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(54) Title: MELANOCORTIN RECEPTOR BINDING MIMETIBODIES, COMPOSITIONS, METHODS AND USES

(57) Abstract: Melanocortin receptor binding mimetibody polypeptides are disclosed. Polynucleotides encoding these polypeptides, cells comprising these polynucleotides or expressing the mimetibodies, and methods of making and using the forgoing are also disclosed.

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MELANOCORTIN RECEPTOR BINDING MIMETIBODIES, COMPOSITIONS, METHODS AND USES

Field of the Invention

The present invention relates to melanocortin receptor binding mimetibodies, polynucleotides encoding these, cells comprising the polynucleotides or expressing the mimetibodies, and methods of making and using the foregoing.

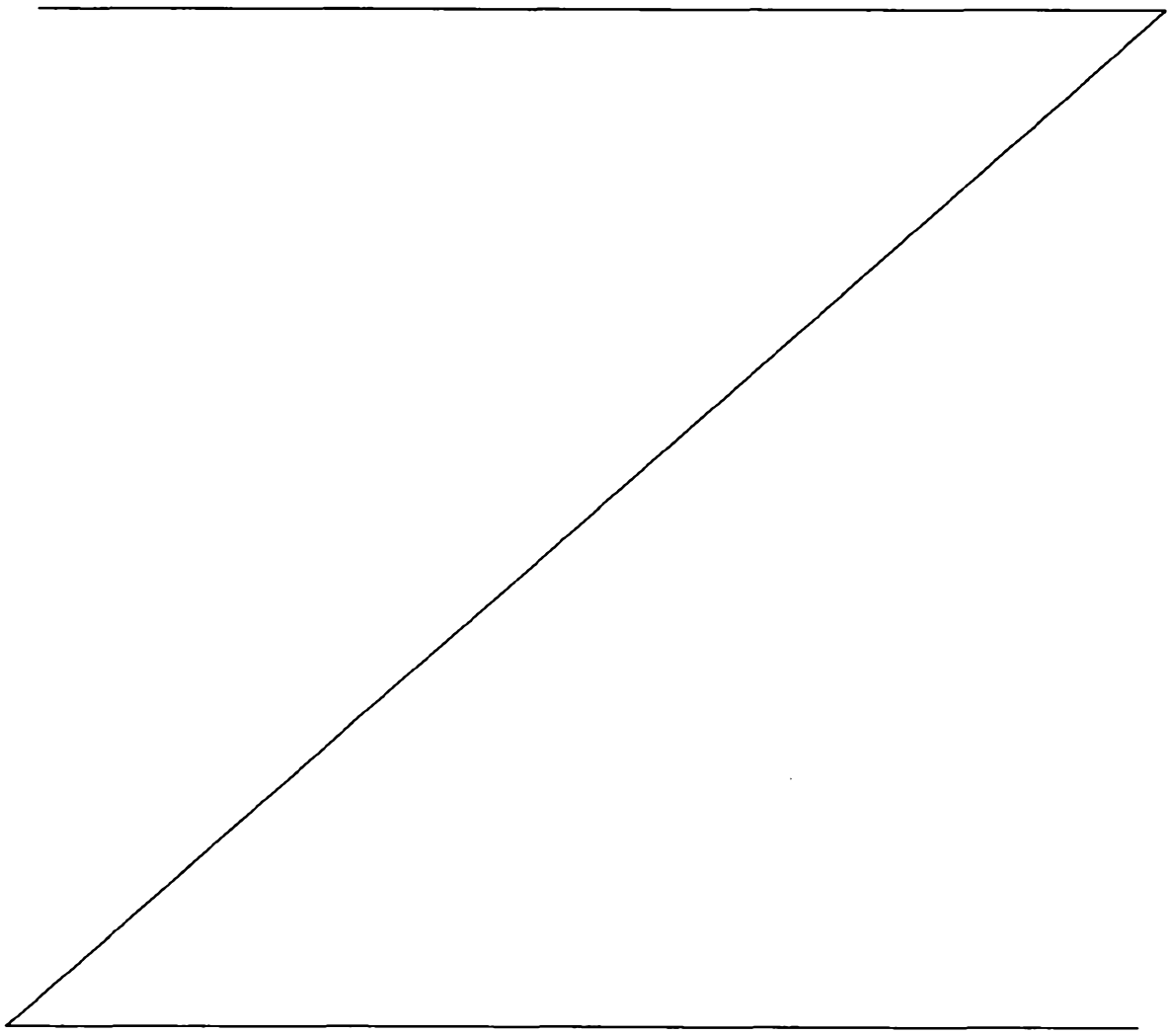
Background of the Invention

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

Obesity is a chronic disease manifested by an excess of fat mass in proportion to body size. Today, every third American is considered over-weight (Body Mass Index (BMI) >25 kg/m^2), thus prompting the United States Centers for Disease Control and Prevention (CDC) to declare that obesity is reaching epidemic proportions (Cummings and Schwartz, *Annu. Rev. Med. 54*:453-471((2003)). The importance of treating obesity is emphasized by the fact that this disease is either the underlying cause, or a risk factor, for developing diseases such as Type 2 Diabetes, congestive heart failure, osteoarthritis and sleep apnea among others.

Additionally, obesity is linked to "Metabolic Syndrome" which is a medical condition characterized by obesity, atherogenic dyslipidemia, elevated blood pressure and insulin resistance. Metabolic Syndrome affects an

increasing number of people in the United States. Importantly, it has been shown that even a modest decrease in body weight (5-10% of initial body weight) may significantly improve Metabolic Syndrome conditions and decrease the risk factors for developing obesity-associated disease (Wing *et al.*, *Arch. Intern. Med. 147*:1749-1753 (1987); Tuomilehto *et al.*, *New Engl. J. Med. 344*:1343-1350 (2001); Knowler *et al.*, *New Engl. J Med. 346*:393-403 (2002); Franz *et al.*, *Diabetes Care 25*:148-198 (2002)). Additionally, treatment of obesity may be important from a mental health perspective due to the social stigma often attached to obese individuals in some cultures.



Melanocortin receptors play a major role in the regulation of overall energy balance and obesity in both humans and rodents. Alpha-melanocyte stimulating hormone (alpha-MSH) is a 13 amino acid peptide hormone that is an important component of the melanocortin system. Alpha-MSH is produced by the proteolytic processing of proopiomelanocortin (POMC) released by the pituitary gland. Alpha-MSH binds with high affinity to the melanocortin 4 receptor (MC4R), but also binds melanocortin receptor 3 (MC3R) and melanocortin receptor 5 (MC5R) with lower affinity. MC4R is a G-coupled protein receptor found in the brain which, when stimulated by alpha-MSH binding, causes decreased food intake and increased fat oxidation. Ultimately, stimulation of melanocortin receptors such as MC4R results in weight loss.

In humans and rodents, loss of function mutations in the different components of the melanocortin system are closely correlated with obesity and related conditions. In mice, mutations within POMC, or MC4R and MC3R produce obesity, insulin resistance and hyperphagia (Goodfellow and Saunders, *Curr. Topics Med. Chem. 3*: 855-883 (2003); Huszar *et al., Cell 88*:131-141 (1997); Yaswen *et al., Nat. Med. 5*: 1066-1070 (1999)). In man mutations within POMC or MC4R lead to the development of obesity associated with increased food intake (Krude *et al., Nat. Genet. 19*:155-157 (1998); Yeo *et al., Nature Genetics 20*:111-112 (1998); Branson *et al., New Engl. J. Med. 348*: 1096-1103 (2003); Vaisse *et al., J. Clin. Invest. 106*):253-262 (2000); Ho and MacKenzie, *J. Biol. Chem. 275*: 35816-35822 (1999)).

Weight loss can result from the pharmacological stimulation of melanocortin system activity. In rodents pharmacological stimulation of melanocortin receptors such as MC4R leads to decreased food intake, increased energy expenditure and weight loss (Pierroz *et al., Diabetes 51*: 1337-1345 (2002)). In man the intranasal administration of alpha-MSH to stimulate MC4R in non-obese men results in decreased body weight due to the loss of fat- but not lean body mass (Fehm *et al., J. Clin. Endo. Metabol. 86*: 1144-1148 (2001)).

Obesity is currently treated, with only limited success, by several different strategies. These strategies primarily involve

"life-style" changes (e.g. diet and exercise), small molecule based pharmaceutical therapies or surgical removal of a portion of the stomach (gastric by-pass surgery). Additionally, weight loss stimulating melanocortin receptor binding peptides such as alpha-MSH are of limited use as pharmaceuticals due to the extremely short serum half-life of such peptides. Thus, a need exists for additional obesity treatments and in particular for melanocortin receptor binding molecules that overcome the short serum half-life of melanocortin receptor binding peptides such as alpha-MSH.

Brief Description of the Drawings

Fig. 1 shows elements of a melanocortin receptor binding mimetibody polypeptide.

Fig 2 shows a cartoon of a melanocortin receptor binding mimetibody.

Fig. 3 shows the amino acid (SEQ ID NO: 62) and cDNA (SEQ ID NO: 61) sequences of a melanocortin receptor binding alpha-MSH mimetibody. The amino terminal portions of individual mimetibody elements are underlined.

Fig. 4 shows alpha-MSH mimetibody binding to MC4R in a competitive binding assay.

Fig. 5 shows alpha-MSH mimetibody activation of MC4R in cells expressing a high level of MC4R.

Fig. 6 shows alpha-MSH mimetibody activation of MC4R in cells expressing a low level of MC4R.

Fig. 7 shows alpha-MSH mimetibody-mediated decrease in animal food intake.

Fig. 8 shows alpha-MSH mimetibody-mediated decrease in animal body weight.

Summary of the Invention

One aspect of the invention is a polypeptide according to formula (I):

$$(Mp\text{-}Lk\text{-}V2\text{-}Hg\text{-}C_H2\text{-}C_H3)_{(t)}$$

(I)

where Mp is a melanocortin receptor binding molecule, Lk is a polypeptide or chemical linkage, V2 is a portion of a C-terminus of an immunoglobulin variable region, Hg is at least a portion of an immunoglobulin variable hinge region, C_H2 is an immunoglobulin heavy chain C_H2 constant region and C_H3 is an immunoglobulin heavy chain C_H3 constant region and t is independently an integer from 1 to 10. Another aspect of the invention is a polypeptide comprising SEQ ID NO: 60 or 62.

Another aspect of the invention is a polynucleotide comprising SEQ ID NO: 59 or SEQ ID NO: 61 or a polynucleotide complementary to SEQ ID NO: 59 or SEQ ID NO: 61.

Another aspect of the invention is a polynucleotide comprising a polynucleotide encoding the polypeptide of SEQ ID NO: 60 or SEQ ID NO: 62.

Another aspect of the invention is a vector comprising the polynucleotide of the invention.

Another aspect of the invention is a cell expressing a polypeptide of the invention.

Another aspect of the invention is a cell comprising the vector of the invention.

Another aspect of the invention is a method to produce a polypeptide comprising the steps of culturing the cell of the invention and purifying the expressed polypeptide.

Another aspect of the invention is a pharmaceutical composition comprising an effective amount of at least one polypeptide of the invention and a pharmaceutically acceptable carrier or diluent.

Another aspect of the invention is a method of modifying the biological activity of a melanocortin receptor in a cell, tissue or organ comprising contacting

the cell, tissue or organ with the pharmaceutical composition of the invention.

Another aspect of the invention is a method of modulating at least one melantocortin receptor mediated condition comprising administering a polypeptide or the pharmaceutical composition of the invention to a patient in need thereof.

Another aspect of the invention is use of a polypeptide of the invention in the manufacture of a medicament for modulating at least one melantocortin receptor mediated condition in a patient.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

Detailed Description of the Invention

All publications, including but not limited to patents and patent applications, cited in this specification are herein incorporated by reference as though fully set forth.

The present invention provides polypeptides having the properties of binding a melanocortin receptor and mimicking different isotypes of antibody immunoglobulin molecules such as IgA, IgD, IgE, IgG, or IgM, and any subclass thereof, such as IgA_1, IgA_2, IgG_1, IgG_2, IgG_3 or IgG_4, or combinations thereof, herein after generally referred to as "mimetibodies." In some embodiments, the mimetibody polypeptides of the invention contain an alpha melanocyte

stimulating hormone peptide (alpha-MSH) sequence and are designated melanocortin receptor binding alpha-MSH mimetibody. Such alpha-MSH mimetibody polypeptides can bind melanocortin receptor 4 (MC4R) and, with equal and lower affinity, for MC3R and MC5R respectively. One result of such melanocortin receptor binding can be the stimulation or inhibition of melanocortin receptor activity. Stimulation can cause weight loss while inhibition may cause weight gain.

In one embodiment the polypeptides of the invention have the generic formula (I):

$$(Mp\text{-}Lk\text{-}V2\text{-}Hg\text{-}C_H2\text{-}C_H3)_{(t)} \quad (I)$$

where Mp is a melanocortin receptor binding molecule, Lk is a polypeptide or chemical linkage, V2 is a portion of a C-terminus of an immunoglobulin variable region, Hg is at least a portion of an immunoglobulin variable hinge region, C_H2 is an immunoglobulin heavy chain C_H2 constant region and C_H3 is an immunoglobulin heavy chain C_H3 constant region and t is independently an integer of 1 to 10.

As used herein, "melanocortin receptor binding molecule" means a molecule, which can bind at least one melanocortin receptor such as *Homo sapiens* MC4R (SEQ ID NO: 77). Examples of other *Homo sapiens* melanocortin receptors include MCR1 (SEQ ID NO: 71), MCR2 (SEQ ID NO: 73), MCR3 (SEQ ID NO: 75), and MCR5 (SEQ ID NO: 79). A given peptide chain is a "melanocortin receptor" if it has at least 85% amino acid sequence identity to a known melanocortin receptor sequence or the mature form of a known melanocortin receptor and can function as a G-protein coupled receptor. Percent identity between two peptide chains can be determined by pairwise alignment using the default settings of the AlignX module of Vector NTI v.9.0 .0 (Invitrogen Corp., Carslbad, CA). An exemplary melanocortin receptor binding molecule is the 13 amino acid alpha-MSH peptide having the amino acid sequence shown in (SEQ ID NO: 2). Other melanocortin receptor binding molecules include biologically active fragments of SEQ ID NO: 2 and other amino acid sequences that can bind a melanocortin receptor. The term "biologically active fragment" as used herein, refers to a portion of an alpha-MSH peptide that can bind to a melanocortin receptor such as MC4R. The peptide sequence HFRW (SEQ. ID. NO. 81) is an exemplary

"biologically active fragment" of the alpha-MSH peptide sequence SYSMEHFRWGKPV (SEQ ID NO: 2). The HFRW fragment has been incorporated into the structure of the synthetic melanocortin receptor activator molecule melanotan II (MTII) (Fan *et al., Nature 385:* 165-168 (1997)).

Incorporation of melanocortin receptor binding molecules in the mimetibody polypeptides of the invention provides for binding to melanocortin receptors with a wide range of affinities. The mimetibody polypeptides of the invention may bind a melanocortin receptor with a K_d less than or equal to about 10^{-7}, 10^{-8}, 10^{-9}, 10^{-10}, 10^{-11} or 10^{-12} M. The range of obtained IC50 values for aMSH peptide, MTII peptide and aMSHMMB were 260-400 nM, 5-30 nM and 200-300 nM respectively. The affinity of a mimetibody polypeptide for a melanocortin receptor can be determined experimentally using any suitable method. Such methods may utilize Biacore or KinExA instrumentation, ELISA or competitive binding assays. Mimetibody polypeptides binding specific melanocortin receptors with a desired affinity can be selected from libraries of variants or fragments by techniques known to those skilled in the art.

An alpha-MSH peptide having the amino acid sequence shown in SEQ ID NO: 2 may be modified to obtain other melanocortin receptor binding molecules. Such modifications may comprise the incorporation of C-$[X]_n$-C motifs into the peptide to conformationally constrain the peptide through the formation of disulfide bonds. In a C-$[X]_n$-C motif, C is a cysteine residue, X is a amino acid residues and n is an integer necessary to acheive the required conformational constraint. In this instance n can be as little as 1 residue and as high as 50. Exemplary C-$[X]_n$-C modified peptide sequences are shown in SEQ ID NOs: 4, 6, 8 and 10.

The modification may also comprise the incorporation of a Wa-$[X]_n$-Wa motif into the peptide to conformationally constrain the peptide through the formation of a tryptophan zipper. In a Wa-$[X]_n$-Wa motif W is tryptophan residue, X is an amino acid, a is an integer ususlly 2, but can be from 1 to 10, and n is an integer necessary to acheive the required conformational constraint. In this instance n can be as little a 1 residue and as high as 50. Exemplary Wa-$[X]_n$-Wa peptides are shown in SEQ ID NOs: 12, 14, 16

and 18. Further, the sequence HFRW (SEQ ID NO: 81) present in the alpha-MSH peptide may also be modified by substituting any residue in this sequence with any one of F, H, W and M; for example, HFRW (SEQ ID NO: 81) can be substituted to FHWM (SEQ ID NO: 83).

In the polypeptides of the invention, the linker portion (Lk) provides structural flexibility by allowing the mimetibody to have alternative orientations and binding properties. Exemplary linkers include non-peptide chemical linkages or one to 20 amino acids linked by peptide bonds, wherein the amino acids are selected from the 20 naturally occurring amino acids or other amino acids (e.g. D-amino acids, non-naturally occurring amino acids, or rare naturally occuring amino acids). The linker portion can include a majority of amino acids that are sterically unhindered, such as glycine, alanine and serine and can include GS, poly GS (e.g. GSGS (SEQ ID NO: 20)), GGSG (SEQ ID NO: 22), GSGGGS (SEQ ID NO: 24), GSGGGSG (SEQ ID NO: 26), GSSG (SEQ ID NO: 28), or GSGGGS (SEQ ID NO: 30) or GGGS (SEQ ID NO: 85) or any combination or polymer thereof. Other exemplary linkers within the scope of the invention may be longer than 20 residues and may include residues other than glycine, alanine and serine.

In the polypeptides of the invention, V2 is a portion of a carboxy terminal domain of an immunoglobulin variable region such as a heavy chain variable region. Exemplary V2 amino acid sequences are GTLVTVSS (SEQ ID NO: 32) and TLVAVSS (SEQ ID NO: 34).

In the polypeptides of the invention, Hg is a portion of the hinge domain of an immunoglobulin variable region such as a heavy chain variable region. Exemplary Hg amino acid sequences include EPKSCDKTHTCPPCP (SEQ ID NO: 36), EPKSADKTHTCPPCP (SEQ ID NO: 38), ESKYGPPCPSCP (SEQ ID NO: 40), ESKYGPPCPPCP (SEQ ID NO: 42), CPPCP (SEQ ID NO: 44) and CPSC (SEQ ID NO: 46).

In the polypeptides of the invention, C_H2 is an immunoglobulin heavy chain C_H2 constant region. Exemplary C_H2 amino acid sequences include:

APELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNS TYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAK (SEQ ID NO: 48),

APEAAGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNS TYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAK (SEQ ID NO: 50),

APEFLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSQEDPEVQFNWYVDGVEVHNAKTKPREEQFNS TYRVVSVLTVLHQDWLNGKEYKCKVSNKGLPSSIEKTISKAK (SEQ ID NO: 52) and APEAAGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSQEDPEVQFNWYVDGVEVHNAKTKPREEQFNS TYRVVSVLTVLHQDWLNGKEYKCKVSNKGLPSSIEKTISKAK (SEQ ID NO: 54).

In the polypeptides of the invention, C_H3 is an immunoglobulin heavy chain C_H3 constant region. Exemplary C_H3 amino acid sequences include:

GQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYS KLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK (SEQ ID NO: 56) and GQPREPQVYTLPPSQEEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYS RLTVDKSRWQEGNVFSCSVMHEALHNHYTQKSLSLSLGK (SEQ ID NO: 58). It will be recognized by those skilled in the art that the C_H3 region of the polypeptides of the invention may have its C-terminal amino acid cleaved off when expressed in certain recombinant systems.

In the mimetibody polypeptides of invention Hg, C_H2 or C_H3 may be of the IgG_1 or IgG_4 subclass. A sequence is of the IgG_1 or IgG_4 subclass if it is formed or developed from a γ1 or γ4 heavy chain respectively. A given peptide chain is a γ1 or γ4 heavy chain if it is at least 80% identical to a known γ1 or γ4 heavy chain sequence of a given species. Percent identity between two peptide chains can be determined by pairwise alignment using the default settings of the AlignX module of Vector NTI v.9.0.0 (Invitrogen Corp., Carlsbad, CA).

In the mimetibody polypeptides of the invention Hg, C_H2 or C_H3 may individually be of the IgG_1 or IgG_4 subclass. The mimetibodies of the invention may also comprise combinations of Hg, C_H2 or C_H3 elements from each subclass For example, Hg may be of the IgG_4 subclass while C_H2 and C_H3 are of the IgG_1 subclass. Alternatively, Hg, C_H2 and C_H3 may all of the IgG_4 or IgG_1 subclass. The polypeptide EPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVE VHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTL PPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQ GNVFSCSVMHEALHNHYTQKSLSLSPGK (SEQ ID NO: 65) is exemplary of a polypeptide in which Hg (residues 1-15 of SEQ ID NO: 65), C_H2 (residues 16-125 of SEQ ID NO: 65), and C_H3 (residues 126-232 of SEQ ID NO: 65) are all of the IgG_1 subclass.

The IgG_1 and IgG_4 subclasses differ in the number of cysteines in the hinge region. Most IgG type antibodies, such as IgG_1, are homodimeric molecules made up of two identical heavy (H) chains and two identical light (L) chains, typically abbreviated H_2L_2. Thus, these molecules are generally bivalent with respect to antigen binding due to the formation of inter-heavy chain disulfide bonds and both antigen binding (Fab) arms of the IgG molecule have identical binding specificity. IgG_4 isotype heavy chains, in contrast, contain a CPSC (SEQ ID NO: 46) motif in their hinge regions capable of forming either inter- or intra-heavy chain disulfide bonds, *i.e.*, the two Cys residues in the CPSC motif may disulfide bond with the corresponding Cys residues in the other H chain (inter) or the two Cys residues within a given CPSC motif may disulfide bond with each other (intra). Since the HL pairs in those IgG_4 molecules with intra-heavy chain bonds in the hinge region are not covalently associated with each other, they may dissociate into HL monomers that then reassociate with HL monomers derived from other IgG_4 molecules forming bispecific, heterodimeric IgG_4 molecules. *In vivo* isomerase enzymes may facilitate this process. In a bispecific IgG antibody the two Fab "arms" of the antibody molecule differ in the epitopes that they bind. Substituting Ser residues in the hinge region of IgG_4 with Pro results in "IgG_1-like behavior," *i.e.*, the molecules form stable disulfide bonds between heavy chains and therefore, are not susceptible to HL exchange with other IgG_4 molecules.

The mimetibody polypeptides of the invention may be made more IgG_4-like, or IgG_1-like by the modification of sites which are involved in disulfide bond formation and are present in the Hg-C_H2-C_H3 portion of the mimetibody polypeptides. Such sites may be modified by removal, deletion, insertion or substitution with other amino acids. Typically, the cysteine residues present in disulfide bond associated motifs are removed or substituted. Removal of these sites may avoid covalent disulfide bonding with other cysteine-containing proteins present in the mimetibody producing host cell or intra-heavy chain disulfide bonding in IgG_4-based constructs while still allowing for noncovalent dimerization of mimetibody Hg-C_H2-C_H3 domains. Modification of such sites can permit the formation of bispecific mimetibody polypeptides with two different M portions or

prevent the formation of such bispecific species.

The IgG_1 and IgG_4 subclasses also differ in their ability to mediate complement dependent cytotoxicity (CDC) and antibody-dependent cellular cytotoxicity (ADCC). CDC is the lysing of a target cell in the presence of complement. The complement activation pathway is initiated by the binding of the first component of the complement system (C1q) to a molecule complexed with a cognate antigen. IgG_1 is a strong inducer of the complement cascade and subsequent CDC activity, while IgG_4 has little complement-inducing activity. ADCC is a cell-mediated process in which nonspecific cytotoxic cells that express Fc receptors (FcRs) involved in ADCC (*e.g.*, natural killer (NK) cells, neutrophils, and macrophages) recognize bound antibody on a target cell and subsequently cause lysis of the target cell. The IgG_1 subclass binds with high affinity to Fc receptors involved in ADCC and contributes to ADCC, while IgG_4 binds only weakly to such receptors and has little ADCC inducing activity. The relative inability of IgG_4 to activate effector functions such as ADCC is desirable since delivery of the mimetibody polypeptide to cells without cell killing is possible.

The CDC and ADCC activity of the mimetibody polypeptides of the invention may be modified by altering sites involved in CDC and ADCC present in the Hg-C_H2-C_H3 portion of the mimetibody polypeptide. Such sites may be modified by removal, deletion, insertion or substitution with other amino acids. In the mimetibodies of the invention sites involved in CDC, such as the C1q binding site, are typically removed or otherwise modified to minimize CDC activity. Additionally, Fc receptor binding sites involved in ADCC can also be similarly modified in the mimetibodies of the invention. In general, such modification will remove Fc receptor binding sites involved in ADCC activity from the mimetibodies of the invention. The substitution of Leu residues with Ala residues in the C_H2 portion of the polypeptides of the invention is one example of a modification which can minimize ADCC activity in the polypeptides of the invention. The C_H2 amino acid sequence APEAAGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNS TYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAK (SEQ ID NO: 52) is

exemplary of such a Leu to Ala substitution at residues 4 and 5 (in sequence above). Further, the V1 domain can be removed such that the N-terminus of the peptide is free following cleavage of the signal peptide, and is accessible to and could be modified by enzymes such as acetylases.

Antibodies of both the IgG_4 and IgG_1 isotypes contain FcRn salvage receptor binding sites. The FcRn salvage receptor helps maintain IgG antibody levels in the body by recycling or transporting IgG type antibodies across enodothelial cell layers such as those lining the inside of body cavities and blood vessels. The FcRn salavage receptor does this by binding IgGs that have entered endothelial cells by nonspecific pinocytosis and preventing these IgG antibody molecules from being degraded in the lysosome of the cell. The result of such FcRn receptor activity is that the serum half-life of a molecule with an FcRn binding site is extended relative to an otherwise identical molecule lacking such a site.

It is desirable that the Hg-C_H2-C_H3 portion of the mimetibodies of the invention contain a FcRn binding site at the junction of the C_H2 and C_H3 regions. It is expected that such FcRn sites will increase the serum half-life of the mimetibodies of the invention as well as improve other pharmacokinetic properties relative to a melanocortin receptor binding molecule, such as alpha-MSH alone. In the mimetibodies of the invention FcRn sites may be modified or added by removal, deletion, insertion or substitution of amino acids. Typically, such modifications are used to improve the binding of a given site to the FcRn. One example of a human FcRn binding sites is the sequence MISRTPTVLHQHNHY (SEQ. ID. NO.: 69) found in both IgG_1 and IgG_4 antibodies. Other FcRn binding sites are well known by those skilled in the art.

Antibodies with different isotypes, such as IgG_4 and IgG_1, may contain glycosylation sites. Glycosylation of these sites can alter the properties and activites of antibody molecules. Antibody molecules may be N-glycosylated or O-glycosylated. N-glycosylation of antibody amino acid residue side chains containing nitrogen atoms (*e.g.*, Asn) can modulate antibody Fc effector functions such as ADCC by conferring a cytolytic activity to N-glycosylated antibody molecules. This ADCC associated cytolytic activity causes the lysis

of cells effected by such N-glycosylated antibodies. Alternatively, an antibody molecule may be O-glycosylated by modification of amino acid residue side chains containing oxygen atoms (*e.g.*, Ser or Thr). O-glycosylation can decrease the serum half-life of an antibody molecule through increased lectin mediated clearance of O-glycosylated antibody molecules from the serum. Additionally, O-glycosylation can cause undesirable increases in antibody heterogeneity due to differing extents of O-glycosylation between various antibody molecules. Lastly, both O-glycosylation and N-glycosylation can alter the structure dependent properties of antibody molecules such as binding affinity and immunogenicity.

Like the antibody molecules they mimic, the mimetibody polypeptides of the invention may also be post-translationally modified by N-glycosylation and O-glycosylation. In most instances, it is desirable to limit the N-glycosylation of the mimetibodies of the invention to minimize cytolytic activity. N-glycosylation can be limited by the removal or substitution of amino acid residues, such as Asn, which are typically N-glycosylated. It is also desirable to limit mimetibody O-glycosylation to minimize lectin-mediated clearance, mimetibody heterogeneity and the alteration of structure dependent mimetibody properties such as binding affinity and immunogenicity. One way to minimize O-linked glycosylation in the mimetibodies of the invention is to substitute Ala residues for Thr residues in the V2 portion of the polypeptides of the invention. The V2 amino acid sequence TLVAVSS (SEQ ID NO: 34) is exemplary of such a Thr to Ala substitution; this particular V2 substitution can also be obtained by a Thr to Ala substitution at postion 47 of SEQ ID NO: 62. Those skilled in the art also will recognize other ways to control N-linked and O-linked glycosylation including modulation of glycosylase enzyme activity.

The monomeric structure Mp-Lk-V2-Hg-C_H2-C_H3 of the mimetibody polypeptides of the invention can be linked to "t" other monomers where t is an integer from 1 to 10. Such linking can occur through non-covalent interactions or covalent linkages such as a Cys-Cys disulfide bond. In this way multimeric structures such as dimers and higher order multimers of the polypeptides of the invention can be formed. It is expected that dimerization of the polypeptides of

the invention will increase the affinity of these polypeptides to melanocortin receptors such as MC4R. The term "multimers" as used herein means molecules that have quaternary structure and are formed by the association of two or more subunits.

The polypeptides of the invention can optionally comprise at the amino terminus, a amino terminal portion of an immunoglobulin variable region, designated V1 as shown in Formula II:

$$(V1\text{-}Mp\text{-}Lk\text{-}V2\text{-}Hg\text{-}C_H2\text{-}C_H3)_{(t)} \quad (II)$$

Exemplary V1 amino acid sequences include QIQ and QVQ.

The polypeptides of the invention may also comprise secretory signals necessary to facilitate protein secretion or other signals necessary for protein trafficking in the cell. An exemplary secretory signal sequence is MAWVWTLLFLMAAAQSIQA (SEQ ID NO: 69). Those skilled in the art will recognize other secretory signals.

In one embodiment the polypeptides of the invention comprise SEQ ID NO: 60 or 62. SEQ ID NO: 62 represents a $(V1\text{-}Mp\text{-}Lk\text{-}V2\text{-}Hg\text{-}C_H2\text{-}C_H3)_{(t)}$ melanocortin receptor binding alpha-MSH polypetide of generic formula (II) which has the secretory signal MAWVWTLLFLMAAAQSIQA (SEQ ID NO: 69) fused to its amino terminus. SEQ ID NO: 60 represents a $(Mp\text{-}Lk\text{-}V2\text{-}Hg\text{-}C_H2\text{-}C_H3)_{(t)}$ melanocortin receptor binding alpha-MSH polypetide of generic formula (I). No secretory signal is present in SEQ ID NO: 60.

Another aspect of the present invention is a polynucleotide comprising, complementary to or having significant identity with, a polynucleotide encoding at least one melanocortin receptor binding mimetibody. Other aspects of the present invention include vectors comprising at least one polynucleotide molecule encoding a melanocortin receptor binding mimetibody. In a different aspect the invention provides a cell comprising a vector of the invention or a cell expressing a mimetibody polypeptide of the invention. The polynucleotides, vectors and cells may be used to produce the mimetibody polypeptides of the invention.

In one embodiment, the polynucleotides of the invention comprise SEQ ID NO: 59 or SEQ ID NO: 61 or a polynucleotide complementary to SEQ ID NO: 59 or SEQ ID NO: 61. SEQ ID NO: 59 is a

cDNA encoding a (Mp-Lk-V2-Hg-C_H2-C_H3)$_{(t)}$ melanocortin receptor binding alpha-MSH polypetide of generic formula (I) which lacks a signal sequence. SEQ ID NO: 61 is a cDNA encoding a (V1-Mp-Lk-V2-Hg-C_H2-C_H3)$_{(t)}$ melanocortin receptor binding alpha-MSH polypetide of generic formula (II) which has a secretory signal fused to its amino terminus.

In one embodiment, the polynucleotides of the invention comprise a polynucleotide encoding the polypeptide of SEQ ID NO: 60 or SEQ ID NO: 62. Exemplary nucleic acid sequences that encode the polypeptide sequences shown in SEQ ID NO 60 or SEQ ID NO: 62 are shown in SEQ ID NO 59 or SEQ ID NO: 61, respectively. Also provided are polynucleotides that are substantially identical to the above described polynucleotides.

The term "substantially identical" in the context of polynucleotides means that a given polynucleotide sequence is identical to a polynucleotide sequence of the invention, or portion thereof, in at least 60% or at least about 70% or at least about 80% or at least about 90% or at least about 95-98% of the nucleotides. Percent identity between two polynucleotide sequences can be determined by pairwise alignment using the default settings of the AlignX module of Vector NTI v.9.0.0 (Invitrogen Corp., Carlsbad, CA).

Typically, the polynucleotides of the invention are used in expression vectors for the preparation of the mimetibody polypeptides of the invention. Vectors within the scope of the invention provide necessary elements for eukaryotic expression and include viral promoter driven vectors, such as CMV promoter driven vectors, e.g., pcDNA3.1, pCEP4, and their derivatives, Baculovirus expression vectors, *Drosophila* expression vectors, and expression vectors that are driven by mammalian gene promoters, such as human Ig gene promoters. Other examples include prokaryotic expression vectors, such as T7 promoter driven vectors, e.g. pET41, lactose promoter driven vectors and arabinose gene promoter driven vectors.

The present invention also relates to a cell that expresses a mimetibody of the invention or comprises a vector of the invention. Such a cell can be prokaryotic or eukaryotic. Exemplary eukaryotic cells are mammalian cells, such as but not limited to, COS-1, COS-7,

HEK293, BHK21, CHO, BSC-1, HepG2, 653, SP2/0, NS0, 293, HeLa, myeloma, lymphoma cells or any derivative thereof. Most preferably, the eukaryotic cell is a HEK293, NS0, SP2/0, or CHO cell. *E. coli* is an exempary prokaryotic cell. A cell according to the invention may be generated by transfection, cell fusion, immortalization, or other procedures that are well known in the art. Polynucleotides transfected into a cell may be extrachromasomal or stably integrated into the chromosome of the cell.

The mimetibodies of the invention can be made more compatible with a given host cell by modification of the Hg-C_H2-C_H3 portion of the polypeptide. For example, when a mimetibody of the invention is expressed recombinantly in a bacterial cell such as *E. coli*, the Pro-Ala sequence in the Hg element may be removed to prevent digestion by the *E. coli* enzyme proline iminopeptidase. Similarly, a portion of the Hg element can be deleted or substituted with other amino acids in the mimetibodies of the invention to prevent heterogeneity in the products expressed in a selected host cell.

The present invention further provides a method to produce a mimetibody polypeptide comprising the steps of culturing a cell of the invention and purifying an expressed mimetibody polypeptide of the invention. Cell components, such as those necessary for *in vitro* transcription and translation, may also be used to express the polypeptides of the invention. The present invention encompasses mimetibodies produced by both methods. Expressed mimetibody polypeptides can be recovered and purified from cells or cell component based systems by methods well known in the art including, but not limited to, protein A purification, ammonium sulfate or ethanol precipitation, acid extraction, anion or cation exchange chromatography, phosphocellulose chromatography, hydrophobic interaction chromatography, affinity chromatography, hydroxylatpatite chromatography and lectin chromatography. High performance liquid chroatography (HPLC) can also be employed for purification. Typically purfication will require a combination of several different methods.

Another aspect of the present invention is a pharmaceutical composition comprising an effective amount of at least one mimetibody polypeptide and a pharmaceutically acceptable carrier or

diluent. The term "effective amount" generally refers to the quantity of mimetibody necessary for effective therapy, *i.e.*, the partial or complete alleviation of the symptom or disorder for which treatment was sought. The composition can optionally comprise at least one further compound, protein or composition useful for treating obesity and the other conditions described below. The parmaceutically acceptable carrier or diluent in the compositions can be a solution, suspension, emulsion, colloid or powder. Those skilled in the art will recognize other parmaceutically acceptable carriers and diluents.

Another aspect of the present invention is a method of modifying the biological activity of a melanocortin receptor in a cell, tissue or organ comprising contacting the pharmaceutical compositions of the invention with the cell, tissue or organ. The method may be used to modify melanocortin receptor activity in the brain, brain tissue, or brain cells. Alternatively, the method of the invention may be used to modify melanocortin receptor activity in other peripheral cells or tissues such as muscle, or other organs such as the stomach. Those skilled in the art will recognize other cells, tissues or organs, which may be used.

Another aspect of the invention is a method of modulating at least one melanocortin receptor-mediated condition comprising administering a pharmaceutical composition of the invention to a patient in need thereof. The pharmaceutical compositions of the invention can be administered by any suitable route. Such routes may be intrathecal, intranasal, peripheral (*e.g.*, subcutaneous, intramuscular, intradermal, intravenous) or by any other means known in the art. As described previously, abnormal melanocortin receptor activity has been implicated in a number of pathological conditions, such as obesity and Type 2 diabetes. The mimetibody polypeptides of the invention may be also be used to modulate other melanocortin receptor mediated conditions such as male and female erectile dysfunction, inflammation, congestive heart failure, central nervous system disorders, nerve damage, infectious disease, pulmonary disease, skin disease, fever and pain.

The present invention is further described with reference to the following examples. These examples are merely to illustrate aspects of the present invention and are not intended as limitations of this invention.

Example 1

Alpha-MSH Mimetibody and Expression Vector Construction

An alpha-MSH mimetibody protein comprising a secretory signal sequence, an alpha-MSH peptide sequence, a linker sequence, V_H sequence, a hinge sequence, a human IgG_1 C_H2 sequence and a human IgG_1 C_H3 sequence was designed (Fig. 3 and SEQ ID NO. 62) Analytical data, *e.g.*, mass spectroscopy, has confirmed that a mature polypeptide is generated (61,344.6 for G1/G1 form). Nucleic acid sequences encoding this alpha-MSH mimetibody protein (Fig. 3; SEQ ID NO: 61) were generated using standard molecular biology techniques. Nucleic acid sequences encoding the alpha-MSH mimetibody sequence were subcloned into the p2389 expression vector to generate an alpha-MSH mimetibody expression vector (SEQ ID NO: 63).

Example 2

Alpha-MSH Mimetibody Expression

The alpha-MSH mimetibody was transiently expressed in HEK293E cells. Cells were cultured using standard conditions and transiently transfected with the alpha-MSH mimetibody expression vector using Lipofectamine 2000 (Invitrogen, Carlsbad, CA) as directed by the manufacturer. 24 h after transfection cells were transferred to a serum free media formulation and cultured for 5 days. The culture media was then removed and centrifuged to remove debris. Clarified media was incubated with Protein A-Sepharose™ (HiTrap rProtein A FF, Amersham Biosciencies, Piscataway, NJ) and proteins were eluted from the Protein A-Sepharose™ conjugate as directed by the manufacturer. The eluted protein solution was then further purified via Superose™ 12 size exclusion chromatography (Superose 12 10/300 GL, Amersham Biosciencies, Piscataway, NJ) using standard methods. Column eluant was then subjected to SDS-PAGE and visualized by silver and Coomassie blue staining. Western blots

were then prepared and the blots were probed with either an Fc specific primary antibody or an alpha-MSH specific primary antibody. Together, the Western Blot and SDS-PAGE staining results indicated that a purified alpha-MSH mimetibody, composed of two polypeptide chains, had been obtained from the transiently transfected HEK293 cells.

Example 3

Alpha-MSH Mimetibody Binds MC4R

The alpha-MSH mimetibody binds to MC4R and can compete with radiolabeled [Nle(4), D-Phe(7)]-alpha-MSH (NDP-alpha-MSH) agonist molecules for MC4R binding (Fig. 4). MC4R is a receptor for alpha-MSH. alpha-MSH binding to recombinantly expressed MC4R in HEK293 cell membranes (Perkin Elmer Life and Analytical Sciences, Boston, MA) was examined by competive binding assays in which increasing amounts of unlabeled MC4R agonists (positive controls) and the Fc domain of a human antibody (negative control) were added to assay cocktails containing [^{125}I]-NDP-alpha-MSH as indicated in Fig. 4. The unlabeled MC4R agonists were melanotan II (MTII; an alpha MSH analog), alpha-MSH, and NDP-alpha-MSH. Alpha-MSH mimetibody binding to MC4R was stable after two weeks of storage at 4°C, -20°C, and -80°C in PBS (phosphate buffered saline) as assessed by competive binding assays.

Competivive binding assays were performed using Scintillation Proximity Assays® (Amersham Biosciences Corp, Piscataway, NJ) as directed by the assay manufacturer. Assay cocktails contained [^{125}I]-NDP-alpha-MSH at EC80, *i.e.*, ~0.5 nM, 0.1 μg of MC4R membranes, 1 mM $MgSO_4$, 1.5 mM $CaCl_2$, 25 mM Hepes, 0.2% BSA, 1 mM 1,10-phenthroline, an assay manufacturer recommended quantity of protease inhibitor cocktail (Roche Diagnostics Corp., Indianapolis, IN) and SPA beads. Light emission from Scintillation Proximity Assay® beads was measured with a Packard Top Count NXT Instrument (Perkin Elmer Life and Analytical Sciences, Boston, MA) for 5 minutes.

Example 4

Alpha-MSH Mimetibody Activates MC4R

The alpha-MSH mimetibody can activate MC4R signalling to increase cAMP production in CHOK1 cells expressing MC4R (Fig. 5 and Fig. 6). MC4R is a seven transmembrane (7TM) G-protein coupled receptor. Activation of MC4R by ligand or agonist results in an increase in cyclic AMP levels (cAMP).

MC4R receptor activation assays were performed using two different clonal CHOK1 cell lines stably transfected with a MC4R expression vector and expressing MC4R. Clone 1 (Fig. 5) expressed MC4R at high levels relative to Clone 2 (Fig. 6). Clone 1 and Clone 2 cells were grown as a monolayer using standard culture conditions to a density of approximately 100,000 cells/well and then incubated with increasing amounts (0-100 μM) of alpha-MSH, MTII, or alpha-MSH mimetibody for 15 minutes as indicated in Fig. 5 and Fig. 6. Cells were then lysed and cAMP assays were performed using the cAMP-Screen Direct™ Chemiluminescent Immunoassay System (Applied Biosystems, Foster City, CA) as directed by the manufacturer. EC_{50} values from cAMP assays using Clone 1 (Fig. 5) and Clone 2 (Fig. 6) are listed in Table 1 below

Table 1

	Clone 1	Clone 2
alpha-MSH peptide (Positive control)	EC_{50} = 3.29 nM	EC_{50} = 9.46 nM
MT II (Positive control)	EC_{50} = 0.52 nM	EC_{50} = 0.52 nM
alpha-MSH mimetibody	EC_{50} = 14.36 nM	EC_{50} = 52.4 nM

Example 5

Alpha-MSH Mimetibody Administration Decreases Animal Food Intake and Body Weight

Alpha-MSH mimetibody administration to *Rattus norvegicus* brain ventricules decreases animal food intake (Fig. 7) and body weight (Fig. 8). Alpha-MSH mimetibody was supplied to brain ventricules by intracerebroventricular injections (ICV) via a cannula surgically inserted into the left lateral brain ventricle.

Cannulae were surgically inserted into male Sprague-Dawley or Wistar rats weighing 250 g to 350 g. Cannula placement coordinates were as follows: -0.8 mm from bregma, -4.5 mm ventral and -1.5 posterior-anterior. Animals recovered for 7 to 10 days after surgery. Animals were acclimatized to the experimental procedures by both daily handling and mock injection, in order to minimize stress. In addition animals were submitted to the reversal of dark-light cycle.

Proper cannula placement was confirmed by an angiotensin II test. The test confirmed proper cannula placement if the ICV administration of 10 ng of angiotensin II via the cannula caused the rats to drink 5-10 ml of water in 30 minutes. Only animals that passed this angiotensin II test were used in food intake experiments.

Animals were fasted for 18-24 hours and alpha-MSH mimetibody, alpha-MSH (positive control), or PBS (negative control) were then administered to the brain ventricles via the cannula at an injection rate of 9 μl/min. Each treatment group had a minimum of 7 animals. Treatments and dosages were as indicated in Fig. 7 and Fig. 8.

Food and water was given to the animals after injection. The amount of food and water consumed was measured at 0 h, 4 h, 24 h, 48 h and 72 h (Fig. 7) after injection. Body weight at 72 hours post injection was measured as ahown in Fig. 6.

The present invention now being fully described, it will be apparent to one of ordinary skill in the art that many changes and modifications can be made thereto without departing from the spirit or scope of the appended claims.

2005299440 17 Nov 2011

CLAIMS

1. A polypeptide according to formula (I):

$$(Mp\text{-}Lk\text{-}V2\text{-}Hg\text{-}C_H2\text{-}C_H3)_{(t)} \quad (I)$$

where Mp is a melanocortin receptor binding molecule, Lk is a polypeptide or chemical linkage, V2 is a portion of a C-terminus of an immunoglobulin variable region, Hg is at least a portion of an immunoglobulin variable hinge region, C_H2 is an immunoglobulin heavy chain C_H2 constant region and C_H3 is an immunoglobulin heavy chain C_H3 constant region and t is independently an integer from 1 to 10.

2. The polypeptide of claim 1 wherein Mp is a biologically active fragment of SEQ ID NO: 2, 4, 6, 8, 10, 12, 14, 16, or 18.

3. The polypeptide of any one of claims 1 to 3, wherein Mp has the amino acid sequence shown in SEQ ID NO: 2, 4, 6, 8, 10, 12, 14, 16, or 18.

4. The polypeptide of claim 1 wherein the polypeptide binds to at least one melanocortin receptor.

5. The polypeptide of claim 4 wherein the melanocortin receptor is a melanocortin 4 receptor.

6. A polypeptide comprising SEQ ID NO: 60 or 62.

7. A polynucleotide encoding a polypeptide according to any one of claims 1 to 6.

8. A polynucleotide comprising SEQ ID NO: 59 or SEQ ID NO: 61 or a polynucleotide complementary to SEQ ID NO: 59 or SEQ ID NO: 61.

9. A polynucleotide comprising a polynucleotide encoding the polypeptide of SEQ ID NO: 60 or SEQ ID NO: 62.

10. A vector comprising the polynucleotide of claim 8 or 9.

11. The vector of claim 10 comprising SEQ ID NO: 63.

12. A cell expressing a polypeptide according to any one of claims 1 to 6.

13. A cell comprising the vector of claim 10.

14. The cell of claim 13 wherein the cell is a HEK293 derived cell.

15. A method to produce a polypeptide comprising the steps of culturing the cell of claim 12 and purifying the expressed polypeptide.

16. A pharmaceutical composition comprising an effective amount of at least one polypeptide according to any one of claims 1 to 6 and a pharmaceutically acceptable carrier or diluent.

17. A method of modifying the biological activity of a melanocortin receptor in a cell, tissue or organ comprising contacting the cell, tissue or organ with the polypeptide of any one of claims 1 to 6 or the pharmaceutical composition of claim 16.

18. A method of modulating at least one melantocortin receptor mediated condition comprising administering a polypeptide of any one of claims 1 to 6 or the pharmaceutical composition of claim 16 to a patient in need thereof.

19. The method of claim 18 wherein the melanocortin receptor mediated condition is obesity.

20. Use of a polypeptide of any one of claims 1 to 6 in the manufacture of a medicament for modulating at least one melantocortin receptor mediated condition in a patient.

21. The use of claim 20 wherein the melanocortin receptor mediated condition is obesity.

22. A polypeptide according to claim 1 or 6; or a polynucleotide according to any one of claims 7 to 9; or a vector according to claim 10; or a cell according to claim 12 or 13; or a method according to any one of claims 15, 17 or 18; or a pharmaceutical composition according to claim 16; or a use according to claim 20, substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings and/or examples.

Fig. 1

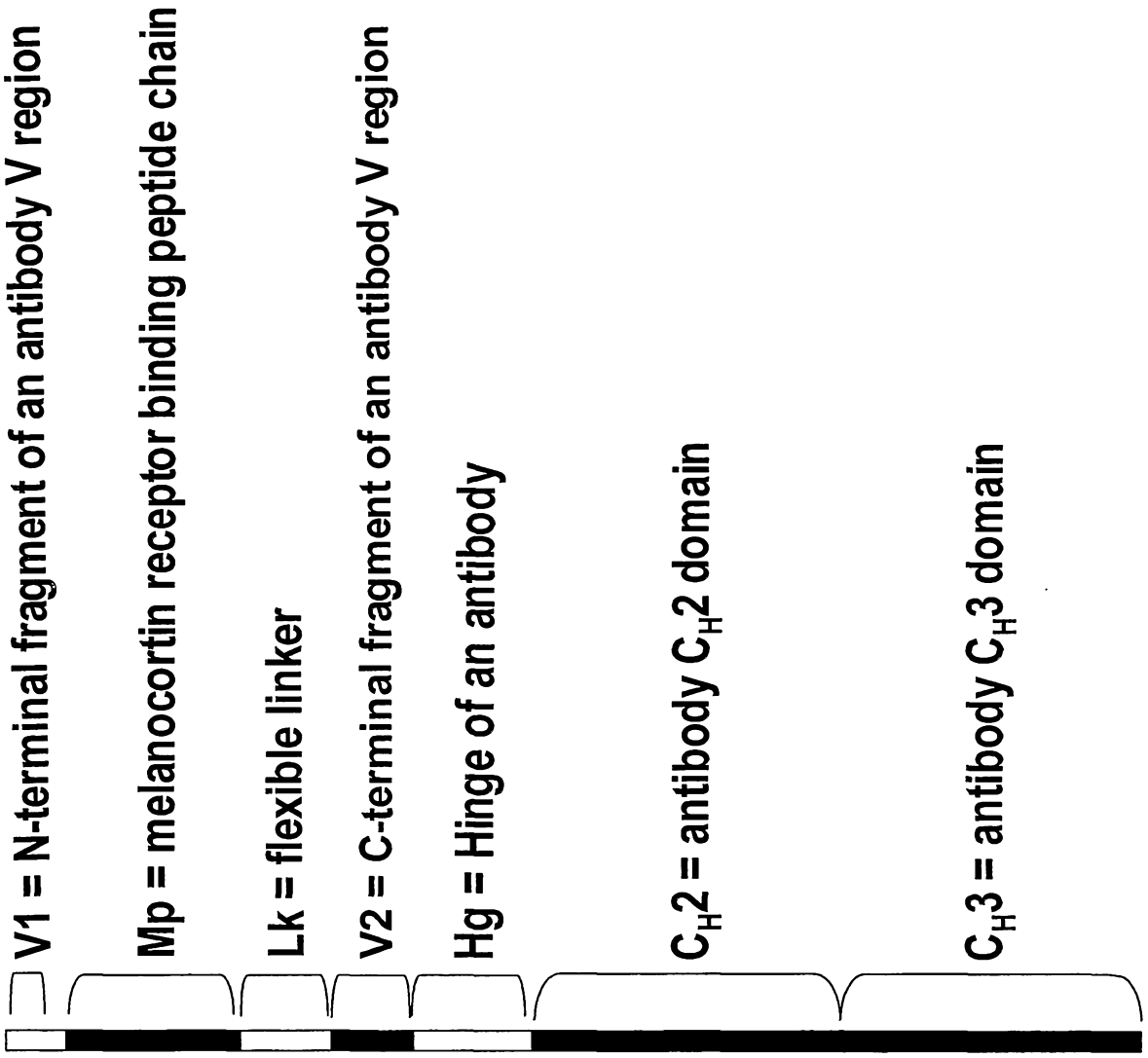

V1 = N-terminal fragment of an antibody V region
Mp = melanocortin receptor binding peptide chain
Lk = flexible linker
V2 = C-terminal fragment of an antibody V region
Hg = Hinge of an antibody
C_H2 = antibody C_H2 domain
C_H3 = antibody C_H3 domain

Fig. 2

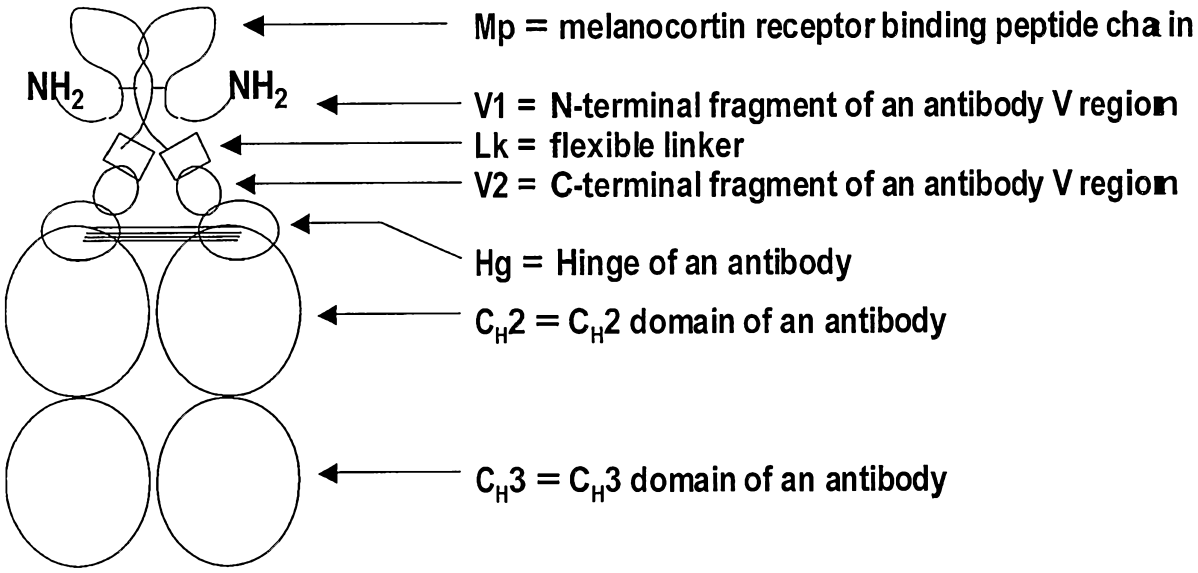

NH2
NH2
Mp = melanocortin receptor binding peptide chain
V1 = N-terminal fragment of an antibody V region
Lk = flexible linker
V2 = C-terminal fragment of an antibody V region
Hg = Hinge of an antibody
CH2 = CH2 domain of an antibody
CH3 = CH3 domain of an antibody

Fig. 3

SIGNAL SEQUENCE

Met Ala Trp Val Trp Thr Leu Leu Phe Leu Met Ala Ala Ala Gln

ATG GCT TGG GTG TGG ACC TTG CTA TTC CTG ATG GCG GCC GCC CAA

V1 alpha-MSH

Ser Ile Gln Ala Gln Ile Gln Ser Tyr Ser Met Glu His Phe Arg

AGT ATA CAG GCC CAG ATC CAG TCC TAC TCC ATG GAG CAC TTC CGC

LINKER V_H

Trp Gly Lys Pro Val Gly Ser Gly Gly Gly Ser Gly Thr Leu

TGG GGC AAG CCG GTG GGA TCC GGT GGA GGC TCC GGT ACC TTA

HINGE

Val Thr Val Ser Ser Glu Pro Lys Ser Cys Asp Lys Thr His Thr

GTC ACC GTC TCC TCA GAG CCC AAA TCT TGT GAC AAA ACT CAC ACG

C_H2

Cys Pro Pro Cys Pro Ala Pro Glu Leu Leu Gly Gly Pro Ser Val

TGC CCA CCG TGC CCA GCA CCT GAA CTC CTG GGG GGA CCG TCA GTC

Phe Leu Phe Pro Pro Lys Pro Lys Asp Thr Leu Met Ile Ser Arg

TTC CTC TTC CCC CCA AAA CCC AAG GAC ACC CTC ATG ATC TCC CGG

Thr Pro glu Val Thr Cys Val Val Val Asp Val Ser His Glu Asp

ACC CCT GAG GTC ACA TGC GTG GTG GTG GAC GTG AGC CAC GAA GAC

Pro Glu Val Lys Phe Asn Trp Tyr Val Asp Gly Val Glu Val His

CCT GAG GTC AAG TTC AAC TGG TAC GTG GAC GGC GTG GAG GTG CAT

Asn Ala Lys Thr Lys Pro Arg GLu Glu Gln Tyr Asn Ser Thr tyr

AAT GCC AAG ACA AAG CCG CGG GAG GAG CAG TAC AAC AGC ACG TAC

Arg Val Val Ser Val Leu Thr Val Leu His Gln Asp Trp Leu Asn

CGG GTG GTC AGC GTC CTC ACC GTC CTG CAC CAG GAC TGG CTG AAT

Gly Lys Glu Tyr Lys Cys Lys Val Ser Asn Lys Ala Leu Pro Ala

FIG. 3-Cont.

GGC AAG GAG TAC AAG TGC AAG GTC TCC AAC AAA GCC CTC CCA GCC

..... C_H3.....

Pro Ile Glu Lys Thr Ile Ser Lys Ala Lys **Gly** Gln Pro Arg Glu

CCC ATC GAG AAA ACC ATC TCC AAA GCC AAA **GGG** CAG CCC CGA GAA

.....

Pro Gln Val Tyr Thr Leu Pro Pro Ser Arg Asp Glu Leu Thr Lys

CCA CAG GTG TAC ACC CTG CCC CCA TCC CGG GAT GAG CTG ACC AAG

.....

Asn Gln Val Ser Leu Thr Cys Leu Val Lys Gly Phe Tyr Pro Ser

AAC CAG GTC AGC CTG ACC TGC CTG GTC AAA GGC TTC TAT CCC AGC

.....

Asp Ile Ala Val Glu Trp Glu Ser Asn Gly Gln Pro Glu Asn Asn

GAC ATC GCC GTG GAG TGG GAG AGC AAT GGG CAG CCG GAG AAC AAC

.....

Tyr Lys Thr Thr Pro Pro Val Leu Asp Ser Asp Gly Ser Phe Phe

TAC AAG ACC ACG CCT CCC GTG CTG GAC TCC GAC GGC TCC TTC TTC

.....

Leu Tyr Ser Lys Leu Thr Val Asp Lys Ser Arg Trp Gln Gln Gly

CTC TAC AGC AAG CTC ACC GTG GAC AAG AGC AGG TGG CAG CAG GGG

.....

Asn Val Phe Ser Cys Ser Val Met His Glu Ala Leu His Asn His

AAC GTC TTC TCA TGC TCC GTG ATG CAT GAG GCT CTG CAC AAC CAC

..... **STOP**

Tyr Thr Gln Lys Ser Leu Ser Leu Ser Pro Gly Lys

TAC ACG CAG AAG AGC CTC TCC CTG TCT CCG GGT AAA **TGA**

FIG. 4

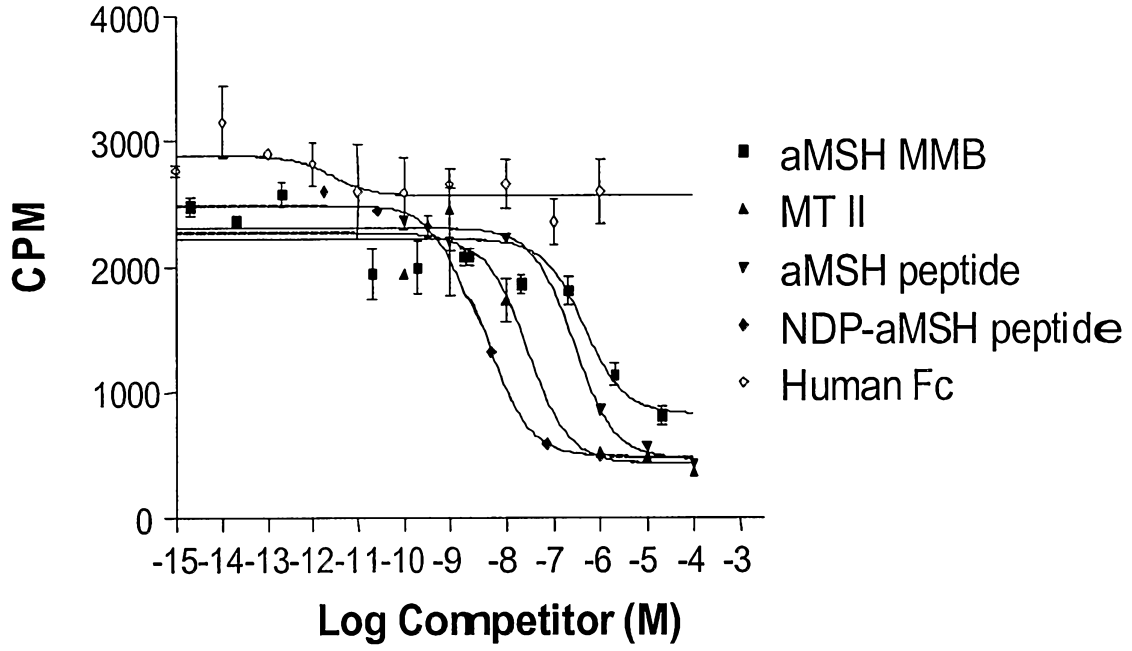

4000
3000
2000
1000
0
CPM
-15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3
Log Competitor (M)
aMSH MMB
MT II
aMSH peptide
NDP-aMSH peptide
Human Fc

FIG. 5

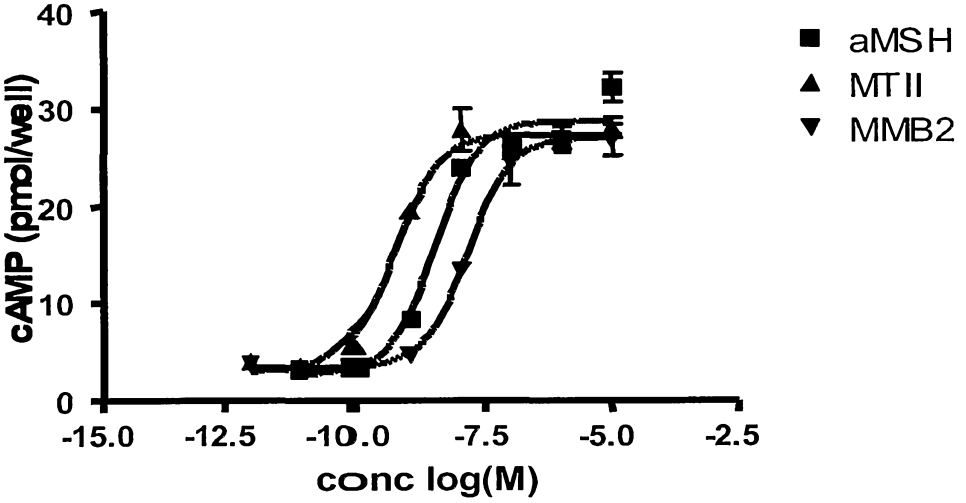

40
30
20
10
0
cAMP (pmol/well)
-15.0
-12.5
-10.0
-7.5
-5.0
-2.5
conc log(M)
aMSH
MTII
MMB2

FIG. 6

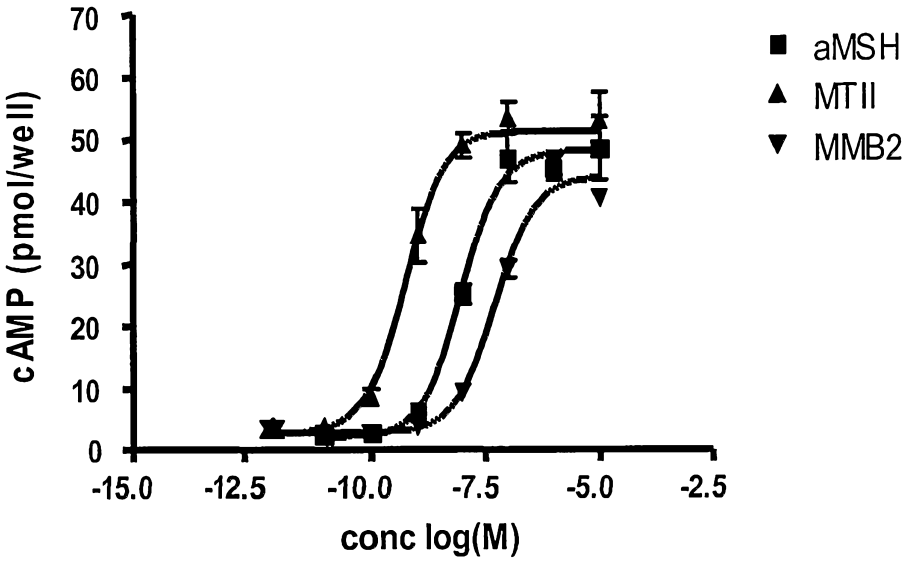

70
60
50
40
30
20
10
0
cAMP (pmol/well)
-15.0
-12.5
-10.0
-7.5
-5.0
-2.5
conc log(M)
aMSH
MTII
MMB2

FIG. 7

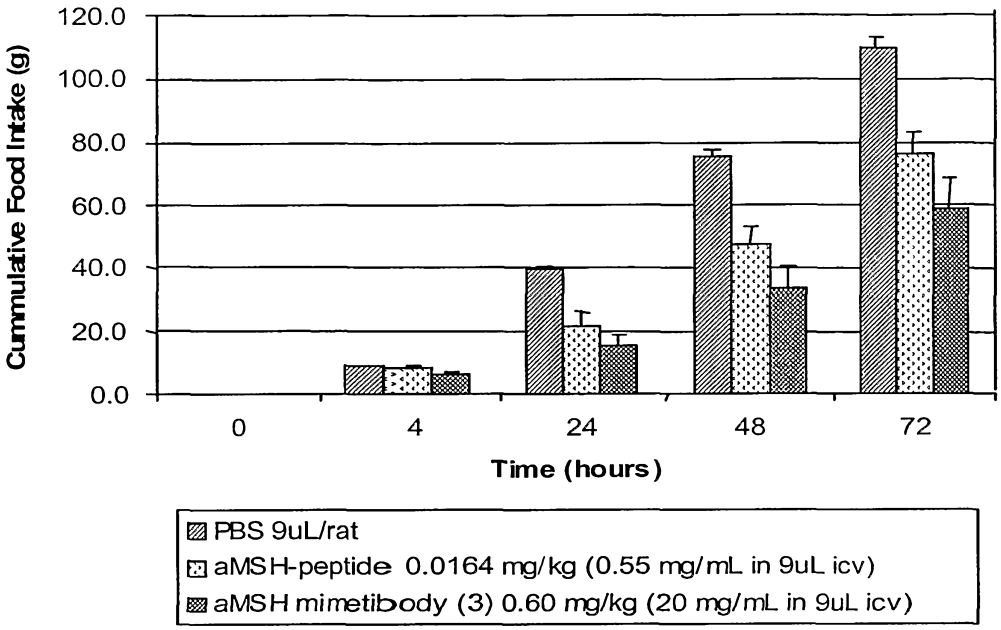
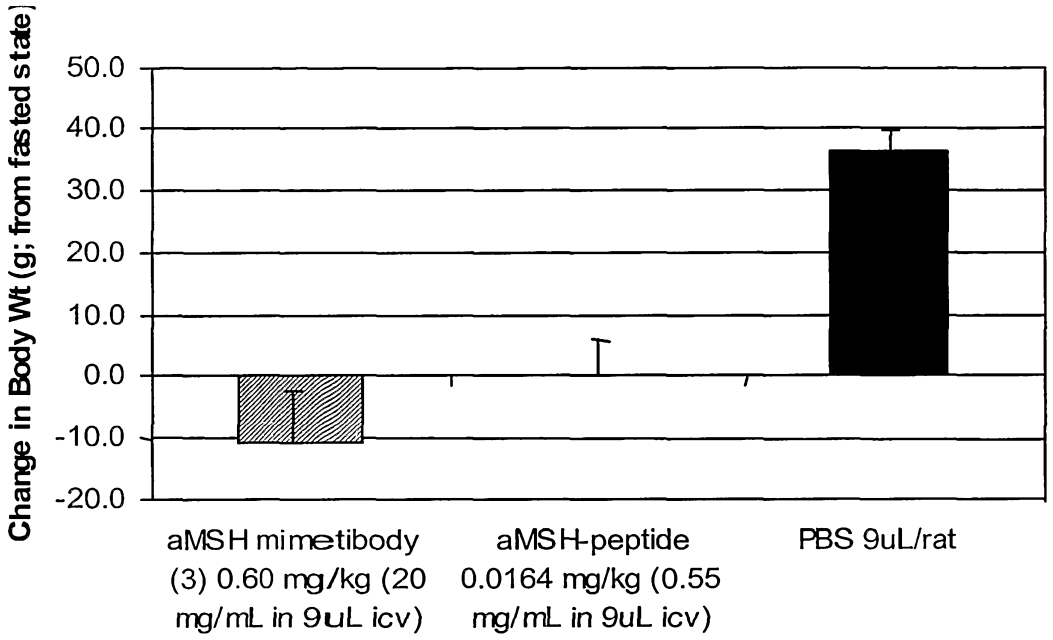

120.0
100.0
80.0
60.0
40.0
20.0
0.0
Cummulative Food Intake (g)
0
4
24
48
72
Time (hours)
PBS 9uL/rat
aMSH-peptide 0.0164 mg/kg (0.55 mg/mL in 9uL icv)
aMSH mimetibody (3) 0.60 mg/kg (20 mg/mL in 9uL icv)

FIG. 8


Change in Body Wt (g; from fasted state)
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
-20.0
aMSH mimetibody (3) 0.60 mg/kg (20 mg/mL in 9uL icv)
aMSH-peptide 0.0164 mg/kg (0.55 mg/mL in 9uL icv)
PBS 9uL/rat

SEQUENCE LISTING

<110> Centocor, Inc.

<120> Melanocortin Receptor Binding Mimetibodies, Compositions, Methods and Uses

<130> CEN5080 PCT

<140> To Be Assigned
<141> 2005-10-25

<150> 60/621,960
<151> 2004-10-25

<160> 85

<170> PatentIn version 3.2

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1 5 10

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Lys

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Thr Trp Lys

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Thr Trp Lys

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1 5

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<400> 32

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1 5

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<213> Artificial Sequence

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<223> T-->A substitution to limit O-linked glycosylation

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<400> 36

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<210> 37
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<210> 38
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<400> 38

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1 5 10 15

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<211> 36
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1 5 10

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<212> DNA
<213> Homo sapiens

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<400> 42

Glu Ser Lys Tyr Gly Pro Pro Cys Pro Pro Cys Pro
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<210> 43
<211> 15
<212> DNA
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<400> 43
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<210> 44
<211> 5
<212> PRT
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<400> 44

Cys Pro Pro Cys Pro
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<400> 45
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<210> 46
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<400> 46

Cys Pro Ser Cys
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<211> 330
<212> DNA
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ctgatgatta gccgcaccc ggaagtgacc tgcgtggtgg tggatgtgag ccatgaagat 120

ccggaagtga aatttaactg gtatgtggat ggcgtggaag tgcataacgc gaaaaccaaa 180

ccgcgcgaag aacagtataa cagcacctat cgcgtggtga gcgtgctgac cgtgctgcat 240

caggattggc tgaacggcaa agaatataaa tgcaaagtga gcaacaaagc gctgccggcg 300

ccgattgaaa aaaccattag caaagcgaaa 330

<210> 48
<211> 110
<212> PRT
<213> Homo sapiens

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Ala Pro Glu Leu Leu Gly Gly Pro Ser Val Phe Leu Phe Pro Pro Lys
1 5 10 15

Pro Lys Asp Thr Leu Met Ile Ser Arg Thr Pro Glu Val Thr Cys Val
20 25 30

Val Val Asp Val Ser His Glu Asp Pro Glu Val Lys Phe Asn Trp Tyr
35 40 45

Val Asp Gly Val Glu Val His Asn Ala Lys Thr Lys Pro Arg Glu Glu
50 55 60

Gln Tyr Asn Ser Thr Tyr Arg Val Val Ser Val Leu Thr Val Leu His
65 70 75 80

Gln Asp Trp Leu Asn Gly Lys Glu Tyr Lys Cys Lys Val Ser Asn Lys
85 90 95

Ala Leu Pro Ala Pro Ile Glu Lys Thr Ile Ser Lys Ala Lys
100 105 110

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<212> DNA
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ccggaagtga aatttaactg gtatgtggat ggcgtggaag tgcataacgc gaaaaccaaa 180

ccgcgcgaag aacagtataa cagcacctat cgcgtggtga gcgtgctgac cgtgctgcat 240

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ccgattgaaa aaaccattag caaagcgaaa 330

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Ala Pro Glu Ala Ala Gly Gly Pro Ser Val Phe Leu Phe Pro Pro Lys
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Pro Lys Asp Thr Leu Met Ile Ser Arg Thr Pro Glu Val Thr Cys Val
20 25 30

Val Val Asp Val Ser His Glu Asp Pro Glu Val Lys Phe Asn Trp Tyr
35 40 45

Val Asp Gly Val Glu Val His Asn Ala Lys Thr Lys Pro Arg Glu Glu
50 55 60

Gln Tyr Asn Ser Thr Tyr Arg Val Val Ser Val Leu Thr Val Leu His
65 70 75 80

Gln Asp Trp Leu Asn Gly Lys Glu Tyr Lys Cys Lys Val Ser Asn Lys
85 90 95

Ala Leu Pro Ala Pro Ile Glu Lys Thr Ile Ser Lys Ala Lys
100 105 110

<210> 51

<211> 330
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ctgatgatta gccgcacccc ggaagtgacc tgcgtggtgg tggatgtgag ccaggaagat 120

ccggaagtgc agtttaactg gtatgtggat ggcgtggaag tgcataacgc gaaaaccaaa 180

ccgcgcgaag aacagtttaa cagcacctat cgcgtggtga gcgtgctgac cgtgctgcat 240

caggattggc tgaacggcaa agaatataaa tgcaaagtga gcaacaaagg cctgccgagc 300

agcattgaaa aaaccattag caaagcgaaa 330

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<211> 110
<212> PRT
<213> Homo sapiens

<400> 52

Ala Pro Glu Phe Leu Gly Gly Pro Ser Val Phe Leu Phe Pro Pro Lys
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Pro Lys Asp Thr Leu Met Ile Ser Arg Thr Pro Glu Val Thr Cys Val
20 25 30

Val Val Asp Val Ser Gln Glu Asp Pro Glu Val Gln Phe Asn Trp Tyr
35 40 45

Val Asp Gly Val Glu Val His Asn Ala Lys Thr Lys Pro Arg Glu Glu
50 55 60

Gln Phe Asn Ser Thr Tyr Arg Val Val Ser Val Leu Thr Val Leu His
65 70 75 80

Gln Asp Trp Leu Asn Gly Lys Glu Tyr Lys Cys Lys Val Ser Asn Lys
85 90 95

Gly Leu Pro Ser Ser Ile Glu Lys Thr Ile Ser Lys Ala Lys
100 105 110

<210> 53
<211> 330
<212> DNA
<213> Homo sapiens

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ctgatgatta gccgcacccc ggaagtgacc tgcgtggtgg tggatgtgag ccaggaagat 120

ccggaagtgc agtttaactg gtatgtggat ggcgtggaag tgcataacgc gaaaaccaaa 180

ccgcgcgaag aacagtttaa cagcacctat cgcgtggtga gcgtgctgac cgtgctgcat 240

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<400> 54

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Pro Lys Asp Thr Leu Met Ile Ser Arg Thr Pro Glu Val Thr Cys Val
20 25 30

Val Val Asp Val Ser Gln Glu Asp Pro Glu Val Gln Phe Asn Trp Tyr
35 40 45

Val Asp Gly Val Glu Val His Asn Ala Lys Thr Lys Pro Arg Glu Glu
50 55 60

Gln Phe Asn Ser Thr Tyr Arg Val Val Ser Val Leu Thr Val Leu His
65 70 75 80

Gln Asp Trp Leu Asn Gly Lys Glu Tyr Lys Cys Lys Val Ser Asn Lys
85 90 95

Gly Leu Pro Ser Ser Ile Glu Lys Thr Ile Ser Lys Ala Lys
100 105 110

<210> 55
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<212> DNA
<213> Homo sapiens

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tgggaaagca acggccagcc ggaaaacaac tataaaacca ccccgccggt gctggatagc 180

gatggcagct tttttctgta tagcaaactg accgtggata aaagccgctg gcagcagggc 240

aacgtgttta gctgcagcgt gatgcatgaa gcgctgcata accattatac ccagaaaagc 300

ctgagcctga gcccgggcaa a 321

<210> 56
<211> 107
<212> PRT
<213> Homo sapiens

<400> 56

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Glu Leu Thr Lys Asn Gln Val Ser Leu Thr Cys Leu Val Lys Gly Phe
20 25 30

Tyr Pro Ser Asp Ile Ala Val Glu Trp Glu Ser Asn Gly Gln Pro Glu
35 40 45

Asn Asn Tyr Lys Thr Thr Pro Pro Val Leu Asp Ser Asp Gly Ser Phe
50 55 60

Phe Leu Tyr Ser Lys Leu Thr Val Asp Lys Ser Arg Trp Gln Gln Gly
65 70 75 80

Asn Val Phe Ser Cys Ser Val Met His Glu Ala Leu His Asn His Tyr
85 90 95

Thr Gln Lys Ser Leu Ser Leu Ser Pro Gly Lys
100 105

<210> 57
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<212> DNA
<213> Homo sapiens

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aaccaggtga gcctgacctg cctggtgaaa ggcttttatc cgagcgatat tgcggtggaa 120

tgggaaagca acggccagcc ggaaaacaac tataaaacca ccccgccggt gctggatagc 180

gatggcagct ttttctgtta tagccgcctg accgtggata aaagccgctg gcaggaaggc 240

aacgtgttta gctgcagcgt gatgcatgaa gcgctgcata accattatac ccagaaaagc 300

ctgagcctga gcctgggcaa a 321

<210> 58
<211> 107
<212> PRT
<213> Homo sapiens

<400> 58

Gly Gln Pro Arg Glu Pro Gln Val Tyr Thr Leu Pro Pro Ser Gln Glu
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Glu Met Thr Lys Asn Gln Val Ser Leu Thr Cys Leu Val Lys Gly Phe
20 25 30

Tyr Pro Ser Asp Ile Ala Val Glu Trp Glu Ser Asn Gly Gln Pro Glu
35 40 45

Asn Asn Tyr Lys Thr Thr Pro Pro Val Leu Asp Ser Asp Gly Ser Phe
50 55 60

Phe Leu Tyr Ser Arg Leu Thr Val Asp Lys Ser Arg Trp Gln Glu Gly
65 70 75 80

Asn Val Phe Ser Cys Ser Val Met His Glu Ala Leu His Asn His Tyr
85 90 95

Thr Gln Lys Ser Leu Ser Leu Ser Leu Gly Lys
100 105

<210> 59
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<220>
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accttagtca ccgtctcctc agagcccaaa tcttgtgaca aaactcacac gtgcccaccg 120

tgcccagcac ctgaactcct gggggggaccg tcagtcttcc tcttcccccc aaaacccaag 180

gacaccctca tgatctcccg gacccctgag gtcacatgcg tggtggtgga cgtgagccac 240

gaagaccctg aggtcaagtt caactggtac gtggacggcg tggaggtgca taatgccaag 300

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ccagccccca tcgagaaaac catctccaaa gccaaagggc agccccgaga accacaggtg 480

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aacaactaca agaccacgcc tcccgtgctg gactccgacg gctccttctt cctctacagc 660

aagctcaccg tggacaagag caggtggcag caggggaacg tcttctcatg ctccgtgatg 720

catgaggctc tgcacaacca ctacacgcag aagagcctct ccctgtctcc gggtaaa 777

<210> 60
<211> 259
<212> PRT
<213> Artificial Sequence

<220>
<223> Melanocortin receptor binding alpha-MSH mimetibody without
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<400> 60

Ser Tyr Ser Met Glu His Phe Arg Trp Gly Lys Pro Val Gly Ser Gly
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Gly Gly Ser Gly Thr Leu Val Thr Val Ser Ser Glu Pro Lys Ser Cys
20 25 30

Asp Lys Thr His Thr Cys Pro Pro Cys Pro Ala Pro Glu Leu Leu Gly
35 40 45

Gly Pro Ser Val Phe Leu Phe Pro Pro Lys Pro Lys Asp Thr Leu Met
50 55 60

Ile Ser Arg Thr Pro Glu Val Thr Cys Val Val Val Asp Val Ser His
65 70 75 80

Glu Asp Pro Glu Val Lys Phe Asn Trp Tyr Val Asp Gly Val Glu Val
85 90 95

His Asn Ala Lys Thr Lys Pro Arg Glu Glu Gln Tyr Asn Ser Thr Tyr
100 105 110

Arg Val Val Ser Val Leu Thr Val Leu His Gln Asp Trp Leu Asn Gly
115 120 125

Lys Glu Tyr Lys Cys Lys Val Ser Asn Lys Ala Leu Pro Ala Pro Ile
130 135 140

Glu Lys Thr Ile Ser Lys Ala Lys Gly Gln Pro Arg Glu Pro Gln Val
145 150 155 160

Tyr Thr Leu Pro Pro Ser Arg Asp Glu Leu Thr Lys Asn Gln Val Ser
165 170 175

Leu Thr Cys Leu Val Lys Gly Phe Tyr Pro Ser Asp Ile Ala Val Glu
180 185 190

Trp Glu Ser Asn Gly Gln Pro Glu Asn Asn Tyr Lys Thr Thr Pro Pro
195 200 205

Val Leu Asp Ser Asp Gly Ser Phe Phe Leu Tyr Ser Lys Leu Thr Val
210 215 220

Asp Lys Ser Arg Trp Gln Gln Gly Asn Val Phe Ser Cys Ser Val Met
225 230 235 240

His Glu Ala Leu His Asn His Tyr Thr Gln Lys Ser Leu Ser Leu Ser
245 250 255

Pro Gly Lys

<210> 61
<211> 843
<212> DNA
<213> Artificial Sequence

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<223> signal and V1.

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atccagtcct actccatgga gcacttccgc tggggcaagc cggtgggatc cggtggaggc 120

tccggtacct tagtcaccgt ctcctcagag cccaaatctt gtgacaaaac tcacacgtgc 180

ccaccgtgcc cagcacctga actcctgggg ggaccgtcag tcttcctctt cccccaaaa 240

cccaaggaca ccctcatgat ctcccggacc cctgaggtca catgcgtggt ggtggacgtg 300

agccacgaag accctgaggt caagttcaac tggtacgtgg acggcgtgga ggtgcataat 360

gccaagacaa agccgcggga ggagcagtac aacagcacgt accgggtggt cagcgtcctc 420

accgtcctgc accaggactg gctgaatggc aaggagtaca agtgcaaggt ctccaacaaa 480

gccctcccag ccccatcga gaaaaccatc tccaaagcca aagggcagcc ccgagaacca 540

caggtgtaca ccctgccccc atcccgggat gagctgacca agaaccaggt cagcctgacc 600

tgcctggtca aaggcttcta tcccagcgac atcgccgtgg agtgggagag caatgggcag 660

ccggagaaca actacaagac cacgcctccc gtgctggact ccgacggctc cttcttcctc 720

tacagcaagc tcaccgtgga caagagcagg tggcagcagg ggaacgtctt ctcatgctcc 780

gtgatgcatg aggctctgca caaccactac acgcagaaga gcctctccct gtctccgggt 840

aaa 843

<210> 62
<211> 281
<212> PRT
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<220>

<223> Melanocortin receptor binding alpha-MSH mimetibody with secretory
<223> signal and V1.

<400> 62

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            20                  25                  30

Lys Pro Val Gly Ser Gly Gly Gly Ser Gly Thr Leu Val Thr Val Ser
        35                  40                  45

Ser Glu Pro Lys Ser Cys Asp Lys Thr His Thr Cys Pro Pro Cys Pro
    50                  55                  60

Ala Pro Glu Leu Leu Gly Gly Pro Ser Val Phe Leu Phe Pro Pro Lys
65                  70                  75                  80

Pro Lys Asp Thr Leu Met Ile Ser Arg Thr Pro Glu Val Thr Cys Val
                85                  90                  95

Val Val Asp Val Ser His Glu Asp Pro Glu Val Lys Phe Asn Trp Tyr
            100                 105                 110

Val Asp Gly Val Glu Val His Asn Ala Lys Thr Lys Pro Arg Glu Glu
        115                 120                 125

Gln Tyr Asn Ser Thr Tyr Arg Val Val Ser Val Leu Thr Val Leu His
    130                 135                 140

Gln Asp Trp Leu Asn Gly Lys Glu Tyr Lys Cys Lys Val Ser Asn Lys
145                 150                 155                 160

Ala Leu Pro Ala Pro Ile Glu Lys Thr Ile Ser Lys Ala Lys Gly Gln
                165                 170                 175

Pro Arg Glu Pro Gln Val Tyr Thr Leu Pro Pro Ser Arg Asp Glu Leu
            180                 185                 190

Thr Lys Asn Gln Val Ser Leu Thr Cys Leu Val Lys Gly Phe Tyr Pro
        195                 200                 205

Ser Asp Ile Ala Val Glu Trp Glu Ser Asn Gly Gln Pro Glu Asn Asn
    210                 215                 220

Tyr Lys Thr Thr Pro Pro Val Leu Asp Ser Asp Gly Ser Phe Phe Leu
225                 230                 235                 240
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Tyr Ser Lys Leu Thr Val Asp Lys Ser Arg Trp Gln Gln Gly Asn Val
245 250 255

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<400> 66
atgattagcc gcaccccgac cgtgctgcat cagcataacc attat 45

<210> 67
<211> 15
<212> PRT
<213> Homo sapiens

<400> 67

Met Ile Ser Arg Thr Pro Thr Val Leu His Gln His Asn His Tyr
1 5 10 15

<210> 68
<211> 57
<212> DNA
<213> Homo sapiens

<400> 68
atggcttggg tgtggacctt gctattcctg atggcggccg cccaaagtat acaggcc 57

<210> 69
<211> 19
<212> PRT
<213> Homo sapiens

<400> 69

Met Ala Trp Val Trp Thr Leu Leu Phe Leu Met Ala Ala Ala Gln Ser
1 5 10 15

Ile Gln Ala

<210> 70

<211> 951
<212> DNA
<213> Homo sapiens

<400> 70
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atcccccagc tggggctggc tgccaaccag acaggagccc ggtgcctgga ggtgtccatc 120

tctgacgggc tcttcctcag cctggggctg gtgagcttgg tggagaacgc gctggtggtg 180

gccaccatcg ccaagaaccg gaacctgcac tcacccatgt actgcttcat ctgctgcctg 240

gccttgtcgg acctgctggt gagcgggagc aacgtgctgg agacggccgt catcctcctg 300

ctggaggccg gtgcactggt ggcccgggct gcggtgctgc agcagctgga caatgtcatt 360

gacgtgatca cctgcagctc catgctgtcc agcctctgct tcctgggcgc catcgccgtg 420

gaccgctaca tctccatctt ctacgcactg cgctaccaca gcaccgtgac cctgccgcgg 480

gcgcggcgag ccgttgcggc catctgggtg gccagtgtcg tcttcagcac gctcttcatc 540

gcctactacg accacgtggc cgtcctgctg tgcctcgtgg tcttcttcct ggctatgctg 600

gtgctcatgg ccgtgctgta cgtccacatg ctggcccggg cctgccagca cgcccagggc 660

atcgcccggc tccacaagag gcagcgcccg gtccaccagg gcttctggcct taaaggcgct 720

gtcaccctca ccatcctgct gggcattttc ttcctctgct ggggccccctt cttcctgcat 780

ctcacactca tcgtcctctg ccccgagcac cccacgtgcg gctgcatctt caagaacttc 840

aacctctttc tcgccctcat catctgcaat gccatcatcg accccctcat ctacgccttc 900

cacagccagg agctccgcag gacgctcaag gaggtgctga cgtgctcctg g 951

<210> 71
<211> 317
<212> PRT
<213> Homo sapiens

<400> 71

Met Ala Val Gln Gly Ser Gln Arg Arg Leu Leu Gly Ser Leu Asn Ser
1 5 10 15

Thr Pro Thr Ala Ile Pro Gln Leu Gly Leu Ala Ala Asn Gln Thr Gly
20 25 30

Ala Arg Cys Leu Glu Val Ser Ile Ser Asp Gly Leu Phe Leu Ser Leu
35 40 45

Gly Leu Val Ser Leu Val Glu Asn Ala Leu Val Val Ala Thr Ile Ala
50 55 60

Lys Asn Arg Asn Leu His Ser Pro Met Tyr Cys Phe Ile Cys Cys Leu
65 70 75 80

Ala Leu Ser Asp Leu Leu Val Ser Gly Ser Asn Val Leu Glu Thr Ala
85 90 95

Val Ile Leu Leu Leu Glu Ala Gly Ala Leu Val Ala Arg Ala Ala Val
100 105 110

Leu Gln Gln Leu Asp Asn Val Ile Asp Val Ile Thr Cys Ser Ser Met
115 120 125

Leu Ser Ser Leu Cys Phe Leu Gly Ala Ile Ala Val Asp Arg Tyr Ile
130 135 140

Ser Ile Phe Tyr Ala Leu Arg Tyr His Ser Thr Val Thr Leu Pro Arg
145 150 155 160

Ala Arg Arg Ala Val Ala Ala Ile Trp Val Ala Ser Val Val Phe Ser
165 170 175

Thr Leu Phe Ile Ala Tyr Tyr Asp His Val Ala Val Leu Leu Cys Leu
180 185 190

Val Val Phe Phe Leu Ala Met Leu Val Leu Met Ala Val Leu Tyr Val
195 200 205

His Met Leu Ala Arg Ala Cys Gln His Ala Gln Gly Ile Ala Arg Leu
210 215 220

His Lys Arg Gln Arg Pro Val His Gln Gly Phe Gly Leu Lys Gly Ala
225 230 235 240

Val Thr Leu Thr Ile Leu Leu Gly Ile Phe Phe Leu Cys Trp Gly Pro
245 250 255

Phe Phe Leu His Leu Thr Leu Ile Val Leu Cys Pro Glu His Pro Thr
260 265 270

Cys Gly Cys Ile Phe Lys Asn Phe Asn Leu Phe Leu Ala Leu Ile Ile
275 280 285

Cys Asn Ala Ile Ile Asp Pro Leu Ile Tyr Ala Phe His Ser Gln Glu
290 295 300

Leu Arg Arg Thr Leu Lys Glu Val Leu Thr Cys Ser Trp
305 310 315

<210> 72

<211> 891
<212> DNA
<213> Homo sapiens

<400> 72
atgaagcaca ttatcaactc gtatgaaaac atcaacaaca cagcaagaaa taattccgac 60

tgtcctcgtg tggttttgcc ggaggagata tttttcacaa tttccattgt tggagttttg 120

gagaatctga tcgtcctgct ggctgtgttc aagaataaga atctccaggc acccatgtac 180

tttttcatct gtagcttggc catatctgat atgctgggca gcctatataa gatcttggaa 240

aatatcctga tcatattgag aaacatgggc tatctcaagc cacgtggcag ttttgaaacc 300

acagccgatg acatcatcga ctccctgttt gtcctctccc tgcttggctc catcttcagc 360

ctgtctgtga ttgctgcgga ccgctacatc accatcttcc acgcactgcg gtaccacagc 420

atcgtgacca tgcgccgcac tgtggtggtg cttacggtca tctggacgtt ctgcacgggg 480

actggcatca ccatggtgat cttctcccat catgtgccca cagtgatcac cttcacgtcg 540

ctgttcccgc tgatgctggt cttcatcctg tgcctctatg tgcacatgtt cctgctggct 600

cgatcccaca ccaggaagat ctccaccctc cccagagcca acatgaaagg ggccatcaca 660

ctgaccatcc tgctcggggt cttcatcttc tgctgggccc cctttgtgct tcatgtcctc 720

ttgatgacat tctgcccaag taacccctac tgcgcctgct acatgtctct cttccaggtg 780

aacggcatgt tgatcatgtg caatgccgtc attgacccct tcatatatgc cttccggagc 840

ccagagctca gggacgcatt caaaaagatg atcttctgca gcaggtactg g 891

<210> 73
<211> 297
<212> PRT
<213> Homo sapiens

<400> 73

Met Lys His Ile Ile Asn Ser Tyr Glu Asn Ile Asn Asn Thr Ala Arg
1 5 10 15

Asn Asn Ser Asp Cys Pro Arg Val Val Leu Pro Glu Glu Ile Phe Phe
20 25 30

Thr Ile Ser Ile Val Gly Val Leu Glu Asn Leu Ile Val Leu Leu Ala
35 40 45

Val Phe Lys Asn Lys Asn Leu Gln Ala Pro Met Tyr Phe Phe Ile Cys
50 55 60

Ser Leu Ala Ile Ser Asp Met Leu Gly Ser Leu Tyr Lys Ile Leu Glu
65 70 75 80

```
Asn Ile Leu Ile Ile Leu Arg Asn Met Gly Tyr Leu Lys Pro Arg Gly
                85                  90                  95

Ser Phe Glu Thr Thr Ala Asp Asp Ile Ile Asp Ser Leu Phe Val Leu
            100                 105                 110

Ser Leu Leu Gly Ser Ile Phe Ser Leu Ser Val Ile Ala Ala Asp Arg
        115                 120                 125

Tyr Ile Thr Ile Phe His Ala Leu Arg Tyr His Ser Ile Val Thr Met
    130                 135                 140

Arg Arg Thr Val Val Val Leu Thr Val Ile Trp Thr Phe Cys Thr Gly
145                 150                 155                 160

Thr Gly Ile Thr Met Val Ile Phe Ser His His Val Pro Thr Val Ile
                165                 170                 175

Thr Phe Thr Ser Leu Phe Pro Leu Met Leu Val Phe Ile Leu Cys Leu
            180                 185                 190

Tyr Val His Met Phe Leu Leu Ala Arg Ser His Thr Arg Lys Ile Ser
        195                 200                 205

Thr Leu Pro Arg Ala Asn Met Lys Gly Ala Ile Thr Leu Thr Ile Leu
    210                 215                 220

Leu Gly Val Phe Ile Phe Cys Trp Ala Pro Phe Val Leu His Val Leu
225                 230                 235                 240

Leu Met Thr Phe Cys Pro Ser Asn Pro Tyr Cys Ala Cys Tyr Met Ser
                245                 250                 255

Leu Phe Gln Val Asn Gly Met Leu Ile Met Cys Asn Ala Val Ile Asp
            260                 265                 270

Pro Phe Ile Tyr Ala Phe Arg Ser Pro Glu Leu Arg Asp Ala Phe Lys
        275                 280                 285

Lys Met Ile Phe Cys Ser Arg Tyr Trp
    290                 295
```

<210> 74
<211> 1080
<212> DNA
<213> Homo sapiens

<400> 74
atgagcatcc aaaagacgta tctggaggga gattttgtct ttcctgtgag cagcagcagc 60

ttcctacgga ccctgctgga gccccagctc ggatcagccc ttctgacagc aatgaatgct 1120

tcgtgctgcc tgccctctgt tcagccaaca ctgcctaatg gctcggagca cctccaagcc 1180

cctttcttca gcaaccagag cagcagcgcc ttctgtgagc aggtcttcat caagcccgag 2240

gttttcctgt ctctgggcat cgtcagtctg ctggaaaaca tcctggttat cctggccgtg 3300

gtcaggaacg gcaacctgca ctccccgatg tacttctttc tctgcagcct ggcggtggcc 3360

gacatgctgg taagtgtgtc caatgccctg gagaccatca tgatcgccat cgtccacagc 4220

gactacctga ccttcgagga ccagtttatc cagcacatgg acaacatctt cgactccatg 4280

atctgcatct ccctggtggc ctccatctgc aacctcctgg ccatcgccgt cgacaggtac 5340

gtcaccatct tttacgcgct ccgctaccac agcatcatga ccgtgaggaa ggccctcacc 6000

ttgatcgtgg ccatctgggt ctgctgcggc gtctgtggcg tggtgttcat cgtctactcg 6660

gagagcaaaa tggtcattgt gtgcctcatc accatgttct tcgccatgat gctcctcatg 7220

ggcaccctct acgtgcacat gttcctcttt gcgcggctgc acgtcaagcg catagcagca 7880

ctgccacctg ccgacggggt ggccccacag caacactcat gcatgaaggg ggcagtcacc 8440

atcaccattc tcctgggcgt gttcatcttc tgctgggccc ccttcttcct ccacctggtc 9000

ctcatcatca cctgccccac caacccctac tgcatctgct acactgccca cttcaacacc 9660

tacctggtcc tcatcatgtg caactccgtc atcgacccac tcatctacgc tttccggagc 10220

ctggaattgc gcaacacctt tagggagatt ctctgtggct gcaacggcat gaacttggga 10880

<210> 75
<211> 360
<212> PRT
<213> Homo sapiens

<400> 75

Met Ser Ile Gln Lys Thr Tyr Leu Glu Gly Asp Phe Val Phe Pro Val
1 5 10 15

Ser Ser Ser Ser Phe Leu Arg Thr Leu Leu Glu Pro Gln Leu Gly Ser
20 25 30

Ala Leu Leu Thr Ala Met Asn Ala Ser Cys Cys Leu Pro Ser Val Gln
35 40 45

Pro Thr Leu Pro Asn Gly Ser Glu His Leu Gln Ala Pro Phe Phe Ser
50 55 60

Asn Gln Ser Ser Ser Ala Phe Cys Glu Gln Val Phe Ile Lys Pro Glu
65 70 75 80

```
Val Phe Leu Ser Leu Gly Ile Val Ser Leu Leu Glu Asn Ile Leu Val
                85                  90                  95

Ile Leu Ala Val Val Arg Asn Gly Asn Leu His Ser Pro Met Tyr Phe
            100                 105                 110

Phe Leu Cys Ser Leu Ala Val Ala Asp Met Leu Val Ser Val Ser Asn
        115                 120                 125

Ala Leu Glu Thr Ile Met Ile Ala Ile Val His Ser Asp Tyr Leu Thr
    130                 135                 140

Phe Glu Asp Gln Phe Ile Gln His Met Asp Asn Ile Phe Asp Ser Met
145                 150                 155                 160

Ile Cys Ile Ser Leu Val Ala Ser Ile Cys Asn Leu Leu Ala Ile Ala
                165                 170                 175

Val Asp Arg Tyr Val Thr Ile Phe Tyr Ala Leu Arg Tyr His Ser Ile
            180                 185                 190

Met Thr Val Arg Lys Ala Leu Thr Leu Ile Val Ala Ile Trp Val Cys
        195                 200                 205

Cys Gly Val Cys Gly Val Val Phe Ile Val Tyr Ser Glu Ser Lys Met
    210                 215                 220

Val Ile Val Cys Leu Ile Thr Met Phe Phe Ala Met Met Leu Leu Met
225                 230                 235                 240

Gly Thr Leu Tyr Val His Met Phe Leu Phe Ala Arg Leu His Val Lys
                245                 250                 255

Arg Ile Ala Ala Leu Pro Pro Ala Asp Gly Val Ala Pro Gln Gln His
            260                 265                 270

Ser Cys Met Lys Gly Ala Val Thr Ile Thr Ile Leu Leu Gly Val Phe
        275                 280                 285

Ile Phe Cys Trp Ala Pro Phe Phe Leu His Leu Val Leu Ile Ile Thr
    290                 295                 300

Cys Pro Thr Asn Pro Tyr Cys Ile Cys Tyr Thr Ala His Phe Asn Thr
305                 310                 315                 320

Tyr Leu Val Leu Ile Met Cys Asn Ser Val Ile Asp Pro Leu Ile Tyr
                325                 330                 335
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Ala Phe Arg Ser Leu Glu Leu Arg Asn Thr Phe Arg Glu Ile Leu Cys
340 345 350

Gly Cys Asn Gly Met Asn Leu Gly
355 360

<210> 76
<211> 999
<212> DNA
<213> Homo sapiens

<400> 76
atggtgaact ccacccaccg tgggatgcac acttctctgc acctctggaa ccgcagcagt 60

tacagactgc acagcaatgc cagtgagtcc cttggaaaag gctactctga tggagggtgc 120

tacgagcaac tttttgtctc tcctgaggtg tttgtgactc tgggtgtcat cagcttgttg 180

gagaatatct tagtgattgt ggcaatagcc aagaacaaga atctgcattc acccatgtac 240

tttttcatct gcagcttggc tgtggctgat atgctggtga gcgtttcaaa tggatcagaa 300

accattatca tcaccctatt aaacagtaca gatacggatg cacagagttt cacagtgaat 360

attgataatg tcattgactc ggtgatctgt agctccttgc ttgcatccat ttgcagcctg 420

ctttcaattg cagtggacag gtactttact atcttctatg ctctccagta ccataacatt 480

atgacagtta agcgggttgg gatcatcata agttgtatct gggcagcttg cacggtttca 540

ggcattttgt tcatcattta ctcagatagt agtgctgtca tcatctgcct catcaccatg 600

ttcttcacca tgctggctct catggcttct ctctatgtcc acatgttcct gatggccagg 660

cttcacatta agaggattgc tgtcctcccc ggcactggtg ccatccgcca aggtgccaat 720

atgaagggag cgattacctt gaccatcctg attggcgtct ttgttgtctg ctgggcccca 780

ttcttcctcc acttaatatt ctacatctct tgtcctcaga atccatattg tgtgtgcttc 840

atgtctcact ttaacttgta tctcatactg atcatgtgta attcaatcat cgatcctctg 900

atttatgcac tccggagtca agaactgagg aaaaccttca aagagatcat ctgttgctat 960

cccctgggag gcctttgtga cttgtctagc agatattaa 999

<210> 77
<211> 332
<212> PRT
<213> Homo sapiens

<400> 77

Met Val Asn Ser Thr His Arg Gly Met His Thr Ser Leu His Leu Trp
1 5 10 15

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Asn Arg Ser Ser Tyr Arg Leu His Ser Asn Ala Ser Glu Ser Leu Gly
            20                  25                  30

Lys Gly Tyr Ser Asp Gly Gly Cys Tyr Glu Gln Leu Phe Val Ser Pro
        35                  40                  45

Glu Val Phe Val Thr Leu Gly Val Ile Ser Leu Leu Glu Asn Ile Leu
    50                  55                  60

Val Ile Val Ala Ile Ala Lys Asn Lys Asn Leu His Ser Pro Met Tyr
65                  70                  75                  80

Phe Phe Ile Cys Ser Leu Ala Val Ala Asp Met Leu Val Ser Val Ser
                85                  90                  95

Asn Gly Ser Glu Thr Ile Ile Ile Thr Leu Leu Asn Ser Thr Asp Thr
            100                 105                 110

Asp Ala Gln Ser Phe Thr Val Asn Ile Asp Asn Val Ile Asp Ser Val
        115                 120                 125

Ile Cys Ser Ser Leu Leu Ala Ser Ile Cys Ser Leu Leu Ser Ile Ala
    130                 135                 140

Val Asp Arg Tyr Phe Thr Ile Phe Tyr Ala Leu Gln Tyr His Asn Ile
145                 150                 155                 160

Met Thr Val Lys Arg Val Gly Ile Ile Ile Ser Cys Ile Trp Ala Ala
                165                 170                 175

Cys Thr Val Ser Gly Ile Leu Phe Ile Ile Tyr Ser Asp Ser Ser Ala
            180                 185                 190

Val Ile Ile Cys Leu Ile Thr Met Phe Phe Thr Met Leu Ala Leu Met
        195                 200                 205

Ala Ser Leu Tyr Val His Met Phe Leu Met Ala Arg Leu His Ile Lys
    210                 215                 220

Arg Ile Ala Val Leu Pro Gly Thr Gly Ala Ile Arg Gln Gly Ala Asn
225                 230                 235                 240

Met Lys Gly Ala Ile Thr Leu Thr Ile Leu Ile Gly Val Phe Val Val
                245                 250                 255

Cys Trp Ala Pro Phe Phe Leu His Leu Ile Phe Tyr Ile Ser Cys Pro
            260                 265                 270
```

```
Gln Asn Pro Tyr Cys  Val Cys Phe Met Ser His Phe Asn Leu Tyr Leu
        275                 280                 285

Ile Leu Ile Met Cys  Asn Ser Ile Ile Asp Pro Leu Ile Tyr Ala Leu
    290                 295                 300

Arg Ser Gln Glu Leu  Arg Lys Thr Phe Lys Glu Ile Ile Cys Cys Tyr
305                 310                 315                 320

Pro Leu Gly Gly Leu  Cys Asp Leu Ser Ser Arg Tyr
                325                 330
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<210> 78
<211> 975
<212> DNA
<213> Homo sapiens

<400> 78
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ctttcaggac ccaatgtcaa aaacaagtct tcaccatgtg aagacatggg cattgctgtg 120

gaggtgtttc tcactctggg tgtcatcagc ctcttggaga acatcttggt catagggggcc 180

atagtgaaga acaaaaacct gcactccccc atgtacttct tcgtgtgcag cctggcagtg 240

gcggacatgc tggtgagcat gtccagtgcc tgggagacca tcaccatcta cctactcaac 300

aacaagcacc tagtgatagc agacgccttt gtgcgccaca ttgacaatgt gtttgactcc 360

atgatctgca tttccgtggt ggcatccatg tgcagcttac tggccattgc agtggatagg 420

tacgtcacca tcttctacgc cctgcgctac caccacatca tgacggcgag gcgctcaggg 480

gccatcatcg ccggcatctg ggctttctgc acgggctgcg gcattgtctt catcctgtac 540

tcagaatcca cctacgtcat cctgtgcctc atctccatgt tcttcgctat gctgttcctc 600

ctggtgtctc tgtacataca catgttcctc ctggcgcgga ctcacgtcaa gcggatcgcg 660

gctctgcccg gggccagctc tgcgcggcag aggaccagca tgcagggcgc ggtcaccgtc 720

accatgctgc tgggcgtgtt taccgtgtgc tgggccccgt tcttccttca tctcacttta 780

atgctttctt gccctcagaa cctctactgc tctcgcttca tgtctcactt caatatgtac 840

ctcatactca tcatgtgtaa ttccgtgatg gaccctctca tatatgcctt ccgcagccaa 900

gagatgcgga agacctttaa ggagattatt tgctgccgtg gtttcaggat cgcctgcagc 960

tttcccagaa gggat 975

<210> 79
<211> 325
<212> PRT
<213> Homo sapiens

<400> 79

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Met Asn Ser Ser Phe His Leu His Phe Leu Asp Leu Asn Leu Asn Ala
1               5                   10                  15

Thr Glu Gly Asn Leu Ser Gly Pro Asn Val Lys Asn Lys Ser Ser Pro
            20                  25                  30

Cys Glu Asp Met Gly Ile Ala Val Glu Val Phe Leu Thr Leu Gly Val
        35                  40                  45

Ile Ser Leu Leu Glu Asn Ile Leu Val Ile Gly Ala Ile Val Lys Asn
    50                  55                  60

Lys Asn Leu His Ser Pro Met Tyr Phe Phe Val Cys Ser Leu Ala Val
65                  70                  75                  80

Ala Asp Met Leu Val Ser Met Ser Ser Ala Trp Glu Thr Ile Thr Ile
                85                  90                  95

Tyr Leu Leu Asn Asn Lys His Leu Val Ile Ala Asp Ala Phe Val Arg
            100                 105                 110

His Ile Asp Asn Val Phe Asp Ser Met Ile Cys Ile Ser Val Val Ala
        115                 120                 125

Ser Met Cys Ser Leu Leu Ala Ile Ala Val Asp Arg Tyr Val Thr Ile
    130                 135                 140

Phe Tyr Ala Leu Arg Tyr His His Ile Met Thr Ala Arg Arg Ser Gly
145                 150                 155                 160

Ala Ile Ile Ala Gly Ile Trp Ala Phe Cys Thr Gly Cys Gly Ile Val
                165                 170                 175

Phe Ile Leu Tyr Ser Glu Ser Thr Tyr Val Ile Leu Cys Leu Ile Ser
            180                 185                 190

Met Phe Phe Ala Met Leu Phe Leu Leu Val Ser Leu Tyr Ile His Met
        195                 200                 205

Phe Leu Leu Ala Arg Thr His Val Lys Arg Ile Ala Ala Leu Pro Gly
    210                 215                 220

Ala Ser Ser Ala Arg Gln Arg Thr Ser Met Gln Gly Ala Val Thr Val
225                 230                 235                 240
```

Thr Met Leu Leu Gly Val Phe Thr Val Cys Trp Ala Pro Phe Phe Leu
245 250 255

His Leu Thr Leu Met Leu Ser Cys Pro Gln Asn Leu Tyr Cys Ser Arg
260 265 270

Phe Met Ser His Phe Asn Met Tyr Leu Ile Leu Ile Met Cys Asn Ser
275 280 285

Val Met Asp Pro Leu Ile Tyr Ala Phe Arg Ser Gln Glu Met Arg Lys
290 295 300

Thr Phe Lys Glu Ile Ile Cys Cys Arg Gly Phe Arg Ile Ala Cys Ser
305 310 315 320

Phe Pro Arg Arg Asp
325

<210> 80
<211> 12
<212> DNA
<213> Homo sapiens

<400> 80
cattttcgct gg 12

<210> 81
<211> 4
<212> PRT
<213> Homo sapiens

<400> 81

His Phe Arg Trp
1

<210> 82
<211> 12
<212> DNA
<213> Artificial Sequence

<220>
<223> Modification of alpha-MSH HFRW core.

<400> 82
tttcattgga tg 12

<210> 83
<211> 4
<212> PRT
<213> Artificial Sequence

<220>
<223> Modification of alpha-MSH HFRW core.

<400> 83

Phe His Trp Met
1

<210> 84
<211> 12
<212> DNA
<213> Artificial Sequence

<220>
<223> Flexible peptide

<400> 84
ggcggcggca gc 12

<210> 85
<211> 4
<212> PRT
<213> Artificial Sequence

<220>
<223> Flexible peptide

<400> 85

Gly Gly Gly Ser
1