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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 June 2012 (07.06.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/074725 A2

(51) International Patent Classification:
A61K 39/385 (2006.01)

(21) International Application Number:
PCT/US2011/060482

(22) International Filing Date:
11 November 2011 (11.11.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/413,375 12 November 2010 (12.11.2010) US

(71) Applicant *(for all designated States except US)*: **CEDARS-SINAI MEDICAL CENTER** [US/US]; 8700 Beverly Boulevard, Los Angeles, California 90048 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **CHYU, Kuang-Yuh** [US/US]; 8052 Kentwood Ave., Los Angeles, California 90045 (US). **SHAH, Prediman K.** [IN/US]; 111 North Layton Drive, Los Angeles, California 90049 (US).

(74) Agents: **BRUNO, Enrica** et al.; Steinfl & Bruno LLP, 155 N. Lake Ave., Stuite 810, Pasadena, California 91101 (US).

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

— *with sequence listing part of description (Rule 5.2(a))*

(54) Title: IMMUNOMODULATORY METHODS AND SYSTEMS FOR TREATMENT AND/OR PREVENTION OF HYPERTENSION

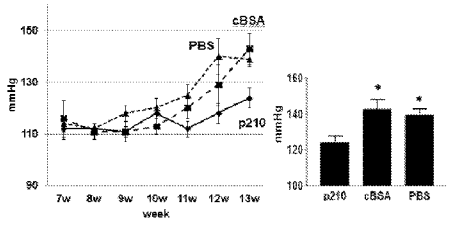

Fig 2B: p210 vaccine significantly decreased mean BP at 13 weeks of age. *p<0.05 vs. p210 by ANOVA followed by post-hoc analysis using Bonferroni test.

FIG. 2B

(57) Abstract: Immunomodulatory agents, T cell, compositions, methods and systems for treating and/or preventing hypertension and/or a condition associated thereto in an individual.

WO 2012/074725 A2

Immunomodulatory Methods and Systems for Treatment and/or Prevention of Hypertension

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to US Provisional Application S/N 61/413,375entitled Immunomodulatory Methods and Systems for Treatment and/or Prevention of Hypertension" filed on November 12, 2010, with docket number P694-USP, which is herein incorporated by reference in its entirety. The present application is also related to PCT application WO 02/080954 filed on April 5, 2002, PCT application S/N _____entitled "Immunomodulatory Methods and Systems for Treatment and/or Prevention of Aneurysms" filed on November 11, 2011 with docket number P686-PCT, and to PCT application S/N_____entitled "Immunomodulatory Compositions, Methods And Systems Comprising Immunogenic Fragments Of Apob100" filed on November 11, 2011 with attorney docket P700-PCT, each of which is herein incorporated by reference in its entirety.

FIELD

[0002] The present disclosure relates to immunomodulatory methods, systems, compositions, and vaccines that are particularly suitable for the treatment or prevention of hypertension and/or of a condition associated thereto.

BACKGROUND

[0003] Hypertension and its complications affect an increasing percentage of the population.

[0004] Treatment of hypertension is typically performed through lifestyle modification and through administration of various medications. However, lifestyle modification and/or hypertension medications may not be enough to achieve satisfactory control of blood pressure. Many patients with hypertension require 2 to 3 different classes of anti-hypertensive medications enhance rendering patients less compliant to medications. Furthermore, some individuals have resistant hypertension that cannot be treated with current medications adequately.

[0005] Providing an effective treatment and/or prevention for hypertension is currently still challenging.

SUMMARY

[0006] Provided herein are methods and systems that allow in several embodiments treatment and/or prevention of hypertension in an individual, alone or in combination with other treatments, including various medications.

[0007] According to a first aspect, a method to treat and/or prevent hypertension and/or a condition associated thereto is described. The method comprises administering to an individual an immunogenic fragment of ApoB-100 or an immunogenically active portion thereof.

[0008] According to a second aspect, a method to treat and/or prevent hypertension and/or a condition associated thereto is described. The method comprises administering to an individual CD8(+) T specific for an immunogenic fragment of ApoB-100 or an immunogenically active portion thereof.

[0009] According to a third aspect, a system to treat and/or prevent hypertension and/or a condition associated thereto in an individual is described. The system comprises at least two of one or more of a CD8(+) T cell specific for an immunogenic fragment of ApoB-100 or an immunogenically active portion thereof and one or more enhancers the CD8(+) T cell. In particular, in several embodiments, the one or more of a CD8(+) T cell specific for an immunogenic fragment of ApoB-100 or an immunogenically active portion thereof and one or more enhancers of the CD8(+) T cell are included in the system for simultaneous, combined or sequential use in methods herein described.

[0010] According to a fourth aspect, a system to treat and/or prevent hypertension and/or a condition associated thereto in an individual is described. The system comprises one or more immunogenic fragments of ApoB-100 or an immunogenically active portion thereof and CD8(+) T cells, and one or more of a CD8(+) T cell specific for an immunogenic fragment of ApoB-100. In particular, in several embodiments, the one or more immunogenic fragments of ApoB-100 or an immunogenically active portion thereof and CD8(+) T cells, and one or more of a CD8(+) T

cell are included in the system for simultaneous, combined or sequential use in methods herein described.

[0011] The fragments, cells, compositions, methods and systems herein described can be used in connection with applications wherein reduction hypertension and/or a therapeutic or preventive effect for hypertension in an individual are desired.

[0012] The details of one or more embodiments of the disclosure are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, which are incorporated into and constitute a part of this specification, illustrate one or more embodiments of the present disclosure and, together with the detailed description and the examples, serve to explain the principles and implementations of the disclosure.

[0014] **Figure 1**shows the effect of p210 immunization on mean blood pressure in various groups of mice according to an embodiment herein described.

[0015] **Figures 2A and 2B**show the effect of p210 immunization on heart rate in various groups of mice according to embodiments herein described.

[0016] **Figure 3** shows p210 immunization confers athero-protective effect. (A) Immunization with native p210 resulted in a significant reduction in aortic atherosclerosis when compared to PBS and cBSA/Alum group (n=9-10 each group, representative picture from each group shown). (B) P210 immunization significantly reduced macrophage infiltration and DC presence assessed by MOMA-2 (n=9-10 each group) and CD11c (n=7-12 each group) immuno-reactivity, respectively in aortic sinus plaques.

[0017] **Figure 4** Effect of p210 immunization on DCs. One week after primary immunization, (A) CD11c(+) or (B) CD11c(+)CD86(+) cells at the immunization sites was significantly reduced in p210/cBSA/alum group when compared to cBSA/alum group. N=10 each group. (C)

One week after third immunization, p210 immunized mice had reduced CD11c(+)CD86(+) cells in lymph nodes compared to cBSA/alum group (n=5 in each group; ANOVA followed by multiple group comparison).

[0018] **Figure 5** shows IgM or IgG titer against p210 before and after p210 immunization. (A) The p210 IgG titers were low before immunization and remained low in the PBS group at euthanasia but significantly increased in cBSA/alum and p210/cBSA/alum groups, with the highest titer in the cBSA/alum group. (B) The p210 IgM titers were low before immunization and significantly increased at euthanasia with no difference among 3 groups of mice. N=5 for 6-7 week time-point and n=9 for 25 week time-point.

[0019] **Figure 6** shows activated lymphocyte population after immunization *in vivo*. (A) CD8(+)CD25(+) T-cell population in the lymph nodes was significantly higher in p210/cBSA/alum group when compared to that of PBS or cBSA/alum groups; (B) CD4(+)CD25(+) T-cells in the lymph nodes did not differ among the three groups. There was a significantly larger population of splenic CD8(+)CD25(+)IL-10(+) T-cells in p210/cBSA/alum group among 3 groups (C) without difference in splenic CD8(+)CD25(+)IL12(+) T-cells among 3 groups (D). Splenic CD4(+)CD25(+)IL-10(+) T-cell population significantly increased in the cBSA/alum group, but was significantly attenuated by the p210/cBSA/alum immunization (E) and (F) splenic CD4(+)CD25(+)IL12(+) T-cells did not differ among 3 groups. N=9-10 in each group for (A) and (B); n=5 in each group for (C), (D), (E) and (F).

[0020] **Figure 7** shows adoptive transfer of CD8(+) T-cells from p210 immunized donors recapitulated the athero-protective effect of p210 immunization but not by transfer of B-cells or CD4(+)CD25(+) T-cells. (A) The recipient mice of CD8(+) T-cells from p210/cBSA/alum immunized donors developed significantly smaller atherosclerotic lesions compared to the recipient mice of CD8(+) T-cells from other 2 groups (n=9-10 each group). (B) Adoptive transfer of B-cells from p210/cBSA/alum donors did not reduce atherosclerosis when compared to the recipient mice of B-cells from PBS or cBSA/alum groups (n=9 each group). Recipient mice of CD4(+)CD25(+) T-cells (n=9-13 each group) with 2 different doses (C. $1x10^5$ cells/mouse or D. $3x10^5$ cells/mouse) did not reproduce the athero-reducing effect of p210 immunization.

[0021] **Figure 8** shows increased cytolytic activity of CD8(+) T cells from p210 immunized mice against dendritic cells in vitro. CD8(+) T-cells from p210 immunized mice significantly had a higher cytolytic activity against dendritic cells when compared to those from PBS or BSA/alum groups. Experiments were repeated 4 times with CD8(+) T-cells pooled from 5 mice in each group each time. Duplicate or triplicate was done each time with total of 11 data-points in each group altogether.

[0022] **Figure 9** shows CD8(+) T-cells from p210 immunized mice containing higher level of Granzyme B when compared to those from PBS or cBSA/alum group; whereas there is no difference in perforin level

[0023] **Figure 10** shows IgG titers against KLH or TNP after p210 immunization. (A) Prior immunization with p210 did not affect the efficacy of subsequent T-cell dependent (KLH, n=3-6 each group) or (B) T-cell independent (TNP, n=4-5 each group) immunization as assessed by the IgG antibody titers when compared to mice received PBS or cBSA/alum.

[0024] **Figure 11** shows a Kaplan Meier survival curve for mice immunized with or without p210 according to one embodiment herein described.

[0025] **Figure 12** shows Antibody response to p210 in apoE-/- mice according one embodiment herein described.

[0026] **Figure 13** shows cytolytic activity of p210-immune $CD8^+$ T cells is abrogated by depletion of $CD25^+$ cells. Lytic activity specific to p210 is also abrogated by absence of serum lipids in the assay medium.

[0027] **Figure 14** shows endocytosis of FITC-labeled p210 by DCs according one embodiment herein described.

[0028] **Figure 15** shows presentation of the peptide p210 by DCs to $CD8^+CD25^-$ T cells in vitro as shown by increased activated CD25+ cells according one embodiment herein described.

Figure 16 shows $CD8^+$ lytic activity gated on $FITC^+$ cells according an embodiment herein described. p210-specific lytic activity by $CD8^+$ T cells from p210-vaccinated mice using DCs loaded with FITC-labeled p210.

DETAILED DESCRIPTION

[0029] Methods and systems are herein described that allow in several embodiments, treatment and/or prevention of hypertension and/or of a condition associated thereto.

[0030] The term "hypertension" as used herein refers to high blood pressure. In particular, hypertension (HTN) or high blood pressure is a chronic medical condition in which the systemic arterial blood pressure is elevated. It is the opposite of hypotension. It is classified as either primary (essential) or secondary. About 90–95% of cases are termed "primary hypertension", which refers to high blood pressure for which no medical cause can be found. The remaining 5–10% of cases (Secondary hypertension) is caused by other conditions that affect the kidneys, arteries, heart, or endocrine system.

[0031] The term "treat," or "treating" or "treatment" as used herein indicates any activity that is part of a medical care for, or that deals with, a condition medically or surgically. The term "preventing" or "prevention" as used herein indicates any activity, which reduces the burden of mortality or morbidity from a condition in an individual. This takes place at primary, secondary and tertiary prevention levels, wherein: a) primary prevention avoids the development of a disease; b) secondary prevention activities are aimed at early disease treatment, thereby increasing opportunities for interventions to prevent progression of the disease and emergence of symptoms; and c) tertiary prevention reduces the negative impact of an already established disease by restoring function and reducing disease-related complications.

[0032] The term "condition" as used herein indicates the physical status of the body of an individual (as a whole or of one or more of its parts) that does not conform to a physical status of the individual (as a whole or of one or more of its parts) that is associated with a state of complete physical, mental and possibly social well-being. Conditions herein described include but are not limited to disorders and diseases wherein the term "disorder" indicates a condition of the living individual that is associated to a functional abnormality of the body or of any of its

parts, and the term "disease" indicates a condition of the living individual that impairs normal functioning of the body or of any of its parts and is typically manifested by distinguishing signs and symptoms. Exemplary conditions include but are not limited to injuries, disabilities, disorders (including mental and physical disorders), syndromes, infections, deviant behaviours of the individual and atypical variations of structure and functions of the body of an individual or parts thereof.

[0033] The wording "associated to" or "associated hereto" as used herein with reference to two items indicates a relation between the two items such that the occurrence of a first item is accompanied by the occurrence of the second item, which includes but is not limited to a cause-effect relation and sign/symptoms-disease relation. Exemplary conditions associated with hypertension are high blood pressure, abnormal heart rates, aneurysms, atherosclerosis, stroke, myocardial infarction, and kidney failure. Additional, conditions associated to HTN comprise left ventricular hypertrophy, congestive heart failure associated with hypertension (e.g. left ventricular diastolic dysfunction). Many immune components have been identified that participate in conditions associated with hypertension, and suggest that immune-modulatory therapies targeting these components can reduce the likelihood of having hypertension.

[0034] In some embodiments, treatment and/or prevention of hypertension can be provided by administering to an individual an effective amount of one or more immunogenic fragments of ApoB-100 or an immunogenically active portion thereof.

[0035] The term "administer" or "administering" or "administration" as used herein means any method of providing an individual with a substance in any fashion including, but not limited to, those discussed herein.

[0036] The term "individual" or "individuals" as used herein indicates a single biological organism such as higher animals and in particular vertebrates such as mammals and more particularly human beings..

[0037] The term "immunogenic fragment" or "antigenic fragment" as used herein indicates a portion of a polypeptide of any length capable of generating an immune response, such as an antigen. An antigen is a molecule recognized by the immune system. An antigenic fragment of

apoB100 is accordingly a portion of apoB-100 that presents antigenic properties (e.g. a specific humoral or cellular response).

[0038] The term "fragment of ApoB100" in the sense of the present disclosure comprises not only fragments of any length from ApoB100, but also peptides produced by genetic recombination or chemically synthesized comprising sequences from ApoB100 The term "immunogenic fragments" in the sense of the present disclosure further comprise also derivative of any fragment, such as mutated fragments (including fragments with replaced, added or deleted residues) oxidative derivative and/or peptide treated with MDA or copper, which maintain a detectable antigenic property of the original fragment.

[0039] The term "derivative" as used herein with reference to a first peptide (e.g., an immunogenic fragment), indicates a second peptide that is structurally related to the first peptide and is derivable from the first peptide by a modification that introduces a feature that is not present in the first peptide while retaining functional properties of the first peptide. Accordingly, a derivative polypeptide of an immunogenic fragment, or of any portion thereof, e.g. an epitope thereof, usually differs from the original an immunogenic fragment or portion thereof by modification of the amino acidic sequence that might or might not be associated with an additional function not present in the original peptide or portion thereof. A derivative peptide of an immunogenic fragment or of any portion thereof retains however one or more of the immunogenic activities that are herein described in connection with an immunogenic fragment or portion thereof. The antigenic properties can be verified with methods and systems such as the ones already described for the immunogenic fragments and additional methods and systems identifiable to a skilled person. Typically, a derivative of an immunogenic fragment comprises at least one epitope of the immunogenic fragment.

[0040] The term "immunogenically active portion" in the sense of the present disclosure indicates any part of a reference antigen that can elicit specific immune response. Exemplary immunogenically active portions are the epitopes typically formed by 5 or more residues comprised within an immunogenic fragment. In some embodiments, epitopes within one or more fragments can overlap.

[0041] Immunogenic fragments can be expressed by recombinant technology, such as a fusion with an affinity or epitope tag, chemical synthesis of an oligopeptide, either free or conjugated to carrier proteins, or any other methods known in the art to express the ApoB-100 peptides.

[0042] Exemplary fragments of ApoB100 are peptides each comprising one of the sequences listed in the Sequence Listing as SEQ ID NO: 1 to SEQ ID NO: 302 described in further detail in the Examples section. Methods and systems suitable to identify an immunogenic fragment in the sense of the present are described in WO 02/080954, hereby incorporated by reference. Additional methods are exemplified in the Examples section (see e.g. Example 1).

[0043] The term "protein" or "polypeptide" or "peptide" as used herein indicates an organic polymer composed of two or more amino acid monomers and/or analogs thereof. The term "polypeptide" includes amino acid polymers of any length including full length proteins or peptides, as well as analogs and fragments thereof. A peptide of three or more amino acids is also called an oligopeptide. As used herein the term "amino acid", "amino acidic monomer", or "amino acid residue" refers to any of the twenty amino acids including synthetic amino acids with unnatural side chains and including both D and L optical isomers. The term "amino acid analog" refers to an amino acid in which one or more individual atoms have been replaced, either with a different atom, isotope, or with a different functional group but is otherwise identical to its natural amino acid analog.

[0044] In an embodiment, the one or more immunogenic fragments of ApoB100 suitable to treat hypertension are associated to atherosclerosis reduction.

[0045] Methods to identify a molecule associated with atherosclerosis reduction are identifiable by a skilled person and include the exemplary procedures described in WO 02/080954 herein incorporated by reference in its entirety. In particular, the ability of a molecule to reduce atherosclerosis can be tested in an animal model following administration of the molecule in a suitable amount using procedure identifiable by a skilled person. For example following subcutaneous administration of a molecule herein described the ability of the molecule to affect atherosclerosis can be tested in mice as illustrated in the Examples sections. A skilled person will be able to identify additional procedure, schedule of administration and dosages upon reading of

the present disclosure.

[0046] Accordingly in an exemplary embodiment, immunogenic molecule associated with atherosclerosis reduction can be identified by identifying a candidate immunogenic molecule able to provide a cellular and/or humoral response in the individual of interest; and testing the candidate immunogenic molecule for an ability to reduce atherosclerosis, to select the candidate immunogenic molecule associated with atherosclerosis reduction.

[0047] In particular, in some embodiments, immunogenic fragments of ApoB100 are immunogenic fragments producing an immune response associated to atherosclerosis reduction in the individual or in an animal model. In some of those embodiments, a percentage atherosclerosis reduction is at least about 20%, or at least about 30%,from about 40% to about 60% or about 50% to about 80%.

[0048] Reference is made to Examples section wherein embodiments of the present disclosure are exemplified with reference to immunogenic fragment p210 associated with a reduction of hypertension of about 11% (see Example 2). Additional fragments associated to atherosclerosis reduction are particularly expected to be effective in treatment and/or prevention of hypertension (see Examples section).

[0049] In some embodiments, the immunogenic fragment associated to atherosclerosis reduction and suitable to be used to treat and/or prevent hypertension comprises at least one of peptide, each comprising p1 (SEQ ID NO: 1), p2 (SEQ ID NO: 2), p11 (SEQ ID NO:11), p25 (SEQ ID NO:25), , p45 (SEQ ID NO:45), p74 (SEQ ID NO:74), p99 (SEQ ID NO:99), p100 (SEQ ID NO:100), p102(SEQ ID NO:102), p103 (SEQ ID NO: 103), p105 (SEQ ID NO:105), p129 (SEQ ID NO:129), p143 (SEQ ID NO:143), p148 (SEQ ID NO:148), p210 (SEQ ID NO:210), or p301 (SEQ ID NO:301).

[0050] In an embodiment, the one or more immunogenic fragments associated to atherosclerosis reduction and suitable to be used to treat and/or prevent hypertension comprises one or more peptides each comprising p2 (SEQ ID NO:2), p11 (SEQ ID NO:11), p45 (SEQ ID NO: 45), p74 (SEQ ID NO: 74), p102 (SEQ ID NO: 102), p148 (SEQ ID NO:148), or p210 (SEQ ID NO:210).

[0051] In an embodiment, the one or more immunogenic fragments associated to atherosclerosis reduction and suitable to be used to treat and/or prevent hypertension comprises two peptides each comprising p143 (SEQ ID NO: 143), or p210 (SEQ ID NO:210). In an embodiment, the one or more immunogenic fragments associated to atherosclerosis reduction comprises three peptides each comprising, one of p11 (SEQ ID NO:11), p25 (SEQ ID NO: 25), or p74 (SEQ ID NO:74). In an embodiment, the one or more immunogenic fragments associated to atherosclerosis reduction comprises five peptides each comprising one of p99 (SEQ ID NO: 99), p100 (SEQ ID NO: 100), p102 (SEQ ID NO: 102), p103 (SEQ ID NO: 103), and p105 (SEQ ID NO: 105).

[0052] In an embodiment, the one or more immunogenic fragments associated to atherosclerosis reduction and suitable to be used to treat and/or prevent hypertension comprises one or more peptides each comprising p2 (SEQ ID NO: 2), p45 (SEQ ID NO: 45), p74 (SEQ ID NO: 74), p102 (SEQ ID NO: 102), or p210 (SEQ ID NO:210).

[0053] In an embodiment, the one or more immunogenic fragments associated to atherosclerosis reduction and suitable to be used to treat and/or prevent hypertension comprise a peptide comprising amino acids 16-35 of human apoB-100 (p2; SEQ ID NO:2).

[0054] In an embodiment the one or more immunogenic fragments associated to atherosclerosis reduction and suitable to be used to treat and/or prevent hypertension comprise a peptide comprising amino acids 661-680 of human apoB-100 (p45; SEQ ID NO:45).

[0055] In an embodiment, the one or more immunogenic fragments associated to atherosclerosis reduction and suitable to be used to treat and/or prevent hypertension comprise a peptide comprising amino acids 3136-3155 of human apoB-100 (P210; SEQ ID NO: 210).

[0056] In an embodiment, the one or more immunogenic fragments associated to atherosclerosis reduction and suitable to be used to treat and/or prevent hypertension comprise a peptide comprising amino acids 4502-4521 of human apoB-100 (P301; SEQ ID NO: 301).

[0057] In an embodiment, the one or more immunogenic fragments associated to atherosclerosis reduction and suitable to be used to treat and/or prevent hypertension comprise a peptide

comprising amino acids 1-20 of human apoB-100 (P1; SEQ ID NO: 1).

[0058] Exemplary data showing association of the above peptides to atherosclerosis reduction are shown in Example 3 of the present disclosure and in International application WO 02/080954, herein incorporated by reference in its entirety (see in particular Table 1, Table 2, Table A and Table B). In particular for some of those peptides or combination thereof a percentage reduction of 64.6% (p143 and p210), 59.6% (p11, p25 and p74), 56.8% (p129,p148, and p167), p67.7 (p2), 57.9% (p210), 55.2% (p301), 47.4% (p45), 31% (p1) has been detected (see W0/02080954 incorporated herein by reference in its entirety, and in particular Table B)

[0059] Immunogenic peptides comprising any of the sequences herein described or immunogenically active portions of those peptides are identifiable by a skilled person using *in silico* and/or *in vitro* approaches. For example, in silico methods can be used to identify any of said epitopes or immunogenic peptides based on any of the sequences herein described. Reference is made for example, to the papers [44] to [51] each of which is incorporated herein by reference in its entirety.

[0060] Such papers describe various algorithms such as Tepitope (Radrizzani et al 2000), Adept (Maksuytov et al 1993), antigenic index (Jameson et al 1988) and others which can be used to identify the immunogenic molecules comprising the sequences at issue or any relevant epitopes.

[0061] Additional tests and laboratory procedures *in vitro* and/or *in vivo* suitable to be used alone or in connection with the identification in *silico* (e.g. ELISA) are identifiable by a skilled person that can be used by a skilled person to verify the in silico data and/or identify immunologically active molecules comprising any of the sequences herein described or immunologically active portions of those sequences.

[0062] Accordingly, in an exemplary embodiments, immunogenic peptides, herein described, immunogenically active portions thereof as well as derivative thereof can be identified by identifying candidate peptides, candidate active portion and/or candidate derivative by *in silico* analysis of any one of the sequences herein described, and by identifying the immunogenic peptides, immunogenically active portions and/or derivative by *in vitro* and/or *in vivo* testing of the candidate peptides, candidate active portion and/or candidate derivative. In particular, the in

silico analysis can be performed by analyzing the sequence of the candidate with algorithm suitable to identify immunogenicity of a molecule or portion thereof. Similarly, the *in vitro* and/or *in vivo* testing comprises methods directed to identify immunogenicity of the candidate peptide, candidate active portion and/or derivative as well as effects of those molecules on aneurysm, with particular reference to formation or regression. Suitable methods and techniques are identifiable by a skilled person upon reading of the present disclosure.

[0063] In several embodiments, the immunogenic peptides, active portions thereof and derivative thereof are expected to include a sequence of at least about 5 amino acids, consistently with the typical length of epitopes as indicated in WO 02/080954 herein incorporated by reference in its entirety.

[0064] In an embodiment, immunization with one or more of the immunogenic molecules herein described reduces the incidence of blood pressure (e.g. Example 2).

[0065] The expected reduction of blood pressure after immunization is at least about 10%, when compared to a control measurement and in particular from about 10% to an amount determined by a physician based on the condition and the individual to be immunized.

[0066] The term "effective amount" as used herein is meant to describe that amount of antigen, e.g. P210, which induces an antigen-specific immune response. .

[0067] Effective amounts of an immunogenic fragment and of one or more of the immunogenic molecules herein described to treat and/or prevent hypertension will depend on the individual wherein the activation is performed and will be identifiable by a skilled person. For example in an embodiment the T cell activation can be performed with an effective amount of from about 100 μg to less than about 1000μg immunogenic fragment or immunogenically active portion thereof. In an embodiment, treatment and/or prevention hypertension can be performed with an effective amount of from about 1 to about 100 mg immunogenic fragment or immunogenically active portion thereof. Additional effective amounts are identifiable by a skilled person in view of the individual where activation is performed and the desired activation.

[0068] In an embodiment, an effective amount for the treatment or prevention can be about 100

μg or more. In some embodiments, treatment and/or prevention can be performed with an amount that is 1 mg or more, e.g. up to 100 mg.

[0069] A greater concentration can be used in some embodiments depending on the desired effect as illustrated in the present disclosure. For example, in embodiments wherein treatment of severe hypertension is desired, treatment is expected to be performed with an effective amount be 250 μg or more and in particular with about 500 μg. In another example, wherein the hypertension is less severe an effective amount to treat hypertension is expected to be at a lower amount compared to an amount used for treatment (e.g. from 100 to 250 μg) even if in some cases, an amount falling within the range of 250μg or 500 μg or higher is also expected to be effective also depending on other factors affecting the pharmacological activity of the molecule in an individual. .

[0070] In particular the effective amount is also expected to vary depending on the number and combination of peptides utilized for each particular vaccine, and specific characteristic and conditions of the individual treated (e.g. immune system diet and general health and additional factors identifiable by a skilled person). More particular, lower or higher amounts within the defined range are expected to be effective in an individual depending on factors such as weight, age, gender of the individual as well as additional factors identifiable by a skilled person.

[0071] In some embodiments, the immunogenic peptides herein described or related immunogenically active portions can be administered in combination with an adjuvant or other carrier suitable to affect and in particular increase immunogenicity of the peptide o active portion thereof. In particular, in some embodiments, the immunogenic peptide or active portion thereof can be conjugated to the adjuvant or carrier according to procedures identifiable to a skilled person. Suitable carriers comprise BSA, and in particular, cationized BSA, aluminum salts such as aluminum phosphate and aluminum hydroxide and additional carriers identifiable by a skilled person.

[0072] In some embodiments, immunogenic molecules herein described can be administered in ratios of immunogenic molecule to carrier to aluminum of about: 1:2:35, 1:2:20.6, 1:2:7.7, 1:2:3.3, 1:1:13.8 weight to weight ratios. In particular, in some embodiments, ratios can be

provided wherein the number of peptides conjugated to each carrier molecule while minimizing the amount of aluminum (adjuvant). In particular in one embodiment, ratio can be provided that result in a concentration up to 2.7 mg conjugate/mL.

[0073] In an embodiment, the administering is performed according to a schedule of administration to be determined in view of the desired effect. In particular, administration is expected to be performed in accordance with dosages and schedule which will be identified based on the condition of the individual to be treated and the desired effect. For example, administration can be performed by performing either a single administration, or a plurality of administrations (e.g. 3 administrations or more, in particular up to 6 administrations) of immunogenic fragments or immunogenically active portion thereof herein described in intervals to obtain a desired immunization based on the condition of the individual.

[0074] In some embodiments the immunogenic molecules herein described can be administered according to a schedule of administration devised in view of the amount of time required by the adaptive immune system of an individual to mount a response to the initial exposure to an immunogen. Typically, the response is expected to plateau at 2 – 3 weeks after exposure. Subsequent exposures often elicit a more rapid response. In various embodiments, the following schedules and manner of administration can be followed: (1) single administration, (2) two administrations 2 – 3 weeks apart, (3) three weekly administrations, (4) up to 6 administrations on a 1 every 3 week schedule. The vaccines have been administered by: (1) subcutaneous injection; (2) intraperitoneal injection; (3)nasal installation; (4) subcutaneous infusion.

[0075] The route of immunization can vary depending on the purposes of immunization described herein. Successful prevention and treatment of hypertension in mice occurred by subcutaneous osmotic pump injections (see Example 2). The type of immune response triggered is largely determined by the route of immunization. Various routes can be used comprising subcutaneous, parenteral, and systemic among the others. In particular, the mucosal linings of airways and intestines contain lymphatic tissue that, when exposed to antigen, elicits anti-inflammatory, immunosuppressive responses. Distinct immunological features of the respiratory and intestinal mucosa lead to partly different types of protective immunity upon antigen exposure by the nasal or oral route.

[0076] In an embodiment, administering one or more immunogenic fragment or an immunogenically active portion thereof can be performed intramuscularly, or mucosally (e.g. nasally, orally, and/or vaginally).

[0077] In some embodiments, methods are provided to prevent hypertension and/or a condition associated thereto in an individual, the method comprising administering to the individual an effective amount of CD8(+) T cells specific for an immunogenic fragment of ApoB-100.

[0078] In some embodiments, methods are provided to prevent hypertension and/or a condition associated thereto in an individual, the method comprising increasing in the individual an activated CD8(+) T cell specific for an immunogenic fragment of ApoB-100 or an immunogenically active portion thereof.

[0079] The term "T cells" as used herein indicates T lymphocytes belonging to a group of white blood cells known as lymphocytes, and participate in humoral or cell-mediated immunity. T cells can be distinguished from other lymphocyte types, such as B cells and natural killer cells (NK cells) by the presence of special markers on their cell surface such as T cell receptors (TCR). Additional markers identifying T cell include CD1a, CD3, CD4, CD8 and additional markers possibly associated to a T cell state and/or functionality as will be understood by a skilled person.

[0080] The term "CD8(+) T cells" indicates T cells expressing the CD8 glycoprotein at their surface, wherein the CD8 (cluster of differentiation 8) glycoprotein is a transmembrane glycoprotein that serves as a co-receptor for the T cell receptor (TCR). Similarly to the TCR, CD8 binds to a major histocompatibility complex (MHC) molecule, but is specific for the class I MHC protein. Exemplary CD8 T cells comprise cytotoxic memory CD8 T cells, regulatory CD8 T cells, cytotoxic effector CD8 T-cells and additional cells identifiable by a skilled person. There are two isoforms of the protein, alpha and beta, each encoded by a different gene. In humans, both genes are located on chromosome 2 in position 2p12.

[0081] The term "activated" and activation as used herein indicate the process by which a T cells interacts with an antigen presenting cell which presents a specific antigen for a time and under condition resulting in a T cell having a preassigned immunological role (e.g. cytotoxicity) within

the immune system. The term "antigen-presenting cell" (APC) indicates a cell that displays antigen complex with major histocompatibility complex (MHC) on its surface. T-cells recognize this complex using their T-cell receptor (TCR). Exemplary APCs comprise dendritic cells (DCs) which are known to play an important role in linking innate and acquired immunity(3)(4) and both immune responses participate in atherogenesis (5),(6).

[0082] Detection of T cells and in particular, CD8(+) T cells, can be performed by detection of markers such as CD8, alone or in combination with TCRCD3 and additional markers identifiable by a skilled person. Detection of activated CD8(+) T cells can be performed by detection of T cells markers and in particular of markers such as CD25, CD44, CD62, and additional markers identifiable by a skilled person using process and techniques suitable for detecting surface markers.

[0083] The terms "detect" or "detection" as used herein indicates the determination of the existence, presence or fact of a molecule or cell in a limited portion of space, including but not limited to a sample, a reaction mixture, a molecular complex and a substrate. The "detect" or "detection" as used herein can comprise determination of chemical and/or biological properties of the target, including but not limited to ability to interact, and in particular bind, other compounds, ability to activate another compound and additional properties identifiable by a skilled person upon reading of the present disclosure. The detection can be quantitative or qualitative. A detection is "quantitative" when it refers, relates to, or involves the measurement of quantity or amount of the target or signal (also referred as quantitation), which includes but is not limited to any analysis designed to determine the amounts or proportions of the target or signal. A detection is "qualitative" when it refers, relates to, or involves identification of a quality or kind of the target or signal in terms of relative abundance to another target or signal, which is not quantified.

[0084] Exemplary techniques suitable for detecting T cell markers comprise use of suitable monoclonal or polyclonal antibodies or antigen-specific HLA or MHC pentamers or hexamers labeled with an appropriate molecule allowing detection as well as additional methods and techniques identifiable by a skilled person. In an exemplary approach T cell markers are identified by flow cytometric analysis as described in the Examples section. Exemplary

techniques suitable for detecting T cell markers comprise use of suitable monoclonal or polyclonal antibodies or antigen-specific HLA or MHC pentamers or hexamers labeled with an appropriate molecule allowing detection as well as additional methods and techniques identifiable by a skilled person. In an exemplary approach T cell markers are identified by flow cytometric analysis as described in the Examples section. In some embodiments of the T cell, compositions methods and systems herein described CD8(+) T cells can be activated using one or more immunogenic fragments of ApoB100 or an immunogenically active portion thereof.

[0085] In particular, activated CD8(+) T cells specific for an immunogenic fragment of ApoB100 are obtainable by contacting a CD8(+) T cells with one or more peptides selected from the group consisting ofp1 (SEQ ID NO: 1), p2 (SEQ ID NO: 2), , p11 (SEQ ID NO:11), p25 (SEQ ID NO:25), , p45 (SEQ ID NO:45), p74 (SEQ ID NO:74), , p99 (SEQ ID NO:99), p100 (SEQ ID NO:100), p102(SEQ ID NO:102), p103 (SEQ ID NO: 103), p105 (SEQ ID NO:105), p129 (SEQ ID NO:129), p143 (SEQ ID NO:143), p148 (SEQ ID NO:148), , , p210 (SEQ ID NO:210), or p301 (SEQ ID NO:301)or an immunogenically active portion thereof for a time and under condition to activate the CD8(+) T cell, the activated CD8(+) T cell specific for the one or more peptides or the immunogenically active portion thereof.

[0086] Activated CD8(+) T cells according to the present disclosure are activated with one or more immunogenic fragment of ApoB100 or an immunogenically active portion thereof and are typically specific for the immunogenic fragment or the immunogenically active portion used for the activation.

[0087] The wording "specific" "specifically" or "specificity" as used herein with reference to the immunogenic response refers to the ability of an immunological agent to direct the immunological activity towards an antigen, together with substantially less to no immunological activity towards other antigen that may be present. As consequence, CD8 (+) T cells herein are specifically activated towards the immunogenic fragment or active portion used to activate them and not for other antigens.

[0088] Exemplary antigenic properties that can be used to identify CD8 T cell specific for the immunogenic fragments comprise humoral and/or cellular responses detectable using methods

and techniques such as the ones exemplified in the Examples section as well as other methods and techniques identifiable by a skilled person. Exemplary methods and systems for detecting antigenic properties in the sense of the present disclosure comprise ELISA and in particular serum ELISA and additional methods exemplified in the Examples section. Exemplary techniques suitable for detecting T cell markers comprise use of suitable monoclonal or polyclonal antibodies or antigen-specific HLA or MHC pentamers or hexamers labeled with an appropriate molecule allowing detection as well as additional methods and techniques identifiable by a skilled person. In an exemplary approach T cell markers are identified by flow cytometric analysis as described in the Examples section.

[0089] In an embodiment, activated the CD8(+) T cells are specific for one or more of any of the peptides between SEQ ID NO:1 and SEQ ID NO:302 or an immunogenically active portion thereof that are associated with treatment or prevention of atherosclerosis. In some embodiments the immunogenic fragment comprises one or more of the peptides SEQ ID NO:2, SEQ ID NO:11, SEQ ID NO: 45, SEQ ID NO: 74, SEQ ID NO: 102, SEQ ID NO:148, SEQ ID NO:210 or an immunogenically active portion thereof. In some embodiments the immunogenic fragment comprises one or more of the peptides SEQ ID NO:2, SEQ ID NO: 45, SEQ ID NO: 74, SEQ ID NO: 102, SEQ ID NO:210 or an immunogenically active portion thereof. Even more particularly, in some embodiments the immunogenic fragment comprises amino acids 3136-3155 of human apoB-100 (P210; SEQ ID NO: 210) or an immunogenically active portion thereof. In general, the same combination of immunogenic fragments proven or expected to be associated with treatment and/or prevention of hypertension in an individual are also expected to be able to activate CD8(+)T cells to be used in treatment and/or prevention of hypertension in the individual. In particular, T cell activation can be performed using any of the molecules herein described administered *in vivo* in an amount suitable to treat or prevent aneurysms, (see e.g. Example section). Activation of T cell can also be performed *in vitro* using methods and procedures such as the ones described in ref [52] as well as additional procedures identifiable by a skilled person.

[0090] In an embodiment, an increasing of CD8(+)T cell to treat and/or prevent hypertension in the individual can be performed by administering to the individual an effective amount of an

activated CD8(+) T cell.

[0091] In an embodiment the effective amount is expected to be comprised between about 500,000 to about 2,000,000 cells. In embodiment the effective amount is expected to be comprised between about 750,000 to about 1,500,000 cells. In an embodiment, the effective amount is expected to be about 1,000,000 cells.

[0092] In particular, in an embodiment administration of about 1,000,000 cells is expected to result in both treatment and prevention of atherosclerosis and is therefore expected to also be effective in treatment and prevention of hypertension. Administration is expected to be performed in accordance with dosages and schedule which will be identified based on the condition of the individual to be treated and the desired effect. For example in administration directed to prevention, administering an effective amount of activated CD8(+) T cell can performed by performing either a single administration, or a plurality of administrations (e.g. 3 administrations or more, in particular up to 6 administrations) of activated CD8(+) T cell herein described in intervals to obtain a desired immunization based on the condition of the individual. In particular, a plurality of administrations can be performed whenever a prolonged immunizing effect is desired.

[0093] In some embodiments, activated CD8+ T cells herein described are expected to be effective according to a schedule of administration wherein those cells are administered daily (for up to 21 days) and on an every 10 day schedule (days 0, 10, 20). Additional schedules expected to be effective can be identified by a skilled person based on cell treatments of other condition such as HIV and/or cancer.

[0094] Administration of CD8(+) T cell herein described can be performed according to methods to immunize an individual identifiable to a skilled person. In an embodiment, the administering can be performed by parenteral administration. Parenteral administration is a systemic route of administration where the substance is given by route other than the digestive tract and includes but is not limited to intravenous administration, intra-arterial administration, intramuscular administration, subcutaneous administration, intradermal, administration, intraperitoneal administration, and intravesical infusion. In particular, in an embodiment the administering can

be performed by intravenous administration.

[0095] In an embodiment, administration can be performed by administering activated CD8(+) T cell one time, typically via intravenous route, one time or multiple times, depending on the desired duration of the immunization effect.

[0096] In some embodiments wherein methods are provided to treat and/or prevent hypertension and/or a condition associated thereto in an individual an effective amount of CD8(+) T cells specific for an immunogenic fragment of ApoB100 can be administered alone or in combination with an effective amount of one or more immunogenic fragments herein described or immunogenically active portion thereof. In particular, the one or more immunogenic fragments or immunogenically active portion thereof can be administered with CD8(+)T cells in the same or less the concentration required as an effective amount of immunogenic fragment used to treat and/or prevent hypertension.

[0097] In some embodiments wherein methods are provided to treat and/or prevent hypertension and/or a condition associated thereto in an individual, the effective amount of activated CD8(+) T cells and/or immunogenic fragment of ApoB100 or immunogenically active portion thereof vary, and so is the route of immunization which can vary depending on the purposes of immunization described herein. Various routes can be used comprising subcutaneous, parenteral, and systemic among the others. In particular, the mucosal linings of airways and intestines contain lymphatic tissue that, when exposed to cells, elicits anti-inflammatory, immunosuppressive responses.

[0098] In some embodiments, administering of an immunogenic fragment and/or a CD8(+) T cell can be performed in combination with an enhancer of CD8(+) T cell activation.

[0099] The terms “enhancer” and “enhance” as it pertains to a molecule in connection with CD8 T cell refers to the ability of a molecule to modify the immune response by promoting the activation of cells of the immune system. The choice of appropriate enhancer can allow control of activation of the immune response. Exemplary enhancers include cytokines such as IL 10, IL-2, IL 12, IL-4 IL-16. The term “cytokine” as used herein refers cell signaling molecules that act as has immunomodulating agents, and comprise proteins such as interleukins and interferons as

would be identifiable to a skilled person. Selection of a suitable cytokine can result under appropriate conditions in the preferential induction of a humoral or cellular immune response.

[00100] In an embodiment, the enhancer can be Interleukin 2 (IL2), interleukin 10 (IL10), Interleukin 15 (IL-15), TGF-beta (TGF-β), IL2-antiIL-2 antibody complex and/or additional enhancer identifiable by a skilled person upon reading of the present disclosure. Reference is made to the references Mitchell et al 2010 (38), Perret et al 2008 (39) and Kamimura et al 2007 (40), each incorporated by reference in their entirety, which describe exemplary use of enhancer in connection with T cell activation.

[00101] In particular in some embodiments, the enhancing is performed by reducing CD86 expression and/or IL12 secretion by dendritic cells in the individual.

[00102] In some embodiments, an immunogenic fragment of ApoB-100 is further administered with the methods that are provided to treat and/or prevent hypertension and/or a condition associated thereto in an individual together with an effective amount of CD8(+) T cells specific for an immunogenic fragment of ApoB100 and possibly an enhancer.

[00103] As disclosed herein, the immunogenic fragments or immunogenically active portion thereof, CD8 (+) Tcell, and enhancers herein described can be provided as a part of systems to treat and/or prevent hypertension or of a condition associated thereto.

[00104] In an embodiment, the system comprises at least two of one or more of an activates CD8(+) T cell and one or more cytokine able to enhance the activated CD8(+) T cell.

[00105] In an embodiment, the system comprises at least two of one or more immunogenic fragments of ApoB-100 or immunogenically active portion thereof and one or more of an activated CD8(+) T cell specific for an immunogenic fragment of ApoB-100.

[00106] In an embodiment, the system comprises at least two of one or more immunogenic fragments of apoB-100 or immunogenically active portion thereof an activated CD8(+) T cell herein described and further comprising one or more enhancersof the CD8(+) T cell.

[00107] The systems can be provided in the form of kits of parts. In a kit of parts, the immunogenic fragments, CD8(+) T cell herein described and other reagents to perform the method herein described can be comprised in the kit independently. The CD8(+) T cell herein described can be included in one or more compositions, and each CD8(+) T cell herein described can be in a composition together with a suitable vehicle.

[00108] Additional components can include enhancers molecules able to detect CD8(+) Tcell herein described, such as labeled molecules and in particular, labeled antibodies, labels, microfluidic chip, reference standards, and additional components identifiable by a skilled person upon reading of the present disclosure. The terms "label" and "labeled molecule" as used herein as a component of a complex or molecule referring to a molecule capable of detection, including but not limited to radioactive isotopes, fluorophores, chemiluminescent dyes, chromophores, enzymes, enzymes substrates, enzyme cofactors, enzyme inhibitors, dyes, metal ions, nanoparticles, metal sols, ligands (such as biotin, avidin, streptavidin or haptens) and the like. The term "fluorophore" refers to a substance or a portion thereof which is capable of exhibiting fluorescence in a detectable image. As a consequence, the wording "labeling signal" as used herein indicates the signal emitted from the label that allows detection of the label, including but not limited to radioactivity, fluorescence, chemiluminescence, production of a compound in outcome of an enzymatic reaction and the like.

[00109] In some embodiments, detection of a CD8(+) Tcell or immunogenic fragments herein described can be carried either via fluorescent based readouts, in which the labeled antibody is labeled with fluorophore, which includes, but not exhaustively, small molecular dyes, protein chromophores, quantum dots, and gold nanoparticles. Additional techniques are identifiable by a skilled person upon reading of the present disclosure and will not be further discussed in detail.

[00110] In particular, the components of the kit can be provided, with suitable instructions and other necessary reagents, in order to perform the methods here described. The kit will normally contain the compositions in separate containers. Instructions, for example written or audio instructions, on paper or electronic support such as tapes or CD-ROMs, for carrying out the assay, will usually be included in the kit. The kit can also contain, depending on the particular method used, other packaged reagents and materials (i.e. wash buffers and the like).

[00111] In some embodiments, the immunogenic fragments, active portions thereof, CD8(+) Tcell and/or enhancers herein described can be included in compositions together with a suitable vehicle.

[00112] The term "vehicle" as used herein indicates any of various media acting usually as solvents, carriers, binders or diluents for T cell comprised in the composition as an active ingredient.

[00113] In some embodiments, where the composition is to be administered to an individual the composition can be a pharmaceutical anti-inflammatory composition, and comprises T cell and a pharmaceutically acceptable vehicle

[00114] In particular, in some embodiments, disclosed are pharmaceutical compositions which contain at least one the immunogenic fragments, active portions thereof, CD8(+) Tcell and/or enhancers herein described as herein described, in combination with one or more compatible and pharmaceutically acceptable vehicles, and in particular with pharmaceutically acceptable diluents or excipients. In those pharmaceutical compositions the immunogenic fragments, active portions thereof, CD8(+) Tcell and/or enhancers herein described can be administered as an active ingredient for treatment or prevention of a condition in an individual.

[00115] The term "excipient" as used herein indicates an inactive substance used as a carrier for the active ingredients of a medication. Suitable excipients for the pharmaceutical compositions herein disclosed include any substance that enhances the ability of the body of an individual to absorb a immunogenic fragments, active portions thereof, CD8(+) Tcell and/or enhancers herein described. Suitable excipients also include any substance that can be used to bulk up formulations with the immunogenic fragments, active portions thereof, CD8(+) Tcell and/or enhancers herein described to allow for convenient and accurate dosage. In addition to their use in the single-dosage quantity, excipients can be used in the manufacturing process to aid in the handling of the immunogenic fragments, active portions thereof, CD8(+) Tcell and/or enhancers herein described. Depending on the route of administration, and form of medication, different excipients can be used. Exemplary excipients include but are not limited to antiadherents, binders, coatingsdisintegrants, fillers, flavors (such as sweeteners) and colors, glidants,

lubricants, preservatives, sorbents.

[00116] The term "diluent" as used herein indicates a diluting agent which is issued to dilute or carry an active ingredient of a composition. Suitable diluent include any substance that can decrease the viscosity of a medicinal preparation.

[00117] In an embodiment, compositions herein described can further include an adjuvant. The term "adjuvant" as used herein indicates an agent that can stimulate the immune system and increase the response to a vaccine, without having any specific antigenic effect in itself. The word "adjuvant" comes from the Latin word *adjuvare*, meaning to help or aid. Typically, an immunologic adjuvant is defined as any substance that acts to accelerate, prolong, or enhance antigen-specific immune responses when used in combination with specific vaccine antigens.

[00118] In some embodiments, pharmaceutical composition can include (1) a peptide or other immunogenic molecule herein described administered alone, (2) a peptide or other immunogenic molecule herein described + carrier(s); (3) a peptide or other immunogenic molecule herein described + adjuvant; (4) a peptide or other immunogenic molecule herein described + carrier + adjuvant. In particular, the carriers for each of the exemplary composition (1) to (4) can comprise: (1) cBSA, (2) rHSA, (3) KLH, (4) cholera toxin subunit B, respectively, each of which can be mineral salt-based. Other carriers, known to those skilled in the art, are expected to be suitable as well as will be identified by a skilled person. Examples of those adjuvants comprise adjuvants having Th2 effects, carriers having adjuvant properties, e.g., diphtheria toxoid, and adjuvants able to function as carriers, e.g., oil-water emulsions. In some embodiments, a necessary, and under certain conditions sufficient, component for the pharmaceutical composition is the immunogenic peptides. Additional components of the composition can be selected to modulate the immunological impact of the peptides or other immunogenic molecule herein described as will be understood by a skilled person.

[00119] Further advantages and characteristics of the present disclosure will become more apparent hereinafter from the following detailed disclosure by way of illustration only with reference to an experimental section.

EXAMPLES

[00120] The methods system herein described are further illustrated in the following examples, which are provided by way of illustration and are not intended to be limiting. A person skilled in the art will appreciate the applicability of the features described in detail.

[00121] In particular, the following examples illustrate exemplary immunogenic fragments, and methods for immunizing individuals to treat or prevent hypertension and in particular methods using fragment p210.

[00122] A person skilled in the art will appreciate the applicability and the necessary modifications to adapt the features described in detail in the present section, to additional immunogenic fragments, administered subcutaneously or using other routes of administration *in vivo* or *in vitro* according to embodiments of the present disclosure.

[0051] Unless otherwise indicated the following material and methods were followed in the Examples reported below.

[0052] **Selection of peptides and their preparation for immunization** The establishment and screening of human apoB-100 peptides has been reported (8). Based on Applicants pilot experiments and prior reports,(9),(10) Applicants selected peptide 210 (p210, KTTKQ SFDLS VKAQY KKNKH – SEQ ID NO: 210) as a candidate immunogen. Native p210 peptide (Euro-Diagnostica AB, Sweden) was conjugated to cationic bovine serum albumin (cBSA) as carrier using a method described previously.(3),(4) Alum was used as adjuvant and mixed with peptide/cBSA conjugate with 1:1 ratio in volume. Peptide conjugation and mixing with alum were prepared fresh prior to each immunization.

[0053] **Immunization protocols** Male apoE (-/-) mice (Jackson Laboratories) were housed in an animal facility accredited by the American Association of Accreditation of Laboratory Animal Care and kept on a 12-hour day/night cycle with unrestricted access to water and food. The Institutional Animal Care and Use Committee of Cedars-Sinai Medical Center approved the experimental protocols. In a pilot experiment, p210 immunization using 100μg dose conferred optimum athero-reduction compared to 25 or 50μg dose. Hence 100μg dose was used for all subsequent experiments.Mice, maintained on normal chow diet, received subcutaneous primary

immunization in the dorsal area between scapulas at 6–7 weeks of age, followed by a booster at 9 and 12 weeks of age. One week after last booster, diet was switched to high cholesterol chow (TD 88137, Harlan-Teklad) and continued until euthanasia at the age of 25 weeks. Separate groups of mice receiving PBS or cBSA/alum at the same immunization time-points served as control. Some mice were sacrificed at 8 or 13 weeks of age to assess immune response against p210.

[0054] Tissue harvesting and preparation At euthanasia the hearts were harvested and embedded in OCT compound (Tissue-Tek) for cryo-section. Whole aortas were cleaned, processed and stained with Oil Red O to assess the extent of atherosclerosis *en face* with computer-assisted histomorphometry.(3),(4).

[0055] Immunohistochemistry and histomorphometry The sections from aortic sinus were stained with MOMA-2 (Serotec), or CD11c (eBioscience) antibody to identify macrophages or dendritic cells immunohistochemically using standard protocol. Oil-Red-O stain for plaque size was done using standard protocol. Computer-assisted morphometric analysis was performed to assess histomorphometry as described previously.(3),(4)

[0056] Serum ELISA Flat-bottomed 96-well polystyrene plates (MaxiSorp, Germany) were pre-coated with 100ul (20μg/ml) p210, KLH, TNP-KLH (Biosearch Technologies T-5060) or BSA (2μg/ml for IgG or 10μg/ml for IgM) respectively by incubation overnight at 4°C to assess antibodies levels using standard protocol. The coating concentration was optimized in pilot experiments. Goat anti-mouse HRP -IgG (Pierce 31437) or IgM (Southern Biotech) were used as detecting antibodies and the bound antibodies were detected by developing in ABTS (Southern Biotech) as substrate and optical density values were recorded at 405 nm.

[0057] Flow cytometric analysis Flow cytometric analysis was performed using standard protocols with antibodies listed in **Table 1** below and a FACScan (Becton Dickinson) or a CyAn ADP analyzer (Beckman Coulter). For intracellular cytokine staining, Brefeldin A (3 μg/ml) was added to the cultured cells for 2 hours before cells subject to staining procedure. Cell membranes were permeabilized for staining intracellular molecules.

Table 1

Antigen	Clone	Type	Supplier
CD4	GK1.5	FITC-Rat IgG2b, κ	BD Pharmingen
CD8b.2	53-5.8	FITC-Rat IgG1, κ	BD Pharmingen
CD25	PC61.5	PE-Rat IgG1, λ	eBioscience
IL-10	JES5-16E3	Percp-Cy5.5- Rat IgG2a, κ	eBioscience
IL-12	Clone C17.8	Percp-Cy5.5- Rat IgG2b, κ	eBioscience
CD11c	HL3	FITC-Hamster IgG1, λ	BD Pharmingen
CD86	GL1	PE-Rat IgG2a, κ	BD Pharmingen
TGF-Beta	1D11	APC-Mouse IgG1	R&D system
Granzyme B	16G6	Alexa-Fluo 647 Rat IgG2b, κ	eBioscience
Perforin	eBioOMAK-D	FITC-Rat IgG2a, κ	eBioscience

[0058] Adoptive transfer experiment Male apoE (-/-) mice on regular chow received subcutaneous immunization as described in previous paragraph and were sacrificed at 13 weeks of age as donors. Splenocytes from the same treatment group were pooled before cell isolation. Donor CD8(+) T-cells, CD4(+)CD25(+) T-cells or B-cells were isolated using Dynabeads FlowComp (Invitrogen) according to the manufacturer's protocols. CD4(+) T-cells were negatively selected from the splenocytes followed by positive selection of CD4(+)CD25(+) cells. B cells were negatively isolated whereas CD8(+) T-cells were positively isolated first and released from beads. The purity of pooled CD8(+) T-cells, CD4(+)CD25(+) T-cells and B-cells was 90%, 80% and 70%, respectively. The isolated CD8(+) T-cells ($1x10^6$ cells/mouse), CD4(+)CD25(+) T-cells ($1x10^5$ or $3x10^5$ cells/mouse) or B-cells ($2x10^7$ cells/mouse) were then adoptively transferred to naïve male apoE (-/-) recipient mice at 6-7 weeks of age via tail vein injection. In the published literatures of vascular biology, the number of adoptively transferred lymphocytes varied greatly. For B-cells transfer, the number of $2x10^7$ cells/mouse was chosen based on two prior reports.(11),(12) For CD4(+)CD25(+) T-cells transfer, the number of cells transferred ranged from $5x10^4$ cells/mouse to $1x10^6$ cells/mouse in the published literature.(13),(14),(15) Hence we chose 2 intermediate doses for our experiment. As to CD8(+) T-cells, $1x10^6$ cells was chosen based on a report from the field of autoimmune disease.(16) We

did not adoptively transferred CD4(+) T-cells because naïve or antigen-primed CD4(+) T-cells are known to be pro-atherogenic.(17),(18)Recipient mice were fed normal chow until 13 weeks of age when chow was switched to high cholesterol diet until euthanasia at 25 weeks of age. Aortas were harvested to assess the extent of atherosclerosis.

[0059] KLH or Trinitrophenyl-lipopolysaccharide (TNP-LPS) Immunization Applicants also tested if p210 immunization affected the efficacy of subsequent immunization with other antigens. KLH was chosen as a prototypical T-cell dependent and TNP as a T-cell independent antigen. Male C57/BL6 mice on regular chow received subcutaneous immunization with p210 conjugate or adjuvant control as described in previous paragraphs for apoE (-/-) mice. At 13 and 15 weeks of age mice were subcutaneously immunized with 100 μg KLH (with alum as adjuvant) at injection sites away from p210 sites or injected intraperitoneally with 100 μg TNP-LPS (Sigma). KLH or TNP immunization was done in separate groups of mice. Blood was collected via retro-orbital puncture at euthanasia (16 weeks of age).

[0060] ***In vitro*** **Generation of BM-derived dendritic cells (BMDCs)** The method for generating BMDC with GM-CSF was adapted from previous publication with modification.(19) Briefly, bone marrow cells from femurs and tibiae of male apoE-/- mice were plated into 10cm culture plates (Falcon) with 20 ml complete RPMI-1640 containing 10ng/ml GM-CSF (R&D Systems) and 10ng/ml IL-4 (Invitrogen). Cells were washed and fed on day 3 and day 5 by removing the old medium followed by replenishing with fresh culture medium with GM-CSF and IL-4. On day 8, the immature DC appeared as non-adherent cells under the microscope and harvested by vigorous pipetting and subcultured into new culture plates with $2x10^5$ DCs in 1.5ml medium.

[0061] ***In vitro*** **CD8(+) T-cells isolation and co-culture with dendritic cells** Donor mice [male apoE (-/-) mice] for CD8(+) T-cells were immunized with PBS, cBSA/Alum, or cBSA/Alum/P210 according to the schedule described in earlier paragraphs and splenocytes were harvested at 13 weeks of age. CD8(+) T-cells were negatively isolated using a CD8 selection Dynabeads kit (Invitrogen) per manufacturer's protocol. The selected CD8(+) T-cells were then co-culture with DCs in a CD8:DC ratio of 3:1. A series of pilot studies has been performed to determine the optimal CD8:DC ratio for this assay. After co-culture for 4 hours,

cells were collected and processed for flow cytometric determination of CD11c and 7-AAD by LSR II flow cytometer (BD Biosciences) and data was analyzed with Summit V4.3 software. Dendritic cell death without CD8(+) T-cells in the co-culture was used as baseline and percentage of specific lysis of cells was calculated using a method described previously.(20)

[00123] Statistics Data are presented as mean ± Std. Number of animals in each group is listed in text or description of the figures. Data were analyzed by ANOVA followed by Newman-Keuls multiple group comparison, or by t-test when appropriate. $P < 0.05$ was considered as statistically significant and horizontal bars in each figure indicated statistically significant difference between groups.

Example 1: Immunogenic fragments of ApoB-100

[00124] Specific immunogenic epitopes by focusing on the single protein found in LDL, apolipoprotein B-100 (apo B) were characterized. A peptide library comprised of 302 peptides, 20 amino acid residues in length, covering the complete 4563 amino acid sequence of human ApoB-100 was produced. The peptides were produced with a 5 amino acid overlap to cover all sequences at break points. Peptides were numbered 1-302 starting at the N-terminal of apo B as indicated in **Table 2** below.

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P1:	EEEML ENVSL VCPKD ATRFK	aa 1-20	SEQ ID NO: 1
P2:	ATRFK HLRKY TYNYE AESSS	aa 16-35	SEQ ID NO:2
P3:	AESSS GVPGT ADSRS ATRIN	aa 31-50	SEQ ID NO:3
P4:	ATRIN CKVEL EVPQL CSFIL	aa 46-65	SEQ ID NO:4
P5:	CSFIL KTSQC TLKEV YGFNP	aa 61-80	SEQ ID NO:5
P6:	YGFNP EGKAL LKKTK NSEEF	aa 76-95	SEQ ID NO:6
P7:	NSEEF AAAMS RYELK LAIPE	aa 91-110	SEQ ID NO:7
P8:	LAIPE GKQVF LYPEK DEPTY	aa 106-125	SEQ ID NO:8
P9:	DEPTY ILNIK RGIIS ALLVP	aa 121-140	SEQ ID NO:9
P10:	ALLVP PETEE AKQVL FLDTV	aa 136-155	SEQ ID NO:10
P11:	FLDTV YGNCS THFTV KTRKG	aa 151-170	SEQ ID NO:11
P12:	KTRKG NVATE ISTER DLGQC	aa 166-185	SEQ ID NO:12
P13:	DLGQC DRFKP IRTGI SPLAL	aa 181-200	SEQ ID NO:13

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P14:	SPLAL IKGMT RPLST LISSS	aa 196-215	SEQ ID NO:14
P15:	LISSS QSCQY TLDAK RKHVA	aa 211-230	SEQ ID NO:15
P16:	RKHVA EAICK EQHLF LPFSY	aa 226-245	SEQ ID NO:16
P17:	LPFSY NNKYG MVAQV TQTLK	aa 241-260	SEQ ID NO:17
P18:	TQTLK LEDTP KINSR FFGEG	aa 256-275	SEQ ID NO:18
P19:	FFGEG TKKMG LAFES TKSTS	aa 271-290	SEQ ID NO:19
P20:	TKSTS PPKQA EAVLK TLQEL	aa 286-305	SEQ ID NO:20
P21:	TLQEL KKLTI SEQNI QRANL	aa 301-320	SEQ ID NO:21
P22:	QRANL FNKLV TELRG LSDEA	aa 316-335	SEQ ID NO:22
P23:	LSDEA VTSLL PQLIE VSSPI	aa 331-350	SEQ ID NO:23
P24:	VSSPI TLQAL VQCGQ PQCST	aa 346-365	SEQ ID NO:24
P25:	PQCST HILQW LKRVH ANPLL	aa 361-380	SEQ ID NO:25
P26:	ANPLL IDVVT YLVAL IPEPS	aa 376-395	SEQ ID NO:26
P27:	IPEPS AQQLR EIFNM ARDQR	aa 391-410	SEQ ID NO:27
P28:	ARDQR SRATL YALSH AVNNY	aa 406-425	SEQ ID NO:28
P29:	AVNNY HKTNP TGTQE LLDIA	aa 421-440	SEQ ID NO:29
P30:	LLDIA NYLME QIQDD CTGDE	aa 436-455	SEQ ID NO:30
P31:	CTGDE DYTYL ILRVI GNMGQ	aa 451-470	SEQ ID NO:31
P32:	GNMGQ TMEQL TPELK SSILK	aa 466-485	SEQ ID NO:32
P33:	SSILK CVQST KPSLM IQKAA	aa 481-500	SEQ ID NO:33
P34:	IQKAA IQALR KMEPK DKDQE	aa 496-515	SEQ ID NO:34
P35:	DKDQE VLLQT FLDDA SPGDK	aa 511-530	SEQ ID NO:35
P36:	SPGDK RLAAY LMLMR SPSQA	aa 526-545	SEQ ID NO:36
P37:	SPSQA DINKI VQILP WEQNE	aa 541-560	SEQ ID NO:37
P38:	WEQNE QVKNF VASHI ANILN	aa 556-575	SEQ ID NO:38
P39:	ANILN SEELD IQDLK KLVKE	aa 571-590	SEQ ID NO:39
P40:	KLVKE ALKES QLPTV MDFRK	aa 586-605	SEQ ID NO:40
P41:	MDFRK FSRNY QLYKS VSLPS	aa 601-620	SEQ ID NO:41
P42:	VSLPS LDPAS AKIEG NLIFD	aa 616-635	SEQ ID NO:42
P43:	NLIFD PNNYL PKESM LKTTL	aa 631-650	SEQ ID NO:43
P44:	LKTTL TAFGF ASADL IEIGL	aa 646-665	SEQ ID NO:44

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P45:	IEIGL EGKGF EPTLE ALFGK	aa 661-680	SEQ ID NO:45
P46:	ALFGK QGFFP DSVNK ALYWV	aa 676-695	SEQ ID NO:46
P47:	ALYWV NGQVP DGVSK VLVDH	aa 691-710	SEQ ID NO:47
P48:	VLVDH FGYTK DDKHE QDMVN	aa 706-725	SEQ ID NO:48
P49:	QDMVN GIMLS VEKLI KDLKS	aa 721-740	SEQ ID NO:49
P50:	KDLKS KEVPE ARAYL RILGE	aa 736-755	SEQ ID NO:50
P51:	RILGE ELGFA SLHDL QLLGK	aa 751-770	SEQ ID NO:51
P52:	QLLGK LLLMG ARTLQ GIPQM	aa 766-785	SEQ ID NO:52
P53:	GIPQM IGEVI RKGSK NDFFL	aa 781-800	SEQ ID NO:53
P54:	NDFFL HYIFM ENAFE LPTGA	aa 796-815	SEQ ID NO:54
P55:	LPTGA GLQLQ ISSSG VIAPG	aa 811-830	SEQ ID NO:55
P56:	VIAPG AKAGV KLEVA NMQAE	aa 826-845	SEQ ID NO:56
P57:	NMQAE LVAKP SVSVE FVTNM	aa 841-860	SEQ ID NO:57
P58:	FVTNM GIIIP DFARS GVQMN	aa 856-875	SEQ ID NO:58
P59:	GVQMN TNFFH ESGLE AHVAL	aa 871-890	SEQ ID NO:59
P60:	AHVAL KAGKL KFIIP SPKRP	aa 886-905	SEQ ID NO:60
P61:	SPKRP VKLLS GGNTL HLVST	aa 901-920	SEQ ID NO:61
P62:	HLVST TKTEV IPPLI ENRQS	aa 916-935	SEQ ID NO:62
P63:	ENRQS WSVCK QVFPG LNYCT	aa 931-950	SEQ ID NO:63
P64:	LNYCT SGAYS NASST DSASY	aa 946-965	SEQ ID NO:64
P65:	DSASY YPLTG DTRLE LELRP	aa 961-980	SEQ ID NO:65
P66:	LELRP TGEIE QYSVS ATYEL	aa 976-995	SEQ ID NO:66
P67:	ATYEL QREDR ALVDT LKFVT	aa 991-1010	SEQ ID NO:67
P68:	LKFVT QAEGA KQTEA TMTFK	aa 1006-1025	SEQ ID NO:68
P69:	TMTFK YNRQS MTLSS EVQIP	aa 1021-1040	SEQ ID NO:69
P70:	EVQIP DFDVD LGTIL RVNDE	aa 1036-1055	SEQ ID NO:70
P71:	RVNDE STEGK TSYRL TLDIQ	aa 1051-1070	SEQ ID NO:71
P72:	TLDIQ NKKIT EVALM GHLSC	aa 1066-1085	SEQ ID NO:72
P73:	GHLSC DTKEE RKIKG VISIP	aa 1081-1100	SEQ ID NO:73
P74:	VISIP RLQAE ARSEI LAHWS	aa 1096-1115	SEQ ID NO:74
P75:	LAHWS PAKLL LQMDS SATAY	aa 1111-1130	SEQ ID NO:75

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P76:	SATAY GSTVS KRVAW HYDEE	aa 1126-1145	SEQ ID NO:76
P77:	HYDEE KIEFE WNTGT NVDTK	aa 1141-1160	SEQ ID NO:77
P78:	NVDTK KMTSN FPVDL SDYPK	aa 1156-1175	SEQ ID NO:78
P79:	SDYPK SLHMY ANRLL DHRVP	aa 1171-1190	SEQ ID NO:79
P80:	DHRVP ETDMT FRHVG SKLIV	aa 1186-1205	SEQ ID NO:80
P81:	SKLIV AMSSW LQKAS GSLPY	aa 1201-1220	SEQ ID NO:81
P82:	GSLPY TQTLQ DHLNS LKEFN	aa 1216-1235	SEQ ID NO:82
P83:	LKEFN LQNMG LPDFH IPENL	aa 1231-1250	SEQ ID NO:83
P84:	IPENL FLKSD GRVKY TLNKN	aa 1246-1260	SEQ ID NO:84
P85:	TLNKN SLKIE IPLPF GGKSS	aa 1261-1280	SEQ ID NO:85
P86:	GGKSS RDLKM LETVR TPALH	aa 1276-1295	SEQ ID NO:86
P87:	TPALH FKSVG FHLPS REFQV	aa 1291-1310	SEQ ID NO:87
P88:	REFQV PTFTI PKLYQ LQVPL	aa 1306-1325	SEQ ID NO:88
P89:	LQVPL LGVLD LSTNV YSNLY	aa 1321-1340	SEQ ID NO:89
P90:	YSNLY NWSAS YSGGN TSTDH	aa 1336-1355	SEQ ID NO:90
P91:	TSTDH FSLRA RYHMK ADSVV	aa 1351-1370	SEQ ID NO:91
P92:	ADSVV DLLSY NVQGS GETTY	aa 1366-1385	SEQ ID NO:92
P93:	GETTY DHKNT FTLSC DGSLR	aa 1381-1400	SEQ ID NO:93
P94:	DGSLR HKFLD SNIKF SHVEK	aa 1396-1415	SEQ ID NO:94
P95:	SHVEK LGNNP VSKGL LIFDA	aa 1411-1430	SEQ ID NO:95
P96:	LIFDA SSSWG PQMSA SVHLD	aa 1426-1445	SEQ ID NO:96
P97:	SVHLD SKKKQ HLFVK EVKID	aa 1441-1460	SEQ ID NO:97
P98:	EVKID GQFRV SSFYA KGTYG	aa 1456-1475	SEQ ID NO:98
P99:	KGTYG LSCQR DPNTG RLNGE	aa 1471-1490	SEQ ID NO:99
P100:	RLNGE SNLRF NSSYL QGTNQ	aa 1486-1505	SEQ ID NO:100
P101:	QGTNQ ITGRY EDGTL SLTST	aa 1501-1520	SEQ ID NO:101
P102:	SLTST SDLQS GIIKN TASLK	aa 1516-1535	SEQ ID NO:102
P103:	TASLK YENYE LTLKS DTNGK	aa 1531-1550	SEQ ID NO:103
P104:	DTNGK YKNFA TSNKM DMTFS	aa 1546-1565	SEQ ID NO:104
P105:	DMTFS KQNAL LRSEY QADYE	aa 1561-1580	SEQ ID NO:105
P106:	QADYE SLRFF SLLSG SLNSH	aa 1576-1595	SEQ ID NO:106

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P107:	SLNSH GLELN ADILG TDKIN	aa 1591-1610	SEQ ID NO:107
P108:	TDKIN SGAHK ATLRI GQDGI	aa 1606-1625	SEQ ID NO:108
P109:	GQDGI STSAT TNLKC SLLVL	aa 1621-1640	SEQ ID NO:109
P110:	SLLVL ENELN AELGL SGASM	aa 1636-1655	SEQ ID NO:110
P111:	SGASM KLTTN GRFRE HNAKF	aa 1651-1670	SEQ ID NO:111
P112:	HNAKF SLDGK AALTE LSLGS	aa 1666-1685	SEQ ID NO:112
P113:	LSLGS AYQAM ILGVD SKNIF	aa 1681-1700	SEQ ID NO:113
P114:	SKNIF NFKVS QEGLK LSNDM	aa 1696-1715	SEQ ID NO:114
P115:	LSNDM MGSYA EMKFD HTNSL	aa 1711-1730	SEQ ID NO:115
P116:	HTNSL NIAGL SLDFS SKLDN	aa 1726-1745	SEQ ID NO:116
P117:	SKLDN IYSSD KFYKQ TVNLQ	aa 1741-1760	SEQ ID NO:117
P118:	TVNLQ LQPYS LVTTL NSDLK	aa 1756-1775	SEQ ID NO:118
P119:	NSDLK YNALD LTNNG KLRLE	aa 1771-1790	SEQ ID NO:119
P120:	KLRLE PLKLH VAGNL KGAYQ	aa 1786-1805	SEQ ID NO:120
P121:	KGAYQ NNEIK HIYAI SSAAL	aa 1801-1820	SEQ ID NO:121
P122:	SSAAL SASYK ADTVA KVQGV	aa 1816-1835	SEQ ID NO:122
P123:	KVQGV EFSHR LNTDI AGLAS	aa 1831-1850	SEQ ID NO:123
P124:	AGLAS AIDMS TNYNS DSLHF	aa 1846-1865	SEQ ID NO:124
P125:	DSLHF SNVFR SVMAP FTMTI	aa 1861-1880	SEQ ID NO:125
P126:	FTMTI DAHTN GNGKL ALWGE	aa 1876-1895	SEQ ID NO:126
P127:	ALWGE HTGQL YSKFL LKAEP	aa 1891-1910	SEQ ID NO:127
P128:	LKAEP LAFTF SHDYK GSTSH	aa 1906-1925	SEQ ID NO:128
P129:	GSTSH HLVSR KSISA ALEHK	aa 1921-1940	SEQ ID NO:129
P130:	ALEHK VSALL TPAEQ TGTWK	aa 1936-1955	SEQ ID NO:130
P131:	TGTWK LKTQF NNNEY SQDLD	aa 1951-1970	SEQ ID NO:131
P132:	SQDLD AYNTK DKIGV ELTGR	aa 1966-1985	SEQ ID NO:132
P133:	ELTGR TLADL TLLDS PIKVP	aa 1981-2000	SEQ ID NO:133
P134:	PIKVP LLLSE PINII DALEM	aa 1996-2015	SEQ ID NO:134
P135:	DALEM RDAVE KPQEF TIVAF	aa 2011-2030	SEQ ID NO:135
P136:	TIVAF VKYDK NQDVH SINLP	aa 2026-2045	SEQ ID NO:136
P137:	SINLP FFETL QEYFE RNRQT	aa 2041-2060	SEQ ID NO:137

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P138:	RNRQT IIVVV ENVQR NLKHI	aa 2056-2075	SEQ ID NO:138
P139:	NLKHI NIDQF VRKYR AALGK	aa 2071-2090	SEQ ID NO:139
P140:	AALGK LPQQA NDYLN SFNWE	aa 2086-2105	SEQ ID NO:140
P141:	SFNWE RQVSH AKEKL TALTK	aa 2101-2120	SEQ ID NO:141
P142:	TALTK KYRIT ENDIQ IALDD	aa 2116-2135	SEQ ID NO:142
P143:	IALDD AKINF NEKLS QLQTY	aa 2131-2150	SEQ ID NO:143
P144:	QLQTY MIQFD QYIKD SYDLH	aa 2146-2165	SEQ ID NO:144
P145:	SYDLH DLKIA IANII DEIIE	aa 2161-2180	SEQ ID NO:145
P146:	DEIIE KLKSL DEHYH IRVNL	aa 2176-2195	SEQ ID NO:146
P147:	IRVNL VKTIH DLHLF IENID	aa 2191-2210	SEQ ID NO:147
P148:	IENID FNKSG SSTAS WIQNV	aa 2206-2225	SEQ ID NO:148
P149:	WIQNV DTKYQ IRIQI QEKLQ	aa 2221-2240	SEQ ID NO:149
P150:	QEKLQ QLKRH IQNID IQHLA	aa 2236-2255	SEQ ID NO:150
P151:	IQHLA GKLKQ HIEAI DVRVL	aa 2251-2270	SEQ ID NO:151
P152:	DVRVL LDQLG TTISF ERIND	aa 2266-2285	SEQ ID NO:152
P153:	ERIND VLEHV KHFVI NLIGD	aa 2281-2300	SEQ ID NO:153
P154:	NLIGD FEVAE KINAF RAKVH	aa 2296-2315	SEQ ID NO:154
P155:	RAKVH ELIER YEVDQ QIQVL	aa 2311-2330	SEQ ID NO:155
P156:	QIQVL MDKLV ELTHQ YKLKE	aa 2326-2345	SEQ ID NO:156
P157:	YKLKE TIQKL SNVLQ QVKIK	aa 2341-2360	SEQ ID NO:157
P158:	QVKIK DYFEK LVGFI DDAVK	aa 2356-2375	SEQ ID NO:158
P159:	DDAVK KLNEL SFKTF IEDVN	aa 2371-2390	SEQ ID NO:159
P160:	IEDVN KFLDM LIKKL KSFDY	aa 2386-2405	SEQ ID NO:160
P161:	KSFDY HQFVD ETNDK IREVT	aa 2401-2420	SEQ ID NO:161
P162:	IREVT QRLNG EIQAL ELPQK	aa 2416-2435	SEQ ID NO:162
P163:	ELPQK AEALK LFLEE TKATV	aa 2431-2450	SEQ ID NO:163
P164:	TKATV AVYLE SLQDT KITLI	aa 2446-2465	SEQ ID NO:164
P165:	KITLI INWLQ EALSS ASLAH	aa 2461-2480	SEQ ID NO:165
P166:	ASLAH MKAKF RETLE DTRDR	aa 2476-2495	SEQ ID NO:166
P167:	DTRDR MYQMD IQQEL QRYLS	aa 2491-2510	SEQ ID NO:167
P168:	QRYLS LVGQV YSTLV TYISD	aa 2506-2515	SEQ ID NO:168

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P169:	TYISD WWTLA AKNLT DFAEQ	aa 2521-2540	SEQ ID NO:169
P170:	DFAEQ YSIQD WAKRM KALVE	aa 2536-2555	SEQ ID NO:170
P171:	KALVE QGFTV PEIKT ILGTM	aa 2551-2570	SEQ ID NO:171
P172:	ILGTM PAFEV SLQAL QKATF	aa 2566-2585	SEQ ID NO:172
P173:	QKATF QTPDF IVPLT DLRIP	aa 2581-2600	SEQ ID NO:173
P174:	DLRIP SVQIN FKDLK NIKIP	aa 2596-2615	SEQ ID NO:174
P175:	NIKIP SRFST PEFTI LNTFH	aa 2611-2630	SEQ ID NO:175
P176:	LNTFH IPSFT IDFVE MKVKI	aa 2626-2645	SEQ ID NO:176
P177:	MKVKI IRTID QMQNS ELQWP	aa 2641-2660	SEQ ID NO:177
P178:	ELQWP VPDIY LRDLK VEDIP	aa 2656-2675	SEQ ID NO:178
P179:	VEDIP LARIT LPDFR LPEIA	aa 2671-2690	SEQ ID NO:179
P180:	LPEIA IPEFI IPTLN LNDFQ	aa 2686-2705	SEQ ID NO:180
P181:	LNDFQ VPDLH IPEFQ LPHIS	aa 2701-2720	SEQ ID NO:181
P182:	LPHIS HTIEV PTFGK LYSIL	aa 2716-2735	SEQ ID NO:182
P183:	LYSIL KIQSP LFTLD ANADI	aa 2731-2750	SEQ ID NO:183
P184:	ANADI GNGTT SANEA GIAAS	aa 2746-2765	SEQ ID NO:184
P185:	GIAAS ITAKG ESKLE VLNFD	aa 2761-2780	SEQ ID NO:185
P186:	VLNFD FQANA QLSNP KINPL	aa 2776-2795	SEQ ID NO:186
P187:	KINPL ALKES VKFSS KYLRT	aa 2791-2810	SEQ ID NO:187
P188:	KYLRT EHGSE MLFFG NAIEG	aa 2806-2825	SEQ ID NO:188
P189:	NAIEG KSNTV ASLHT EKNTL	aa 2821-2840	SEQ ID NO:189
P190:	EKNTL ELSNG VIVKI NNQLT	aa 2836-2855	SEQ ID NO:190
P191:	NNQLT LDSNT KYFHK LNIPK	aa 2851-2870	SEQ ID NO:191
P192:	LNIPK LDFSS QADLR NEIKT	aa 2866-2885	SEQ ID NO:192
P193:	NEIKT LLKAG HIAWT SSGKG	aa 2881-2900	SEQ ID NO:193
P194:	SSGKG SWKWA CPRFS DEGTH	aa 2896-2915	SEQ ID NO:194
P195:	DEGTH ESQIS FTIEG PLTSF	aa 2911-2930	SEQ ID NO:195
P196:	PLTSF GLSNK INSKH LRVNQ	aa 2926-2945	SEQ ID NO:196
P197:	LRVNQ NLVYE SGSLN FSKLE	aa 2941-2960	SEQ ID NO:197
P198:	FSKLE IQSQV DSQHV GHSVL	aa 2956-2975	SEQ ID NO:198
P199:	GHSVL TAKGM ALFGE GKAEF	aa 2971-2990	SEQ ID NO:199

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P200:	GKAEF TGRHD AHLNG KVIGT	aa 2986-3005	SEQ ID NO:200
P201:	KVIGT LKNSL FFSAQ PFEIT	aa 3001-3020	SEQ ID NO:201
P202:	PFEIT ASTNN EGNLK VRFPL	aa 3016-3035	SEQ ID NO:202
P203:	VRFPL RLTGK IDFLN NYALF	aa 3031-3050	SEQ ID NO:203
P204:	NYALF LSPSA QQASW QVSAR	aa 3046-3065	SEQ ID NO:204
P205:	QVSAR FNQYK YNQNF SAGNN	aa 3061-3080	SEQ ID NO:205
P206:	SAGNN ENIME AHVGI NGEAN	aa 3076-3095	SEQ ID NO:206
P207:	NGEAN LDFLN IPLTI PEMRL	aa 3091-3110	SEQ ID NO:207
P208:	PEMRL PYTII TTPPL KDFSL	aa 3106-3125	SEQ ID NO:208
P209:	KDFSL WEKTG LKEFL KTTKQ	aa 3121-3140	SEQ ID NO:209
P210:	KTTKQ SFDLS VKAQY KKNKH	aa 3136-3155	SEQ ID NO:210
P211:	KKNKH RHSIT NPLAV LCEFI	aa 3151-3170	SEQ ID NO:211
P212:	LCEFI SQSIK SFDRH FEKNR	aa 3166-3185	SEQ ID NO:212
P213:	FEKNR NNALD FVTKS YNETK	aa 3181-3200	SEQ ID NO:213
P214:	YNETK IKFDK YKAEK SHDEL	aa 3196-3215	SEQ ID NO:214
P215:	SHDEL PRTFQ IPGYT VPVVN	aa 3211-3230	SEQ ID NO:215
P216:	VPVVN VEVSP FTIEM SAFGY	aa 3226-3245	SEQ ID NO:216
P217:	SAFGY VFPKA VSMPS FSILG	aa 3241-3260	SEQ ID NO:217
P218:	FSILG SDVRV PSYTL ILPSL	aa 3256-3275	SEQ ID NO:218
P219:	ILPSL ELPVL HVPRN LKLSL	aa 3271-3290	SEQ ID NO:219
P220:	LKLSL PHFKE LCTIS HIFIP	aa 3286-3305	SEQ ID NO:220
P221:	HIFIP AMGNI TYDFS FKSSV	aa 3301-3320	SEQ ID NO:221
P222:	FKSSV ITLNT NAELF NQSDI	aa 3316-3335	SEQ ID NO:222
P223:	NQSDI VAHLL SSSSS VIDAL	aa 3331-3350	SEQ ID NO:223
P224:	VIDAL QYKLE GTTRL TRKRG	aa 3346-3365	SEQ ID NO:224
P225:	TRKRG LKLAT ALSLS NKFVE	aa 3361-3380	SEQ ID NO:225
P226:	NKFVE GSHNS TVSLT TKNME	aa 3376-3395	SEQ ID NO:226
P227:	TKNME VSVAK TTKAE IPILR	aa 3391-3410	SEQ ID NO:227
P228:	IPILR MNFKQ ELNGN TKSKP	aa 3406-3425	SEQ ID NO:228
P229:	TKSKP TVSSS MEFKY DFNSS	aa 3421-3440	SEQ ID NO:229
P230:	DFNSS MLYST AKGAV DHKLS	aa 3436-3455	SEQ ID NO:230

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P231:	DHKLS LESLT SYFSI ESSTK	aa 3451-3470	SEQ ID NO:231
P232:	ESSTK GDVKG SVLSR EYSGT	aa 3466-3485	SEQ ID NO:232
P233:	EYSGT IASEA NTYLN SKSTR	aa 3481-3500	SEQ ID NO:233
P234:	SKSTR SSVKL QGTSK IDDIW	aa 3496-3515	SEQ ID NO:234
P235:	IDDIW NLEVK ENFAG EATLQ	aa 3511-3530	SEQ ID NO:235
P236:	EATLQ RIYSL WEHST KNHLQ	aa 3526-3545	SEQ ID NO:236
P237:	KNHLQ LEGLF FTNGE HTSKA	aa 3541-3560	SEQ ID NO:237
P238:	HTSKA TLELS PWQMS ALVQV	aa 3556-3575	SEQ ID NO:238
P239:	ALVQV HASQP SSFHD FPDLG	aa 3571-3590	SEQ ID NO:239
P240:	FPDLG QEVAL NANTK NQKIR	aa 3586-3605	SEQ ID NO:240
P241:	NQKIR WKNEV RIHSG SFQSQ	aa 3601-3620	SEQ ID NO:241
P242:	SFQSQ VELSN DQEKA HLDIA	aa 3616-3635	SEQ ID NO:242
P243:	HLDIA GSLEG HLRFL KNIIL	aa 3631-3650	SEQ ID NO:243
P244:	KNIIL PVYDK SLWDF LKLDV	aa 3646-3665	SEQ ID NO:244
P245:	LKLDV TTSIG RRQHL RVSTA	aa 3661-3680	SEQ ID NO:245
P246:	RVSTA FVYTK NPNGY SFSIP	aa 3676-3695	SEQ ID NO:246
P247:	SFSIP VKVLA DKFIT PGLKL	aa 3691-3710	SEQ ID NO:247
P248:	PGLKL NDLNS VLVMP TFHVP	aa 3706-3725	SEQ ID NO:248
P249:	TFHVP FTDLQ VPSCK LDFRE	aa 3721-3740	SEQ ID NO:249
P250:	LDFRE IQIYK KLRTS SFALN	aa 3736-3755	SEQ ID NO:250
P251:	SFALN LPTLP EVKFP EVDVL	aa 3751-3770	SEQ ID NO:251
P252:	EVDVL TKYSQ PEDSL IPFFE	aa 3766-3785	SEQ ID NO:252
P253:	IPFFE ITVPE SQLTV SQFTL	aa 3781-3800	SEQ ID NO:253
P254:	SQFTL PKSVS DGIAA LDLNA	aa 3796-3815	SEQ ID NO:254
P255:	LDLNA VANKI ADFEL PTIIV	aa 3811-3830	SEQ ID NO:255
P256:	PTIIV PEQTI EIPSI KFSVP	aa 3826-3845	SEQ ID NO:256
P257:	KFSVP AGIVI PSFQA LTARF	aa 3841-3860	SEQ ID NO:257
P258:	LTARF EVDSP VYNAT WSASL	aa 3856-3875	SEQ ID NO:258
P259:	WSASL KNKAD YVETV LDSTC	aa 3871-3890	SEQ ID NO:259
P260:	LDSTC SSTVQ FLEYE LNVLG	aa 3886-3905	SEQ ID NO:260
P261:	LNVLG THKIE DGTLA SKTKG	aa 3901-3920	SEQ ID NO:261

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P262:	SKTKG TLAHR DFSAE YEEDG	aa 3916-3935	SEQ ID NO:262
P263:	YEEDG KFEGL QEWEG KAHLN	aa 3931-3950	SEQ ID NO:263
P264:	KAHLN IKSPA FTDLH LRYQK	aa 3946-3965	SEQ ID NO:264
P265:	LRYQK DKKGI STSAA SPAVG	aa 3961-3980	SEQ ID NO:265
P266:	SPAVG TVGMD MDEDD DFSKW	aa 3976-3995	SEQ ID NO:266
P267:	DFSKW NFYYS PQSSP DKKLT	aa 3991-4010	SEQ ID NO:267
P268:	DKKLT IFKTE LRVRE SDEET	aa 4006-4025	SEQ ID NO:268
P269:	SDEET QIKVN WEEEA ASGLL	aa 4021-4040	SEQ ID NO:269
P270:	ASGLL TSLKD NVPKA TGVLY	aa 4036-4055	SEQ ID NO:270
P271:	TGVLY DYVNK YHWEH TGLTL	aa 4051-4070	SEQ ID NO:271
P272:	TGLTL REVSS KLRRN LQNNA	aa 4066-4085	SEQ ID NO:272
P273:	LQNNA EWVYQ GAIRQ IDDID	aa 4081-4100	SEQ ID NO:273
P274:	IDDID VRFQK AASGT TGTYQ	aa 4096-4115	SEQ ID NO:274
P275:	TGTYQ EWKDK AQNLY QELLT	aa 4111-4130	SEQ ID NO:275
P276:	QELLT QEGQA SFQGL KDNVF	aa 4126-4145	SEQ ID NO:276
P277:	KDNVF DGLVR VTQKF HMKVK	aa 4141-4160	SEQ ID NO:277
P278:	HMKVK HLIDS LIDFL NFPRF	aa 4156-4175	SEQ ID NO:278
P279:	NFPRF QFPGK PGIYT REELC	aa 4171-4190	SEQ ID NO:279
P280:	REELC TMFIR EVGTV LSQVY	aa 4186-4205	SEQ ID NO:280
P281:	LSQVY SKVHN GSEIL FSYFQ	aa 4201-4220	SEQ ID NO:281
P282:	FSYFQ DLVIT LPFEL RKHKL	aa 4216-4235	SEQ ID NO:282
P283:	RKHKL IDVIS MYREL LKDLS	aa 4231-4250	SEQ ID NO:283
P284:	LKDLS KEAQE VFKAI QSLKT	aa 4246-4265	SEQ ID NO:284
P285:	QSLKT TEVLR NLQDL LQFIF	aa 4261-4280	SEQ ID NO:285
P286:	LQFIF QLIED NIKQL KEMKF	aa 4276-4295	SEQ ID NO:286
P287:	KEMKF TYLIN YIQDE INTIF	aa 4291-4310	SEQ ID NO:287
P288:	INTIF NDYIP YVFKL LKENL	aa 4306-4325	SEQ ID NO:288
P289:	LKENL CLNLH KFNEF IQNEL	aa 4321-4340	SEQ ID NO:289
P290:	IQNEL QEASQ ELQQI HQYIM	aa 4336-4355	SEQ ID NO:290
P291:	HQYIM ALREE YFDPS IVGWT	aa 4351-4370	SEQ ID NO:291
P292:	IVGWT VKYYE LEEKI VSLIK	aa 4366-4385	SEQ ID NO:292

Table 2

Peptide	Sequence	Apolipoprotein B aa	SEQ ID NO
P293:	VSLIK NLLVA LKDFH SEYIV	aa 4381-4400	SEQ ID NO:293
P294:	SEYIV SASNF TSQLS SQVEQ	aa 4396-4415	SEQ ID NO:294
P295:	SQVEQ FLHRN IQEYL SILTD	aa 4411-4430	SEQ ID NO:295
P296:	SILTD PDGKG KEKIA ELSAT	aa 4426-4445	SEQ ID NO:296
P297:	ELSAT AQEII KSQAI ATKKI	aa 4441-4460	SEQ ID NO:297
P298:	TKKII SDYHQ QFRYK LQDFS	aa 4457-4476	SEQ ID NO:298
P299:	LQDFS DQLSD YYEKF IAESK	aa 4472-4491	SEQ ID NO:299
P300:	IAESK RLIDL SIQNY HTFLI	aa 4487-4506	SEQ ID NO:300
P301:	HTFLI YITEL LKKLQ STTVM	aa 4502-4521	SEQ ID NO:301
P302:	STTVM NPYMK LAPGE LTIIL	aa 4517-4536	SEQ ID NO:302

[00125] The full length sequence of ApoB100 can be found in various publications such as reference (43) (see in particular Figure 1) herein incorporated by reference in its entirety.

Example 2: ApoB-100 related peptide P210 immunization reduces blood pressure induced by angiotensin

[00126] Male apoE KO mice were subcutaneously immunized at 7, 10, and 12 weeks of age with 100 µg of either ***Group 1:*** P210/cBSA conjugate using alum as adjuvant (P210); ***Group 2***: control-100 µg of cBSA/alum (cBSA); ***Group 3***: control PBS (PBS). 14 P210, 17 cBSA, 16 PBS, and 8 Saline injected mice were examined.

[00127] AngII (1000ng/Kg/min) was delivered by a subcutaneous osmotic pump implanted at 10 weeks of age for 4 weeks to cause an increase in blood pressure in all three groups. Saline was delivered to the control group. Mice were sacrificed at 14 weeks of age of age. The mice were fed normal chow for the duration of the experiment.

[00128] **Figure 1** shows an approximate 11% reduction in blood pressure in P210 vaccinated mice 4 weeks after pump implantation with a concomitant approximate7% change in hearth rate in P210 vaccinated mice 4 weeks after pump implantation (**Figure 2A**). **Figure 2B** shows the time course of mean blood pressure change throughout the duration of experiments. Mice received treatment (PBS, cBSA/alum or p210/cBSA/alum) at 7, 10 and 12 weeks of age.

Angiotensin II infusion via implanted osmotic pump was started at 10 weeks of age. Mice were euthanized at 14 weeks of age. Blood pressure was measured throughout the duration of experiment. Mean blood pressure gradually increased after angiotensin II infusion was started. At 13 weeks of age, mice immunized with p210/cBSA/alum had a significantly lower mean blood pressure when compared to that in the other 2 groups.

[00129] According to the above data it is expected that a p210 vaccine can prevent HTN.

[00130] A possible mechanism of action provided herein for guidance purposes only and not intended to be limiting is that p210 immunization reduces BP; and that the effect of p210 immunization is mediated by CD8 to a same or comparable extent detected for reduction of atherosclerosis illustrated in the following examples. Accordingly, ability to elicit a T cell response is specific for p210 (antigen specificity) and other apoB-100 peptides are expected to show similar antigen-specific CD8 effect.

[00131] A further possible mechanism of action provided herein for guidance purposes only and not intended to be limiting is that p210 action is performed also through modulation of angiotensin expression. Based on published anti-HTN vaccine literature, an anti-angiotensin vaccine can treat HTN. As a consequence, based on anti-angiotensin vaccine, multiple administration can be desired in certain condition and for certain types of individuals.

Example 3: Athero-protective effects of p210 immunization

[00132] The vaccine preparation consisted of the p210 peptide (Euro-Diagnostica AB, Sweden) conjugated to cationic bovine serum albumin (cBSA) as carrier using a method described previously[3;4]. Alum was used as adjuvant and mixed with peptide/cBSA conjugated with 1:1 ratio in volume. Peptide conjugation was performed on the day of immunization and freshly mixed with alum just prior to each immunization. Mice fed normal chow diet received subcutaneous primary immunization in the dorsal area between scapulas at 6–7 weeks of age, followed by a booster at 10 and 12 weeks of age. One week after the last booster, diet was switched to high cholesterol chow (TD 88137, Harlan-Teklad) and continued until euthanasia at the age of 25 weeks.

[00133] Immunization with p210 reduced aortic atherosclerosis by 57% and 50% compared to

PBS and cBSA/Alum group, respectively (**Figure 3A**) without affecting circulating cholesterol levels or body weight (**Table 3**).

Table 3 Circulating level of cholesterol and body weight of mice from PBS, cBSA/alum and p210/cBSA/alum group

	PBS (n=10)	cBSA/alum (n=10)	P210/cBSA/alum (n=10)	P value (ANOVA)
Cholesterol (mg/dl)	1503±485	1395±420	1135±382	0.17
Body weight (gm)	37.9±5.4	34.8±5.4	34.3±6.5	0.33

[00134] The aortic sinus plaques from p210/cBSA/alum group contained significantly reduced macrophage and DC immuno-reactivity assessed by MOMA-2 and CD11c immuno-staining, respectively (**Figure 3B**)with no difference in the atherosclerotic lesions (PBS group 0.40±0.13 mm^2, n=10; cBSA/alum group 0.42±0.09 mm^2, n=10; p210/cBSA/alum group 0.40±0.08 mm^2, n=9). .

Example 4: Characterization of p210-immunization elicited immune responses

[00135] Since DCs are the major cell type upstream to both cellular and humoral immune responses, Applicants determined if these cells were affected by the immunization strategy. Cells from the subcutaneous immunization sites were isolated for flow cytometric analysis one week after primary immunization. The PBS group could not be included in this analysis because mice receiving PBS injection did not develop swelling or cell accumulation at the injection site.

[00136] There were significantly fewer CD11c(+) and CD11c(+)CD86(+) cells in p210/cBSA/alum group compared to cBSA/alum group at the immunization site (**Figure 4A and 4B**). When flow cytometry was performed on LN cells 1 week after the third immunization, CD11c(+)CD86(+) cells were also significantly reduced compared with cBSA/alum group (**Figure 4C**).

[00137] Applicants next assessed antibody response to define the humoral immune response

against p210. Before immunization all 3 groups of mice had low levels of IgG titers against p210. At euthanasia, the IgG titer against p210 remained low in the PBS group but was significantly increased in cBSA/alum group. Immunization with p210/cBSA/alum resulted in increased p210 IgG titer compared with PBS group but was significantly reduced compared with cBSA/alum group (**Figure 5A**). In contrast to p210 IgG response, there was a significant increase in p210 IgM titer in all groups (**Figure 5B**), suggesting an endogenous immune response against p210.

[00138] The IL-2Rα (CD25) is a well-defined lymphocyte activation marker. Applicants therefore analyzed the expression of CD25 on CD4(+) or CD8(+) T-cells from superficial cervical and axillary lymph nodes (LN) from mice one week after primary immunization to assess the T-cell immune response. CD8(+)CD25(+) T-cell population in the lymph nodes was significantly higher in p210/cBSA/alum group when compared to that of PBS or cBSA/alum groups (**Figure 6A**) whereas CD4(+)CD25(+) T-cells in the lymph nodes (**Figure 6B**) did not differ among 3 groups.

[00139] There was a significantly larger population of splenic CD8(+)CD25(+)IL-10(+) T-cells in p210/cBSA/alum group when compared to PBS or cBSA/alum groups (**Figure 6C**) without difference in splenic CD8(+)CD25(+)IL12(+) T-cells among 3 groups (**Figure 6D**). Splenic CD4(+)CD25(+)IL-10(+) T-cell population significantly increased in the cBSA/alum group. However, this increased response was significantly attenuated by the p210/cBSA/alum immunization (**Figure 6E**); whereas splenic CD4(+)CD25(+)IL12(+) T-cells did not differ among the three groups (**Figure 6F**).

Example 5: Adoptive transfer of CD8(+) T-cells from p210 immunized mice to naive recipients recapitulates the athero-protective effect of p210 immunization

[00140] Donor apoE(-/-) mice were subjected to the same immunization protocol with the same groupings, namely: PBS, cBSA/alum, or p210/cBSA/alum. Recipient naïve male apoE(-/-) mice were injected with donor cells at 6-7 weeks of age and were fed normal chow until 13 weeks of age when chow was switched to high cholesterol diet until euthanasia at 25 weeks of age.

[00141] At euthanasia, the recipient mice injected with CD8(+) T-cells from p210/cBSA/alum

group developed significantly less atherosclerotic lesions in aorta compared to the recipient mice injected with CD8(+) T-cells from PBS or cBSA/alum groups, strongly suggesting that the effector T cell induced by the vaccine are $CD8^+$ and is mechanistically involved (**Figure 7A**).

[00142] This reduction of aortic lesions was coupled with decreased splenic CD11c(+) DCs (PBS group: 4.3±1.7%; cBSA/alum group: 3.4±0.3%; p210/cBSA/alum group: 1.5±0.3%; n=5 each group, $p < 0.05$ p210/cBSA/alum group vs. PBS or cBSA/alum group by ANOVA) with no difference in circulating levels of total cholesterol among 3 groups (PBS group: 1083±296 mg/dl; cBSA/alum group: 975±401 mg/dl; p210/cBSA/alum group: 1098±379 mg/dl).

[00143] Adoptive transfer of B cells isolated from the spleens of p210 immunized donor mice did not affect atherosclerosis in recipient mice compared to mice receiving B cells from other donors (**Figure 7B**) These observations ruled out B cells as mediators of athero-protective effect of p210 immunization.

[00144] To rule out CD4(+)CD25(+) T-cells as possible athero-protective mediators induced by sub-cutaneous p210 immunization, Applicants adoptively transferred CD4(+)CD25(+)T-cells at a dose of $1x10^5$ cells/mouse into naïve recipient apoE-/- mice. There was no difference in lesion size among the 3 groups of CD4(+)CD25(+)T-cell recipients Depletion of $CD25^+$ cells from the pool of $CD8^+$ T cells abrogated the reduction in atherosclerosis observed in the p210/cBSA/alum recipient mice, further supporting the notion that $CD8^+CD25^+$ T cells are mechanistically involved in the protective effects of the vaccine against atherosclerosis(**Figure 7C**). Transfer of a higher number of CD4(+)CD25(+) T-cells at $3x10^5$ cells/mouse did not reduce lesion sizes in all 3 recipient groups (**Figure 7D**).

Example 6: Increased cytolytic activity of CD8(+) T cells from p210 immunized mice against dendritic cells in vitro

[00145] Given the observation that p210 immunization reduced DCs in the immunization sites and atherosclerotic plaques and adoptive transfer of CD8(+) T-cells from p210 immunized donors rendered a decrease of splenic DCs in the recipients, Applicants hypothesized that DCs could be a potential target of CD8(+) T-cells.

[00146] To test this, Applicants co-cultured bone marrow derived DCs with CD8(+) T-cells from

various immunized groups. CD8(+) T-cells from p210 immunized mice significantly increased the percentage of DC death when compared to those from PBS or BSA/alum groups (**Figure 8**). This increased cytolytic function of CD8(+) T-cells was associated with increased granzyme B expression but not perforin (**Figure 9**).

Example 7: Immunization with p210 does not affect the adaptive immune response to other T-cell dependent or independent antigens

[00147] Given the observations that p210 immunization decreased CD11c(+) DCs and reduced adaptive IgG response to p210, Applicants next tested if such modulation of DCs by p210 immunization would alter the host immune response to other antigens.

[00148] Applicants first immunized mice with p210 as described in previous sections followed by two separate subcutaneous KLH immunizations or intra-peritoneal injection of TNP-LPS. Using the KLH- or TNP-IgG titer as a surrogate for the efficacy of individual immunization, Applicants found that there was no difference in KLH- or TNP-IgG titers between p210 immunized mice and the titers from mice of PBS or cBSA/alum groups (**Figure 10**).

Example 8: Immunization with an apoB-100 immunogenic fragments reduces hypertension and mortality in Angiotensin II-induced aortic aneurysm

[00149] ApoE (-/-) mice were immunized with p210/cBSA/Alum (p210; 100 μg) at 7, 10, and 12 weeks of age. Mice receiving PBS or cBSA/Alum (cBSA) served as controls. At 10 weeks of age, mice were subcutaneously implanted with an osmotic pump which released AngII (1 mg/Kg/min), and were euthanized 4 weeks later. The aorta, spleen, and lymph nodes (LN) were harvested. The p210 vaccine significantly reduced mortality due to AA rupture compared to controls (see **Figure 11**).

[00150] Flow cytometric analysis of dendritic cells (DCs) in LNs and spleen showed intracellular IFN-γ expression was up regulated in the p210 group. Aortic superoxide production measured by in situ dihydroethidine method and aortic AT1 receptor (AT1R) expression measured by Western blot were significantly decreased in p210 group. The p210 vaccine significantly decreased mean arterial BP at 13 weeks of age (see **Table 4**).

[00151] Mortality from AngII induced AA rupture was significantly reduced by thep210 vaccine. This protective effect was associated with up regulation of IFN-γ expression in DCs and decreased arterial BP, AT1R expression, and superoxide production in aorta. The vaccine may be a promising new non-invasive treatment for AA.

Table 4 Flow cytometric analysis of intracellular IFN-γ expression of dendritic cells (DCs)

	p210	cBSA	PBS
Spleen $CD11c^+CD86^+IFN\text{-}\gamma^+$ DCs (N=8 each)	19.5±1.6*	13.9±1.4	15.3±0.7
LN $CD11c^+CD86^+IFN\text{-}\gamma^+$ DCs (N=6 each)	26.7±1.6*	17.7±2.3	18.1±2.4
Aortic AT1R (N=6 each)	1.0±0.2*	3.1±0.6	3.2±0.5
Aortic superoxide production (N=9 each)	1.1±0.1*	1.9±0.2	1.6±0.1
Mean Arterial Blood Pressure (BP)	124±4*	143±6	139±3

Spleen and LN DC values are percentage ± SEM of CD11c-gated cells.

AT1R values are arbitrary densitometric unit ± SEM.

Superoxide values are arbitrary fluorescent intensity unit ± SEM.

Mean BP values are mmHg ± SEM at 13 weeks of age; number of mice: p210 N=9; cBSA N=7; PBS N=10.

*$p<0.05$ vs cBSA and PBS control; ANOVA, followed by post-hoc test.

Example 9: Increased cytolytic activity of CD8(+) T cells from apoB-100 immunogenic fragments immunized mice is specific to lipid-associated antigens

[00152] Applicants have shown that immunization with apoB-100 related-peptide p210 significantly reduces atherosclerosis and decreases intra-plaque $CD11c^+$ dendritic cells (DCs) in apoE-/- mice. Adoptive transfer experiments showed that athero-protection was mediated by $CD8^+$ T cells. Because apoB-100 is found on the LDL fraction of serum lipids, Applicants assessed the $CD8^+$ T cell cytolytic activity of p210 immunized mice specific to lipid-associated antigens presented by DCs.

[00153] ApoE-/- mice were immunized at 7, 9, and 12 weeks of age with p210/cBSA/alum, cBSA/alum, or PBS. One week after the third immunization, mice were euthanized to collect spleen $CD8^+$ T cells. Bone-marrow derived DCs were differentiated from naïve apoE-/- mice and used as target cells. A four-hour lytic assay was performed using a CD8-to-DC ratio of 3:1 in culture medium with 10% FBS. The cells were then collected and stained for CD11c to identify DCs and 7-AAD to assess cell lysis using flow cytometry. There was significantly more lytic activity by $CD8^+$ T cells from p210/cBSA/alum immunized mice compared to cBSA/alum and PBS (Table). When the assay was performed in media with delipidated FBS, the lytic activity specific to $CD8^+$ T cells from from p210/cBSA/alum immunized mice was abrogated (**Table 5**), suggesting that the lipid fraction of FBS in the culture media provided a source of antigen. Loading of DCs with FITC-labeled p210 24 hours prior to the lytic assay demonstrated antigen uptake and specificity of the lytic activity of $CD8^+$ T cells from p210/cBSA/alum immunized mice (see **Table 5**).

[00154] These results show that the cytolytic function of $CD8^+$ T cells targeting DCs are specific to lipid-associated antigens, specifically the p210 fragment of apoB-100, and this may underlie the protective effects of p210 immunization.

Table 5 Flow cytometric analysis of cytolytic activity of CD8 (+) T cells.

	p210/cBSA/alum	cBSA/alum	PBS
Normal medium (N=11 each)	3.7±0.6*	2.7±0.6	2.3±0.8
Delipidated medium (N=5 each)	2.3±0.4	2.4±0.8	2.5±0.5
FITC-p210 loaded (N=3 each)	10.4±0.1†	7.3±0.4	7.8±1.2
All flow cytometric analysis performed on CD11c-gated cells. CD11c-gated $FITC^+$ cells only were assessed in FITC-p210 loaded assay. Values are percent lysis relative to basal lysis. *P<0.001; †P<0.01 by ANOVA.			

Example 10: Antibody response to the p210 vaccine

[00155] Antibody titers to p210 was low prior to immunization. At euthanasia at 25 weeks of age, there was a significant increase in p210 IgM titer in all groups (**Figure 12**), suggesting an

endogenous immune response against self-peptide p210. There was a significant increase in p210 IgG titers in both cBSA/alum group and p210/cBSA/alum compared with the PBS group, but titers in the cBSA/alum was surprisingly the higher between the 2 responding groups. The presence of alum as adjuvant in the cBSA/alum group and p210/cBSA/alum groups likely resulted in class switching of the IgM response to IgG, which did not occur in the PBS group.

Example 11: CD4 (+) T cell and CD8 (+) T cell response to the p210 vaccine

[00156] T cells from superficial cervical and axillary lymph nodes (LN) from mice one week after primary immunization were collected to assess the T cell immune response. $CD4^+CD25^+$ T cells in the lymph nodes (Table 1) did not differ among 3 groups. Splenic $CD4^+CD25^+IL\text{-}10^+$ T cell population significantly increased in the cBSA/alum group. However, this increased response was significantly attenuated by the p210/cBSA/alum immunization (**Table 6**). Interestingly, splenic $CD4^+CD62L^+$ T cell (Table 1) population was lower in cBSA/alum group.

[00157] One week after primary immunization, the $CD8^+CD25^+$ T cell population in the lymph nodes was significantly higher in p210/cBSA/alum group when compared to that of PBS or cBSA/alum groups (Table 2). There was a significantly larger population of splenic $CD8^+CD25^+IL\text{-}10^+$ T cells in p210/cBSA/alum group when compared to PBS or cBSA/alum groups (Table 2). The splenic $CD8^+CD62L^+$ T cell population was significantly higher in p210/cBSA/alum group when compared to that of PBS or cBSA/alum groups (**Table 6**). The T cell profile at other time points were not significantly different between groups.

Table 6 CD4 (+) and CD8 (+) T cell response to the p210 vaccine

CD4+ T cell response to p210 vaccine.			
	PBS	cBSA/alum	p210/cBSA/alum
LN CD4+CD25+	12.9±1.9	12.5±1.4	14.0±2.8
Spl CD4+CD25+IL-10+	2.3±0.3	4.3±2.1*	1.7±0.6
Spl CD4+CD62L+	26.7±1.7	21.4±2.7*	29.9±4.8
P<0.05 vs. other groups			

CD8+ T cell response to p210 vaccine.			
	PBS	cBSA/alum	p210/cBSA/alum
LN CD8+CD25+	4.4±0.8	4.1±1.0	6.8±3.0*
Spl CD8+CD25+IL-10+	4.9±3.9	6.0±3.2	12.6±3.9*
Spl CD8+CD62L+	18.4±3.4	19.0±5.5	27.6±5.1*
P<0.05 vs. other groups			

Example 12: Effector role of $CD8^+CD25^+$ T cells involves cytotoxic function

[00158] The vaccine reduced DC presence in the plaques (**Figure 3**), and in the spleens of p210/cBSA/alum recipient mice, suggesting that the effector role of $CD8^+$ T cells after immunization was manifested in decreasing DCs in the plaque. Applicants therefore assessed the effect of the vaccine on cytotoxic activity of $CD8^+$ T cells against syngeneic bone marrow-derived DCs. $CD8^+$ T cells from the immunized groups were negatively isolated using a CD8 selection Dynabeads kit (Invitrogen) followed by co-culture with DCs in a CD8:DC ratio of 3:1 in RPMI supplemented with 10% FBS. Cells were collected and processed for flow cytometric determination of $CD11c^+$ and 7-AAD 4 hours later.[20] Dendritic cell death without $CD8^+$ T cells in the co-culture was used as baseline and percentage of specific lysis of cells was calculated using a method described previously.[20]

[00159] $CD8^+$ T cells from p210 immunized mice significantly increased the percentage of DC lysis when compared to those from PBS or cBSA/alum groups (**Figure 13**, panel A). This increased cytolytic function of $CD8^+$ T cells was associated with increased granzyme B expression but not perforin. Depletion of $CD25^+$ cells abrogated the increased cytolytic activity specific to the $CD8^+$ T cells from p210 immunized mice (**Figure 13**, panel B) indicating that $CD8^+CD25^+$ T cells were the effector population. The increased cytolytic function specific to

$CD8^+$ T cells from p210 immunized mice was also lost with the use of delipidated serum supplemented medium (**Figure 13**, panel C), indicating that the antigen on the target DCs recognized by the CTLs was derived from serum LDL containing apoB-100 in the medium.

Example 13: p210 peptide is endocytosed by DCs in vitro.

[00160] Peptide loading on BMDCs was defined using p210 labeled with FITC (FITC conjugating kit from Pierce). The presence of FITC fluorescence in the dendritic cells indicated uptake of p210 by dendritic cells. Reference is made in particular to **Figure14** which shows the FITC-labeled p210 is endocytosed by DCs, indicating antigen uptake.

Example 14: p210 peptide is presented by DCs to CD8+ T cells.

[00161] The p210 peptide contains the proteoglycan binding site of the apoB-100 molecule. This peptide is a cell-penetrating peptide capable of efficiently delivering antigens for cross-presentation to cytotoxic $CD8^+$ T cells.[53] Applicants therefore assessed activation of $CD8^+CD25^-$ T cells co-cultured with DCs loaded with p210 and matured with LPS. There was significantly increased $CD8^+CD25^+$ T cells 48 hours after co-culture with p210-loaded DCs treated with LPS compared to untreated, or LPS only treated co-cultures (**Figure15**). The results suggest that the p210 antigen is presented by DCs to $CD8^+$ T cells.

Example 15: p210-loaded DCs are specifically targeted by immune $CD8^+$ T cells.

[00162] The results shown above in **Example 14** support the notion that p210 is presented by DCs to $CD8^+$ T cells. It remained unclear if the lytic activity against DCs was specific to the p210 antigen. Applicants therefore repeated the lytic assay using FITC-labeled p210 loaded BMDC as targets. Lytic activity against $FITC^+$ DCs was significantly increased in $CD8^+$ T cells from the p210/cBSA/alum mice (**Figure 16**), indicating antigen specific lytic activity.

[00163] In summary, in several embodiments, described herein are immunomodulatory agents, T cell, compositions, methods and systems for treating and/or preventing hypertension and/or a condition associated thereto in an individual

[00164] The examples set forth above are provided to give those of ordinary skill in the art a

complete disclosure and description of how to make and use the embodiments of the molecules, compositions, systems and methods of the disclosure, and are not intended to limit the scope of what the inventors regard as their disclosure. All patents and publications mentioned in the specification are indicative of the levels of skill of those skilled in the art to which the disclosure pertains.

[00165] The entire disclosure of each document cited (including patents, patent applications, journal articles, abstracts, laboratory manuals, books, or other disclosures) in the Background, Summary, Detailed Description, and Examples is hereby incorporated herein by reference. All references cited in this disclosure are incorporated by reference to the same extent as if each reference had been incorporated by reference in its entirety individually. However, if any inconsistency arises between a cited reference and the present disclosure, the present disclosure takes precedence. Further, the sequence listing submittedherewith in the txt file "P694-PCT-2011-11-11-Sequence Listing_ST25" created on November 11, 2011, forms an integralpart of the present application and is incorporated herein by reference in its entirety.

[00166] The terms and expressions which have been employed herein are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the disclosure claimed Thus, it should be understood that although the disclosure has been specifically disclosed by preferred embodiments, exemplary embodiments and optional features, modification and variation of the concepts herein disclosed can be resorted to by those skilled in the art, and that such modifications and variations are considered to be within the scope of this disclosure as defined by the appended claims.

[00167] It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting. As used in this specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the content clearly dictates otherwise. The term "plurality" includes two or more referents unless the content clearly dictates otherwise. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary

skill in the art to which the disclosure pertains.

[00168] When a Markush group or other grouping is used herein, all individual members of the group and all combinations and possible subcombinations of the group are intended to be individually included in the disclosure. Every combination of components or materials described or exemplified herein can be used to practice the disclosure, unless otherwise stated. One of ordinary skill in the art will appreciate that methods, device elements, and materials other than those specifically exemplified can be employed in the practice of the disclosure without resort to undue experimentation. All art-known functional equivalents, of any such methods, device elements, and materials are intended to be included in this disclosure. Whenever a range is given in the specification, for example, a temperature range, a frequency range, a time range, or a composition range, all intermediate ranges and all subranges, as well as, all individual values included in the ranges given are intended to be included in the disclosure. Any one or more individual members of a range or group disclosed herein can be excluded from a claim of this disclosure. The disclosure illustratively described herein suitably can be practiced in the absence of any element or elements, limitation or limitations which is not specifically disclosed herein.

[00169] A number of embodiments of the disclosure have been described. The specific embodiments provided herein are examples of useful embodiments of the disclosure and it will be apparent to one skilled in the art that the disclosure can be carried out using a large number of variations of the devices, device components, methods steps set forth in the present description. As will be obvious to one of skill in the art, methods and devices useful for the present methods can include a large number of optional composition and processing elements and steps.

[00170] In particular, it will be understood that various modifications may be made without departing from the spirit and scope of the present disclosure. Accordingly, other embodiments are within the scope of the following claims.

REFERENCES

1. Shah, P. K., K. Y. Chyu, G. N. Fredrikson, and J. Nilsson. 2005. Immunomodulation of atherosclerosis with a vaccine. *Nat. Clin. Pract. Cardiovasc. Med.* 2:639-646

2. Hansson, G. K., P. Libby, U. Schonbeck, and Z. Q. Yan. 2002. Innate and adaptive immunity

in the pathogenesis of atherosclerosis. *Circ. Res.* 91:281-291

3. Chyu, K. Y., X. Zhao, O. S. Reyes, S. M. Babbidge, P. C. Dimayuga, J. Yano, B. Cercek, G. N. Fredrikson, J. Nilsson, and P. K. Shah. 2005. Immunization using an Apo B-100 related epitope reduces atherosclerosis and plaque inflammation in hypercholesterolemic apo E (-/-) mice. *Biochem. Biophys. Res. Commun.* 338:1982-1989

4. Fredrikson, G. N., I. Soderberg, M. Lindholm, P. Dimayuga, K. Y. Chyu, P. K. Shah, and J. Nilsson. 2003. Inhibition of Atherosclerosis in ApoE-Null Mice by Immunization with ApoB-100 Peptide Sequences. *Arterioscler. Thromb. Vasc. Biol.* 23:879-884

5. Fredrikson, G. N., L. Andersson, I. Soderberg, P. Dimayuga, K. Y. Chyu, P. K. Shah, and J. Nilsson. 2005. Atheroprotective immunization with MDA-modified apo B-100 peptide sequences is associated with activation of Th2 specific antibody expression. *Autoimmunity* 38:171-179

6. Fredrikson, G. N., H. Bjorkbacka, I. Soderberg, I. Ljungcrantz, and J. Nilsson. 2008. Treatment with apo B peptide vaccines inhibits atherosclerosis in human apo B-100 transgenic mice without inducing an increase in peptide-specific antibodies. *J. Intern. Med.*1-8

7. Klingenberg, R., M. Lebens, A. Hermansson, G. N. Fredrikson, D. Strodthoff, M. Rudling, D. F. Ketelhuth, N. Gerdes, J. Holmgren, J. Nilsson, and G. K. Hansson. 2010. Intranasal Immunization With an Apolipoprotein B-100 Fusion Protein Induces Antigen-Specific Regulatory T Cells and Reduces Atherosclerosis. *Arterioscler. Thromb. Vasc. Biol.* 30:946-952

8. Fredrikson, G. N., B. Hedblad, G. Berglund, R. Alm, M. Ares, B. Cercek, K. Y. Chyu, P. K. Shah, and J. Nilsson. 2003. Identification of Immune Responses Against Aldehyde-Modified Peptide Sequences in ApoB Associated With Cardiovascular Disease. *Arterioscler. Thromb. Vasc. Biol.* 23:872-878

9. Schiopu, A., J. Bengtsson, I. Soderberg, S. Janciauskiene, S. Lindgren, M. P. Ares, P. K. Shah, R. Carlsson, J. Nilsson, and G. N. Fredrikson. 2004. Recombinant Human Antibodies Against Aldehyde-Modified Apolipoprotein B-100 Peptide Sequences Inhibit Atherosclerosis. *Circulation 2004.* 110:2047-2052

10. Sjogren, P., G. N. Fredrikson, A. Samnegard, C. G. Ericsson, J. Ohrvik, R. M. Fisher, J. Nilsson, and A. Hamsten. 2008. High plasma concentrations of autoantibodies against native peptide 210 of apoB-100 are related to less coronary atherosclerosis and lower risk of myocardial infarction. *Eur. Heart J.* 29:2218-2226

11. Dimayuga, P., B. Cercek, S. Oguchi, G. N. Fredrikson, J. Yano, P. K. Shah, S. Jovinge, and J. Nilsson. 2002. Inhibitory effect on arterial injury-induced neointimal formation by adoptive B-

cell transfer in Rag-1 knockout mice. *Arterioscler. Thromb. Vasc. Biol.* 22:644-649

12. Caligiuri, G., A. Nicoletti, B. Poirier, and G. K. Hansson. 2002. Protective immunity against atherosclerosis carried by B cells of hypercholesterolemic mice. *J. Clin. Invest.* 109:745-753

13. Yang, K., D. Li, M. Luo, and Y. Hu. 2006. Generation of HSP60-specific regulatory T cell and effect on atherosclerosis. *Cell Immunol.* 243:90-95

14. Mor, A., D. Planer, G. Luboshits, A. Afek, S. Metzger, T. Chajek-Shaul, G. Keren, and J. George. 2007. Role of naturally occurring CD4+ CD25+ regulatory T cells in experimental atherosclerosis. *Arterioscler. Thromb. Vasc. Biol.* 27:893-900

15. Ait-Oufella, H., B. L. Salomon, S. Potteaux, A. K. Robertson, P. Gourdy, J. Zoll, R. Merval, B. Esposito, J. L. Cohen, S. Fisson, R. A. Flavell, G. K. Hansson, D. Klatzmann, A. Tedgui, and Z. Mallat. 2006. Natural regulatory T cells control the development of atherosclerosis in mice. *Nat. Med.* 12:178-180

16. Yang, G. X., Z. X. Lian, Y. H. Chuang, Y. Moritoki, R. Y. Lan, K. Wakabayashi, A. A. Ansari, R. A. Flavell, W. M. Ridgway, R. L. Coppel, K. Tsuneyama, I. R. Mackay, and M. E. Gershwin. 2008. Adoptive transfer of CD8(+) T cells from transforming growth factor beta receptor type II (dominant negative form) induces autoimmune cholangitis in mice. *Hepatology.* 47:1974-1982

17. Zhou, X., A. Nicoletti, R. Elhage, and G. K. Hansson. 2000. Transfer of CD4(+) T cells aggravates atherosclerosis in immunodeficient apolipoprotein E knockout mice. *Circulation* 102:2919-2922

18. Zhou, X., A. K. Robertson, C. Hjerpe, and G. K. Hansson. 2006. Adoptive transfer of CD4+ T cells reactive to modified low-density lipoprotein aggravates atherosclerosis. *Arterioscler. Thromb. Vasc. Biol.* 26:864-870

19. Inaba, K., M. Inaba, N. Romani, H. Aya, M. Deguchi, S. Ikehara, S. Muramatsu, and R. M. Steinman. 1992. Generation of large numbers of dendritic cells from mouse bone marrow cultures supplemented with granulocyte/macrophage colony-stimulating factor. *J. Exp. Med.* 176:1693-1702

20. Lecoeur, H., M. Fevrier, S. Garcia, Y. Riviere, and M. L. Gougeon. 2001. A novel flow cytometric assay for quantitation and multiparametric characterization of cell-mediated cytotoxicity. *J. Immunol. Methods* 253:177-187

21. Palinski, W., E. Miller, and J. L. Witztum. 1995. Immunization of low density lipoprotein (LDL) receptor-deficient rabbits with homologous malondialdehyde-modified LDL reduces

atherogenesis. *Proc. Natl. Acad. Sci. U. S. A* 92:821-825

22. Ameli, S., A. Hultgardh-Nilsson, J. Regnstrom, F. Calara, J. Yano, B. Cercek, P. K. Shah, and J. Nilsson. 1996. Effect of immunization with homologous LDL and oxidized LDL on early atherosclerosis in hypercholesterolemic rabbits. *Arterioscler. Thromb. Vasc. Biol.* 16:1074-1079

23. Freigang, S., S. Horkko, E. Miller, J. L. Witztum, and W. Palinski. 1998. Immunization of LDL receptor-deficient mice with homologous malondialdehyde-modified and native LDL reduces progression of atherosclerosis by mechanisms other than induction of high titers of antibodies to oxidative neoepitopes. *Arterioscler. Thromb. Vasc. Biol.* 18:1972-1982

24. George, J., A. Afek, B. Gilburd, H. Levkovitz, A. Shaish, I. Goldberg, Y. Kopolovic, G. Wick, Y. Shoenfeld, and D. Harats. 1998. Hyperimmunization of apo-E-deficient mice with homologous malondialdehyde low-density lipoprotein suppresses early atherogenesis. *Atherosclerosis* 138:147-152

25. Zhou, X., G. Caligiuri, A. Hamsten, A. K. Lefvert, and G. K. Hansson. 2001. LDL immunization induces T-cell-dependent antibody formation and protection against atherosclerosis. *Arterioscler. Thromb. Vasc. Biol.* 21:108-114

26. Chyu, K. Y., O. S. Reyes, X. Zhao, J. Yano, P. Dimayuga, J. Nilsson, B. Cercek, and P. K. Shah. 2004. Timing affects the efficacy of LDL immunization on atherosclerotic lesions in apo E (-/-) mice. *Atherosclerosis* 176:27-35

27. Zhou, X., A. K. Robertson, M. Rudling, P. Parini, and G. K. Hansson. 2005. Lesion development and response to immunization reveal a complex role for CD4 in atherosclerosis. *Circ. Res.* 96:427-434

28. Roselaar, S. E., P. X. Kakkanathu, and A. Daugherty. 1996. Lymphocyte populations in atherosclerotic lesions of apoE -/- and LDL receptor -/- mice. Decreasing density with disease progression. *Arterioscler. Thromb. Vasc. Biol.* 16:1013-1018

29. Zhou, X., S. Stemme, and G. K. Hansson. 1996. Evidence for a local immune response in atherosclerosis. CD4+ T cells infiltrate lesions of apolipoprotein-E-deficient mice. *Am. J. Pathol.* 149:359-366

30. Fyfe, A. I., J. H. Qiao, and A. J. Lusis. 1994. Immune-deficient mice develop typical atherosclerotic fatty streaks when fed an atherogenic diet. *J. Clin. Invest.* 94:2516-2520

31. Bobryshev, Y. V., T. Taksir, R. S. Lord, and M. W. Freeman. 2001. Evidence that dendritic cells infiltrate atherosclerotic lesions in apolipoprotein E-deficient mice. *Histol. Histopathol.* 16:801-808

32. Niessner, A., and C. M. Weyand. 2009. Dendritic cells in atherosclerotic disease. *Clin. Immunol.* 134:25-32

33. Paulson, K. E., S. N. Zhu, M. Chen, S. Nurmohamed, J. Jongstra-Bilen, and M. I. Cybulsky. 2010. Resident intimal dendritic cells accumulate lipid and contribute to the initiation of atherosclerosis. *Circ. Res.* 106:383-390

34. Liu, P., Y. R. Yu, J. A. Spencer, A. E. Johnson, C. T. Vallanat, A. M. Fong, C. Patterson, and D. D. Patel. 2008. CX3CR1 deficiency impairs dendritic cell accumulation in arterial intima and reduces atherosclerotic burden. *Arterioscler. Thromb. Vasc. Biol.* 28:243-250

35. Wu, H., R. M. Gower, H. Wang, X. Y. Perrard, R. Ma, D. C. Bullard, A. R. Burns, A. Paul, C. W. Smith, S. I. Simon, and C. M. Ballantyne. 2009. Functional role of CD11c+ monocytes in atherogenesis associated with hypercholesterolemia. *Circulation.* 119:2708-2717

36. Sakamoto, N., K. Tsuji, L. M. Muul, A. M. Lawler, E. F. Petricoin, F. Candotti, J. A. Metcalf, J. A. Tavel, H. C. Lane, W. J. Urba, B. A. Fox, A. Varki, J. K. Lunney, and A. S. Rosenberg. 2007. Bovine apolipoprotein B-100 is a dominant immunogen in therapeutic cell populations cultured in fetal calf serum in mice and humans. *Blood* 110:501-508

37. van den Elzen, p., S. Garg, L. Leon, M. Brigl, E. A. Leadbetter, J. E. Gumperz, C. C. Dascher, T. Y. Cheng, F. M. Sacks, P. A. Illarionov, G. S. Besra, S. C. Kent, D. B. Moody, and M. B. Brenner. 2005. Apolipoprotein-mediated pathways of lipid antigen presentation. *Nature* 437:906-910

38. Mitchell DM, Ravkov EV, Williams MA Distinct roles for IL-2 and IL-15 in the differentiation and survival of CD8+ effector and memory T cells. J Immunol. 2010 Jun 15;184(12):6719-30. Epub 2010 May 14

39. Perret R, Ronchese F. Effector CD8+ T cells activated in vitro confer immediate and long-term tumor protection in vivo. Eur J Immunol. 2008 Oct;38(10):2886-95.

40. Kamimura D, Bevan MJ. Naive CD8+ T cells differentiate into protective memory-like cells after IL-2 anti IL-2 complex treatment in vivo. J Exp Med. 2007 Aug 6;204(8):1803-12. Epub 2007 Jul 30.

41. J. Immunol. 2006;177:5868-5877

42. J. Immunol. 2004;172:1991-1995

43. San-Hwan Chen et al The complte cDNA and amino acid sequence of Human Apolipoprotein B100 Journal of Biological Chemistry 1986 Vol. 261No 28, Issue of October 5,

12918-12921

44. Chou PY, Fasman GO, Adv Enzymol Relat Areas Mol BioI. 1978; 47: 45-148. Prediction of the secondary structure of proteins from their amino acid sequence;

45. Margalit H, Spouge JL, Cornette JL, Cease KB, Delisi C, Berzofsky JA, J., Immunol. 1987 Apr 1; 138(7):2213-29. Prediction of immunodominant helper T cell antigenic sites from the primary sequence;

46. Jameson BA, Wolf H., Division of Biology, California Institute of Technology, Pasadena, CA 91125, Comput Appl BioscL 1988 Mar;4(1): 181-6. The antigenic index: a novel algorithm for predicting antigenic determinants;

47. Reyes VE, Lew RA, Lu S., Humphreys RE, Methods Enzymol. 1991; 202:22538. Prediction of alpha helices and T cell-presented sequences in proteins with algorithms based on strip-of-helix hydrophobicity index (SOHHI);

48. Maksyutov AZ, Zagrebelnaya ES, Comput Appl BioscL 1993 Jun; 9(3): 291-7. ADEPT: a computer program for prediction of protein antigenic determinants;

49. Pellequer JL, Westhof E., J Mol Graph. 1993 Sep;11(3): 204-10, 1912. PREDITOP: a program for antigenicity prediction;

50. Lu et aI., Tibtech, vol. 9, Jul. 1991 pp. 238-242 Common Principles in Protein Folding and Antigen Protection; and

51. Laura Raddrizzani and Juergen Hammer BRIEFINGS IN BIOINFORMATICS. VOL I. NO 2. 179-189. MAY 2000 Epitope scanning usingvirtual Matrix-based algorithms

52. R. Wu, R. Giscombe, G. Holm & A. K. Lefvert "Induction of Human Cytotoxic T Lymphocytes by Oxidized Low Density Lipoproteins" *Scand. J. Immunol.* 43,381-384, 1996.

53. Sakamoto,N and Rosenberg, AS. Apolipoprotein B binding domains: evidence that they are cell-penetrating peptides that efficiently deliver antigenic peptide for cross-presentation of cytotoxic T cells. *J. Immunol.* 4-15-2011;186:5004-5011.

WHAT IS CLAIMED IS

1. A method to treat and/or prevent hypertension and/or a condition associated thereto in an individual, the method comprising

administering to the individual an effective amount of one or more immunogenic fragments of ApoB-100 or an immunogenically active portion thereof, wherein the one or more immunogenic fragments or immunogenically active portion thereof is associated to atherosclerosis reduction.

2. The method of claim 1, wherein the one or more immunogenic fragments comprises one or more peptides each comprising one of SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO:11, SEQ ID NO:25, SEQ ID NO:45, SEQ ID NO:74, SEQ ID NO:99, SEQ ID NO:100, SEQ ID NO:102, SEQ ID NO: 103, SEQ ID NO:105, SEQ ID NO:129, SEQ ID NO:143, SEQ ID NO:148, SEQ ID NO:210, and SEQ ID NO:301.

3. The method of claim 1, wherein the one or more immunogenic fragments comprises one or more peptides each comprising one of SEQ ID NO:2, SEQ ID NO:11, SEQ ID NO: 45, SEQ ID NO: 74, SEQ ID NO: 102, SEQ ID NO:148, and SEQ ID NO:210.

4. The method of any one of claims 1 to 3, wherein the one or more immunogenic fragments comprises a peptide having SEQ ID NO: 143 and a peptide having SEQ ID NO: 210.

5. The method of any one of claims 1 to 4, wherein the one or more immunogenic fragments comprises a peptide having SEQ ID NO: 11, a peptide having SEQ ID NO: 25 and a peptide having SEQ ID NO: 74.

6. The method of any one of claims 1 to 5, wherein the one or more immunogenic fragments comprises a peptide having SEQ ID NO: 2.

7. The method of any one of claims 1 to 6, wherein the one or more immunogenic fragments comprise a peptide having SEQ ID NO: 45.

8. The method of any one of claims 1 to 7, wherein the one or more immunogenic fragments comprise a peptide having SEQ ID NO: 210.

9. The method of any one of claims 1 to 8, wherein the individual is a human and the concentration is between about 100μg and about less than 1 mg.

10. The method of any one of claims 1 to 9, wherein the administering is performed by administering a dosage of at least about 100μg between 1 and 3 times.

11. A method to treat and/or prevent hypertension and/or a condition associated thereto in an individual, the method comprising

administering to the individual an effective amount of an activated CD8(+) T cells specific for an immunogenic fragment of ApoB-100 or an immunogenically active portion thereof, wherein the one or more immunogenic fragments or immunogenically active portion thereof are associated to atherosclerosis reduction.

12. The method of claim 11, wherein the one or more immunogenic fragments comprises one or more peptides each comprising one of SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO:11, SEQ ID NO:25, SEQ ID NO:45, SEQ ID NO:74, SEQ ID NO:99, SEQ ID NO:100, SEQ ID NO:102, SEQ ID NO: 103, SEQ ID NO:105, SEQ ID NO:129, SEQ ID NO:143, SEQ ID NO:148, SEQ ID NO:210, and SEQ ID NO:301.

13. The method of claim 11 or 12, wherein the one or more immunogenic comprises one or more peptides each comprising one of SEQ ID NO:2, SEQ ID NO:11, SEQ ID NO: 45, SEQ ID NO: 74, SEQ ID NO: 102, SEQ ID NO:148, SEQ ID NO:162, and SEQ ID NO:210.

14. The method of any one of claims 11 to 13, wherein the one or more immunogenic fragments comprises a peptide having SEQ ID NO: 143 and a peptide having SEQ ID NO: 210

15. The method of any one of claims 11 to 14, wherein the one or more immunogenic fragments comprises a peptide having SEQ ID NO: 11, a peptide having SEQ ID NO: 25 and a peptide having SEQ ID NO: 74.

16. The method of any one of claims 11 to 15, wherein the one or more immunogenic fragments comprises a peptide having SEQ ID NO: 2.

17. The method of any one of claims 11 to 16, wherein the one or more immunogenic fragments comprise a peptide having SEQ ID NO: 45.

18. The method of any one of claims 11 to 17, wherein the one or more immunogenic fragments comprise a peptide having SEQ ID NO: 210.

19. The method of any one of claims 11 to 18, wherein the effective amount is between about 500,000 and about 2,000,000 CD8(+) T cells.

20. The method of any one of claims 11 to 19, wherein the administering is performed by administering about 1,000,000 cells to the individual.

21. The method of any one of claims 11 to 20, wherein the method further comprises administering an effective amount of one or more enhancer of CD8(+) T cells.

22. The method of any one of claims 11 to 21 the method further comprising administering an immunogenic fragment of apoB-100 or an immunogenically active portion thereof.

23. The method of any one of claims 11 to 22, wherein the activated CD8 (+) T cells specific for the immunogenic fragment of ApoB100 or immunogenically active portion thereof are obtainable by

contacting a CD8(+) T cells with one or more peptides selected from the group consisting of SEQ ID NO: 1 to SEQ ID NO:302 or an immunogenically active portion thereof for a time and under condition to activate the CD8(+) T cell, the activated CD8(+) T cell specific for the one or more peptides or the immunogenically active portion thereof.

24. A system to treat and/or prevent hypertension and/or a condition associated thereto in an individual, the system comprising at least two of

one or more of a CD8(+) T cell specific for an immunogenic fragment of ApoB-100 or an immunogenically active portion thereof; and

one or more enhancersof the CD8(+) T cell

25. A system to treat and/or prevent hypertension and/or a condition associated thereto in an individual, the system comprising at least two of

one or more immunogenic fragments of apoB-100 or an immunogenically active portion thereof and CD8(+) T cell; and

one or more of a CD8(+) T cell specific for an immunogenic fragment of ApoB-100 or an immunogenically active portion thereof.

26. The system of claim 25, further comprising one or more enhancers of the CD8(+) T cell.

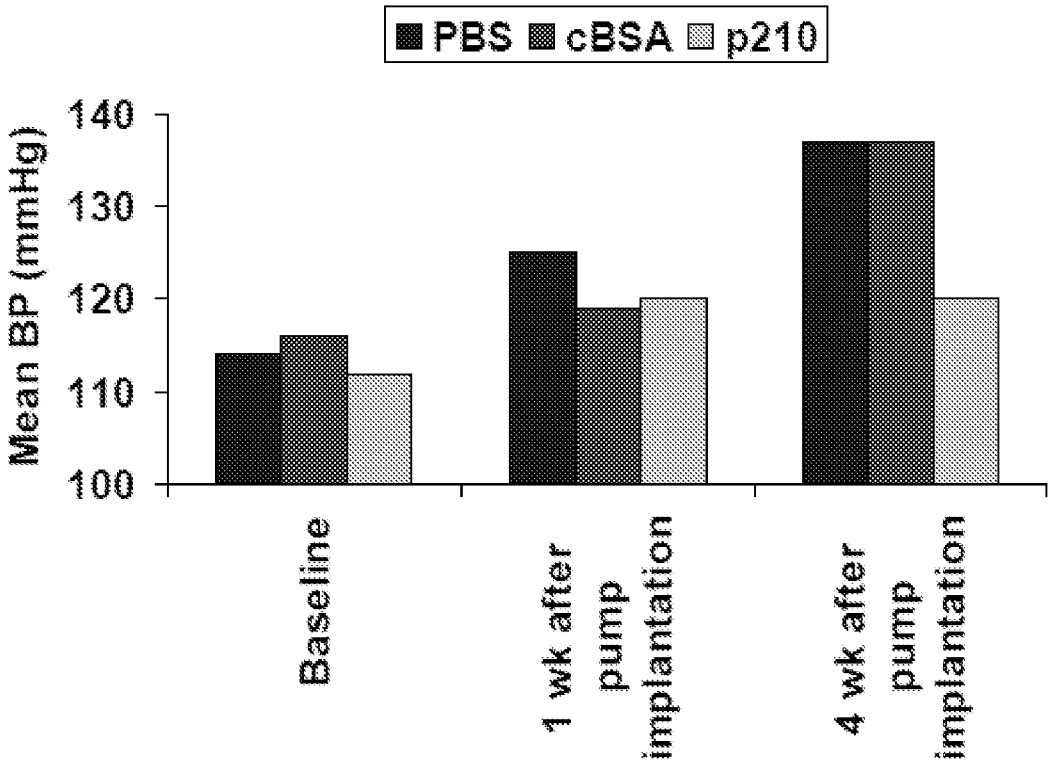
PBS
cBSA
p210
Mean BP (mmHg)
140
130
120
110
100
Baseline
1 wk after pump implantation
4 wk after pump implantation

FIG. 1

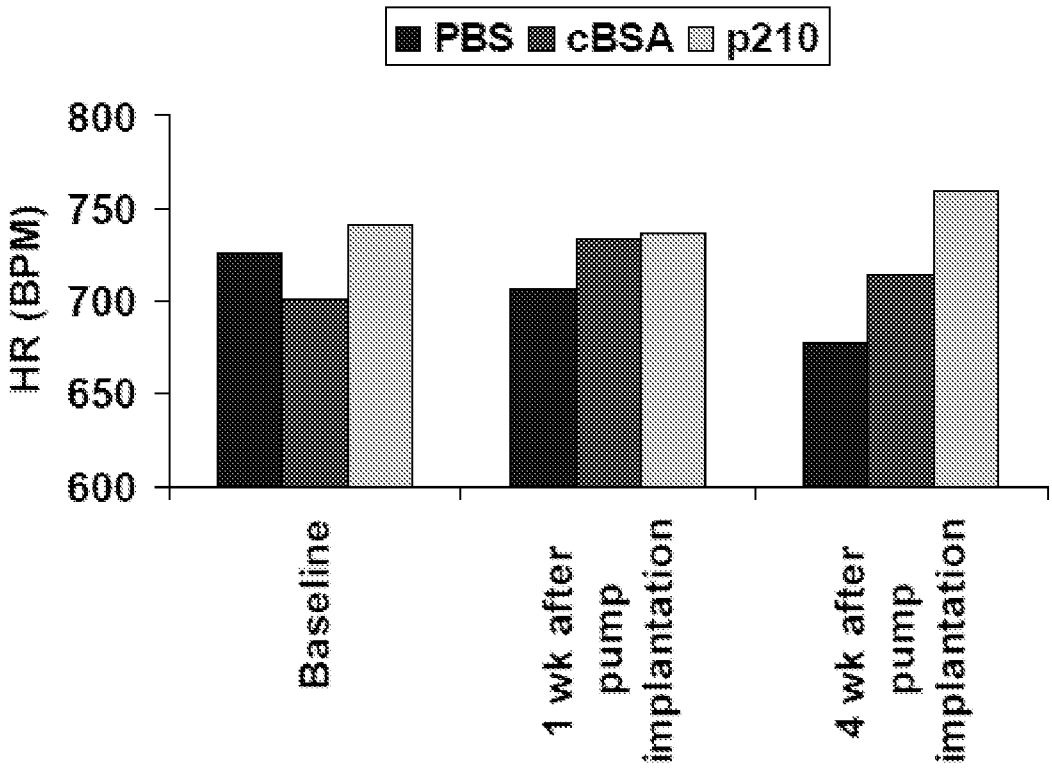
PBS
cBSA
p210
HR (BPM)
800
750
700
650
600
Baseline
1 wk after pump implantation
4 wk after pump implantation

FIG. 2A

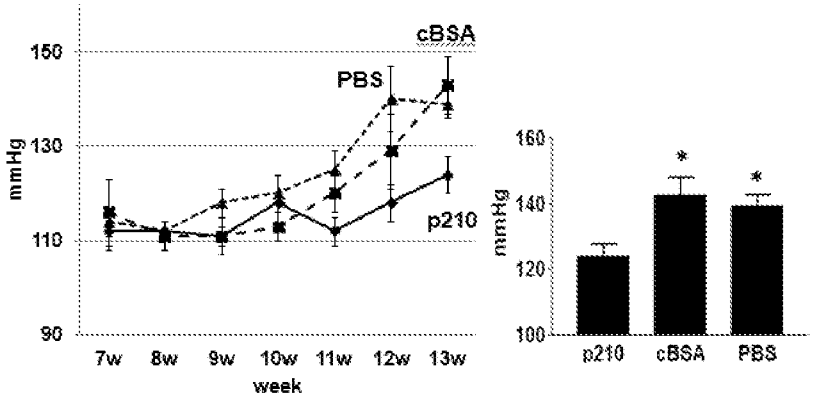

Fig 2B: p210 vaccine significantly decreased mean BP at 13 weeks of age. *p<0.05 vs. p210 by ANOVA followed by post-hoc analysis using Bonferroni test.

FIG. 2B

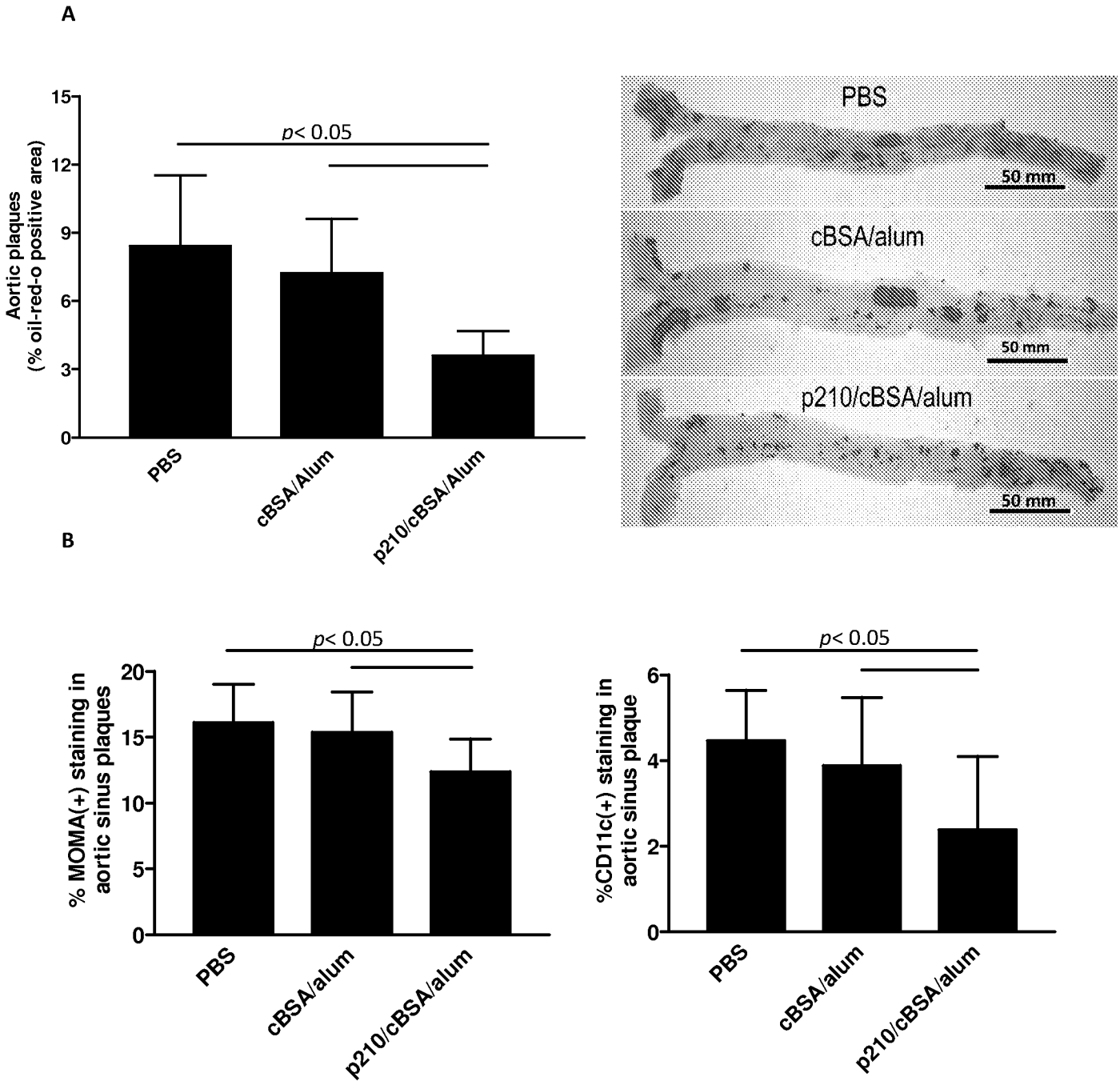
A
Aortic plaques
(% oil-red-o positive area)
15
12
9
6
3
0
p< 0.05
PBS
cBSA/Alum
p210/cBSA/Alum
PBS
50 mm
cBSA/alum
50 mm
p210/cBSA/alum
50 mm
B
% MOMA(+) staining in
aortic sinus plaques
20
15
10
5
0
p< 0.05
PBS
cBSA/alum
p210/cBSA/alum
%CD11c(+) staining in
aortic sinus plaque
6
4
2
0
p< 0.05
PBS
cBSA/alum
p210/cBSA/alum

FIG. 3

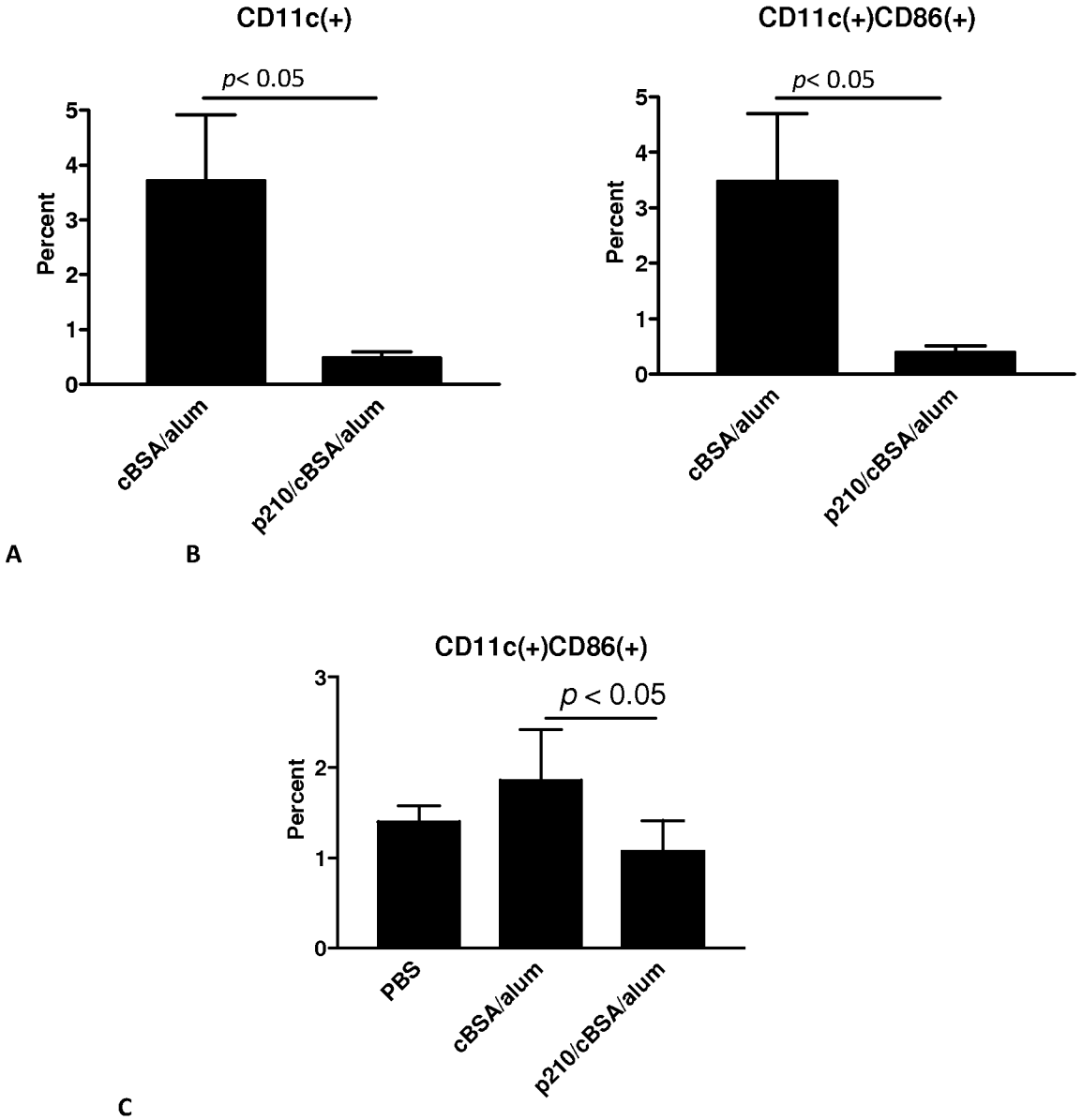
CD11c(+)
p< 0.05
Percent
5
4
3
2
1
0
cBSA/alum
p210/cBSA/alum
A
CD11c(+)CD86(+)
p< 0.05
Percent
5
4
3
2
1
0
cBSA/alum
p210/cBSA/alum
B
CD11c(+)CD86(+)
p < 0.05
Percent
3
2
1
0
PBS
cBSA/alum
p210/cBSA/alum
C

FIG. 4

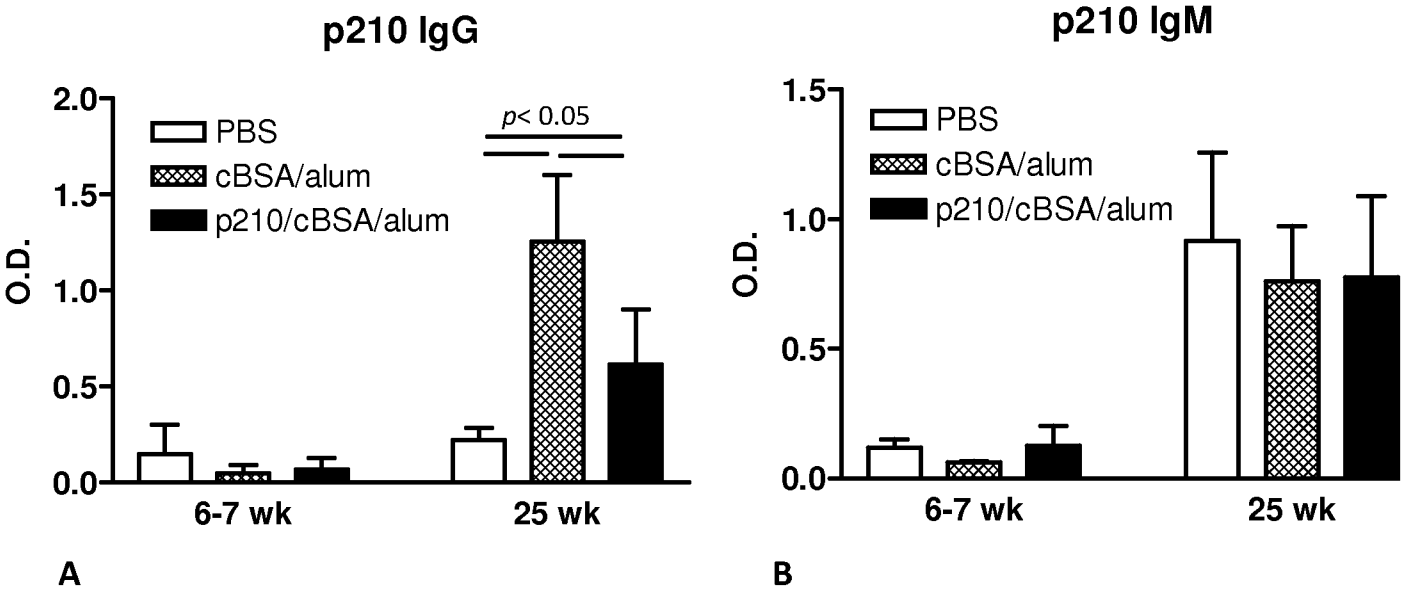
p210 IgG
2.0
1.5
1.0
0.5
0.0
O.D.
PBS
cBSA/alum
p210/cBSA/alum
p< 0.05
6-7 wk
25 wk
A
p210 IgM
1.5
1.0
0.5
0.0
O.D.
PBS
cBSA/alum
p210/cBSA/alum
6-7 wk
25 wk
B

FIG. 5

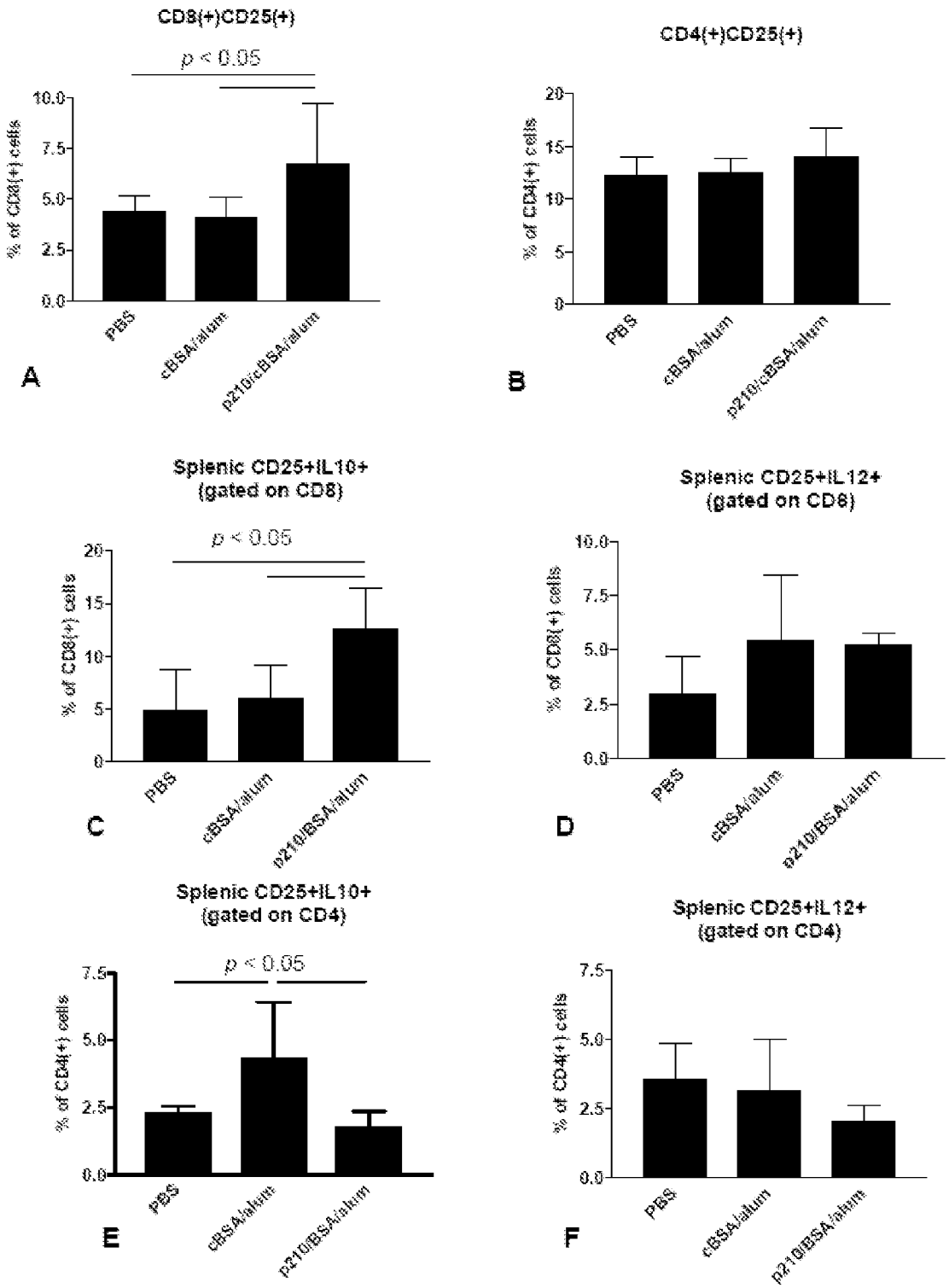
CD8(+)CD25(+)
p < 0.05
% of CD8(+) cells
10.0
7.5
5.0
2.5
0.0
PBS
cBSA/alum
p210/cBSA/alum
A
CD4(+)CD25(+)
% of CD4(+) cells
20
15
10
5
0
PBS
cBSA/alum
p210/cBSA/alum
B
Splenic CD25+IL10+
(gated on CD8)
p < 0.05
% of CD8(+) cells
20
15
10
5
0
PBS
cBSA/alum
p210/BSA/alum
C
Splenic CD25+IL12+
(gated on CD8)
% of CD8(+) cells
10.0
7.5
5.0
2.5
0.0
PBS
cBSA/alum
p210/BSA/alum
D
Splenic CD25+IL10+
(gated on CD4)
p < 0.05
% of CD4(+) cells
7.5
5.0
2.5
0.0
PBS
cBSA/alum
p210/BSA/alum
E
Splenic CD25+IL12+
(gated on CD4)
% of CD4(+) cells
7.5
5.0
2.5
0.0
PBS
cBSA/alum
p210/BSA/alum
F

FIG.6

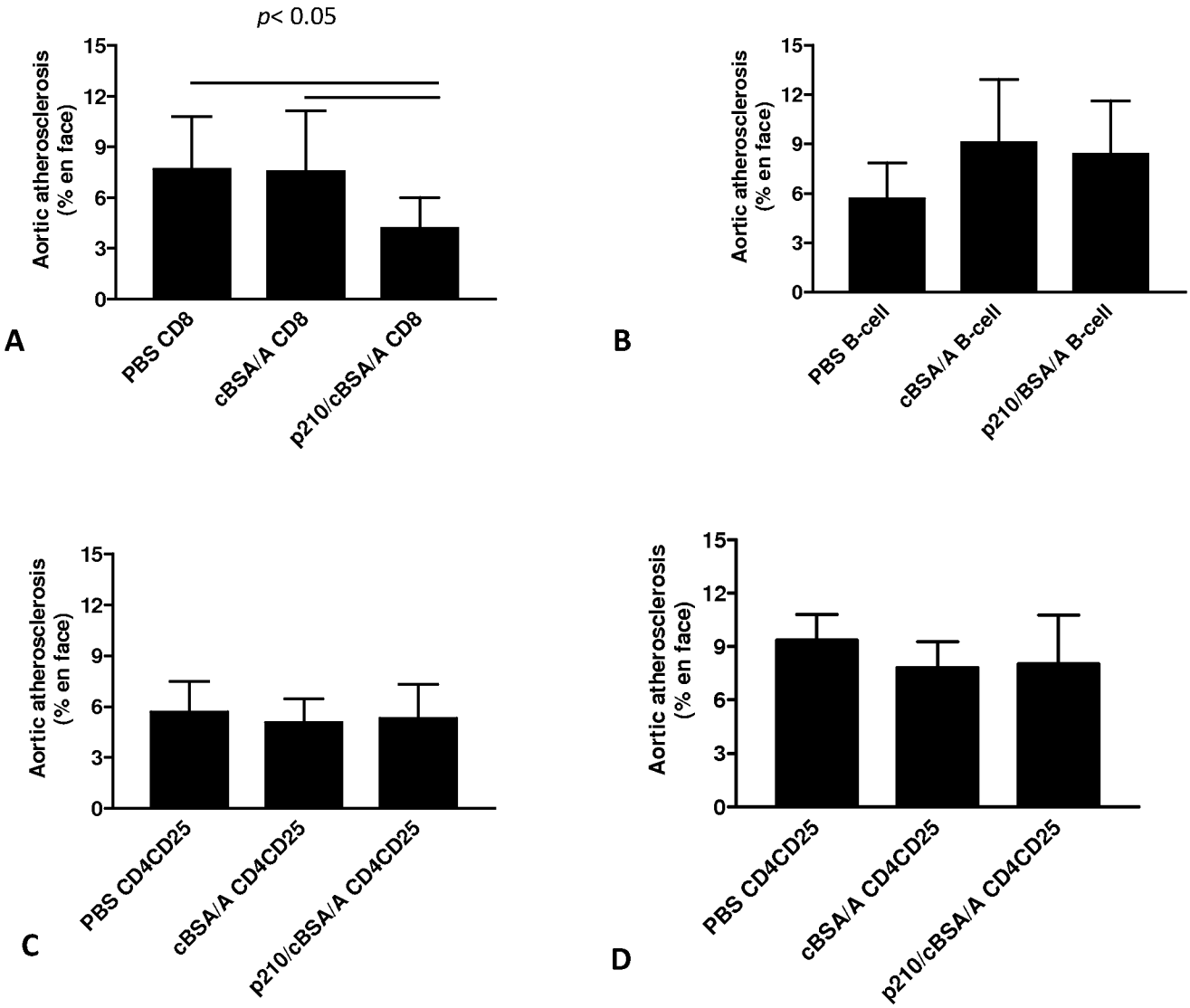
p< 0.05
Aortic atherosclerosis (% en face)
15
12
9
6
3
0
PBS CD8
cBSA/A CD8
p210/cBSA/A CD8
A
PBS B-cell
cBSA/A B-cell
p210/BSA/A B-cell
B
PBS CD4CD25
cBSA/A CD4CD25
p210/cBSA/A CD4CD25
C
D

FIG. 7

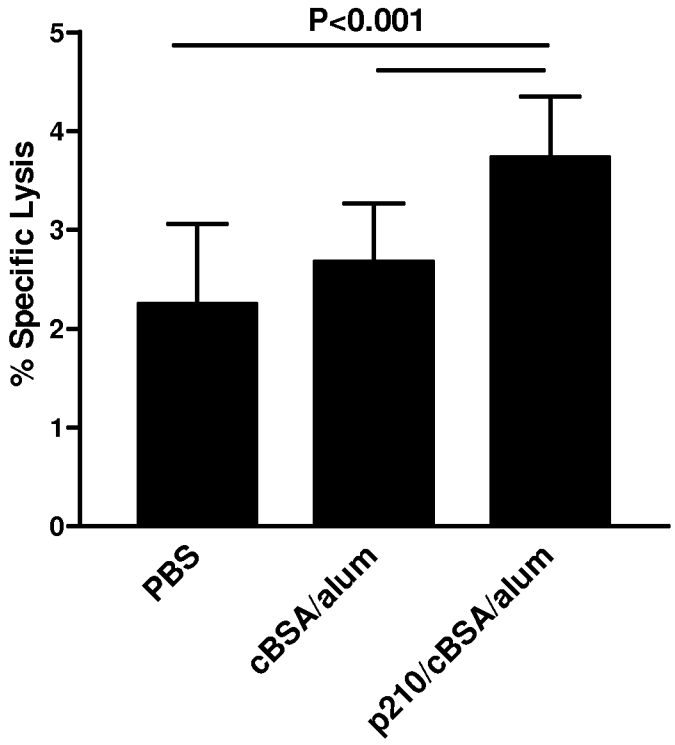

FIG. 8

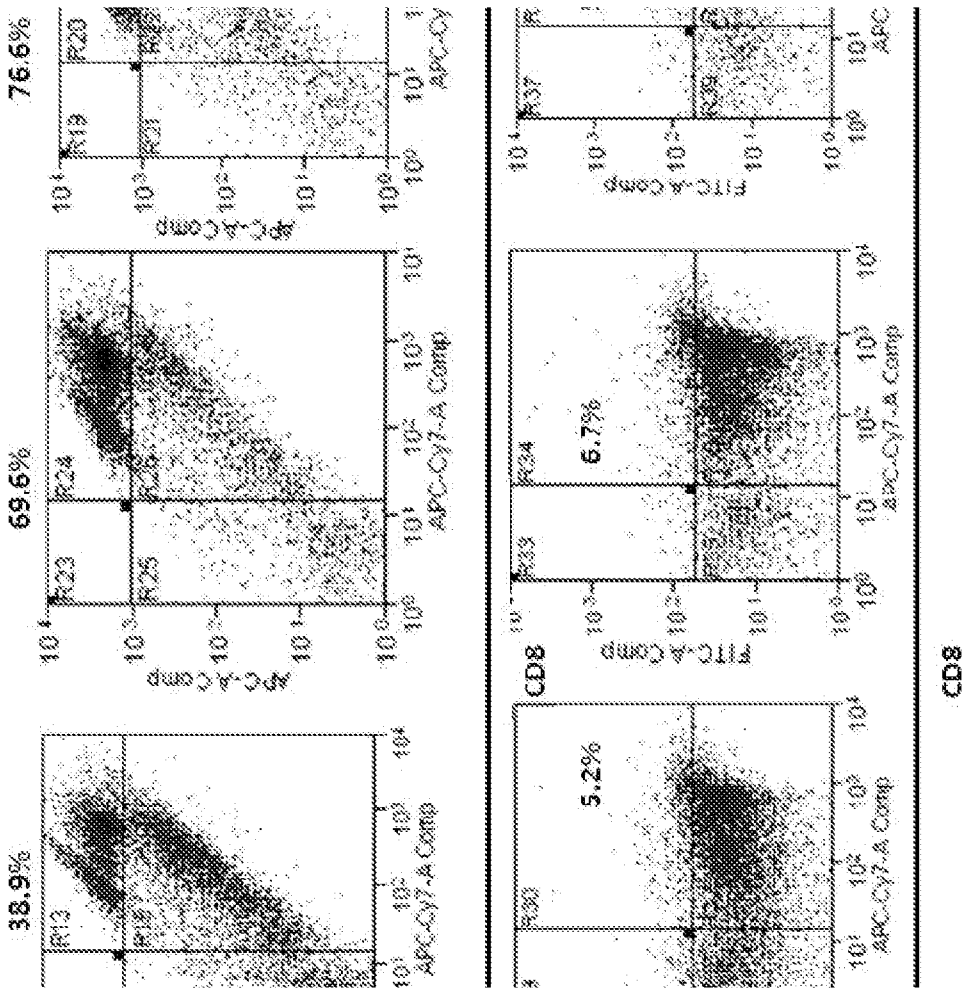

FIG. 9

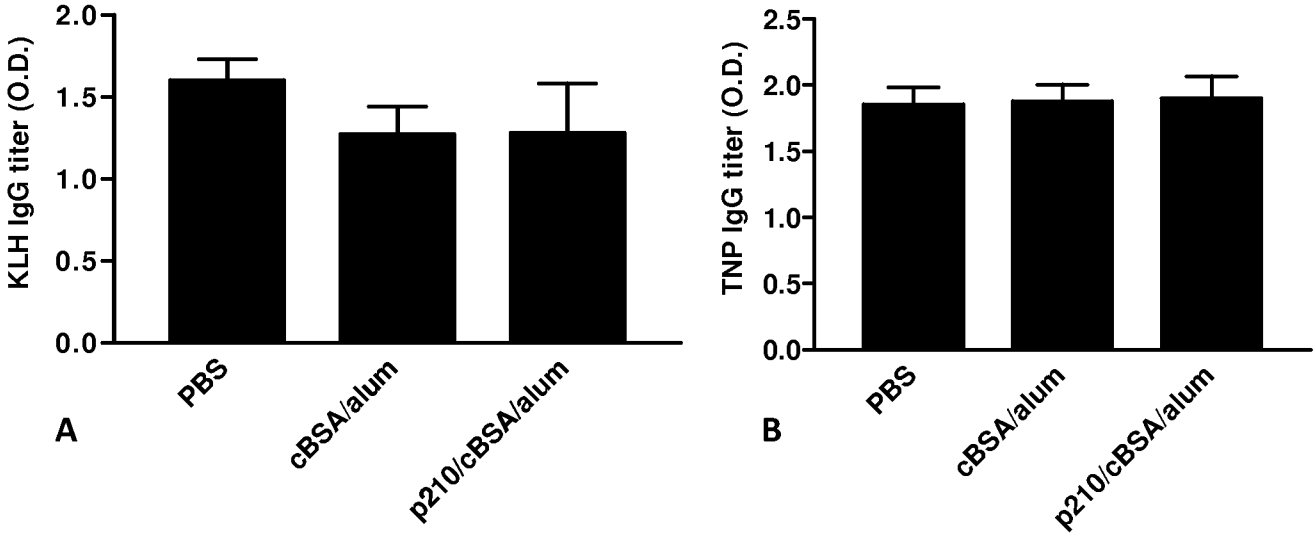
KLH IgG titer (O.D.)
2.0
1.5
1.0
0.5
0.0
PBS
cBSA/alum
p210/cBSA/alum
A
TNP IgG titer (O.D.)
2.5
2.0
1.5
1.0
0.5
0.0
PBS
cBSA/alum
p210/cBSA/alum
B

FIG. 10

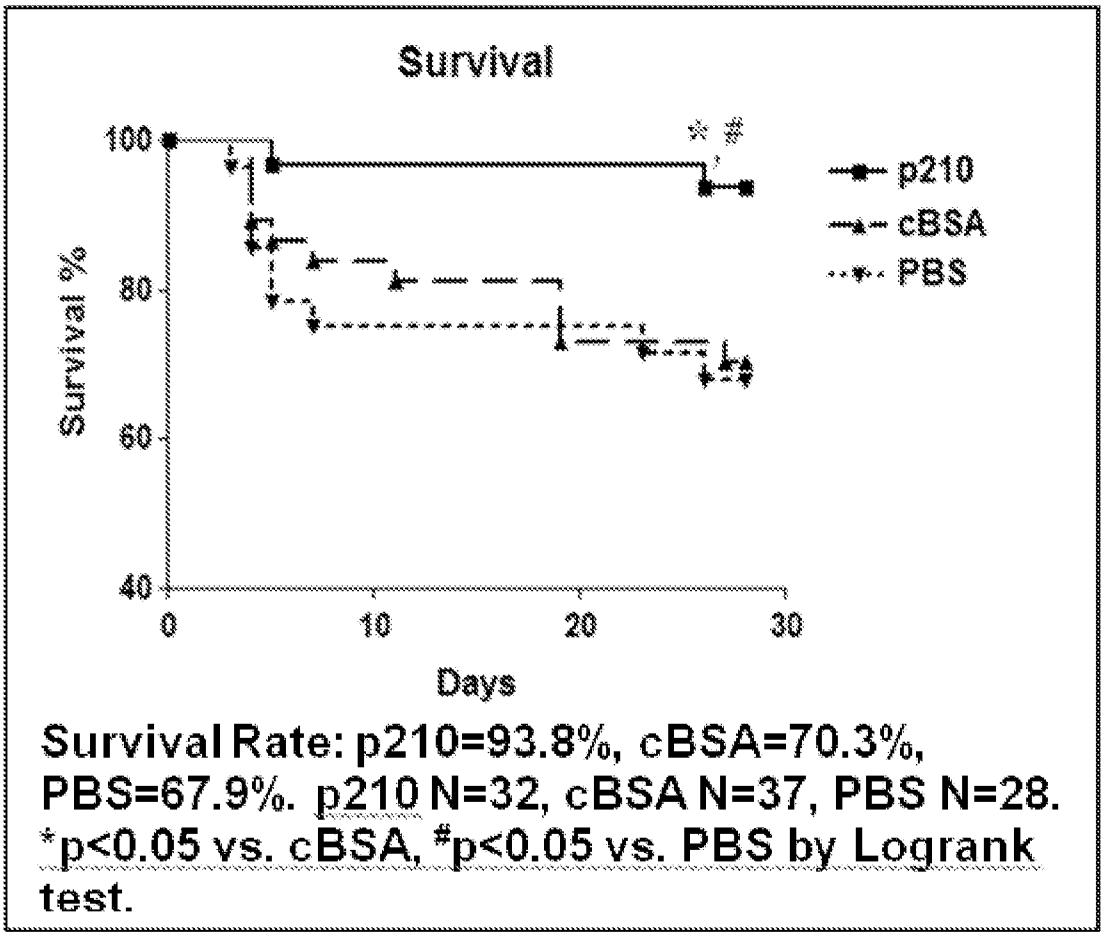
Survival
100
80
60
40
Survival %
0
10
20
30
Days
* #
p210
cBSA
PBS
Survival Rate: p210=93.8%, cBSA=70.3%, PBS=67.9%. p210 N=32, cBSA N=37, PBS N=28.
*p<0.05 vs. cBSA, #p<0.05 vs. PBS by Logrank test.

FIG.11

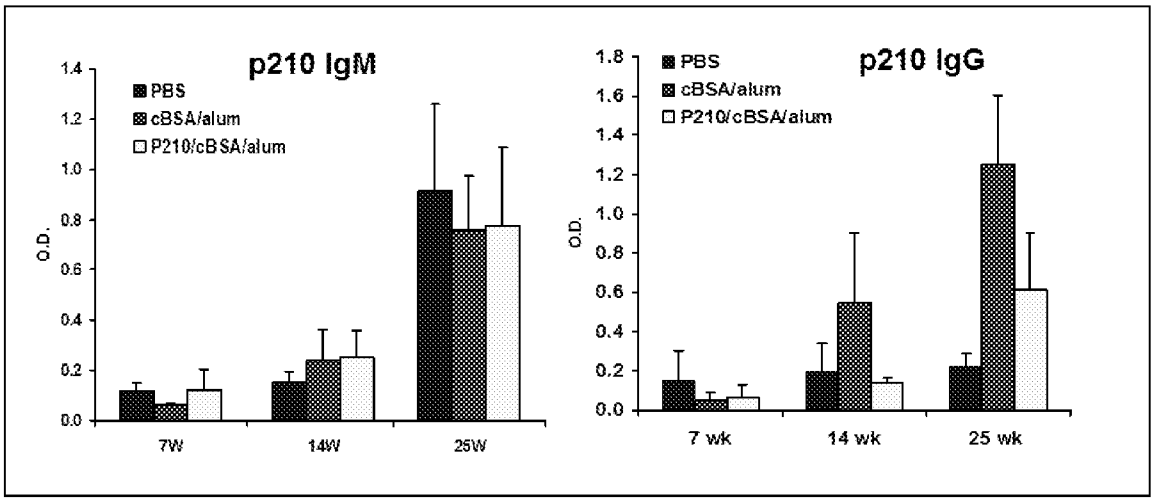
p210 IgM
PBS
cBSA/alum
P210/cBSA/alum
O.D.
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
7W
14W
25W
p210 IgG
PBS
cBSA/alum
P210/cBSA/alum
O.D.
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
7 wk
14 wk
25 wk

FIG.12

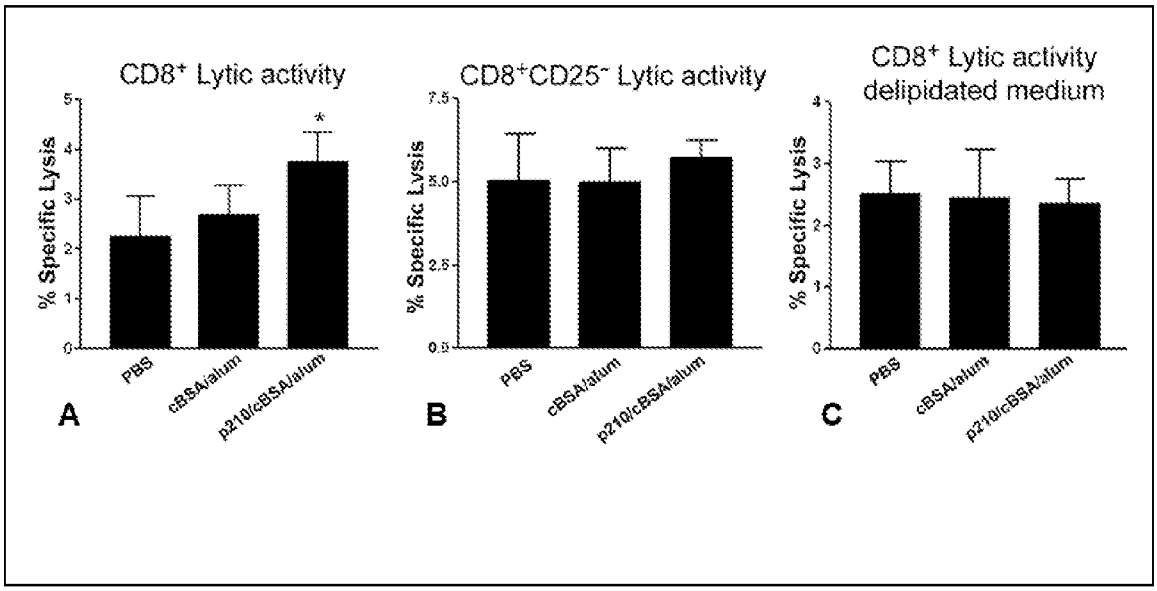
CD8+ Lytic activity
% Specific Lysis
PBS
cBSA/alum
p210/cBSA/alum
A
CD8+CD25- Lytic activity
% Specific Lysis
PBS
cBSA/alum
p210/cBSA/alum
B
CD8+ Lytic activity
delipidated medium
% Specific Lysis
PBS
cBSA/alum
p210/cBSA/alum
C

FIG.13

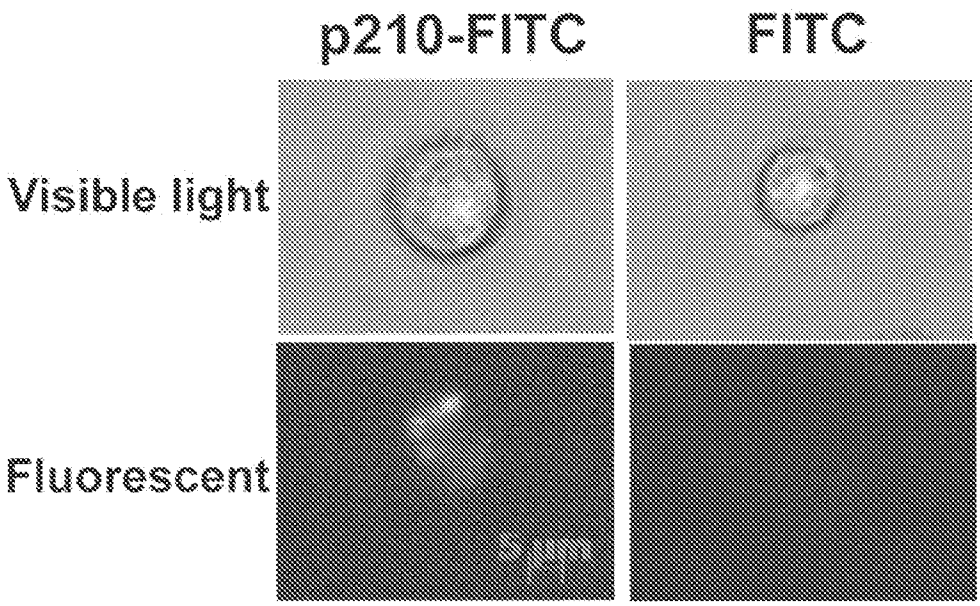

FIG.14

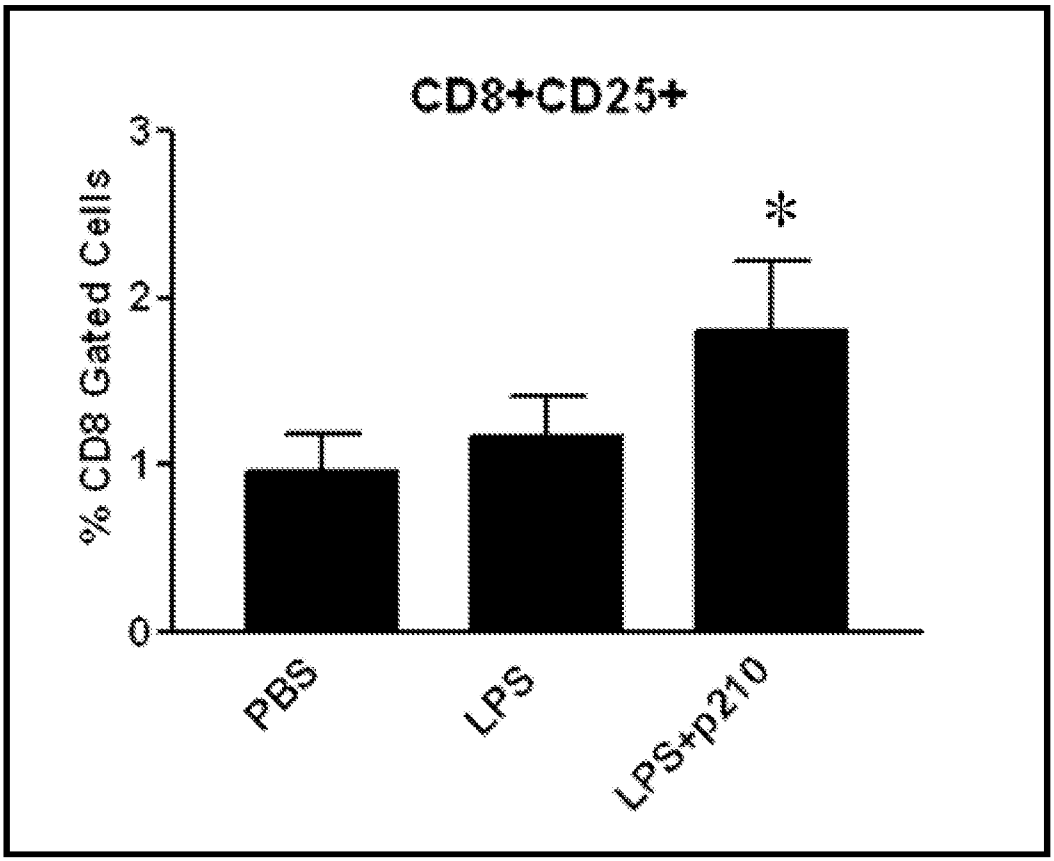

FIG.15

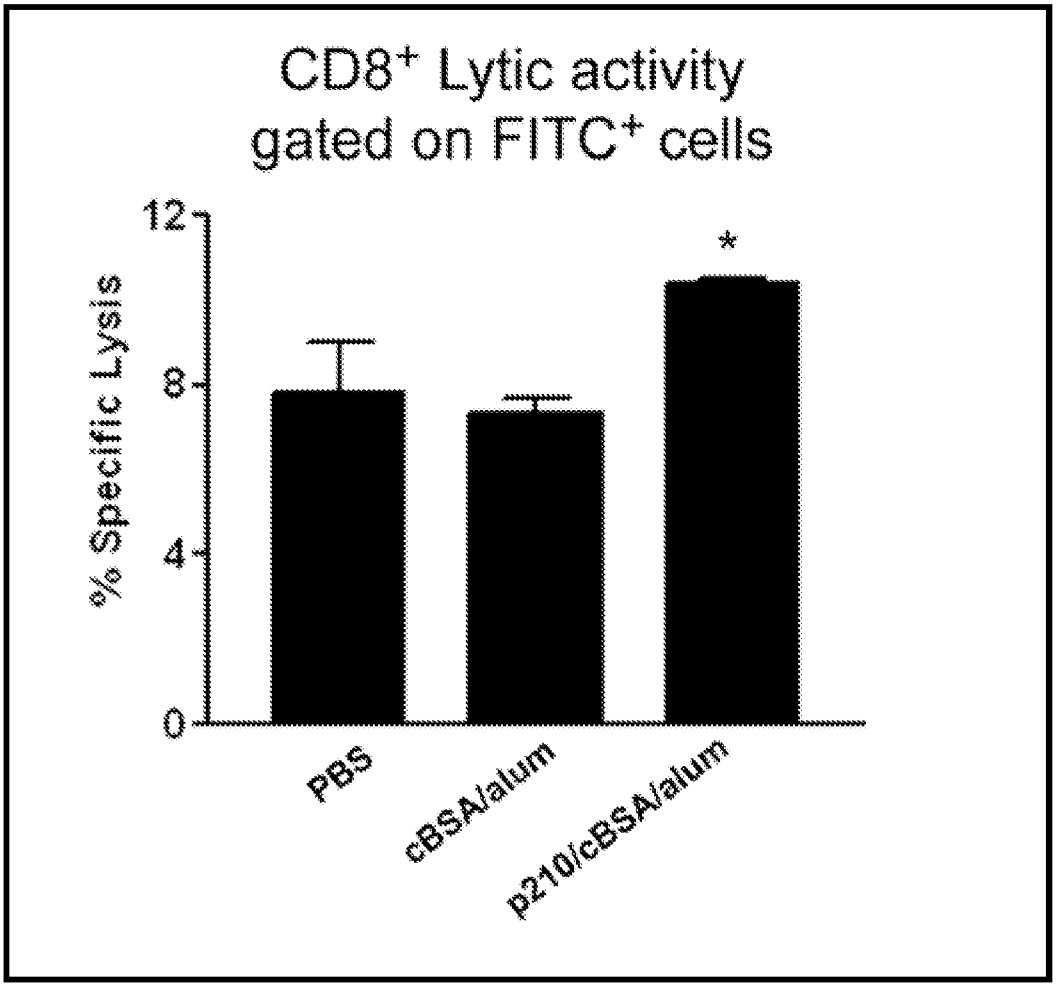
CD8+ Lytic activity
gated on FITC+ cells
% Specific Lysis
12
8
4
0
*
PBS
cBSA/alum
p210/cBSA/alum

FIG.16