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(54) Titre : STRUCTURE, FABRICATION ET UTILISATIONS DE PEPTIDES PERMEABLES AUX CELLULES D'ORIGINE HUMAINE CONJUGUES A DES PEPTIDES CARGO SPECIFIQUES BIOLOGIQUEMENT ACTIFS
(54) Title: STRUCTURE, MANUFACTURING AND USES OF HUMAN-DERIVED CELL-PERMEABLE PEPTIDES CONJUGATED WITH SPECIFIC BIOLOGICALLY ACTIVE CARGO PEPTIDES

(57) **Abrégé/Abstract:**

Embodiments disclosed herein provide compositions for conjugates, including fusion proteins, and methods of using them to treat a variety of conditions. In some embodiments, the conjugates and/or fusion proteins incorporate a 60-amino acid human homeodomain (e.g., peptides derived from human HOX genes), to translocate functional and regulatory peptides and proteins or other biologically active molecules such as nucleic acids, which are not naturally associated with the human homeodomain, across cell and nuclear membranes to intended sites of action without provoking an unwanted immune response that may reduce exposure to the conjugate and/or result in a clinical adverse event. In further embodiments, disclosed conjugates and fusion proteins can pass through the blood-brain barrier to allow entry into the CNS. In various embodiments, the disclosed compositions are suitable for delivery into a cell (i) the expression product of a gene of interest and/or (ii) novel peptides or polynucleotides to regulate gene function.



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(54) Title: STRUCTURE, MANUFACTURING AND USES OF HUMAN-DERIVED CELL-PERMEABLE PEPTIDES CONJUGATED WITH SPECIFIC BIOLOGICALLY ACTIVE CARGO PEPTIDES

(57) Abstract: Embodiments disclosed herein provide compositions for conjugates, including fusion proteins, and methods of using them to treat a variety of conditions. In some embodiments, the conjugates and/or fusion proteins incorporate a 60-amino acid human homeodomain (e.g., peptides derived from human HOX genes), to translocate functional and regulatory peptides and proteins or other biologically active molecules such as nucleic acids, which are not naturally associated with the human homeodomain, across cell and nuclear membranes to intended sites of action without provoking an unwanted immune response that may reduce exposure to the conjugate and/or result in a clinical adverse event. In further embodiments, disclosed conjugates and fusion proteins can pass through the blood-brain barrier to allow entry into the CNS. In various embodiments, the disclosed compositions are suitable for delivery into a cell (i) the expression product of a gene of interest and/or (ii) novel peptides or polynucleotides to regulate gene function.



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STRUCTURE, MANUFACTURING AND USES OF HUMAN-
DERIVED CELL-PERMEABLE PEPTIDES CONJUGATED WITH
SPECIFIC BIOLOGICALLY ACTIVE CARGO PEPTIDES

TECHNICAL FIELD

[0001] The embodiments disclosed herein relate generally to compositions and methods for treating a variety of conditions or diseases through administration of cell permeable peptide conjugates, particularly, but not exclusively, in the form of a fusion protein or protein/nucleic acid complex utilizing peptides derived from the amino acid homeodomain sequences coded for by human homeobox (HOX) genes and other human genes containing a homeodomain with cell permeabilizing properties. More particularly, the embodiments relate to a delivery system comprising a human homeodomain or variant or portion thereof, linked to one or more functional or regulatory peptides or proteins. These peptides facilitate entry into tissues, cells and the nucleus of cells thus allowing the fusion protein or conjugate containing a biologically active second region or “cargo” to reach its site of action for therapeutic purposes.

BACKGROUND

[0002] In diseases with manifestations due to aberrant gene function or deficient function, genes may be regulated through the direct delivery of biologically active molecules, such as nucleic acids, peptides and proteins, to their intracellular and intranuclear sites of action to influence gene expression either directly or indirectly through interference with transcription, translation or transcription factor production and action and also missing or defective protein products may be replaced to provide these types of molecules in individuals with germ-line or somatic mutations. The direct replacement of biologically important proteins in genetically deficient individuals is hampered by both (i) the inability of these proteins to reach intracellular sites and tissue sites such as the central nervous system (CNS) where they normally function and (ii) by the immunogenicity of these proteins.

SUMMARY

[0003] The embodiments disclosed herein together with a range of modifications provide compositions for conjugates, including fusion proteins, and methods of using them to treat a variety of conditions. The conjugates or fusion proteins incorporate a human HOX gene-derived 60 amino acid sequence or variant, or other human homeodomain sequence or variant or portion thereof to translocate functional and regulatory molecules, which are not naturally associated with the human homeodomain or variant or portion thereof, across cell and nuclear membranes to their intended sites of action without provoking an unwanted immune response that may reduce exposure and/or effectiveness of the conjugate, or which may produce an adverse clinical event. Further, such conjugates and fusion proteins also allow entry into the CNS by facilitating passage through the blood-brain barrier and then entry into cells in the CNS, such as microglia and neurons; they also allow for engagement of these functional or regulatory molecules to their intra-cytoplasmic and intranuclear targets. The ability to deliver directly into a cell (i) the expression product of a gene of interest or (ii) novel molecules able to regulate gene function has wide applicability in the medical field.

[0004] In addition to facilitating delivery of biologically active molecules to local (topical) and systemic intracellular and intranuclear targets, peptide sequences from human HOX genes also facilitate transport across the blood-brain barrier thus providing for CNS intracellular exposure to molecules containing these HOX gene sequences. Exploiting the technology's application of delivery of treatments across what are currently barriers to the delivery of drugs (such as the blood brain barrier), systemic administration can target cancers of the central nervous system by delivering drugs across the blood brain barrier. Examples of such applications are HOX gene derived peptides conjugated with adriamycin, doxorubicin or monoclonal antibodies directed at cancer cell targets such as Her2 (e.g., trastuzumab) for treatment of brain metastasized Her2 positive breast cancer. In addition, anti-bacterial and anti-viral agents that otherwise do not achieve therapeutic levels in the CNS are able to penetrate the blood brain barrier and successfully treat intracellular and extracellular bacterial and viral CNS infections in animal models.

[0005] In one embodiment, the conjugate comprises a first region, having a sequence described in any of SEQ ID Nos. 1-19 or variant or portion thereof,

conjugated to a second region not naturally associated with the first region, wherein the second region is a polypeptide having a sequence set forth in any one of SEQ ID Nos. 20, 23, 26, 30, 33, 36, 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, 69, and 72 or a variant or variant or portion thereof. In one embodiment, the first region is derived from the human gene.

[0006] In one embodiment the conjugate comprises:

- (a) a first region comprising a 60-amino acid domain or variant portion thereof of one of two HOX genes, HOX C12 and HOX D12; and
- (b) a second region not naturally associated with the first region; and wherein at least the first region is non-denatured.

[0007] According to one embodiment, the second region may comprise a nucleic acid. This may be associated via the specific 1,3 dipolar Huisgen cycloaddition reaction known as 'click-reaction' between azide and alkyne groups and is employed for the synthesis of peptide-oligonucleotide conjugates. Alternatively, this embodiment may be seen as a protein/nucleic acid complex where the second region may comprise a nucleic acid binding domain, capable of binding nucleic acids as part of the complex.

[0008] According to another embodiment, the first and second regions are associated via the specific 1,3 dipolar Huisgen cycloaddition reaction (i.e., 'click-reaction'), wherein the oligonucleotides act as miRNAs or antagonists to miRNAs in order to affect gene expression. These oligonucleotides may comprise DNA, RNA, LNA (locked nucleic acid), PNA (peptide nucleic acid) or other nucleic acids.

[0009] According to a further embodiment, the first and second regions are connected via standard peptide bonds wherein nucleobases are attached to a peptide backbone rather than to a phosphodiester backbone. Some or all of these nucleobases are capable of hybridizing to other nucleic acids in the cell and affecting gene expression. These nucleobases may be PNA, γ PNA or contain other side chains with similar properties.

[0010] In yet another embodiment, peptide or peptide-nucleic acid conjugates can be used to affect the activity of miRNAs including, but not limited to, antagonizing miRNA-132 for inhibition of the Ras pathway and cancer, antagonizing

miR-21 for inhibiting cancer or the NF- κ B pathway and inflammation, or affecting the function of other miRNAs and pathways that may have detrimental and/or undesirable effects on health.

[0011] According to a further embodiment the conjugate is in the form of a fusion protein. In this embodiment, the second region is a functional or regulatory protein.

[0012] In another embodiment a conjugate can comprise:

(a) a first region comprising a human homeodomain with cell permeabilizing capabilities linked to

(b) a second region not naturally associated with the first region comprising a protein such as a functional enzyme.

[0013] In another embodiment a composition comprises a conjugate or fusion protein that may take any of the following forms: an inhalable composition; an eye drop or other ophthalmic composition for local or injectable use; an enema; a topical composition; or an injectable composition, including an injectable implant for sustained release.

[0014] Another embodiment disclosed is a method comprising steps that permit a conjugate or fusion protein containing one or more biologically active peptides or proteins to be translocated to cells of the CNS.

[0015] Other embodiments comprise methods to prevent immunogenicity of otherwise antigenic proteins delivered as conjugates or fusion proteins to their intended cytosolic or nuclear sites of action.

[0016] These and other embodiments will be disclosed in further detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 shows an exemplary 60-amino acid human HOX C12 homeodomain (first region) or variant or portion thereof at the N-terminus of a Cargo peptide.

[0018] FIG. 2 shows an exemplary cargo peptide (second region) at the N-terminus of 60-amino acid human HOX D12 homeodomain or variant or portion thereof.

[0019] FIG. 3a shows an exemplary 60-amino acid human HOX D12 homeodomain (first region) or variant or portion thereof at its C-terminus with Cargo peptides (second and third regions), where the third region may be used to target the entire structure to specific tissues or cell types.

[0020] FIG. 3b shows an exemplary 60-amino acid human HOX D12 homeodomain (first region) or variant or portion thereof at its N-terminus with Cargo peptides (second and third regions), where the third region may be used to target the entire structure to specific tissues or cell type.

[0021] FIG. 4 shows an exemplary 60-amino acid human HOX C12 homeodomain (first region) or variant or portion thereof at the N-terminus of a Cargo peptide (second region), and His-tail conjugated to C-terminus through GS linker.

[0022] FIG. 5 shows an exemplary 60-amino acid human HOX D12 homeodomain (first region) or variant or portion thereof at N-terminus of NBD Cargo peptide (second region), and His-tail conjugated to C-terminus through GS linker.

[0023] FIG. 6 shows an exemplary sequence for plasmid pJ411:129925, showing a 6 HIS leader, with a transition sequence of SAA followed by the TEV cleavage site (ENLYFQS) to produce SEQ. ID No. 21 (also referred to as PPL-002) with the appropriate N-terminus.

[0024] FIG. 7 shows an exemplary sequence for plasmid pJ411:129926, showing a 6 HIS leader, with a transition sequence of SAA followed by the TEV cleavage site (ENLYFQS) to produce SEQ ID No. 22 (also referred to as PPL-003) with the appropriate N-terminus.

[0025] FIG. 8a shows inhibition of NF- κ B activation in murine RAW 264.7 cells (LPS 4-hour stimulation). Error bars represent SEM.

[0026] FIG. 8b shows inhibition of NF- κ B activation in Human Embryonic Kidney (HEK) 293 cells (TNF- α 4-hour stimulation). Error bars represent SEM.

[0027] FIG. 9 shows inhibition of TNF- α -stimulated NF- κ B activation in HEK 293 NF- κ B Luciferase Reporter Cells by NBD cargo containing cell permeable peptides
FIG. 10: Timeline for determining *in vivo* activity of NBD cargo-containing cell permeable peptides: Mice were pretreated with peptides, challenged by injection of

lipopolysaccharide (LPS) and blood samples were taken for cytokine assays at the indicated times

[0028] FIG. 11a shows TNF- α response following LPS injection and peptide or dexamethasone (Dex) pretreatment. Each datapoint represents the value for a single mouse.

[0029] FIG. 11b shows IP-10 response following LPS injection and peptide or dexamethasone (Dex) pretreatment. Each datapoint represents the value for a single mouse.

[0030] FIG. 12 shows IL-10 response following LPS injection and peptide or dexamethasone (Dex) pretreatment. Each datapoint represents the value for a single mouse.

[0031] FIG. 13 shows PPL-003 concentration in plasma following dosing at 500, 1000, and 2000 microgram.

[0032] FIG. 14 shows PPL-003 $C_{\max}$ in plasma by dose, showing average and median at $C_{\max}$ (30 min.).

[0033] FIGS. 15a and 15b show amyloid A protein (SAA) response at 2 hours following LPS challenge with pretreatment of 2000 microgram of PPL-003 at 0, 30- and 60-minutes prior to LPS stimulation. Error bars represent SEM in FIG 15a and data points in FIG 15b are individual mice, horizontal lines are median values.

[0034] FIGS. 16a and 16b show amyloid A protein (SAA) response to LPS following PPL-003 pretreatment at doses of 500, 1000, and 2000 micrograms. Error bars represent SEM in FIG 16a, and data points in FIG 16b are individual mice, horizontal lines are median values. Percentages are percent inhibition relative to vehicle/LPS.

[0035] FIGS. 17a and 17b show IL-10 and Mouse Kc responses, respectively, following 2000 microgram PPL-003 dose at 0, 30- and 60-minutes prior to LPS stimulation. Error bars represent SEM.

[0036] FIGs. 18a and 18b show inhibition of GM-CSF response following 2000 microgram PPL-003 or PPL-004 dose, respectively, at 0, 30- and 60-minutes prior to LPS stimulation. Error bars represent SEM.

DETAILED DESCRIPTION

[0037] The human HOX genes and other homeodomain coding genes are important in embryonic development and include small regions homologous to the gene antennapedia (Antp) but where the majority of amino acids are included in uniquely human sequences that facilitate their function. The protein sequence of antennapedia is characterized by the presence of a 60-amino acid motif (homeodomain) that binds to specific DNA target elements. The Antp homeodomain (see US Pat. No. 7,968,512) and much smaller sequences from the Antp gene have been shown to facilitate the entry of biologically active (“cargo”) peptides into tissues and cells to reach their site of action for therapeutic purposes.

[0038] While the homeodomain and smaller regions of Antp can be used to translocate proteins, including functional and regulatory proteins in vitro and in animal models, peptide sequences from human HOX genes and certain other human homeodomain sequences can also facilitate transport of biologically active molecules such as peptides, proteins and nucleotides to their intracellular and intranuclear sites of action (i) without provoking an unwanted immune response that may reduce exposure and/or effectiveness of the conjugate or may produce an adverse event, and (ii) with greater efficiency than Antp conjugates and fusion proteins. The ability to deliver biologically active molecules including the expression product of a gene of interest directly into a cell has wide applicability, particularly in the medical field. HOX and other human homeodomain peptides are also able to translocate nucleic acids. This is especially advantageous for applications utilizing a mechanism of gene regulation.

[0039] Several of the disclosed embodiments and their modifications relate to novel conjugates, which may take the form of fusion proteins, each comprising a 60-amino acid peptide or variant or portion thereof (**1** e.g. as shown in FIG. 1) derived from human HOX genes or from other human genes containing a homeodomain with cell permeabilizing properties, linked (e.g. **12** or **13** as shown in FIG. 1) to a second region (**2**): at least one of the biologically active “cargo” peptides disclosed herein. FIG. 1 shows one embodiment comprising the 60-amino acid human HOX C12 homeodomain (“first region”) (**1**) linked on its C-terminus (**4**) to the N-terminus (**5**) of a biologically-active cargo peptide (“second region”) (**2**). FIG. 2 shows an alternative embodiment comprising the 60-amino acid human HOX D12 homeodomain (“first

region”) (1) is linked on its N-terminus (3) to the C-terminus (6) of a biologically-active cargo peptide (“second region”) (2). The links in both embodiments may be a simple peptide bond (13) or a linker sequence known in the art (12) provided that function of the fusion protein or conjugate is not compromised by its addition.

[0040] The term “compromised” refers to reduced function of the conjugate embodiments as reflected in reduced efficacy of treatment for any of the outcomes discussed herein, e.g., compromised function could be reflected in an attenuated reduction in immunogenicity as compared to the reduction in immunogenicity observed with (1) the conjugate in the form of a fusion protein, or (2) the conjugate comprising an alternative linker.

[0041] Cargo peptides include both small synthetic peptides and larger proteins such as antibodies or the binding regions of antibodies into cells for therapeutic purposes. (Schutze-Redelmeier M-P et al. “Introduction of exogenous antigens into the MHC class 1 processing and presentation pathway by *Drosophila* antennapedia homeodomain primes cytotoxic T cells *in vivo*.” J. Immunol. 157(2):650-55, July 15, 1996; M.J. May et al. “Selective inhibition of NF-κB activation by a peptide that blocks the interaction of NEMO with the IκB kinase complex” Science 289:1550-54, Sept. 1, 2000; I Strickland and S Ghosh. “Use of cell permeable NBD peptides for suppression of inflammation” Ann. Rheum. Dis. 65(Suppl 3):iii75-iii82, 2006; C. Avignolo et al. “Internalization *via* Antennapedia protein transduction domain of an scFv antibody toward c-Myc protein” FASEB J. 22:1237-45, 2008.)

[0042] The terms “peptide(s),” “protein(s),” and “polypeptide(s)” are used synonymously.

[0043] The term “human homeodomain” refers to (1) human HOX-derived homeodomains such as the HOX C12 and HOX D12 sequences shown in Table 3 as SEQ ID No. 1 and SEQ ID No. 2, respectively, or variants or portions thereof; and (2) any other human homeodomain that has cell permeabilizing activity, such as SEQ ID Nos. 3 through 19, or variants or portions thereof.

[0044] The phrase “not naturally associated with” means that entire sequence of the conjugate or fusion protein is not found in nature, and that the entire sequence is not encoded for by a single gene found in nature.

[0045] The phrase "operably linked" means that the first and second region are linked such that the second region is able to translocate a cell membrane. Such linkage may be produced via application of "click" chemistry methods or other methods known in the art or may be incorporated as a fusion protein with a peptide bond between regions.

[0046] A person of ordinary skill in the molecular biology/biotechnology art would appreciate that numerous variations of the sequences shown in Tables 3 and 4 would fall within the embodiments disclosed herein. As used herein, homology refers to identity or near identity of nucleotide or amino acid sequences. As is understood in the art, nucleotide mismatches can occur at the third or wobble base in the codon without causing amino acid substitutions in the translated polypeptide sequence. Also, minor nucleotide modifications (e.g., substitutions, insertions or deletions) in certain regions of the gene sequence can be tolerated whenever such modifications result in changes in amino acid sequence that do not alter functionality of the final gene product. Homologs of specific DNA sequences may be identified by those skilled in the art using the test of cross-hybridization of nucleic acids under conditions of stringency as is well understood in the art (as described in Hames et al., Nucleic Acid Hybridisation, (1985) IRL Press, Oxford, UK). Extent of homology is often measured in terms of percentage of identity between the sequences compared.

[0047] The term "variant" refers to a polypeptide or protein that differs from a reference polypeptide or protein, but retains essential properties. A typical variant of a polypeptide differs in amino acid sequence from another, reference polypeptide. Generally, differences are limited so that the sequences of the reference polypeptide and the variant are closely similar overall (homologous) and, in many regions, identical. A variant and reference polypeptide may differ in amino acid sequence by one or more modifications (e.g., substitutions, additions, and/or deletions). A substituted or inserted amino acid residue may or may not be one encoded by the genetic code. A variant of a polypeptide may be naturally occurring such as an allelic variant, or it may be a variant that is not known to occur naturally.

[0048] Modifications and changes can be made in the structure of the polypeptides and proteins of this disclosure and still result in a molecule having similar characteristics as the polypeptide (e.g., a conservative amino acid substitution). For example, certain amino acids can be substituted for other amino

acids in a sequence without appreciable loss of activity. Because it is the interactive capacity and nature of a polypeptide that defines that polypeptide's or protein's biological functional activity, certain amino acid sequence substitutions can be made in a polypeptide or protein sequence and nevertheless obtain a polypeptide or protein with like properties.

[0049] Amino acid substitutions are generally based on the relative similarity of the amino acid side-chain substituents, for example, their hydrophobicity, hydrophilicity, charge, size, and the like. Exemplary substitutions that take one or more of the foregoing characteristics into consideration are well known to those of skill in the art and include, but are not limited to (original residue: exemplary substitution): (Ala: Gly, Ser), (Arg: Lys), (Asn: Gln, His), (Asp: Glu, Cys, Ser), (Gln: Asn), (Glu: Asp), (Gly: Ala), (His: Asn, Gln), (Ile: Leu, Val), (Leu: Ile, Val), (Lys: Arg), (Met: Leu, Tyr), (Ser: Thr), (Thr: Ser), (Tyr: Trp, Phe), and (Val: Ile, Leu). Embodiments of this disclosure, therefore, consider functional or biological equivalents of a polypeptide or protein as set forth above. In particular, embodiments of the polypeptides and proteins can include variants having about 50%, 60%, 70%, 80%, 90%, and 95% sequence identity to the polypeptide and protein of interest.

[0050] "Identity," as known in the art, is a relationship between two or more polypeptide or protein sequences, as determined by comparing the sequences. In the art, "identity" also refers to the degree of sequence relatedness between polypeptides or proteins, as determined by the match between strings of such sequences. "Identity" can be readily calculated by known bioinformational methods.

[0051] *First Region:* The first region of the conjugate or fusion protein embodiments disclosed may comprise a natural or synthetic 60-amino acid peptide or variant or portion thereof derived from the HOX C12 or HOX D12 gene or any other human homeodomain that has cell permeabilizing activity, such as SEQ ID Nos. 3 through 19, or variants or portions thereof.

[0052] In one embodiment, the HOX C12 (SEQ ID No. 1) amino acid sequence is:

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQNR
RMKKKRLL

[0053] In a another embodiment, the HOX D12 (SEQ ID No. 2) amino acid sequence is:

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDDQQVKIWFQNR
RMKKKRVV

[0054] Alternatively, other embodiments will include any one of 17 additional human 60-amino acid homeodomain sequences or variants or portions thereof with permeabilizing properties to allow for intracellular and intranuclear delivery of conjugates and fusion proteins. Further, these additional sequences each provide for CNS penetration of molecules that otherwise would not penetrate the blood brain barrier. Examples of amino acid sequences of these conjugates and fusion proteins with HOX C12 and HOX D12 homeodomains in the first region are shown in Table 3 (SEQ ID Nos. 21-22, 24-25, 27-28, 31-32, 34-35, 37-38, 40-41, 43-44, 46-47, 49-50, 52-53, 55-56, 58-59, 61-62, 64-65, 67-68, 70-71, and 73-74, or variants or portions thereof) and any of the other human homeodomains or variants or portions thereof (SEQ ID Nos. 3-19) and variations on these sequences may be substituted for either of the HOX C12 and D12 homeodomains. Each of the human homeodomain sequences is less than 50% identical to the 60-amino acid Antp sequence and thus is structurally distinct and has unique human properties. Additionally, because all of the homeodomain sequences shown in the table are of human origin they will not be antigenic in humans. Each of the human homeodomain sequences is listed below in Table 3 along with the abbreviation of the name of the human gene from which it is derived (SEQ ID Nos. 1 through 19). Cargo sequences may or may not be of human origin depending on their intended function.

[0055] In addition synthetic variants may be used provided that they retain the ability to translocate the membrane. Synthetic variants will generally differ from the naturally-occurring proteins by substitution, particularly conservative substitution. The phrase “conservative amino acid changes” herein means replacing an amino acid from one of the amino acid groups, namely hydrophobic, polar, acidic or basic, with an amino acid from within the same group. An example of such a change is the replacement of valine by methionine and vice versa. Other examples of conservative substitutions may be seen by reference to Table 1 below:

[0056] Table 1: Conservative Amino Acid Substitutions.

ALIPHATIC	Non-polar	GAP	ILV
	Polar-uncharged	CSTM	NQ
	Polar - charged	DE	RK
AROMATIC			HFWY
OTHER			N

[0057] Such variants may be synthesized directly or prepared using standard recombinant DNA techniques such as site-directed mutagenesis. Where insertions are to be made, synthetic DNA encoding the insertion together with 5' and 3' flanking regions corresponding to the naturally-occurring sequence either side of the insertion site. The flanking regions will contain convenient restriction sites corresponding to sites in the naturally-occurring sequence so that the sequence may be cut with the appropriate enzyme(s) and the synthetic DNA ligated into the cut. The DNA is then expressed to make the encoded protein. These methods are only illustrative of the numerous standard techniques known in the art for manipulation of DNA sequences and other known techniques may also be used. Variants that retain at least 50% sequence identity with the claimed 60-amino acid sequences or variants or portions thereof derived from HOX-C12 and HOX-D12 will likely maintain their cell permeability characteristics and retain their human characteristics resulting in low immunogenicity potential. The ability of a naturally occurring or synthetic HOX sequence to translocate the membrane may be tested by routine methods known in the art. Any polynucleotide which encodes the amino acid of SEQ ID Nos. 1-19 (Table 3) or variant or portion thereof can be used in a fusion protein or conjugate herein.

[0058] *Second Region Peptides or Proteins:* The second region of the conjugate or fusion protein embodiments disclosed may comprise any peptide or protein sequence not naturally associated with the first region. The gene encoding the first region may or may not also encode the second region. The second region also may or may not be from the same species as the first region, but the first and second regions will be present in the conjugate or fusion protein embodiments in a manner different from the natural situation.

[0059] The second region of the fusion protein or conjugate embodiments may be a peptide or protein of any length as long as it is biologically active on its target when included in the fusion protein or conjugate.

[0060] *Second Region Nucleic Acids:* The second region may include any nucleic acid that may be therapeutically active. In one embodiment, the nucleic acid can be DNA or RNA. In another embodiment, the nucleic acid is an oligonucleotide or a PNA.

[0061] In one embodiment, the second region may include any peptide nucleic acid such as PNAs in which nucleobases replace standard amino acids and the second region may be therapeutically active, including acting via antagonizing or activating miRNAs, in order *to affect gene expression or other* biological process.

[0062] In another embodiment, the second region may include any peptide nucleic acid such as PNAs and wherein the second region may be therapeutically active, including acting via antagonizing or activating mRNAs, by activating or repressing splicing or translation in order to affect gene expression or other biological process.

[0063] In certain embodiments comprising a protein/nucleic acid complex, the complex can further comprise a nucleic acid or PNA as part of the second region that, when inside a cell, binds to a RISC complex or an miRNA. For example, binding to miR132 miRNA may inhibit cancer or NF- κ B. Such binding to an miRNA molecule can form a stable complex, wherein the miRNA molecule can become incapable of affecting the expression of genes as would normally be the case for an unbound miRNA.

[0064] In some embodiments comprising a protein/nucleic acid complex, the complex can further comprise a nucleic acid or PNA as part of the second region that, when inside a cell, binds to genomic DNA. For example, binding to DNA at transcription factor binding sites may prevent transcription factor binding and/or activity and thus affect gene transcription.

[0065] In further embodiments comprising a protein/nucleic acid complex, the complex can further comprise a nucleic acid, LNA or PNA as part of the second region that, when inside a cell, binds to an mRNA. For example, binding to DYRK1b mRNA can down-regulate DYRK1b expression and/or translation.

[0066] In additional embodiments comprising a protein/nucleic acid complex, the complex can further comprise a nucleic acid (or DNA) binding domain as part of the second region. In one embodiment, the nucleic acid binding domain may serve to mediate the specific, high affinity and non-covalent interaction of the protein component with the nucleic acid or PNA component.

[0067] The nucleic acid binding domain may be an RNA or DNA binding domain, e.g., the DNA binding domain of a transcription factor, particularly a yeast or human transcription factor. For example, a GAL4-derivable domain, mediates the selective binding of the protein to the DNA sequence CGGAGGACAGTCCTCCG (Cavey et al J Mol Biol 209:423, 1989). Further, the DNA binding domain consists of GAL4 amino acids 2 to 147. A DNA binding domain may bind to single-stranded or to a double-stranded DNA on the second domain.

[0068] Other applications for the conjugate or fusion protein embodiments disclosed include development of antibacterial and antiviral measures. For example, HOX gene-derived or other human homeodomain-derived cell permeable peptides may be used to transport in the cytoplasm of infected cells recombinant antibodies, naturally occurring innate immunity effector molecules or DNA binding molecules and which destroy bacteria, parasites or interfere with a crucial step of bacterial or viral replication.

[0069] Suitable peptides and proteins include those that are of therapeutic and/or diagnostic application such as, but are not limited to: cytokines, chemokines, hormones, antibodies, engineered immunoglobulin-like molecules, a single chain antibody, conjugates, enzymes, immune co-stimulatory molecules, immunomodulatory molecules, anti-sense RNA, a transdominant negative mutant of a target protein, a toxin, such as endotoxin A, Colicin A, d-endotoxin, diphtheria toxin, Bacillus anthrox toxin, Cholera toxin, Pertussis toxin, E. coli toxins, Shigatoxin or a Shiga-like toxin, a conditional toxin, an antigen, a tumor suppressor protein and growth factors, membrane proteins, vasoactive proteins and peptides, anti-viral proteins and ribozymes, and derivatives. When included, such coding sequences may be typically operatively linked to a suitable promoter, which may be a promoter driving expression of a ribozyme(s), or a different promoter or promoters.

[0070] One or more embodiments may provide a pharmaceutical composition for treating an individual by gene therapy in animals or humans, wherein the composition comprises a therapeutically effective amount of the conjugate or fusion protein. Typically, a physician will determine the actual dosage which will be most suitable for an individual subject and it will vary with the age, weight and response of the particular individual.

[0071] Fusion protein or conjugate embodiments delivering one or more therapeutic molecules such as genes or proteins may be used alone or in combination with other treatments or components of the treatment. Diseases which may be treated include, but are not limited to: cancer, neurological diseases, inherited diseases, heart disease, stroke, arthritis, viral and bacterial infections, and diseases of the immune system. Suitable therapeutic genes include those coding for tumor suppressor proteins, enzymes, pro-drug activating enzymes, immunomodulatory molecules, antibodies, engineered immunoglobulin-like molecules, conjugates, hormones, membrane proteins, vasoactive proteins or peptides, cytokines, chemokines, anti-viral proteins, antisense RNA and ribozymes.

[0072] The conjugate may also contain one or more cytokine-encoding nucleic acids or cytokines. Suitable cytokines and growth factors include but are not limited to: ApoE, Apo-SAA, BDNF, Cardiotrophin-1, EGF, ENA-78, Eotaxin, Eotaxin-2, Exodus-2, FGF-acidic, FGF-basic, fibroblast growth factor-10 (Marshall 1998 Nature Biotechnology 16: 129), FLT3 ligand (Kimura et al. (1997), Fractalkine (CX3C), GDNF, G-CSF, GM-CSF, GF-[beta]1, insulin, IFN-[gamma], IGF-I IGF-II, IL-1[alpha], IL-1[beta], IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-8 (72 a.a.), IL-8 (77 a.a.), IL-9, IL-10, IL-11, IL-12, IL-13, IL-15, IL-16, IL-17, IL-18 (IGIF), Inhibin [alpha], Inhibin [beta], IP-10, keratinocyte growth factor-2 (KGF-2), KGF, Leptin, LIF, Lymphotoxin, Mullerian inhibitory substance, monocyte colony inhibitory factor, monocyte attractant protein (Marshall 1998 ibid), M-CSF, MDC (67 a.a.), MDC (69 a.a.), MCP-1 (MCAF), MCP-2, MCP-3, MCP4, MDC (67 a.a.), MDC (69 a.a.), MIG, MIP-1[alpha], MIP-1[beta], MIP-3[alpha], MIP-3[beta], MIP4, myeloid progenitor inhibitor factor-1 (MPLF-1), NAP-2, Neurturin, Nerve growth factor, [beta]-NGF, NT-3, NT-4, Oncostatin M, PDGF-AA, PDGF-AB, PDGF-BB, PF-4, RANTES, SDF1[alpha], SDF1[beta], SCF, SCGF, stem cell factor (SCF), TARC, TGF-[alpha], TGF-[beta], TGF-[beta]2, TGF-[beta]3, tumor necrosis factor (TNF), TNF-[alpha], TNF-[beta], TNF-1, TPO, VEGF, GCP-2

GRO/IMGSA, GRO-[beta], GRO-[gamma], HCC1, and 1-309. It is also contemplated that homologous cytokines and growth factors can be used as cargo in suitable animal systems for research or veterinary applications.

[0073] The fusion protein or conjugate embodiments disclosed may comprise further suitable domains known to those skilled in the art. For example, an endoplasmic reticulum retention signal functions to affect the intracellular routing of the internalized conjugate or protein/nucleic acid complex. A suitable endoplasmic retention signal may be a mammalian endoplasmic reticulum retention signal.

[0074] Also present may be a translocation domain which serves to enhance nucleic acid or protein escape from the cellular vesicle system and thus to augment nucleic acid transfer by this route. This domain may serve to reduce or avoid lysosomal degradation after internalization of the protein/nucleic acid into the target cell. Suitable translocation domains are derivable from toxins, particularly bacterial toxins, such as exotoxin A, Colicin A, d-endotoxin, diphtheria toxin, Bacillus anthrax toxin, Cholera toxin, Pertussis toxin, E. coli toxin toxins, Shigatoxin or Shiga-like toxin.

[0075] The first binding domain may be modified to target cell sites other than the nucleus.

[0076] Additionally, or alternatively, a target cell-specific binding domain recognizing a cell surface structure may be present, such as a receptor protein or surface antigen on the target cell.

[0077] The term "conjugate" or "conjugates" herein comprises a category of structures, including fusion proteins, in which the first region, a 60-amino acid human homeodomain sequence or variant or portion thereof, is conjugated directly via a peptide bond or other type of bond including both covalent and non-covalent bonds. Conjugates may include a linker region that connects the homeodomain sequence to a second region, a functional or regulatory peptide or protein ("cargo" peptide) that is not naturally associated with the first region. Any of a wide variety of linkers (short, connecting sequences) known in the art may be utilized to form the conjugate provided that function of the conjugate is not compromised by its addition. Thus, translocation of the second region is enabled through a cellular or nuclear membrane. For example, see a wide variety of linkers known in the art in Chen et al.

“Fusion protein linkers: property, design and functionality.” Advanced Drug Delivery Reviews. <http://dx.doi.org/10.1016/J.addr.2012.09.039>. In alternative embodiments the term “fusion protein” is used to refer to a particular subcategory of conjugate that exists when no such linkers are used to form the conjugate and the domains are linked entirely by peptide bonds.

[0078] The first (HOX or other human homeodomain) region and second (cargo) regions may be linked by a cleavable linker region this may be any region suitable for this purpose provided the function of the conjugate is not compromised by its addition. The cleavable linker region is a protease cleavable linker, although other linkers, cleavable for example by small molecules, may be used. These include Met-X sites, cleavable by cyanogen bromide, Asn-Gly, cleavable by hydroxylamine, Asp-Pro, cleavable by weak acid and Trp-X cleavable by, inter alia, NBS-skatole. Protease cleavage sites require milder cleavage conditions and are found in, for example, factor Xa, thrombin and collagenase. Any of these may be used. The precise sequences are available in the art and the skilled person will have no difficulty in selecting a suitable cleavage site. By way of example, the protease cleavage region targeted by Factor Xa is I E G R. The protease cleavage region targeted by Enterokinase is D D D D K. The protease cleavage region targeted by Thrombin is L V P R G. The cleavable linker region may be one that is targeted by endocellular proteases. Linkers may not be required for function but linkers may be included between first and second regions to allow targeted release of the second region without compromising function or to enhance biological activity of the second region with linker cleavage.

[0079] Table 2 - showing partial listing of linkers known in the art, adapted from Chen et al., 2012.

(GGGS)_n, where n = 1, 2, 3, or 4
 (Gly)_n, where n = 6 or 8
 (EAAAK)_n where n = 1 – 3
 A(EAAAK)₄ALEA(EAAAK)₄ A
 PAPAP
 AEAAAKEAAKA
 (Ala-Pro)_n where n = 10 – 34 aa
 VSQTSKLTR↓AETVFPDV
 PLG↓LWAc
 RVL↓AEA; EDVVCC↓SMSY; GGIEGR↓GS
 TRHRQPR↓GWE; AGNRVRR↓SVG; RRRRRRR↓R↓R
 GFLG↓
 A(EAAAK)₄ALEA(EAAAK)₄A

↓ = cleavable at this location

[0080] The embodiments disclosed allow for potent therapeutic action, including efficient translocation into intracellular and intranuclear sites of action of any of a number of identified peptides for the specified therapeutic treatments, wherein (i) the CNS is a target tissue; and (ii) regardless of the target tissue, such translocation does not provoke an unwanted immune response that may reduce the exposure and/or effectiveness of the conjugate or produce an adverse or undesirable clinical event. The biologically-active peptide of the “second region” is not naturally associated with the human homeodomain sequence or variant or portion thereof (the “first region”) before they are joined.

[0081] Further, in a variety of embodiments the conjugate or fusion protein may comprise a third region also comprising a cargo peptide. FIGS. 3a and 3b show alternative embodiments comprising the 60-amino acid human homeodomain (“first region,” shown abbreviated here) and an additional cargo protein that may target the fusion protein or conjugate to its cellular site of action. In FIG. 3a, the human HOX D12 homeodomain on the left (**1**), is linked on its C-terminus (**4**) to the N-terminus (**5**) of a biologically-active cargo peptide of interest (“second region”) (**2**), while a third cargo peptide of interest (“third region”) (**7**) is linked on its N-terminus (**8**) to the C-terminus (**6**) of the “second region” (**2**). This third region may remain linked or fused via peptide bonds to the entire fusion protein or may be designed for removal after uptake or binding to specific sites in targeted tissues.

[0082] FIG. 3b shows an alternative embodiment, with the human HOX D12 homeodomain on the right (**1**), linked through its N-terminus (**3**) to the C-terminus (**6**) of the second region (**2**), while a third region cargo peptide (**7**) is linked through the

N-terminus (5) of the second region (2). The links may be simple peptide bonds (13) or a linker sequences known in the art (12), or a combination of both, provided that the function of the conjugate is not compromised by the addition of a linker sequence. A *second* cargo peptide ("third region") (7) may target the conjugate or fusion protein to its cellular site of action. See Example 2.

[0083] Conjugate and fusion protein embodiments herein may be produced in accordance with any of the standard molecular biology techniques described in the literature. See, for example, Ausubel et al. (2002) Short Protocols in Molecular Biology: A Compendium of Methods from Current Protocols in Molecular Biology, 5th Ed. John Wiley & Sons. Manufacturing methods including purification methods that may be used are also disclosed in U.S. Pat. No. 7,968,512, the entirety of which is incorporated herein by reference.

[0084] "Expression vectors" or "plasmids" (used interchangeably herein) may be used for producing conjugates or components thereof to introduce heterologous DNA into host cells, either for expression or replication. Selection by the artisan of the appropriate vector will depend on its intended use, i.e. (DNA amplification or DNA expression), the size of the DNA to be inserted into the vector, and the host cell to be transformed with the vector. Each vector contains various components depending on its intended use, which comprise one or more of: an origin of replication, one or more marker genes, an enhancer element, a promoter, a transcription termination sequence and a signal sequence.

[0085] Sources of nucleic acid may be ascertained by reference to published literature or databanks provided by organizations such as NCBI or EMBL. Identification of sequences of interest may be accomplished by using BLAST, BLAT, or other homology search algorithms. Further, nucleic acid encoding the desired first or second region may be obtained from academic or commercial sources where such sources are willing to provide the material or by synthesizing or cloning the appropriate sequence where only the sequence data are available. Generally, this may be done by reference to literature sources which describe the cloning of the gene in question. Alternatively, where limited sequence data are available or where it is desired to express a nucleic acid homologous or otherwise related to a known nucleic acid, exemplary nucleic acids can be characterized as those nucleotide sequences which hybridize to the nucleic acid sequences known in the art.

[0086] The phrase “stringency of hybridization” refers to conditions under which polynucleic acids hybrids are stable. Such conditions are evident to those of ordinary skill in the art. Also as understood by persons skilled in the art, the stability of hybrids is reflected in the melting temperature (T_m) of the hybrid which decreases approximately 1 to 1.5[deg.] C. with every 1% decrease in sequence homology. In general, the stability of a hybrid is a function of sodium ion concentration and temperature. The hybridization reaction typically is performed under conditions of higher stringency, followed by washes of varying stringency.

[0087] As used herein, the phrase “high stringency” refers to conditions that permit hybridization of only those nucleic acid sequences that form stable hybrids in 1 M Na⁺ at 65-68[deg.] C. High stringency conditions can be provided, for example, by hybridization in an aqueous solution containing 6*SSC, 5* Denhardt's, 1% SDS (sodium dodecyl sulphate), 0.1 Na⁺ pyrophosphate and 0.1 mg/ml denatured salmon sperm DNA as nonspecific competitor. Following hybridization, high stringency washing may be done in several steps, with a final wash (about 30 minutes) at the hybridization temperature in 0.2-0.1*SSC, 0.1% SDS.

[0088] The phrase “moderate stringency” refers to conditions equivalent to hybridization in the above described solution, except that the temperature is at about 60-62[deg.] C. In that case the final wash is performed at the hybridization temperature in 1*SSC, 0.1% SDS.

[0089] Low stringency refers to conditions equivalent to hybridization in the above described solution at about 50-52[deg.] C. In that case, the final wash is performed at the hybridization temperature in 2*SSC, 0.1% SDS.

[0090] It is understood that these conditions may be adapted and duplicated using a variety of buffers, e.g., formamide-based buffers, and temperatures. Denhardt's solution and SSC are well known to those of skill in the art as are other suitable hybridization buffers (see, e.g. Sambrook, et al., eds. (1989) Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press, New York or Ausubel, et al., eds. (1990) Current Protocols in Molecular Biology, John Wiley & Sons, Inc.). Optimal hybridization conditions must be determined empirically, as the length and the GC content of the probe also play a role.

[0091] In one embodiment, the conjugate or fusion protein may be produced through use of an expression vector comprising the nucleic acid sequence and a promoter for recombinant synthesis in, for example, plant cells (including algae), in bacteria such as *E. coli*, or in eukaryotic cells such as Chinese Hamster Ovary (CHO) cells or yeast cells.

[0092] In another embodiment, a host cell is transformed with the expression vector.

[0093] In yet another embodiment a nucleic acid sequence encodes the conjugate or fusion protein for the purposes of synthesis and manufacture by recombinant technology.

[0094] In some embodiments, the conjugate or fusion protein is non-denatured, meaning it may exist in its native state, the form in which the protein occurs in the intact cell in its three-dimensional structure.

[0095] The term “non-denatured” may also, but need not, imply a specific non-denaturing step. Denaturing alters the three-dimensional shape of the protein molecule without rupture of its peptide bonds; disulfide bonds may be ruptured, or certain groups in the protein may be chemically modified if such processes are also accompanied by changes in its overall three-dimensional structure.

[0096] In other embodiments, the conjugate or fusion protein is renatured, a process by which the denatured protein is returned to its original conformation prior to denaturation. For peptides, reversible denaturation is generally brought about by disulfide reducing agents and urea, and for nucleic acid, by heat and salts.

[0097] In one embodiment, the first region is at the N-terminus of the second region. In another embodiment the first region is at the C-terminus of the second region.

[0098] Purification methods known in the art may be used in the process of preparing conjugates and fusion proteins according to the embodiments disclosed, for example, as described in Zachariou, M. (2010) Affinity Chromatography: Methods and Protocols, 2nd Ed. Totoua, NJ:Humana Press. The conjugate or fusion protein can be obtained from bacterial or eukaryotic cell lysates, as denaturing reagents, small changes in pH, and differences in osmolarity may have an effect on the

translocation properties of the peptides. Conditions for obtaining and purifying the human homeodomain peptides, including HOX-derived peptides are disclosed herein.

[0099] The ability of HOX peptide-conjugates to translocate across the cell surface membrane may be dependent on the conformation of the recombinant proteins. For example, translocation of the polypeptide by using either bacteria cell extracts or purified proteins exposed to small amounts of detergent (ionic and non-ionic) or denaturing agents (urea or guanidinium) may prevent or inhibit translocation. This conformation-dependent property may be preserved by purifying the HOX peptide-conjugate or other human homeodomain conjugate under native conditions.

[00100] In one embodiment, both the first (the human homeodomain or variant or portion thereof) and second (biologically active peptide or protein) regions are purified from a bacterial lysate. In other embodiments, the conjugate or fusion protein is purified from a plant cell lysate. In yet another embodiment, the conjugate or fusion protein is purified from an eukaryotic cell lysate, culture medium or fermentation broth.

[00101] One embodiment is a method for preparing a conjugate or fusion protein, comprising:

(a) culturing the host cell under conditions which provide for the expression of the conjugate from the expression vector within the host cell; and

(b) recovering the conjugate, which recovery comprises

(i) fusing an amino acid tail or other specific ligand to the conjugate, which tail is capable of binding to at least one substrate and not to another substrate, and wherein the conjugate or fusion protein is caused to bind via the tail to at least one substrate, and wherein components of the host cell do not bind to this substrate, and

(ii) putting into contact the conjugate and remaining components of the host cell with the other substrate such that the conjugate is not bound and the remaining components of the host cell are bound to the other substrate.

[00102] Another embodiment is a method for preparing a conjugate or fusion protein comprising:

(i) culturing a host cell, transformed with an expression vector comprising nucleic acid, operably linked to a promoter, encoding a fusion protein where

(a) a first region comprises the HOX peptide or other human homeodomain peptide; and

(b) a second region not naturally associated with the first region comprises a peptide or protein, under conditions which provide for expression of the fusion protein from the expression vector within the host cell; and

(ii) recovering the fusion protein, which method comprises fusing an amino acid tail or other ligand to the conjugate, which tail is capable of binding to at least one substrate and not to another substrate, and wherein the conjugate is caused to bind via the tail to at least one substrate such that components of the host cell do not bind to this substrate; and the conjugate is contacted with the other substrate such that the conjugate is not bound and remaining components of the host cell are bound to the other substrate.

[00103] In another embodiment as part of the affinity purification process, the embodiments include the use of a tail or ligand that is attached to the conjugate or fusion protein; this allows for both positive and negative purification steps.

[00104] For all combined first and second region sequences, additional amino acid sequences can be added to either the amino or carboxy termini in order to facilitate purification. Such sequences may include FLAG-tags (DYKDDDDK), myc-tags (EQKLISEEDL), His-tags (such as HHHHHH, HHHHHHGS, the latter utilizing a GS linker, see FIGs. 4 and 5), and other similar tags known to those in the art. In addition, ligands such as the biotin-acceptor protein (GLNDIFEAQKIEWHE) together with the active BirA protein may be used. For sequences that include an N-terminal initiating methionine, if a N-terminal purification domain is added the methionine will be on the N-terminal of the purification domain instead of at the N-terminal of the human homeodomain peptide first region. For any tag, a peptide linker known in the art may be used and removed after purification with a specific protease.

[00105] In one embodiment, the amino acid tail or ligand is fused to the C-terminus of the conjugate. For example, FIG. 4 shows an embodiment comprising a biologically-active cargo peptide (2), linked on its C-terminus (6) through either a peptide bond (13) or a linker sequence known in the art (12) to the N-terminus (3) of the human homeodomain “first region” shown abbreviated here (1). A GS linker (14) is shown attaching a His-tag (“tail”) to the C-terminus (6) of the cargo peptide (2). Any linker may be used provided it does not compromise the function of the conjugate.

[00106] In one embodiment, the immobilized substrate is a nickel or cobalt column, avidin column, or an antibody column with affinity for the amino acid tail. In another embodiment, the conjugate’s amino acid tail is serially brought into contact with at least two immobilized substrates with which the tail has affinity, in which case the nickel or cobalt column and/or avidin and/or antibody may be used in any order.

[00107] In another embodiment, the method of purifying a conjugate comprises fusing an amino acid tail or ligand to the conjugate or fusion protein, which tail is capable of binding to at least one substrate while impurities bind only to a second substrate; the conjugate is contacted with the other substrate such that the conjugate is not bound and remaining impurities are bound to the other substrate.

[00108] According to another embodiment, a method for producing and purifying a conjugate or fusion protein comprising the 60-amino acid human homeodomain or variant or portion thereof and a biologically-active peptide or protein comprises culturing the host cell for the expression of the conjugate or fusion protein from the expression vector and subsequently recovering the conjugate or fusion protein using affinity purification techniques known in the art.

[00109] When the second region is a DNA binding domain, a complex with nucleic acid may be formed by mixing the conjugate formed with the nucleic acid.

[00110] Further embodiments include pharmaceutical compositions comprising the conjugates or fusion proteins of the embodiments disclosed herein, and methods of use of the conjugates or fusion proteins in the preparation of a medicament for the treatment of a disease.

[00111] In one embodiment, a conjugate or fusion protein comprises a biologically active peptide or protein that is a functional enzyme, linked to the human homeodomain or variant or portion thereof.

[00112] Other embodiments comprise any of a variety of formulations for treating conditions or diseases identified.

[00113] **Upstream Production of SEQ ID No. 21 and SEQ ID No. 22.** A bacterial expression construct was generated for two homeobox candidate proteins PPL-002 (SEQ ID No. 21, Table 3) and PPL-003 (SEQ ID No. 22, Table 3) capable of regulated expression of the target protein with a TEV cleavable N-terminal His tag in the T7 vector system. The T7 expression system is suitable for producing material for animal efficacy studies; however, other expression vectors/system are also contemplated and are known by one of ordinary skill in the molecular biology/biotechnology art.

[00114] Synthetically-created, codon-optimized gene sequences were cloned into the vector for inducible expression of the selected protein with kanamycin selection. The DNA and corresponding amino acid sequences for homeobox proteins PPL-002 (e.g., plasmid pJ411:129925) and PPL-003 (e.g., pJ411:129926) are shown in FIG. 6 and FIG. 7, respectively. Each expressed protein contains a 6 HIS leader, with a transition sequence of SAA, followed by the TEV cleavage site (ENLYFQS) to produce the PPL-002 or PPL-003 sequence with the appropriate N terminus.

[00115] Upon transformation into DH5 α , six clones for each construct were tested for presence of the insert by restriction digest. The synthesized DNA sequence was sequenced for confirmation. Verified expression constructs for each protein were used to transform bacterial strain E. coli BL21 (DE3), a commercially available strain from Invitrogen (www.lifetechnologies.com/us/en/home/brands/invitrogen), and a PD glycerol cell stock was prepared for each best expressing clone.

[00116] Preliminary expression optimization studies were performed in shake flask cultures. Upon moving to small scale fermenters, further optimization of cell growth was performed. Early oxygen supplementation and a pH set point of about 7.1 were shown to be optimal. Induction temperature was optimized at about 18 °C.

[00117] Composition embodiments disclosed herein may comprise a pharmaceutically acceptable carrier, diluent or excipient. The term "pharmaceutically

acceptable carrier diluent or excipient" refers to any substance, not itself a therapeutic agent, used as a carrier or vehicle for delivery of a therapeutic agent to a subject or added to a pharmaceutical composition to improve its handling or storage properties or to permit or facilitate formation of a unit dose of the composition, and that does not produce unacceptable toxicity or interaction with other components in the composition.

[00118] The choice of pharmaceutically acceptable carrier, excipient or diluent may be selected based on the formulation and the intended route of administration, as well as standard pharmaceutical practice. Such compositions may comprise any agents that may aid, regulate, release or increase entry into the body compartment, tissue, intracellular or intranuclear target site, such as binder(s), lubricant(s), suspending agent(s), coating agent(s), solubilizing agent(s), or other agents. An injectable implant for the sustained release of the protein may also be used to obtain prolonged exposure and action. The term "sustained release" refers to formulations from which the conjugate is released at a slow rate allowing for a longer period of exposure at active concentrations.

[00119] The compositions comprising one or more conjugates or fusion proteins disclosed herein can be administered, depending on condition to be treated or other considerations, in any number of ways, for example without limitation, by any one or more of the following: (1) inhalation; (2) in the form of a suppository or pessary; (3) in the form of a topical lotion, solution, cream, ointment or dusting powder; (4) by use of a skin patch; (5) orally in the form of tablets containing excipients such as starch or lactose, or in capsules or ovules either alone or in admixture with excipients, or in the form of elixirs, solutions or suspensions containing flavoring or coloring agents; (6) injected parenterally, for example intracavernosally, intravenously, intramuscularly or subcutaneously; (7) for ophthalmic diseases, they may be formulated as eye drops or for intraocular injection; (8) for parenteral administration, they may be in the form of a sterile aqueous solution or injectable implant which may contain other substances, for example, with adequate salt or monosaccharide content to make the solution isotonic with blood or substances that allow slow release; and (9) for buccal or sublingual administration the compositions may be administered in the form of tablets or lozenges which can be formulated in a conventional manner.

[00120] In one embodiment, the conjugate comprises:

a first region comprising a structure derived from (1) the human HOX genes, or (2) other human genes having a sequence described in any of SEQ ID Nos. 1 - 19, wherein 1 - 20, 1 - 15, or 1 - 10 amino acid residues are substituted, deleted, added, and/or inserted; and

a second region is a functional or regulatory polypeptide or protein not naturally associated with the first region. In various embodiments, the second region is selected from the group consisting of NBD peptide, PC1 CTT-derived p200, PC1 CTT-derived p21, glucocerebrosidase, alpha-L-iduronidase, iduronidate-2-sulfatase, retinal membrane guanylyl cyclase, the zinc finger peptide construct, ZF6xHunt-Kox-1, the zinc finger peptide construct, ZF12xHunt-Kox-1, and the zinc finger peptide construct, ZF18xHunt-Kox-1.

[00121] In one embodiment, the conjugate comprises:

a first region comprising a structure derived from (1) the human HOX genes, or (2) other human genes having a sequence described in any of SEQ ID Nos. 1 - 19, wherein 1 - 20, 1 - 15, or 1 - 10 amino acid residues are substituted, deleted, added, and/or inserted and wherein said amino acid has (i) has human homeodomain activity; and (ii) maintains the cell permeabilizing activity of the helical regions of the human HOX genes or other human genes containing a homeodomain with cell permeabilizing properties; and

a second region is a functional or regulatory polypeptide or protein not naturally associated with the first region. In various embodiments the second region is selected from the group consisting of NBD peptide, PC1 CTT-derived p200, PC1 CTT-derived p21, glucocerebrosidase, alpha-L-iduronidase, iduronidate-2-sulfatase, retinal membrane guanylyl cyclase, the zinc finger peptide construct, ZF6xHunt-Kox-1, the zinc finger peptide construct, ZF12xHunt-Kox-1, and the zinc finger peptide construct, ZF18xHunt-Kox-1.

[00122] In one embodiment, the active concentration of fusion protein or conjugate in cell culture is less than about 115 μ M, less than about 100 μ M, less than about 90 μ M, less than about 80 μ M, less than about 70 μ M, less than about 65 μ M, less than about 60 μ M, less than about 55 μ M, less than about 50 μ M, less than about 45 μ M, less than about 40 μ M, less than about 35 μ M, less than about 30 μ M, less than about 25 μ M, less than about 20 μ M, less than about 15 μ M, less than

about 10 μM , less than about 5 μM , or less than about 1 μM for example, less than about 1 μM to about 3 μM , less than about 1 μM to about 6 μM , less than about 1 μM to about 8 μM , less than about 1 μM to about 15 μM , less than about 1 μM to about 25 μM , less than about 1 μM to about 50 μM , less than about 1 μM to about 70 μM , less than about 1 μM to about 85 μM , less than about 1 μM to about 110 μM , less than about 10 μM to about 110 μM , less than about 15 μM to about 70 μM , less than about 15 μM to about 60 μM , less than about 20 μM to about 55 μM , or less than about 25 μM to about 45 μM .

[00123] In other embodiments, the dosage delivered (daily or as required) in mouse models (per 20 g mouse) through (1) an intravenous (i.v.) or intraperitoneal (i.p.) injection, (2) a topical formulation, or (3) an inhaled formulation is at least 500 μg , at least 450 μg , at least 400 μg , at least 350 μg , at least 300 μg , at least 250 μg , at least 200 μg , at least 150 μg , at least 100 μg , at least 80 μg , at least 70 μg , at least 60 μg , at least 50 μg , at least 40 μg , at least 30 μg , at least 20 μg , at least 10 μg , or at least 1 μg , for example, about 1 μg to about 500 μg , about 10 μg to about 450 μg , about 20 μg to about 400 μg , about 30 μg to about 350 μg , about 30 μg to about 200 μg , about 30 μg to about 100 μg , about 40 μg to about 300 μg , about 40 μg to about 200 μg , about 50 μg to about 100 μg , about 50 μg to about 90 μg , about 55 μg to about 85 μg , about 60 μg to about 80 μg , about 60 μg to about 100 μg ; about 1 μg to about 200 μg ; about 1 μg to about 100 μg , about 1 μg to about 90 μg , about 1 μg to about 80 μg , about 1 μg to about 70 μg , about 1 to about 60 μg , about 1 to about 50 μg , about 1 to about 40 μg , about 1 to about 30 μg , about 1 to about 20 μg , about 1 to about 15 μg , about 1 to about 12 μg , about 1 to about 10 μg , about 1 to about 8 μg , about 1 to about 6 μg , about 1 to about 4 μg , or about 1 to about 3 μg .

[00124] In other embodiments, the dosage delivered (daily or as required) through an intravenous (i.v.) or intraperitoneal (i.p.) injection in a mouse model is at least 100 mg/kg, less than about 80 mg/kg, less than about 45 mg/kg, less than about 40 mg/kg, less than about 30 mg/kg, less than about 25 mg/kg, less than about 20 mg/kg, less than about 15 mg/kg, less than about 12 mg/kg, less than about 10 mg/kg, less than about 8 mg/kg, less than about 4 mg/kg, less than about 2 mg/kg, or less than about 1 mg/kg, for example, less than about 1 mg/kg to about 50 mg/kg, about 5 mg/kg to about 40 mg/kg, about 8 mg/kg to about 30 mg/kg, about 10 mg/kg to about 20 mg/kg, or about 12 mg/kg to about 15 mg/kg, about 8 mg/kg to about 12

mg/kg, about 5 mg/kg to about 9 mg/kg, about 3 mg/kg to about 6 mg/kg, about 2 mg/kg to about 5 mg/kg, about 2 mg/kg to about 4 mg/kg, about 1 mg/kg to about 3 mg/kg, about 1 mg/kg to about 2.0 mg/kg.

[00125] In other embodiments, the dosage delivered (daily or as required) through an inhaled formulation in humans (70 kg weight) is at least about 600 mg, at least about 500 mg, at least about 450 mg, at least about 400 mg, at least about 350 mg, at least about 300 mg, at least about 250 mg, at least about 200 mg, at least about 150 mg, at least about 125 mg, at least about 100 mg, at least about 75 mg, at least about 50 mg, at least about 25 mg, at least about 20 mg, at least about 15 mg, at least about 10 mg, at least about 5 mg, at least about 1 mg, at least about 500 µg, at least about 450 µg, at least about 400 µg, at least about 350 µg, at least about 300 µg, at least about 250 µg, at least about 200 µg, at least about 150 µg, at least about 100 µg, at least about 80 µg, at least about 70 µg, at least about 60 µg, at least about 50 µg, at least about 40 µg, at least about 30 µg, at least about 20 µg, at least about 10 µg, or at least about 1 µg, for example, between about 1 µg to about 750 µg; about 1 µg to about 500 µg, about 10 µg to about 450 µg, about 20 µg to about 400 µg about 30 µg to about 350 µg, about 30 µg to about 200 µg, about 30 µg to about 100 µg, about 40 µg to about 300 µg, about 40 µg to about 200 µg, about 50 µg to about 100 µg, about 50 µg to about 90 µg, about 55 µg to about 85 µg, about 60 µg to about 80 µg, about 60 µg to about 100 µg; about 1 µg to about 200 µg; about 1 µg to about 100 µg, about 1 µg to about 90 µg, about 1 µg to about 80 µg, about 1 µg to about 70 µg, about 1 to about 60 µg, about 1 to about 50 µg, about 1 to about 40 µg, about 1 to about 30 µg, about 1 to about 20 µg, about 1 to about 15 µg, about 1 to about 12 µg, about 1 to about 10 µg, about 1 to about 8 µg about 1 to about 6 µg, about 1 to about 4 µg, about 1 µg to about 3 µg, about 1 µg to about 1 mg, about 1 µg to about 2 mg, about 1 µg to about 5 mg; about 1 µg to about 10 mg; about 1 mg to about 10 mg, about 1 mg to about 15 mg; about 2 mg to about 20 mg, about 3 mg to about 30 mg, about 4 mg to about 40 mg, about 5 mg to about 50 mg, about 5 mg to about 80 mg, about 5 mg to about 110 mg, about 10 mg to about 150 mg, about 10 mg to about 80 mg, about 20 mg to about 70 mg, about 20 mg to about 60 mg, about 30 mg to about 60 mg, about 120 mg to about 190 mg, about 130 mg to about 180 mg, about 130 mg to about 200 mg, about 140 mg to about 250 mg, about 180 mg to about 300 mg, about 190 mg to about 350 mg, about 220 mg to

about 400 mg, about 250 mg to about 425 mg, about 280 mg to about 460 mg, about 300 mg to about 480 mg, about 350 mg to about 490 mg, about 380 mg to about 550 mg, about 400 mg to about 580 mg, about 480 mg to about 590 mg, or about 520 mg to about 600 mg.

[00126] In other embodiments, the dosage delivered (daily or as required) through topical formulation in humans and in mouse models is less than about 5% wt/vol, less than about 4.5% wt/vol, less than about 3.5% wt/vol, less than about 2.5% wt/vol, less than about 1.5% wt/vol, less than about 0.5% wt/vol, less than about 0.4% wt/vol, less than about 0.3% wt/vol, less than about 0.2%, less than about 0.1% wt/vol, less than about 0.09% wt/vol, less than about 0.08% wt/vol, less than about 0.07% wt/vol, less than about 0.06% wt/vol, less than about 0.05% wt/vol, less than about 0.04% wt/vol, less than about 0.03% wt/vol, less than about 0.02% wt/vol, less than about 0.01% wt/vol, less than about 0.008% wt/vol, less than about 0.006% wt/vol, less than about 0.004% wt/vol, or less than about 0.002% wt/vol, for example between about 0.002% wt/vol and about 5% wt/vol, about 0.01% wt/vol and about 4% wt/vol, about 0.05% wt/vol and about 3% wt/vol, about 0.02% wt/vol and about 2.5% wt/vol, about 0.03% wt/vol and about 2% wt/vol, about 0.05% wt/vol and about 1% wt/vol, about 0.06% wt/vol and about 0.9% wt/vol, about 0.07% wt/vol and about 0.6% wt/vol, about 0.08% wt/vol and about 0.4% wt/vol, about 0.09% wt/vol and about 0.2% wt/vol or about 0.09 wt/vol and about 0.1% wt/vol.

[00127] In other embodiments the dosage delivered (daily or as required) through a topical formulation in humans (70 kg weight) is less than about 70 µg, less than about 50 µg, less than about 45 µg, less than about 40 µg, less than about 30 µg, less than about 25 µg, less than about 20 µg, less than about 15 µg, less than about 12 µg, less than about 10 µg, less than about 8 µg, less than about 4 µg, less than about 2 µg, or less than about 1 µg, for example, about 1 µg to about 50 µg, about 5 µg to about 40 µg, about 8 µg to about 30 µg, about 10 µg to about 20 µg, or about 12 µg to about 15 µg, about 8 µg to about 12 µg, about 5 µg to about 9, about 3 µg to about 6 µg, about 2 µg to about 5 µg, or less than about 1 µg to about 3 µg.

[00128] In another embodiment, the systemic dosage delivered (daily or as required) through an intravenous, subcutaneous or intramuscular injection or an injectable implant for sustained release formulations in humans is less than about 100 mg/kg, less than about 80 mg/kg, less than about 45 mg/kg, less than about 40

mg/kg, less than about 30 mg/kg, less than about 25 mg/kg, less than about 20 mg/kg, less than about 15 mg/kg, less than about 12 mg/kg, less than about 10 mg/kg, less than about 8 mg/kg, less than about 4 mg/kg, less than about 2 mg/kg, less than about 1 mg/kg, less than about 0.1 mg/kg, or less than about 0.01 mg/kg, for example, less than about 0.01 mg/kg to about 50 mg/kg, less than about 5 mg/kg to about 40 mg/kg, less than about 8 mg/kg to about 30 mg/kg, less than about 10 mg/kg to about 20 mg/kg, or less than about 12 mg/kg to about 15 mg/kg, less than about 8 mg/kg to about 12 mg/kg, less than about 5 mg/kg to about 9 mg/kg, less than about 3 mg/kg to about 6 mg/kg, less than about 2 mg/kg to about 5 mg/kg, less than about 2 mg/kg to about 4 mg/kg, less than about 1 mg/kg to about 3 mg/kg, less than about 0.2 mg/kg to about 2.0 mg/kg, less than about 0.1 mg/kg to about 1.5 mg/kg, or less than about 0.01 mg/kg to about 2.00 mg/kg.

[00129] In other embodiments, the dosage delivered (daily or as required) to humans (based on 70 kg weight) through any formulation other than an intravenous, subcutaneous, or intramuscular injection or injectable implant for the sustained release, inhaled or topical formulation is at least about 600 mg, at least about 500 mg, at least about 450 mg, at least about 400 mg, at least about 350 mg, at least about 300 mg, at least about 250 mg, at least about 200 mg, at least about 150 mg, at least about 125 mg, at least about 100 mg, at least about 75 mg, at least about 50 mg, at least about 25 mg, at least about 20 mg, at least about 15 mg, at least about 10 mg, at least about 5 mg, at least about 1 mg, at least about 500 µg, at least about 450 µg, at least about 400 µg, at least about 350 µg, at least about 300 µg, at least about 250 µg, at least about 200 µg, at least about 150 µg, at least about 100 µg, at least about 80 µg, at least about 70 µg, at least about 60 µg, at least about 50 µg, at least about 40 µg, at least about 30 µg, at least about 20 µg, at least about 10 µg, or at least about 1 µg, for example, between about 1 µg to about 750 µg; about 1 µg to about 500 µg, about 10 µg to about 450 µg, about 20 µg to about 400 µg about 30 µg to about 350 µg, about 30 µg to about 200 µg, about 30 µg to about 100 µg, about 40 µg to about 300 µg, about 40 µg to about 200 µg, about 50 µg to about 100 µg, about 50 µg to about 90 µg, about 55 µg to about 85 µg, about 60 µg to about 80 µg, about 60 µg to about 100 µg; about 1 µg to about 200 µg; about 1 µg to about 100 µg, about 1 µg to about 90 µg, about 1 µg to about 80 µg, about 1 µg to about 70 µg, about 1 to about 60 µg, about 1 to about 50 µg, about 1 to about 40 µg, about

1 to about 30 μ g, about 1 to about 20 μ g, about 1 to about 15 μ g, about 1 to about 12 μ g, about 1 to about 10 μ g, about 1 to about 8 μ g about 1 to about 6 μ g, about 1 to about 4 μ g, about 1 μ g to about 3 μ g, about 1 μ g to about 1 mg, about 1 μ g to about 2 mg, about 1 μ g to about 5 mg; about 1 μ g to about 10 mg; about 1 mg to about 10 mg, about 1 mg to about 15 mg; about 2 mg to about 20 mg, about 3 mg to about 30 mg, about 4 mg to about 40 mg, about 5 mg to about 50 mg, about 5 mg to about 80 mg, about 5 mg to about 110 mg, about 10 mg to about 150 mg, about 10 mg to about 80 mg, about 20 mg to about 70 mg, about 20 mg to about 60 mg, about 30 mg to about 60 mg, about 120 mg to about 190 mg, about 130 mg to about 180 mg, about 130 mg to about 200 mg, about 140 mg to about 250 mg, about 180 mg to about 300 mg, about 190 mg to about 350 mg, about 220 mg to about 400 mg, about 250 mg to about 425 mg, about 280 mg to about 460 mg, about 300 mg to about 480 mg, about 350 mg to about 490 mg, about 380 mg to about 550 mg, about 400 mg to about 580 mg, about 480 mg to about 590 mg, or about 520 mg to about 600 mg.

[00130] In one embodiment, the formulation is administered systemically or locally (e.g. intraocular injection, enema formulation, inhalation) at intervals of 6 hours, 12 hours, daily or every other day or on a weekly or monthly basis to elicit the desired benefit or otherwise provide a therapeutic effect. In another embodiment, the formulation is administered as required to elicit the desired benefit or otherwise provide a therapeutic effect.

[00131] In another embodiment, the improvement in post-myocardial infarction (MI) cardiac output will be assessed by ultrasound. In another embodiment, the improvement in post-stroke neurological function will be assessed by determining the percent of patients with a NIHSS of less than 17 one month after presentation. In another embodiment, immunogenicity of the human homeodomain or variant or portion thereof conjugates or fusion proteins will be assessed by determining the incorporation of 3H-thymidine by lymphocytes. In another embodiment, immunogenicity of the human homeodomain or variant or portion thereof conjugates or fusion proteins will be assessed by determining the level of specific antibodies produced by the recipient animal or human. In another embodiment, the extent of ischemia-reperfusion injury will be assessed using known histopathology techniques to examine the area of necrotic tissue in a stroke model. In yet another embodiment, the GAG accumulation will be assessed using known histopathology techniques. In

another embodiment behavioral and motor deficits in a mouse model of Huntington's Disease will be assessed using published methods evaluating grip strength in the forepaws and balance ability on a rotorod balance beam. In other embodiments each outcome will be assessed by known methods.

[00132] In one embodiment, upon treatment of one or more human or animal subjects with any of the fusion protein or conjugate embodiments disclosed, the subject(s) will exhibit one or more of the following outcomes:

- (a) a reduction in shortness of breath or difficulty breathing;
- (b) a reduction in cytokine production;
- (c) a reduction of TNF- α concentration in blood;
- (d) a reduction of IL-1 concentration in blood;
- (e) a reduction of IL-6 concentration in blood;
- (f) a reduction in bronchoalveolar lavage fluid (BALF) inflammatory cell numbers;
- (g) a reduction in BALF cytokine levels (e.g. TNF- α , IL-1, IL-6, IL-8);
- (h) Improvement of pulmonary function (e.g. FEV1);
- (i) Improvement in functional (including exercise) capacity;
- (j) a reduction in exacerbations of COPD requiring emergent care or hospitalization;
- (k) restoration of tear secretion towards normal levels;
- (l) a reduction in hair loss;
- (m) an increase in hair growth;
- (n) a reduction in the area of necrotic brain tissue by MRI;
- (o) a reduction in C-reactive protein (CRP);
- (p) a reduction in acute mortality (i.e., at one month);
- (q) an improvement in post-myocardial infarction (MI) cardiac output as measured by ultrasound;
- (r) an improvement in post-stroke neurological function as measured by the determining the percent of patients with a NIHSS of less than 17 one month after presentation;

- (s) an inhibition in kidney growth;
- (t) reduced allergic responses and infusion reactions to the 60-amino acid human homeodomain (or variant or portion thereof) conjugates or fusion proteins compared to previous treatments with the cargo second region alone;
- (u) reduced anti-cargo peptide specific antibody levels;
- (v) a reduction in the accumulation of a GCase substrate, glycosylceramide;
- (w) a reduction in the urinary excretion of dermatan sulfate;
- (x) a reduction in the urinary excretion of heparan sulfate;
- (y) restoration of electroretinogram (ERG) function;
- (z) restoration of visual acuity as determined through standard clinical methodology;
- (aa) normalization or improvement in motor deficits, as assessed using the Unified Huntington's Disease Rating Scale (UHDRS) Total Motor Score; and/or other clinically validated scoring methods;
- (bb) normalization of skeletal development as assessed by standard growth and development pediatric techniques;
- (cc) normalization of brain development as assessed by standard pediatric techniques;
- (dd) a reduced progression of renal cyst size and number assessed by MRI;
- (ee) an increase in the level of anti-inflammatory interleukin-10 (IL-10) in blood;
- (ff) an increase in the level of anti-inflammatory interleukin-10 (IL-10) in BALF;
- (gg) a reduction in the level of IP-10 in blood;
- (hh) a reduction in the level of IP-10 in BALF; and/or
- (ii) a reduction in amyloid A protein (SAA) in blood;
- (jj) a reduction in mouse Kc or human IL-8 in blood or BALF;
- (kk) a reduction in GM-CSF in blood or BALF;
- (ll) prevention of an increase in graded vitreous haze and/or graded anterior chamber cells;
- (mm) prevention of deterioration of visual acuity;

(nn) reduced tumor cell growth and/or reduced tumor growth;

(oo) reduced expression of DYRK1b; and/or

(pp) reduced activation of NF- κ B regulated genes.

[00133] In another embodiment, the patient will be treated over a period, for example, of about 1 day through the lifetime of the patient, over a period of about 1 day to about 200 weeks, about 1 day to about 100 weeks, about 1 day to about 80 weeks, about 1 day to about 50 weeks, about 1 day to about 40 weeks, about 1 day to about 20 weeks, about 1 day to about 15 weeks, about 1 day to about 12 weeks, about 1 day to about 10 weeks, about 1 day to about 5 weeks, about 1 week to about 4 weeks, about 2 weeks to about 3 weeks, about 1 day to about 2 weeks, about 1 week, about 1 to 5 days, about 1 to 3 days, or about 1 to 2 days.

[00134] In another embodiment comprising a fusion protein or conjugate formulation utilized in any of the proposed studies in the examples provided, in other research and treatment, including animal research for human and animal applications, and veterinary treatment, the treatment group members, or the treatment group(s) will exhibit one or more of the following outcomes, each compared to baseline or control, unless otherwise indicated:

(a) an inhibition of NF- κ B transcriptional activity;

(b) a reduction in cytokine production;

(c) an inhibition of TNF- α concentration in blood;

(d) an inhibition of IL-1 concentration in blood;

(e) an inhibition of IL-6 concentration in blood;

(f) a reduction in bronchoalveolar lavage fluid (BALF) inflammatory cell numbers;

(g) a reduction in bronchoalveolar lavage fluid (BALF) cytokine levels (e.g. TNF- α , IL-1, IL-6, IL-8);

(h) a reduction in goblet cell infiltration in the epithelial cornea;

(i) an attenuation of the loss of goblet cells in the conjunctiva;

(j) reduced lymph-angiogenesis;

(k) restoration of tear secretion towards normal levels;

- (l) a reduction in hair loss or an increase in hair growth;
- (m) a reduction in the area of necrotic brain tissue as assessed with MRI;
- (n) a reduction in C-reactive protein (CRP);
- (o) a reduction in acute mortality (i.e., at one month);
- (p) an improvement in post-myocardial infarction (MI) cardiac output as measured by ultrasound;
- (q) an improvement in post-stroke neurological function as measured by the percent of patients with a NIHSS of less than 17 one month after presentation;
- (r) an inhibition in kidney growth;
- (s) an attenuated change in concentration of osteocalcin in blood, as compared to the change elicited by treatment with the human homeodomain-p200 fusion protein or conjugate, e.g. HOX C12-p200 or HOX D12-p200;
- (t) reduced allergic responses and infusion reactions to the 60-amino acid human homeodomain (or variant or portion thereof) conjugates or fusion proteins, as assessed through incorporation of 3H-thymidine by lymphocytes;
- (u) a reduction in anti-cargo peptide specific antibody levels
- (v) a reduction in the accumulation of a GCase substrate, glycosylceramide;
- (w) a reduction in the accumulation of α -synuclein/ubiquitin aggregates in the brain;
- (x) a reduction in the urinary excretion of dermatan sulfate;
- (y) a reduction in the urinary excretion of heparan sulfate;
- (z) a reduction in dermatan sulfate as determined through histopathology;
- (aa) a reduction in heparan sulfate as determined through histopathology;
- (bb) restoration of electroretinogram (ERG) function;
- (cc) restoration of visual acuity as determined through standard clinical methodology;
- (dd) a reduction or repression of the mutant Huntingtin gene expression in the HD murine model;
- (ee) normalization or improvement in motor deficits in patients, as assessed using the Unified Huntington's Disease Rating Scale (UHDRS) Total Motor Score;

- (ff) normalization or improvement in motor deficits in mice as assessed using published methods evaluating grip strength in the forepaws and balance ability on a rotorod balance beam;
- (gg) a reduction in neuronal loss and/or reduced striatal cell volume as assessed by molecular methods and histological analysis in the HD murine model;
- (hh) an increase in the level of anti-inflammatory interleukin-10 (IL-10) in blood;
- (ii) an increase in the level of anti-inflammatory interleukin-10 (IL-10) in BALF;
- (jj) a reduction in the level of IP-10 in blood;
- (kk) a reduction in the level of IP-10 in BALF;
- (ll) a reduction in serum amyloid A protein (SAA) in blood;
- (mm) a reduction in or human IL-8 in blood or BALF;
- (nn) a reduction in GM-CSF in blood or BALF;
- (oo) prevention of an increase in graded vitreous haze and/or graded anterior chamber cells;
- (pp) prevention of deterioration of visual acuity;
- (qq) reduced tumor cell growth and/or reduced tumor growth;
- (rr) reduced expression of DYRK1b; and/or
- (ss) reduced activation of NF- κ B regulated genes.

[00135] In another embodiment, the treatment with a formulation comprising a fusion protein and/or conjugate embodiment disclosed in clinical studies will extend over a period, for example, of about 1 day to about 52 weeks, about 1 day to about 26 weeks, about 1 day to about 16 weeks, about 1 day to about 12 weeks, about 1 day to about 10 weeks, about 1 day to about 5 weeks, about 1 week to about 4 weeks, about 2 weeks to about 3 weeks, about 1 day to about 2 weeks, about 1 week, about 1 to 6 days, about 1 to 4 days, or about 1 to 2 days.

[00136] In another embodiment, upon treatment with a formulation comprising a fusion protein and/or conjugate embodiments disclosed, the (1) patient(s) or (2) treatment group(s) as disclosed in the studies in the examples, including

experimental animals such as mice in animal models, exhibit one or more of the following outcomes compared to controls:

(a) an inhibition in NF- κ B transcriptional activity of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(b) a reduction in cytokine production and/or concentration in blood and/or BALF of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(c) a reduction of TNF- α concentration in blood and/or BALF of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(d) a reduction of IL-1 concentration in blood and/or BALF of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least

about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(e) a reduction of IL-6 concentration in blood and/or BALF of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(f) a reduction in bronchoalveolar lavage fluid (BALF) inflammatory cell numbers of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(g) a reduction in bronchoalveolar lavage fluid (BALF) cytokines (e.g., TNF- α , IL-1, IL-6, IL-8) of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or

about 10% to about 80% (actual % change or median % change compared to baseline or control);

(h) a reduction in goblet cell infiltration in the epithelial cornea of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(i) an attenuation of the loss of goblet cells in the conjunctiva of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(j) reduced lymph-angiogenesis of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(k) restoration of tear secretion towards normal levels as measured by the Schirmer test, with an increase in Schirmer wetting of more than 20 mm, more than 15 mm, more than 10 mm, more than 5 mm, for example between 5 mm and 20 mm, 10 mm

and 20 mm, 5 mm and 15 mm, 5mm and 10 mm or 15 mm to 20 mm (actual % change or median % change compared to baseline or control);

(l) a reduction in hair loss or an increase in hair growth of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(m) a reduction in the area of necrotic brain tissue of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(n) a reduction in serum C-reactive protein (CRP) of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(o) a reduction in acute mortality (i.e., at one month) of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least

about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(p) an improvement in post-myocardial infarction (MI) cardiac output, as measured by ultrasound, of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control)

(q) an improvement in post-stroke neurological function as measured by the percent of patients with a NIHSS of less than 17, one month after presentation, of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(r) an inhibition in kidney growth of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about

5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(s) an attenuated change in concentration of osteocalcin using the HOX C12-p21, HOX D12-p21, or other p21-containing fusion protein or conjugate in blood comprising a human homeodomain with cell membrane permeabilizing properties of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to the change elicited by treatment with, e.g., the HOX C12-p200 fusion protein or conjugate or other p200-containing fusion protein or conjugate comprising a human homeodomain with cell membrane permeabilizing properties);

(t) reduced allergic responses and infusion reactions of the 60-amino acid human homeodomain (or variant or portion thereof) conjugates or fusion proteins compared to their cargo proteins alone, as assessed through incorporation of 3H-thymidine by lymphocytes of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change from baseline or control);

(u) a reduction in anti-cargo peptide specific antibody levels after treatment with 60-amino acid human homeodomain (or variant or portion thereof) conjugates or fusion proteins compared to treatment with their cargo proteins alone, of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about

35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change from baseline or control);

(v) reduction in the accumulation of a GCase substrate, glycosylceramide of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(w) reduction in the accumulation of α -synuclein/ubiquitin aggregates in the brain of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(x) reduction in the urinary excretion of dermatan sulfate of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(y) reduction in the urinary excretion of heparan sulfate of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(z) reduction in dermatan sulfate as determined through histopathology of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(aa) reduction in heparan sulfate as determined through histopathology of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(bb) the restoration of electroretinogram (ERG) function of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40%

to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(cc) the restoration of visual acuity as determined through standard clinical methodology of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(dd) a reduction or repression of the mutant Huntingtin gene expression in the HD murine model of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(ee) normalization or improvement in motor deficits in patients, as assessed using the Unified Huntington's Disease Rating Scale (UHDRS) Total Motor Score by an absolute amount of at least about 4 points, at least about 3 points, at least about 2 points, at least about 1.5 points, at least about 1 point, at least about 0.5 point, at least about 0.4 point, at least about 0.3 point, or at least about 0.2 point, for example about 0.5 to about 2 points, about 1 to about 2 points, or about 1.5 to about 2.5 points, and/or an improvement in total motor score of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least

about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, about 10% to about 80%, about 10% to about 30%, about 10% to about 20%, about 20% to about 40%, about 30% to about 50% (compared to baseline and untreated control groups);

(ff) normalization or improvement in motor deficits in mice as assessed using published methods evaluating grip strength in the forepaws and balance ability on a rotorod balance beam of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, about 10% to about 80%, about 10% to about 30%, about 10% to about 20%, about 20% to about 40%, about 30% to about 50% (compared to baseline and untreated control groups);

(gg) a reduction in neuronal loss and/or reduced striatal cell volume as assessed by molecular methods and histological analysis in the HD murine model of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(hh) an increase in IL-10 in plasma (blood) and/or BALF of at least about 3,000%, at least about 2,000%, at least about 1,000%, at least about 500%, at least about 380%, at least about 360%, at least about 340%, at least about 320%, at least about 300%, at least about 280%, at least about 260%, at least about 240%, at least about 220%, at least about 200%, at least about 180%, at least about 160%, at least about

140%, at least about 120%, at least about 110%, at least about 100%, at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 400% to about 500%, about 450% to about 500%, about 420% to about 480%, about 300% to about 450%, about 350% to about 430%, about 320% to about 380%, about 200% to about 350%, about 250% to about 330%, about 220% to about 280%, about 100% to about 250%, about 150% to about 230%, about 120% to about 180%, about 50% to about 150%, about 60% to about 130%, about 80% to about 110%, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(ii) an increase in IL-10 in blood or BALF to least about 300 pg/mL, to at least about 400 pg/mL, to least about 500 pg/mL, to least about 600 pg/mL, to least about 800 pg/mL, to least about 1000 pg/mL, to least about 1200 pg/mL, to least about 1400 pg/mL, to least about 1600 pg/mL, to least about 1800 pg/mL, to least about 2000 pg/mL, to least about 2200 pg/mL, to least about 2400 pg/mL, to least about 2600 pg/mL, to least about 2800 pg/mL, to least about 3000 pg/mL, to at least about 4000 pg/mL, for example, about 300 pg/mL to about 3900 pg/mL, about 380 pg/mL to about 2900 pg/mL, about 400 pg/mL to about 2800 pg/mL, about 450 pg/mL to about 2500 pg/mL, about 500 pg/mL to about 2400 pg/mL, about 800 pg/mL to about 3000 pg/mL, about 900 pg/mL to about 2900 pg/mL, about 1200 pg/mL to about 2900 pg/mL, about 1400 pg/mL to about 2900 pg/mL, about 1800 pg/mL to about 2900 pg/mL, about 2000 pg/mL to about 2900 pg/mL, about 2200 pg/mL to about 2900 pg/mL, about 2200 pg/mL to about 3000 pg/mL, about 2500 pg/mL to about 3000 pg/mL, or about 2500 pg/mL to about 3000 pg/mL.

(jj) a reduction in the level of IP-10 in blood and BALF to at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about

70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control),

(kk) a reduction in serum amyloid A protein (SAA) in blood (plasma) of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(ll) a reduction in Mouse Kc or human IL-8 in blood and/or BALF of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(mm); a reduction in GM-CSF in blood or BALF of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control);

(nn) prevention of a clinically significant increase in graded vitreous haze and/or graded anterior chamber cells based on commonly accepted clinical criteria known to those expert in the field.

(oo) prevention of deterioration of a clinically significant change in visual acuity based on commonly used and accepted criteria known to those expert in the field;

(pp) reduced tumor cell growth and/or reduced tumor growth of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control); and/or

(rr) reduced expression of DYRK1b of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control); and/or

(ss) reduced activation of NF- κ B regulated genes of at least about 99%, at least about 95%, at least about 90%, at least about 80%, at least about 70%, at least about 60%, at least about 50%, at least about 40%, at least about 35%, at least about 30%, at least about 20%, at least about 15%, at least about 10%, or at least about 5%, for example, about 30% to about 99%, about 80% to about 90%, about 70% to about 90%, about 60% to about 90%, about 50% to about 90%, about 40% to about 90%, about 35% to about 90%, about 30% to about 90%, about 25% to about 90%, about 5% to about 85%, or about 10% to about 80% (actual % change or median % change compared to baseline or control).

[00137] According to the embodiments disclosed and their modifications, the conjugates or fusion proteins may be used alone or in combination with other treatments or components of other treatments. Diseases and disorders or conditions that may be treated include, but are not limited to: cancer, inflammation or inflammatory disease, dermatological disorders, fever, cardiovascular effects, hemorrhage, coagulation and acute phase response, cachexia, anorexia, acute infection, HIV infection, shock states, graft-versus-host reactions, autoimmune disease, reperfusion injury, meningitis, migraine and aspirin-dependent anti-thrombosis; tumor growth, invasion and spread, angiogenesis, metastases, malignant, ascites and malignant pleural effusion; cerebral ischemia, ischemic heart disease, osteoarthritis, rheumatoid arthritis, osteoporosis, asthma, multiple sclerosis, neurodegeneration, Alzheimer's disease, atherosclerosis, stroke, vasculitis, Crohn's disease and ulcerative colitis; periodontitis, gingivitis; psoriasis, atopic dermatitis, chronic ulcers, epidermolysis bullosa; corneal ulceration, retinopathy and surgical wound healing; rhinitis, allergic conjunctivitis, eczema, anaphylaxis; restenosis, congestive heart failure, endometriosis, atherosclerosis or endoscierosis, cytokine and cell proliferation/differentiation activity; immunosuppressant or immunostimulant activity (e.g. for treating immune deficiency, including infection with human immune deficiency virus; regulation of lymphocyte growth; treating cancer and many autoimmune diseases, and to prevent transplant rejection or induce tumor immunity); regulation of haematopoiesis, e.g. treatment of myeloid or lymphoid diseases; promoting growth of bone, cartilage, tendon, ligament and nerve tissue, e.g. for healing wounds, treatment of burns, ulcers and periodontal disease and neurodegeneration: inhibition or activation of follicle-stimulating hormone (modulation of fertility); chemotactic/chemokinetic activity (e.g. for mobilizing specific cell types to sites of injury or infection); haemostatic and thrombolytic activity (e.g. for treating hemophilia and stroke); antiinflammatory activity (for treating e.g. septic shock or Crohn's disease); as antimicrobials: modulators of e.g. metabolism or behavior; as analgesics; treating specific deficiency disorders; in treatment of e.g. psoriasis, in human or veterinary medicine; macrophage inhibitory and/or T cell inhibitory activity and thus, anti-inflammatory activity; anti-immune activity, i.e. inhibitory effects against a cellular and/or humoral immune response, including a response not associated with inflammation; inhibit the ability of macrophages and T cells to adhere

to extracellular matrix components and fibronectin, as well as up-regulated fas receptor expression in T cells; inhibit unwanted immune reaction and inflammation including arthritis, including rheumatoid arthritis, inflammation associated with hypersensitivity, allergic reactions, asthma, systemic lupus erythematosus, collagen diseases and other autoimmune diseases, inflammation associated with atherosclerosis, arteriosclerosis, atherosclerotic heart disease, reperfusion injury, cardiac arrest, myocardial infarction, vascular inflammatory disorders, respiratory distress syndrome or other cardiopulmonary diseases, inflammation associated with peptic ulcer, ulcerative colitis and other diseases of the gastrointestinal tract, hepatic fibrosis, liver cirrhosis or other hepatic diseases, thyroiditis or other glandular diseases, glomerulonephritis or other renal and urologic diseases, otitis or other oto-rhino-laryngological diseases, dermatitis or other dermal diseases, periodontal diseases or other dental diseases, orchitis or epididymo-orchitis, infertility, orchidal trauma or other immune-related testicular diseases, placental dysfunction, placental insufficiency, habitual abortion, eclampsia, pre-eclampsia and other immune and/or inflammatory-related gynaecological diseases, posterior uveitis, intermediate uveitis, anterior uveitis, conjunctivitis, chorioretinitis, uveoretinitis, optic neuritis, intraocular inflammation, e.g. retinitis or cystoid macular oedema, sympathetic ophthalmia, scleritis, retinitis pigmentosa, immune and inflammatory components of degenerative fundus disease, inflammatory components of ocular trauma, ocular inflammation caused by infection, proliferative vitreo-retinopathies, acute ischaemic optic neuropathy, excessive scarring, e.g. following glaucoma filtration operation, immune and/or inflammation reaction against ocular implants and other immune and inflammatory-related ophthalmic diseases, inflammation associated with autoimmune diseases or conditions or disorders where, both in the central nervous system (CNS) or in any other organ, immune and/or inflammation suppression would be beneficial, Parkinson's disease, complication and/or side effects from treatment of Parkinson's disease, AIDS-related dementia complex HIV-related encephalopathy, Devic's disease, Sydenham chorea, Alzheimer's disease and other degenerative diseases, conditions or disorders of the CNS, inflammatory components of stokes, post-polio syndrome, immune and inflammatory components of psychiatric disorders, myelitis, encephalitis, subacute sclerosing pan-encephalitis, encephalomyelitis, acute neuropathy, subacute neuropathy, chronic neuropathy, Guillain-Barre syndrome,

Sydenham chora, myasthenia gravis, pseudo-tumor cerebri, Down's Syndrome, Huntington's disease, amyotrophic lateral sclerosis, inflammatory components of CNS compression or CNS trauma or infections of the CNS, inflammatory components of muscular atrophies and dystrophies, and immune and inflammatory related diseases, conditions or disorders of the central and peripheral nervous systems, post-traumatic inflammation, septic shock, infectious diseases, inflammatory complications or side effects of surgery, bone marrow transplantation or other transplantation complications and/or side effects, inflammatory and/or immune complications and side effects of gene therapy, e.g. due to infection with a viral carrier, or inflammation associated with AIDS, to suppress or inhibit a humoral and/or cellular immune response, to treat or ameliorate monocyte or leukocyte proliferative diseases, e.g. leukemia, by reducing the amount of monocytes or lymphocytes, for the prevention and/or treatment of graft rejection in cases of transplantation of natural or artificial cells, tissue and organs such as cornea, bone marrow, organs, lenses, pacemakers, natural or artificial skin tissue.

[00138] Table 3: Peptide Sequence Identities.

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
1	HOX C12	SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS RLNLSDQQVKIWFQNRRMKKKRL
2	HOX D12	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKEL SNRLNLSDQQVKIWFQNRRMKKKRV
3	OTP	QKRHRTRFTPAQLNELERSFAKTHYPDIFMREEL ALRIGLTESRVQVWFQNRRAKWKKRK
4	TLX1	KKKPRTSFTRLQICELEKRFHRQKYLASAERAAL AKALKMTDAQVKTWFQNRRTKWRRQT
5	TLX3	RKKPRTSFSRVQICELEKRFHRQKYLASAERAAL AKSLKMTDAQVKTWFQNRRTKWRRQT
6	TLX2	RKKPRTSFSRSQVLELERRFLRQKYLASAERAAL AKALRMTDAQVKTWFQNRRTKWRRQT
7	NKX6-1	RKHTRPTFSGQQIFALEKTFEQTKYLAGPERARL AYSLGMTESQVKVWFQNRRTKWRRKH
8	NKX6-2	KKHSRPTFSGQQIFALEKTFEQTKYLAGPERARL AYSLGMTESQVKVWFQNRRTKWRRKH
9	NKX6-3	KKHTRPTFTGHQIFALEKTFEQTKYLAGPERARL AYSLGMTESQVKVWFQNRRTKWRRKS
10	NKX3-2	KKRSRAAFSHAQVFELERRFNHQRYLSGPERADL AASLKLTETQVKIWFQNRRYKTKRRQ
11	BARHL1	PRKARTAFTHQQLAQLERSFERQKYLSVQDRMEL AASLNLTDTQVKTWYQNRRTKWKRQT
12	BARHL2	PRKARTAFSDHQLNQLERSFERQKYLSVQDRMDL AAALNLTDTQVKTWYQNRRTKWKRQT

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
13	BARX1	GRRSRTVFTTELQLMGLEKRFEKQKYLSTPDRIDLAE SLGLSQLQVKTWYQNRRMKWKKIV
14	BARX2	PRRSRTIFTELQLMGLEKKFQKQKYLSTPDRLDLAQ SLGLTQLQVKTWYQNRRMKWKKMV
15	BSX	RRKARTVFSDSQLSGLEKRFEIQRYLSTPERVELAT ALSLSETQVKTWFQNRRMKHKKQL
16	DLX2	VRKPRTIYSSFQLAALQRRFQKTQYLALPERAELAA SLGLTQTQVKIWFQNRRSKFKKMW
17	DLX3	VRKPRTIYSSYQLAALQRRFQKAQYLALPERAELA AQLGLTQTQVKIWFQNRRSKFKKLY
18	DBX1	GMLRRAVFSDVQRKALEKMFQKQKYISKPD RKKL AAKLGLKDSQVKIWFQNRRMKWRNSK
19	DBX2	GILRRAVFSEDQRKALEKMFQKQKYISKTD RKKLAI NLGLKESQVKIWFQNRRMKWRNSK
20	NEMO binding domain (“NBD”) (second region peptide only)	TALDWSWLQTE
21	HOX C12-NBD (Entire sequence: combined SEQ ID Nos. 1 and 20)	SRKKRKPY SKLQLAELEGEFLVNEFITRQRRRELS D RLNLSDQQVKIWFQNRRMKKKRLLTALDWSWLQT E

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
22	HOX D12-NBD (Entire sequence: combined SEQ ID Nos. 2 and 20)	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQQVKIWFQNRRMKKKRVTALDWSWLQTE
23	p200 peptide derived from the PC1 CTT (second region peptide only)	VILRWRYHALRGELYRPAWEPQDYEMVELFLRRLRLWMGLSKVKEFRHKVRFEGMEPLPSRSSRGSKVSPDVPPPSAGSDASHPSTSSSQLDGLSVSLGRLGTRCEPEPSRLQAVFEALLTQFDRLNQATEDVYQLEQQQLHSLQGRRSSRAPAGSSRGSPGLRPALPSRLARASRGVDLATGPSRTPLRAKNKVHPSST
24	HOX C12-p200 (Entire sequence: combined SEQ ID Nos. 1 and 23, also showing initiating methionine residue)	MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDQQQVKIWFQNRRMKKKRLLVILRWRYHALRGELYRPAWEPQDYEMVELFLRRLRLWMGLSKVKEFRHKVRFEGMEPLPSRSSRGSKVSPDVPPPSAGSDASHPSTSSSQLDGLSVSLGRLGTRCEPEPSRLQAVFEALLTQFDRLNQATEDVYQLEQQQLHSLQGRRSSRAPAGSSRGSPGLRPALPSRLARASRGVDLATGPSRTPLRAKNKVHPSST
25	HOX D12-p200 (Entire sequence: combined SEQ ID Nos. 2 and 23, also showing initiating methionine residue)	MARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQQVKIWFQNRRMKKKRVVILRWRYHALRGELYRPAWEPQDYEMVELFLRRLRLWMGLSKVKEFRHKVRFEGMEPLPSRSSRGSKVSPDVPPPSAGSDASHPSTSSSQLDGLSVSLGRLGTRCEPEPSRLQAVFEALLTQFDRLNQATEDVYQLEQQQLHSLQGRRSSRAPAGSSRGSPGLRPALPSRLARASRGVDLATGPSRTPLRAKNKVHPSST
26	p21 peptide (alternate second region peptide for PKD structures)	IRRIRLWMGLSKVKEFRHKVR

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
27	HOX C12-p21 (Entire sequence: combined SEQ ID Nos. 1 and 26, also showing initiating methionine residue)	MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDQQVKIWFQNRRMKKKRLLRIRLWMG LSKVKEFRHKVR
28	HOX D12-p21 (Entire sequence: combined SEQ ID Nos. 2 and 26, also showing initiating methionine residue)	MARKKRKPYTKQQIAELENEFLVNEFINRQKRKEL SNRLNLSDQQVKIWFQNRRMKKKRVVIRIRLWM GLSKVKEFRHKVR
29	VRQ397- (noncompetitive V2 receptor antagonist. that can be linked to protein structures for targeting p21 and p200 containing HOX or Human Homeodomain fusion peptides)	CRAVKY

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
30	glucocerbrosi dase amino acid sequence (“GCase”) (second region peptide only)	ARPCIPKSFGYSSVVCVCNATYCDSDPPTFPALGTF SRYESTRSGRRMELSMGPIQANHTGTGLLLTLOPEQ KFQKVKGF GGAMTDAAALNILALSPPAQNLLLKSY FSEEGIGYNIIRVPMASCDFSIRTYTYADTPDDFQLH NFSLPEEDTKLKIPLIHRALQLAQRPVSLASPWTSP TWLKTNGAVNGKGSLKGQPGDIYHQTWARYFVKF LDAYAEHKLQFWAVTAENEPSAGLLSGYPFQCLGF TPEHQRDFIARDLGPTLANSTHHNVRLMLDDQRL LLPHWAKVVLTDPEAAKYVHGIAVHWYLDLFLAPA KATLGETHRLFPNTMLFASEACVGSKFWEQSVRLG SWDRGMQYSHSIITNLLYHVVGWTDWNLALNPEG GPNWVRNFVDSPHVDITKDTFYKQPMFYHLGHFSK FIPEGSQLRVGLVASQKNDLDAVALMHPDGSVAVV VLNRSSKDVPLTIKDPAVGFLETISPGYSIHTYLWRR Q
31	HOX C12-GCase (Entire sequence: combined SEQ ID Nos. 1 and 30, also showing initiating methionine residue)	MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDQQVKIWFQNRMMKKKRLRLARPCIPKSFG YSSVVCVCNATYCDSDPPTFPALGTF SRYESTRSG RRMELSMGPIQANHTGTGLLLTLOPEQKFQKVKGF GGAMTDAAALNILALSPPAQNLLLKSYFSEEGIGYN IIRVPMASCDFSIRTYTYADTPDDFQLHNFSLPEEDT KLKIPLIHRALQLAQRPVSLASPWTSP TWLKTNGA VNGKGSLKGQPGDIYHQTWARYFVKFLDAYAEHK LQFWAVTAENEPSAGLLSGYPFQCLGFTPEHQRDFI ARDLGPTLANSTHHNVRLMLDDQRLLLPHWAKV VLTDPEAAKYVHGIAVHWYLDLFLAPAKATLGETH RLFPNTMLFASEACVGSKFWEQSVRLGSWDRGMQ YSHSIITNLLYHVVGWTDWNLALNPEGGPNWVRN FVDSPHVDITKDTFYKQPMFYHLGHFSKFIPEGSQL VGLVASQKNDLDAVALMHPDGSVAVVVVLNRSSKD VPLTIKDPAVGFLETISPGYSIHTYLWRRQ

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
32	HOX D12-GCase (Entire sequence: combined SEQ ID Nos. 2 and 30, also showing initiating methionine residue)	MARKKRKPYTKQQIAELENEFLVNEFINRQKRKEL SNRLNLSDDQVQKIWFQNRMMKKRVVARPCIPKSF GYSSVVCVCNATYCDSFDPPTFPALGTFSRYESTRS GRRMELSMGPIQANHTGTGLLLTLQPEQKFQKVKG FGGAMTDAAALNILALSPPAQNLLLKSYFSEEGIGY NIIRVPMASCDIFSIRTYTYADTPDDFQLHNFSLPEED TKLKIPLIHRALQLAQRVSLASPWTSPWLKTNG AVNGKGSLSKGQPGDIYHQTWARYFVKFLDAYAEH KLQFWAVTAENEPSAGLLSGYPFQCLGFTPEHQRD FIARDLGPTLANSTHHNVRLMLDDQRLLLPHWAK VVLTDPEAAKYVHGIAVHWYLDLAPAKATLGET HRLFPNTMLFASEACVGSKFWEQSVRLGSWDRGM QYSHSIITNLLYHVVGWTDWNLALNPEGGPWVR NFVDSPIIVDITKDTFYKQPMFYHLGHFSKFIPEGSQ RVGLVASQKNDLDAVALMHPDGSVVVVLNRSSK DVPLTIKDPAVGLETISPGYSIHTYLWRRQ

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
33	RetGC-1 (second region peptide only)	AVFTVGVLPWACDPIFSRARPDLAARLAAARLNR DPGLAGGPRFEVALLPEPCRTPGSLGAVSSALARVS GLVGPVNPAACRPAELLAEEAGIALVPWGCPWTQA EGTTAPAVTPAADALYALLRAFGWARVALVTAPQ DLWVEAGRSLSTALRARGLPVASVTSMEPLDLGA REALRKVRDGPVRTAVIMVMHSVLLGGEEQRYLL EAAEELGLTDGSLVFLPFDTHYALSPGPEALAA NSSQLRRAHDAVLTLTRHCPSEGSVLDSLRRARER RELPSDLNLQQVSPLFGTIYDAVFLARGVAEAAA AGGRWVSGAAVARHIRDAQVPGFCGDLGGDEEPP FVLLDTDAAGDRLFATYMLDPARGSFLSAGTRMHF PRGGSAPGPDPCWFDPNNICGGGLEPGLVFLGFLL VVGMGLAGAFLAHYVRHRLMHMQMVSGPNKIILT VDDITFLHPHGGTSRKVAQGSRSSLGARSMSDIRSG PSQHLDSPNIGVYEGDRVWLKKFPGDQHIAIRPATK TAFSKLQELRHENVALYLGLFLARGAEGPAALWEG NLAVVSEHCTRGSLLQDLAQREIKLDWMFKSSLL DLIKIRYLHHRGVAHGRLLKSRNCIVDGRFVLKITD HGHGRLLEAQKVLPEPPRAEDQLWTAPELLRDPAL ERRGTLAGDVFSLAIMQEVVCRSAPYAMLELTPEE VVQVRSPPLCRPLVSMDQAPVECILLMKQCWAE QPELRPSMDHTFDLFDKNINKGRKTNIIDSMMLRMLEQ YSSNLEDLIRERTEEELEKQKTDRLLTQMLPPSVA EALKTGTPVEPEYFEQVTLYFSDIVGFTTISAMSEPI EVVDLLNDLYTLFDIIGSHDVYKVETIGDAYMVA SGLPQRNGQRHAAEIANMSLDILSAVGTFMRMRHMP EVPVRIRIGLHSGPCVAGVVGLTMPRYCLFGDTVN TASRMESTGLPYRIHVNLSTVGILRALDSGYQVELR GRTELKGKGAEDTFWLVGRRGFNKPIPKPPDLQPG SSNHGISLQEIPERRRKLEKARPGQFS

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
34	HOX C12-RetGC-1 (Entire sequence: combined SEQ ID Nos. 1 and 33, also showing initiating methionine residue)	MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDDQQVKIWFQNRMMKKKRLAVFTVGVLG PWACDPIFSRARPDLAARLAAARLNDRDPGLAGGPR FEVALLPEPCRTPGSLGAVSSALARVSGLVGPVNPA ACRPAELLAEEAGIALVPWGCPWTQAEGTTAPAVT PAADALYALLRAFGWARVALVTAPQDLWVEAGRS LSTALRARGLPVASVTSMEPLDLGAREALRKVRD GPRVTAVIMVMHSVLLGGEEQRYLLEAAEELGLTD GSLVFLPFDTIHYALSPGPEALAALANSSQLRRAHD AVLTLTRHCPSEGSVLDLRRRAQERRELPSDLNLQQ VSPLFGTIYDAVFLLARGVAEAAAAGGRWVSGA AVARHIRDAQVPGFCGDLGGDEEPPFVLLDTDAAG DRLFATYMLDPARGSFLSAGTRMHFPRGGSAPGPD PSCWFDPNNICGGGLEPGLVFLGFLLVVGMLAGA FLAHYVRHRLLMQMVSGPNKIILTVDDITFLPHG GTSRKVAQGSRSSLGARMSDIRSGPSQHLDSPNIG VYEGDRVWLKKFPGDQHIAIRPATKTAFSKLQELR HENVALYLGLFLARGAEGPAALWEGNLAVVSEHC TRGSLQDLLAQREIKLDWMFKSSLLDLIKGIRYLH HRGVAHGRLKSRNCIVDGRFVLKITDHGHGRLLA QKVLPEPPRAEDQLWTAPELLRDPALERRGTLAGD VFSLAIIIMQEVVCRSAPYAMLELTPEEVVQVRSP PLCRPLVSMDQAPVECILLMKQCWAEQPELRPSMD HTFDLDFKNINKGRKTNIIDSMRLMLEQYSSNLEDLI RERTEEELEKQKTDRLLTQMLPPSVAEALKTGTPV EPEYFEQVTLYFSDIVGFTTISAMSEPIEVVDLLNDL YTLFDAIIGSHDVYKVETIGDAYMVASGLPQRNGQ RHAAEIANMSLDILSAVGTFMRMRHMPEVPVRIRIGL HSGPCVAGVVGLTMPRYCLFGDTVNTASRMESTG LPYRIHVNLSTVGILRALDSGYQVELRGRTELKGKG AEDTFWLVGRRGFNKPIPKPPDLQPGSSNHGISLQEI PPERRRKLEKARPGQFS

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
35	HOX D12-RetGC-1 (Entire sequence: combined SEQ ID Nos. 2 and 33, also showing initiating methionine residue)	MARKKRKPYTKQQIAELENEFLVNEFINRQKRKEL SNRLNLSDDQQVKIWFQNRRMKKKRVVAVFTVGVL GPWACDPIFSRARPDLAARLAAARLNRPGLAGGP RFEVALLPEPCRTPGSLGAVSSALARVSGLVGPVNP AACRPAELLAEEAGIALVPWGCPWTQAEGTTAPAV TPAADALYALLRAFGWARVALVTAPQDLWVEAGR SLSTALRARGLPVASVTSMEPLDLSGAREALRKVR DGPRVTAVIMVMHSVLLGGEEQRYLLEAAEELGLT DGSLVFLPFDTHYALSPGPEALAALANSSQLRRAH DAVLTLTRHCPSEGSVLDLRLRAQERRELPSDLNLQ QVSPLFGTIYDAVFLLARGVAEAAAAAGGRWVSG AAVARHIRDAQVPGFCGDLGGDEEPPFVLLDTDAA GDRLFATYMLDPARGSFLSAGTRMHFPRGGSAPGP DPSCWFDPNNICGGGLEPGLVFLGFLLVVGMGLAG AFLAHYVRHRLLMQMVSGPNKIILTVDDITFLPH GGTSRKVAQGSRSSLGARMSDIRSGPSQHLDSPNI GVYEGDRVWLKKFPGDQHIAIRPATKTAFSKLQEL RHENVALYLGLFLARGAEGPAALWEGNLAVVSEH CTRGSLLQDLAQREIKLDWMFKSSLLDLIKGIRYL HHRGVAHGRLKSRNCIVDGRFVLKITDHGHGRLL AQKVLPEPPRAEDQLWTAPELLRDPALERRGTLAG DVFSLAIIHQEVVCRSAPYAMLELTPEEVVQVRSP PPLCRPLVSMDQAPVEICLLMKQCWAEQPELRPSM DHTFDLDFKNINKGRKTNIIDSMRLMLEQYSSNLEDL IRERTEELELEKQKTDRLLTQMLPPSVAEALKTGTP VEPEYFEQVTLYFSDIVGFTTISAMSEPIEVVDLLND LYTLFDIIGSHDVYKVETIGDAYMVASGLPQRNG QRHAAEIANMSLDILSAVGTFMRMRHMPEVPVRIRIG LHSGPCVAGVVGLTMPRYCLFGDTVNTASRMEST GLPYRIHVNLSTVGILRALDSGYQVELRGRTELKKG GAEDTFWLVGRRGFNKPIPKPPDLQPGSSNHGISLQ EIPPERRRKLEKARPGQFS
36	ZF6xHunt-Kox-1 (second region peptide only) showing 6 zinc finger repeats	TGAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFAC DICGRKFAQRATLQRHTKIHTGSERPFQCRICMRN FSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQ RHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHT GEKPFACDICGRKFAQRATLQRHTKIHLRQKDGGG GSGGGGSGGGGSQLVSSLSPQHSAVTQGIKNKEG MDAKSLTAWSTRLVTFKDVFDFTREEWKLLDTA QQIVYRNVMLENYKNLVSLGYQLTKPDVILRLEKG EEPWLVEREIHQETHPDSETAFEIKSSV

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
37	HOX C12-ZF6xHunt-Kox-1 (Entire sequence: combined SEQ ID Nos. 1 and 36, also showing initiating methionine residue)	MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDDQQVKIWFQNRRMKKKRLTGAERPFC RICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFA QRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQR HIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGS ERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDI CGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGSG GGGSQLVSSLSPQHSAVTQGIIKNKEGMDAKSLTA WSRTLVTFKDVFVDFTREEWKLLDTAQQIVYRNV MLENYKNLVSLGYQLTKPDVILRLEKGEEPWLVER EIHQETHPDSETAFEIKSSV
38	HOX D12-ZF6xHunt-Kox-1 (Entire sequence: combined SEQ ID Nos. 2 and 36, also showing initiating methionine residue)	MARKKRKPYTKQQIAELENEFLVNEFINRQKRKEL SNRLNLSDDQQVKIWFQNRRMKKKRVVTGAERPFC CRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKF AQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQ RHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTG SERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDI CGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGSG GGGSQLVSSLSPQHSAVTQGIIKNKEGMDAKSLTA WSRTLVTFKDVFVDFTREEWKLLDTAQQIVYRNV MLENYKNLVSLGYQLTKPDVILRLEKGEEPWLVER EIHQETHPDSETAFEIKSSV
39	ZF12xHunt-Kox-1 (second region peptide only) showing 12 zinc finger repeats	TGAERPFCRICMRNFSQRATLQRHIRTHTGEKPFAC DICGRKFAQRATLQRHTKIHTGSERPFQCRICMRN FSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQ RHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHT GEKPFACDICGRKFAQRATLQRHTKIHLRQKDGGG SGGGGGSGGGGSQLVGTAERPFCRICMRNFSQRA TLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKI HTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPF ACDICGRKFAQRATLQRHTKIHTGSERPFQCRICMR NFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATL QRHTKIHLRQKDGGGGSGGGGSGGGGSQLVSSLSP QHSAVTQGIIKNKEGMDAKSLTAWSRVLVTFKDVF VDFTREEWKLLDTAQQIVYRNVMLENYKNLVSLG YQLTKPDVILRLEKGEEPWLVEREIHQETHPDSETA FEIKSSV

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
40	HOX C12-ZF12xHunt-Kox-1 (entire sequence, combined SEQ ID Nos. 1 and 39, also showing initiating methionine residue)	MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDDQQVKIWFQNRRMKKKRLTGAERPFC RICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFA QRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQR HIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGS ERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDI CGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGSG GGGSQLVGTAERPFCRICMRNFSQRATLQRHIRT TGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQ CRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKF AQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQ RHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLR QKDGGGGSGGGGSGGGGSQLVSSLSPQHS AVTQGI IKNKEGMDAKSLTAW SRTLVTFKDVFVDFTREEW KLLDTAQQIVYRNVML ENYKNLVSLGYQLTKPDVI LRLEKGEEPWLVEREIHQETHPDSETAFEIKSSV
41	HOX D12-ZF12xHunt-Kox-1 (entire sequence, combined SEQ ID Nos. 2 and 39, also showing initiating methionine residue)	MARKKRKPYTKQQIAELENEFLVNEFINRQKRKEL SNRLNLSDDQQVKIWFQNRRMKKKRVVTGAERPFC CRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKF AQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQ RHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTG SERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDI CGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGSG GGGSQLVGTAERPFCRICMRNFSQRATLQRHIRT TGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQ CRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKF AQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQ RHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLR QKDGGGGSGGGGSGGGGSQLVSSLSPQHS AVTQGI IKNKEGMDAKSLTAW SRTLVTFKDVFVDFTREEW KLLDTAQQIVYRNVML ENYKNLVSLGYQLTKPDVI LRLEKGEEPWLVEREIHQETHPDSETAFEIKSSV

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
42	ZF18xHunt-Kox-1 (second region peptide only) showing 18 zinc finger repeats	TGAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGGSQLVGTAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGGSQLVGTAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGGSQLVSSLSPPQHSAVTQGIKNKEGMDAKSLTAWSR TLVTFKDVFDFTREEWKLLDTAQQIVYRNVMLENYKNLVSLGYQLTKPDVILRLEKGEEPWLVEREIHQETHPDSETAFEIKSSV
43	HOX C12-ZF18xHunt-Kox-1 (entire sequence, combined SEQ ID Nos. 1 and 42, also showing initiating methionine residue)	MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDQQVKIWFQNR RMKKKRLLTGAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGGSQLVGTAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGGSQLVGTAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGGSQLVSSLSPPQHSAVTQGIKNKEGMDAKSLTAWSR TLVTFKDVFDFTREEWKLLDTAQQIVYRNVMLENYKNLVSLGYQLTKPDVILRLEKGEEPWLVEREIHQETHPDSETAFEIKSSV

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
44	HOX D12-ZF12xHunt-Kox-1 (entire sequence, combined SEQ ID Nos. 2 and 42, also showing initiating methionine residue)	MARKKRKPYTKQQIAELENEFLVNEFINRQKRKEL SNRLNLSDDQQVKIWFQNRRMKKKR VVTGAERPFO CRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKF AQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQ RHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTG SERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDI CGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGSG GGGSQLVGTAERPFOCRICMRNFSQRATLQRHIRT TGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQ CRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKF AQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQ RHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLR QKDGGGGSGGGGSGGGGSQLVGTAERPFOCRICM RNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRAT LQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRT HTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPF QCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRK FAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSG QLVSSLSPQHSAVTQGIKNKEGMDAKSLTAWSTR LVTFKDVFVDFTREEWKLLDTAQQIVYRNVMLN YKNLVSLGYQLTKPDVILRLEKGEEPWLVEREIHQE THPDSETAFEIKSSV
45	Alpha-L-iduronidase (second region 653 amino acid second region peptide including the 27 amino acid signal sequence)	MRPLRPRAALLALLASLLAAPPVAPAEAPHLVHVD AARALWPLRRFWRSTGFCPPLPHSQADQYVLSWD QQLNLAYVGAVPHRGIKQVRTHWLLELVTTTRGST GRGLSYNFTHLDGYLDLLRENQLLPGFELMGASG HFTDFEDKQQVFEWKDLVSSLARRYIGRYGLAHVS KWNFETWNEPDHHDNDVSMTMQGFLNYYDACS EGLRAASPALRLGGPGDSFHTPPRSPLSWGLLRHCH DGTNFFTGEAGVRLDYISLHRKGARSSISILEQEKV VAQQIRQLFPKFADTPIYNDEADPLVGWSLPQPWR ADVTYAAMVVKVIAQHQNLLANTTSAPFYALLS NDNAFLSYHHPFAQRTLTA RFQVNNTRPPHVQLL RKPVLTA MGLLALLDEEQLWAEVSQAGTVLDSNH TVGVLASAHRPQGPADAWRAAVLIYASDDTRAHP NRSVAVTLRLRGVPPGGLVYVTRYLDNGLCSPDG EWRRLGRP VFPTAEQFRRMRAAEDPVAAAPRPLPA GGRLTLRPALRLPSLLLHVHVCARPEKPPGQVTRLRA LPLTQGQLVLVWSDEHVGSKCLWTYEIQFSQDGKA YTPVSRKPSTFNLVFVSPDTGAVSGSYRVRALDYW ARPGPFSDPVYPYLEVPVPRGPPSPGNP

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
46	HOX C12-Alpha-L-iduronidase (Entire sequence , combined SEQ ID Nos. 1 and 45, also showing initiating methionine residue	MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDDQQVKIWFQNRMMKKKRLMRPLRPRAA LLALLASLLAAPPVAPAEAPHLVHVDAARALWPLR RFWRSTGFCPPLPHSQADQYVLSWDQQNLAYVG AVPHRGIKQVRTHWLLELVTTTRGSTGRGLSYNFTH LDGYLDLLRENQLLPGFELMGSASGHFTDFEDKQQ VFEWKDLVSSLARRYIGRYGLAHVSKWNFETWNE PDHHDFDNVSMTMQGFNLNYYDACSEGLRAASPAL RLGGPGDSFHTPPRSPLSWGLLRHCHDGTNFFTGEA GVRLDYISLHRKGARSSISILEQEKVVAQQIRQLFPK FADTPIYNDEADPLVGWSLPQPWRADVITYAAMVV KVIAQHQNLLANTTSAPFYALLSNDNAFLSYHPHP FAQRTLTA RFQVNNTRPPHVQLLRKPVLTAMGLLA LLDEEQLWAEVSQAGTVLDSNHTVGVLASAHRPQ GPADAWRAAVLIYASDDTRAHPNRSVAVTLRLRG VPPGPGLVYVTRYLDNGLCSPDGEWRRRLGRPVPFT AEQFRRMRAAEDPVAAAPRPLPAGGRLTLRPALRL PSLLLHVHVCARPEKPPGQVTRLRALPLTQGQLVLV WSDEHVGSKCLWTYEIQFSQDGKAYTPVSRKPSTF NLFVFSPDTGAVSGSYRVRALDYWARPGPFSDPVP YLEVPVPRGPPSPGNP
47	HOX D12-Alpha-L-iduronidase (Entire sequence , combined SEQ ID Nos. 2 and 45, also showing initiating methionine residue	MARKKRKPYTKQQIAELENEFLVNEFINRQKRKEL SNRLNLSDDQQVKIWFQNRMMKKKRVVMRPLRPRA ALLALLASLLAAPPVAPAEAPHLVHVDAARALWPL RRFWRSTGFCPPLPHSQADQYVLSWDQQNLAYV GAVPHRGIKQVRTHWLLELVTTTRGSTGRGLSYNFT HLDGYLDLLRENQLLPGFELMGSASGHFTDFEDKQ QVFEWKDLVSSLARRYIGRYGLAHVSKWNFETWN EPDHHDFDNVSMTMQGFNLNYYDACSEGLRAASPA LRLGGPGDSFHTPPRSPLSWGLLRHCHDGTNFFTGE AGVRLDYISLHRKGARSSISILEQEKVVAQQIRQLFP KFADTPIYNDEADPLVGWSLPQPWRADVITYAAMV VKVIAQHQNLLANTTSAPFYALLSNDNAFLSYHP HPFAQRTLTA RFQVNNTRPPHVQLLRKPVLTAMGL LALLDEEQLWAEVSQAGTVLDSNHTVGVLASAHR PQGPADAWRAAVLIYASDDTRAHPNRSVAVTLRLR GVPPGPGLVYVTRYLDNGLCSPDGEWRRRLGRPVPF TAEQFRRMRAAEDPVAAAPRPLPAGGRLTLRPALR LPSLLLHVHVCARPEKPPGQVTRLRALPLTQGQLVLV WSDEHVGSKCLWTYEIQFSQDGKAYTPVSRKPSTF NLFVFSPDTGAVSGSYRVRALDYWARPGPFSDPVP YLEVPVPRGPPSPGNP

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
48	Iduronate-2-sulfatase (second region 550 amino acid sequence including the 25 amino acid signal sequence)	MPPPRTGRGLLWLGLVLSSVCVALGSETQANSTTD ALNVLLIIVDDLRLPSLGCYGDKLVRSPNIDQLASHS LLFQNAFAQQAVCAPSRVSFLTGRRPDTTRLYDFNS YWRVHAGNFSTIPQYFKENGYVTMSVGKVFHHPGIS SNHTDDSPYSWSFPPYHPSSEKYENTKTCRGPDGEL HANLLCPVDVLDVPEGTLDPKQSTEQAIQLLEKMK TSASPFFLAVGYHKPHIPFRYPKEFQKLYPLENITLA PDPEVPDGLPPVAYNPWMDIRQREDVQALNISVPY GPIPVDFQRKIRQSYFASVSYLDTQVGRLLSALDDL QLANSTIIAFTSDHGWALGEHGEWAKYSNFDVATH VPLIFYVPGRTASLPEAGEKLFYLDPFDSASQLMEP GRQSMDLVELVSLFPTLAGLAGLQVPPRCVPVPSFHV ELCREGKNLLKHFRFRDLEEDPYLPGNPRELIAYSQ YPRPSDIPQWNSDKPSLKDIKIMGYSIRTIDYRYTV WVGFPNDEF LANFSDIHAGELYFVDS DPLQDHNMY NDSQGGDLFQLLMP
49	HOX C12-Iduronate-2-sulfatase (Entire sequence, combined SEQ ID nos. 1 and 48, also showing initiating methionine)	MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRELS DRLNLS DQQVKIWFQNR RMKKKRLLMPPPRTGRG LLWLGLVLSSVCVALGSETQANSTTDALNVLLIIVD DLRLPSLGCYGDKLVRSPNIDQLASHSLLFQNAFAQQ AVCAPSRVSFLTGRRPDTTRLYDFNSYWRVHAGNF STIPQYFKENGYVTMSVGKVFHHPGISSNHTDDSPYS WSFPPYHPSSEKYENTKTCRGPDGELHANLLCPVD VLDVPEGTLDPKQSTEQAIQLLEKMKTSASPFFLAV GYHKPHIPFRYPKEFQKLYPLENITLAPDPEVPDGLP PVAYNPWMDIRQREDVQALNISVPYGPIPVDFQRKI RQSYFASVSYLDTQVGRLLSALDDLQLANSTIIAFT SDHGWALGEHGEWAKYSNFDVATHVPLIFYVPGR TASLPEAGEKLFYLDPFDSASQLMEPGRQSMDLV ELVSLFPTLAGLAGLQVPPRCVPVPSFHVELCREGKN LLKHFRFRDLEEDPYLPGNPRELIAYSQYPRPSDIPQ WNSDKPSLKDIKIMGYSIRTIDYRYTVWVGFPNDEF LANFSDIHAGELYFVDS DPLQDHNMYNDSQGGDLF QLLMP

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
50	HOX D12-Iduronate-2-sulfatase (Entire sequence, combined SEQ ID nos. 2 and 48, also showing initiating methionine)	MARKKRKPYTKQQIAELENEFLVNEFINRQKRKEL SNRLNLSDQQVKIWFQNRRMKKKRVMPPPTGR GLLWLGLVLSSVCVALGSETQANSTTDALNVLLIIV DDLRLPSLGCYGDKLVRSPNIDQLASHSLLFQNAFAQ QAVCAPSRVSFLTGRRPDTTRL YDFNSYWRVHAGN FSTIPQYFKENGYVTMSVGKVFHPGISSNHTDDSPY SWSFPPYHPSSEKYENTKTCRGPDGELHANLLCPV DVLDPVPEGTLPDKQSTEQAIIQLLEKMKTSASPFFLA VGYHKPHIPFRYPKEFQKLYPLENITLAPDPEVPDG LPPVAYNPWMDIRQREDVQALNISVPYGPVDFQR KIRQSYFASVSYLDTQVGRLLSALDDLQLANSTIIAF TSDHGWALGEHGEWAKYSNFDVATHVPLIFYVPG RTASLPEAGEKLPYLDPFDSASQLMEPGRQSM DL VELVSLFPTLAGLAGLQVPPRCVPVPSFHVELCREGK NLLKHFRFRDLEEDPYLPGNPRELIAYSQYPRPSDIP QWNSDKPSLKDIKIMGYSIRTIDYRYTVWVGFNPD EFLANFSDIHAGELYFVDS DPLQDHNMYNDSQGGD LFQLLMP
51	Peptide One of Four spanning the Ag85A 99-118 Epitope (second region 15 amino acid sequence, TB Vaccine)	ETFLTSELPGWLQAN
52	HOX C12-Ag85A 99-118 Epitope Peptide One of Four (Entire sequence, combined SEQ ID nos. 1 and 51, TB Vaccine)	SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSD RLNLSDQQVKIWFQNRRMKKKRLL ETFLTSELPGW LQAN

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
53	HOX D12-Ag85A 99-118 Epitope, Peptide One of Four (Entire sequence, combined SEQ ID nos. 2 and 51, TB Vaccine)	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSN RLNLSDQQVKIWFQNRRMKKKR VVETFLTSELP G WLQAN
54	Peptide Two of Four spanning the Ag85A 99-118 epitope (second region 15 amino acid sequence, TB Vaccine)	SELPGWLQANRHVKP
55	HOX C12-Ag85A 99-118 Epitope, Peptide Two of Four (Entire sequence, combined SEQ ID nos. 1 and 54, TB Vaccine)	SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS D RLNLSDQQVKIWFQNRRMKKKRLLSELP G WLQAN RHVKP

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
56	HOX D12-Ag85A 99-118 Epitope, Peptide Two of Four (Entire sequence, combined SEQ ID nos. 2 and 54, TB Vaccine)	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSN RLNLSDQQVKIWFQNRRMKKKR VVSELP GWLQAN RHVKP
57	Peptide Three of Four spanning the Ag85A 99-118 epitope (second region 15 amino acid sequence, TB Vaccine)	WLQANRHVKPTGSAV
58	HOX C12-Ag85A 99-118 Epitope, Peptide Three of Four (Entire sequence, combined SEQ ID nos. 1 and 57, TB Vaccine)	SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSD RLNLSDQQVKIWFQNRRMKKKRLLWLQANRHVKP TGS AV

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
59	HOX D12-Ag85A 99-118 Epitope, Peptide Three of Four (Entire sequence, combined SEQ ID nos. 2 and 57, TB Vaccine)	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSN RLNLSDQQVKIWFQNRRMKKKR VVWLQANRHVK PTGSAV
60	Peptide Four of Four spanning the Ag85A 99-118 epitope (second region 15 amino acid sequence, TB Vaccine)	RHVKPTGSAVVGLSM
61	HOX C12-Ag85A 99-118 Epitope, Peptide Four of Four (Entire sequence, combined SEQ ID nos. 1 and 60, TB Vaccine)	SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDQQVKIWFQNRRMKKKRLLRHVKPTGSAV VGLSM

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
62	HOX D12-Ag85A 99-118 Epitope, Peptide Four of Four (Entire sequence, combined SEQ ID nos. 2 and 60, TB Vaccine)	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSN RLNLSDQQVKIWFQNRRMKKKRVRHVKPTGSAV VGLSM
63	Peptide One of Three spanning the Ag85A 70-78 epitope (second region 15 amino acid sequence, TB Vaccine)	QSGLSVVMPVGGQSS
64	HOX C12-Ag85A 70-78 Epitope, Peptide One of Three (Entire sequence, combined SEQ ID nos. 1 and 63, TB Vaccine)	SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS RLNLSDQQVKIWFQNRRMKKKRLLQSGLSVVMPV GGQSS

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
65	HOX D12-Ag85A 70-78 Epitope, Peptide One of Three (Entire sequence, combined SEQ ID nos. 2 and 63, TB Vaccine)	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSN RLNLSDQQQVKIWFQNRRMKKKR VVQSGLSVVMPV GGQSS
66	Peptide Two of Three spanning the Ag85A 70-78 Epitope (second region 15 amino acid sequence, TB Vaccine)	VVMPVGGQSSFYSDW
67	HOX C12-Ag85A 70-78 Epitope, Peptide Two of Three (Entire sequence, combined SEQ ID nos. 1 and 66, TB Vaccine)	SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSD RLNLSDQQQVKIWFQNRRMKKKRLLVVMPVGGQSS FYSDW

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
68	HOX D12-Ag85A 70-78 Epitope, Peptide Two of Three (Entire sequence, combined SEQ ID nos. 2 and 66, TB Vaccine)	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSN RLNLSDQQVKIWFQNRRMKKKR VVVVMPVGGQSS FYSDW
69	Peptide Three of Three spanning the Ag85A 70-78 Epitope (second region 15 amino acid sequence, TB Vaccine)	GGQSSFYSDWYQPAC
70	HOX C12-Ag85A 70-78 Epitope, Peptide Three of Three (Entire sequence, combined SEQ ID nos. 1 and 69, TB Vaccine)	SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDQQVKIWFQNRRMKKKRLLGGQSSFYSDW YQPAC

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
71	HOX D12-Ag85A 70-78 Epitope, Peptide Three of Three (Entire sequence, combined SEQ ID nos. 2 and 69, TB Vaccine)	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSN RLNLSDQQVKIWFQNRRMKKKR VVGGQSSFYSDW YQPAC
72	Ag85A Epitope (second region cargo)	AFSRPGLP VEYLQVPSPS MGRDIKVQFQ SGGANSPALY LLDGLRAQDD FSGWDINTPA FEWYDQSGLS VVMPVGGQSS FYSDWYQPAC GKAGCQTYKW ETFLTSELPG WLQANRHVKP TGSAVVGLSM AASSALTLAI YHPQQFVYAG AMSGLLDPSQ AMGPTLIGLA MGDAGGYKAS DMWGPKEPA WQRNDPLLNK GKLIANNTRV WVYCGNGKPS DLGGNNLPAK FLEGFVRTSN IKFQDAYNAG GGHNQVDFDP DSGTHSWEYW GAQLNAMKPD LQRALGATPN TGPAPQGA
73	HOX C12-Ag85A (Entire sequence, combined SEQ ID nos. 1 and 72, TB Vaccine)	SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSD RLNLSDQQVKIWFQNRRMKKKRLL AFSRPGLP VEYLQVPSPS MGRDIKVQFQ SGGANSPALY LLDGLRAQDD FSGWDINTPA FEWYDQSGLS VVMPVGGQSS FYSDWYQPAC GKAGCQTYKW ETFLTSELPG WLQANRHVKP TGSAVVGLSM AASSALTLAI YHPQQFVYAG AMSGLLDPSQ AMGPTLIGLA MGDAGGYKAS DMWGPKEPA WQRNDPLLNK GKLIANNTRV WVYCGNGKPS DLGGNNLPAK FLEGFVRTSN IKFQDAYNAG GGHNQVDFDP DSGTHSWEYW GAQLNAMKPD LQRALGATPN TGPAPQGA

Sequence ID No.	Descriptor or Gene from which the Sequence was Derived	Sequence
74	HOX D12-Ag85A (Entire sequence, combined SEQ ID nos. 2 and 72, TB Vaccine)	ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSN RLNLSDQQVKIWFQNRMMKKKRVV AFSRPGLP VEYLQVPSPS MGRDIKVQFQ SGGANSPALY LLDGLRAQDD FSGWDINTPA FEWYDQSGLS VVMPVGGQSS FYSDWYQPAC GKAGCQTYKW ETFLTSELPG WLQANRHVKP TGSAVVGLSM AASSALTLAI YHPQQFVYAG AMSGLLDPSQ AMGPTLIGLA MGDAGGYKAS DMWGPKEDEPA WQRNDPLLNV GKLIANNTRV WVYCGNGKPS DLGGNNLPAK FLEGFVRTSN IKFQDAYNAG GGHNGVFDFP DSGTHSWEYW GAQLNAMKPD LQRALGATPN TGPAPQGA

[00139] Various features and embodiments and select modifications will now be described by way of non-limiting examples. In all examples where an initiating methionine is included in a complete sequence to allow recombinant synthesis, the initiating methionine may be removed during purification to derive the active product with the indicated human homeodomain sequence. References to sequence numbers for complete conjugates in paragraphs describing their use are referring to the conjugate after removal of the initiating methionine.

EXAMPLE 1

[00140] Conjugates or fusion peptides or proteins comprised of the 60-amino acid human homeodomain and the cargo NBD peptide that inhibits NF- κ B transcription factor generation are examples of embodiments that regulate gene expression through interference with protein-protein interactions.

[00141] In one embodiment, the HOX C12 amino acid sequence first region is SEQ ID No. 1:

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQNR
RMKKKRLL

In another embodiment, the HOX D12 amino acid sequence first region is SEQ ID No. 2:

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQNR
RMKKKRVV

In these two embodiments, this first region is linked via a simple peptide bond or, alternatively, a linker known in the art, (See Table 2), to the NF- κ B essential modifier (NEMO), abbreviated NBD, for **NEMO binding domain**, the “cargo” peptide. Any linker may be used provided its addition does not compromise the function of the conjugate. The NBD amino acid sequence is SEQ ID No. 20, the second region:

TALDWSWLQTE

and the entire fusion protein sequence embodiment incorporating the HOX C12 first region (SEQ ID No. 1), containing only a peptide bond linking the two regions, is:

SEQ ID No. 21,

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQNR
RMKKKRLLTALDWSWLQTE

The entire fusion protein sequence embodiment incorporating the HOX D12 first region (SEQ ID No. 2), containing only a peptide bond linking the two regions, is:

SEQ ID No. 22:

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQNR
RMKKKRVTALDWSWLQTE

[00142] The size of each of SEQ ID Nos 21 and 22 allows the entire fusion protein to be produced synthetically. If it is produced through recombinant synthesis SEQ ID Nos. 21 and 22, or variants or portions thereof may include an N-terminal methionine. Linkers are not required for function but linkers may be included in alternative embodiments between the first and second regions provided they do not compromise function of the conjugate. To that end, any linker known in the art (see, e.g., Table 2) may be used to produce embodiments of this conjugate, and would alter SEQ ID Nos. 21 and 22, at least in part, to the extent that the linker sequence would bridge these first and second regions.

[00143] In still further embodiments, additional amino acid sequences ("tails") can be added to either the amino or carboxy termini in order to facilitate purification. Such sequences may include FLAG-tags (DYKDDDDK), myc-tags (EQKLISEEDL), His-tags (HHHHHH), and other similar tags known to those in the art. Such tags may or may not include linkers. In addition, ligands such as the biotin-acceptor protein (GLNDIFEAQKIEWHE) together with the active BirA protein may be used. For sequences that include an N-terminal initiating methionine, if a N-terminal purification domain is added the methionine will be on the N-terminal of the purification domain instead of at the N-terminal of the human homeodomain peptide first region. FIG. 5 shows one embodiment in which the HOX D12 homeodomain is conjugated to the NBD cargo peptide, and is further conjugated to a His-tag through a GS linker.

[00144] In various embodiments, SEQ ID Nos. 21 and 22 or a portion thereof may be formulated for systemic or local delivery for the treatment of inflammatory diseases. Embodiments of local delivery include examples such as an inhaled liquid or dry powder formulation for chronic obstructive lung disease (COPD), a colonic enema formulation for ulcerative colitis or Crohn's disease (inflammatory bowel disease) with colonic and/or rectal inment, an eye drop formulation for inflammatory eye diseases such as dry eyes (keratoconjunctivitis sicca), uveitis and scleritis and topical ointment and cream formulations for inflammatory and autoimmune skin diseases such as psoriasis and alopecia areata. Systemic formulations include intravenous, subcutaneous and intramuscular injection and injectable implant formulations for sustained release for the treatment of chronic inflammatory diseases such as rheumatoid arthritis, ulcerative colitis, Crohn's disease, psoriasis, etc., and

acute inflammatory conditions such as inflammatory atherosclerotic plaque instability for the prevention of acute myocardial infarction (coronary artery thrombosis) and stroke, prevention of ischemia-reperfusion injury in stroke and myocardial infarction (reduced infarct size and improved function) and in organ transplant patients (improved organ function). To the extent that activation of NF- κ B inflammatory pathways are involved in the pathogenesis and progression of certain cancers, as reported widely in the literature, for example, in colon, lung and some skin cancers, systemic administration includes treatment of cancer.

[00145] SEQ ID No. 21 (labeled PPL-002 in the studies described) and SEQ ID No. 22 (labeled PPL-003 in the studies described) were chemically synthesized and their respective physical and biological properties were characterized and compared to two Antennapedia-based cell permeable membrane constructs with the same 11-amino acid NEMO binding domain (NBD) cargo (SEQ ID No. 20) that has been previously described (M.J. May et al. "Selective inhibition of NF- κ B activation by a peptide that blocks the interaction of NEMO with the I κ B kinase complex" Science 289:1550-54, Sept. 1, 2000; I Strickland and S Ghosh. "Use of cell permeable NBD peptides for suppression of inflammation" Ann. Rheum. Dis. 65(Suppl 3):iii75-iii82, 2006). One of these fusion peptides utilizes an N-terminal 17-amino acid sequence from the Antennapedia homeodomain and the 11-amino acid NBD peptide at its C-terminal end and was labeled PPL-004 in these studies. The other Antennapedia-based construct is a fusion peptide combining the 60 amino acid homeodomain of Antennapedia with the same 11-amino acid NBD cargo and is labeled PPL-001 in these studies.

[00146] Physical characteristics: SEQ ID No. 22,(PPL-003), differed in its solubility and salt interactions compared to SEQ ID No. 21 (PPL-002) that make it better suited for pharmaceutical development. It also differed in these characteristics compared to the published Antennapedia based NBD peptide (PPL-004) and the other Antennapedia based NBD peptide, PPL-001.

[00147] PPL-001, PPL-002 and PPL-004 peptides are soluble in water; however, they did not demonstrate solubility in salt containing buffers such as those commonly used as pharmaceutical vehicles or formulations. In 10 mM Tris buffered saline, pH 7.4, which is conventionally used pharmaceutical administration, PPL-003 was soluble as a clear solution even at the highest concentration tested, 5 mg/mL (0.566

mM), while PPL-002 (1 mg/mL) formed a cloudy solution possibly due to salt interactions with the charged groups on the peptide. The Antennapedia-based NBD peptides (PPL-001 and PPL-004) were also insoluble in this buffered saline solution. Using 1mM arginine, 0.01% and 0.1% Tween 20 or adding histidine to Tris buffered saline and using citrate buffered solutions did not improve the solubility characteristics of PPL-001, PPL-002 or PPL-004. The different solubility characteristics of PPL-003 compared to PPL-002 and the Antennapedia-based peptides was not predicted on the basis of structural differences. In addition only PPL-003 could be completely dissolved at 5 mg/mL in phosphate buffered physiological saline solutions at pH 7.4.

[00148] We tested the ability of certain embodiments of the human HOX C12 or HOX D12 homeodomain–NBD permeabilizing peptides (fusion proteins) disclosed to inhibit NF- κ B activation and the formation of cytokines such as tumor necrosis factor alpha (TNF- α) when it is preincubated with cells prior to stimulation with endotoxin using techniques known in the art. We conducted *in vitro* studies utilizing embodiments comprising SEQ ID No. 21 and/or No. 22, or a portion thereof in which TNF- α -stimulated NF- κ B transcriptional activities were measured and where endotoxin-stimulated cytokine production was studied.

[00149] Embodiments of the NBD cargo peptide conjugated to the human HOX C12 or HOX D12 homeodomain (SEQ ID Nos. 21 and/or 22 or variant or portion thereof) were active in both of these *in vitro* assays at various concentrations between about 50 μ M to about 200 μ M, and TNF- α -stimulated NF- κ B transcriptional activity and/or cytokine production was measured by known methods and compared to the control group.

[00150] ***In Vitro* Activity using NF- κ B luciferase reporter cell lines:** An *in vitro* assay measuring the inhibition of NF- κ B activation utilizing a TNF- α stimulated human embryonic kidney cell line (HEK 293) and an endotoxin (LPS) stimulated murine macrophage-like cell line (RAW 264.7), both with an NF- κ B luciferase reporter gene, were utilized to measure the bioactivity of embodiments of cell permeable peptides with the NBD cargo (Park et al. Phosphoinositide-dependent kinase 1 integrates T cell receptor and CD28 co-receptor signaling to effect NF- κ B

induction and T cell activation. Nat Immunol. 10(2):158–166, Feb. 2009). (FIGs. 8a and 8b.)

[00151] KEY to FIGs. 8a, 8b and 9:

Unstimulated or Vehicle	Cells without endotoxin (LPS) or TNF- α stimulation
LPS	Cells stimulated with endotoxin (LPS) 10 ng/mL or human TNF- α at 10 ng/mL for 4 hours following a 3-hour incubation with control buffer
Mutant:200 micromolar	Cells stimulated with endotoxin (LPS) 10 ng/mL or human TNF- α at 10 ng/mL for 4 hours following a 3-hour incubation with the NBD mutant inactive peptide
NBD	Cells stimulated with endotoxin (LPS) 10 ng/mL or human TNF- α at 10 ng/mL for 4 hours following a 30-hour incubation with commercially purchased peptide with a 17-amino acid Antennapedia-based homeodomain sequence and a C-terminal 11-amino acid NBD sequence (SEQ ID No. 020 is the NBD portion)
PPL-001	Cells stimulated with endotoxin (LPS) 10 ng/mL or human TNF- α at 10 ng/mL for 4 hours following a 3-hour incubation with a Portage Pharmaceuticals-produced peptide with a 60-amino acid Antennapedia-based homeodomain sequence and a C-terminal 11-amino acid NBD sequence (SEQ ID No. 020).
PPL-002 (SEQ ID No. 21)	Cells stimulated with endotoxin (LPS) 10 ng/mL or human TNF- α at 10 ng/mL for 4 hours following a 3-hour incubation with a Portage Pharmaceuticals-produced peptide with a 60-amino acid human HOX-C12 homeodomain sequence (SEQ ID No. 001) and a C-terminal 11-amino acid NBD sequence (SEQ ID No. 020)
PPL-003 (SEQ ID No. 22)	Cells stimulated with endotoxin (LPS) 10 ng/mL or human TNF- α at 10 ng/mL for 4 hours following a 3-hour

	incubation with a Portage Pharmaceuticals-produced peptide with a 60-amino acid human HOX-D12 homeodomain sequence (SEQ ID 002) and a C-terminal 11-amino acid NBD sequence (SEQ ID 020).
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[00152] In initial experiments these peptides were first dissolved in DMSO and then diluted in phosphate buffered saline prior to addition to complete tissue culture medium containing the NF- κ B luciferase reporter cell lines. In these studies PPL-003 was found to have activity similar to PPL-004 and a commercially available version of PPL-004 with the identical structure. In one test, a control mutant peptide with a change in the NBD sequence rendering it unable to bind to the NBD target sequence was inactive demonstrating the specificity of the test for the NBD sequence used as cargo.

[00153] When the final concentration of DMSO was adjusted to 1% for all peptides and their ability to inhibit human TNF- α -stimulated (5 ng/ml) NF- κ B activation was measured using HEK 293 cells, there was a clear dose-response for all peptides. However, PPL-003 appeared to be more potent than the others at the same and lowest 50 micromolar concentration. FIG. 9 reports the luciferase signal as a percent of the TNF- α -stimulated cells with no peptide pretreatment.

[00154] In the rodent-systemic intravenous endotoxin challenge model, mice were pretreated using systemic intravenous (i.v.) or intraperitoneal (i.p.) administration of an embodiment formulations comprising the NBD cargo peptide conjugated to a human HOX C12 or HOX D12 homeodomain (SEQ ID Nos. 21 and/or 22) as described below and in future studies at a dose per 20 g mouse of 1 μ g to at least 2,000 μ g or more. Multiple inflammatory and anti-inflammatory cytokines and the acute phase protein, serum amyloid A (SAA) were measured in blood and results compared to the vehicle negative control group and to a dexamethasone pretreated positive control group.

[00155] *In Vivo* activity of NBD cargo-containing cell permeable peptides: Initial studies were conducted in mice pretreated by i.p. injection of peptides at a dose of 500 micrograms (μ g) per mouse (10 mg/kg) or dexamethasone (3 mg/kg) 30 minutes prior to challenge by injection of endotoxin (LPS) at a dose of 50 micrograms/kg. The ability of peptide pretreatment to inhibit the inflammatory

cytokine response or stimulate the anti-inflammatory cytokine response to LPS was determined 2 hours after LPS injection (FIG. 10).

[00156] Cytokine levels in mouse plasma two hours after LPS injection were reduced in mice treated with NBD-containing peptides. (FIGs. 11a and 11b) For example, levels of TNF- α and IP-10 (CXCL 10) were convincingly reduced by pretreatment with PPL-003 with some mice demonstrating reduced levels of these cytokines similar to the dexamethasone-treated group. Interestingly PPL-003 was differentiated from PPL-004 with respect to their abilities to reduce the IP-10 response. While IP-10 levels were reduced by i.p. pretreatment with PPL-003 to levels similar to those measured after dexamethasone treatment, there was no effect of PPL-004 i.p. pretreatment on IP-10 plasma levels. These selective effects on specific cytokines may have important implications for PPL-003 as a therapeutic agent for inflammatory diseases.

[00157] Pretreatment with PPL-002 and PPL-003 embodiments also lead to increased levels of the anti-inflammatory cytokine Interleukin-10 (IL-10). Peptides were dosed both i.p. and i.v. at 500 micrograms per mouse (10 mg/kg) 30 minutes prior to challenge by injection of endotoxin (LPS) at a dose of 50 micrograms/kg. Dexamethasone dosed i.p. at 3 mg/kg had no effect on IL-10 levels while PPL-002 (SEQ ID No. 21) i.p. pretreatment led to a significant increase in IL-10 ($p < 0.01$). PPL-002 (SEQ ID No. 21) and PPL-003 (SEQ ID No. 22) embodiment i.v. pretreatments also increased IL-10 levels. Interestingly this ability to increase IL-10 levels after LPS challenge was not seen in mice pretreated with PPL-004, the published NBD cell permeable peptide with an N-terminal 17-amino acid sequence from the Antennapedia homeodomain and the 11-amino acid NBD peptide at its C-terminal end (FIG. 12) where there was no detectable difference between PPL-004 and vehicle pretreated groups. .

[00158] Activity and pharmacokinetics of E. coli-derived recombinant PPL-003. A recombinant PPL-003 (SEQ ID No. 22) embodiment produced in E. coli and purified as described above (see *Upstream Production of SEQ ID No. 21 and SEQ ID No. 22*) was administered by intra-peritoneal injection in a 10 mM Tris buffered physiological saline solution, pH 7.4, to mice, and the plasma concentration of PPL-003 was measured by ELISA assay that utilized an affinity purified rabbit antibody to SEQ ID No. 20, the NBD cargo. Mice were injected with 500 μ g [micrograms], 1,000

µg or 2,000 µg of PPL-003 and blood was sampled at the indicated time points (FIG. 13). Blood was anti-coagulated with EDTA and plasma separated by centrifugation. PPL-003 levels were measured by ELISA and calculated using a standard curve of chemically synthesized pure PPL-003. Plasma PPL-003 was measurable at 5 minutes post-dose and Cmax was at about 30 minutes with levels reaching the lower limit of detection at about 240 minutes after dosing (FIGs. 13-14).

[00159] As before mice were challenged with LPS after dosing with recombinant PPL-003 and multiple cytokine responses to the LPS injection were measured 2 hours after the LPS challenge. Dosing with PPL-003 was at the same time as LPS challenge, 30 minutes prior to LPS challenge or 60 minutes prior to LPS challenge. For comparison, dexamethasone was injected 30 minutes prior to LPS challenge.

[00160] LPS-stimulated plasma levels of amyloid A protein (SAA), TNFα, IP-10, GM-CSF, IL-6, KC (equivalent of human IL-8, CXCL1) and MCP-1 were reduced to levels lower than achieved with dexamethasone pre-treatment while anti-inflammatory cytokine IL-10 levels were significantly elevated. In general the greatest inhibition was with dosing 30 minutes prior to LPS challenge although SAA inhibition was greatest with simultaneous injection of PPL-003 and LPS (FIGs. 15a, 15b, 16a and 16b). The average percent reductions in SAA concentration are indicated above the bars in Figure 16a. IL-10 increases and Kc decreases were greatest with dosing 60 minutes prior to LPS injection. (FIGs. 17a and 17b)

[00161] FIGs. 18a and 18b. show inhibition of the GM-CSF response to the i.v. LPS (endotoxin) challenge in mice when PPL-003 was injected (i.p.). 60-and 30-minutes before LPS was administered, and at the same time LPS was administered (0 min.). GM-CSF reduction is greater than seen after pretreatment with dexamethasone, which provides only modest inhibition. PPL-003 is more potent than PPL-004 at the same microgram dosage, although the molar dosage of PPL-004 was about three times higher than that of PPL-003 at equivalent microgram doses.

[00162] Local delivery or topical delivery will prevent unwanted systemic activity that could result in susceptibility to infections in the case of the NBD peptide containing fusion protein. As an inhaled formulation for the treatment of inflammatory airway diseases such as chronic obstructive pulmonary disease

(COPD), one or more of the human HOX C12 or HOX D12 homeodomain-NBD conjugate or fusion protein embodiments disclosed (SEQ ID Nos. 21 or 22, or a portion thereof) will be evaluated for their ability to inhibit the airway inflammatory response in a well-described model in rodents (mice and rats) following pretreatment by inhalation of these compounds prior to inhalation of endotoxin. Specifically, we will conduct a study utilizing one or more human homeodomain-NBD fusion protein or conjugate embodiments at various concentrations, for example between about 1 μ M to about 115 μ M, and evaluate the corresponding maximal inhibition of the endotoxin-stimulated cellular and cytokine responses in BALF. In addition, studies are planned in humans challenged with small doses of inhaled endotoxin to evaluate (i) liquid formulation embodiments delivered by nebulizer; and (ii) dry powder formulation embodiments, each such formulation comprising SEQ ID Nos. 21 and/or 22, or a portion thereof. These formulation and delivery system embodiments will have efficacy in patients with inflammatory airway diseases such as COPD.

[00163] In the rodent-inhaled endotoxin challenge, administered to mice through an inhaled formulation, an embodiment comprising the NBD cargo peptide conjugated to a human HOX C12 or HOX D12 homeodomain (for example, SEQ ID Nos. 21 and/or 22, or a portion thereof) at a dose per mouse of at least 1 μ g to at least about 200 μ g or more. TNF- α and IL-6 concentrations in bronchoalveolar lavage fluid (BALF) fluid will be measured by known methods and results compared to the control group.

[00164] Also in the rodent-inhaled endotoxin challenge, administered to mice through an inhaled formulation, another embodiment comprising the NBD cargo peptide conjugated to the human HOX C12 or HOX D12 homeodomain or variant or portion thereof (for example, SEQ ID Nos. 21 and/or 22, or a portion thereof) at a dose per mouse of at least 1 μ g to at least about 200 μ g or more. Bronchoalveolar lavage fluid (BALF) inflammatory cell numbers will be measured by known methods, and results compared to the control group.

[00165] In the human-inhaled endotoxin challenge, an inhaled formulation embodiment will be administered to healthy volunteers comprising the NBD cargo peptide conjugated to the human homeodomain or variant or portion thereof (for example, SEQ ID Nos. 21 and/or 22, or a portion thereof), at a dose per 70 kg person of at least 1 μ g to at least about 600 mg or more. TNF- α , IL-6, and IL-1

concentrations and inflammatory cell numbers in bronchoalveolar lavage fluid (BALF) will be measured by known methods, and results compared to the control group.

[00166] Dry eyes, keratoconjunctivitis sicca, is a medical condition in which local inflammation leads to reduced tear production. In its extreme case, corneal damage occurs. Symptoms of dry eyes such as burning, pain, excess tearing reflex in dry air or windy conditions are very common and mild cases are treated with “artificial tears.” However, topical immunosuppressive therapy is required for moderate to severe cases, for example, cyclosporine eye drops (Restasis®) made by Allergan. Recently the importance of Toll-like receptor (TLR) signaling has been implicated, and murine models have been developed (Redfern et.al. “Toll-Like Receptor Expression and Activation in Mice with Experimental Dry Eye” that appeared in Invest. Ophthalmol. Vis. Sci. 54(2):1554-63, Feb. 28, 2013). Initially, we will conduct a study in the murine experimental dry eye (EDE) model in which inflammatory biomarkers and pathological changes can be evaluated. For example, we will evaluate the effect of one or more embodiments of the NBD peptide-containing fusion protein or conjugate administered in a topical formulation on (1) goblet cell infiltration in epithelial cornea and loss in the conjunctiva; (2) tear secretion and (3) lymph-angiogenesis. and/or (4) inflammatory cell accumulation in lachrymal tissues.

[00167] In the EDE rodent model, chronically administered daily, every other day, or weekly with a topical formulation, another embodiment comprising the NBD cargo peptide conjugated to the human HOX C12 or HOX D12 homeodomain or variant or portion thereof (SEQ ID Nos. 21 and/or 22, or a portion thereof), at a dose per mouse of at least 1 µg to at least about 500 µg or more if solubility permits. Tear production, goblet cell infiltration in epithelial cornea and loss of goblet cells in the conjunctiva will be assessed by known methods and the results compared to controls.

[00168] In more severe dry eye rodent models, administered daily, every other day, or weekly with a topical formulation, another embodiment comprising the NBD cargo peptide conjugated to the human HOX C12 or HOX D2 homeodomain or variant or portion thereof (for example, SEQ ID Nos. 21 and/or 22, or a portion thereof) at a dose per 20 g mouse of at least 1 µg to at least about 500 µg or more if

solubility permits. Lymph-angiogenesis and corneal pathology will be assessed by known methods, and the results compared to controls.

[00169] In humans, chronic daily, every other day, or weekly administration with a topical formulation, another embodiment comprising the NBD cargo peptide conjugated to the human HOX C12 or HOX D12 homeodomain or variant or portion thereof (for example, SEQ ID Nos. 21 and/or 22, or a portion thereof) at dose per 70 kg person of less than 1 µg to about 100 µg changes in tear secretion towards normal levels compared to control subjects receiving a placebo treatment will be measured by the Schirmer test.

[00170] Alopecia areata is a common autoimmune skin disease resulting in the loss of hair on the scalp and elsewhere on the body. It usually starts with one or more small, round, smooth patches on the scalp and can progress to total scalp hair loss (alopecia totalis) or complete body hair loss (alopecia universalis). Alopecia areata affects approximately two percent of the population overall, including more than 5 million people in the United States alone. This common skin disease is highly unpredictable and cyclical. Hair can grow back in or fall out again at any time, and the disease course is different for each person.

[00171] Formulated in an appropriate shampoo or topical formulation for application to the scalp and other involved areas, we will evaluate the human HOX C12 or HOX D12 homeodomain-NBD fusion protein embodiment or alternative NBD protein-containing conjugate embodiments to affect (1) the downstream inflammatory response to T-cell derived cytokines by skin biopsy, (2) hair loss, and (3) hair regrowth. In this double-blind study in alopecia areata patients, paired signal lesions at the same stage of hair loss development will be treated with placebo (topical formulation alone) and with the human HOX C12 or HOX D12 homeodomain-NBD peptide-containing formulation. Hair growth and hair follicle inflammation will be measured in both lesions and compared in untreated lesions. In other parallel group studies hair loss and growth of signal lesions and numbers of new lesions will be measured and compared between treatment groups.

[00172] In rodent models of alopecia areata, for example, the Dundee Experimental Bald Rat (DEBR) model, and in alopecia areata patients, chronic administration daily, every other day, or weekly with a topical formulation, an

embodiment comprising the NBD cargo peptide conjugated to the human HOX C12 or HOX D12 homeodomain or variant or portion thereof (SEQ ID Nos. 21 and/or 22, or a portion thereof) at a dosage of less than about 0.01% wt/vol to less than about 5% wt/vol. Hair loss and hair growth will be assessed by known methods in treated versus untreated lesions.

[00173] Administered as an i.v. or i.p. formulation, we will evaluate the effect of pretreatment of rodents with embodiments of the human gene-derived permeabilizing NBD fusion protein or conjugate described (SEQ ID Nos. 21 and/or 22, or a portion thereof) on ischemia-reperfusion injury in well described animal models, including a stroke model. Specifically, we will examine by known histopathology techniques in this stroke model the area of necrotic tissue, an indicator of ischemia-reperfusion injury.

[00174] In the rodent stroke model, sub-acute administration beginning within 1 hour of the ischemic event and continued at intervals such as every 6 hours, 12 hours or daily for one to three days) through an i.v. or i.p. formulation, another embodiment comprising the NBD cargo peptide conjugated to the human HOX C12 or HOX D12 homeodomain or variant or portion thereof (SEQ ID Nos. 21 and/or 22, or a portion thereof) at a dosage of less than about 0.1 mg/kg to less than about 100 mg/kg. The area of necrotic brain tissue in the treatment group will be assessed using known histopathology methods.

[00175] Uveitis is a common inflammatory condition of the eye. The many versions of uveitis can be sight-threatening, ocular inflammatory diseases. Experimental auto-immune uveoretinitis (EAU) is thought to be an animal model of human uveitis. Immunosuppressants used to treat human uveitis are effective in such an animal model. Furthermore, the NF- κ B inflammatory pathway, a target of HOX C12 and HOX D12 homeodomain-NBD fusion proteins, is reported to be involved in EAU pathogenesis. Additionally, there is a particular form of familial granulomatous uveitis, Blau syndrome, which can be caused by specific mutations in the human NOD2 gene and is directly associated with NF- κ B inflammation.

[00176] Formulated as a topical administration to the eye, a human HOX D12 homeodomain-NBD fusion protein embodiment will be evaluated for its ability to reduce inflammation of an animal model of uveitis. Mice deficient in NOD2 are given

an intravitreal injection of muramyl dipeptide (MDP) and the intravascular response can be measured within the iris and cellular infiltration can be assessed by intravitreal microscopy and histology. Or, as a preliminary test of topical efficacy, the fusion proteins can be evaluated for their ability in mice to reduce ocular inflammation caused by the administration of the LPS endotoxin. It is anticipated that following indication of effectiveness in animal models of uveitis, human trials could be considered in more common types of uveitis. Clinical endpoints used in uveitis clinical trials include mean change from baseline in graded vitreous haze and mean change from baseline in graded anterior chamber cells after 16 weeks of therapy. Prevention of deterioration shown by not observing an increase in vitreous haze of greater than or equal to 2 grades, shown by preventing an increase in anterior chamber cells greater than or equal to 2 grades or preventing deterioration of visual acuity of greater than or equal to 0.3 logMAR from baseline.

[00177] In one embodiment, the effect of treatment in human subjects with an intravenous formulation of the human-derived permeabilizing NBD conjugate described (SEQ ID Nos. 21 and/or 22, or a portion thereof) can be evaluated with respect to the clinical consequences of atherosclerotic plaque instability that lead to intravascular thrombosis and unstable angina, acute myocardial infarction and acute stroke. In human subjects with symptoms of unstable angina, acute MI and/or acute stroke, the underlying pathology is associated with inflammatory atherosclerotic plaque instability with production of prothrombotic factors by macrophages within the atherosclerotic lesion that lead to thrombus formation and partial or complete vascular occlusion. Specifically, evaluation may begin at presentation to an acute care facility. Further evaluation can include observing/measuring the effects of acute and subacute treatment for one to five days on biomarkers of inflammation such as C-reactive protein (CRP) at 24 hours post presentation. Clinical outcomes, such as mortality, cardiac function (ejection fraction in the case of acute MI) and neurological function (in the case of acute stroke) measured with the National Institutes of Health Stroke Scale (NIHSS) can be assessed at approximately one month following presentation. The NIHSS is a systematic assessment tool that provides a quantitative measure of stroke-related neurologic deficit. For example, a stroke patient with a NIHSS value below 12-14 will have an 80% chance for a good or excellent outcome while a NIHSS value above

20-26 has less than a 20% chance for a good or excellent outcome. Therefore, in these studies, the percent of human subjects with a NIHSS score below 17 at one month may be used as an endpoint for neurological function.

[00178] In another embodiment, daily intravenous therapy of a human gene-derived cell-permeabilizing NBD conjugate (SEQ ID Nos. 21 and/or 22, or a portion thereof), at daily doses of about 0.1 mg/kg to less than about 100 mg/kg, can be evaluated. CRP concentrations at 24 hours will be assessed in serum by known methods. In addition, we will assess at one month post presentation: (1) post-stroke neurological function as measured by the percent of patients with a NIHSS of less than 17; (2) post-MI cardiac output as measured by ultrasound; and (3) acute mortality levels. Results will be compared to controls.

[00179] Alternative embodiments comprising any of SEQ ID Nos. 1 through 19, or variants or portions thereof, conjugated to the NBD peptide include a variety of fusion proteins or conjugates comprising any one or more linkers known in the art, provided the function of the fusion protein or conjugate is not compromised by its addition.

EXAMPLE 2

PC1 Cytoplasmic C-terminal Tail Peptide for Polycystic Kidney Disease

[00180] Another embodiment of a human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) fusion protein that inhibits protein-protein interactions is one in which the second region is composed of a 200 amino acid peptide whose sequence is derived from the cytoplasmic C-terminal tail region of the PC1 protein (PC1 CTT), also referred to as p200 (Lal et al. "Polycystin-1 C-terminal tail associates with β -catenin and inhibits canonical Wnt Signaling" Hum. Mol. Genet. 17(20):3105-17, Oct. 15, 2008, including supplemental materials). The PC1 gene and/or the PC2 gene are commonly mutated in polycystic kidney disease (PKD). These mutations are inherited or result from somatic mutation or a combination of these events and result in unregulated activation of genes by a transcription factor cleaved from the c-terminal cytoplasmic tail region of the PC1 protein. The p200 protein blocks the action of this transcription factor and may be able to restore normal renal tubular development in patients with PKD if it can be effectively delivered to its site of action inside renal tubular cells.

[00181] In one embodiment, the first region human HOX C12 homeodomain 60-amino acid sequence is:

SEQ ID No. 1 (Table 3):

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDDLNLSDQQVKIWFQNR
RMKKKRLL

In another embodiment the first region human HOX D12 homeodomain 60-amino acid sequence is:

SEQ ID No. 2 (Table 3):

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQNR
RMKKKRVV

and the linked second region is the p200 peptide derived from the PC1 CTT sequence; the amino acid sequence of this second portion is:

SEQ ID No. 23 (Table 3):

VILRWRYHALRGELYRPAWEPQDYEMVELFLRRLRLWMGLSKVKEFRHKV
RFEGMEPLPSRSSRGSKVSPDVPPPSAGSDASHPSTSSSQLDGLSVSLGR
LGTRCEPEPSRLQAVFEALLTQFDRLNQATEDVYQLEQQQLHSLQGRRSSRA
PAGSSRGPSGLRPALPSRLARASRGVDLATGPSRTPLRAKNKVHPSST

In yet other embodiments, the second region is a variation on the cargo sequence shown here. With the addition of an initiating methionine, the entire fusion protein sequence embodiment containing HOX C12 is shown as SEQ ID No. 24 (Table 3):

MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDDLNLSDQQVKIWFQ
NRRMKKKRLLVILRWRYHALRGELYRPAWEPQDYEMVELFLRRLRLWMGL
SKVKEFRHKVRFEGMEPLPSRSSRGSKVSPDVPPPSAGSDASHPSTSSSQ
LDGLSVSLGRLGTRCEPEPSRLQAVFEALLTQFDRLNQATEDVYQLEQQQLH
SLQGRRSSRAPAGSSRGPSGLRPALPSRLARASRGVDLATGPSRTPLRA
KNKVHPSST

and with the addition of an initiating methionine, the entire fusion protein sequence embodiment containing HOX D12 is shown as SEQ ID No. 25 (Table 3):

MARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSQQVQKIWFQN
 RRMKKKRVVVILRWRYHALRGELYRPAWEPQDYEMVELFLRRLRLWMGLS
 KVKEFRHKVRFEGMEPLPSRSSRGSKVSPDVPPPSAGSDASHPSTSSSQL
 DGLSVSLGRLGTRCEPEPSRLQAVFEALLTQFDRLNQATEDVYQLEQQLHS
 LQGRRSSRAPAGSSRGPSGLRPALPSRLARASRGVDLATGPSRTPLRAK
 NKVHPSST

Linkers are not required for function but linkers may be included between SEQ ID Nos.1 and 23 or a portion thereof or between SEQ ID Nos. 2 and 23, or a portion thereof, without compromising function. A linker known in the art may be used, and SEQ ID Nos. 24 and 25 embodiments would be altered, at least in part, to the extent that the linker sequence would bridge the first and second regions of each conjugate.

[00182] In other embodiments, the p200 peptide may be conjugated to any of SEQ ID Nos. 3 through 19.

[00183] In still further embodiments, additional amino acid sequences can be added to either the amino or carboxy termini in order to facilitate purification. Such sequences may include FLAG-tags (DYKDDDDK), myc-tags (EQKLISEEDL), His-tags (HHHHHH), and other similar tags known to those in the art. Such tags may or may not include linkers. In addition, ligands such as the biotin-acceptor protein (GLNDIFEAQKIEWHE) together with the active BirA protein may be used. For sequences that include an N-terminal initiating methionine, if a N-terminal purification domain is added the methionine will be on the N-terminal of the purification domain instead of at the N-terminal of the human HOX C12 or HOX D12 homeodomain.

[00184] The fusion protein embodiment that includes the 60-amino acid human HOX C12 or HOX D12 homeodomain or variant or portion thereof with the PC1 CTT p200 peptide in the second region will be included in systemic formulations including intravenous, subcutaneous, intramuscular and injectable implant formulations for sustained release. They may also be formulated to include specific structures that target them for reuptake by renal tubular cells after they are filtered by the glomerulus and enter the nephron or via specific receptors such as the vasopressin 2 receptor (V2R, see below) that can target renal cyst cells via the blood. See, e.g., FIG. 3, showing a third region representing such a structure. As noted the biological activity of the fusion protein can be demonstrated *in vitro* in renal tubule cell cultures with PKD mutations where cyst-like structure formation is inhibited, and also in

rodent models of PKD where the progression of cyst formation and kidney growth is inhibited. (Lal et.al. 2008). We will evaluate the effect of the fusion protein embodiments (SEQ ID Nos. 24 or 25, or a portion thereof without the initiating methionine, or an alternative PC1 CTT p200 peptide-containing conjugate embodiment) on cyst formation *in vitro* in these renal tubular cell cultures and also in animal models of PKD (e.g., Pkd1 transgenic mice (Pkd2W525/-)). In this PKD-1 transgenic mouse model we will measure by ultrasound inhibition of increase in kidney size (i.e., inhibition of kidney growth). In patients with PKD, using pharmaceutical formulations of one or more of the disclosed fusion protein and/or conjugate embodiments comprising the PC1 CTT p200 peptide in the second region, we will evaluate by MRI total kidney volume and the progression of cyst size and number.

[00185] In another embodiment of a PC1 CTT peptide-containing fusion protein or conjugate for treatment of PKD, the second region of the protein is p21, a portion of the p200 molecule that retains some but not all of the biological activities of p200. See Table 3, SEQ ID No. 26. The p21 peptide when genetically expressed in PKD renal tubule cell cultures described above restores the normal tubule-like phenotype to the cells in a manner similar to the effect of expressing the entire p200 peptide in these cells. Removal of the p21 amino acids from the p200 construct also eliminates the ability of p200 expression to correct the cyst-like phenotype of these cells in culture. Unlike p200, p21 does not activate the Wnt signaling pathway and hence may not induce osteoblastic activity. These differences can be measured *in vivo* using osteoblastic bone formation biomarkers like osteocalcin in mouse models of PKD where the beneficial effects on progression of renal cyst formation and kidney size can also be measured using ultrasound.

[00186] The amino acid sequence of the 60-amino acid human HOX C12 homeodomain first region (SEQ ID No. 1) is shown above. The amino acid sequence of this second region p21 (SEQ ID No. 26) is:

IRRIRLWMGLSKVKEFRHKVR.

In yet other embodiments, the second region is a variation on the cargo sequence shown here.

[00187] Certain embodiments such as fusion proteins containing HOX C12 and HOX D12, each with an initiating methionine, are shown in SEQ ID Nos. 27 and 28, respectively, below and in Table 3.

SEQ ID No. 27:

MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQ
NRRMKKKRLIRRLWMGLSKVKEFRHKVR

SEQ ID No. 28:

MARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQN
RRMKKKRVVIRRLWMGLSKVKEFRHKVR

[00188] Linkers are not required for function but linkers may be included, for example, between SEQ ID Nos. 1 and 27 or 28, and between SEQ ID Nos. 2 and 27 or 28 without compromising function. Any linker known in the art may be used, and SEQ ID Nos. 27 and 28 embodiments would be altered, at least in part, to the extent that the linker sequence would bridge these first and second regions.

[00189] In other embodiments, the p21 peptide may be conjugated to any of SEQ ID Nos. 3 through 19.

[00190] In the PKD-1 transgenic mouse model, we will evaluate using ultrasound the effect of chronic daily i.p. or i.v. injections of formulations including (1) our human HOX C12 or HOX D12 homeodomain-p200 fusion protein or conjugate embodiment and (2) our human HOX C12 or HOX D12 homeodomain-p21 fusion protein or conjugate embodiment on kidney size.

[00191] In the PKD-1 transgenic mouse model, an embodiment comprising the PC1 CTT cargo peptide (either p200 (SEQ ID No. 23) or p21 (SEQ ID No. 26)) conjugated to the human HOX C12 or HOX D12 homeodomain (as SEQ ID Nos. 27 and 28 in the case of p21, and as SEQ ID Nos. 24 and 25 in the case of p200), or an alternative PC1 CTT peptide-containing embodiment varying by the type of linker, if any, at a dose per mouse of at least about 1 µg to at least 500 µg or more if solubility permits. Kidney size and growth rate will be assessed by ultrasound, and results from the group receiving the human HOX C12 or HOX D12 homeodomain-p21 treatment formulation will be compared to those of the control group and the group

receiving the human HOX C12 or HOX D12 homeodomain-p200 fusion protein or conjugate treatment formulation.

[00192] In the PKD-1 transgenic mouse model, we will further evaluate the ability of another embodiment comprising the human HOX C12 or HOX D12 homeodomain-p21 and the human HOX C12 or HOX D12 homeodomain-p200 fusion proteins or conjugates to reduce kidney growth in comparison to the control group, and to compare effect of both human homeodomain-p21 and human homeodomain-p200 changes in osteoblastic bone biomarkers, such as osteocalcin in blood in comparison. The human HOX C12 or HOX D12 homeodomain-p21 and the human HOX C12 or HOX D12 homeodomain-p200 fusion protein or conjugate embodiments will be administered in a formulation at a dose per mouse of at least about 1 µg to at least 500 µg or more if solubility permits. Osteocalcin concentration in blood will be assessed by known methods, and results from the group receiving embodiments such as the human HOX C12 or HOX D12 homeodomain-p21 treatment formulation will be compared to those of the control group and the group receiving embodiments such as the human HOX C12 or HOX D12 homeodomain-p200 fusion protein or conjugate treatment formulation.

[00193] In patients with PKD treated systemically with chronic daily dosing of the formulations described above, embodiments comprising the PC1 CTT cargo peptide (either p200 (SEQ ID No. 23) or p21 (SEQ ID No. 26) or a portion thereof) conjugated through a peptide bond to the human HOX C12 or HOX D12 homeodomain or variant or portion thereof (with, e.g., the full sequence embodiments as SEQ ID Nos. 27-28, or variant or portion thereof, in the case of p21, and as the full sequence embodiments as SEQ ID Nos. 24-25, or variant or portion thereof, in the case of p200) or an alternative PC1 CTT peptide-containing conjugate embodiment varying by the type of linker, if any, will be administered at a dosage of less than about 0.01 mg/kg to less than about 100 mg/kg. Kidney growth rate will be assessed by known methods, and results from in the group receiving the human HOX C12 or HOX D12 homeodomain-p21 treatment formulation embodiment will be compared to those of the control group and the group receiving the human HOX C12 or HOX D12 homeodomain-p200 fusion protein or conjugate treatment formulation embodiment.

[00194] Targeting Renal Cysts: Renal collecting ducts are thought to be the origin of some or most cysts in PKD. Collecting duct cells express the vasopressin 2 receptor (V2R). It may be possible to target fusion protein and conjugate embodiments with a human HOX C12 or HOX D12 homeodomain peptide or variant or portion thereof in the first region and p200 or p21 in the second region to the renal cysts of collecting duct origin by including in some embodiments a linked peptide V2R antagonist or by adding a peptide V2R antagonist as an additional segment of the fusion protein. In some embodiments a removable linker may be used if function of the conjugate is not compromised with its addition. An example of a non-competitive peptide V2R antagonist was reported by Rihakova, et al. "VRQ397 (CRAVKY): a novel noncompetitive V2 receptor antagonist" Am. J. Physiol. Integr. Comp. Physiol. 297:R1009-R1018, 2009. We intend to test the addition of VRQ397 (CRAVKY) (SEQ ID No. 29, shown in Table 3), a non-competitive peptide V2R antagonist, to the N-terminal or C-terminal of the human HOX C12 or HOX D12 homeodomain-p200 and/or the human HOX C12 or HOX D12 homeodomain-p21 fusion (conjugate) protein embodiments with a linker designed to unlink or dissolve once the exposed human homeodomain region has facilitated cell entry into the cytoplasm to evaluate the dosage needed for efficacy (such as change in kidney size), as well as the efficiency of delivery to the site of action. Further, we will examine whether the peptide V2R antagonist affects the efficacy of the fusion protein or conjugate embodiment via a different mechanism.

[00195] SEQ ID No. 29 (Table 3): Peptide V2R six amino acid antagonist: CRAVKY.

[00196] In various embodiments, targeted peptides for the treatment of PKD may be any of the following: CRAVKY-(linker)-p200-human homeodomain; CRAVKY-(linker)-p21-human homeodomain; human homeodomain-p200-(linker)-CRAVKY; human homeodomain-p21-(linker)-CRAVKY where the CRAVKY sequence is at the N-terminal of the protein in the first two examples and at the C-terminal of the protein in the second two examples.

[00197] The relative activity of embodiments comprising, for example, p21 and p200 peptides with and without the linked CRAVKY peptide can be evaluated *in vitro* in PKD cyst cell cultures as described above provided these cells are engineered to also express V2R on their surface. The *in vitro* dose response to the various

CRAVKY-containing fusion protein or conjugate embodiments described, for example, above can be compared to the same fusion protein or conjugate embodiments without CRAVKY for their ability to change the *in vitro* phenotype of the cell cultures from cyst-like to tubule-like. In addition, these constructs can also be tested in the murine PKD model described above for their relative ability to reduce the growth in kidney size.

[00198] If (1) the efficacy of the human HOX C12 or HOX D12 homeodomain-p21 and/or human HOX C12 or HOX D12 homeodomain-p200 fusion protein or conjugate formulation embodiments in the PKD cyst cell cultures is observed, and (2) greater potency (i.e., a shift in the dose-response curve to the left) in the PDK-1 transgenic mouse model described above is observed when targeted using the CRAVKY peptide, at least one of the sequence embodiments described above that comprises SEQ ID No. 29 will be tested in the PDK-1 transgenic mouse model as well as in affected patients instead of SEQ ID Nos. 24, 25, 27 and/or 28 (or variant or portion thereof), or their conjugate counterparts. Kidney growth rate will be assessed by known methods.

[00199] Alternative embodiments, including those comprising any of SEQ ID Nos. 1 through 19, or variants or portions thereof, conjugated to the (1) the p200 peptide or (2) the p21 peptide include a variety of fusion proteins or conjugates comprising any one or more linkers known in the art provided function is not compromised, and may further comprise the CRAVKY peptide.

EXAMPLE 3

Cell Permeable Peptide Enzyme Replacement Therapy for Lysosomal Storage Disease

[00200] There is strong evidence that cell permeable peptides can enable large “cargo” peptides or proteins such as antibodies to enter cells. Embodiments of conjugates or fusion proteins comprising a HOX-derived peptide or other human homeodomain cell permeable peptides such as those disclosed similarly can chaperone larger molecules across cell membranes to intracellular sites of action. They also reduce the immunogenicity of the otherwise antigenic cargo peptides and proteins, and allow them to cross the blood brain barrier and enter the CNS. The embodiments disclosed and their modifications therefore also include embodiments

in which the first region of the conjugate or fusion protein is the 60-amino acid human homeodomain or variant or portion thereof, and the second region is an active enzyme. These compounds will restore enzymatic function in patients with inherited enzyme deficiencies such as in lysosomal storage diseases. We include three examples of lysosomal storage disease and associated “cargo” structures ((1) glucocerebrosidase (GCase), for example, as shown in SEQ ID No. 30, for Gaucher Disease, (2), alpha-L-iduronidase, for example, as shown in SEQ ID No. 45, for Hurler Syndrome; and (3) iduronate-2-sulfatase, for example, as shown in SEQ ID No. 48, for Hunter Syndrome), the same principles apply to human homeodomain fusion proteins or conjugates with other “cargo” enzymes that are absent or defective in the other lysosomal storage diseases.

[00201] The lysosomal storage diseases are generally classified by the nature of the primary stored material involved, and can be broadly broken into the following: (ICD-10 codes are provided where available).

[00202] •(E75) lipid storage disorders, mainly sphingolipidoses (including Gaucher's and Niemann-Pick diseases (E75.0-E75.1) gangliosidosis (including Tay-Sachs disease (E75.2) leukodystrophies.

[00203] •(E76.0) mucopolysaccharidoses (including Hunter syndrome and Hurler disease)

[00204] •(E77) glycoprotein storage disorders

[00205] •(E77.0-E77.1) mucopolipidoses

[00206] Also, Glycogen storage disease type II (Pompe disease) is also a defect in lysosomal metabolism, although it is otherwise classified into E74.0 in ICD-10.

Gaucher Disease

[00207] Gaucher Disease is an inherited lysosomal storage disorder caused by the absence or mutation of the gene GBA 1, which in turn leads to a deficiency in the GBA1 product, glucocerebrosidase (GCase). Intravenous administration of GCase relieves some symptoms of Gaucher in patients. A GCase deficiency also contributes to some inherited forms of Parkinson's Disease.

[00208] In one embodiment, the first region human HOX C12 homeodomain 60-amino acid sequence is:

SEQ ID No. 1 (Table 3):

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLNSDQQVKIWFQNR
RMKKKRLL

In another embodiment the first region human HOX D12 homeodomain 60-amino acid sequence is:

SEQ ID No. 2 (Table 3):

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNSDQQVKIWFQNR
RMKKKRVV

and in some embodiments, the linked second portion is the GCase amino acid sequence:

SEQ ID No. 30 (Table 3):

ARPCIPKSFGYSSVVCVCNATYCDSFDPPTFPALGTFSRYESTRSGRRMEL
SMGPIQANHTGTGLLLTLQPEQKFQKVKGFGGAMTDAAALNILALSPPAQNL
LLKSYFSEEGIGYNIIRVPMASCDFSIRTYTYADTPDDFQLHNFSLPEEDTKLK
IPLIHRALQLAQRPVSLASPWTSPTWLKTNGAVNGKGS�KGQPGDIYHQT
WARYFVKFLDAYAEHKLQFWAVTAENEPSAGLLSGYPFQCLGFTPEHQRD
FIARDLGPTLANSTHHNVRLMLDDQRLLPHWAKVVLTDPEAAKYVHGIAV
HWYLDLAPAKATLGETHRLFPNTMLFASEACVGSKFWEQSVRLGSWDRG
MQYSHSIITNLLYHVVGWTDWNLALNPEGGPNNWRNFVDSPHVDITKDTFY
KQPMFYHLGHFSKFIPEGSSQRVGLVASQKNDLDAVALMHPDGSAVVVVLNR
SSKDVPLTIKDPAVGFLETISPGYSIHTYLWRRQ

In yet other embodiments, the second region is a variation on the cargo sequence shown here. In another embodiment with the addition of an initiating methionine, the entire peptide sequence of the fusion protein with HOX C12 is

SEQ ID No. 31 (Table 3):

MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQ
 NRRMKKKRLLARPCIPKSFGYSSVVCVCNATYCDSFDPPTFPALGTFSRYE
 STRSGRRMELSMGPIQANHTGTGLLLTLQPEQKFQKVKGFGGAMTDAAAL
 NILALSPPAQNLLLKSYFSEEGIGYNIIRVPMASCDFSIRTYTYADTPDDFQLH
 NFSLPEEDTKLKIPLIHRALQLAQRPVSLASPWTSPTWLKTNGAVNGKGS
 KGQPGDIYHQTWARYFVKFLDAYAEHKLQFWAVTAENEPSAGLLSGYPFQ
 CLGFTPEHQRDIFIARDLGPTLANSTHHNVRLMLDDQRLLPHWAKVVLTD
 P EAAKYVHGI AVHWYLD FLAPAKATLGETHRLFPNTMLFASEACVGSKFWEQ
 SVRLGSWDRGMQYSHSIITNLLYHVVGWTDWNLALNPEGGPNNWRNFVDS
 PIIVDITKDTFYKQPMFYHLGHFSKFIPEGSQRVGLVASQKNDLDAVALMHPD
 GSAVVVLNRSSKDVPLTIKDPAVGFLETISPGYSIHTYLWRRQ

With the addition of an initiating methionine in yet another embodiment, the entire peptide sequence of the fusion protein with HOX D12 is

SEQ ID No. 32 (Table 3):

MARKKRKPYPYTKQQAELNEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQN
 RRMKKKRVARPCIPKSFGYSSVVCVCNATYCDSFDPPTFPALGTFSRYES
 TRSGRRMELSMGPIQANHTGTGLLLTLQPEQKFQKVKGFGGAMTDAAALNI
 LALSPPAQNLLLKSYFSEEGIGYNIIRVPMASCDFSIRTYTYADTPDDFQLHNF
 SLPEEDTKLKIPLIHRALQLAQRPVSLASPWTSPTWLKTNGAVNGKGS
 KGQPGDIYHQTWARYFVKFLDAYAEHKLQFWAVTAENEPSAGLLSGYPFQCLG
 FTPEHQRDIFIARDLGPTLANSTHHNVRLMLDDQRLLPHWAKVVLTDPEAA
 KYVHGI AVHWYLD FLAPAKATLGETHRLFPNTMLFASEACVGSKFWEQSVR
 LGSWDRGMQYSHSIITNLLYHVVGWTDWNLALNPEGGPNNWRNFVDSPIIV
 DITKDTFYKQPMFYHLGHFSKFIPEGSQRVGLVASQKNDLDAVALMHPDGS
 AVVVVLNRSSKDVPLTIKDPAVGFLETISPGYSIHTYLWRRQ

[00209] Linkers may not be required for function but linkers may be included in certain embodiments, for example, between SEQ ID Nos. 1 and 30 or between SEQ ID Nos. 2 and 30 without compromising function. Any linker known in the art may be used provided the function of the conjugate is not compromised with its addition. SEQ ID Nos. 31 and 32 embodiments, or variants or portions thereof would be altered, at least in part, to the extent that the linker sequence would bridge the first and second regions in each.

[00210] Protein glycosylation may be altered in the final structure as well. Exposure of mannose at several glycosylation sites may enhance lysosomal targeting of embodiments including, for example, SEQ ID Nos. 31 and/or 32 or variants or portions thereof.

[00211] In still further embodiments, additional amino acid sequences can be added to either the amino or carboxy termini in order to facilitate purification. Such sequences may include FLAG-tags (DYKDDDDK), myc-tags (EQKLISEEDL), His-tags (HHHHHH), and other similar tags known to those in the art. Such tags may or may not include linkers. In addition, ligands such as the biotin-acceptor protein (GLNDIFEAQKIEWHE) together with the active BirA protein may be used. For sequences that include an N-terminal initiating methionine, if a N-terminal purification domain is added the methionine will be on the N-terminal of the purification domain instead of at the N-terminal of the human homeodomain or HOX peptide first region.

[00212] Conjugate or fusion protein embodiments that include a human homeodomain or variant or portion thereof and, for example, the GCase sequence in the second region will be included in systemic formulations including intravenous, subcutaneous, intramuscular and injectable implant formulations for sustained release. In murine models of Gaucher Disease where human mutations are incorporated into the mouse GCase sequence, these fusion proteins prevent the accumulation of substrate in various tissues and prevent neurological manifestations of Gaucher Disease.

[00213] We will examine immunogenicity of the 60-amino acid human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) conjugate or fusion protein embodiments using lymphocyte proliferation assays that are well known in the art. To study the general ability of, for example, the 60-amino acid human homeodomain or variant or portion thereof to eliminate the immunogenicity of otherwise immunogenic proteins, isolated human mononuclear cells from subjects immune to tetanus toxoid are incubated *in vitro* for three days with tetanus toxoid or human homeodomain (or variant or portion thereof) peptide-tetanus toxoid conjugates at various concentrations to be determined, ranging from about 1 μ M to about 115 μ M. ³H-thymidine incorporation by lymphocytes in the cultures will then be determined.

[00214] In addition, we will evaluate immunogenicity of the enzyme fusion proteins or conjugate embodiments *in vitro*. Specifically, mononuclear leukocytes will be isolated from patients with known infusion reactions and antibody formation to the enzyme. Using techniques well known in the art these cells will be incubated *in vitro* with media alone and with various concentrations of the standard enzyme formulation and with various concentrations of the human HOX C12 or HOX D12 homeodomain peptide fusion protein and/or conjugate embodiments such as the GCcase sequence or variant or portion thereof, for example, between 1 μ M and about 115 μ M. The incorporation of 3H-thymidine by lymphocytes will be determined as a measure of the lymphocyte immune response.

[00215] For example, *in vitro* testing of the fusion protein embodiments comprising the GCcase cargo peptide conjugated to the 60-amino acid human HOX C12 or HOX D12 homeodomain or variant or portion thereof (e.g., embodiments comprising SEQ ID Nos. 24, 25, 27 and/or 28, or variants or portions thereof) will be evaluated. In one embodiment we will compare immunogenicity of the 60-amino acid human homeodomain conjugates or fusion proteins containing the GCcase peptide with the immunogenicity of the enzyme alone using lymphocyte proliferation assays of isolated human mononuclear leukocytes from patients with known immune-mediated infusion reactions when treated with enzyme alone. Following incubation *in vitro* for three to five days at an optimal micromolar concentration to be determined. Immunogenicity of embodiments comprising the 60-amino acid human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) conjugates or fusion proteins will be assessed by examining incorporation of 3H-thymidine by lymphocytes, and results compared to controls.

[00216] Later in clinical testing, various embodiments comprising human HOX C12 or HOX D12 homeodomain peptide fusion proteins or conjugates that include the GCcase sequence will be evaluated on the basis of their abilities to restore function without either clinically significant infusion reactions or functionally important anti-GCcase antibody production.

[00217] There are two examples of cellular assays that can be used to determine that an human homeodomain-GCcase conjugate embodiment is effective, and at what concentration. In normal cells, for example, to fibroblasts in culture, the addition of the substrate for GCcase results in activation of the enzyme and reduction of the

substrate (which accumulates in Gaucher Disease). In fibroblasts with defective or absent GBA 1 genes, the addition of the substrate for GCCase does not lead to substrate turnover. However in cultures with these cells, the addition of increasing amounts of human homeodomain-GCCase with exposed mannose residues or human homeodomain-GCCase conjugates delivers more enzyme to the cell and decreases, for example, radio-labeled substrate. Alternatively, in cells taken from Gaucher patients, for example, leukocytes, a fluorometric beta-glucosidase assay determines relative GCCase activity as a diagnosis of the disease, and is also usable as human cell assay to demonstrate the effectiveness of embodiments such as human homeodomain-GCCase fusion protein or conjugate in restoring enzyme activity.

[00218] In the fibroblast cell cultures with Gba1 gene mutations, GCCase cargo peptide (for example, SEQ ID No. 30) conjugated as a fusion protein to the human HOX C12 or HOX D12 homeodomain (for example, any of SEQ ID Nos. 1 and/or 2 or a portion thereof) will be active in this *in vitro* assay at various concentrations between about 1 μ M to about 115 μ M. We will measure the accumulation of the GCCase substrate, glucosylceramide, compared to that in control cultures.

[00219] Point mutations in the GBA1 gene of mice have produced a reliable model of Gaucher Disease. We will evaluate for up to two months of daily i.v. or i.p. administration of an embodiment comprising the human homeodomain-GCCase fusion protein or conjugate to reduce glucosylceramide (the GCCase substrate) accumulation in this murine model. The GCCase cargo peptide (for example, SEQ ID No. 30) conjugated as a fusion protein to the human HOX C12 or HOX D12 homeodomain (for example, any of SEQ ID Nos. 1 and/or 2 or a portion thereof) will be administered at a dose per mouse of between at least about 1 μ g to at least about 500 μ g or more. Again, we will assess the accumulation of the GCCase substrate, glucosylceramide, compared to that in control group.

[00220] In another mouse model of Gaucher Disease with central nervous system involvement, accumulation of α -synuclein and tau inclusions occur in regions of the brain and are hallmarks of neurodegenerative diseases, such as Parkinson's Disease. For example, single point mutations in the murine Gba1 locus (Gba1D409V/D409V) result in accumulation of α -synuclein/ubiquitin aggregates in the CNS and a measureable deficit in hippocampal memory. In this mouse model we will evaluate the ability of embodiments comprising the human HOX C12 or HOX

D12 homeodomain-GCase fusion protein or conjugate to cross the blood brain barrier and deliver enzyme capable of preventing the structural associations of Parkinson's Disease, with the goal of reducing accumulation of α -synuclein/ubiquitin aggregates in the brain, compared to the administration of the pure enzyme systemically. In this mouse model of Gaucher disease, the GCase cargo peptide (for example, SEQ ID No. 30) conjugated as a fusion protein to the human homeodomain (for example, any of SEQ ID Nos. 1 through 19, or a portion thereof) will be administered intravenously or intraperitoneally for up to two months at a dose per mouse of between at least about 1 μ g to at least about 500 μ g. We will assess the accumulation of the α -synuclein/ubiquitin aggregates in the brain by known methods compared to that in control group.

[00221] Alternative embodiments such as any of SEQ ID Nos. 1 through 19, or variants or portions thereof, conjugated to the GCase peptide include a variety of fusion proteins or conjugates comprising one or more linkers known in the art, provided the function of the conjugate is not compromised.

Hurler Syndrome

[00222] Another lysosomal storage disease, Hurler Syndrome, mucopolysaccharidosis I (MPS I), is one of the mucopolysaccharidoses, a group of inherited disorders caused by a lack of specific lysosomal enzymes involved in the degradation of glycosaminoglycans (GAGs), or mucopolysaccharides. The accumulation of partially degraded GAGs causes interference with cell, tissue, and organ function. Hurler Syndrome is due to an inherited deficiency of alpha-L-iduronidase due to abnormal IDUA gene structure or IDUA gene regulation and can result in a wide range of phenotypic involvement with 3 major recognized clinical entities: Hurler (MPS IH), Scheie (MPS IS; 607016), and Hurler-Scheie (MPS IH/S) syndromes. Hurler and Scheie syndromes represent phenotypes at the severe and mild ends of the MPS I clinical spectrum, respectively, and the Hurler-Scheie syndrome is intermediate in phenotypic expression.

[00223] Mucopolysaccharidosis 1H (MPS1H) is a severe form of mucopolysaccharidosis type 1 characterized by progressive physical deterioration with urinary excretion of dermatan sulfate and heparan sulfate. Patients with MPS1H usually present, within the first year of life, a combination of

hepatosplenomegaly, skeletal deformities, corneal clouding and severe mental retardation. Obstructive airways disease, respiratory infection and cardiac complications usually result in death before 10 years of age.

[00224] Mucopolysaccharidosis 1H/S (MPS1H/S) is a form of mucopolysaccharidosis type 1 characterized by progressive physical deterioration with urinary excretion of dermatan sulfate and heparan sulfate. MPS1H/S represents an intermediate phenotype of the MPS1 clinical spectrum. It is characterized by relatively little neurological involvement, but most of the somatic symptoms described for severe MPS1 develop in the early to mid-teens, causing considerable loss of mobility.

[00225] Mucopolysaccharidosis 1S (MPS1S) is a mild form of mucopolysaccharidosis type 1 characterized by progressive physical deterioration with urinary excretion of dermatan sulfate and heparan sulfate. Patients with MPS1S may have little or no neurological involvement, normal stature and life span, but present development of joints stiffness, mild hepatosplenomegaly, aortic valve disease and corneal clouding.

Here we refer to all of these clinical phenotypes as Hurler syndrome or MPS I. It is more frequent than MPS II (Hunter syndrome), which has no corneal clouding and pursues a slower course (see below).

[00226] In one embodiment, the HOX C12 amino acid sequence first region is SEQ ID No. 1:

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQNR
RMKKKRLL

In another embodiment, the HOX D12 amino acid sequence first region is SEQ ID No. 2:

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQNR
RMKKKRVV

The second region may be, for example, SEQ ID No. 45 (Table 3), the 653 amino acid Alpha-L-iduronidase sequence (including the 27 amino acid signal peptide):

MRPLRPRAALLALLASLLAAPPVAPAEAPHLVHVDAARALWPLRRFWRSTG
 FCPPLPHSQADQYVLSWDQQLNLAYVGAVPHRGIKQVRTHWLLELVTTRGS
 TGRGLSYNFTHLDGYLDLLRENQLLPGFELMGSASGHFTDFEDKQQVFEW
 KDLVSSLARRYIGRYGLAHVSKWNFETWNEPDHHDFDNVSMTMQGFLNYY
 DACSEGLRAASPALRLGGPGDSFHTPPRSPLSWGLLRHCHDGTNFFTGEA
 GVRLDYISLHRKGARSSISILEQEKVVAQQIRQLFPKFADTPIYNDEADPLVG
 WSLPQPWRADVITYAAMVVKVIAQHQNLLANTTSAPFYALLSNDNAFLSYH
 PHPFAQRTLRTARFQVNNTRPPHVQLLRKPVLTAMGLLALLDEEQLWAEVSQ
 AGTVLDSNHTVGVLASAHRPQGPADAWRAAVLIYASDDTRAHPNRSVAVTL
 RLRGVPPGPGLVYVTRYLDNGLCSPDGEWRRRLGRPVPFPTAEQFRRMRAAE
 DPVAAAPRPLPAGGRLTLRPALRLPSLLLHVHVCARPEKPPGQVTRLRALPLT
 QGQLVLVWSDEHVGSKCLWTYEIQFSQDGKAYTPVSRKPSTFNLVFVSPDT
 GAVSGSYRVRALDYWARPGPFSDPVPYLEVPVPRGPPSPGNP

In yet other embodiments, the second region is a variation on the cargo sequence shown here. And the complete sequence of this embodiment including the HOX C12 homeodomain with an initiating methionine may be, for example, SEQ ID No. 46 (Table 3):

MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQ
 NRRMKKKRLLMRPLRPRAALLALLASLLAAPPVAPAEAPHLVHVDAARALW
 PLRRFWRSTGFCPPLPHSQADQYVLSWDQQLNLAYVGAVPHRGIKQVRTH
 WLLELVTTRGSTGRGLSYNFTHLDGYLDLLRENQLLPGFELMGSASGHFTD
 FEDKQQVFEWKDLVSSLARRYIGRYGLAHVSKWNFETWNEPDHHDFDNVS
 MTMQGFLNYYDACSEGLRAASPALRLGGPGDSFHTPPRSPLSWGLLRHCH
 DGTNFFTGEAGVRLDYISLHRKGARSSISILEQEKVVAQQIRQLFPKFADTPIY
 NDEADPLVGWSLPQPWRADVITYAAMVVKVIAQHQNLLANTTSAPFYALLS
 NDNAFLSYHPPHFAQRTLRTARFQVNNTRPPHVQLLRKPVLTAMGLLALLDEE
 QLWAEVSQAGTVLDSNHTVGVLASAHRPQGPADAWRAAVLIYASDDTRAH
 PNRSVAVTLRLRGVPPGPGLVYVTRYLDNGLCSPDGEWRRRLGRPVPFPTAE
 QFRRMRAAEDPVAAAPRPLPAGGRLTLRPALRLPSLLLHVHVCARPEKPPGQ
 VTRLRALPLTQGQLVLVWSDEHVGSKCLWTYEIQFSQDGKAYTPVSRKPST
 FNLVFVSPDTGAVSGSYRVRALDYWARPGPFSDPVPYLEVPVPRGPPSPG
 NP

The complete sequence of another embodiment including the HOX D12 homeodomain with an initiating methionine may be, for example, SEQ ID No. 47 (Table 3):

MARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDDQQVKIWFQN
 RRMKKKRVMRPLRPRAALLALLASLLAAPPVAPAEAPHLVHVDAARALWP
 LRRFWRSTGFCPPPLPHSQADQYVLSWDQQLNLAYVGAVPHRGIKQVRTHW
 LLELVTTTRGSTGRGLSYNFTHLDGYLDLLRENQLLPGFELMGSASGHFTDFE
 DKQQVFEWKDLVSSLARRYIGRYGLAHVSKWNFETWNEPDHHDNDVSM
 MQGFLNYYDACSEGLRAASPALRLGGPGDSFHTPPRSPLSWGLLRHCHDG
 TNFFTGEAGVRLDYISLHRKGARSSISILEQEKVVAQQIRQLFPKFADTPIYND
 EADPLVGWSLPQPWRADVITYAAMVVKVIAQHQNLLANTTSAPFYALLSND
 NAFLSYHHPFAQRTLTA RFQVNNTRPPHVQLLRKPVLTAMGLLALLDEEQ
 WAEVSQAGTVLDSNHTVGVLASAHRPQGPADAWRAAVLIYASDDTRAHPN
 RSVAVTLRLRGVPPGPGLVYVTRYLDNGLCSPDGEWRRLGRPVPFPTAEQF
 RRMRAAEDPVAAAPRPLPAGGRLTLRPALRLPSLLLVHVCARPEKPPGQVT
 RLRLPLTQGGQLVLVWSDEHVGSKCLWTYEIQFSQDGKAYTPVSRKPSTFN
 LFVFSPDTGAVSGSYRVRALDYWARPGPFSDPVPYLEVPVPRGPPSPGNP

[00227] In some embodiments, protein glycosylation may be altered in the final structure as well. Exposure of mannose at several glycosylation sites may enhance lysosomal targeting of an alpha-L-iduronidase-containing fusion protein or conjugate embodiment.

[00228] Fusion protein and conjugate embodiments comprised of the 60-amino acid human homeodomain or variant or portion thereof and the active alpha-L-iduronidase enzyme or an alternative alpha-L-iduronidase-containing fusion protein or conjugate embodiment with one or more linkers will be evaluated in a mouse model for their abilities to reach (1) sites of accumulated GAGs in (1) brain tissue, (2) chondrocytes within articular cartilage, and (3) the growth plate cartilage of long bones.

[00229] The MPS 1-H knock-in mouse model of Hurler Syndrome carries a mutation that is analogous to the mutation found in the Hurler Syndrome patients (IDUA-W402X); the MPS 1-H mice exhibit a phenotype of biochemical, metabolic and morphological abnormalities that correlate with abnormalities in previously utilized Hurler Syndrome animal models, and with abnormalities in the most severe form of alpha-L-iduronidase deficiency in these patients. Wang et al. "Characterization of an MPS 1-K knock-in mouse that carries a nonsense mutation analogous to the human IDUA-W402X mutation" Molecular Genetics and Metabolism 99:62-71, 2010.

[00230] In this model we will administer i.v. or i.p. injections of a formulation embodiment comprising the alpha-L-iduronidase enzyme conjugated to the human homeodomain or variant or portion thereof, or an alternative alpha-L-iduronidase-containing fusion protein or conjugate embodiment with one or more linkers at a dose per mouse of 1 µg to at least 500 µg, if solubility permits. We will assess the accumulation of GAGs (heparan sulfate and dermatan sulfate) using histopathology techniques, and compare these results to a control group's results.

[00231] In patients with Hurler Syndrome, we will evaluate the effects of fusion protein or conjugate embodiments comprising the active alpha-L-iduronidase enzyme on GAG accumulation by measuring the reduction of urinary excretion of GAGs, including heparan sulfate and dermatan sulfate. Specifically, patients with Hurler Syndrome will be treated systemically with chronic daily dosing of the formulation embodiments comprising alpha-L-iduronidase enzyme conjugated to a 60-amino acid human HOX C12 or HOX D12 homeodomain or variant or portion thereof, or an alternative alpha-L-iduronidase-containing fusion protein or conjugate embodiment with one or more linkers at a dose of less than about 0.01 mg/kg to less than about 100 mg/kg. GAG excretion in urine (heparan sulfate and dermatan sulfate) will be assessed by known methods, and results will be compared to patients who received a formulation embodiment comprising the alpha-L-iduronidase enzyme not in fusion protein or conjugate form. Further, we will evaluate skeletal and brain development assessed by standard growth and development pediatric techniques.

[00232] Various embodiments comprising the human HOX C12 or HOX D12 homeodomain-alpha-L-iduronidase fusion protein or conjugate will be tested *in vitro* in cultures of fibroblast cell lines with homozygous mutations of the IDUA gene as occurs in patients born with Hurler Syndrome. In these cultures, GAG turnover with and without a fusion protein or conjugate embodiment will be measured to confirm active enzyme and reduced lysosomal accumulation of dermatan sulfate and heparan sulfate.

[00233] In the fibroblast cell cultures with homozygous mutations of the IDUA gene, one embodiment comprising the human HOX C12 or HOX D12 homeodomain-alpha-L-iduronidase fusion protein, or alternative alpha-L-iduronidase-containing fusion protein or conjugate embodiment comprising one or more linkers, will be active in this *in vitro* assay at an optimal concentration between about 1 µM to about

115 μ M. Again, we will measure the accumulation of GAG substrates, dermatan sulfate and heparin sulfate, and compare our results to control cultures.

[00234] We will further evaluate the immunogenicity of the human HOX C12 or HOX D12 homeodomain-alpha-L-iduronidase fusion protein or conjugate embodiments in lymphocyte cultures using peripheral blood mononuclear cells from MPS I patients with documented infusion reactions while receiving replacement enzyme therapy.

[00235] In one embodiment we will compare immunogenicity of the 60-amino acid human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) conjugates or fusion proteins containing the alpha-L-iduronidase peptide with the immunogenicity of the enzyme alone using lymphocyte proliferation assays in isolated human mononuclear leukocytes from patients with known allergic (infusion) reactions when receiving standard alpha-L-iduronidase enzyme replacement therapy. ³H-thymidine incorporation is measured following incubation *in vitro* for three to five days at an optimal enzyme concentration between about 1 μ M to about 115 μ M. Immunogenicity of an embodiment comprising the 60-amino acid human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) conjugate or fusion protein will be assessed by examining incorporation of ³H-thymidine by lymphocytes, and results will be compared to those of the treatment group receiving only the enzyme.

[00236] Immunogenicity of human HOX C12 or HOX D12 homeodomain-enzyme fusion protein and/or conjugate embodiments in the clinic will be compared to that of standard enzyme replacement proteins by comparing the occurrence of allergic infusion reactions and the production of IgG anti-enzyme antibody.

[00237] Alternative embodiments comprising, for example, any of SEQ ID Nos. 1 through 19, or variants or portions thereof, conjugated to the α -L-iduronidase peptide include a variety of fusion protein or conjugate embodiments, and can further comprise any one or more linkers known in the art provided the function of the conjugate is not compromised with the addition of one or more linker(s).

Hunter Syndrome

[00238] Hunter Syndrome or mucopolysaccharidosis II (MPS II) is a rare X-linked recessive disorder caused by deficiency of the lysosomal enzyme iduronate-2-

sulfatase, leading to progressive accumulation of glycosaminoglycans in nearly all cell types, tissues, and organs. Patients with MPS II excrete excessive amounts of chondroitin sulfate B (dermatan sulfate) and heparitin sulfate (heparan sulfate) in the urine. MPS II is a multisystem disorder. Most children with MPS2 have a severe form with early somatic abnormalities including skeletal deformities, hepatosplenomegaly, and progressive cardiopulmonary deterioration. A prominent feature is neurological damage that presents as developmental delay and hyperactivity but progresses to mental retardation and dementia. They die before 15 years of age, usually as a result of obstructive airway disease or cardiac failure. In contrast, those with a mild form of MPS2 may survive into adulthood, with attenuated somatic complications and often without mental retardation (Wraith, J. E. et al. "Mucopolysaccharidosis type II (Hunter syndrome): a clinical review and recommendations for treatment in the era of enzyme replacement therapy" Europ. J. Pediat. 167: 267-277, 2008).

[00239] In one embodiment, the first region human HOX C12 homeodomain 60-amino acid sequence is:

SEQ ID No. 1 (Table 3):

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQNR
RMKKKRLL

In another embodiment the first region human HOX D12 homeodomain 60-amino acid sequence is:

SEQ ID No. 2 (Table 3):

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQNR
RMKKKRVV

And the second region may be, for example, SEQ ID No. 48, the Iduronate-2-sulfatase enzyme (550 amino acids including 25 amino acid signal sequence):

MPPPRTGRGLLWLGLVLSSVCVALGSETQANSTTDALNVLLIIVDDLRLPSLG
 CYGDKLVRSPNIDQLASHSLLFQNAFAQQAVCAPSRVSFLTGRRPDTTRL
 YDFNSYWRVHAGNFSTIPQYFKENGYVTMSVGKVFHPGISSNHTDDSPYSW
 SFPPYHPSSSEKYENTKTCRGPDGELHANLLCPVDVLDVPEGTL PDKQSTEQ
 AIQLLEKMKTSASPPFLAVGYHKPHIPFRYPKEFQKLYPLENITLAPDPEVPD
 GLPPVAYNPWMDIRQREDVQALNISVPYGPVDFQRKIRQSYFASVSYLDT
 QVGRLLSALDDLQLANSTIIAFTSDHGWALGEHGEWAKYSNFDVATHVPLIF
 YVPGRTASLPEAGEKLPYLPFDSASQLMEPGRQSMDLVELVSLFPTLAG
 LAGLQVPPRCPVPSFHVELCREGKNLLKHFRFRDLEEDPYLPGNPRELIAYS
 QYPRPSDIPQWNSDKPSLKD IKIMGYSIRTIDYRYTVWVGFPNDEF LANFSDI
 HAGELYFVDS DPLQDHNMYNDSQGGDLFQLLMP

In yet other embodiments, the second region is a variation on the cargo sequence shown here. The complete amino acid sequence embodiment of the combined first (HOX C12) and second region with an initiating methionine is, for example, SEQ ID No. 49:

MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDQQVKIWFQ
 NRRMKKKRLLMPPPRTGRGLLWLGLVLSSVCVALGSETQANSTTDALNVLLI
 IVDDLRLPSLGCYGDKLVRSPNIDQLASHSLLFQNAFAQQAVCAPSRVSFLTG
 RRPDTTRL YDFNSYWRVHAGNFSTIPQYFKENGYVTMSVGKVFHPGISSNH
 TDDSPYSWSFPPYHPSSSEKYENTKTCRGPDGELHANLLCPVDVLDVPEGTL
 PDKQSTEQAIQLLEKMKTSASPPFLAVGYHKPHIPFRYPKEFQKLYPLENITL
 APDPEVPDGLPPVAYNPWMDIRQREDVQALNISVPYGPVDFQRKIRQSYF
 ASVSYLDTQVGRLLSALDDLQLANSTIIAFTSDHGWALGEHGEWAKYSNFDV
 ATHVPLIFYVPGRTASLPEAGEKLPYLPFDSASQLMEPGRQSMDLVELVS
 LFPTLAGLAGLQVPPRCPVPSFHVELCREGKNLLKHFRFRDLEEDPYLPGN
 PRELIAYSQYPRPSDIPQWNSDKPSLKD IKIMGYSIRTIDYRYTVWVGFPNDE
 FLANFSDIHAGELYFVDS DPLQDHNMYNDSQGGDLFQLLMP

The complete amino acid sequence embodiment of the combined first (HOX D12) and second region with an initiating methionine is, for example SEQ ID No. 50:

MARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSQQVQKIWFQN
 RRMKKKRVMPPPTGRGLLWLGLVLSSVCVALGSETQANSTTDALNVLLII
 VDDLRLPSLGCGDKLVRSPNIDQLASHSLLFQNAFAQQAVCAPSRVSFLTG
 RRPDTTRLTYDFNSYWRVHAGNFSTIPQYFKENGYVTMSVGKVFHPGISSNH
 TDDSPYSWSFPPYHPSSSEKYENTKTCRGPDGELHANLLCPVDVLDVPEGTL
 PDKQSTEQAIIQLLEKMKTSASPFLLAVGYHKPHIPFRYPKEFQKLYPLENITL
 APDPEVPDGLPPVAYNPWMDIRQREDVQALNISVPYGPPIVDFQRKIRQSYF
 ASVSYLDTQVGRLLSALDDLQLANSTIIAFTSDHGWALGEHGEWAKYSNFDV
 ATHVPLIFYVPGRTASLPEAGEKLPYLDPFDSASQLMEPGRQSMDELVELVS
 LFPTLAGLAGLQVPPRCVPSPFHVELCREGKNLLKHFRFRDLEEDPYLPGN
 PRELIAYSQYPRPSDIPQWNSDKPSLKDIIKIMGYSIRTIDYRYTVWVGFPNPDE
 FLANFSDIHAGELYFVDSPLQDHNMYNDSQGGDLFQLLMP

[00240] In some embodiments, protein glycosylation may be altered in the final structure as well. Exposure of mannose at several glycosylation sites may enhance lysosomal targeting of the human HOX C12 or HOX D12 homeodomain-iduronate-2-sulfatase fusion protein or conjugate embodiments.

[00241] In the fibroblast cell cultures with homozygous mutations of the IDS gene, an embodiment such as the human HOX C12 or HOX D12 homeodomain-iduronate-2-sulfatase fusion protein, or alternative iduronate-2-sulfatase-containing fusion protein or conjugate embodiment comprising one or more linkers, will be active in this *in vitro* assay at various concentrations between about 1 μ M to about 115 μ M. Again, we will measure the accumulation of GAG substrates, and compare our results to control cultures.

[00242] In a murine model (*idsy*/−) of MPSII (Hunter Syndrome) that has also been used to evaluate experimental gene therapy approaches, the onset of the gross morphological phenotype is manifest at 3–4 months of age, and becomes progressively more severe until death at age 60 to 70 weeks. This phenotype includes reduced weight gain, craniofacial and other skeletal abnormalities, with a short cranium and alopecia and thickening of the digits. Further, these mice show irregular gait, abnormal walking pattern and poor locomotor and exploratory abilities in the open-field test. IDS activity in this mouse model is undetectable in liver, spleen, lung, heart, kidney, skeletal muscle, brain and eye when compared with the activities of this enzyme in the wild-type tissues. However, IDS initiates the catabolism of the dermatan and heparan sulfate GAGs. The loss of IDS activity

causes GAG accumulation within all tissues after just several days of life, with a dramatic increase seen during adult life stages; it leads to progressive cellular vacuolization and the consequent cell death. MPSII mice at 3 and 9 months of age show high levels of GAG storage within the cells and, as shown in radiographic assays, progressive GAG accumulation caused skeletal deformation as well, which affected the performance in locomotor tests. (Polito, VA et al. "Correction of Hunter syndrome in the MPSII mouse model by AAV2/8-mediated gene delivery." Hum. Mol. Genet. 15(7):1225-36, April 1, 2006).

[00243] We will examine IDS activity by visualizing and quantifying GAG accumulation in protein extracts prepared from tissue homogenates of these MPSII mice using the fluorescent substrate 4-methylumbelliferyl- α -iduronate-2-sulfate. GAGs can be visualized in tissues by Alcian-blue staining of the paraffin-embedded sections of liver, spleen, lung, heart, kidney and skeletal muscle in these mice. In addition, GAG concentrations will be determined using a dimethyl-methylene blue assay with protein.

[00244] We will administer to male *idsy*^{-/-} mice i.v. or i.p. injections of a formulation embodiment comprising the iduronate-2-sulfatase peptide conjugated to the human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) at a dose per mouse of 1 μ g to at least 500 μ g or more, if solubility permits. We will assess the accumulation of GAGs (heparan sulfate and dermatan sulfate) using histopathology techniques, and compare these results to those of a control group.

[00245] In patients with Hunter Syndrome, we intend to evaluate the effect of treatment with formulation embodiments comprising the human HOX C12 or HOX D12 homeodomain-iduronate-2-sulfatase fusion protein or conjugate on systemic manifestations of the disease, including those in the CNS, in bone, and in joints, in relation to normal development. Patients with Hunter Syndrome will be treated systemically with chronic daily dosing of the formulation embodiments comprising, for example, iduronate-2-sulfatase enzyme conjugated to the human HOX C12 or HOX D12 homeodomain or variant or portion thereof, or an alternative fusion protein or conjugate embodiment comprising the iduronate-2-sulfatase sequence and one or more linkers at a dose of less than about 0.01 mg/kg to less than about 100 mg/kg. GAG excretion in urine (heparan sulfate and dermatan sulfate) will be assessed by known methods, and results will be compared to patients who received a formulation

comprising the iduronate-2-sulfatase enzyme not in fusion protein or conjugate form. Further, we will evaluate skeletal and brain development assessed by standard growth and development pediatric techniques.

[00246] We will further evaluate the *in vitro* immunogenicity of human HOX C12 or HOX D12 homeodomain-iduronate-2-sulfatase fusion protein or conjugate embodiments by comparing the proliferative responses in the treatment versus control (placebo) groups. Lymphocyte cultures will be prepared using peripheral blood mononuclear cells from MPS II patients in whom there have been documented infusion reactions while receiving replacement enzyme therapy. Proliferative responses will be determined by measuring incorporation of 3H-thymidine in these cells after three to five days of culture. In one embodiment we will compare immunogenicity of the 60-amino acid human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) conjugates or fusion proteins containing the human homeodomain-iduronate-2-sulfatase peptide with the immunogenicity of the enzyme alone using lymphocyte proliferation assays in isolated human mononuclear leukocytes following incubation *in vitro* for three to five days at an optimal concentration to be determined, in the range of about 1 μ M to about 115 μ M. Immunogenicity of embodiments comprising the 60-amino acid human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) conjugates or fusion proteins will be assessed by examining incorporation of 3H-thymidine by lymphocytes.

[00247] Alternative embodiments comprising, for example, any of SEQ ID Nos. 1 through 19, or variants or portions thereof, conjugated to the iduronate-2-sulfatase peptide include a variety of fusion proteins or conjugates, and can comprise any one or more linkers known in the art provided the function of the conjugate is not compromised by the addition of one or more linker(s).

EXAMPLE 4

Retinal membrane guanylyl cyclase (RetGC-1) Replacement Therapy in Congenital Blindness

[00248] Leber Congenital Amourosis type 1 (LCA1): Human RetGC-1 is an 1103 amino acid protein, including amino acids 52-1103 coding the enzyme alone without the signal peptide. RetGC-1 is the gene product of RPE65 which, when absent or mutated, causes blindness. In this disease residual cone-photoreceptor vision

correlates with biochemical properties of the mutants implying that vision restoration can be achieved if RetGC-1 enzyme activity in the retinal can be restored. Embodiments and their modifications disclosed herein therefore include fusion proteins or conjugates comprising the 60-amino acid human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) cell permeable peptides and the RetGC-1 enzyme as a cargo peptide, and can be administered in any number or formulation embodiments for periodic intraocular injection or topical administration.

[00249] In one embodiment, the first region human HOX C12 homeodomain 60-amino acid sequence is:

SEQ ID No. 1 (Table 3):

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLNSDQQVKIWFQNR
RMKKKRLL

In another embodiment the first region human HOX D12 homeodomain 60-amino acid sequence is:

SEQ ID No. 2 (Table 3):

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNSDQQVKIWFQNR
RMKKKRVV

and the linked second region is, for example, a RetGC-1 enzyme sequence such as:

SEQ ID No. 33 (Table 3):

AVFTVGVLPWACDPIFSRARPDLAARLAAARLNRPGLAGGPRFEVALLP
 EPCRTPGSLGAVSSALARVSGLVGPVNPAACRPAELLAEEAGIALVPWGCP
 WTQAEGTTAPAVTPAADALYALLRAFGWARVALVTAPQDLWVEAGRSLSTA
 LRARGLPVASVTSMEPLDLGAREALRKVRDGPRTAVIMVMHVSLLGGEE
 QRYLLEAAEELGLTDGSLVFLPFDTIHYALSPGPEALAALANSSQLRRAHDA
 VLTLTRHCPSEGSVLDSLRRARERRELPSDLNLQQVSPLFGTIYDAVFLAR
 GVAEAAAAGGRWVSGAAVARHIRDAQVPGFCGDLGGDEEPPFVLLDTDA
 AGDRLFATYMLDPARGSFSLGATRMHFPRGGSAPGPDPSWFDPNNICGG
 GLEPGLVFLGFLLVGMGLAGAFLAHYVRHRLHMQMVSGPNKIILTVDDITF
 LHPHGGTSRKVAQGSRSSLGARMSDIRSGPSQHLDSPNIGVYEGDRVWL
 KKFPDQGHIAIRPATKTAFSKLQELRHENVALYLGLFLARGAEGPAALWEGN
 LAVVSEHCTRGSLQDLLAQREIKLDWMFKSSLLLDLIKIRYLHHRGVAGHR
 LKSRNCIVDGRFVLKITDHGHGRLLAQKVLPEPPRAEDQLWTAPELLRDPA
 LERRGTLAGDVFSLAIMQEVVCRSAPYAMLELTPEEVVQVRSPPLCRPL
 VSMQAPVECILLMKQCWAEQPELRPSMDHTFDLFKNINKGRKTNIIDSMRL
 MLEQYSSNLEDLIRERTEELELEKQKTDRLLTQMLPPSVAEALKTGTPVEPE
 YFEQVTLYFSDIVGFTTISAMSEPIEVVDLLNDLYTLFDAIGSHDVYKVETIGD
 AYMVASGLPQRNGQRHAAEIANMSLDILSAVGTFMRMHMPEVPVRIRIGLHS
 GPCVAGVGLTMPRYCLFGDTVNTASRMESTGLPYRIHVNLSTVGILRALDS
 GYQVELRGRTELKGKGAEDTFWLVGRRGFNKPIPKPPDLQPGSSNHGISLQ
 EIPPERRRKLEKARPGQFS.

In yet other embodiments, the second region is a variation on the cargo sequence shown here. And in another embodiment with the addition of an initiating methionine, the entire peptide sequence of the fusion protein including HOX C12 is, for example:

SEQ ID No. 34 (Table 3):

MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQ
 NRRMKKKRL LAVFTVGV LGPWACDPIFSRARPD LAARLAAARLNRDPGLAG
 GPRFEVALLPEPCRTPGSLGAVSSALARVSGLVGPVNPAACRPAELLAEEA
 GIALVPWGPCWTQAEGTTAPAVTPAADALYALLRAFGWARVALVTAPQDL
 WVEAGRSLSTALRARGLPVASVTSMEPLDL SGAREALRKVRDGPRVTAVIM
 VMHSVLLGGEEQRYLLEAAEELGLTDGSLVFLPFDTHYALSPGPEALAALA
 NSSQLRRAHDAVLTLTRHCPSEGSVLD SLRRAQERRELP SDDLNLQQVSPLF
 GTIYDAVFLLARGVAEAAAAGGRWVSGAAVARHIRDAQVPGFCGDLGGD
 EEPFVLLDTDAAGDRLFATYMLDPARGSFLSAGTRMHFPRGGSAPGPDPS
 CWFDPNNICGGGLEPGLVFLGFLLVGMGLAGAF LAHYVRHRLLMQMV
 GPNKIILTVDDITFLHPHGGTSRKVAQGSRSSLGARMSDIRSGPSQHLDSP
 NIGVYEGDRVWLKKFPGDQHIAIRPATKTAFSKLQELRHENVALYLGLFLAR
 GAEGPAALWEGNLAVVSEHCTRGS LQDLAQREIKLDWMFKSSLLDLIKGI
 RYLHHRGVAHGRLKSRNCIVDGRFVLKITDHGHGRLL EAQKVLPEPPRAED
 QLWTAPELLRDPALERRGTLAGDVFS LAIIMQEVVCRSAPYAMLELTPEEVV
 QVRSPPLCRPLVSM DQAPVE CILLMKQCWAEQPELRPSMDHTFDLFKNI
 NKGRKTNIIDSMLRMLEQYSSNLEDLIRERTEEELEKQKTDRLLTQMLPPSV
 AEALKTGTPVEPEYFEQVTLYFSDIVGFTTISAMSEPIEVVDLLNDLYTLFDAI
 GSHDVYKVETIGDAYMVASGLPQRNGQRHAAEIANMSLDILSAVGTFMRH
 MPEVPVRIRIGLHSGPCVAGVVGLTMPRYCLFGDTVNTASRMESTGLPYRIH
 VNLSTVGILRALDSGYQVELRGRTELKGKGAEDTFWLVGRRGFNKPIPKPP
 DLQPGSSNHGISLQEIPERRRKLEKARPGQFS

And in yet another embodiment with the addition of an initiating methionine, the entire peptide sequence of the fusion protein including HOX D12 is, for example:

SEQ ID No. 35 (Table 3):

MARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSQQVQKIWFQN
 RRMKKKRVVAVFTVGVLPWACDPIFSRARPDLAARLAAARLNDRDPGLAGG
 PRFEVALLPEPCRTPGSLGAVSSALARVSGLVGPVNPAACRPAELLAEEAGI
 ALVPWGCPWTQAEGTTAPAVTPAADALYALLRAFGWARVALVTAPQDLWV
 EAGRSLSTALRARGLPVASVTSMEPLDLSGAREALRKVRDGPRVTAVIMVM
 HSVLLGGEEQRYLLEAAEELGLTDGSLVFLPFDTIHYALSPGPEALAALANSS
 QLRRAHDAVLTLTRHCPSEGSVLDSLRRARERRELPSDLNLQQVSPLFGTIY
 DAVFLLARGVAEAAAAGGRWVSGAAVARHIRDAQVPGFCGDLGGDEEPP
 FVLLDTDAAGDRLFATYMLDPARGSFLSAGTRMHFPRGGSAPGPDPSCHF
 DPNNICGGGLEPGLVFLGFLLVGMGLAGAFLAHYVRHRLMHMQMVSGPNK
 IILTVDDITFLHPHGGTSRKVAQGSRSSLGARMSDIRSGPSQHLDSPNIGVY
 EGDRVWLKKFPGDQHIAIRPATKTAFSKLQELRHENVALYLGLFLARGAEGP
 AALWEGNLAVVSEHCTRGSLLQDLAQREIKLDWMFKSSLLLDLIKIRYLHH
 RGVAHGRLKSRNCIVDGRFVLKITDHGHGRLLLEAQKVLPEPPRAEDQLWTA
 PELLRDPALERRGTLAGDVFSLAIMQEVVCRSAPYAMLELTPEEVVQVRVS
 PPPLCRPLVSMDQAPVEICILLMKQCWAEQPELRPSMDHTFDLFKNINKGRK
 TNIIDSMLRMLEQYSSNLEDLIRERTEEELEKQKTDRLLTQMLPPSVAEALK
 TGTPVEPEYFEQVTLYFSDIVGFTTISAMSEPIEVVDLLNDLYTLFDAIGSHDV
 YKVETIGDAYMVASGLPQRNGQRHAAEIANMSLDILSAVGTFMRMRHMPEVP
 VRIRIGLHSGPCVAGVVGLTMPRYCLFGDTVNTASRMESTGLPYRIHVNLST
 VGILRALDSGYQVELRGRTELKGKGAEDTFWLVGRRGFNKPIPKPPDLQPG
 SSNHGISLQEIPERRRKLEKARPGQFS

[00250] Linkers may not be required for function but linkers may be included in a variety of embodiments, for example, between SEQ ID Nos. 1 and 33, or between SEQ ID Nos. 2 and 33, or variants or portions thereof, without compromising function. Any linker known in the art may be used, provided the function of the conjugate is not compromised by its addition. Embodiments, for example, such as SEQ ID Nos. 34 and/or 35 or variants or portions thereof would be altered, at least in part, to the extent that the linker sequence would bridge these first and second regions.

[00251] In still further embodiments, additional amino acid sequences can be added to either the amino or carboxy termini in order to facilitate purification. Such sequences may include FLAG-tags (DYKDDDDK), myc-tags (EQKLISEEDL), His-tags (HHHHHH), and other similar tags known to those in the art. Such tags may or

may not include linkers. In addition, ligands such as the biotin-acceptor protein (GLNDIFEAQKIEWHE) together with the active BirA protein may be used. For sequences that include an N-terminal initiating methionine, if a N-terminal purification domain is added the methionine will be on the N-terminal of the purification domain instead of at the N-terminal of the human homeodomain or HOX peptide first region.

[00252] Successful functional translocation of the enzyme into cells in which the enzyme is usually low or absent, for example, enzyme translocation in HEK293 cells can be determined by providing the enzyme's substrate and measuring guanylyl cyclase activity by standard methods. Evidence of increased guanylyl cyclase activity would be taken as experimental evidence that an embodiment such as a human HOX C12 or HOX D12 homeodomain with cell permeabilizing capabilities can deliver functional enzyme to human cells.

[00253] We will evaluate embodiments comprising, for example, a human HOX C12 or HOX D12 homeodomain-RetGC-1 enzyme fusion protein or conjugate in a mouse knock-out model. The animal model that best approximates LCA1 is a mouse knock-out of Gucy2e, a gene that encodes RetGC-1. This mouse exhibits nonresponsive cone photoreceptors and demonstrates the LCA1 phenotype. Jacobson et al. "Determining consequences of retinal membrane guanylyl cyclase (RetGC1) deficiency in human Leber congenital amaurosis en route to therapy: residual cone-photoreceptor vision correlates with biochemical properties of the mutants." Human Molecular Genetics 22(1):168-83, 2013.

[00254] We will administer an embodiment of a human homeodomain-RetGC-1 conjugate or fusion protein by retinal (retrobulbar) injection or by eye drops (i.e., topically) to the knock-out mice with evaluation of restored electroretinogram (ERG) function as a measure of returned vision. Results will be compared to those in a control group administered a buffer without the human HOX C12 or HOX D12 homeodomain-RetGC-1. In one embodiment, proteins will be administered to mice by retinal (retrobulbar) injection or by eye drops a formulation comprising the RetGC-1 peptide conjugated to the human HOX C12 or HOX D12 homeodomain or variant or portion thereof, or alternative RetGC-1-containing fusion protein or conjugate embodiments comprising one or more linkers at a dose per 20 g mouse of at least about 1 µg to at least about 500 µg. We will examine restoration of ERG function compared to that of an untreated control group.

[00255] In children with Leber Congenital Amourosis type 1 (LCA1), changes in visual acuity and electroretinogram function will be evaluated after chronic (daily, every other day, twice per week, weekly or less frequent) treatment with an ophthalmic formulation embodiment comprising the RetGC-1 peptide conjugated to the human HOX C12 or HOX D12 homeodomain or variant or portion thereof or alternative fusion protein or conjugate embodiments comprising the RetGC-1 sequence and one or more linkers at a dose of less than about 0.01 mg/kg to less than about 100 mg/kg. After various treatment durations such as 1 day, 3 days, 1 week, 2 weeks, 3 weeks or 4 weeks or longer, Patients receiving the fusion protein or conjugate treatment will be compared to their pretreatment values to evaluate clinically meaningful improvements in visual function using standard clinical methods to assess visual acuity, including, without limitation, ERG function.

[00256] Alternative embodiments comprising any of SEQ ID Nos. 1 through 19, or variants or portions thereof, conjugated to the RetGC-1 peptide include a variety of fusion proteins or conjugates comprising any one or more linkers known in the art, provided the function of the conjugate is not compromised by the addition.

EXAMPLE 5

A Regulatory Peptide for Huntington's Disease (HD)

[00257] Huntington's Disease (HD), a neurodegenerative genetic disorder that affects muscle coordination and leads to cognitive decline, is caused by the expression of a mutant Huntingtin gene (HTT). It often manifests in the mid-30s to early 40s, but may begin earlier with both physical and mental abilities declining over time; gradually coordinated movement becomes very difficult. Clinically, there are also a number of subtle defects seen in patients with HD, including oculomotor, speech and cognitive problems. Mutant HTT expression is specific to the striatum, a part of the brain which controls movements, and neuronal loss and/or inflammation here is thought to underlie the clinical signs of HD.

[00258] ZF6xHunt-Kox-1 is a specifically designed zinc finger protein which binds longer CAG repeats and represses mutant HTT gene expression. Other lengths of zinc finger proteins are also possible including but not limited to ZF12xHunt-Kox-1 and ZF18xHunt-Kox-1. Fusion protein or conjugate embodiments with the human HOX C12 or HOX D12 homeodomain cell permeable peptide will enable ZF6xHunt-

Kox-1, ZF12xHunt-Kox-1, ZF18xHunt-Kox-1, and related proteins to enter cells and the nucleus to effectively and selectively down regulate mutant HTT gene expression. We will evaluate the effect of a variety of embodiments comprising the 60-amino acid human HOX C12 or HOX D12 homeodomain-zinc finger fusion proteins or conjugates on neurological pathology. To this end we will administer intravenous formulations comprising the human homeodomain-zinc finger embodiments to Huntington's Disease patients. Specifically, we will evaluate the ability of the human HOX C12 or HOX D12 homeodomain peptide to cross the blood brain barrier and enter the central nervous system.

[00259] In one embodiment, the first region human HOX C12 homeodomain 60-amino acid sequence is:

SEQ ID No. 1 (Table 3):

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQNR
RMKKKRLL

In another embodiment the first region human HOX D12 homeodomain 60-amino acid sequence is:

SEQ ID No. 2 (Table 3):

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQNR
RMKKKRVV

and the linked second region is, for example, a ZF6xHunt-Kox-1 sequence;

SEQ ID No. 36 (Table 3):

TGAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQ
RHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQ
RATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICG
RKFAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSQLVSSLSPQHSAVT
QGIKNKEGMDAKSLTAWSRITLVTFKDVFDFTREEWKLLDTAQQIVYRNVM
LENYKNLVSLGYQLTKPDVILRLEKGEEPWLVEREIHQETHPDSETAFEIKSS
V

In yet other embodiments, the second region is a variation on the cargo sequence shown here. And, in another embodiment with the addition of an initiating

methionine, the entire peptide sequence of the fusion protein including the HOX C12 peptide is, for example:

SEQ ID No. 37 (Table 3):

```
MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQ
NRRMKKKRLLTGAERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICG
RKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFAC
DICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTG
EKPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGGSGGGGSQLVS
SLSPQHSAVTQGIIKNKEGMDAKSLTAWSTRLVTFKDVFDFTREEWKLLDT
AQQIVYRNVMLENYKNLVSLGYQLTKPDVILRLEKGEEPWLVEREIHQETHP
DSEAFEIKSSV
```

and in yet another embodiment with the addition of an initiating methionine, the entire peptide sequence of the fusion protein including the HOX D12 peptide is, for example:

SEQ ID No. 38 (Table 3):

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MARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQN
RRMKKKRVTGAERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICGR
KFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFAC
DICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGE
KPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGGSGGGGSQLVSS
LSPQHSAVTQGIIKNKEGMDAKSLTAWSTRLVTFKDVFDFTREEWKLLDTA
QQIVYRNVMLENYKNLVSLGYQLTKPDVILRLEKGEEPWLVEREIHQETHPD
SEAFEIKSSV
```

[00260] In a further embodiment or embodiments, additional numbers of zinc finger repeats may be included as shown in these examples of the second component with 12 and 18 repeats respectively:

[00261] ZF12xHunt-Kox-1, for example:

SEQ ID No. 39 (Table 3):

TGAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQ
 RHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQ
 RATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICG
 RKFAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSQLVGTAERPFQCRI
 CMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSER
 PFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKI
 TGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQ
 RHTKIHLRQKDGGGGSGGGGSGGGGSQLVSSLSPQHSAVTQGIIKNKEGM
 DAKSLTAWSR TLVTFKDVFDFTREEWKLLDTAQQIVYRNVMLENYKNLVSL
 GYQLTKPDVILRLEKGEEPWLVEREIHQETHPDSETAFEIKSSV

[00262] ZF18xHunt-Kox-1, for example:

SEQ ID No. 42 (Table 3):

TGAERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQ
 RHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQ
 RATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICG
 RKFAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSQLVGTAERPFQCRI
 CMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSER
 PFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKI
 TGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQ
 RHTKIHLRQKDGGGGSGGGGSGGGGSQLVGTAERPFQCRICMRNFSQRA
 TLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRN
 FSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPFQCR
 ICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHLRQKD
 GGGGSGGGGSGGGGSQLVSSLSPQHSAVTQGIIKNKEGMDAKSLTAWSR
 TLVTFKDVFDFTREEWKLLDTAQQIVYRNVMLENYKNLVSLGYQLTKPDVIL
 RLEKGEEPWLVEREIHQETHPDSETAFEIKSSV

[00263] In further embodiments, these sequences with additional numbers of zinc finger repeats are shown with the human homeodomain peptide included, for example, in an embodiment comprising the sequence with an initiating methionine residue:

[00264] Human HOX C12-ZF12xHunt-Kox-1, for example:

SEQ ID No. 40 (Table 3):

MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQ
 NRRMKKKRLTGAERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICG
 RKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFAC
 CDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTG
 EKPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSSQLVG
 TAERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQR
 HTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQR
 ATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGR
 KFAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSSQLVSSLSPQHSAVT
 QGIKNKEGMDAKSLTAWSR TLVTFKDVFDFTREEWKLLDTAQQIVYRNVM
 LENYKNLVSLGYQLTKPDVILRLEKGEEPWLVEREIHQETHPDSETAFEIKSS
 V

[00265] Human HOX D12-ZF12xHunt-Kox-1, for example:

SEQ ID No. 41 (Table 3):

MARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQN
 RRMKKKRVVTGAERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICGR
 KFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFAC
 DICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGE
 KPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSSQLVGT
 AERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRH
 TKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRA
 TLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRK
 FAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSSQLVSSLSPQHSAVTQ
 GIIKNKEGMDAKSLTAWSR TLVTFKDVFDFTREEWKLLDTAQQIVYRNVML
 ENYKNLVSLGYQLTKPDVILRLEKGEEPWLVEREIHQETHPDSETAFEIKSSV

[00266] Human HOX C12-ZF18xHunt-Kox-1, for example:

SEQ ID No. 43 (Table 3):

MSRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELSDRNLSDQQVKIWFQ
 NRRMKKKRLLTGAERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICG
 RKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFA
 CDICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTG
 EKPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSQLVG
 TAERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQR
 HTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQR
 ATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGR
 KFAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSQLVGTAERPFCRIC
 MRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPF
 QCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTG
 SERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRH
 TKIHLRQKDGGGGSGGGGSGGGGSQLVSSLSPQHSAVTQGIIKNKEGMDA
 KSLTAWSR TLVTFKDVFDFTREEWKLLDTAQQIVYRNVMLENYKNLVSLGY
 QLTCPDVILRLEKGEEPWLVEREIHQETHPDSETAFEIKSSV

[00267] Human HOX D12-ZF18xHunt-Kox-1, for example:

SEQ ID No. 44 (Table 3):

MARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQN
 RRMKKKRVVTGAERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICGR
 KFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFAC
 DICGRKFAQRATLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGE
 KPFACDICGRKFAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSQLVGT
 AERPFCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRH
 TKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRA
 TLQRHTKIHTGSERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRK
 FAQRATLQRHTKIHLRQKDGGGGSGGGGSGGGGSQLVGTAERPFCRIC
 MRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTGSERPF
 QCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRHTKIHTG
 SERPFQCRICMRNFSQRATLQRHIRTHTGEKPFACDICGRKFAQRATLQRH
 TKIHLRQKDGGGGSGGGGSGGGGSQLVSSLSPQHSAVTQGIIKNKEGMDA
 KSLTAWSR TLVTFKDVFDFTREEWKLLDTAQQIVYRNVMLENYKNLVSLGY
 QLTCPDVILRLEKGEEPWLVEREIHQETHPDSETAFEIKSSV

[00268] In other embodiments, the second region may be a variation on any of the cargo sequences shown above.

[00269] Linkers may not be required for function but linkers may be included in a variety of embodiments, for example, between SEQ ID Nos. 1 and 36, 39, or 42 or between SEQ ID Nos. 2 and 36, 39, or 42 or a portion thereof without compromising function. Any linker known in the art may be used provided the function of the conjugate is not compromised by its addition; see, e.g., Table 2. Embodiments such as SEQ ID nos. 37, 38, 40, 41, 43 and/or 44 would be altered, at least in part, to the extent that the linker sequence would bridge these first and second regions.

[00270] In still further embodiments, additional amino acid sequences can be added to either the amino or carboxy termini in order to facilitate purification. Such sequences may include FLAG-tags (DYKDDDDK), myc-tags (EQKLISEEDL), His-tags (HHHHHH), and other similar tags known to those in the art. In addition, ligands such as the biotin-acceptor protein (GLNDIFEAQKIEWHE) together with the active BirA protein may be used. For sequences that include an N-terminal initiating methionine, if a N-terminal purification domain is added the methionine will be on the N-terminal of the purification domain instead of at the N-terminal of the human homeodomain or HOX peptide first region. Embodiments of the human HOX C12 or HOX D12 homeodomain-zinc finger fusion protein or conjugate will be tested in an appropriate cell line to determine that the constructs are functionally translocated and that the mutant HTT gene is repressed. Knock-in STHdh cells, where the first exon of the mouse HTT gene has been replaced by a human exon with 111 CAG repeats (STHdhQ111/HdhQ111 or STHdhQ7/HdhQ111) will be used.

[00271] In one embodiment, we will examine the translocation of the zinc finger cargo protein using the 60-amino acid human HOX C12 or HOX D12 homeodomain (or variant or portion thereof) containing fusion protein or conjugate present following incubation of knock-in STHdh cells in culture for various periods of time such as 1 hour, 2 hours, 3 hours, 4 hours, 6 hours, or 24 hours at an optimal micromolar concentration to be determined, likely between about 1 μ M to about 115 μ M. We will evaluate expression of the mutant HTT gene by known methods and compare the results to control cultures.

[00272] R6/2 mice are the most widely used animal model of HD. This knock-in mouse model for HD overexpresses the human HTT gene in the brain at a location known to be effected in human patients, the striatum. R6/2 mice demonstrate motor

deficits phenotypically that are analogous to the signs and symptoms in HD patients, for example, the R6/2 mice lack the ability to grasp with their front claws.

[00273] In one embodiment, beginning at three or four weeks of age we will evaluate motor skills in R6/2 mice; half will be treated and the others will serve as a control group. We will administer to mice through i.v. or i.p. injections a formulation daily, every other day or every third day, a human HOX C12 or HOX D12 homeodomain-zinc finger fusion protein or conjugate embodiment comprising, for example, any of SEQ ID Nos. 37, 38, 40, 41, 42, or 43 or any portion thereof, for one to two weeks. At four to six weeks of age we will reevaluate motor skills just prior to sacrifice for histological analysis. Histological analysis will be in two parts. Firstly, using rtPCR, mutant HTT expression will be evaluated in each striatum of treated and control groups of mice. Secondly, evidence of striatal neuronal loss will be evaluated in the striata of treated vs. non-treated control mice. The reduction in neuronal loss and/or striatal cell volume will be assessed using techniques well known in neurohistology laboratories, and will be reported as density of neurons per standard microscope field at common magnification. Thus, we will evaluate both the expression of the mutant HTT gene and evidence of neuronal loss in the striatum of the brain by known methods, and after assessing motor deficits, compare the results of treated R6/2 mice to those of the untreated R6/2 controls; we will further compare each group's post-treatment motor deficits score to its own baseline score.

[00274] In clinical trials with Huntington's Disease patients motor deficits will be evaluated by using the Unified Huntington's Disease Rating Scale (UHDRS) Total Motor Score, a clinical tool used to evaluate patients in HD therapy trials. It provides a quantitative assessment of treatment benefits in HD, providing a composite score based on a number of motor deficits. Huntington Study Group authors, "Unified Huntington's Disease Rating Scale: Reliability and Consistency" Movement Disorders 11(2):136-142, 1996. A change from pre- to post-treatment overall motor score of one point or more is considered clinically significant.

[00275] We will evaluate the progression of the disease as reflected in the change in motor skills in HD patients following administration of a formulation embodiment comprising an human HOX C12 or HOX D12 homeodomain-zinc finger fusion protein or conjugate comprising. For example, any of SEQ ID Nos. 37, 38, 40, 41, 42, or 43, or a portion thereof. First we will assess UHDRS scores in this treatment

group of these patients and then, over the course of six to eight weeks, administer the fusion protein or conjugate formulation embodiment by intravenous or subcutaneous injection on a daily basis as an optimal dose to be determined, ranging from at least 0.01 mg/kg to at least about 500 mg/kg body weight. Motor function and other HD scored deficits will be evaluated post-treatment based on the Unified Huntington's Disease Rating Scale (UHDRS) Total Motor Score; results will be compared to the baseline score. We will assess percent improvement in UHDRS relative to non-treated controls or historical controls followed for the same period.

[00276] Alternative embodiments comprising any of SEQ ID Nos. 1 through 19, or variants or portions thereof, conjugated to any of the zinc finger peptides discussed above include a variety of fusion proteins or conjugates comprising any one or more linkers known in the art, provided the function of the conjugate is not compromised with the addition.

EXAMPLE 6

[00277] Cell-Penetrating Peptides and Vaccine Applications. Cell penetrating peptides have been shown to facilitate the delivery of antigenic epitopes into the cytoplasm of antigen-presenting cells, such as dendritic cells, enabling antigen processing and presentation in a major histocompatibility complex (MHC) class I or class II dependent manner to CD8 and CD4 T-cells respectively and provoke an effective immune response (Brooks, et al. Cell-penetrating peptides: Application in vaccine delivery, Biochimica et Biophysica Acta 1805:25–34, 2010). CPPs utilizing a furin-sensitive linker for conjugation with antigenic epitopes have been shown effective at provoking antigen specific cytolytic CD8 T-cell responses when administered with oligodeoxynucleotides containing CpG motifs (Lu et al. TAP-independent presentation of CTL epitopes by Trojan antigens, J. Immunol. 166:7063–7071, 2001.). Other methods of conjugation that allow for release of the antigenic cargo in antigen presenting cells include use of a disulfide linkage that is cleaved by cytoplasmic glutathione (Kim et al. Introduction of soluble proteins into the MHC class I pathway by conjugation to an HIV tat peptide, J. Immunol. 159:1666–68, 1997) and use of antigenic peptides treated with sulfosuccinimidyl 4-maleimidomethylcyclohexane carboxylate (SMCC) followed by reaction with a C-terminal cysteine modified CPP (Apostolopoulos et.al. Delivery of tumor associated

antigens to antigen presenting cells using penetratin induces potent immune responses, Vaccine 24:3191–202, 2006). CPP fusion proteins without linkers have also been successfully used to generate specific T-cell responses to tumor antigens (Batchu et.al. Protein transduction of dendritic cells for NY-ESO-1-based immunotherapy of myeloma, Cancer Res. 65:10041–49, 2005, Scheller et.al. Human cytomegalovirus protein pp65: an efficient protein carrier system into human dendritic cells, Gene Ther. 15:318–325, 2008, Viehl et.al. Tat mammaglobin fusion protein transduced dendritic cells stimulate mammaglobin-specific CD4 and CD8 T cells, Breast Cancer Res. Treat. 91:271–78, 2005).

[00278] Traditionally vaccines have relied on adjuvants that are often ligands for toll-like receptors (TLRs) to target antigens to dendritic cells for enhanced immune responses. This approach has not worked well in the case of vaccines to prevent or improve outcomes in tuberculosis. Perhaps one reason is a TLR2-dependent inhibition of MHC class II dependent antigen presentation that has also been reported to be an important mechanism allowing persistent infection of mycobacteria in macrophages (Harding, C.V and Boom, W.H., Regulation of antigen presentation by Mycobacterium tuberculosis: a role for Toll-like receptors. Nat Rev Microbiol. 8(4):296-307, 2010). Thus the use of CPPs may promote efficient dendritic cell antigen processing and presentation and avoid this undesirable effect of TLR2 agonists while many of the current tuberculosis vaccine candidates such as those that rely on adenovirus vectors (Appledorn et.al. Adenovirus Vector-Induced Innate Inflammatory Mediators, MAPK Signaling, As Well As Adaptive Immune Responses Are Dependent upon Both TLR2 and TLR9 In Vivo. J Immunol 181:2134-44, 2008) and adjuvants do not (Frick, M. The Tuberculosis Vaccines Pipeline, June 2013 <http://www.pipelinereport.org/2013/tb-vaccine> and Rowland, R. and McShane. Expert Rev Vaccines 10(5):645-58, 2011).

[00279] In one vaccine embodiment, the conjugate comprises a first region, the human homeodomain or variant or portion thereof having a sequence described in, for example, any of SEQ ID Nos. 1-19 or variant or portion thereof conjugated to a second region not naturally associated with the first region, wherein the second region is a peptide antigen or portion of the antigen that is an antigenic epitope. In a variety of embodiments, conjugation may be as a fusion protein (peptide linkage) or

may utilize a linker such as the furin-sensitive linker (RVKR), a disulfide linkage, or other types of protein to protein conjugation known in the art.

[00280] Tuberculosis Vaccine Antigen 85A and its Epitopes. The antigen 85 complex is a multigene family encoding several closely related major secreted proteins in mycobacteria. The signal peptide is cleaved in mature Ag85 proteins. Ag85A is a peptide of 338 amino acids with a molecular mass of 35.7 kDa and a predicted pI of 6.5. It is also called extracellular α -antigen and has mycolyltransferase activity important in cell wall synthesis. Analysis of the immunogenicity and protective activity of smaller peptide epitopes in Balb/c mice (Tchilian et. al. Immunization with different formulations of Mycobacterium tuberculosis antigen 85A induces immune responses with different specificity and protective efficacy. Vaccine 31:4624-31, 2013) after intranasal and systemic immunization of mice using a recombinant adenoviral vector, recombinant Ag85A itself or as a set of overlapping 15mer peptides (single Balb/c H-2D restricted epitopes) demonstrated superior protection against mycobacterium tuberculosis (Mtb) challenge after intranasal immunization. CD4 85A99-118 and CD8 85A70-78 responses were protective while response to CD8 85A145-152 was not protective.

[00281] Human vaccine trials using the adenovirus Ag85A vaccine to enhance the effectiveness of BCG vaccine in infants induced only modest immune responses and did not have any clinical efficacy (Tameris et.al. Safety and efficacy of MVA85A, a new tuberculosis vaccine, in infants previously vaccinated with BCG: a randomised, placebo-controlled phase 2b trial. The Lancet 381:1021-1028, 2013). This could be due to the inhibitory effects of TLR2 agonist properties of the adenovirus component shown to provoke IL-10 responses that down-regulate the immune response or due to non-protective responses to some Ag85A epitopes.

[00282] Tuberculosis Vaccine. The current embodiments for a protective human tuberculosis vaccine are conjugates or a mixture of conjugates administered by the inhaled, intranasal or parenteral injection route. In one embodiment the inhaled route provides local immunity in the lung.

[00283] In Balb/c mice the concept will be tested where a conjugate or conjugate mixture is composed of a first region, the human homeodomain or variant or portion thereof including but not limited to sequences described in any of SEQ ID Nos. 1-19

or variant or portion thereof conjugated to a second region not naturally associated with the first region. In certain embodiments, the second region is one or more of four peptides that span the Ag85A 99-118 epitope (See Table 3):

Peptide one of four of the Ag85A 99-118 epitope is SEQ ID No. 51: ETFLTSELPGWLQAN;

Peptide two of four of the Ag85A 99-118 epitope is SEQ ID No. 54: SELPGWLQANRHKVP;

Peptide three of four of the Ag85A 99-118 epitope is SEQ ID No. 57: WLQANRHKVPTGSA; and

Peptide four of four of the Ag85A 99-118 epitope is SEQ ID No. 60: RHVKPTGSAVVGLSM.

In yet other embodiments, the second region is a variation on one or more of these four peptides. The sequence ID numbers for several of these conjugates are shown in Table 3. For example, in one embodiment, the complete amino acid sequence of the combined first (HOX C12) and second region SEQ ID No. 51 of the Ag85A 99-118 epitope is SEQ ID No. 52: SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLSDQQVKIWFQNRRM KKKRLLETFLTSELPGWLQAN. Likewise, in another embodiment, the complete amino acid sequence of the combined first (HOX D12) and second region SEQ ID No. 51 of the Ag85A 99-118 epitope is SEQ ID No. 53: ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLSDQQVKIWFQNRRM KKKRVVETFLTSELPGWLQAN.

[00284] The second conjugate or conjugate mixture for testing in Balb/c mice is composed of a first region, the human homeodomain or variant or portion thereof having a sequence described in any of SEQ ID Nos. 1-19 or variant or portion thereof conjugated to a second region not naturally associated with the first region. In certain embodiments, the second region is one or more of three peptides that span the Ag85A 70-78 epitope (See Table 3):

Peptide one of three of the Ag85A 70-78 epitope is SEQ ID No. 63: QSGLSVVMVGGQSS;

Peptide two of three of the Ag85A 70-78 epitope is SEQ ID No. 66: VVMPVGGQSSFYSDW; and

Peptide three of three of the Ag85A 70-78 epitope is SEQ ID No. 69: GGQSSFYSDWYQPAC.

In yet other embodiments, the second region is a variation on one or more of these three peptides. The sequence ID numbers for several of these conjugates are also shown in Table 3. For example, in one embodiment the complete amino acid sequence of the combined first (HOX C12) and second region SEQ ID No. 63 of the Ag85A 70-78 epitope is SEQ ID No. 64: SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLS DQQVKIWFQNRRM KKKRLLQSGLSVVMPVGGQSS. Likewise, in another embodiment the complete amino acid sequence of the combined first (HOX D12) and second region SEQ ID No. 63 of the Ag85A 70-78 epitope is SEQ ID No. 65: ARKKRKPYPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLS DQQVKIWFQNRRM KKKRVVQSGLSVVMPVGGQSS.

[00285] Thus, the entire vaccine to be tested in mice and later in humans is composed of mixtures of conjugates where each conjugate has, as its cargo in a variety of embodiments, one or more of these smaller peptides or variations thereof, and together they provide for a robust CD4 response to Ag85A 99-118 and a robust CD8 response to Ag85A 70-78.

[00286] In one human vaccine embodiment the vaccine will be composed of a first region, the human homeodomain or variant or portion thereof including but not limited to a sequence described in any of SEQ ID Nos. 1-19 or variant or portion thereof conjugated to a second region not naturally associated with the first region, wherein the second region is, in one embodiment, the entire Ag85A 338-amino acid peptide or an HLA-restricted epitope of Ag85A such as one or more specific HLA-restricted epitopes of Ag85A shown to provoke immune responses in appropriate human subjects (see Table 3). The Ag85A peptide, or its human epitopes, may be linked to the first region as described above. In another embodiment, the entire Ag85A sequence is linked to the first region to provide a single vaccine construct for subjects with different HLA class I and class II genotypes. The Ag85A sequence is: MQLVDRVRGA VTGMSRRLVV GAVGAALVSG LVGAVGGTAT AGAFSRPGLP

VEYLQVPSPS MGRDIKVQFQ SGGANSPALY LLDGLRAQDD FSGWDINTPA
FEWYDQSGLS ***VVMPVGGQSS*** FYSDWYQPAC GKAGCQTYKW ETFLTSELPG
 WLQANRHVKP TGSVVGLSM AASSALTLAI YHPQQFVYAG AMSGLLDPSQ
 AMGPTLIGLA MGDAGGYKAS DMWGPKEDPA WQRNDPLLNV GKLIANNTRV
 WVYCGNGKPS DLGGNNLPAK ***FLEGFVRTSN*** IKFQDAYNAG GGHNGVFDFP
 DSGTHSWEYW GAQLNAMKPD LQRALGATPN TGPAPQGA:

[00287] Here the the longer region of the sequence in bold and underlined font above is the signal peptide that is cleaved when the mature Ag85A sequence is produced (the remaining 296 amino acid peptide). The fibronectin binding domain is shown in bold and italicized font just below it, and the three amino acids below that in bold, underlined and italicized font are in the catalytic domain.

[00288] In one embodiment, the second region amino acid sequence for Ag85A (without the signal peptide) would be: AFSRPGLP VEYLQVPSPS MGRDIKVQFQ SGGANSPALY LLDGLRAQDD FSGWDINTPA ***FEWYDQSGLS*** ***VVMPVGGQSS*** FYSDWYQPAC GKAGCQTYKW ETFLTSELPG WLQANRHVKP TGSVVGLSM AASSALTLAI YHPQQFVYAG AMSGLLDPSQ AMGPTLIGLA MGDAGGYKAS DMWGPKEDPA WQRNDPLLNV GKLIANNTRV WVYCGNGKPS DLGGNNLPAK ***FLEGFVRTSN*** IKFQDAYNAG GGHNGVFDFP DSGTHSWEYW GAQLNAMKPD LQRALGATPN TGPAPQGA. The sequence ID number (SEQ. ID No. 72) for this Ag85A cargo peptide is shown in Table 3, along with two of many possible embodiments in which the Ag85A cargo peptide or a variation comprises the second region of the conjugate or fusion protein: those containing the first region HOX C12 (SEQ. ID No. 73) or HOX D12 (SEQ. ID No. 74) sequences. A person of ordinary skill in the molecular biology/biotechnology art would appreciate that numerous variations on any of these and other sequences shown in Table 3 would fall within the embodiments disclosed herein.

[00289] Measurement of the Vaccine-Induced Immune Response. In vitro whole blood cultures with specific antigens and measurement of type I cytokine responses was successfully used to measure the immune response to the adenovirus vector Ag85A vaccine in a phase I clinical trial (Smaill et.al. A Human Type 5 Adenovirus–Based Tuberculosis Vaccine Induces Robust T Cell Responses in Humans Despite Preexisting Anti-Adenovirus Immunity. Sci. Transl. Med. 5, 205: 1-11, 2013). This technique can be used to measure the immune response in

humans to CPP-based Ag85A epitope vaccine mixtures. In murine models similar methods can be used with post-treatment cultures of splenic lymphocytes and measurement of cytokine responses in Balb/c mice using the epitopes described.

[00290] The number of responsive CD4 T-cells to specific antigenic epitopes can be quantitated by IFN-gamma ELISPOT assays and both CD4 and CD8 T-cell responses can be measured by intracellular cytokine staining together with T-cell subtype classification in peripheral blood lymphocyte cultures (Smaill et.al. 2013).

EXAMPLE 7

[00291] Human-derived CPP structures can include, but are not limited to, the first region, which can comprise the HOX D12 homeodomain, the HOX C12 homeodomain, or other first region structures, such as those described in Table 3 (SEQ ID Nos. 1-19). The first region can be conjugated to a second region such that the first region can be used to carry 'cargo' to intracellular and/or intranuclear targets that may be abnormally expressed in disease states. Such targets may include nucleic acid structures such as genes, mRNA and miRNA. Here DNA, RNA, LNA, PNA, γ PNA, other standard or modified nucleic acid or a combination of these components can be designed to bind to these intracellular and/or intranuclear targets and reduce abnormal expression or activation characteristic of the disease state. Table 4 shows nucleotide sequences, and three examples are described below.

[00292] Table 4: Nucleotide Sequence Identities

SEQ. ID No.	Descriptor	Nucleotide Sequence
75	miRNA132 target sequence to which cargo binds	5'-UAACAGUCUACAGCCAUGGUCG-3'
76	Cargo sequence that binds to miRNA21	5'-TCAACATCAGTCTGATAAGCTA-3'
77	miRNA21 target sequence to which the cargo binds	5'- TAGCTTATCAGACTGATGTTGA-3'
78	Cargo sequence that binds to miRNA132	5'-CGACCATGGCTGTAGACTGTTA-3'

SEQ. ID No.	Descriptor	Nucleotide Sequence
79	Cargo sequence that binds to DYRK1b	5'-GTGGTGAAAGCCTATGATCAT-3'

[00293] Affecting the Ras Pathway: In one or more embodiments, a second region cargo binds to an miRNA132 target sequence to affect the Ras pathway.

[00294] The Ras pathway is abnormally expressed in many types of cancer and constructs that affect the pathway would reduce the growth of tumors dependent on it. Diagnostic tests would identify those patients whose tumors would be most likely to respond to this treatment. Tumor cell lines known to have an activated Ras pathway can be used to demonstrate the biological activity of Ras-inhibiting constructs described below. They will reduce the growth of these tumor cells in vitro and reduce the growth of tumors in murine xenograft models that use these cells following systemic treatment.

[00295] In one embodiment, the HOX C12 amino acid sequence first region is SEQ ID No. 1:

SRKKRKPYSKLQLAELEGEFLVNEFITRQRRRELS DRLNLS DQQVKIWFQNR
RMKKKRLL

In another embodiment, the HOX D12 amino acid sequence first region is SEQ ID No. 2:

ARKKRKPYTKQQIAELENEFLVNEFINRQKRKELSNRLNLS DQQVKIWFQNR
RMKKKR VV

[00296] In another embodiment, the second region cargo may be, for example, nucleic acid SEQ ID No. 76 (Table 4) (or a variation thereof):

[00297] 5'-TCAACATCAGTCTGATAAGCTA-3' In yet another embodiment, for example, the complete conjugate comprises SEQ ID Nos. 1 and 76.

[00298] Affecting Tumor Suppressor Pathways in Many Cancers: The second region cargo binds to miRNA21 target sequence to affect tumor suppressor pathways found in many types of cancers. As in the Ras pathway example described above, in a variety of embodiments the first region homeodomain

sequence may be, for example, HOX C12 (SEQ ID No. 1) or HOX D12 (SEQ ID No. 2) (see Table 3). In one or more embodiments, the conjugate's second region cargo binds to an miRNA21 target sequence, which sequence includes but is not limited to SEQ. ID No. 77 (Table 4), or any variation thereof. Thus, in one embodiment the second region cargo, for example, 5'-CGACCATGGCTGTAGACTGTTA-3' (SEQ. ID No. 76), binds to the miRNA21 target sequence, for example, 5'-TAGCTTATCAGACTGATGTTGA-3' (SEQ. ID No. 77) to affect tumor suppressor pathways found in many types of cancers.

[00299] Testing these constructs in vitro and in murine xenograft tumor models can confirm their activity by measuring reduced tumor cell growth and tumor growth. Treatment of cancer patients found to have tumors that have abnormal expression of this miRNA will have clinical benefit. In one embodiment, the second region cargo sequence (SEQ. ID No. 79) binds to target sequence DYRK1b. In other embodiments variations to SEQ. ID No. 79 bind to DYRK1b, or a functional variation thereof.

[00300] Affecting Gene Expression: In one or more embodiments, the second region cargo binds to DYRK1b to reduce gene expression.

[00301] Over expression of this gene is present in many cancers including lung and pancreatic cancers. Mutations in DYRK1b that result in increased expression also are associated with familial inheritance of type II diabetes, central obesity and early coronary artery disease, all features of the metabolic syndrome. It is likely that this pathway is also contributing to the pathogenesis of type II diabetes and obesity in the general population. Thus systemic treatment with inhibitors of DYRK1b such as those described below will have efficacy in cancers with abnormal high expression of DYRK1b and also in patients with type II diabetes and other features of metabolic syndrome. It will be especially effective in those patients with identified mutations in DYRK1b that lead to over expression. As in the Ras and tumor suppressor pathways examples discussed above, a variety of embodiments the first region homeodomain sequence may be, for example HOX C12 (SEQ ID No. 1) or HOX D12 (SEQ ID No. 2) (see Table 3). In one embodiment, the sequence 5'-GTGGTGAAAGCCTATGATCAT-3' (SEQ. ID No. 79, see Table 4) or variation thereof, binds to DYRK1b. In other embodiments variations to SEQ. ID No. 79 bind to DYRK1b, or a functional variation thereof.

[00302] For certain comparisons between groups reported in the studies described in the examples above, significance was tested at $p < 0.05$.

[00303] From the foregoing, it will be appreciated that specific embodiments have been described herein for purposes of illustration, but that various modifications may be made without deviating from the spirit and scope of the disclosure. Accordingly, the disclosure is not limited except as by the appended claims.

CLAIMS

We claim:

1. A conjugate comprising:
a first region comprising a homeodomain structure and having a polypeptide sequence as described in any one of SEQ ID Nos. 1 to 19 or a variant thereof; and
a second region comprising a functional or regulatory polypeptide or protein not naturally associated with the first region.
2. A conjugate comprising:
a first region comprising at least one of a HOX D12 homeodomain or a HOX C12 homeodomain; and
a second region comprising a functional or regulatory polypeptide or protein not naturally associated with the first region.
3. A conjugate of claim 1 or claim 2 wherein the second region includes at least one of a NEMO binding domain, a PC1 CTT-derived fusion protein, an enzyme that restores enzymatic function in subjects with inherited enzyme deficiencies, a gene product of RPE65, a zinc finger peptide, an Ag85A 99-118 epitope peptide, or an Ag85A 70-78 epitope peptide.
4. The conjugate of claim 3 wherein the NEMO binding domain has a polypeptide sequence set forth in SEQ. ID No. 20 or a variant thereof.
5. The conjugate of claim 3 wherein the PC1 CTT-derived fusion protein has a polypeptide sequence set forth in at least one of SEQ. ID Nos. 23 or 26 or a variant thereof.
6. The conjugate of claim 3 wherein the enzyme that restores enzymatic function in subjects with inherited enzyme deficiencies has a polypeptide sequence of at least one of SEQ. ID Nos. 30, 45, or 48 or a variant thereof.

7. The conjugate of claim 3 wherein the gene product of RPE65 has a polypeptide sequence that includes at least SEQ. ID No. 33 or a variant thereof.

8. The conjugate of claim 3 wherein the zinc finger peptide sequence includes at least one of SEQ. ID Nos. 36, 29, or 42 or a variant thereof.

9. The conjugate of claim 3 wherein the Ag85A 99-118 epitope peptide has a sequence that includes at least one of SEQ. ID Nos. 51, 54, 57, or 60 or a variant thereof.

10. The conjugate of claim 3 wherein the Ag85A 70-78 epitope peptide has a sequence that includes at least one of SEQ. ID Nos. 63, 66, or 69 or a variant thereof.

11. The conjugate of claim 1 or claim 2 wherein the second region is conjugated to the C-terminus of the first region.

12. The conjugate of claim 1 or claim 2 wherein the second region is conjugated to the N-terminus of the first region.

13. The conjugate of any one of claims 1 and 2 in the form of a fusion protein.

14. The conjugate of any one of claims 1 and 2 wherein the second region interacts with an intracellular target and/or an intranuclear target.

15. The conjugate of claim 14 wherein the interaction of the second region with the intracellular target and/or intranuclear target affects one or more of the following: NF- κ B activation, uveitis, PC1 transcription factor activity in renal tubular cells with polycystic kidney disease mutations, glucocerebrosidase substrate in cells with Gaucher Disease mutations of GCase, glycosaminoglycans in subjects with Hurler Syndrome or Hunter Syndrome, retinal membrane guanylyl cyclase substrate in retinal cells deficient in retinal membrane guanylyl cyclase, regulation of Huntingtin

mutant gene transcription in cells with Huntington's Disease mutations, and delivery of antigenic epitopes into cytoplasm of antigen-presenting cells for provoking an effective immune response in a vaccine embodiment such as for a tuberculosis vaccine to prevent tuberculosis in subjects exposed to the infection.

16. The conjugate of any claim 1 or claim 2 wherein the second region has a polypeptide sequence that includes SEQ. ID Nos. 23 or 26 or variant thereof, and wherein the conjugate further comprises a noncompetitive V2 receptor antagonist.

17. The conjugate of claim 1 or claim 2 wherein the second region has a polypeptide sequence selected from the group consisting of SEQ ID Nos: 20, 23, 26, 30, 33, 36, 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, 69, and 72, or a variant thereof.

18. The conjugate of claim 1 or claim 2, further comprising a linker sequence between the first and second regions.

19. The conjugate of claim 1 wherein the first and second regions combined have a polypeptide sequence selected from the group consisting of SEQ ID Nos: 21, 22, 24, 25, 27, 28, 31, 32, 34, 35, 37, 38, 40, 41, 43, 44, 46, 47, 49, and 50, 52, 53, 55, 56, 58, 59, 61, 62, 64, 65, 67, 68, 70, 71, 73 and 74, or a variant thereof.

20. The conjugate of claim 19 wherein an initiating methionine residue of the sequence is removed prior to use as an active and/or therapeutic agent.

21. The conjugate of claim 1 wherein the first and second regions combined have a sequence comprising a homeodomain structure and at least one of a NEMO binding domain, a PC1 CTT-derived fusion protein, an enzyme that restores enzymatic function in subjects with inherited enzyme deficiencies, a gene product of RPE65, a zinc finger peptide, an Ag85A 99-118 epitope peptide, and an Ag85A 70-78 epitope peptide.

22. The conjugate of claim 21 wherein the second region interacts with an intracellular target and/or an intranuclear target.

23. The conjugate of claim 22 wherein the interaction of the second region with an intracellular target and/or intranuclear target affects one or more of the following: NF- κ B activation, uveitis, PC1 transcription factor activity in renal tubular cells with polycystic kidney disease mutations, glucocerebrosidase substrate in cells with Gaucher Disease mutations of GCase, glycosaminoglycans in subjects with Hurler Syndrome or Hunter Syndrome, retinal membrane guanylyl cyclase substrate in retinal cells deficient in retinal membrane guanylyl cyclase, regulation of Huntingtin mutant gene transcription in cells with Huntington's Disease mutations, and delivery of antigenic epitopes into cytoplasm of antigen-presenting cells for provoking an effective immune response as the active component of vaccines as for example in a tuberculosis vaccine to prevent tuberculosis in subjects exposed to the infection.

24. The conjugate of claim 19 or claim 21, further comprising a linker sequence between the first and second regions.

25. A composition comprising the conjugate of claim 1 and a pharmaceutically acceptable carrier.

26. A composition comprising the conjugate of claim 2 and a pharmaceutically acceptable carrier.

27. The composition of claims 25 or claim 24 wherein the composition is in the form of an inhalable composition, an eye drop formulation other ophthalmic composition for local or injectable use, an enema, a topical composition, or an injectable composition including injectable implants for sustained release.

28. The conjugate of claim 1 or claim 2 wherein, when administered to a subject in a formulation, the conjugate enters the central nervous system.

29. The conjugate of claim 1 or claim 2 wherein, when administered in a formulation to a subject, the conjugate elicits a reduced unwanted immune response in the subject compared to an unwanted immune response elicited by the second region when not conjugated to the first region.

30. A method of treating a condition in a subject comprising administering a formulation comprising the conjugate of claim 1 or claim 2 to the subject, wherein the conjugate enters the central nervous system in a subject.

31. A method of treating a condition in a subject comprising administering a formulation comprising the conjugate of claim 21 to the subject, wherein the conjugate enters the central nervous system of the subject.

32. A method of treating a condition in a subject comprising administering a formulation comprising the conjugate of claim 1 or claim 2 to the subject, wherein the conjugate prevents or ameliorates immune responses to antigenic peptides in the subject such that there is at least one of (a) no significant reduction in peptide exposure, and (b) no significant increase in the incidence of immune-mediated adverse clinical events.

33. A method of treating a dry eye in a subject comprising administering a formulation comprising the conjugate of claim 1 or claim 2 to the subject, wherein the first region is conjugated to a NEMO binding domain.

34. The method of claim 33 wherein the NEMO binding domain has a polypeptide sequence set forth in SEQ. ID No. 20 or a variant thereof.

35. A method of treating autoimmune and inflammation-related hair loss in a subject comprising administering a formulation comprising the conjugate of claim 1 to the subject, wherein the second region is a NEMO binding domain.

36. A method of treating autoimmune and inflammation-related hair loss in a subject comprising administering a formulation comprising the conjugate of claim 2 to the subject, wherein the second region is a NEMO binding domain.

37. The method of claim 35 or claim 36 wherein the NEMO binding domain has a polypeptide sequence set forth in SEQ. ID No. 20 or a variant thereof.

38. A method of treating an inflammatory airway disease in a subject comprising administering an inhalable formulation comprising the conjugate of claim 1 to the subject, wherein the second region is a NEMO binding domain.

39. A method of treating an inflammatory airway disease in a subject comprising administering an inhalable formulation comprising the conjugate of claim 2 to the subject, wherein the second region is a NEMO binding domain.

40. The method of claim 38 or claim 39 wherein the inflammatory airway disease is chronic obstructive pulmonary disease.

41. The method of claim 38, wherein the NEMO binding domain has a polypeptide sequence set forth in SEQ. ID No. 20 or a variant thereof.

42. A method of treating colo-rectal inflammatory bowel disease in a subject comprising administering an enema formulation comprising the conjugate of claim 1 to the subject, wherein the second region is a NEMO binding domain.

43. A method of treating colo-rectal inflammatory bowel disease in a subject comprising administering an enema formulation comprising the conjugate of claim 2 to the subject, wherein the second region is a NEMO binding domain.

44. The method of claim 42 or claim 43 wherein the NEMO binding domain has a polypeptide sequence set forth in SEQ. ID No. 20 or a variant thereof.

45. A method of treating a condition in a subject comprising administering a systemic formulation comprising the conjugate of claim 1 to the subject, wherein the second region is a NEMO binding domain.

46. A method of treating a condition in a subject comprising administering a systemic formulation comprising the conjugate of claim 2 to the subject, wherein the second region is a NEMO binding domain.

47. The method of claim 45 or claim 46 wherein the condition is at least one of unstable angina, acute myocardial infarction and acute stroke.

48. The method of claim 45 or claim 46 wherein the NEMO binding domain has a polypeptide sequence set forth in SEQ. ID No. 20 or a variant thereof.

49. A method of treating ischemia reperfusion injury following transient ischemia in a subject comprising administering a systemic formulation comprising the conjugate of claim 1 to the subject, wherein the second region is a NEMO binding domain.

50. A method of treating ischemia reperfusion injury following transient ischemia in a subject comprising administering a systemic formulation comprising the conjugate of claim 2, wherein the second region is a NEMO binding domain.

51. The method of claim 49 or claim 50 wherein the ischemia reperfusion injury is in the brain, kidney or heart.

52. The method of claim 49 or claim 50 wherein the NEMO binding domain has a polypeptide sequence set forth in SEQ. ID No. 20 or a variant thereof.

53. A method of treating polycystic kidney disease in a subject comprising administering a formulation comprising the conjugate of claim 1 to the subject, wherein the second region is a PC1 CTT-derived fusion protein, a PC1 CTT-derived p200 peptide or a PC1 CTT-derived p21 peptide.

54. A method of treating polycystic kidney disease in a subject comprising administering a formulation comprising the conjugate of claim 2 to the subject, wherein the second region is a PC1 CTT-derived fusion protein, a PC1 CTT-derived p200 peptide or a PC1 CTT-derived p21 peptide.

55. The method of claim 53 or claim 54 wherein the second region has a polypeptide sequence set forth in at least one of SEQ. ID Nos. 23 or 26 or a variant thereof.

56. The method of claim 53 or claim 54 wherein the conjugate is further conjugated to a noncompetitive V2 receptor antagonist for targeting renal cysts of collecting duct cells.

57. A method of treating a lysosomal storage disease in a subject comprising administering a formulation comprising the conjugate of claim 1 to the subject, wherein the second region of the conjugate comprises an enzyme that restores enzymatic function in subjects with inherited enzyme deficiencies.

58. A method of treating a lysosomal storage disease in a subject comprising administering a formulation comprising the conjugate of claim 2 to the subject, wherein the second region of the conjugate comprises an enzyme that restores enzymatic function in subjects with inherited enzyme deficiencies.

59. The method of claim 57 or claim 58 wherein the enzyme is selected from the group consisting of glucocerebrosidase, alpha-L-iduronidase, and iduronidate-2-sulfatase.

60. The method of claim 57 or claim 58 wherein the enzyme includes a polypeptide sequence as set forth in at least one of SEQ. ID Nos. 30, 45, or 48 or a variant thereof.

61. A method of treating Leber Congenital Amourosis type 1 in a subject comprising administering a formulation comprising the conjugate of claim 1 to the subject, wherein the second region includes a gene product of RPE65.

62. A method of treating Leber Congenital Amourosis type 1 in a subject comprising administering a formulation comprising the conjugate of claim 2 to the subject, wherein the second region includes a gene product of RPE65.

63. The method of claim 61 or claim 62 wherein the gene product of RPE65 has a polypeptide sequence as set forth in SEQ. ID No. 33 or a variant thereof.

64. A method of treating Huntington's Disease in a subject comprising administering the conjugate of claim 1 to the subject, wherein the second region includes a zinc finger peptide.

65. A method of treating Huntington's Disease in a subject comprising administering the conjugate of claim 2 to the subject, wherein the second region includes a zinc finger peptide.

66. The method of claim 64 or claim 65, wherein the zinc finger peptide sequence includes at least one of SEQ. ID Nos. 36, 29, or 42 or a variant thereof.

67. A method of treating tuberculosis in a subject comprising administering a formulation comprising the conjugate of claim 1 to the subject, wherein the second region comprises an Ag85A 99-118 epitope peptide.

68. The method of treating tuberculosis in a subject comprising administering a formulation comprising the conjugate of claim 2 to the subject, wherein the second region comprises an Ag85A 99-118 epitope peptide.

69. The method of claim 67 or claim 68 wherein the Ag85A 99-118 epitope peptide sequence includes at least one of SEQ. ID Nos. 51, 54, 57, or 60 or a variant thereof.

70. A method of treating tuberculosis in a subject comprising administering a formulation comprising the conjugate of claim 1 to the subject, wherein the second region comprises an Ag85A 70-78 epitope peptide.

71. The method of treating tuberculosis in a subject comprising administering a formulation comprising the conjugate of claim 2 to the subject, wherein the second region comprises an Ag85A 70-78 epitope peptide.

72. The method of claim 70 or claim 71 wherein the Ag85A 70-78 epitope peptide sequence includes at least one of SEQ. ID Nos. 63, 66, or 69 or a variant thereof.

73. A conjugate prepared by a method comprising the steps:
culturing a host cell transformed with an expression vector comprising a nucleic acid encoding a conjugate according to claim 1 under conditions which provide for the expression of the conjugate within the host cell; and
recovering the conjugate by affinity purification.

74. A conjugate comprising:
a first region comprising a homeodomain structure; and
a second region comprising a functional or regulatory nucleic acid or peptide nucleic acid not naturally associated with the first region.

75. The conjugate of claim 74 wherein the first region is a HOX D12 homeodomain.

76. The conjugate of claim 74 wherein the first region is a HOX C12 homeodomain.

77. A conjugate comprising:
a first region comprising a homeodomain structure having a polypeptide sequence described in any one of SEQ ID Nos. 1 to 19 or a variant thereof; and
a second region comprising a functional or regulatory nucleic acid or peptide nucleic acid not naturally associated with the first region.

78. The conjugate of any one of claims 74 to 77 wherein the second region comprises DNA, RNA, LNA, PNA, γ PNA, or a combination of these components that has intracellular biological activity.

79. The conjugate of any one of claims 74 to 77 wherein the second region includes a nucleic acid that binds to miRNA21 or to DYRK1b.

80. The conjugate of any one of claims 74 to 78 wherein the second region has a nucleotide sequence as set forth in at least one of SEQ ID Nos. 76, 78, or 79 or a variant thereof.

81. The conjugate of any one of claims 74 to 79 wherein the second region is conjugated to the C-terminus of the first region.

82. The conjugate of any one of claims 74 to 79 wherein the second region is conjugated to the N-terminus of the first region.

83. The conjugate of any one of claims 74 to 79 wherein the first region is linked to the second region with a peptidic bond.

84. The conjugate of any one of claims 74 to 79 wherein the second region is conjugated to the first region via a non-peptidic bond.

85. The conjugate of any one of claims 74 to 79 wherein the second region interacts with an intracellular target and/or an intranuclear target.

86. The conjugate of claim 85 wherein the second region interacts with an intracellular target and/or an intranuclear target via interactions with an miRNA or a protein complex that binds an miRNA.

87. The conjugate of claim 86 wherein the second region is a nucleic acid or PNA that binds to miRNA132 for affecting the Ras pathway.

88. The conjugate of claim 86 wherein the second region is a nucleic acid sequence or PNA that stably hybridizes to an miRNA nucleotide sequence as set forth in SEQ ID No. 75 or a variant thereof.

89. The conjugate of claim 88 wherein the second region has a nucleotide sequence as set forth in SEQ ID No. 78 or to a portion of said nucleotide sequence or a variant thereof that stably hybridizes to miRNA132.

90. The conjugate of claim 88 wherein the second region is selected based on the specificity of an interaction with miRNA132.

91. The conjugate of claim 88 wherein the second region consists of modified nucleotides to increase stability or reduce degradation.

92. The conjugate of claim 86 wherein the second region is a nucleic acid sequence or PNA that binds to miRNA21 for affecting a tumor suppressor pathway or tumor growth.

93. The conjugate of claim 92 wherein the second region comprises an nucleotide sequence as set forth in SEQ ID No. 76 or variant thereof or can stably hybridize to a nucleotide sequence as set forth in SEQ ID No. 77 or a variant thereof.

94. The conjugate of any one of claims 74, 75 and claims 77 to 93 wherein the first region homeodomain structure has a polypeptide sequence as set forth in SEQ ID No. 2 or a variant thereof.

95. The conjugate of any one of claims 74 to 79 wherein the second region interacts with an intracellular target and/or an intranuclear target via interactions with an mRNA for affecting splicing or protein translation.

96. The conjugate of claim 95 wherein the second region binds to DYRK1b.

97. The conjugate of claim 96 in which the second region has a nucleotide sequence as set forth in SEQ ID No. 79 or a variant thereof.

98. The conjugate of claim 74 wherein the first region and the second region are attached via "click chemistry."

99. The conjugate of claim 74 wherein the second region comprises PNA, and wherein the first region and the second region is attached via a peptide bond.

100. A method of treating cancer in a subject comprising administering a formulation comprising the conjugate of claim 74 to the patient.

101. A method of treating cancer in a subject comprising administering a formulation comprising the conjugate of claim 95 to the subject.

102. A method of treating cancer in a subject comprising administering a formulation comprising the conjugate of claim 96 to the subject.

103. A method of treating cancer in a subject comprising administering a formulation comprising the conjugate of claim 97 to the subject.

104. A method of treating a metabolic syndrome, a lipid disorder and/or obesity in a subject comprising administering a formulation comprising the conjugate of claim 74 to the subject.

105. A method of treating a metabolic syndrome, a lipid disorder and/or obesity in a subject comprising administering a formulation comprising the conjugate of claim 95 to the subject.

106. A method of treating a metabolic syndrome, a lipid disorder and/or obesity in a subject comprising administering a formulation comprising the conjugate of claim 96 to the subject.

107. A method of treating a metabolic syndrome, a lipid disorder or obesity in a subject comprising administering a formulation comprising the conjugate of claim 97 to the subject.

108. The method of treating cancer of claim 100 comprising administration of the formulation as an intravenous solution.

109. The method of treating a metabolic syndrome, a lipid disorder and/or obesity of claim 104 comprising administration of the formulation in sustained release form.

110. A method of treating tuberculosis in a subject comprising administering a formulation comprising the conjugate of claim 1 to the subject, wherein the second region includes at least a portion of one of a Ag85A 99-118 epitope peptide or a Ag85A 70-78 epitope peptide.

111. The method of treating tuberculosis in a subject according to claim 110 wherein:

the formulation is administered to the subject at least once via an inhaled route, intranasal route and/or by intramuscular, intradermal or subcutaneous parenteral injection; and

administration of the formulation provokes a protective immune response that prevents the onset of active lung infection with *Mycobacterium tuberculosis* in the subject.

112. A method of treating tuberculosis in a subject comprising administering a formulation comprising the conjugate of claim 1 to the subject, wherein the second region has a polypeptide sequence of at least one of SEQ ID Nos. 51, 54, 57, 60, 63, 66, 69 and 72 or a variant thereof.

113. A method of treating in a subject any one or more of dry eye, autoimmune-related hair loss, inflammation-related hair loss, chronic obstructive pulmonary disease, an inflammatory airway disease, unstable angina, acute myocardial infarction, acute stroke, and ischemia reperfusion injury to organs, comprising:

administering at least once a formulation comprising the conjugate of claim 1 wherein the second region comprises a NEMO binding domain, and wherein administration of the formulation inhibits NF- κ B activity, reduces blood concentration of TNF- α , IP-10, SAA, IL-6, Kc and/or GM-CSF, and/or increases Interleukin-10 levels in blood.

114. The method of claim 113 wherein the second region has a polypeptide sequence as set forth in SEQ ID No. 20 or a variant thereof.

115. The method of claim 113 wherein the first region comprises a polypeptide sequence as set forth in any of SEQ ID Nos. 1 or 2 or a variant thereof.

116. The conjugate of any one of claims 1, 2, 74 and 77 wherein the first region comprises a polypeptide sequence derived from a human gene.

117. The conjugate of claim 116 wherein the second region includes a polypeptide sequence derived from a human gene or variant thereof.

118. The conjugate of claim 116 wherein the second region includes a nucleic acid sequence derived from a human gene or variant thereof.

119. The method of any one of claims 30-72 and 100-115 wherein the subject is a human.

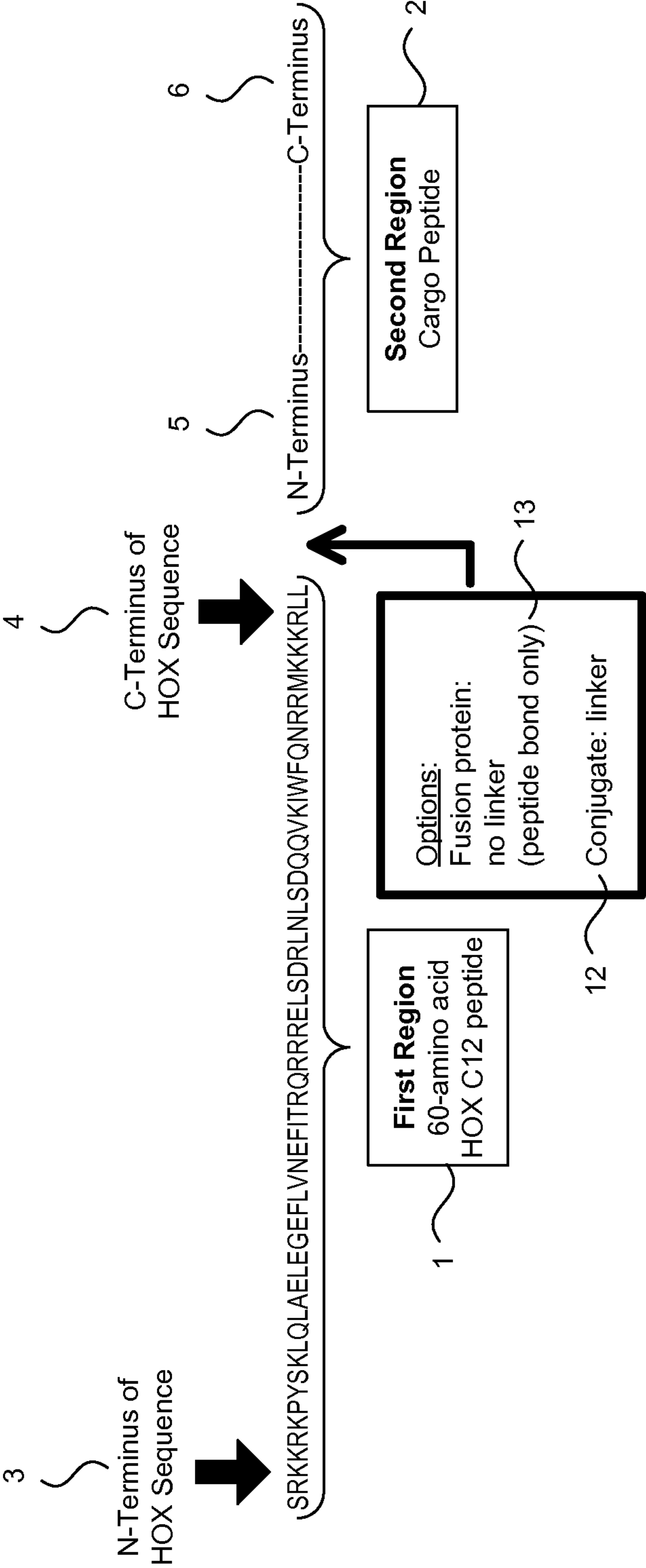


FIG. 1

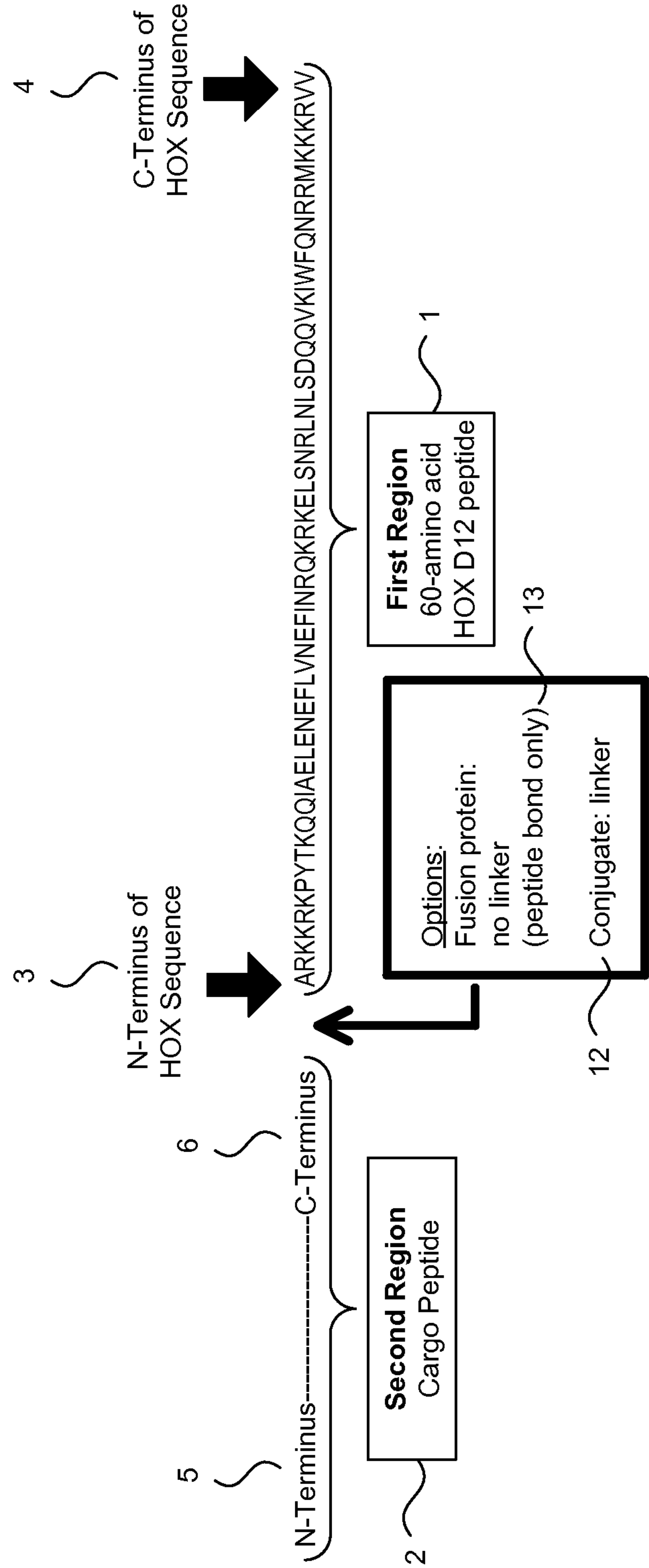


FIG. 2

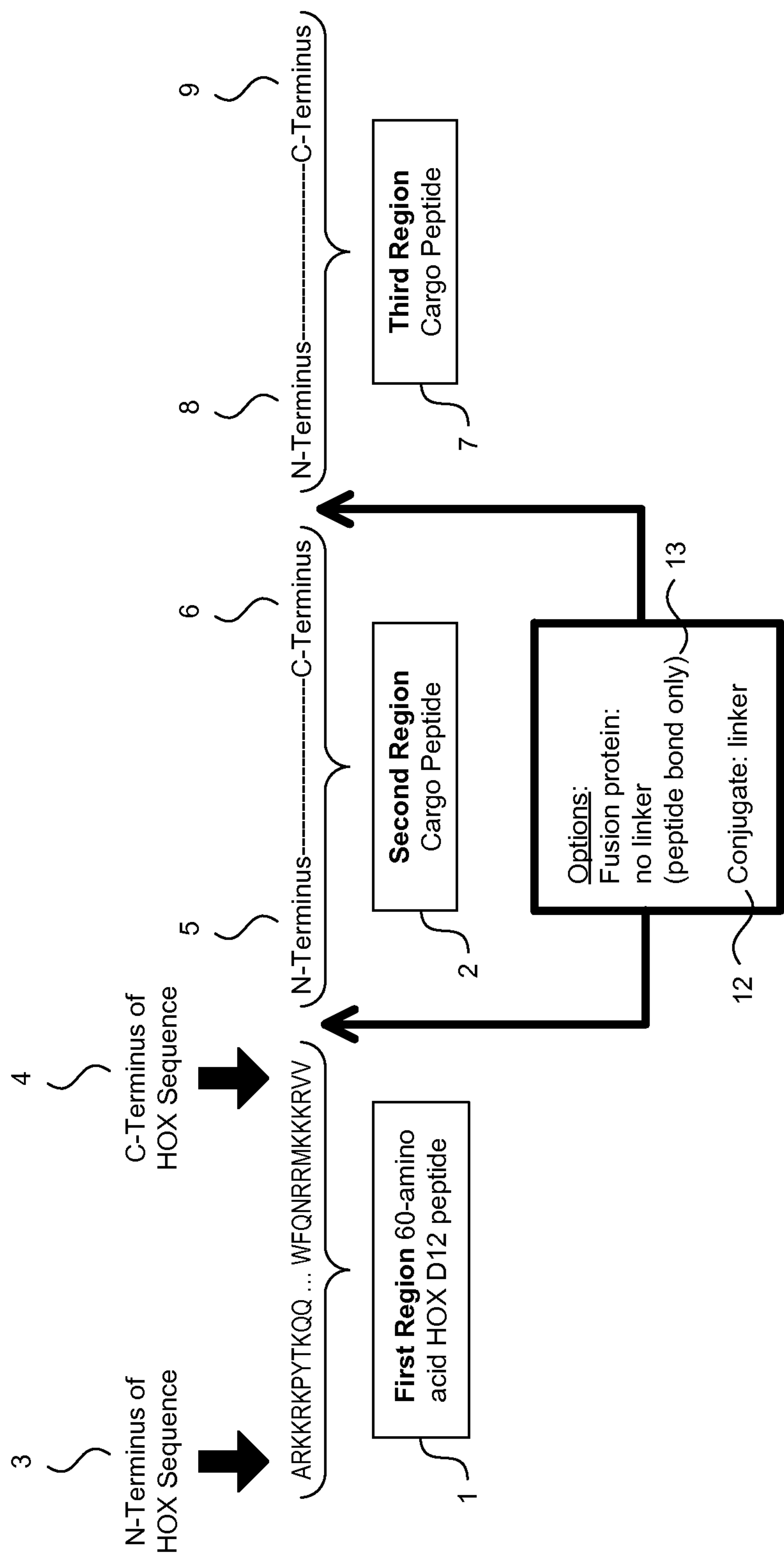


FIG. 3A

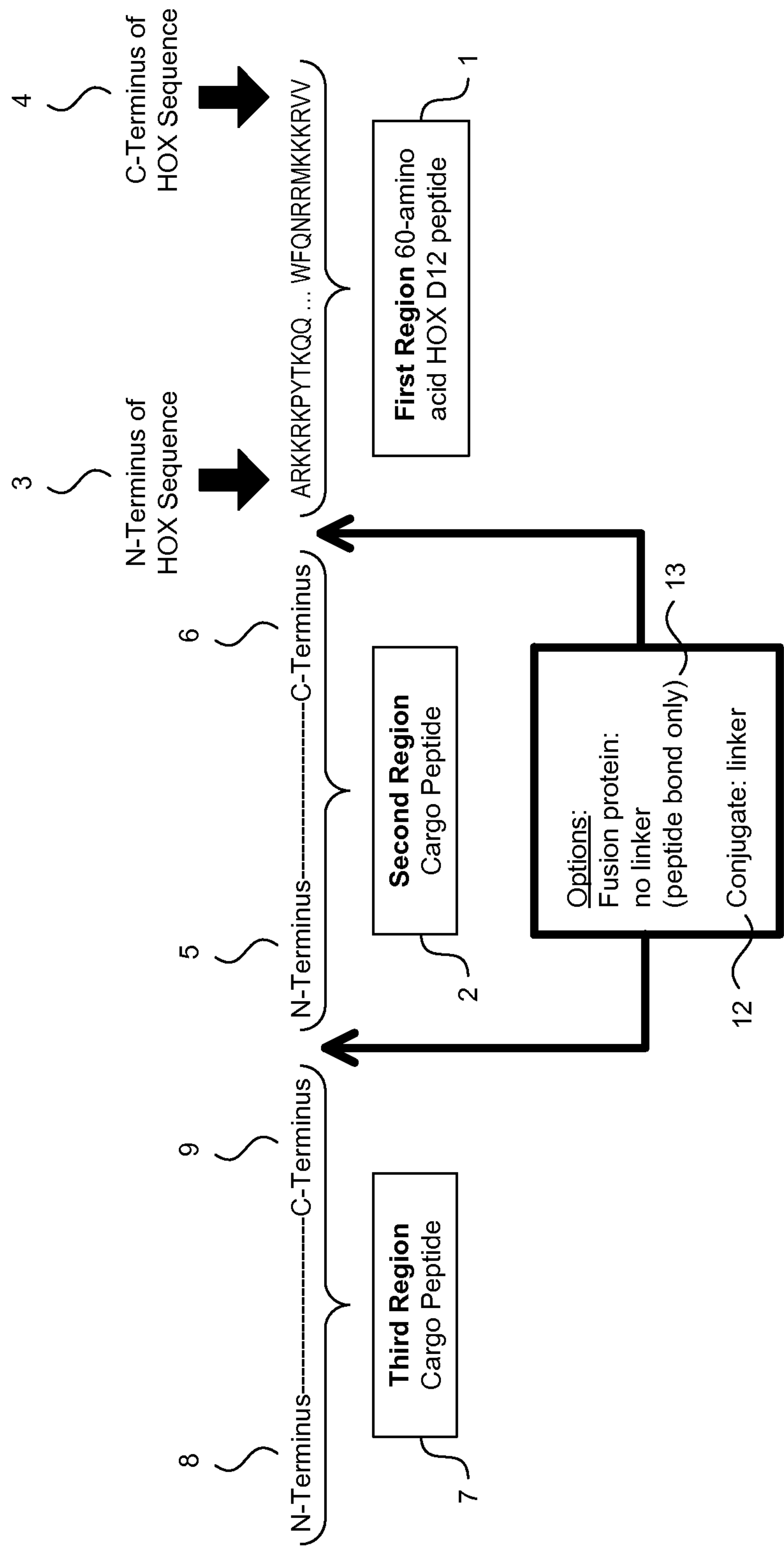


FIG. 3B

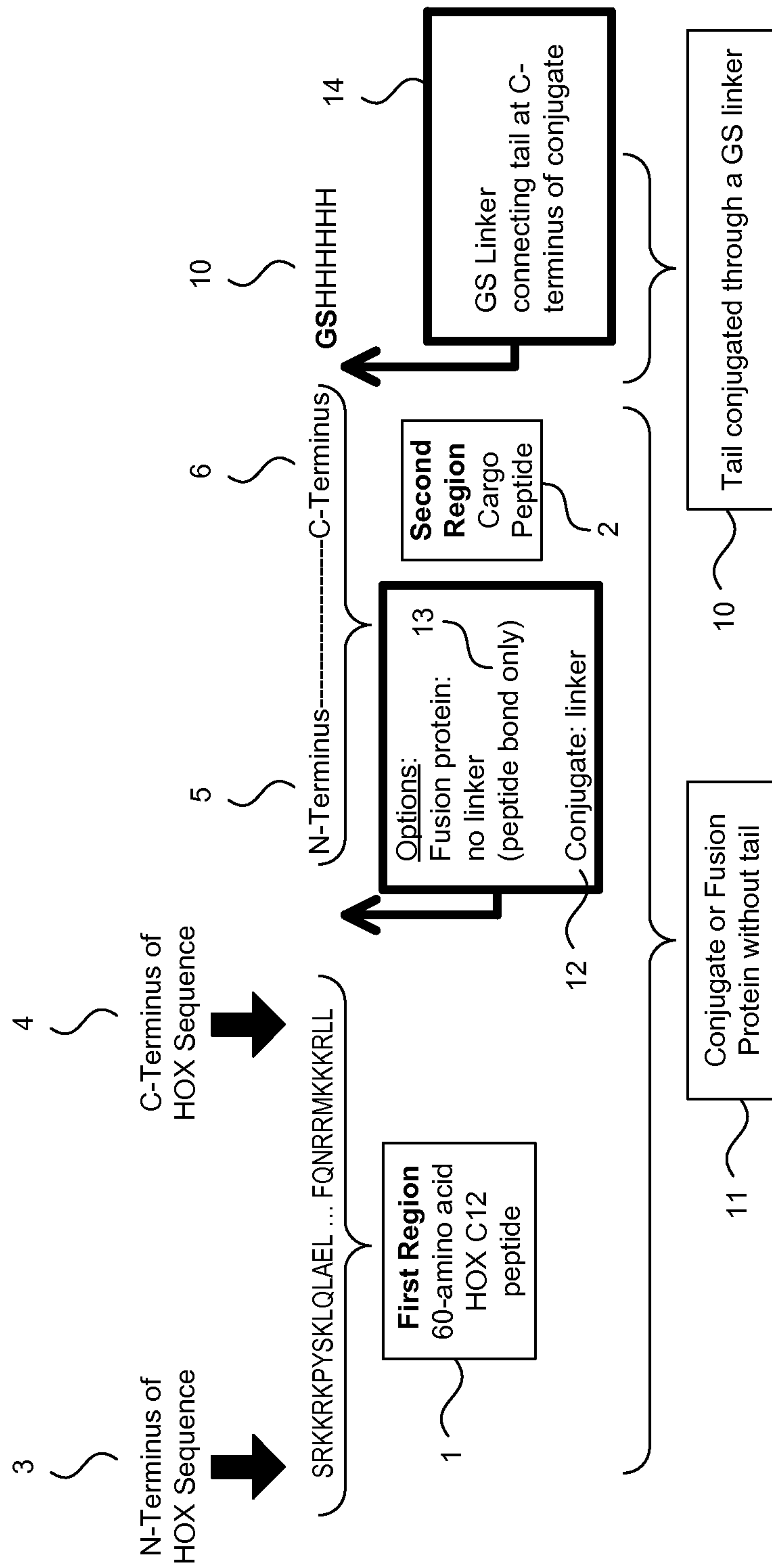


FIG. 4

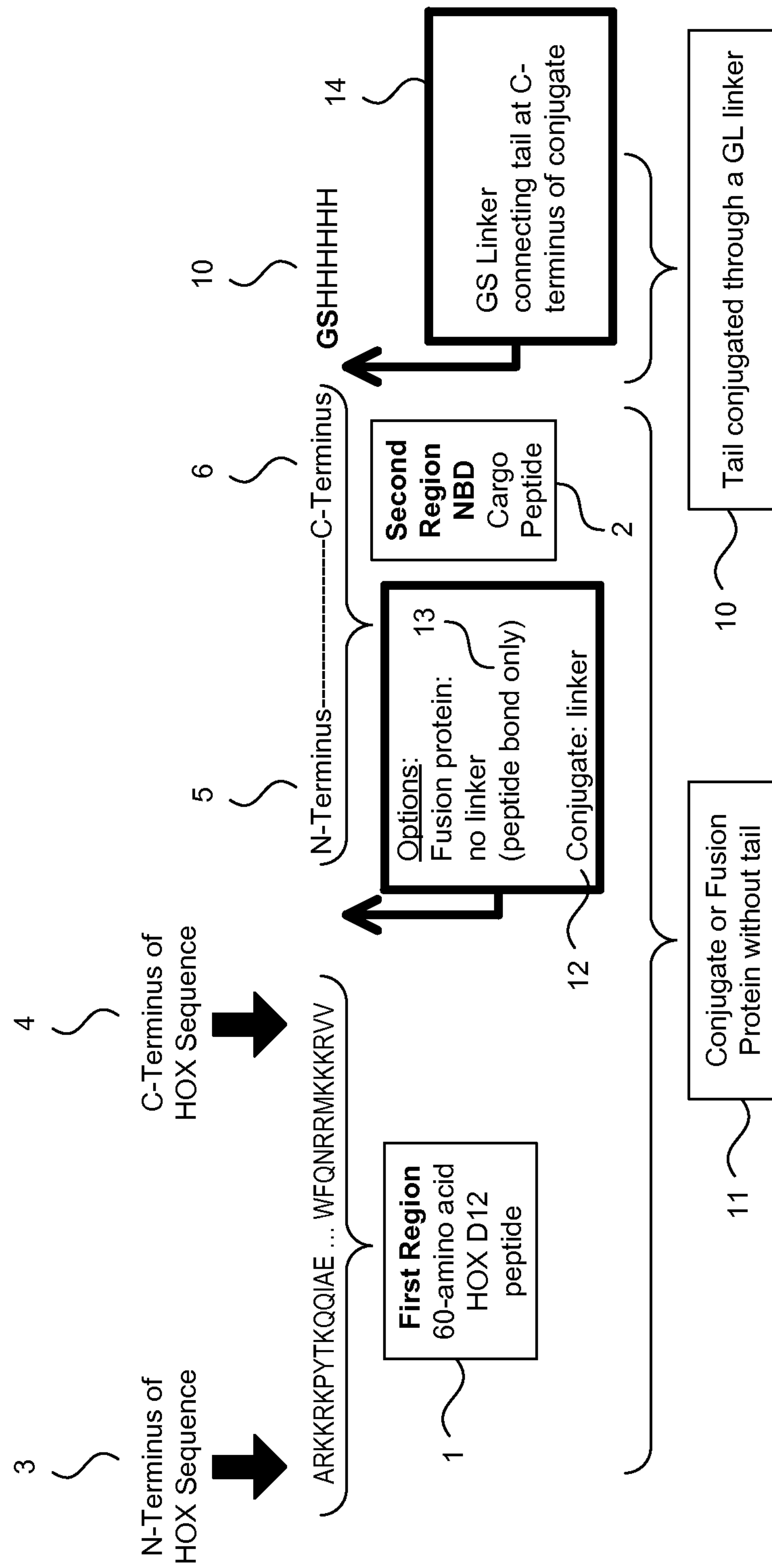
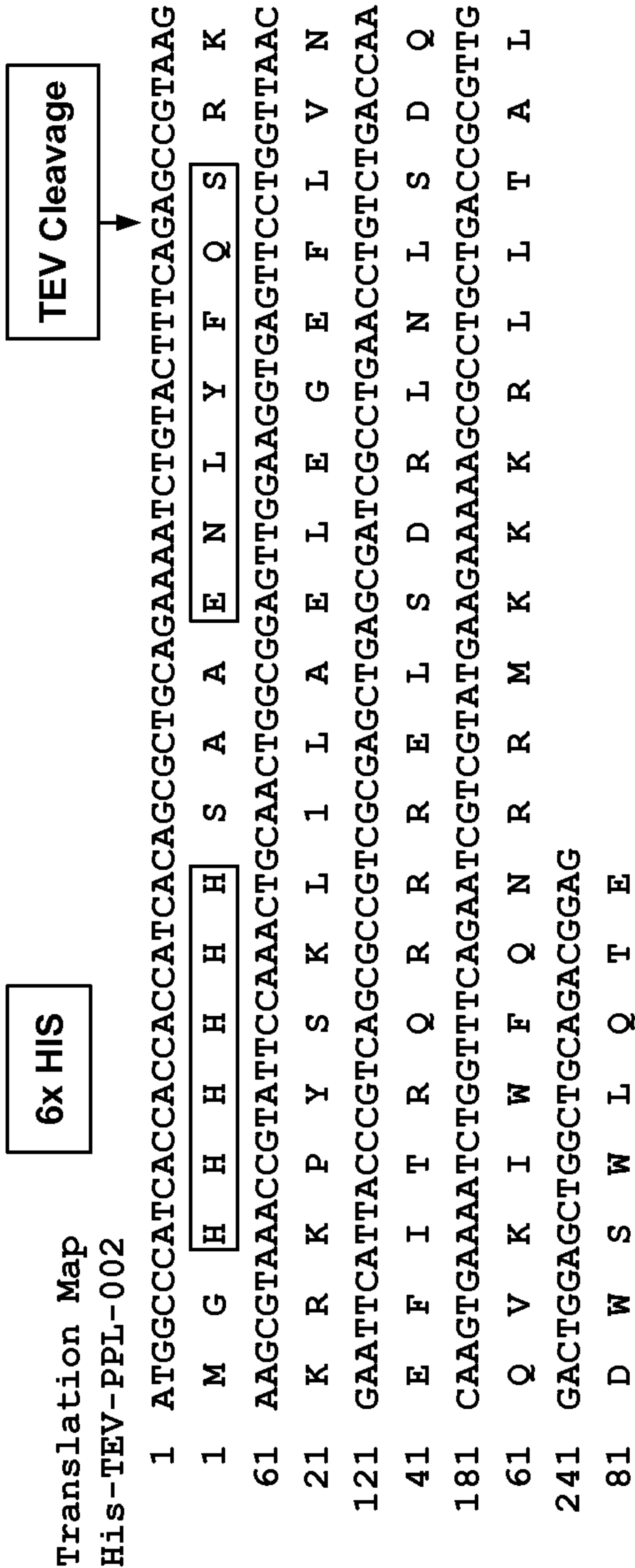
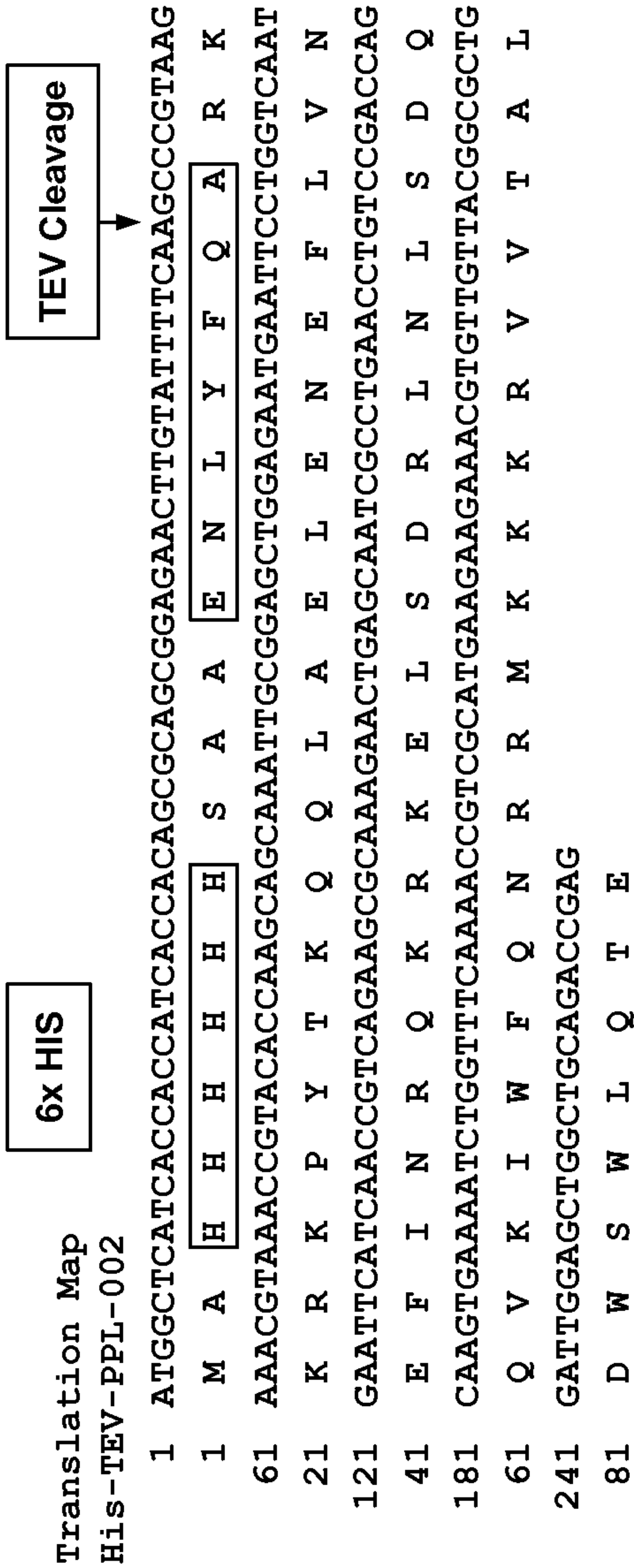


FIG. 5



His-TEV-PPL-002
GC Percentage: 51.568%

FIG. 6



His-TEV-PPL-003
GC Percentage: 48.780%

FIG. 7

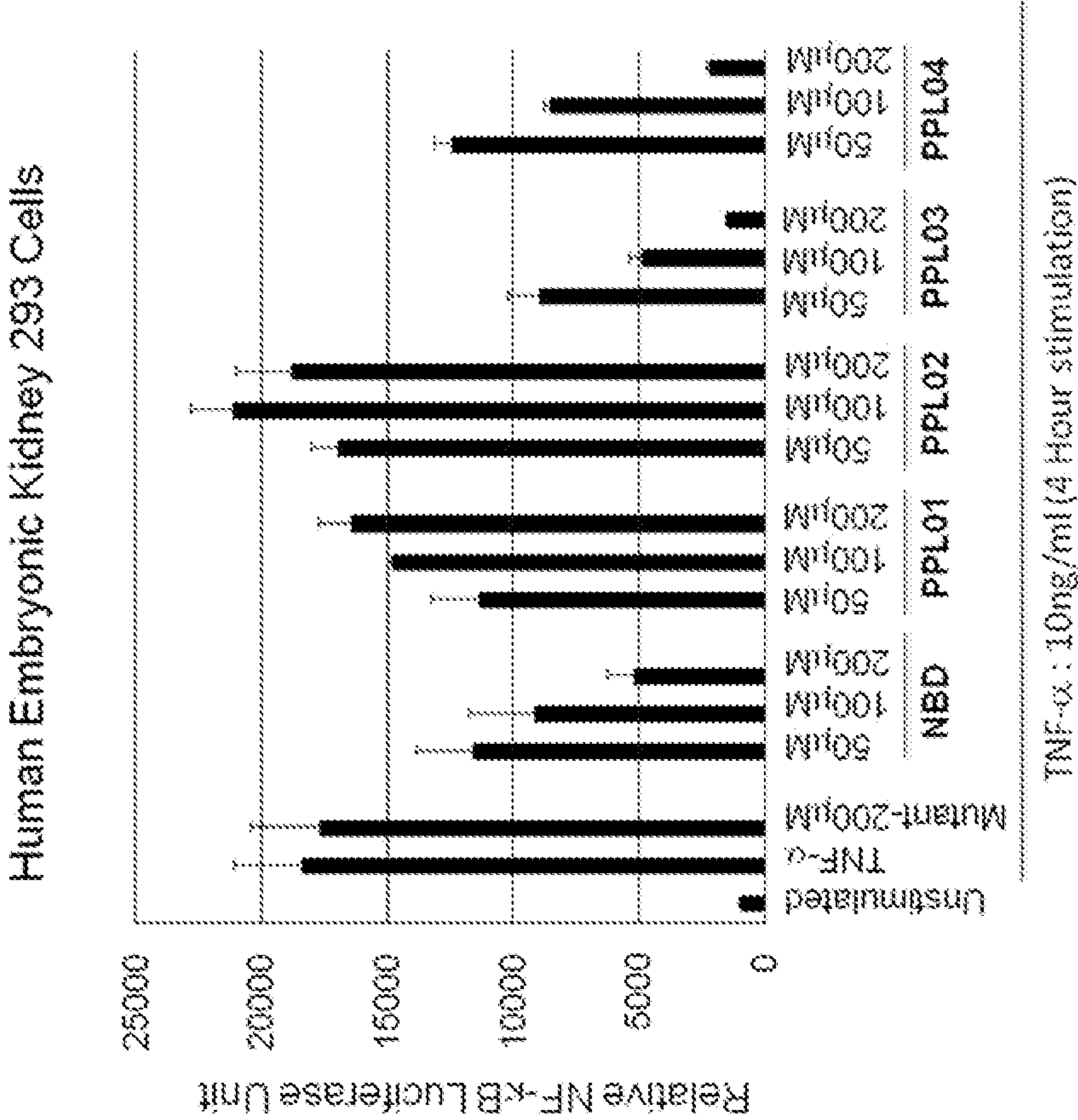


FIG. 8B

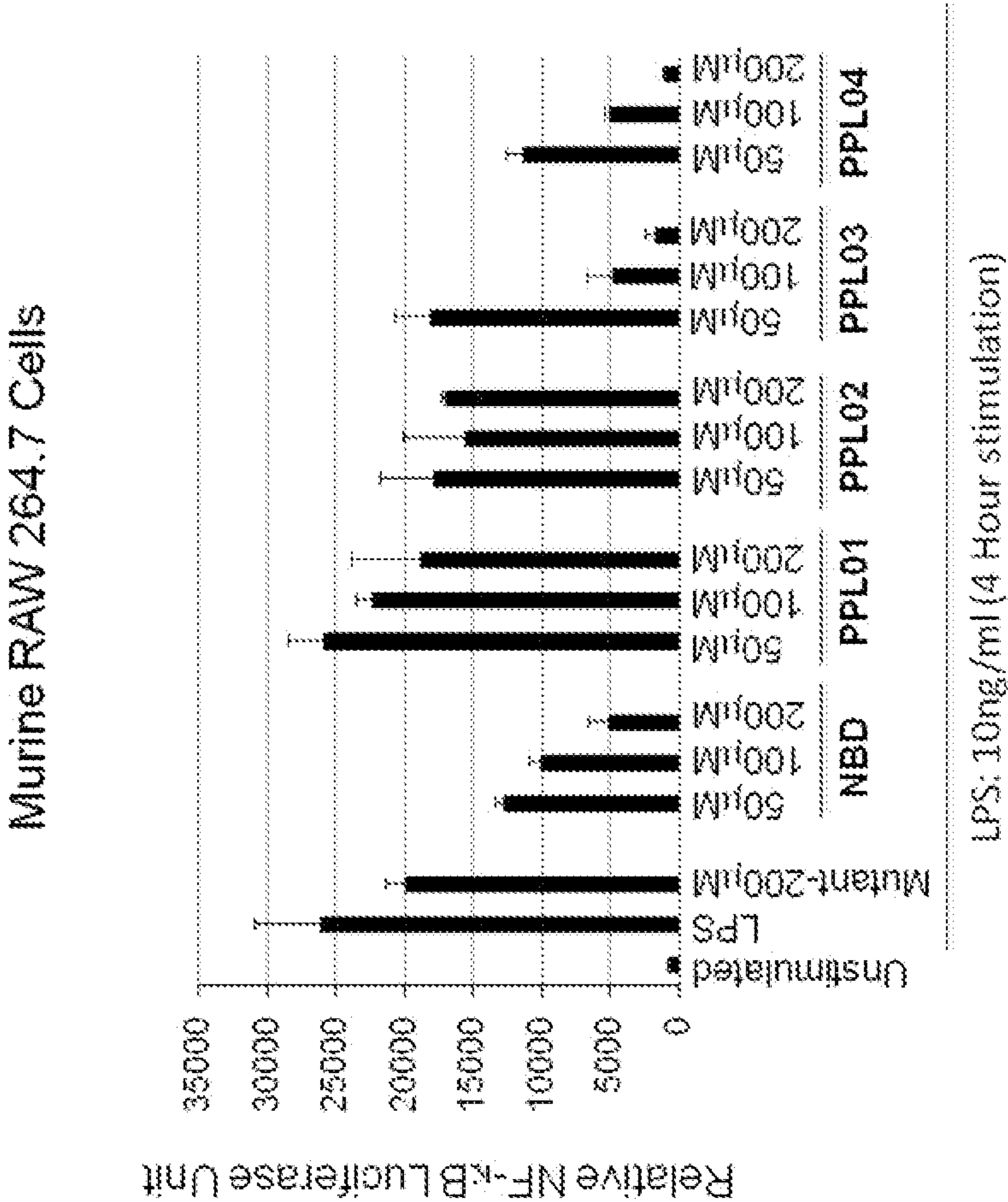


FIG. 8A

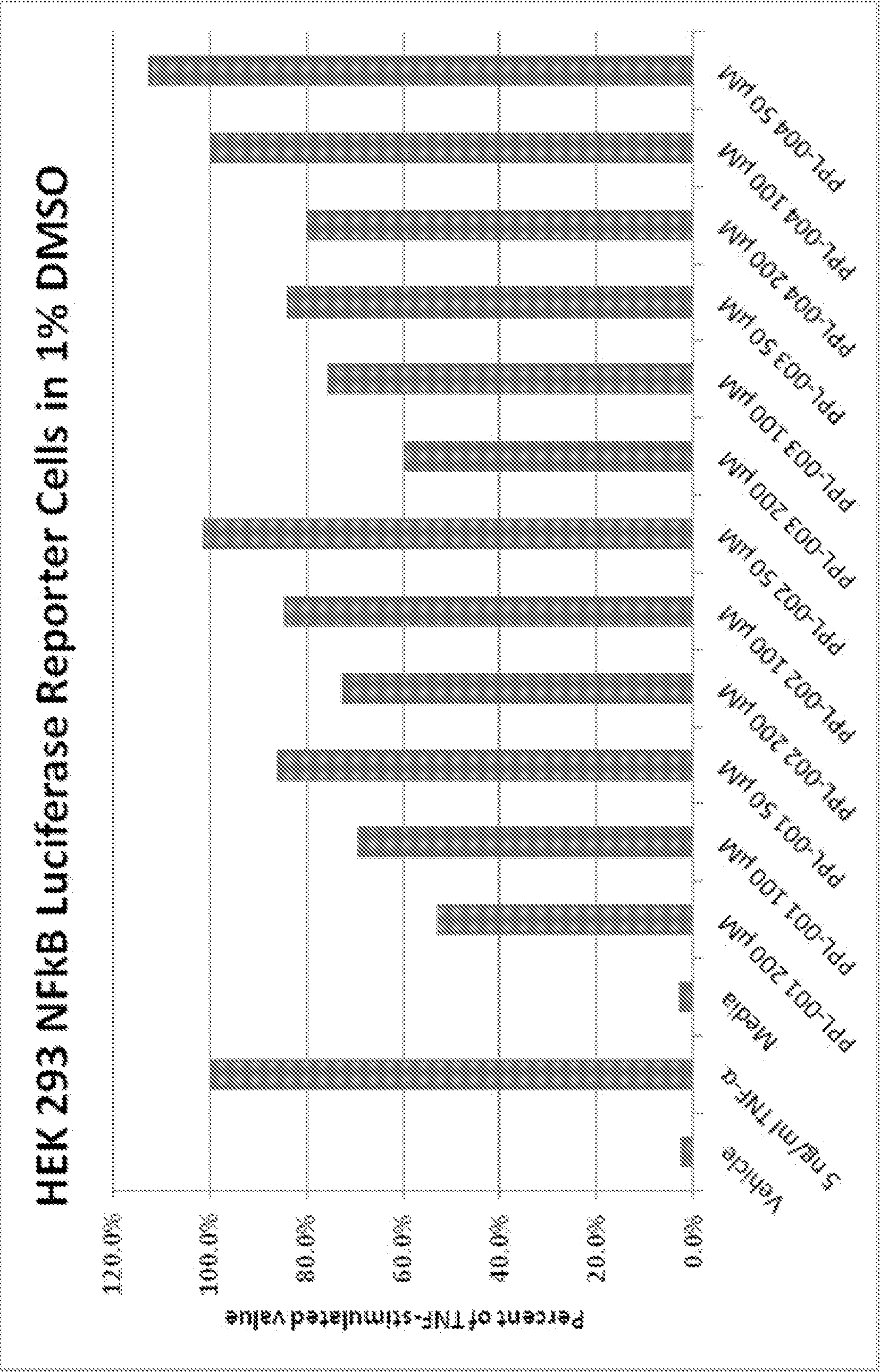
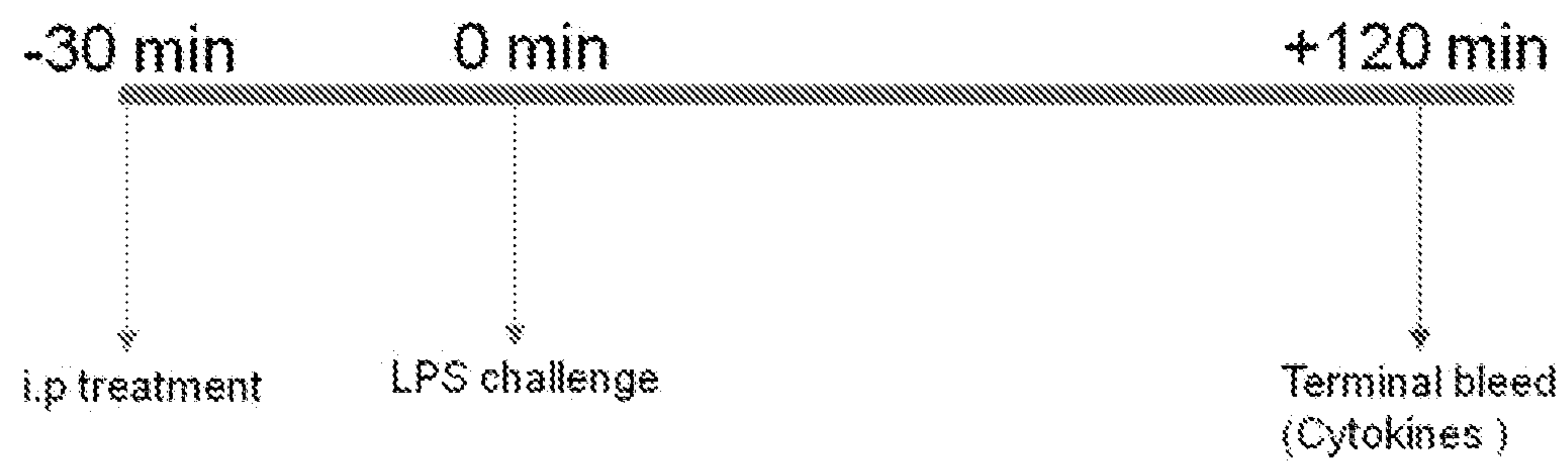


FIG. 9

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***FIG. 10***

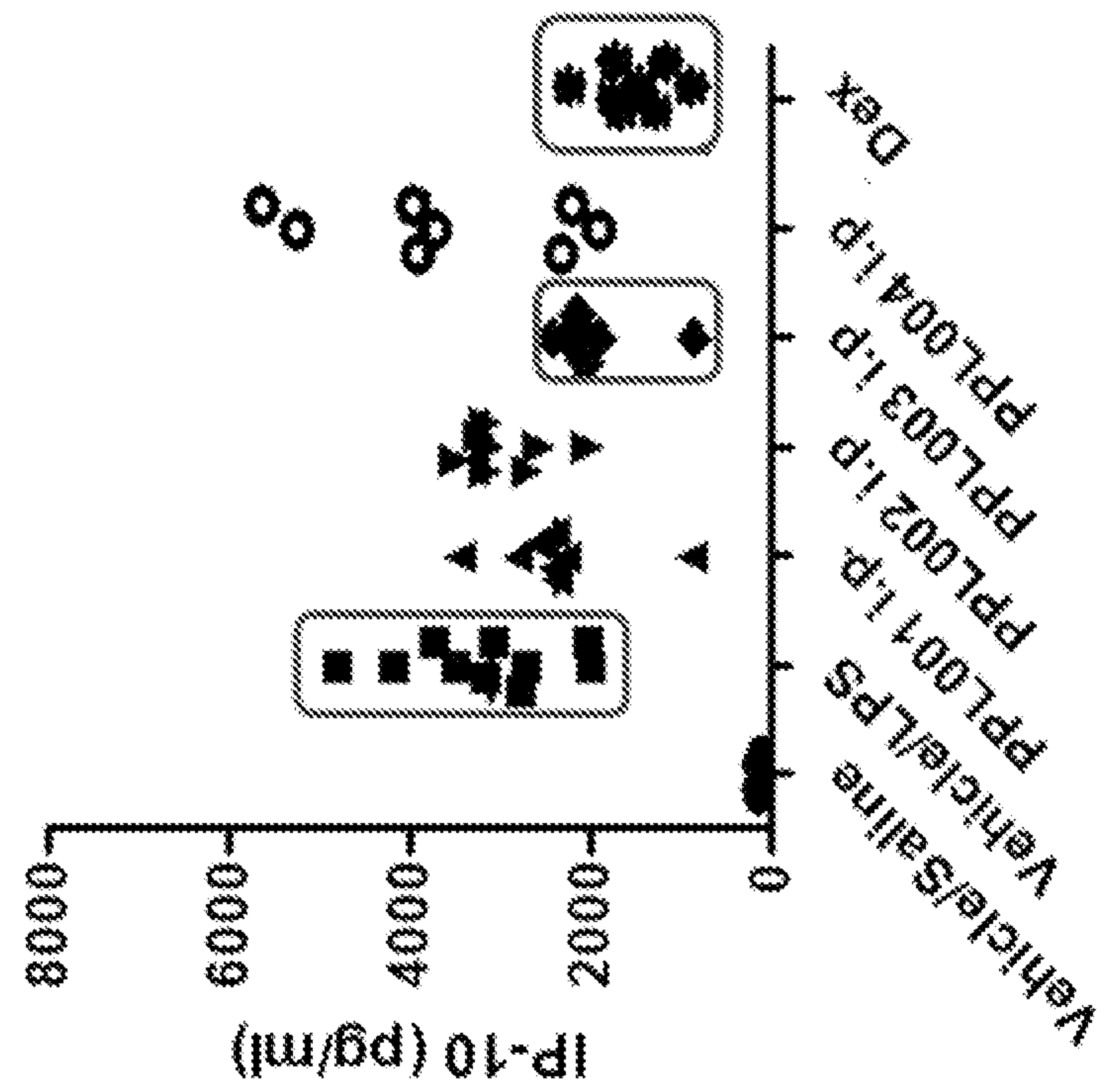


FIG. 11B

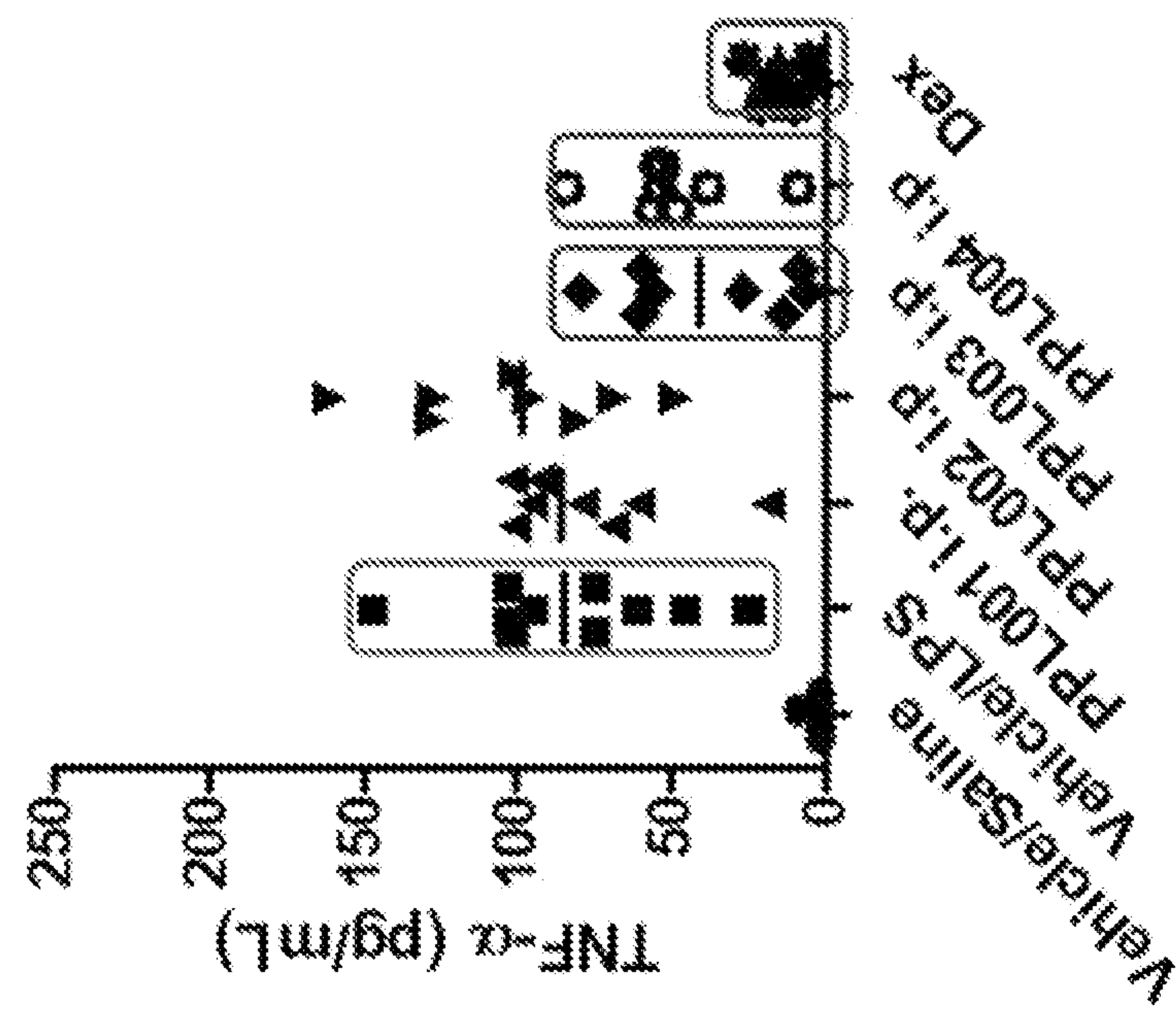


FIG. 11A

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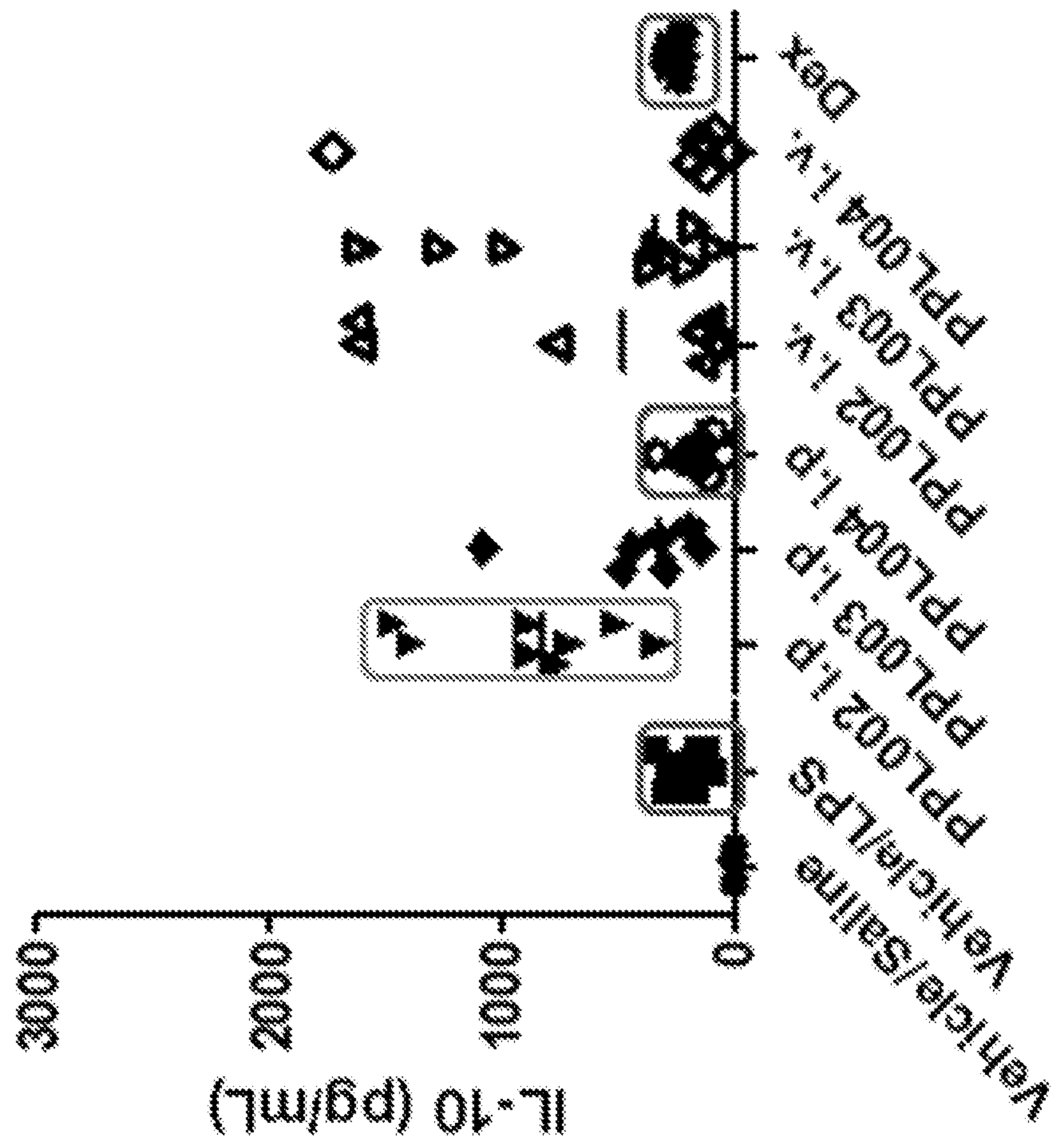


FIG. 12

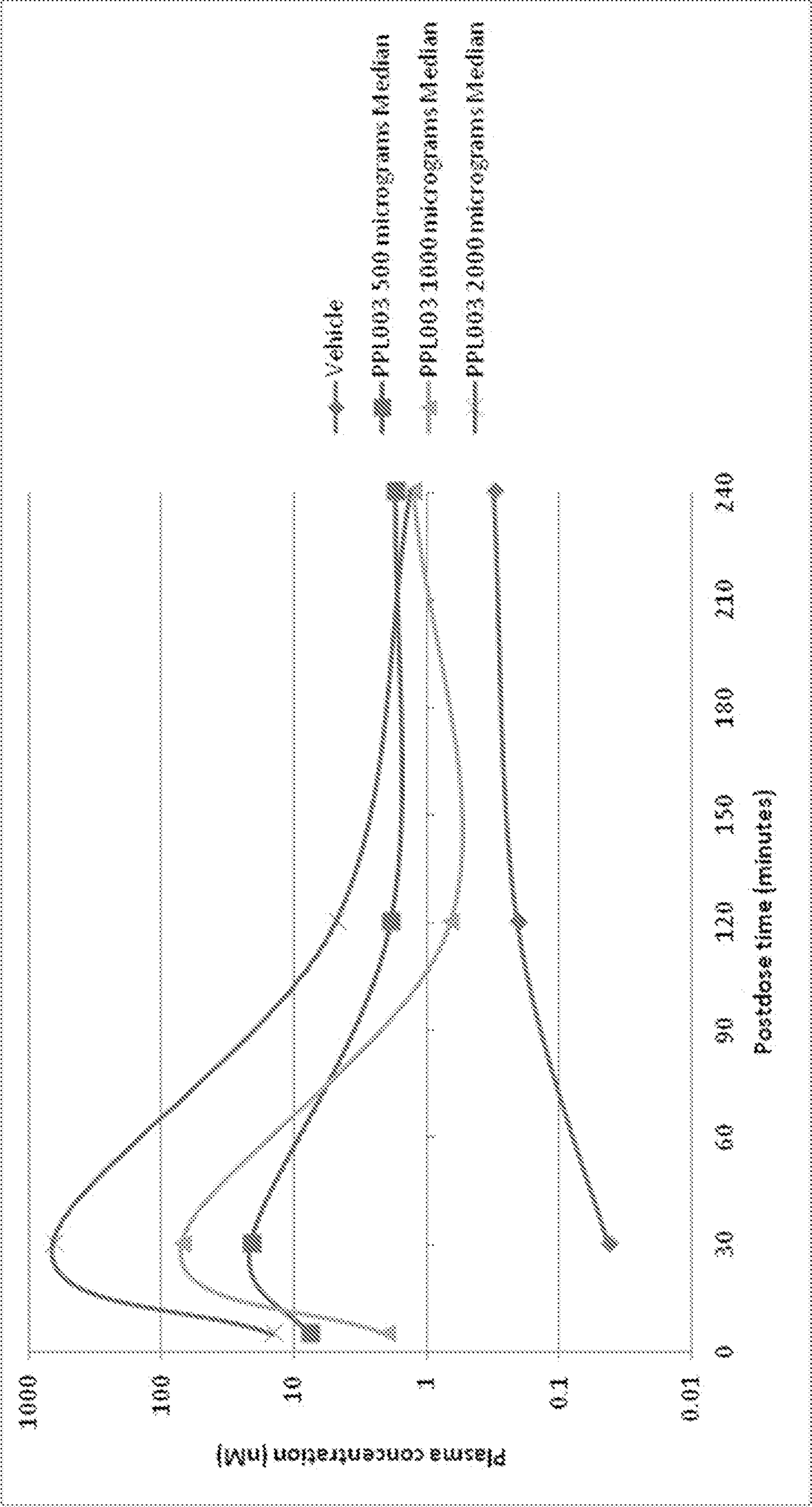


FIG. 13

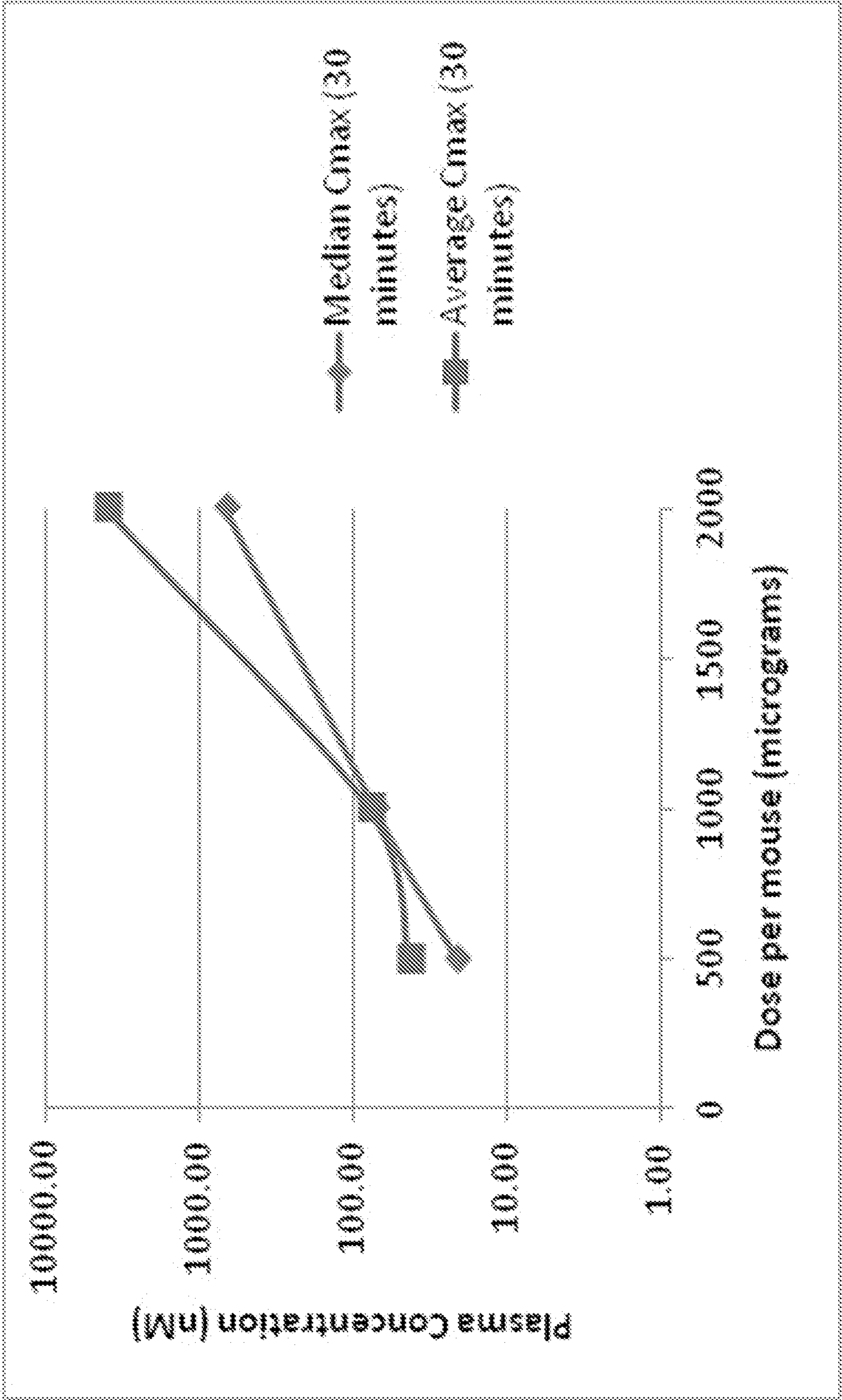


FIG. 14

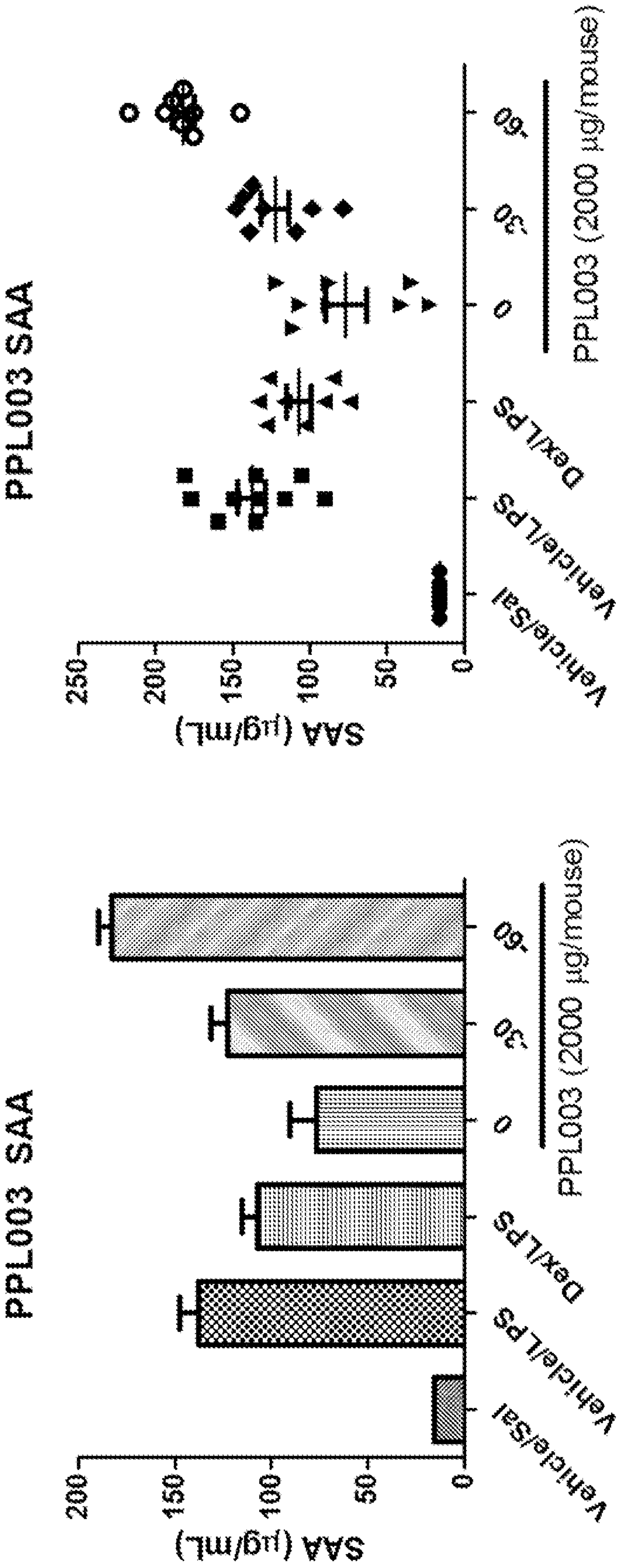


FIG. 15A

FIG. 15B

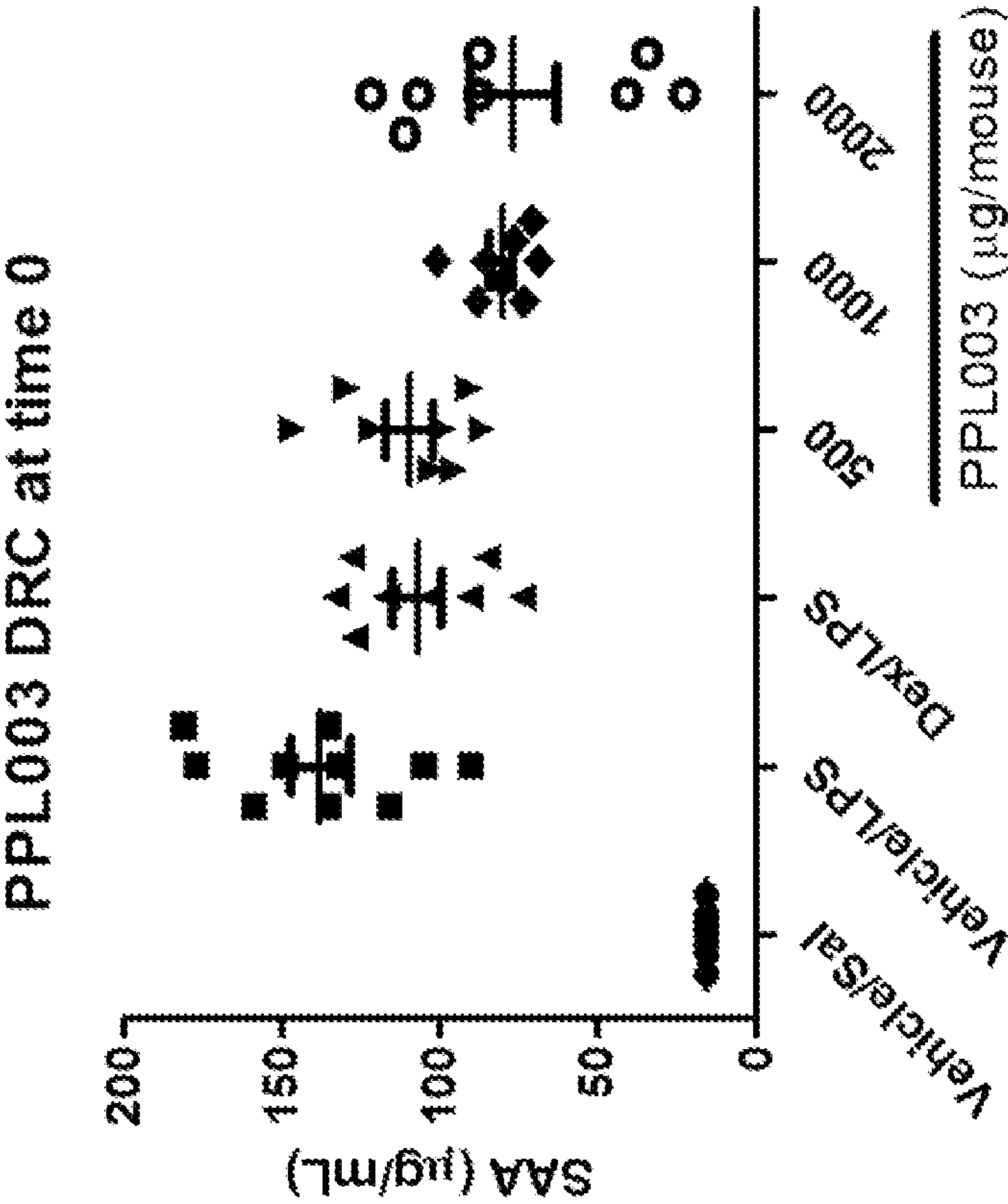


FIG. 16B

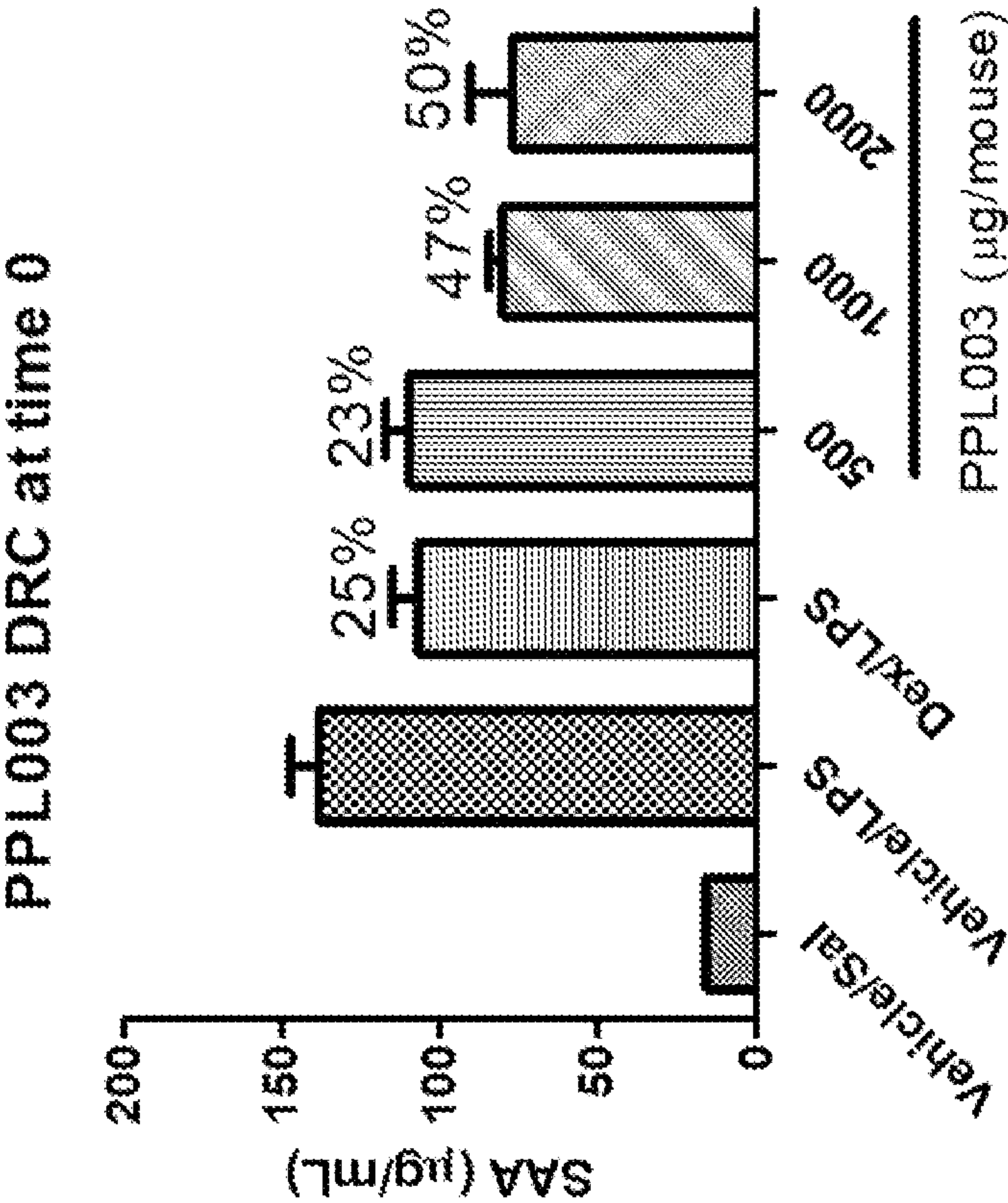


FIG. 16A

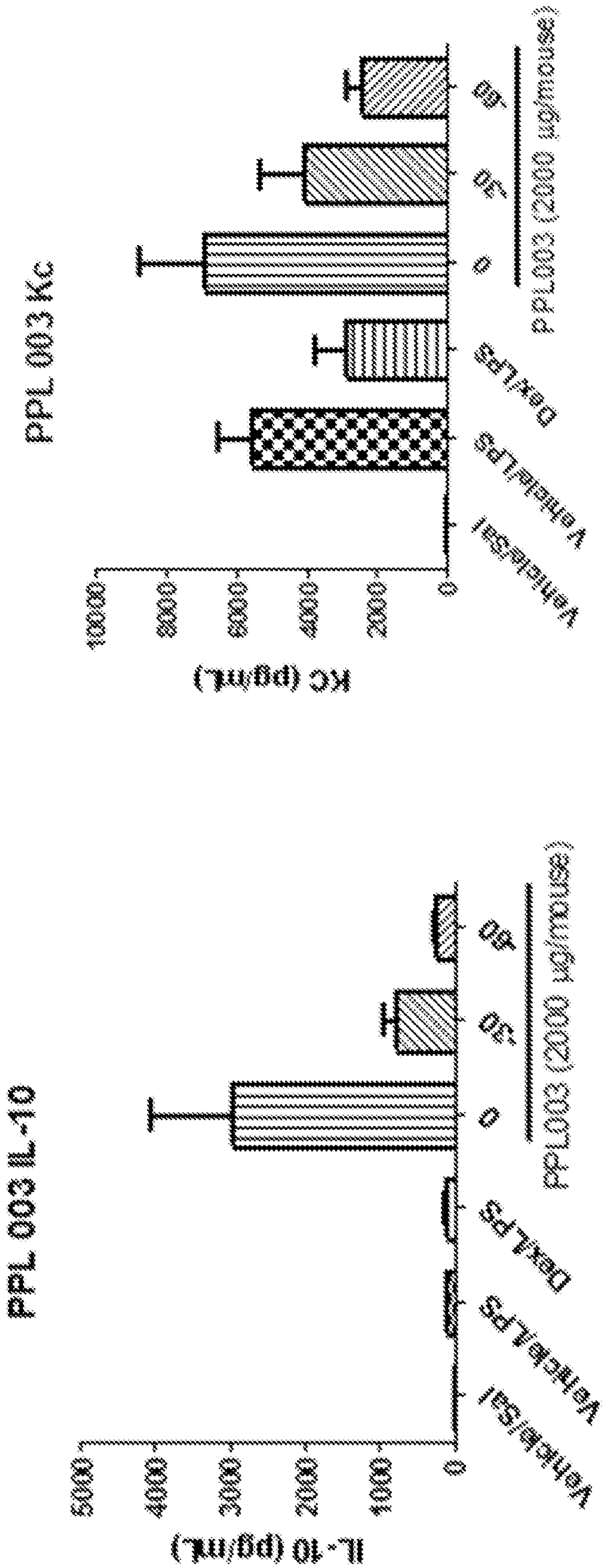


FIG. 17A

FIG. 17B

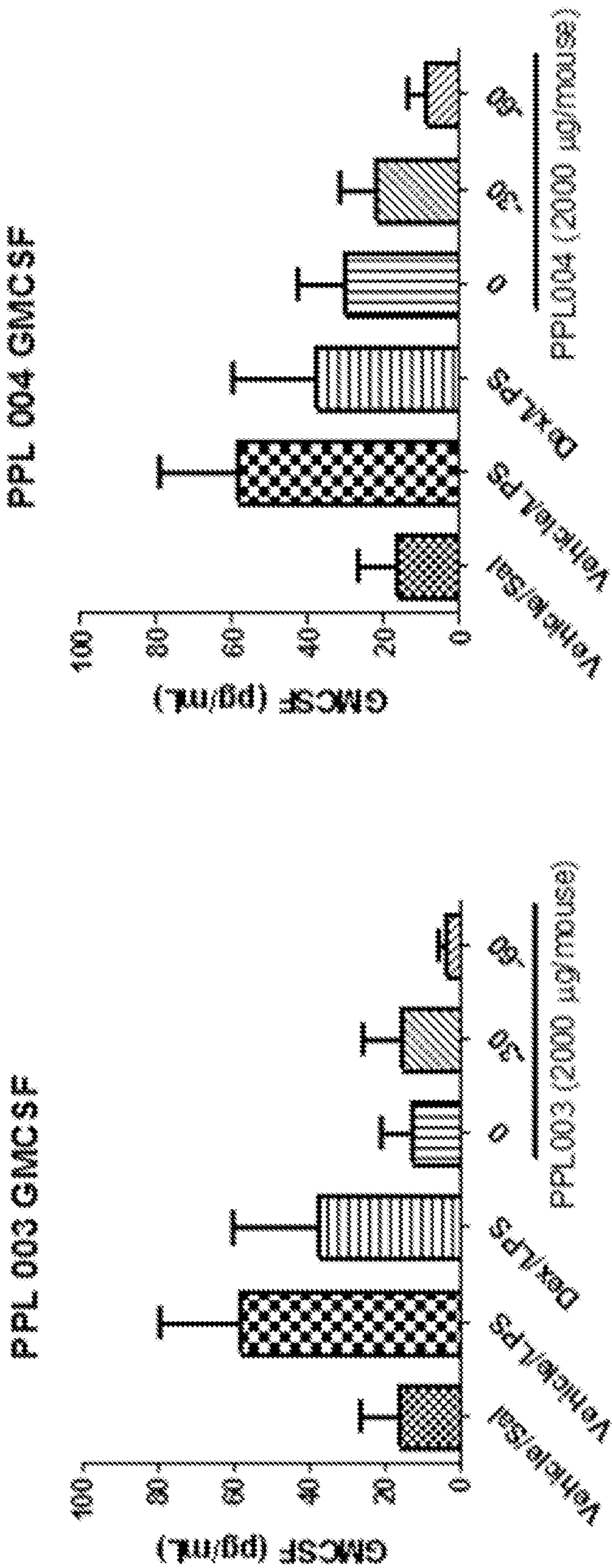


FIG. 18A

FIG. 18B