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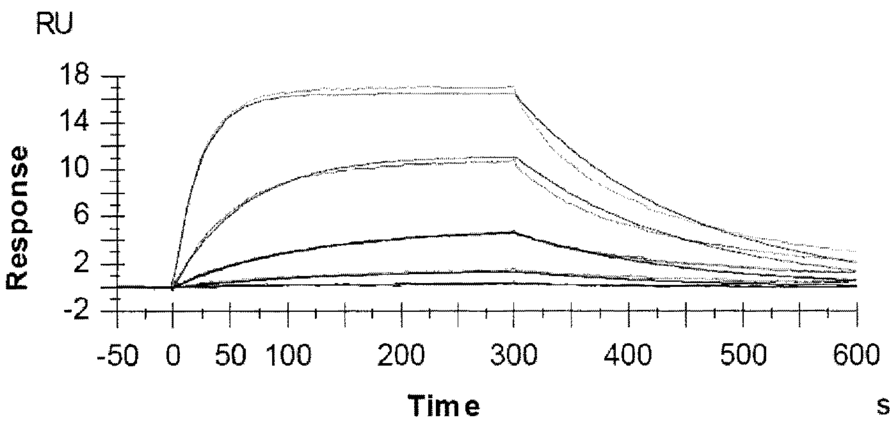

(57) Abrégé/Abstract:
A composition for treating inflammation or auto-immune disorders comprises (i) an antibody that binds to an AGE-modified protein on a cell, and (ii) an anti-inflammation antibody. Furthermore, the antibody that binds to an AGE-modified protein on a cell is also effective to treat inflammation or auto- immune disorders alone.

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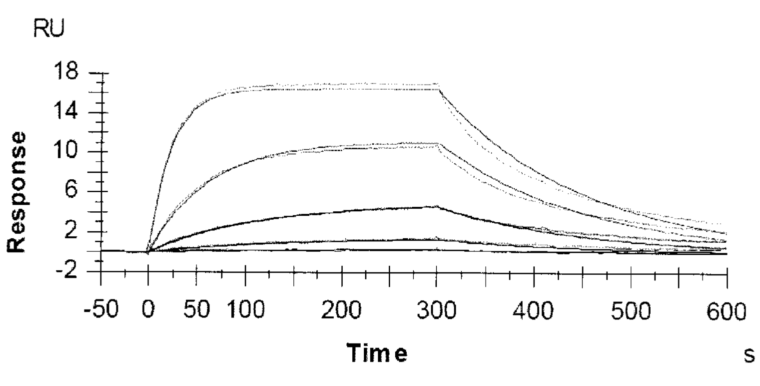

(57) Abstract: A composition for treating inflammation or auto-immune disorders comprises (i) an antibody that binds to an AGE-modified protein on a cell, and (ii) an anti-inflammation antibody. Furthermore, the antibody that binds to an AGE-modified protein on a cell is also effective to treat inflammation or auto- immune disorders alone.

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ANTI-AGE ANTIBODIES FOR TREATING INFLAMMATION AND AUTO-IMMUNE DISORDERS

FIELD OF THE INVENTION

[01] The present invention relates to the field of treatment of inflammation or auto-immune disorders.

BACKGROUND

[02] Chronic inflammation is associated with a variety of diseases, including Alzheimer's disease, diabetes, atherosclerosis, and cancer. Autoimmune diseases, such as osteoarthritis and Crohn's disease are also associated with chronic inflammation. Chronic inflammation may be characterized by the presence of pro-inflammatory factors at levels higher than baseline near the site of pathology, but many fold lower than those found in acute inflammation. Examples of these factors include TNF, IL-1α, IL-1β, IL-5, IL-6, IL-8, IL-12, IL-23, CD2, CD3, CD20, CD22, CD52, CD80, CD86, C5 complement protein, BAFF, APRIL, IgE, α4β1 integrin and α4β7 integrin. Treatments of diseases associated with chronic inflammation include treatments which interfere with the action of pro-inflammatory factors, such as by binding the factors or binding to receptors for the factors.

[03] An important class of drug for the treatment of chronic inflammation and the diseases associate with chronic inflammation include anti-inflammation antibodies. This class of drugs not only includes antibodies, but also other proteins that bind to pro-inflammatory factors or pro-inflammatory factor receptors, and include a constant region of antibody. Examples of anti-inflammation antibodies include abatacept, alefacept, alemtuzumab, atacicept, belimumab, canakinumab, eculizumab, epratuzumab, natalizumab, ocrelizumab, ofatumumab, omalizumab, otelixizumab, rituximab,

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teplizumab, vedolizumab, adalimumab, briakinumab, certolizumab pegol, etanercept, golimumab, infliximab, mepolizumab, reslizumab, tocilizumab and ustekinumab.

[04] Senescent cells are cells in a state of irreversible proliferative arrest. Senescence is a distinct state of a cell, and is associated with biomarkers, such as activation of $p16^{Ink4a}$, and expression of β-galactosidase. Senescent cells are also associated with secretion of many factors involved in intercellular signaling, including pro-inflammatory factors; secretion of these factors has been termed the senescence-associated secretory phenotype, or SASP.

[05] Advanced glycation end-products (AGEs; also referred to AGE-modified proteins, or glycation end-products) arise from a non-enzymatic reaction of sugars with protein side-chains in aging cells (Ando, K. *et al.*, Membrane Proteins of Human Erythrocytes Are Modified by Advanced Glycation End Products during Aging in the Circulation, *Biochem Biophys Res Commun.*, Vol. 258, 123, 125 (1999)). This process begins with a reversible reaction between the reducing sugar and the amino group to form a Schiff base, which proceeds to form a covalently-bonded Amadori rearrangement product. Once formed, the Amadori product undergoes further rearrangement to produce AGEs. Hyperglycemia, caused by diabetes mellitus (DM), and oxidative stress promote this post-translational modification of membrane proteins (Lindsey JB, *et al.*, "Receptor For Advanced Glycation End-Products (RAGE) and soluble RAGE (sRAGE): Cardiovascular Implications," *Diabetes Vascular Disease Research*, Vol. 6(1), 7-14, (2009)). AGEs have been associated with several pathological conditions including diabetic complications, inflammation, retinopathy, nephropathy, atherosclerosis, stroke, endothelial cell dysfunction, and neurodegenerative disorders (Bierhaus A, "AGEs and their interaction with AGE-receptors in vascular disease and diabetes mellitus. I. The AGE concept," Cardiovasc Res, Vol. 37(3), 586-600 (1998)).

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[06] AGE-modified proteins are also a marker of senescent cells. This association between glycation end-product and senescence is well known in the art. See, for example, Gruber, L. (WO 2009/143411, 26 Nov. 2009), Ando, K. *et al.* (Membrane Proteins of Human Erythrocytes Are Modified by Advanced Glycation End Products during Aging in the Circulation, *Biochem Biophys Res Commun.*, Vol. 258, 123, 125 (1999)), Ahmed, E.K. *et al.* ("Protein Modification and Replicative Senescence of WI-38 Human Embryonic Fibroblasts" *Aging Cells*, vol. 9, 252, 260 (2010)), Vlassara, H. *et al.* (Advanced Glycosylation Endproducts on Erythrocyte Cell Surface Induce Receptor-Mediated Phagocytosis by Macrophages, *J. Exp. Med.*, Vol. 166, 539, 545 (1987)) and Vlassara *et al.* ("High-affinity-receptor-mediated Uptake and Degradation of Glucose-modified Proteins: A Potential Mechanism for the Removal of Senescent Macromolecules" *Proc. Natl. Acad. Sci. USAI*, Vol. 82, 5588, 5591 (1985)). Furthermore, Ahmed, E.K. *et al.* indicates that glycation end-products are "one of the major causes of spontaneous damage to cellular and extracellular proteins" (Ahmed, E.K. *et al.*, see above, page 353). Accordingly, the accumulation of glycation end-product is associated with senescence and lack of function.

SUMMARY

[07] In a first aspect, the present invention is a composition for treating inflammation or auto-immune disorders, comprising: (i) an antibody that binds to an AGE-modified protein on a cell, and (ii) an anti-inflammation antibody.

[08] In a second aspect, the present invention is a method of treating inflammation or autoimmune disorders, comprising administering an antibody that binds to an AGE-modified protein on a cell.

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[09] In a third aspect, the present invention is a method of treating inflammation or auto-immune disorders, comprising interfering with the activity of a pro-inflammatory factor, and killing senescent cells.

[10] In another aspect, embodiments of the present invention provide an anti-carboxymethyllysine (CML) antibody for use in treating inflammation or auto-immune disorders, wherein said treating comprises anti-CML antibody-mediated killing of senescent cells.

[11] The anti-CML antibody may be a human antibody.

[12] The anti-CML antibody may be a conjugated antibody. The conjugated antibody may be an anti-CML antibody conjugated to a member selected from the group consisting of a toxin, a cytotoxic agent, magnetic nanoparticles, and magnetic spin-vortex discs.

[13] The anti-CML antibody may be non-immunogenic to a species selected from the group consisting of humans, cats, dogs, horses, camels, alpaca, cattle, sheep, and goats. The anti-CML antibody may be non-immunogenic to humans.

[14] The anti-CML antibody may be a monoclonal antibody.

[15] In another aspect, embodiments of the present invention provide a composition including the anti-CML antibody for use and a pharmaceutical carrier.

[16] In another aspect, embodiments of the present invention provide a composition including an anti-carboxymethyllysine (CML) antibody for use in treating inflammation or auto-immune disorders, wherein said treating comprises anti-CML antibody-mediated killing of senescent cells, the composition further including: (a) an antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor, wherein the pro-inflammatory factor is selected from the group consisting of TNF, IL-1α, IL-1β, IL-5, IL-6,

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IL-8, IL-12, IL-23, CD2, CD3, CD20, CD22, CD52, CD80, CD86, C5 complement protein, BAFF, APRIL, IgE, α4β1 integrin and α4β7 integrin; or (b) abatacept, alefacept, atacicept or etanercept.

[17] The pro-inflammatory factor may be TNF.

[18] The antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor may be at least one member selected from the group consisting of alemtuzumab, belimumab, canakinumab, eculizumab, epratuzumab, natalizumab, ocrelizumab, ofatumumab, omalizumab, otelixizumab, rituximab, teplizumab, vedolizumab, adalimumab, briakinumab, certolizumab pegol, golimumab, infliximab, mepolizumab, reslizumab, tocilizumab and ustekinumab.

[19] The anti-CML antibody may be a human antibody, and/or the antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor may be a human antibody.

[20] The anti-CML antibody may be a conjugated antibody. The conjugated antibody may be an anti-CML antibody conjugated to a member selected from the group consisting of a toxin, a cytotoxic agent, magnetic nanoparticles, and magnetic spin-vortex discs.

[21] The antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor may be a monoclonal antibody, and the anti-CML antibody may be a monoclonal antibody.

[22] The antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor and the anti-CML antibody may both be antibodies which are non-immunogenic to a species selected from the group consisting of humans, cats, dogs,

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horses, camels, alpaca, cattle, sheep, and goats. The anti-CML antibody may be non-immunogenic to humans.

[23] The composition for use may include a pharmaceutical carrier. The composition for use may be in unit dosage form.

[24] DEFINITIONS

[25] The term "advanced glycation end-products" or "AGE-modified protein" (also referred to as "glycation end-products") refers to modified proteins that are formed as the result of the reaction of sugars with protein side chains that further rearrange and form irreversible crosslinking. This process begins with a reversible reaction between the reducing sugar and the amino group to form a Schiff base, which proceeds to form a covalently-bonded Amadori rearrangement product. Once formed, the Amadori product undergoes further rearrangement to produce AGEs. AGE-modified proteins, and antibodies to AGE-modified proteins are described in U.S. 5,702,704 (Bucala) and U.S. 6,380,165 (Al-Abed et al.). Epitopes found on glycated proteins, such as N-deoxyfructosyllysine found on glycated albumin, are not AGEs. Examples of AGEs include 2-(2-furoyl)-4(5)-(2-furanyl)-1H-imidazole ("FFI"); 5-hydroxymethyl-1-alkylpyrrole-2-carbaldehyde ("Pyrraline"); 1-alkyl-2-formyl-3,4-diglycosyl pyrrole ("AFGP"), a non-fluorescent model AGE; carboxymethyllysine; and pentosidine. ALI, another AGE, is described in Al-Abed et al.

[26] "An antibody that binds to an AGE-modified protein on a cell" means an antibody or other protein that binds to an AGE-modified protein and includes a constant region of an antibody, where the protein which has been AGE-modified is a protein normally found bound on the surface of a cell, preferably a mammalian cell, more preferably a human, cat, dog, horse, camelid (for example, camel or alpaca), cattle, sheep, or goat

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cell. AGE-modified albumin is not an AGE-modified protein on a cell, because albumin is not a protein normally found bound on the surface of cells. “An antibody that binds to an AGE-modified protein on a cell” only includes those antibodies which lead to removal, destruction, or death of the cell. Also included are antibodies which are conjugated, for example to a toxin, drug, or other chemical or particle. Preferably, the antibodies are monoclonal antibodies, but polyclonal antibodies are also possible.

[27] “Pro-inflammatory factor” means a factor which promotes inflammation. Examples of pro-inflammatory factors include TNF or TNFα, IL-1α, IL-1β, IL-5, IL-6, IL-8, IL-12, IL-23, CD2, CD3, CD20, CD22, CD52, CD80, CD86, C5 complement protein, BAFF, APRIL, IgE, α4β1 integrin and α4β7 integrin. Many of these factors and/or their receptors may have a different structure in different animals. A small letter preceding the name will be used to designate that factor originating from different animals or humans, as follows: humans = h, cats = f, dogs = d, horses = e, camels (or alpaca) = c, cattle = b, sheep = o, and goats = g; for example hTNF means human TNF. Furthermore, an “R” following the name of the factor represents the receptor for the factor, such as TNF-R being the human receptor for TNF, or IL-6R being the receptor for IL-6. These designations may be used in combination, for example hIL-6R being the human receptor for IL-6.

[28] “Anti-inflammation antibody” means an antibody or other protein that binds to a pro-inflammatory factor or pro-inflammatory factor receptor, reduces the activity of the factor or receptor, and includes a constant region of antibody. Examples of anti-inflammation antibodies include abatacept, alefacept, alemtuzumab, atacicept, belimumab, canakinumab, eculizumab, epratuzumab, natalizumab, ocrelizumab, ofatumumab, omalizumab, otelixizumab, rituximab, teplizumab, vedolizumab, adalimumab, briakinumab, certolizumab pegol, etanercept, golimumab, infliximab, mepolizumab, reslizumab, tocilizumab and ustekinumab. Preferably, the antibodies are monoclonal antibodies, but polyclonal antibodies are also possible.

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[29] "Senescent cell" means a cell which is in a state of irreversible proliferative arrest and expresses one or more biomarkers of senescence, such as activation of $p16^{Ink4a}$, or expression of β-galactosidase. Also included are cells which expresses one or more biomarkers of senescence, do not proliferate *in vivo*, but may proliferate *in vitro* under certain conditions, such as some satellite cells found in the muscles of ALS patients.

DRAWING

[30] Figure 1, the only drawing, is a graph showing response versus time for Example 2.

DETAILED DESCRIPTION

[31] Although senescent cells have been studied for some time, the *in vivo* effects of senescent cells have only recently been carried out. Once recent study, by Baker, D.J. *et al*. ("Clearance of p16Ink4a-positive senescent cells delays ageing-associated disorders", Nature, vol. 479, pp. 232-236, (2011)), examined the effects of clearance of senescent cells in mice. However, the effect on inflammation and pro-inflammatory factors was not noted. Prior to the present application, the effects of removal or killing of senescent cells on inflammation and pro- inflammatory factors, was unknown.

[32] The present invention is based on the recognition that many cellular networks associated with inflammation have a positive feedback component. Because senescent cells produce pro-inflammatory factors, removal of these cells alone, produces a profound reduction in inflammation and the amount and concentration of pro-inflammatory factors. This may be done by administering an antibody that binds to an AGE-modified protein on a cell.

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[33] Furthermore, by coupling the reduction of the activity of pro-inflammatory factors, together with a reduction in the number of senescent cells, a synergistic effect is produced: the reduction in inflammation will be greater than what would have been expected, based on the effects of either component alone. This may be done, for example, by the administration of both an anti-inflammation antibody and an antibody that binds to an AGE-modified protein on a cell.

[34] An antibody that binds to an AGE-modified protein on a cell (or "Anti-AGE antibody") is known in the art. Examples include those described in U.S. 5,702,704 (Bucala) and U.S. 6,380,165 (Al-Abed *et al.*). Examples include an antibody that binds to one or more AGEs, such as FFI, pyrraline, AFGP, ALI, carboxymethyllysine and pentosidine. Preferably, the antibody binds carboxymethyllysine. Preferably, the antibody is non-immunogenic to the animal in which it will be used, such as non-immunogenic to humans; companion animals including cats, dogs and horses; and commercially important animals, such camels (or alpaca), cattle (bovine), sheep, and goats. More preferably, the antibody has the same species constant region as antibodies of the animal to reduce the immune response against the antibody, such as being humanized (for humans), felinized (for cats), caninized (for dogs), equuinized (for horses), camelized (for camels or alpaca), bovinized (for cattle), ovinized (for sheep), or caperized (for goats). Most preferably, the antibody is identical to that of the animal in which it will be used (except for the variable region), such as a human antibody, a cat antibody, a dog antibody, a horse antibody, a camel antibody, a bovine antibody, a sheep antibody or a goat antibody. Details of the constant regions and other parts of antibodies for these animals are described below.

[35] The anti-AGE antibody has low rate of dissociation from the antibody-antigen complex, or k_d (also referred to as k_{back} or off-rate), preferably at most 9 x 10^{-3}, 8 x 10^{-3}, 7 x 10^{-3} or 6 x 10^{-3} (sec^{-1}). The anti-AGE antibody has a high affinity for the AGE-

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modified protein of a cell, which may be expressed as a low dissociation constant K_D of at most 9×10^{-6}, 8×10^{-6}, 7×10^{-6}, 6×10^{-6}, 5×10^{-6}, 4×10^{-6} or 3×10^{-6} (M).

[36] The anti-AGE antibody can be conjugated to an agent that causes the destruction of AGE-modified cells. Such agents may be a toxin, a cytotoxic agent, magnetic nanoparticles, and magnetic spin-vortex discs.

[37] A toxin, such as pore-forming toxins (PFT) (Aroian R. *et al.*, “Pore-Forming Toxins and Cellular Non-Immune Defenses (CNIDs),” *Current Opinion in Microbiology*, 10:57-61 (2007)), conjugated to an anti-AGE antibody may be injected into a patient to selectively target and remove AGE-modified cells. The anti-AGE antibody recognizes and binds to AGE-modified cells. Then, the toxin causes pore formation at the cell surface and subsequent cell removal through osmotic lysis.

[38] Magnetic nanoparticles conjugated to the anti-AGE antibody may be injected into a patient to target and remove AGE-modified cells. The magnetic nanoparticles can be heated by applying a magnetic field in order to selectively remove the AGE-modified cells.

[39] As an alternative, magnetic spin-vortex discs, which are magnetized only when a magnetic field is applied to avoid self-aggregation that can block blood vessels, begin to spin when a magnetic field is applied, causing membrane disruption of target cells. Magnetic spin-vortex discs, conjugated to anti-AGE antibodies specifically target AGE-modified cell types, without removing other cells.

[40] Antibodies typically comprise two heavy chains and two light chains of polypeptides joined to form a "Y" shaped molecule. The constant region determines the mechanism used to target the antigen. The amino acid sequence in the tips of the "Y" (the variable region) varies among different antibodies. This variation gives the antibody its specificity for binding antigen. The variable region, which includes the ends

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of the light and heavy chains, is further subdivided into hypervariable (HV - also sometimes referred to as complementarity determining regions, or CDRs) and framework (FR) regions. When antibodies are prepared recombinantly, it is also possible to have a single antibody with variable regions (or complementary determining regions) that bind to two different antigens, with each tip of the “Y” being specific to each antigen; these are referred to as bi-specific antibodies.

[41] A humanized anti-AGE antibody according to the present invention may have the human constant region sequence of amino acids in SEQ ID NO: 1, in the appended sequence listing.

[42] The anti-AGE antibody may have one or more of the following complementarity determining regions:

[43] CDR1H (heavy Chain): SEQ ID NO: 2

[44] CDR2H (heavy Chain): SEQ ID NO: 3

[45] CDR3H (heavy Chain): SEQ ID NO: 4

[46] CDR1L (Light Chain): SEQ ID NO: 5

[47] CDR2L (Light Chain): SEQ ID NO: 6

[48] CDR3L (Light Chain): SEQ ID NO: 7

[49] Anti-inflammation antibodies are well known, and many have already been approved for human use. Examples of anti-inflammation antibodies include abatacept, alefacept, alemtuzumab, atacicept, belimumab, canakinumab, eculizumab, epratuzumab, natalizumab, ocrelizumab, ofatumumab, omalizumab, otelixizumab, rituximab, teplizumab, vedolizumab, adalimumab, briakinumab, certolizumab pegol,

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etanercept, golimumab, infliximab, mepolizumab, reslizumab, tocilizumab and ustekinumab. Preferably, the anti-inflammation antibody is an antibody that binds to TNF or TNF-R. Any of the above antibodies may be modified to reduce any possible immune reaction in animals other than humans, by replacing the portion which does not bind a pro-inflammatory factor or pro-inflammatory factor receptor which the constant region of an antibody which originates from that animal, such as an antibody constant region of cats, dogs, horses, camels (or alpaca), cattle, sheep, or goats. Such constant regions, as well as other portions of the antibodies of these animals are well known, and some may be found in the following: Yaofeng Zhao, *et al.* “The bovine antibody repertoire” Developmental & Comparative Immunology, Vol. 30, Issues 1–2, 2006, Pages 175–186; Wagner B, *et al*. “the complete map of the Ig heavy chain constant gene region reveals evidence for seven IgG isotypes and for IgD in the horse” J Immunol. 2004 Sep 1;173(5):3230-42; Strietzel CJ, *et al*. “In Vitro functional characterization of feline IgGs” Vet Immunol Immunopathol. 2014 Apr 15;158(3-4):214-23; Mayuri Patel, *et al.* “Sequence of the dog immunoglobulin alpha and epsilon constant region genes” Immunogenetics, March 1995, Volume 41, Issue 5, pp 282-286; and David R. Maass, *et al*. “Alpaca (Lama pacos) as a convenient source of recombinant camelid heavy chain antibodies (VHHs)” J Immunol Methods. Jul 31, 2007; 324(1-2): 13–25.

[50] The anti-inflammation antibody has low rate of dissociation from the antibody-antigen complex, or k_d (also referred to as k_{back} or off-rate), preferably at most 9×10^{-3}, 8×10^{-3}, 7×10^{-3}, 6×10^{-3}, 5×10^{-3}, 4×10^{-3}, 3×10^{-3}, 2×10^{-3}, or 1×10^{-3}, (sec^{-1}). The anti-inflammation antibody has a affinity for its associated antigen, which may be expresses as a low dissociation constant K_D of at most 9×10^{-6}, 8×10^{-6}, 7×10^{-6}, 6×10^{-6}, 5×10^{-6}, 4×10^{-6}, 3×10^{-6}, 2×10^{-6}, 1×10^{-6}, 1×10^{-7} or 1×10^{-8} (M).

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[51] Examples of such antibodies include those from U.S. Pat. No. 6,090,382, describing anti-TNF antibodies. Such antibodies may have one or more of the following:

[52] CDR3L (light chain): SEQ ID NO: 8.

[53] CDR3H (heavy chain): SEQ ID NO: 9.

[54] Light chain variable region: SEQ ID NO: 10.

[55] Heavy chain variable region: SEQ ID NO: 11.

[56] Bi-specific antibodies, which are both anti-AGE antibodies and anti-inflammation antibodies, may also be used. Such antibodies will have a variable region (or complementary determining region) from those of anti-AGE antibodies, and a variable region (or complementary determining region) from anti-inflammation antibodies.

[57] If additional antibodies are desired, they can be produced using well-known methods. For example, polyclonal antibodies (pAbs) can be raised in a mammalian host by one or more injections of an immunogen, and if desired, an adjuvant. Typically, the immunogen (and adjuvant) is injected in a mammal by a subcutaneous or intraperitoneal injection. The immunogen may be an AGE-modified protein of a cell, pro-inflammatory factor, pro-inflammatory factor receptor, or fragment thereof. Examples of adjuvants include Freund's complete, monophosphoryl Lipid A synthetic-trehalose dicorynomycolate, aluminum hydroxide (alum), heat shock proteins HSP 70 or HSP96, squalene emulsion containing monophosphoryl lipid A, α2-macroglobulin and surface active substances, including oil emulsions, pleuronic polyols, polyanions and dinitrophenol. To improve the immune response, an immunogen may be conjugated to a polypeptide that is immunogenic in the host, such as keyhole limpet hemocyanin (KLH), serum albumin, bovine thyroglobulin, cholera toxin, labile enterotoxin, silica

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particles or soybean trypsin inhibitor. Alternatively, pAbs may be made in chickens, producing IgY molecules.

[58] Monoclonal antibodies (mAbs) may also be made by immunizing a host or lymphocytes from a host, harvesting the mAb-secreting (or potentially secreting) lymphocytes, fusing those lymphocytes to immortalized cells (for example, myeloma cells), and selecting those cells that secrete the desired mAb. Other techniques may be used, such as the EBV-hybridoma technique. Techniques for the generation of chimeric antibodies by splicing genes encoding the variable domains of antibodies to genes of the constant domains of human (or other animal) immunoglobulin result in "chimeric antibodies" that are substantially human (humanized) or substantially "ized" to another animal (such as cat, dog, horse, camel or alpaca, cattle, sheep, or goat) at the amino acid level. If desired, the mAbs may be purified from the culture medium or ascites fluid by conventional procedures, such as protein A-sepharose, hydroxylapatite chromatography, gel electrophoresis, dialysis, ammonium sulfate precipitation or affinity chromatography. Additionally, human monoclonal antibodies can be generated by immunization of transgenic mice containing a third copy IgG human trans-loci and silenced endogenous mouse Ig loci or using human-transgenic mice. Production of humanized monoclonal antibodies and fragments thereof can also be generated through phage display technologies.

[59] A "pharmaceutically acceptable carrier" includes any and all solvents, dispersion media, coatings, antibacterial and antifungal agents, isotonic and absorption delaying agents, and the like, compatible with pharmaceutical administration. Preferred examples of such carriers or diluents include water, saline, Ringer's solutions and dextrose solution. Supplementary active compounds can also be incorporated into the compositions. Solutions and suspensions used for parenteral administration can include a sterile diluent, such as water for injection, saline solution, polyethylene glycols, glycerin, propylene glycol or other synthetic solvents; antibacterial agents such as

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benzyl alcohol or methyl parabens; antioxidants such as ascorbic acid or sodium bisulfite; buffers such as acetates, citrates or phosphates, and agents for the adjustment of tonicity such as sodium chloride or dextrose. The pH can be adjusted with acids or bases, such as hydrochloric acid or sodium hydroxide. The parenteral preparation can be enclosed in ampoules, disposable syringes or multiple dose vials made of glass or plastic.

[60] Pharmaceutical compositions suitable for injection include sterile aqueous solutions or dispersions for the extemporaneous preparation of sterile injectable solutions or dispersion. For intravenous administration, suitable carriers include physiological saline, bacteriostatic water, CREMOPHOR EL® (BASF; Parsippany, NJ) or phosphate buffered saline (PBS). In all cases, the composition must be sterile and should be fluid so as to be administered using a syringe. Such compositions should be stable during manufacture and storage and must be preserved against contamination from microorganisms such as bacteria and fungi. Various antibacterial and anti-fungal agents, for example, parabens, chlorobutanol, phenol, ascorbic acid, and thimerosal, can contain microorganism contamination. Isotonic agents such as sugars, polyalcohols, such as manitol, sorbitol, and sodium chloride can be included in the composition. Compositions that can delay absorption include agents such as aluminum monostearate and gelatin. Sterile injectable solutions can be prepared by incorporating antibodies, and optionally other therapeutic components, in the required amount in an appropriate solvent with one or a combination of ingredients as required, followed by sterilization. Methods of preparation of sterile solids for the preparation of sterile injectable solutions include vacuum drying and freeze-drying to yield a solid.

[61] For administration by inhalation, the antibodies are delivered as an aerosol spray from a nebulizer or a pressurized container that contains a suitable propellant, for example, a gas such as carbon dioxide. Antibodies may also be delivered via inhalation as a dry powder, for example using the iSPERSE™ inhaled drug deliver platform

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(PULMATRIX, Lexington, Mass.). The use of chicken antibodies (IgY) may be non-immunogenic in a variety of animals, including humans, when administered by inhalation.

[62] An appropriate dosage level of each type of antibody will generally be about 0.01 to 500 mg per kg patient body weight. Preferably, the dosage level will be about 0.1 to about 250 mg/kg; more preferably about 0.5 to about 100 mg/kg. A suitable dosage level may be about 0.01 to 250 mg/kg, about 0.05 to 100 mg/kg, or about 0.1 to 50 mg/kg. Within this range the dosage may be 0.05 to 0.5, 0.5 to 5 or 5 to 50 mg/kg. Although each type of antibody may be administered on a regimen of 1 to 4 times per day, such as once or twice per day, antibodies typically have a long half-life *in vivo*. Accordingly, each type of antibody may be administered once a day, once a week, once every two or three weeks, once a month, or once every 60 to 90 days.

[63] In order to determine the effectiveness of the treatment with an antibody that binds to an AGE-modified protein on a cell, either alone or in combination with an anti-inflammation antibody, or in combination with multiple anti-inflammation antibodies, or in combination with other anti-inflammation agents (for example NSAIDS and/or steroids), observation of the patient, or various tests may be used. For example, amelioration of symptoms of inflammation or autoimmune disorders may be observed in a patient (for example, a reduction in redness of the skin); blood tests for various pro-inflammatory factors (such as TNF) which show a reduction in the levels as compared to such levels prior to treatment; and tests for various pro-inflammatory factors (such as TNF) in tissue biopsies taken from at or near the site of inflammation which show a reduction in the levels as compared to such levels prior to treatment.

[64] Unit dosage forms can be created to facilitate administration and dosage uniformity. Unit dosage form refers to physically discrete units suited as single dosages for the subject to be treated, containing a therapeutically effective quantity of one or

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more types of antibodies in association with the required pharmaceutical carrier. Preferably, the unit dosage form is in a sealed container and is sterile.

[65] EXAMPLES

[66] Example 1: *In vivo* study of the administration of anti-glycation end-product antibody

[67] To examine the effects of an anti-glycation end-product antibody, the antibody was administered to the aged CD1(ICR) mouse (Charles River Laboratories), twice daily by intravenous injection, once a week, for three weeks (Days 1, 8 and 15), was followed by a 10 week treatment-free period. The test antibody was a commercially available mouse anti-glycation end-product antibody raised against carboxymethyl lysine, a common AGE epitope, conjugated with keyhole limpet hemocyanin. A control reference of physiological saline was used in the control animals.

[68] Mice referred to a “young” were 8 weeks old, while mice referred to as “old” were 88 weeks (±2 days) old. No adverse events were noted from the administration of the antibody. The different groups of animals used in the study are shown in Table 1.

[69] Table 1

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Group No.	Test Material	Mice	Dose Level (µg/gm/BID/ week)	Number of Animals	
				Main Study	Treatment-Free
				Females	Females
1	Saline	young	0	20	-
2	Saline	old	0	20	20
3	Antibody	old	2.5	20	20
4	None	old	0	20	pre
5	Antibody	old	5.0	20	20

- = Not Applicable, Pre = Subset of animals euthanized prior to treatment start for collection of adipose tissue.

[70] $P16^{INK4a}$ mRNA, a marker for senescent cells, was quantified in adipose tissue of the groups by Real Time-qPCR. The results are shown in Table 2. In the table ΔΔCt = ΔCt mean control Group (2) – ΔCt mean experimental Group (1 or 3 or 5); Fold Expression= $2^{-\Delta\Delta Ct}$.

[71] Table 2

Calculation (unadjusted to Group 4: 5.59)	Group 2 vs Group 1		Group 2 vs Group 3		Group 2 vs Group 5	
	Group 2	Group 1	Group 2	Group 3	Group 2	Group 5
Mean ΔCt	5.79	7.14	5.79	6.09	5.79	7.39
ΔΔCt	-1.35		-0.30		-1.60	
Fold Expression	**2.55**		**1.23**		**3.03**	

[72] The table above indicates that untreated old mice (Control Group 2) express 2.55-fold more p16Ink4a mRNA than the untreated young mice (Control Group 1), as expected. This was observed when comparing Group 2 untreated old mice euthanized at end of recovery Day 85 to Group 1 untreated young mice euthanized at end of treatment Day 22. When results from Group 2 untreated old mice were compared to results from Group 3 treated old mice euthanized Day 85, it was observed that p16Ink4a mRNA was 1.23-fold higher in Group 2 than in Group 3. Therefore, the level of

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p16Ink4a mRNA expression was lower when the old mice were treated with 2.5 µg/gram/BID/week of antibody.

[73] When results from Group 2 (Control) untreated old mice were compared to results from Group 5 (5 ug/gram) treated old mice euthanized Day 22, it was observed that p16Ink4a mRNA was 3.03-fold higher in Group 2 (controls) than in Group 5 (5 ug/gram). This comparison indicated that the Group 5 animals had lower levels of p16Ink4a mRNA expression when they were treated with 5.0 µg/gram/BID/week, providing p16Ink4a mRNA expression levels comparable to that of the young untreated mice (i.e. Group 1). Unlike Group 3 (2.5 ug/gram) mice that were euthanized at end of recovery Day 85, Group 5 mice were euthanized at end of treatment Day 22.

[74] These results indicate the antibody administration resulted in the killing of senescent cells.

[75] Example 2: Affinity and kinetics of test antibody

[76] The affinity and kinetics of the test antibody used in Example 1 were analyzed using Nα,Nα-bis(carboxymethyl)-L-lysine trifluoroacetate salt (Sigma-Aldrich, St. Louis, MO) as a model substrate for an AGE-modified protein of a cell. Label-free interaction analysis was carried out on a BIACORE™ T200 (GE Healthcare, Pittsburgh, PA), using a Series S sensor chip CM5 (GE Healthcare, Pittsburgh, PA), with Fc1 set as blank, and Fc2 immodilized with the test antibody (molecular weigh of 150,000 Da). The running buffer was a HBS-EP buffer (10 mM HEPES, 150 mM NaCl, 3 mM EDTA and 0.05% P-20, pH of 7.4), at a temperature of 25 °C. Software was BIACORE™ T200 evaluation software, version 2.0. A double reference (Fc2-1 and only buffer injection), was used in the analysis, and the data was fitted to a Langmuir 1:1 binding model.

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[77] Table 3: Experimental set-up of affinity and kinetics analysis

Association and dissociation	
Flow path	Fc1 and Fc2
Flow rate (µl/min.)	30
Association time (s)	300
Dissociation time (s)	300
Sample concentration (µM)	20 – 5 – 1.25 (x2) – 0.3125 – 0.078 - 0

[78] A graph of the response versus time is illustrated in FIG. 1. The following values were determined from the analysis: k_a (1/Ms) = 1.857 x 10^3; k_d (1/s) = 6.781 x 10^{-3}; K_D (M) = 3.651 x 10^{-6}; R_{max} (RU) = 19.52; and Chi^2 = 0.114. Because the Chi^2 value of the fitting is less than 10% of R_{max}, the fit is reliable.

[79] Example 3 (prophetic): *In vivo* study of the administration of anti-glycation end-product antibody and a mouse anti-mouse TNF antibody, in the antigen-induced arthritis (AIA) mouse model of rheumatoid arthritis

[80] To examine the effects of an anti-glycation end-product antibody and a mouse anti-mouse TNF antibody on rheumatoid arthritis (a classic inflammatory disease, which is also an autoimmune disorder), both antibodies are simultaneously administered to the CD1(ICR) mouse which had been previously treated with methylated bovine serum albumin, first by systemic injection and then injection into the joint, to create AIA mice.

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Administration of a combination of an anti-glycation end-product antibody and anti-TNF antibody is twice daily by intravenous injection, once a week, for three weeks (Days 1, 8 and 15). The anti-glycation end-product antibody is a commercially available mouse anti-glycation end-product antibody raised against carboxymethyl lysine, a common AGE epitope, conjugated with keyhole limpet hemocyanin. A control reference of physiological saline is used in the first control animals, a second experimental group is administered only anti-glycation end-product antibody, and a second control reference of only anti-TNF antibody is used in the second control animals. Dose Levels of 5 µg/gm/BID/week of each antibody is used.

[81] The animals are observed during the course of the study, and blood is taken to determine levels of TNF. At the end of the study, the animals are euthanized and joint tissue is examined for signs of damage associate with rheumatoid arthritis. The results indicate that the second experimental group and second control group show less joint damage and lower levels of TNF than the first control group. Furthermore, the first experimental group not only show the least joint damage and lowest level of TNF of all the study groups, but the reduction in both joint damage and levels of TNF are greater than would have been expected based solely on the second experimental group and second control group. The results demonstrate the anti-inflammatory effects of anti-glycation end-product antibodies, as well as the synergistic effects of using both an anti-glycation end-product antibody and an anti-inflammation antibody.

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WHAT IS CLAIMED IS:

1. An anti-carboxymethyllysine (CML) antibody for use in treating inflammation or auto-immune disorders, wherein said treating comprises anti-CML antibody-mediated killing of senescent cells.

2. The anti-CML antibody for use according to claim 1, wherein the anti-CML antibody is a human antibody.

3. The anti-CML antibody for use according to claim 1 or 2, wherein the anti-CML antibody is a conjugated antibody.

4. The anti-CML antibody for use according to claim 3, wherein the conjugated antibody is an anti-CML antibody conjugated to a member selected from the group consisting of a toxin, a cytotoxic agent, magnetic nanoparticles, and magnetic spin-vortex discs.

5. The anti-CML antibody for use according to any one of claims 1 - 4, wherein the anti-CML antibody is non-immunogenic to a species selected from the group consisting of humans, cats, dogs, horses, camels, alpaca, cattle, sheep, and goats.

6. The anti-CML antibody for use according to claim 5, wherein the anti-CML antibody is non-immunogenic to humans.

7. The anti-CML antibody for use according to any one of claims 1 - 6, wherein the anti-CML antibody is a monoclonal antibody.

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8. A composition comprising:

an anti-CML antibody for use according to any one of claims 1 - 8; and

a pharmaceutical carrier.

9. A composition comprising an anti-carboxymethyllysine (CML) antibody for use in treating inflammation or auto-immune disorders, wherein said treating comprises anti-CML antibody-mediated killing of senescent cells, the composition further comprising:

(a) an antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor, wherein the pro-inflammatory factor is selected from the group consisting of TNF, IL-1α, IL-1β, IL-5, IL-6, IL-8, IL-12, IL-23, CD2, CD3, CD20, CD22, CD52, CD80, CD86, C5 complement protein, BAFF, APRIL, IgE, α4β1 integrin and α4β7 integrin; or

(b) abatacept, alefacept, atacicept or etanercept.

10. The composition for use according to claim 9, wherein the pro-inflammatory factor is TNF.

11. The composition for use according to claim 9 or 10, wherein the antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor is at least one member selected from the group consisting of alemtuzumab, belimumab, canakinumab, eculizumab, epratuzumab, natalizumab, ocrelizumab, ofatumumab, omalizumab, otelixizumab, rituximab, teplizumab, vedolizumab, adalimumab, briakinumab, certolizumab pegol, golimumab, infliximab, mepolizumab, reslizumab, tocilizumab and ustekinumab.

12. The composition for use according to any one of claims 9 - 11, wherein the anti-CML antibody is a human antibody, and/or the antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor is a human antibody.

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13. The composition for use according to any one of claims 9 - 12, wherein the anti-CML antibody is a conjugated antibody.

14. The composition for use according to claim 13, wherein the conjugated antibody is an anti-CML antibody conjugated to a member selected from the group consisting of a toxin, a cytotoxic agent, magnetic nanoparticles, and magnetic spin-vortex discs.

15. The composition for use according to any one of claims 9 - 14, wherein the antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor is a monoclonal antibody, and the anti-CML antibody is a monoclonal antibody.

16. The composition for use according to any one of claims 9 - 15, wherein the antibody that binds to a pro-inflammatory factor or pro-inflammatory factor receptor and the anti-CML antibody are both antibodies which are non-immunogenic to a species selected from the group consisting of humans, cats, dogs, horses, camels, alpaca, cattle, sheep, and goats.

17. The composition for use according to claim 16, wherein the anti-CML antibody is non-immunogenic to humans.

18. The composition for use according to any one of claims 9 - 17, further comprising a pharmaceutical carrier.

19. The composition for use according to any one of claims 9 - 18, wherein the composition is in unit dosage form.

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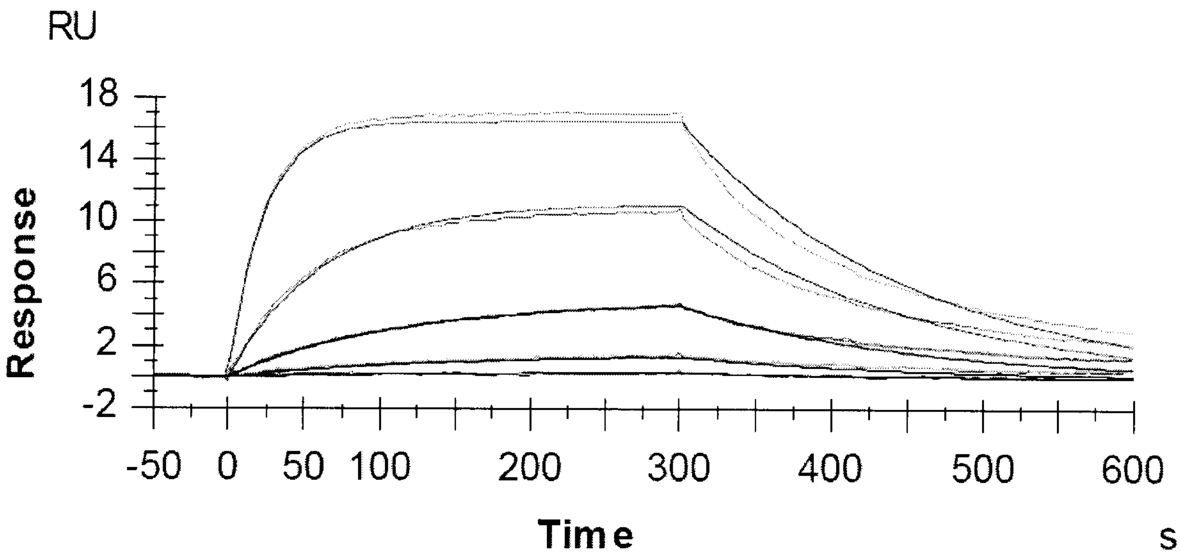
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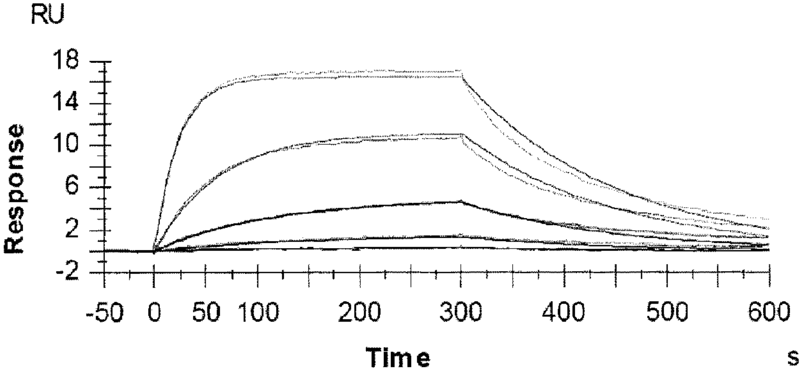

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