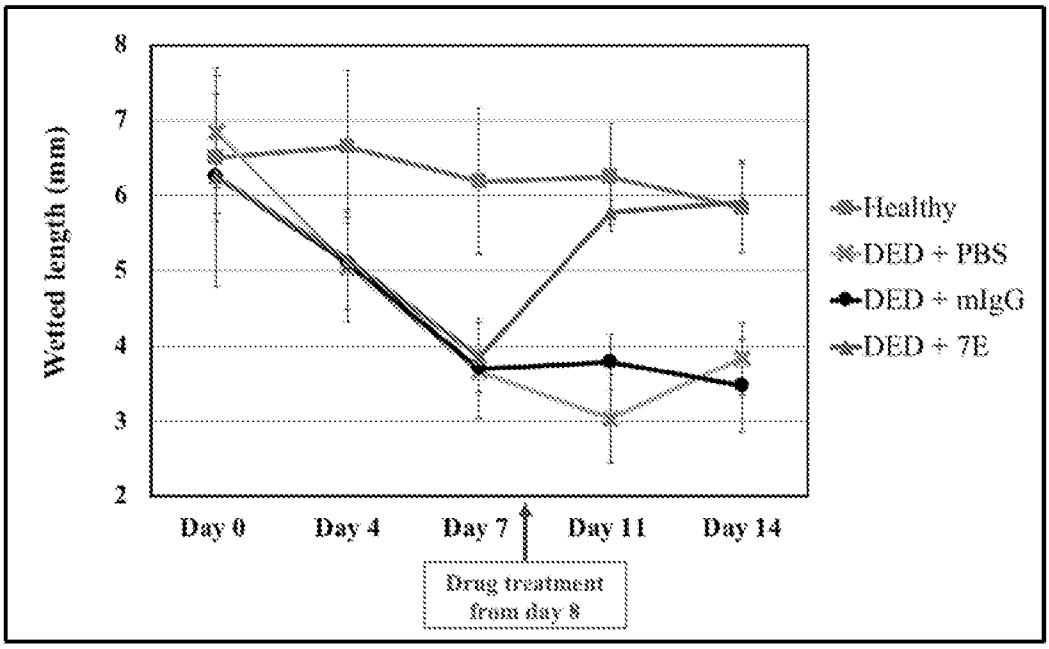
Wetted length (mm)
8
7
6
5
4
3
2
Day 0
Day 4
Day 7
Day 11
Day 14
Drug treatment from day 8
Healthy
DED + PBS
DED + mIgG
DED + 7E

Fig. 1

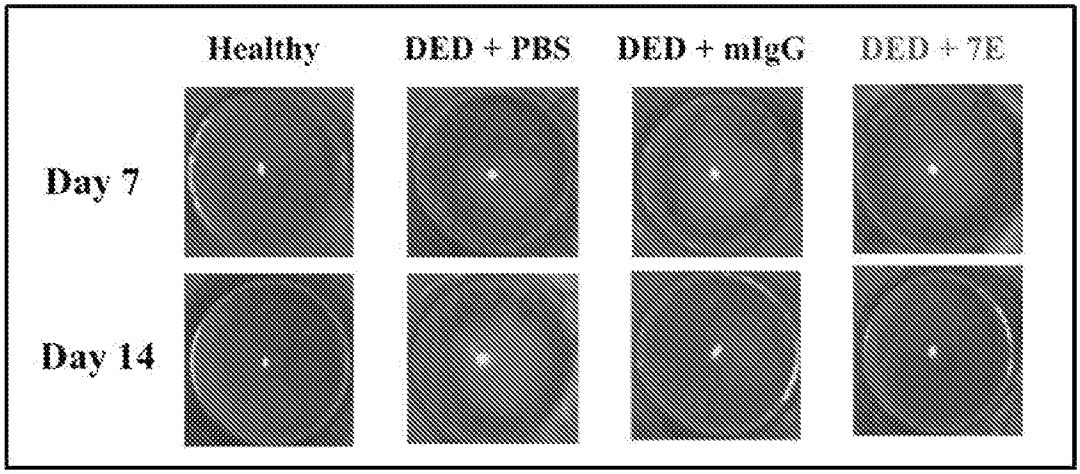

Fig. 2

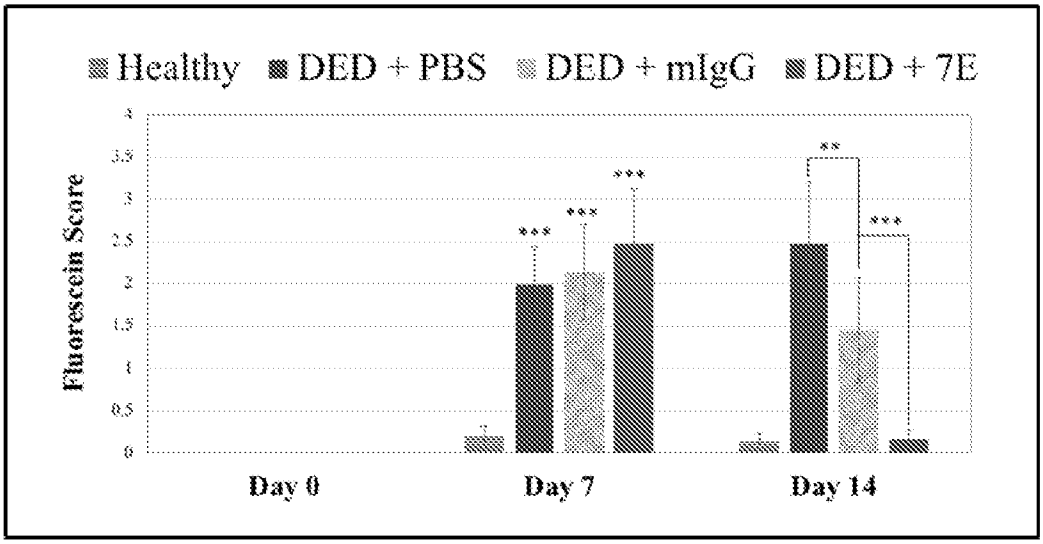
Healthy
DED + PBS
DED + mIgG
DED + 7E
Fluorescein Score
Day 0
Day 7
Day 14
***
**

Fig. 3

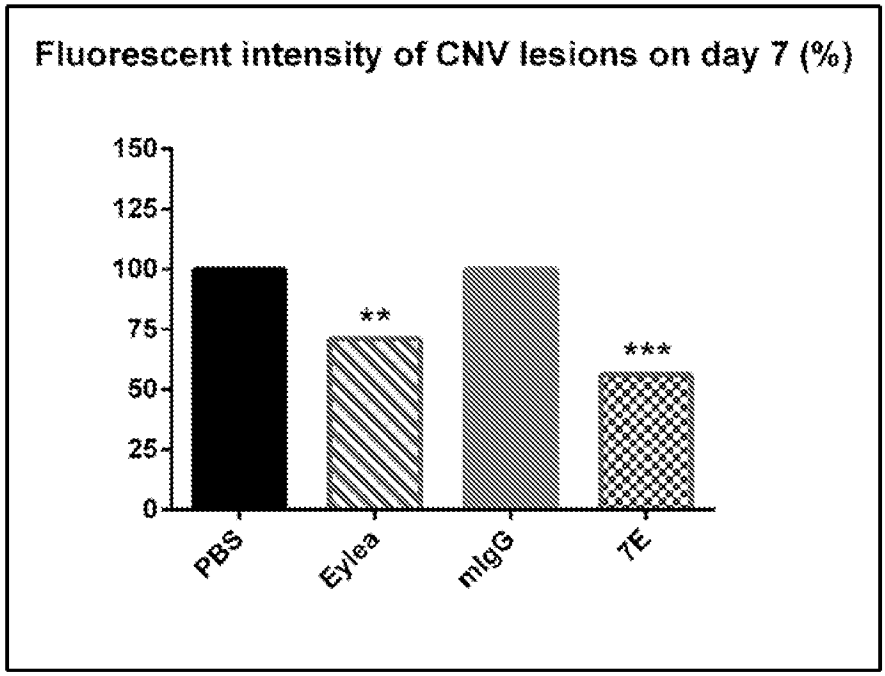
Fluorescent intensity of CNV lesions on day 7 (%)
150
125
100
75
50
25
0
**
***
PBS
Eylea
mIgG
7E

Fig. 4A

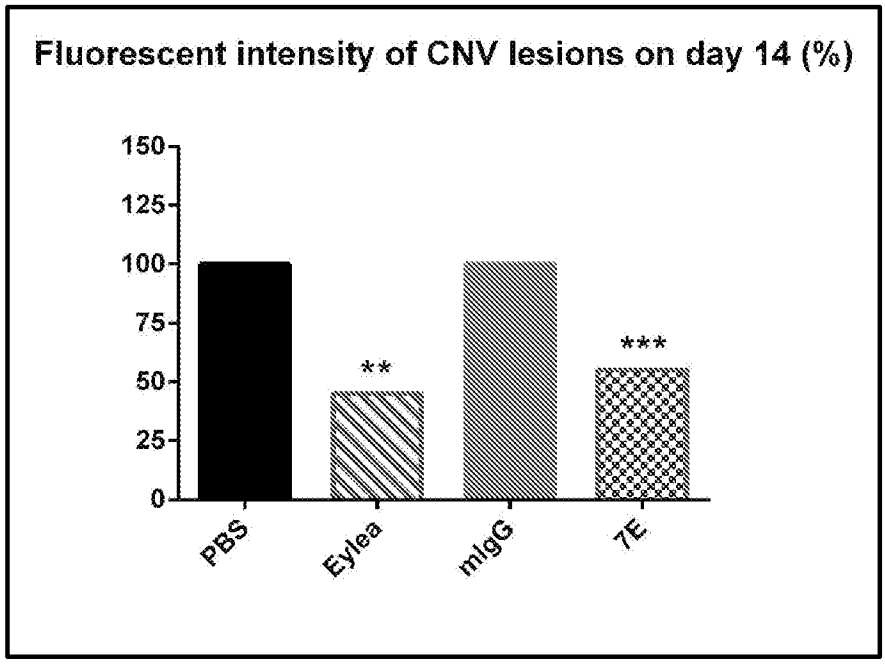
Fluorescent intensity of CNV lesions on day 14 (%)
150
125
100
75
50
25
0
**
***
PBS
Eylea
mIgG
7E

Fig. 4B

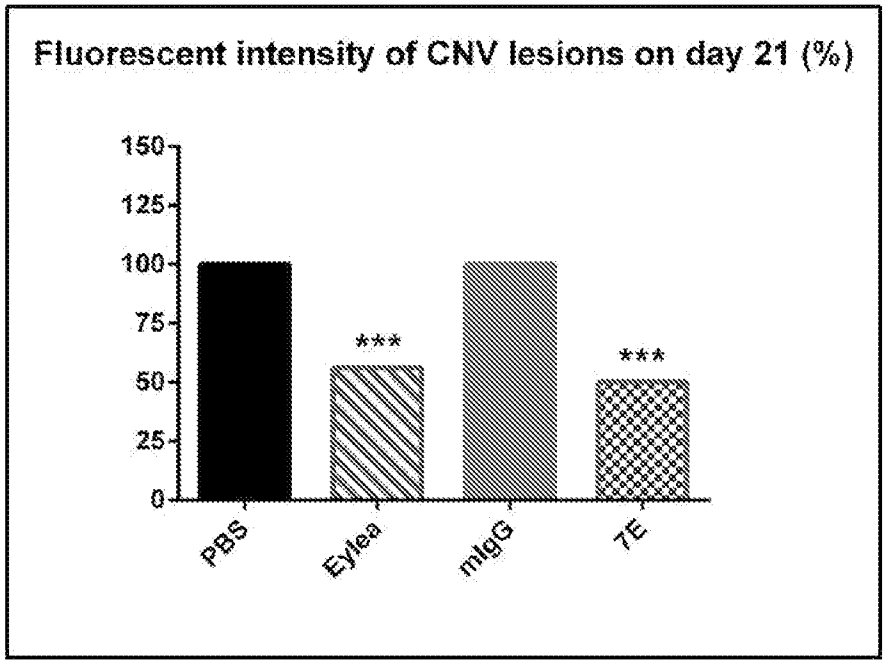
Fluorescent intensity of CNV lesions on day 21 (%)
150
125
100
75
50
25
0
***
***
PBS
Eylea
mIgG
7E

Fig. 4C

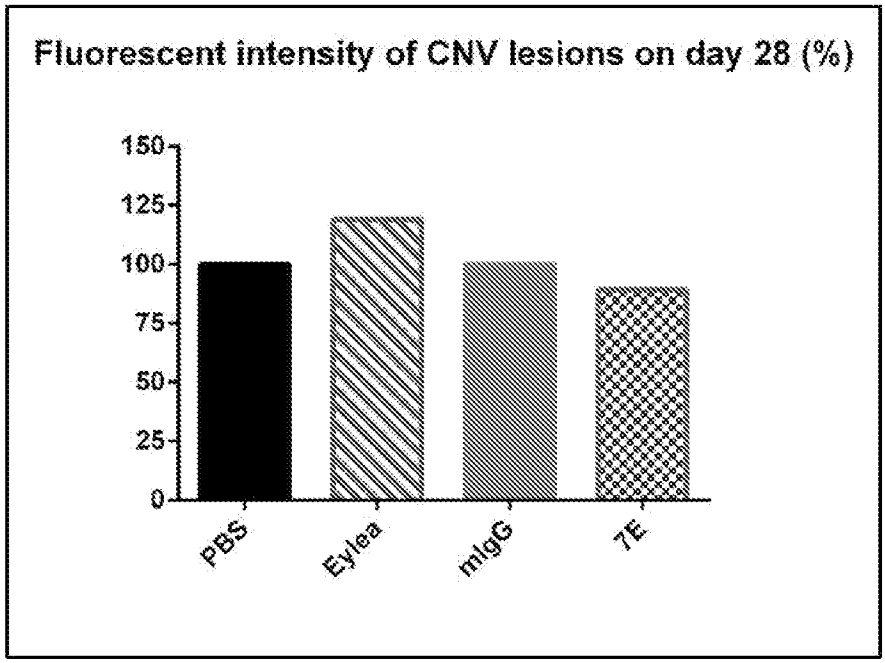
Fluorescent intensity of CNV lesions on day 28 (%)
150
125
100
75
50
25
0
PBS
Eylea
mIgG
7E

Fig. 4D

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 18/29279

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - C07K 16/24 (2018.01)
CPC - C07K 16/244, C07K 2317/21, C07K 2317/56, C07K 2317/565, C07K 2317/76

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History Document

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2006/0188476 A1 (OLSEN et al.) 24 August 2006 (24.08.2006) Abstract, para [0031], [0035], [0120], [0153], [0180], Claim 4	1-5 ------ 6-12, 14-16
Y	US 2013/0315893 A1 (CHANG et al.) 28 November 2013 (28.11.2013) Abstract, para [0003], [0028], [0031], [0069], [0072], [0075], [0076], [0085], Claim 1	6-9
Y	US 2014/0044715 A1 (CHANG) 13 February 2014 (13.02.2014) para [0004], [0007], [0027], [0029], [0034], [0120], Claim 1	10-12, 14-16
A	US 6,486,301 B1 (EBNER et al.) 26 November 2002 (26.11.2002) col 70, ln 8-12	3-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 June 2018	20 JUL 2018
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 18/29279

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 13, 17-21
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.