Description

Title of Invention: A CONJUGATE COMPRISING OXYNTOMODULIN AND AN IMMUNOGLOBULIN FRAGMENT, AND USE THEREOF

Technical Field

[1] The present invention relates to a conjugate comprising oxyntomodulin and an immunoglobulin fragment, and the use thereof. More particularly, the present invention relates to a conjugate comprising oxyntomodulin, an immunoglobulin Fc region, and non-peptidyl polymer wherein the conjugate being obtainable by covalently linking oxyntomodulin to immunoglobulin Fc region via non-peptidyl polymer, and a pharmaceutical composition for the prevention or treatment of obesity comprising the conjugate.

[2]

Background Art

[3] Recently, economic growth and changes in lifestyle are leading to changes in eating habits. The main causes of rising overweight and obesity rates in contemporary people are consumption of high-calorie foods such as fast foods and lack of exercise. World Health Organization (WHO) estimates that more than 1 billion people worldwide are overweight and at least 300 million of them are clinically obese. In particular, 250,000 people die each year in Europe and more than 2.5 million people worldwide die each year as a result of being overweight (World Health Organization, Global Strategy on Diet, Physical Activity and Health, 2004).

[4] Being overweight and obese increases blood pressure and cholesterol levels to cause occurrence or exacerbation of various diseases such as cardiovascular disease, diabetes, and arthritis, and are also main causes of rising incidence rates of arteriosclerosis, hypertension, hyperlipidemia or cardiovascular disease in children or adolescents as well as in adults.

[5] Obesity is a severe condition that causes various diseases worldwide. It is thought to be overcome by individual efforts, and it is also believed that obese patients lack self-control. However, it is difficult to treat obesity, because obesity is a complex disorder involving appetite regulation and energy metabolism. For the treatment of obesity, abnormal actions associated with appetite regulation and energy metabolism should be treated together with efforts of obese patients. Many attempts have been made to develop drugs capable of treating the abnormal actions. As the result of these efforts, drugs such as Rimonabant (Sanofi-Aventis), Sibutramin (Abbott), Contrave (Takeda), and Orlistat (Roche) have been developed, but they have the disadvantages of serious

adverse effects or very weak anti-obesity effects. For example, it was reported that Rimonabant (Sanofi-Aventis) shows a side-effect of central nerve disorder, Sibutramine (Abbott) and Contrave (Takeda) show cardiovascular side-effects, and Orlistat (Roche) shows only 4 kg of weight loss when taken for 1 year. Unfortunately, there are no therapeutic agents for obesity which can be safely prescribed for obese patients.

[6]

[7] Many studies have been made to develop therapeutic agents for obesity which do not have the problems of the conventional anti-obesity drugs. Recently, glucagon derivatives have received much attention. Glucagon is produced by the pancreas when the level of glucose in the blood drops resulting from other medications or diseases, hormone or enzyme deficiencies. Glucagon stimulates glycogen breakdown in the liver, and facilitates glucose release to raise blood glucose levels to a normal range. In addition to the effect of increasing the blood glucose level, glucagon suppresses appetite and activates hormone-sensitive lipase(HSL) of adipocytes to facilitate lipolysis, thereby showing anti-obesity effects. One of the glucagon derivatives, glucagon like peptide-1 (GLP-1) is under development as a therapeutic agent for hyperglycemia in patients with diabetes, and it functions to stimulate insulin synthesis and secretion, to inhibit glucagon secretion, to slow gastric emptying, to increase glucose utilization, and to inhibit food intake. Exendin-4 is isolated from lizard venom that shares approximately 50% amino acid homology with GLP-1 and is also reported to activate the GLP-1 receptor, thereby ameliorating hyperglycemia in patients with diabetes. However, anti-obesity drugs including GLP-1 are reported to show side-effects such as vomiting and nausea.

[8] As an alternative to GLP-1, therefore, much attention has been focused on oxyntomodulin, a peptide derived from a glucagon precursor, pre-glucagon that binds to the receptors of two peptides, GLP-1 and glucagon. Oxyntomodulin represents a potent anti-obesity therapy, because it inhibits food intake like GLP-1, promotes satiety, and has a lipolytic activity like glucagon.

[9] Based on the dual function of the oxyntomodulin peptide, it has been actively studied as a drug for the treatment of obesity. For example, Korean Patent No. 925017 discloses a pharmaceutical composition including oxyntomodulin as an active ingredient for the treatment of overweight human, which is administered via an oral, parenteral, mucosal, rectal, subcutaneous, or transdermal route. However, it has been reported that this anti-obesity drug including oxyntomodulin has a short in vivo half-life and weak therapeutic efficacy, even though administered at a high dose three times a day. Thus, many efforts have been made to improve the in vivo half-life or therapeutic effect of oxyntomodulin on obesity by its modification.

[10] For example, a dual agonist oxyntomodulin (Merck) is prepared by substituting L-

serine with D-serine at position 2 of oxyntomodulin to increase a resistance to dipeptidyl peptidase-IV (DPP-IV) and by attaching a cholesterol moiety at the C-terminal to increase the blood half-life at the same time. ZP2929 (Zealand) is prepared by substituting L-serine with D-serine at position 2 to enhance resistance to DPP-IV, substituting arginine with alanine at position 17 to enhance resistance to protease, substituting methionine with lysine at position 27 to enhance oxidative stability, and substituting glutamine with aspartic acid and alanine at positions 20 and 24 and asparagine with serine at position 28 to enhance deamidation stability. However, even though the half-life of the dual agonist oxyntomodulin (Merck) was enhanced to show half-life 8~12 minutes longer than the native oxyntomodulin, it still has a very short in vivo half-life of 1.7 hr and its administration dose is also as high as several mg/kg. Unfortunately, oxyntomodulin or derivatives thereof have disadvantages of daily administration of high dose due to the short half-life and low efficacy.

[11]

Disclosure of Invention

Technical Problem

[12] Accordingly, the present inventors have made many efforts to develop a method for increasing the blood half-life of oxyntomodulin while maintaining its activity in vivo. As a result, they found that a conjugate prepared by linking a carrier to oxyntomodulin using a non-peptidyl polymer show improved blood half-life while maintaining the activity in vivo so as to exhibit excellent anti-obesity effects, thereby completing the present invention.

[13]

Solution to Problem

[14] An object of the present invention is to provide a conjugate comprising oxyntomodulin, an immunoglobulin Fc region, and non-peptidyl polymer wherein the conjugate being obtainable by covalently linking oxyntomodulin to immunoglobulin Fc region via non-peptidyl polymer.

[15] Another object of the present invention is to provide a pharmaceutical composition for the prevention or treatment of obesity, comprising the conjugates.

[16] Still another object of the present invention is to provide a method for preventing or treating obesity, comprising the step of administering the conjugate or the composition to a subject.

[17] Still another object of the present invention is to provide use of the conjugate or the composition in the preparation of drugs for the prevention or treatment of obesity.

[18]

Advantageous Effects of Invention

[19] The conjugate comprising oxyntomodulin and the immunoglobulin Fc of the present invention reduces food intake, suppresses gastric emptying, and facilitates lipolysis without side-effects, unlike native oxyntomodulin, and also shows excellent receptor-activating effects and long-term sustainability, compared to oxyntomodulin. Thus, it can be widely used in the treatment of obesity with safety and efficacy. Unlike native oxyntomodulin, the novel peptide of the present invention reduces food intake, suppresses gastric emptying, and facilitates lipolysis without side-effects, and also shows excellent receptor-activating effects. Thus, it can be widely used in the treatment of obesity with safety and efficacy.

[20]

Brief Description of Drawings

[21] FIG. 1 is a graph showing changes in food intake according to administration dose of oxyntomodulin or oxyntomodulin derivative.

[22] FIG. 2a is a graph showing the result of purifying mono-PEGylated oxyntomodulin through a SOURCE S purification column.

[23] FIG. 2b is a graph showing the result of peptide mapping of purified mono-PEGylated oxyntomodulin.

[24] FIG. 2c is a graph showing the result of purifying conjugates including oxyntomodulin and immunoglobulin Fc through a SOURCE 15Q purification column.

[25] FIG. 3a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 29) through a SOURCE S purification column.

[26] FIG. 3b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 29) and immunoglobulin Fc through a SOURCE 15Q purification column.

[27] FIG. 4a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 30) through a SOURCE S purification column.

[28] FIG. 4b is a graph showing the result of peptide mapping of purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 30).

[29] FIG. 4c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 30) and immunoglobulin Fc through a SOURCE 15Q purification column.

[30] FIG. 5a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 31) through a SOURCE S purification column.

[31] FIG. 5b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 31) and immunoglobulin Fc through a SOURCE 15Q purification column.

[32] FIG. 6a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin

derivative (SEQ ID NO. 2) through a SOURCE S purification column.

[33] FIG. 6b is a graph showing the result of peptide mapping of purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 2).

[34] FIG. 6c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 2) and immunoglobulin Fc through a SOURCE 15Q purification column.

[35] FIG. 6d is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 2) and immunoglobulin Fc through a Source ISO purification column.

[36] FIG. 7a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 3) through a SOURCE S purification column.

[37] FIG. 7b is a graph showing the result of peptide mapping of purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 3).

[38] FIG. 7c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 3) and immunoglobulin Fc through a Butyl FF purification column.

[39] FIG. 7d is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 3) and immunoglobulin Fc through a Source 15Q purification column.

[40] FIG. 8a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 23) through a SOURCE S purification column;

[41] FIG. 8b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 23) and immunoglobulin Fc through a Source 15Q purification column;

[42] FIG. 8c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 23) and immunoglobulin Fc through a SOURCE ISO purification column;

[43] FIG. 9a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 24) through a SOURCE S purification column;

[44] FIG. 9b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 24) and immunoglobulin Fc through a Source 15Q purification column;

[45] FIG. 9c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 24) and immunoglobulin Fc through a SOURCE ISO purification column;

[46] FIG. 10a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 25) through a SOURCE S purification column;

[47] FIG. 10b is a graph showing the result of purifying conjugates including oxyn-

tomodulin derivative (SEQ ID NO. 25) and immunoglobulin Fc through a Source 15Q purification column;

[48] FIG. 10c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 25) and immunoglobulin Fc through a SOURCE ISO purification column;

[49] FIG. 11a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 28) through a SOURCE S purification column;

[50] FIG. 11b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 28) and immunoglobulin Fc through a Source 15Q purification column;

[51] FIG. 11c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 28) and immunoglobulin Fc through a SOURCE ISO purification column;

[52] FIG. 12 is a graph showing changes in body weight of mice according to the type and administration dose of oxyntomodulin derivative-immunoglobulin Fc conjugates.

[53] FIG. 13 is a graph showing changes in body weight of mice according to the type and administration dose of oxyntomodulin derivative-immunoglobulin Fc conjugates.

[54]

Best Mode for Carrying out the Invention

[55] In one aspect to achieve the above objects, the present invention provides a conjugate comprising oxyntomodulin, an immunoglobulin Fc region, and non-peptidyl polymer wherein the conjugate being obtainable by covalently linking oxyntomodulin to immunoglobulin Fc region via non-peptidyl polymer.

[56]

[57] As used herein, the term "conjugate" means a conjugate comprising oxyntomodulin and other factors. Other factors can be any substance which can induce increased stability in blood, suspend emission through the kidney, or other useful effects. In the present invention, the factors can be immunoglobulin Fc region. Preferably, the conjugate can be comprised of an oxyntomodulin, and an immunoglobulin Fc region, which are linked by a non-peptidyl polymer. The non-peptidyl polymer can link an oxyntomodulin and an immunoglobulin Fc region via covalent bonds. Two terminal ends of non-peptidyl polymer can be linked to an amine group or thiol group of the immunoglobulin Fc region and oxyntomodulin derivatives, respectively.

[58] The conjugate of the present invention means to have an improved in-vivo duration of efficacy, compared to native oxyntomodulin, and the long-acting conjugate may include oxyntomodulin prepared by modification, substitution, addition, or deletion of the amino acid sequences of the native oxyntomodulin, oxyntomodulin conjugated to a

biodegradable polymer such as polyethylene glycol (PEG), oxyntomodulin conjugated to a long-acting protein such as albumin or immunoglobulin, oxyntomodulin conjugated to fatty acid having the ability of binding to albumin in the body, or oxyntomodulin encapsulated in biodegradable nanoparticles, but the type of the long-acting conjugate is not limited thereto.

[59]

[60] As used herein, the term "oxyntomodulin" means a peptide derived from a glucagon precursor, pre-glucagon, and includes a native oxyntomodulin, precursors, derivatives, fragments thereof, and variants thereof. Preferably, it can have the amino acid sequence of SEQ ID NO. 1 (HSQGTFTSDYSKYLDSRRAQDFVQWLMNTKRNRNNIA).

[61] The term, "oxyntomodulin variant" is a peptide having one or more amino acid sequences different from those of native oxyntomodulin, and means a peptide that retains the function of activating the GLP-1 and glucagon receptors, and it may be prepared by any one of substitution, addition, deletion, and modification or by a combination thereof in a part of the amino acid sequences of the native oxyntomodulin.

[62] The term, "oxyntomodulin derivative" includes peptides, peptide derivatives or peptide mimetics that are prepared by addition, deletion or substitution of amino acids of oxyntomodulin so as to activate both of the GLP-1 receptor and the glucagon receptor at a high level, compared to the native oxyntomodulin.

[63] The term, "oxyntomodulin fragment means a fragment having one or more amino acids added or deleted at the N-terminus or the C-terminus of the native oxyntomodulin, in which non-naturally occurring amino acids (for example, D-type amino acid) can be added, and has a function of activating both of the GLP-1 receptor and the glucagon receptor.

[64] Each of the preparation methods for the variants, derivatives, and fragments of oxyntomodulin can be used individually or in combination. For example, the present invention includes a peptide that has one or more amino acids different from those of native peptide and deamination of the N-terminal amino acid residue, and has a function of activating both of the GLP-1 receptor and the glucagon receptor.

[65]

[66] Amino acids mentioned herein are abbreviated according to the nomenclature rule of IUPAC-IUB as follows:

[67]

[68] Alanine A Arginine R

[69] Asparagine N Aspartic acid D

[70] Cysteine C Glutamic acid E

[71] Glutamine Q Glycine G

[72] Histidine H Isoleucine I

[73] Leucine L Lysine K

[74] Methionine M Phenylalanine F

[75] Proline P Serine S

[76] Threonine T Tryptophan W

[77] Tyrosine Y Valine V

[78]

[79] In the present invention, the oxyntomodulin derivative encompasses any peptide that is prepared by substitutions, additions, deletions or post translational modifications (e.g., methylation, acylation, ubiquitination, intramolecular covalent bonding) in the amino acid sequence of oxyntomodulin (HSQGTFTSDYSKYLDSRRAQDFVQWLMNTKRNRNNIA, SEQ ID NO. 1) so as to activate the glucagon and GLP-1 receptors at the same time. Upon substitution or addition of amino acids, any of the 20 amino acids commonly found in human proteins, as well as atypical or non-naturally occurring amino acids can be used. Commercially available sources of atypical amino acids include Sigma-Aldrich, ChemPep Inc., and Genzyme Pharmaceuticals. The peptides including these amino acids and atypical peptide sequences may be synthesized and purchased from commercial suppliers, for example, American Peptide Company or Bachem (USA) or Anygen (Korea).

[80]

[81] In one specific embodiment, the oxyntomodulin derivative of the present invention is a novel peptide including the amino acids of the following Formula 1.

[82]

[83] R1-X1-X2-GTFTSD-X3-X4-X5-X6-X7-X8-X9-X10-X11-X12-X13-X14-X15-X16-X17-X18-X19-X20-X21-X22-X23-X24-R2 (Formula 1)

[84] wherein R1 is histidine, desamino-histidyl, dimethyl-histidyl (N-dimethyl-histidyl), beta-hydroxyimidazopropionyl, 4-imidazoacetyl, beta-carboxy imidazopropionyl or tyrosine;

[85] X1 is Aib(aminosiobutyric acid), d-alanine, glycine, Sar(N-methylglycine), serine, or d-serine;

[86] X2 is glutamic acid or glutamine;

[87] X3 is leucine or tyrosine;

[88] X4 is serine or alanine;

[89] X5 is lysine or arginine;

[90] X6 is glutamine or tyrosine;

[91] X7 is leucine or methionine;

[92] X8 is aspartic acid or glutamic acid;

[93] X9 is glutamic acid, serine, alpha-methyl-glutamic acid or is deleted;

[94] X10 is glutamine, glutamic acid, lysine, arginine, serine or is deleted;

[95] X11 is alanine, arginine, valine or is deleted;

[96] X12 is alanine, arginine, serine, valine or is deleted;

[97] X13 is lysine, glutamine, arginine, alpha-methyl-glutamic acid or is deleted;

[98] X14 is aspartic acid, glutamic acid, leucine or is deleted;

[99] X15 is phenylalanine or is deleted;

[100] X16 is isoleucine, valine or is deleted;

[101] X17 is alanine, cysteine, glutamic acid, lysine, glutamine, alpha-methyl-glutamic acid or is deleted;

[102] X18 is tryptophan or is deleted;

[103] X19 is alanine, isoleucine, leucine, serine, valine or is deleted;

[104] X20 is alanine, lysine, methionine, glutamine, arginine or is deleted;

[105] X21 is asparagine or is deleted;

[106] X22 is alanine, glycine, threonine or is deleted;

[107] X23 is cysteine, lysine or is deleted;

[108] X24 is a peptide having 2 to 10 amino acids consisting of combinations of alanine, glycine and serine, or is deleted; and

[109] R2 is KRNRNNIA (SEQ ID NO. 35), GPSSGAPPPS (SEQ ID NO. 36), GPSSGAPPPSK (SEQ ID NO. 37), HSQGTFTSDYSKYLD (SEQ ID NO. 38), HSQGTFTSDYSRYLDK (SEQ ID NO. 39), HGEGTFTSDLSKQMEEEAVK (SEQ ID NO. 40) or is deleted (excluded if the amino acid sequence of Formula 1 is identical to that of SEQ ID NO. 1).

[110]

[111] In order to enhance the activity of the wild-type oxyntomodulin for the glucagon receptor and the GLP-1 receptor, the peptide of the present invention may be substituted with 4-imidazoacetyl where the alpha carbon of histidine at position 1 of amino acid sequence represented by SEQ ID NO. 1 is deleted, desamino-histidyl where the N-terminal amino group is deleted, dimethyl-histidyl (N-dimethyl-histidyl) where the N-terminal amino group is modified with two methyl groups, beta-hydroxy imidazopropionyl where the N-terminal amino group is substituted with a hydroxyl group, or beta-carboxy imidazopropionyl where the N-terminal amino group is substituted with a carboxyl group. In addition, the GLP-1 receptor-binding region may be substituted with amino acids that enhance hydrophobic and ionic bonds or combinations thereof. A part of the oxyntomodulin sequence may be substituted with the amino acid sequence of GLP-1 or Exendin-4 to enhance the activity on GLP-1 receptor.

[112] Further, a part of the oxyntomodulin sequence may be substituted with a sequence stabilizing alpha helix. Preferably, amino acids at positions 10, 14, 16, 20, 24 and 28 of

the amino acid sequence of Formula 1 may be substituted with amino acids or amino acid derivatives consisting of Tyr(4-Me), Phe, Phe(4-Me), Phe(4-Cl), Phe(4-CN), Phe(4-NO_2), Phe(4-NH_2), Phg, Pal, Nal, Ala(2-thienyl) and Ala(benzothienyl) that are known to stabilize alpha helix, and there are no limitations on the type and number of alpha helix-stabilizing amino acid or amino acid derivatives to be inserted. Preferably, amino acids at positions 10 and 14, 12 and 16, 16 and 20, 20 and 24, and 24 and 28 may be also substituted with glutamic acid or lysine, respectively so as to form rings, and there is no limitation on the number of rings to be inserted. Most preferably, the peptide may be a peptide having an amino acid sequence selected from the following Formulae 1 to 6.

[113]

[114] In one specific embodiment, the oxyntomodulin derivative of the present invention is a novel peptide including the amino acid sequence of the following Formula 2 where the amino acid sequence of oxyntomodulin is substituted with that of exendin or GLP-1.

[115]

[116] R1-A-R3 (Formula 2)

[117]

[118] In another specific embodiment, the oxyntomodulin derivative of the present invention is a novel peptide including the amino acid sequence of the following Formula 3, which is prepared by linking a part of the amino acid sequence of oxyntomodulin and a part of the amino acid sequence of exendin or GLP-1 via a proper amino acid linker.

[119]

[120] R1-B-C-R4 (Formula 3)

[121]

[122] In still another specific embodiment, the oxyntomodulin derivative of the present invention is a novel peptide including the amino acid sequence of the following Formula 4, wherein a part of the amino acid sequence of oxyntomodulin is substituted with an amino acid capable of enhancing the binding affinity to GLP-1 receptor, for example, Leu at position 26 which binds with GLP-1 receptor by hydrophobic interaction is substituted with the hydrophobic residue, Ile or Val.

[123]

[124] R1-SQGTFTSDYSKYLD-D1-D2-D3-D4-D5-LFVQW-D6-D7-N-D8-R3 (Formula 4)

[125]

[126] In still another specific embodiment, the oxyntomodulin derivative of the present invention is a novel peptide including the following Formula 5, wherein a part of the

amino acid sequence is deleted, added, or substituted with other amino acid in order to enhance the activities of native oxyntomodulin on GLP-1 receptor and glucagon receptor.

[127]

[128] R1-E1-QGTFTSDYSKYLD-E2-E3-RA-E4-E5-FV-E6-WLMNT-E7-R5 (Formula 5)

[129]

[130] In Formulae 2 to 5, R1 is the same as in the description of Formula 1;

[131] A is selected from the group consisting of SQGTFTSDYSKYLDSRRAQD-FVQWLMNT (SEQ ID NO. 41), SQGTFTSDYSKYLDEEAVRLFIEWLMNT (SEQ ID NO. 42), SQGTFTSDYSKYLDERRAQDFVAWLKNT (SEQ ID NO. 43), GQGTFTSDYSRYLEEEAVRLFIEWLKNG (SEQ ID NO. 44), GQGTFTSDYS-RQMEEEAVRLFIEWLKNG (SEQ ID NO. 45), GEGTFTSDL-SRQMEEEAVRLFIEWAA (SEQ ID NO. 46), and SQGTFTSDYSRQMEEEAVRL-FIEWLMNG (SEQ ID NO. 47);

[132] B is selected from the group consisting of SQGTFTSDYSKYLDSRRAQD-FVQWLMNT (SEQ ID NO. 41), SQGTFTSDYSKYLDEEAVRLFIEWLMNT (SEQ ID NO. 42), SQGTFTSDYSKYLDERRAQDFVAWLKNT (SEQ ID NO. 43), GQGTFTSDYSRYLEEEAVRLFIEWLKNG (SEQ ID NO. 44), GQGTFTSDYS-RQMEEEAVRLFIEWLKNG (SEQ ID NO. 45), GEGTFTSDL-SRQMEEEAVRLFIEWAA (SEQ ID NO. 46), SQGTFTSDYSRQMEEEAVRL-FIEWLMNG (SEQ ID NO. 47), GEGTFTSDLSRQMEEEAVRLFIEW (SEQ ID NO. 48), and SQGTFTSDYSRYLD (SEQ ID NO. 49);

[133] C is a peptide having 2 to 10 amino acids consisting of combinations of alanine, glycine and serine;

[134] D1 is serine, glutamic acid or arginine;

[135] D2 is arginine, glutamic acid or serine;

[136] D3 is arginine, alanine or valine;

[137] D4 is arginine, valine or serine;

[138] D5 is glutamine, arginine or lysine;

[139] D6 is isoleucine, valine or serine;

[140] D7 is methionine, arginine or glutamine;

[141] D8 is threonine, glycine or alanine;

[142] E1 is serine, Aib, Sar, d-alanine or d-serine;

[143] E2 is serine or glutamic acid;

[144] E3 is arginine or lysine;

[145] E4 is glutamine or lysine;

[146] E5 is aspartic acid or glutamic acid;

[147] E6 is glutamine, cysteine or lysine;

[148] E7 is cysteine, lysine or is deleted;

[149] R3 is KRNRNNIA (SEQ ID NO. 35), GPSSGAPPPS (SEQ ID NO. 36) or GPSSGAPPPSK (SEQ ID NO. 37);

[150] R4 is HSQGTFTSDYSKYLD (SEQ ID NO. 38), HSQGTFTSDYSRYLDK (SEQ ID NO. 39) or HGEGTFTSDLSKQMEEEAVK (SEQ ID NO. 40); and,

[151] R5 is KRNRNNIA (SEQ ID NO. 35), GPSSGAPPPS (SEQ ID NO. 36), GPSSGAPPPSK (SEQ ID NO. 37) or is deleted (excluded if the amino acid sequences of Formulae 2 to 5 are identical to that of SEQ ID NO. 1).

[152]

[153] Preferably, the oxyntomodulin derivative of the present invention may be a noverl peptide of the following Formula 6.

[154]

[155] R1-X1-X2-GTFTSD-X3-X4-X5-X6-X7-X8-X9-X10-X11-X12-X13-X14-X15-X16-X17-X18-X19-X20-X21-X22-X23-X24-R2 (Formula 6)

[156]

[157] wherein R1 is histidine, desamino-histidyl, 4-imidazoacetyl or tyrosine;

[158] X1 is Aib(aminosiobutyric acid), glycine or serine;

[159] X2 is glutamic acid or glutamine;

[160] X3 is leucine or tyrosine;

[161] X4 is serine or alanine;

[162] X5 is lysine or arginine;

[163] X6 is glutamine or tyrosine;

[164] X7 is leucine or methionine;

[165] X8 is aspartic acid or glutamic acid;

[166] X9 is glutamic acid, alpha-methyl-glutamic acid or is deleted;

[167] X10 is glutamine, glutamic acid, lysine, arginine or is deleted;

[168] X11 is alanine, arginine or is deleted;

[169] X12 is alanine, valine or is deleted;

[170] X13 is lysine, glutamine, arginine, alpha-methyl-glutamic acid or is deleted;

[171] X14 is aspartic acid, glutamic acid, leucine or is deleted;

[172] X15 is phenylalanine or is deleted;

[173] X16 is isoleucine, valine or is deleted;

[174] X17 is alanine, cysteine, glutamic acid, glutamine, alpha-methyl-glutamic acid or is deleted;

[175] X18 is tryptophan or is deleted;

[176] X19 is alanine, isoleucine, leucine, valine or is deleted;

[177] X20 is alanine, lysine, methionine, arginine or is deleted;

[178] X21 is asparagine or is deleted;

[179] X22 is threonine or is deleted;

[180] X23 is cysteine, lysine or is deleted;

[181] X24 is a peptide having 2 to 10 amino acids consisting of glycine or is deleted; and

[182] R2 is KRNRNNIA (SEQ ID NO. 35), GPSSGAPPPS (SEQ ID NO. 36), GPSSGAPPPSK (SEQ ID NO. 37), HSQGTFTSDYSKYLD (SEQ ID NO. 38), HSQGTFTSDYSRYLDK (SEQ ID NO. 39), HGEGTFTSDLSKQMEEEAVK (SEQ ID NO. 40) or is deleted (excluded if the amino acid sequence of Formula 6 is identical to that of SEQ ID NO. 1)

[183]

[184] More preferably, the oxyntomodulin derivative of the present invention may be selected from the group consisting of the peptides of SEQ ID NOs. 2 to 34. Much more preferably, the oxyntomodulin derivative of the present invention may be an oxyntomodulin derivative described in Table 1 of Example 2-1.

[185]

[186] Oxyntomodulin has the activities of two peptides, GLP-1 and glucagon. GLP-1 decreases blood glucose, reduces food intake, and suppresses gastric emptying, and glucagon increases blood glucose, facilitate lipolysis and decreases body-weight by increasing energy metabolisms. The different biological effects of the two peptides can cause undesired effects like increasing blood glucose if glucagon shows a more dominant effect than GLP-1, or causing nausea and vomiting if GLP-1 shows more dominant effect than glucagon. For example, the conjugate that was produced in Example 10 below showed greater affinity to GLP-1 receptor than the one produced in Example 12, but the efficacy of the former was lower than the latter as shown in the in vivo experiment in Example 18. This might be due to the increased efficacy of the conjugates in relation to the glucagon receptor in Example 12 inspite of its low efficacy in relation to the GLP-1 receptor. Therefore, the oxyntomodulin derivatives and their conjugates of the present invention are not limited to those derivatives which show for unconditional increase of activities. For example, the amino acids can be modified at positions 1 and 11 of oxyntomodulin, which are known to suppress the activity of glucagon, to control the activity ratio between glucagon and GLP-1.

[187]

[188] The conjugates of the present invention can induce increased stability in blood, suspend emission through the kidney, and change affinity to receptors by linking a carrier to oxyntomodulin via a covalent bond or forming microsphere. The carrier that can form a conjugate containing oxyntomodulin can be selected from the group consisting of albumin, transferrin, antibodies, antibody frangments, elastin, heparin, polysaccharide such as chitin, fibronectin and most favorably immunoglobulin Fc region , all of which can increase the blood half-life of the conjugates when bound to

oxyntomodulin.

[189]

[190] The term "immunoglobulin Fc region" as used herein, refers to a protein that contains the heavy-chain constant region 2 (CH2) and the heavy-chain constant region 3 (CH3) of an immunoglobulin, excluding the variable regions of the heavy and light chains, the heavy-chain constant region 1 (CH1) and the light-chain constant region 1 (CL1) of the immunoglobulin. It may further include a hinge region at the heavy-chain constant region. Also, the immunoglobulin Fc region of the present invention may contain a part or all of the Fc region including the heavy-chain constant region 1 (CH1) and/or the light-chain constant region 1 (CL1), except for the variable regions of the heavy and light chains, as long as it has a physiological function substantially similar to or better than the native protein. Also, the immunoglobulin Fc region may be a fragment having a deletion in a relatively long portion of the amino acid sequence of CH2 and/or CH3. That is, the immunoglobulin Fc region of the present invention may comprise 1) a CH1 domain, a CH2 domain, a CH3 domain and a CH4 domain, 2) a CH1 domain and a CH2 domain, 3) a CH1 domain and a CH3 domain, 4) a CH2 domain and a CH3 domain, 5) a combination of one or more domains and an immunoglobulin hinge region (or a portion of the hinge region), and 6) a dimer of each domain of the heavy-chain constant regions and the light-chain constant region.

[191] The immunoglobulin Fc region of the present invention includes a native amino acid sequence, and a sequence derivative (mutant) thereof. An amino acid sequence derivative is a sequence that is different from the native amino acid sequence due to a deletion, an insertion, a non-conservative or conservative substitution or combinations thereof of one or more amino acid residues. For example, in an IgG Fc, amino acid residues known to be important in binding, at positions 214 to 238, 297 to 299, 318 to 322, or 327 to 331, may be used as a suitable target for modification.

[192] Also, other various derivatives are possible, including one in which a region capable of forming a disulfide bond is deleted, or certain amino acid residues are eliminated at the N-terminal end of a native Fc form or a methionine residue is added thereto. Further, to remove effector functions, a deletion may occur in a complement-binding site, such as a C1q-binding site and an ADCC (antibody dependent cell mediated cytotoxicity) site. Techniques of preparing such sequence derivatives of the immunoglobulin Fc region are disclosed in WO 97/34631 and WO 96/32478.

[193] Amino acid exchanges in proteins and peptides, which do not generally alter the activity of the proteins or peptides, are known in the art (H. Neurath, R. L. Hill, The Proteins, Academic Press, New York, 1979). The most commonly occurring exchanges are Ala/Ser, Val/Ile, Asp/Glu, Thr/Ser, Ala/Gly, Ala/Thr, Ser/Asn, Ala/Val, Ser/Gly, Thy/Phe, Ala/Pro, Lys/Arg, Asp/Asn, Leu/Ile, Leu/Val, Ala/Glu and Asp/Gly, in both

directions. In addition, the Fc region, if desired, may be modified by phosphorylation, sulfation, acrylation, glycosylation, methylation, farnesylation, acetylation, amidation, and the like.

[194] The aforementioned Fc derivatives are derivatives that have a biological activity identical to the Fc region of the present invention or improved structural stability, for example, against heat, pH, or the like.

[195]

[196] In addition, these Fc regions may be obtained from native forms isolated from humans and other animals including cows, goats, pigs, mice, rabbits, hamsters, rats and guinea pigs, or may be recombinants or derivatives thereof, obtained from transformed animal cells or microorganisms. Herein, they may be obtained from a native immunoglobulin by isolating whole immunoglobulins from human or animal organisms and treating them with a proteolytic enzyme. Papain digests the native immunoglobulin into Fab and Fc regions, and pepsin treatment results in the production of pF'c and F(ab)2 fragments. These fragments may be subjected, for example, to size exclusion chromatography to isolate Fc or pF'c. Preferably, a human-derived Fc region is a recombinant immunoglobulin Fc region that is obtained from a microorganism.

[197] In addition, the immunoglobulin Fc region of the present invention may be in the form of having native sugar chains, increased sugar chains compared to a native form or decreased sugar chains compared to the native form, or may be in a deglycosylated form. The increase, decrease or removal of the immunoglobulin Fc sugar chains may be achieved by methods common in the art, such as a chemical method, an enzymatic method and a genetic engineering method using a microorganism. The removal of sugar chains from an Fc region results in a sharp decrease in binding affinity to the C1q part of the first complement component C1 and a decrease or loss in antibody-dependent cell-mediated cytotoxicity or complement-dependent cytotoxicity, thereby not inducing unnecessary immune responses in-vivo. In this regard, an immunoglobulin Fc region in a deglycosylated or aglycosylated form may be more suitable to the object of the present invention as a drug carrier.

[198] As used herein, the term "deglycosylation" refers to enzymatically removing sugar moieties from an Fc region, and the term "aglycosylation" means that an Fc region is produced in an unglycosylated form by a prokaryote, preferably E. coli.

[199] Meanwhile, the immunoglobulin Fc region may be derived from humans or other animals including cows, goats, pigs, mice, rabbits, hamsters, rats and guinea pigs, and preferably from humans.

[200] In addition, the immunoglobulin Fc region may be an Fc region that is derived from IgG, IgA, IgD, IgE and IgM, or that is made by combinations thereof or hybrids thereof. Preferably, it is derived from IgG or IgM, which are among the most abundant

proteins in human blood, and most preferably from IgG, which is known to enhance the half-lives of ligand-binding proteins.

[201] On the other hand, the term "combination", as used herein, means that polypeptides encoding single-chain immunoglobulin Fc regions of the same origin are linked to a single-chain polypeptide of a different origin to form a dimer or multimer. That is, a dimer or multimer may be formed from two or more fragments selected from the group consisting of IgG Fc, IgA Fc, IgM Fc, IgD Fc, and IgE Fc fragments.

[202]

[203] The term "non-peptidyl polymer", refers to a biocompatible polymer including two or more repeating units linked to each other by any covalent bond excluding a peptide bond. In the present invention, the non-peptidyl polymer may be interchangeably used with the non-peptidyl linker.

[204] The non-peptidyl polymer useful in the present invention may be selected from the group consisting of a biodegradable polymer, a lipid polymer, chitin, hyaluronic acid, and a combination thereof, and preferably, the biodegradable polymer may be polyethylene glycol, polypropylene glycol, ethylene glycol-propylene glycol copolymer, polyoxyethylated polyol, polyvinyl alcohol, polysaccharide, dextran, polyvinyl ethyl ether, polylactic acid (PLA) or polylactic-glycolic acid (PLGA), and more preferably, is polyethylene glycol (PEG). In addition, derivatives thereof known in the art and derivatives easily prepared by a method known in the art may be included in the scope of the present invention.

[205] The peptide linker which is used in the fusion protein obtained by a conventional inframe fusion method has drawbacks in that it is easily in-vivo cleaved by a proteolytic enzyme, and thus a sufficient effect of increasing the serum half-life of the active drug by a carrier cannot be obtained as expected. However, in the present invention, the polymer having resistance to the proteolytic enzyme can be used to maintain the serum half-life of the peptide being similar to that of the carrier. Therefore, any non-peptidyl polymer can be used without limitation, as long as it is a polymer having the aforementioned function, that is, a polymer having resistance to the in-vivo proteolytic enzyme. The non-peptidyl polymer has a molecular weight in the range of 1 to 100 kDa, and preferably of 1 to 20 kDa. The non-peptidyl polymer of the present invention, linked to the immunoglobulin Fc region, may be one polymer or a combination of different types of polymers.

[206] The non-peptidyl polymer used in the present invention has a reactive group capable of binding to the immunoglobulin Fc region and protein drug. The non-peptidyl polymer has a reactive group at both ends, which is preferably selected from the group consisting of a reactive aldehyde, a propionaldehyde, a butyraldehyde, a maleimide and a succinimide derivative. The succinimide derivative may be succinimidyl

propionate, hydroxy succinimidyl, succinimidyl carboxymethyl, or succinimidyl carbonate. In particular, when the non-peptidyl polymer has a reactive aldehyde group at both ends thereof, it is effective in linking at both ends with a physiologically active polypeptide and an immunoglobulin with minimal non-specific reactions. A final product generated by reductive alkylation by an aldehyde bond is much more stable than that linked by an amide bond. The aldehyde reactive group selectively binds to an N-terminus at a low pH, and binds to a lysine residue to form a covalent bond at a high pH, such as pH 9.0. The reactive groups at both ends of the non-peptidyl polymer may be the same or different. For example, the non-peptidyl polymer may possess a maleimide group at one end, and an aldehyde group, a propionaldehyde group or a butyraldehyde group at the other end. When a polyethylene glycol having a reactive hydroxy group at both ends thereof is used as the non-peptidyl polymer, the hydroxy group may be activated to various reactive groups by known chemical reactions, or a polyethylene glycol having a commercially available modified reactive group may be used so as to prepare the long acting conjugate of the present invention.

[207]

[208] The conjugate of the present invention, can be which both ends of the non-peptidyl polymer having two reactive terminal groups are linked to an amine group or thiol group of the immunoglobulin Fc region and oxyntomodulin derivatives, respectively.

[209]

[210] The non-peptidyl polymer has a reactive group at both ends, which is preferably selected from the group consisting of a reactive aldehyde group, a propionaldehyde group, a butyraldehyde group, a maleimide group and a succinimide derivative. The succinimide derivative may be succinimidyl propionate, hydroxy succinimidyl, succinimidyl carboxymethyl, or succinimidyl carbonate.

[211] The two reactive terminal groups of the non-peptidyl polymer may be the same as or different from each other. For example, the non-peptide polymer may possess a maleimide group at one end and an aldehyde group, a propionaldehyde group or a butyraldehyde group at the other end. For example, when the non-peptidyl polymer has a reactive aldehyde group at a terminal group, and a maleimide group at the other terminal group, it is effective in linking at both ends with a physiologically active polypeptide and an immunoglobulin with minimal non-specific reactions. According to Examples of the present invention, conjugates were prepared by linking the oxyntomodulin or derivative thereof and the immunoglobulin Fc region via a covalent bond using PEG that is a non-peptidyl polymer including the propionaldehyde group alone or both the maleimides group and the aldehyde group.

[212]

[213] The conjugates of the present invention show excellent activity on GLP-1 receptor

and glucagon receptor, compared to native oxyntomodulin, and the blood half-life is increased by linking with the Fc region so as to maintain in vivo activity for a long period of time.

[214]

[215] In still another aspect, the present invention provides a pharmaceutical composition for the prevention or treatment of obesity comprising the peptide.

[216]

[217] As used herein, the term "prevention" means all of the actions by which the occurrence of the disease is restrained or retarded. In the present invention, "prevention" means that the occurrence of obesity from such factors as an increase in body weight or body fat is restrained or retarded by administration of the conjugates of the present invention.

[218] As used herein, the term "treatment" means all of the actions by which the symptoms of the disease have been alleviated, improved or ameliorated. In the present invention, "treatment" means that the symptoms of obesity are alleviated, improved or ameliorated by administration of the conjugates of the present invention, resulting in a reduction in body weight or body fat.

[219]

[220] As used herein, the term "obesity" implies accumulation of an excess amount of adipose tissue in the body, and a body mass index (body weight (kg) divided by the square of the height (m)) above 25 is to be regarded as obesity. Obesity is usually caused by an energy imbalance, when the amount of dietary intake exceeds the amount of energy expended for a long period of time. Obesity is a metabolic disease that affects the whole body, and increases the risk for diabetes, hyperlipidemia, sexual dysfunction, arthritis, and cardiovascular diseases, and in some cases, is associated with incidence of cancer.

[221]

[222] The conjugates of the present invention, which are prepared by linking oxyntomodulin or a derivative thereof with the immunoglobulin Fc region, show excellent binding affinity to glucagon and GLP-1 receptors (Table 3) and excellent resistance to in-vivo proteolytic enzymes so as to exhibit the in vivo activity for a long period of time, thereby showing excellent anti-obesity effects such as reductions in body weight (FIG. 12).

[223] The pharmaceutical composition of the present invention may further include a pharmaceutically acceptable carrier, excipient, or diluent. As used herein, the term "pharmaceutically acceptable" means that the composition is sufficient to achieve the therapeutic effects without deleterious side effects, and may be readily determined depending on the type of the diseases, the patient's age, body weight, health conditions,

gender, and drug sensitivity, administration route, administration mode, administration frequency, duration of treatment, drugs used in combination or coincident with the composition of this invention, and other factors known in medicine.

[224] The pharmaceutical composition including the derivative of the present invention may further include a pharmaceutically acceptable carrier. For oral administration, the carrier may include, but is not limited to, a binder, a lubricant, a disintegrant, an excipient, a solubilizer, a dispersing agent, a stabilizer, a suspending agent, a colorant, and a flavorant. For injectable preparations, the carrier may include a buffering agent, a preserving agent, an analgesic, a solubilizer, an isotonic agent, and a stabilizer. For preparations for topical administration, the carrier may include a base, an excipient, a lubricant, and a preserving agent.

[225] The composition of the present invention may be formulated into a variety of dosage forms in combination with the aforementioned pharmaceutically acceptable carriers. For example, for oral administration, the pharmaceutical composition may be formulated into tablets, troches, capsules, elixirs, suspensions, syrups or wafers. For injectable preparations, the pharmaceutical composition may be formulated into an ampule as a single dosage form or a multidose container. The pharmaceutical composition may also be formulated into solutions, suspensions, tablets, pills, capsules and long-acting preparations.

[226] On the other hand, examples of the carrier, the excipient, and the diluent suitable for the pharmaceutical formulations include lactose, dextrose, sucrose, sorbitol, mannitol, xylitol, erythritol, maltitol, starch, acacia rubber, alginate, gelatin, calcium phosphate, calcium silicate, cellulose, methylcellulose, microcrystalline cellulose, polyvinylpyrrolidone, water, methylhydroxybenzoate, propylhydroxybenzoate, talc, magnesium stearate and mineral oils. In addition, the pharmaceutical formulations may further include fillers, anti-coagulating agents, lubricants, humectants, flavorants, and antiseptics.

[227] Further, the pharmaceutical composition of the present invention may have any formulation selected from the group consisting of tablets, pills, powders, granules, capsules, suspensions, liquids for internal use, emulsions, syrups, sterile aqueous solutions, non-aqueous solvents, lyophilized formulations and suppositories.

[228] Further, the composition may be formulated into a single dosage form suitable for the patient's body, and preferably is formulated into a preparation useful for peptide drugs according to the typical method in the pharmaceutical field so as to be administered by an oral or parenteral route such as through skin, intravenous, intramuscular, intraarterial, intramedullary, intramedullary, intraventricular, pulmonary, transdermal, subcutaneous, intraperitoneal, intranasal, intracolonic, topical, sublingual, vaginal, or rectal administration, but is not limited thereto.

[229] The composition may be used by blending with a variety of pharmaceutically acceptable carriers such as physiological saline or organic solvents. In order to increase the stability or absorptivity, carbohydrates such as glucose, sucrose or dextrans, antioxidants such as ascorbic acid or glutathione, chelating agents, low molecular weight proteins or other stabilizers may be used.

[230]

[231] The administration dose and frequency of the pharmaceutical composition of the present invention are determined by the type of active ingredient, together with various factors such as the disease to be treated, administration route, patient's age, gender, and body weight, and disease severity.

[232] The total effective dose of the composition of the present invention may be administered to a patient in a single dose, or may be administered for a long period of time in multiple doses according to a fractionated treatment protocol. In the pharmaceutical composition of the present invention, the content of active ingredient may vary depending on the disease severity. Preferably, the total daily dose of the peptide of the present invention may be approximately 0.0001 ㎍ to 500 mg per 1 kg of body weight of a patient. However, the effective dose of the peptide is determined considering various factors including patient's age, body weight, health conditions, gender, disease severity, diet, and secretion rate, in addition to administration route and treatment frequency of the pharmaceutical composition. In view of this, those skilled in the art may easily determine an effective dose suitable for the particular use of the pharmaceutical composition of the present invention. The pharmaceutical composition according to the present invention is not particularly limited to the formulation, and administration route and mode, as long as it shows the effects of the present invention.

[233] The pharmaceutical composition of the present invention shows excellent in-vivo duration of efficacy and titer, thereby remarkably reducing the number and frequency of administration thereof.

[234] Moreover, the pharmaceutical composition may be administered alone or in combination or coincident with other pharmaceutical formulations showing prophylactic or therapeutic effects on obesity. The pharmaceutical formulations showing prophylactic or therapeutic effects on obesity are not particularly limited, and may include a GLP-1 receptor agonist, a leptin receptor agonist, a DPP-IV inhibitor, a Y5 receptor antagonist, a Melanin-concentrating hormone (MCH) receptor antagonist, a Y2/3 receptor agonist, a MC3/4 receptor agonist, a gastric/pancreatic lipase inhibitor, a 5HT2c agonist, a β3A receptor agonist, an Amylin receptor agonist, a Ghrelin antagonist, and/or a Ghrelin receptor antagonist.

[235]

[236] In still another aspect, the present invention provides a method for preventing or

treating obesity, comprising the step of administering to a subject the conjugate or the pharmaceutical composition including the same.

[237] As used herein, the term "administration" means introduction of an amount of a predetermined substance into a patient by a certain suitable method. The composition of the present invention may be administered via any of the common routes, as long as it is able to reach a desired tissue, for example, but is not limited to, intraperitoneal, intravenous, intramuscular, subcutaneous, intradermal, oral, topical, intranasal, intrapulmonary, or intrarectal administration. However, since peptides are digested upon oral administration, active ingredients of a composition for oral administration should be coated or formulated for protection against degradation in the stomach.

[238] In the present invention, the term "subject" is those suspected of having obesity, which means mammals including human, mouse, and livestock having obesity or having the possibility of obesity. However, any subject to be treated with the peptide or the pharmaceutical composition of the present invention is included without limitation. The pharmaceutical composition including the peptide of the present invention is administered to a subject suspected of having obesity, thereby treating the subject effectively. The obesity is as described above.

[239] The therapeutic method of the present invention may include the step of administering the composition including the peptide at a pharmaceutically effective amount. The total daily dose should be determined through appropriate medical judgment by a physician, and administered once or several times. With respect to the objects of the present invention, the specific therapeutically effective dose level for any particular patient may vary depending on various factors well known in the medical art, including the kind and degree of the response to be achieved, concrete compositions according to whether other agents are used therewith or not, the patient's age, body weight, health condition, gender, and diet, the time and route of administration, the secretion rate of the composition, the time period of therapy, other drugs used in combination or coincident with the composition of this invention, and like factors well known in the medical arts.

[240]

[241] In still another aspect, the present invention provides a use of the conjugate or the pharmaceutical composition including the same in the preparation of drugs for the prevention or treatment of obesity.

[242]

Mode for the Invention

[243] Hereinafter, the present invention will be described in more detail with reference to the following Examples. However, these Examples are for illustrative purposes only,

and the invention is not intended to be limited by these Examples.

[244]

[245] **Example 1. Production of in vitro activated cell line**

[246]

[247] **Example 1-1: Production of cell line showing cAMP response to GLP-1**

[248] PCR was performed using a region corresponding to ORF (Open Reading Frame) in cDNA (OriGene Technologies, Inc. USA) of human GLP-1 receptor gene as a template, and the following forward and reverse primers including each of the HindIII and EcoRI restriction sites so as to obtain a PCR product.

[249]

[250] Forward primer: 5'-CCCGGCCCCCGCGGCCGCTATTCGAAATAC-3'(SEQ ID NO. 47)

[251] Reverse primer: 5'-GAACGGTCCGGAGGACGTCGACTCTTAAGATAG-3'(SEQ ID NO. 48)

[252]

[253] The PCR product was cloned into the known animal cell expression vector x0GC/dhfr to prepare a recombinant vector x0GC/GLP1R.

[254] CHO DG44 cell line cultured in DMEM/F12 (10% FBS) medium was transfected with the recombinant vector x0GC/GLP1R using Lipofectamine (Invitrogen, USA), and cultured in a selection medium containing 1 mg/mL G418 and 10 nM methotraxate. Single clone cell lines were selected therefrom by a limit dilution technique, and a cell line showing excellent cAMP response to GLP-1 in a concentration-dependent manner was finally selected therefrom.

[255]

[256] **Example 1-2: Production of cell line showing cAMP response to glucagon**

[257] PCR was performed using a region corresponding to ORF in cDNA (OriGene Technologies, Inc. USA) of human glucagon receptor gene as a template, and the following forward and reverse primers including each of the EcoRI and XhoI restriction sites so as to obtain a PCR product.

[258]

[259] Forward primer: 5'-CAGCGACACCGACCGTCCCCCCGTACTTAAGGCC-3'(SEQ ID NO. 49)

[260] Reverse primer: 5'-CTAACCGACTCTCGGGGAAGACTGAGCTCGCC-3'(SEQ ID NO. 50)

[261]

[262] The PCR product was cloned into the known animal cell expression vector x0GC/dhfr to prepare a recombinant vector x0GC/GCGR.

[263] CHO DG44 cell line cultured in DMEM/F12 (10% FBS) medium was transfected

with the recombinant vector x0GC/GCGR using Lipofectamine, and cultured in a selection medium containing 1 mg/mL G418 and 10 nM methotraxate. Single clone cell lines were selected therefrom by a limit dilution technique, and a cell line showing excellent cAMP response to glucagon in a concentration-dependent manner was finally selected therefrom.

[264]

[265] **Example 2. Test on in vitro activity of oxyntomodulin derivatives**

[266]

[267] **Example 2-1: Synthesis of oxyntomodulin derivatives**

[268] In order to measure in vitro activities of oxyntomodulin derivatives, oxyntomodulin derivatives having the following amino acid sequences were synthesized (Table 1).

[269]

[270] Table 1

[Table 1]

Oxyntomodulin and oxyntomodulin derivatives

SEQ ID NO.	**Amino acid sequence**
SEQ ID NO. 1	HSQGTFTSDYSKYLDSRRAQDFVQWLMNTKRNRNNIA
SEQ ID NO. 2	CA-SQGTFTSDYSKYLDEEAVRLFIEWLMNTKRNRNNIA
SEQ ID NO. 3	CA-SQGTFTSDYSKYLDERRAQDFVAWLKNTGPSSGAPPP S
SEQ ID NO. 4	CA-GQGTFTSDYSRYLEEEAVRLFIEWLKNGGPSSGAPPPS
SEQ ID NO. 5	CA-GQGTFTSDYSRQMEEEAVRLFIEWLKNGGPSSGAPPP S
SEQ ID NO. 6	CA-GEGTFTSDLSRQMEEEAVRLFIEWAAHSQGTFTSDYS KYLD
SEQ ID NO. 7	CA-SQGTFTSDYSRYLDEEAVRLFIEWLMNTK
SEQ ID NO. 8	CA-SQGTFTSDLSRQLEEEAVRLFIEWLMNK
SEQ ID NO. 9	CA-GQGTFTSDYSRYLDEEAVXLFIEWLMNTKRNRNNIA
SEQ ID NO. 10	CA-SQGTFTSDYSRQMEEEAVRLFIEWLMNGGPSSGAPPP SK
SEQ ID NO. 11	CA-GEGTFTSDLSRQMEEEAVRLFIEWAAHSQGTFTSDYS RYLDK
SEQ ID NO. 12	CA-SQGTFTSDYSRYLDGGGHGEGTFTSDLSKQMEEEAV K
SEQ ID NO. 13	CA-SQGTFTSDYSRYLDXEAVXLFIEWLMNTK
SEQ ID NO. 14	CA-GQGTFTSDYSRYLDEEAVXLFIXWLMNTKRNRNNIA
SEQ ID NO. 15	CA-GQGTFTSDYSRYLDEEAVRLFIXWLMNTKRNRNNIA
SEQ ID NO. 16	CA-SQGTFTSDLSRQLEGGGHSQGTFTSDLSRQLEK
SEQ ID NO. 17	CA-SQGTFTSDYSRYLDEEAVRLFIEWIRNTKRNRNNIA
SEQ ID NO. 18	CA-SQGTFTSDYSRYLDEEAVRLFIEWIRNGGPSSGAPPPS K
SEQ ID NO. 19	CA-SQGTFTSDYSRYLD **E** EAV **K** LFIEWIRN-TKRNRNNIA
SEQ ID NO. 20	CA-SQGTFTSDYSRYLD **E** EAV **K** LFIEWIRNGG-PSSGAPPPSK

SEQ ID NO. 21	CA-SQGTFTSDYSRQLEEEAVRLFIEWVRNTKRNRNNIA
SEQ ID NO. 22	DA-SQGTFTSDYSKYLD **E** KRA **K** EFVQWLMNTK
SEQ ID NO. 23	HAibQGTFTSDYSKYLDEKRAKEFVCWLMNT
SEQ ID NO. 24	HAibQGTFTSDYSKYLDEKRAKEFVQWLMNTC
SEQ ID NO. 25	HAibQGTFTSDYSKYLD **E** KRA **K** EFVQWLMNTC
SEQ ID NO. 26	HAibQGTFTSDYS **K** YLD **E** KRAKEFVQWLMNTC
SEQ ID NO. 27	HAibQGTFTSDYSKYLD **E** QAA **K** EFICWLMNT
SEQ ID NO. 28	HAibQGTFTSDYSKYLDEKRAKEFVQWLMNT
SEQ ID NO. 29	H(d)SQGTFTSDYSKYLDSRRAQDFVQWLMNTKRNRNNIA
SEQ ID NO. 30	CA-SQGTFTSDYSKYLDSRRAQDFVQWLMNTKRNRNNIA
SEQ ID NO. 31	CA-(d)SQGTFTSDYSKYLDSRRAQDFVQWLMNTKRNRNNIA
SEQ ID NO. 32	CA-AibQGTFTSDYSKYLDEKRAKEFVQWLMNTC
SEQ ID NO. 33	HAibQGTFTSDYAKYLDEKRAKEFVQWLMNTC
SEQ ID NO. 34	YAibQGTFTSDYSKYLDEKRAKEFVQWLMNTC

[271]

[272] In Table 1, amino acids in bold and underlined represent ring formation, and amino acids represented by X mean a non-native amino acid, alpha-methyl-glutamic acid. In addition, CA represents 4-imidazoacetyl, and DA represents desamino-histidyl.

[273]

[274] **Example 2-2: Test on in vitro activity of oxyntomodulin derivatives**

[275] In order to measure anti-obesity efficacies of the oxyntomodulin derivatives synthesized in Example 2-1, cell activity was measured in vitro using the cell lines prepared in Examples 1-1 and 1-2.

[276] The cell lines were those prepared by transfecting CHO (Chinese Hamster Ovary) to express human GLP-1 receptor gene and glucagon receptor gene, respectively. Thus, they are suitable to measure GLP-1 and glucagon activities. Therefore, the activity of each oxyntomodulin derivative was measured using each transformed cell line.

[277] Specifically, each cell line was sub-cultured twice or three time a week, and aliquoted in each well of a 96-well plate at a density of 1 X 10^5, followed by cultivation for 24 hours.

[278] The cultured cells were washed with KRB buffer and suspended in 40 ml of KRB

buffer containing 1 mM IBMX, and left at room temperature for 5 minutes. Oxyntomodulin (SEQ ID NO. 1) and oxyntomodulin derivatives (represented by SEQ ID NOs. 2-6, 8, 10-13, 17, 18, 23-25, 27, 28 and 32-34) were diluted from 1000 nM to 0.02 nM by 5-fold serial dilution, and each 40 mL thereof was added to the cells, and cultured at 37°C for 1 hour in a CO_2 incubator. Then, 20 mL of cell lysis buffer was added for cell lysis, and the cell lysates were applied to a cAMP assay kit (Molecular Device, USA) to measure cAMP concentrations. EC_{50} values were calculated therefrom, and compared to each other. EC_{50} values are shown in the following Table 2.

[279]

[280] Table 2

[Table 2]

Comparison of in vitro activities for GLP-1 receptor and glucagon receptor between oxyntomodulin and oxyntomodulin derivatives

SEQ ID NO.	EC_{50}(nM)	
	CHO/GLP-1R	CHO/GCGR
SEQ ID NO. 1	50 - 210	10 - 43
SEQ ID NO. 2	51.8	12.8
SEQ ID NO. 3	>1,000	637.7
SEQ ID NO. 4	5.5	>1,000
SEQ ID NO. 5	5.9	>1,000
SEQ ID NO. 6	500.1	>1,000
SEQ ID NO. 8	419.6	>1,000
SEQ ID NO. 10	>1,000	>1,000
SEQ ID NO. 11	>1,000	>1,000
SEQ ID NO. 12	>1,000	>1,000
SEQ ID NO. 13	>1,000	>1,000
SEQ ID NO. 17	97.9	>1,000
SEQ ID NO. 18	96.3	>1,000
SEQ ID NO. 23	2.46	5.8
SEQ ID NO. 24	1.43	6.95
SEQ ID NO. 25	1.9	1.3
SEQ ID NO. 27	2.8-5.5	3.1-5.6
SEQ ID NO. 28	3.1	0.3
SEQ ID NO. 32	14.25	17.3
SEQ ID NO. 33	2.20	80.2
SEQ ID NO. 34	12.5	1.0

[281]

[282] As shown in Table 2, there were oxyntomodulin derivatives showing excellent in vitro activities and different ratios of activities on GLP-1 receptor and glucagon receptor, compared to native oxyntomodulin of SEQ ID NO. 1.

[283]

[284] It is known that oxyntomodulin activates both the GLP-1 receptor and glucagon

receptor to suppress appetite, facilitate lipolysis, and promote satiety, thereby showing anti-obesity effects. The oxyntomodulin derivatives according to the present invention show higher in vitro activities on both the GLP-1 receptor and glucagon receptor than the wild-type oxyntomodulin, and therefore can be used as a therapeutic agent for obesity with higher efficacies than the known oxyntomodulin.

[285]

[286] **Example 3. Test on in vivo activity of oxyntomodulin derivatives**

[287] In order to measure in vivo therapeutic activity of oxyntomodulin derivatives, changes in food intake by administration of oxyntomodulin derivatives were examined in ob/ob mouse using native oxyntomodulin as a control.

[288]

[289] Specifically, obese diabetic ob/ob mice, commonly used to test the efficacies of therapeutic agents for obesity and diabetes, were fasted for 16 hours, and administered with 1 or 10 mg/kg of oxyntomodulin, or 0.02, 0.1, 1 or 10 mg/kg of the oxyntomodulin derivative of SEQ ID NO. 2. Then, food intake was examined for 2 hours (FIG. 1). FIG. 1 is a graph showing changes in food intake according to administration dose of oxyntomodulin or oxyntomodulin derivative. As shown in FIG. 1, administration of 1 mg/kg of oxyntomodulin derivative showed more excellent inhibitory effects on food intake than administration of 10 mg/kg of oxyntomodulin.

[290]

[291] Taken together, the oxyntomodulin derivatives of the present invention have much higher anti-obesity effects than the wild-type oxyntomodulin, even though administered at a lower dose, indicating improvement in the problems of the wild-type oxyntomodulin that shows lower anti-obesity effects and should be administered at a high dose three times a day.

[292]

[293] **Example 4: Preparation of conjugates including oxyntomodulin and immunoglobulin Fc**

[294] Firstly, for PEGylation of lysine residue at position 30 of the amino acid sequence of oxyntomodulin (SEQ ID NO. 1) with 3.4 K PropionALD(2) PEG (PEG with two propylaldehyde groups, NOF, Japan), the oxyntomodulin and 3.4 K PropionALD(2) PEG were reacted at a molar ratio of 1 : 12 with the protein concentration of 5 mg/ml at 4°C for 4.5 hours. At this time, the reaction was conducted in a solvent mixture of 100 mM Na-Borate buffer (pH 9.0) and 45% isopropanol, and 20 mM sodium cyanoborohydride (cyanoborohydride (SCB, NaCNBH3), $NaCNBH_3$) was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE S (XK16, Amersham Biosciences) to purify oxyntomodulin having mono-pegylated lysine (column: SOURCE S (XK16, Amersham Biosciences),

flow rate: 2.0 ml/min, gradient: A 0 →3% 1 min B → 40% 222 min B (A: 20 mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 2a). FIG. 2a is a graph showing the result of purifying mono-PEGylated oxyntomodulin through a SOURCE S purification column. Mono-PEGylation of the eluted peaks was examined by SDS-PAGE, and lysine selectivity was examined by peptide mapping using Asp-N protease (FIG. 2b). FIG. 2b is a graph showing the result of peptide mapping of purified mono-PEGylated oxyntomodulin.

[295] Next, the purified mono-PEGylated oxyntomodulin and immunoglobulin Fc were reacted at a molar ratio of 1 : 10 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column to purify conjugates including oxyntomodulin and immunoglobulin Fc (column: SOURCE 15Q (XK16, Amersham Biosciences), flow rate: 2.0 ml/min, gradient: A 0 → 20% 100 min B (A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 2c). FIG. 2c is a graph showing the result of purifying conjugates including oxyntomodulin and immunoglobulin Fc.

[296]

[297] **Example 5: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 29) and immunoglobulin Fc**

[298] Firstly, for PEGylation of lysine residue at position 30 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 29) with 3.4 K PropionALD(2) PEG, the oxyntomodulin derivative (SEQ ID NO. 29) and 3.4 K PropionALD(2) PEG were reacted at a molar ratio of 1 : 12 with the protein concentration of 5 mg/ml at 4°C for 4.5 hours. At this time, the reaction was conducted in a solvent mixture of 100 mM Na-Borate buffer (pH 9.0) and 45% isopropanol, and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE Sto purify the oxyntomodulin derivative having mono-pegylated lysine (Column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →3% 1 min B → 40% 222 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 3a). FIG. 3a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 29) through a SOURCE S purification column.

[299] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 29) and immunoglobulin Fc were reacted at a molar ratio of 1 : 10 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column to purify conjugates including oxyntomodulin

derivative (SEQ ID NO. 29) and immunoglobulin Fc (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 20% 100 min B (A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 3b). FIG. 3b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 29) and immunoglobulin Fc.

[300]

[301] **Example 6: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 30) and immunoglobulin Fc**

[302] Firstly, for PEGylation of lysine residue at position 30 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 30) with 3.4 K PropionALD(2) PEG, the oxyntomodulin derivative (SEQ ID NO. 30) and 3.4 K PropionALD(2) PEG were reacted at a molar ratio of 1 : 15 with the protein concentration of 3 mg/ml at 4°C for 4.5 hours. At this time, the reaction was conducted in a solvent mixture of 100 mM HEPES buffer (pH 7.5) and 45% isopropanol, and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated lysine (Column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →3% 1 min B → 40% 222 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 4a). FIG. 4a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 30) through a SOURCE S purification column. Mono-PEGylation of the eluted peaks was examined by SDS-PAGE, and lysine selectivity was examined by peptide mapping using Asp-N protease (FIG. 4b). FIG. 4b is a graph showing the result of peptide mapping of purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 30).

[303] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 30) and immunoglobulin Fc were reacted at a molar ratio of 1 : 10 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 30) and immunoglobulin Fc (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 20% 100 min B (A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 4c). FIG. 4c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 30) and immunoglobulin Fc.

[304]

[305] **Example 7: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 31) and immunoglobulin Fc**

[306] Firstly, for PEGylation of lysine residue at position 30 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 31) with 3.4 K PropionALD(2) PEG, the

oxyntomodulin derivative (SEQ ID NO. 31) and 3.4 K PropionALD(2) PEG were reacted at a molar ratio of 1 : 15 with the protein concentration of 3 mg/ml at 4°C for 4.5 hours. At this time, the reaction was conducted in a solvent mixture of 100 mM HEPES buffer (pH 7.5) and 45% isopropanol, and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated lysine (Column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →3% 1 min B → 40% 222 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 5a). FIG. 5a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 31) through a SOURCE S purification column.

[307] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 31) and immunoglobulin Fc were reacted at a molar ratio of 1 : 10 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 31) and immunoglobulin Fc (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 20% 100 min B (A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 5b). FIG. 5b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 31) and immunoglobulin Fc.

[308]

[309] **Example 8: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 2) and immunoglobulin Fc**

[310] Firstly, for PEGylation of lysine residue at position 30 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 2) with 3.4 K PropionALD(2) PEG, the oxyntomodulin derivative (SEQ ID NO. 2) and 3.4 K PropionALD(2) PEG were reacted at a molar ratio of 1 : 10 with the protein concentration of 3 mg/ml at 4°C for 4 hours. At this time, the reaction was conducted in a solvent mixture of 100 mM HEPES buffer (pH 7.5) and 45% isopropanol, and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated lysine (Column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →3% 1 min B → 40% 222 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 6a). FIG. 6a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 2) through a SOURCE S purification column. Mono-PEGylation of the eluted peaks was examined by SDS-PAGE, and lysine selectivity was examined by peptide mapping using Asp-N protease (FIG. 6b). FIG. 6b is

a graph showing the result of peptide mapping of purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 2).

[311] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 2) and immunoglobulin Fc were reacted at a molar ratio of 1 : 8 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column (Column : SOURCE 15Q, flow rate : 2.0 ml/min, gradient : A 0 → 4% 1 min B → 20% 80 min B (A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 6c) and a Source ISO purification column (Column: SOURCE ISO (XK16, Amersham Biosciences), flow rate : 2.0 ml/min, gradient: A 0 → 100% 100 min B, (A: 20mM Tris-HCl, pH 7.5, B: A + 1.3M AS))(FIG. 6d) to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 2) and immunoglobulin Fc. FIG. 6c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 2) and immunoglobulin Fc through a Source ISO purification column, and FIG. 6d is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 2) and immunoglobulin Fc through a Source ISO purification column.

[312]

[313] **Example 9: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 3) and immunoglobulin Fc**

[314] Firstly, for PEGylation of lysine residue at position 27 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 3) with 3.4 K PropionALD(2) PEG, the oxyntomodulin derivative (SEQ ID NO. 3) and 3.4 K PropionALD(2) PEG were reacted at a molar ratio of 1 : 10 with the protein concentration of 3 mg/ml at 4°C for 4 hours. At this time, the reaction was conducted in a solvent mixture of 100 mM HEPES buffer (pH 7.5) and 45% isopropanol, and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated lysine (Column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →3% 1 min B → 40% 222 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 7a). FIG. 7a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 3) through a SOURCE S purification column. Mono-PEGylation of the eluted peaks was examined by SDS-PAGE, and lysine selectivity was examined by peptide mapping using Asp-N protease (FIG. 7b). FIG. 7b is a graph showing the result of peptide mapping of purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 3).

[315] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 3) and

immunoglobulin Fc were reacted at a molar ratio of 1 : 8 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a Butyl FF purification column (Column: Butyl FF(XK16, Amersham Biosciences), flow rate : 2.0 ml/min, gradient : B 0 → 100% 5 min A(A: 20mM Tris-HCl, pH 7.5, B: A + 1.5M NaCl)) (FIG. 7c) and a SOURCE 15Q purification column (Column : SOURCE 15Q, flow rate : 2.0 ml/min, gradient : A 0 → 4% 1 min B → 20% 80 min B(A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 7d) to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 3) and immunoglobulin Fc. FIG. 7c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 3) and immunoglobulin Fc through a Butyl FF purification column, and FIG. 7d is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 3) and immunoglobulin Fc through a SOURCE 15Q purification column.

[316]

[317] **Example 10: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 23) and immunoglobulin Fc**

[318] Firstly, for PEGylation of cysteine residue at position 24 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 23) with MAL-10K-ALD PEG (NOF., Japan), the oxyntomodulin derivative (SEQ ID NO. 23) and MAL-10K-ALD PEG were reacted at a molar ratio of 1 : 3 with the protein concentration of 3 mg/ml at room temperature for 3 hours. At this time, the reaction was conducted in 50 mM Tris buffer (pH 8.0) and 45% isopropanol, and 1M guanidine was added thereto. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated cysteine (column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →100% 50 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 8a). FIG. 8a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 23) through a SOURCE S purification column.

[319] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 23) and immunoglobulin Fc were reacted at a molar ratio of 1 : 5 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 4% 1 min B → 20% 80 min B(A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 8b) and a Source ISO purification column (column: SOURCE ISO,

flow rate: 2.0 ml/min, gradient: B 0 → 100% 100 min A, (A: 20mM Tris-HCl, pH 7.5, B: A + 1.1M AS)) (FIG. 8c) to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 23) and immunoglobulin Fc. FIG. 8b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 23) and immunoglobulin Fc through a SOURCE 15Q purification column, and FIG. 8c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 23) and immunoglobulin Fc through a Source ISO purification column.

[320]

[321] **Example 11: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 24) and immunoglobulin Fc**

[322] Firstly, for PEGylation of cysteine residue at position 30 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 24) with MAL-10K-ALD PEG, the oxyntomodulin derivative (SEQ ID NO. 24) and MAL-10K-ALD PEG were reacted at a molar ratio of 1 : 3 with the protein concentration of 3 mg/ml at room temperature for 3 hours. At this time, the reaction was conducted in 50 mM Tris buffer (pH 8.0) and 45% isopropanol, and 1M guanidine was added thereto. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated cysteine (column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →100% 50 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 9a). FIG. 9a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 24) through a SOURCE S purification column.

[323] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 24) and immunoglobulin Fc were reacted at a molar ratio of 1 : 5 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 4% 1 min B → 20% 80 min B(A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 9b) and a Source ISO purification column (column: SOURCE ISO, flow rate: 2.0 ml/min, gradient: B 0 → 100% 100 min A, (A: 20mM Tris-HCl, pH 7.5, B: A + 1.1M AS)) (FIG. 9c) to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 24) and immunoglobulin Fc. FIG. 9b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 24) and immunoglobulin Fc through a SOURCE 15Q purification column, and FIG. 9c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 24) and immunoglobulin Fc through a Source ISO purification column.

[324]

[325] **Example 12: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 25) and immunoglobulin Fc**

[326] Firstly, for PEGylation of cysteine residue at position 30 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 25) with MAL-10K-ALD PEG, the oxyntomodulin derivative (SEQ ID NO. 25) and MAL-10K-ALD PEG were reacted at a molar ratio of 1 : 3 with the protein concentration of 3 mg/ml at room temperature for 3 hours. At this time, the reaction was conducted in 50 mM Tris buffer (pH 8.0) and 1M guanidine was added thereto. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated cysteine (column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →100% 50 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 10a). FIG. 10a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 25) through a SOURCE S purification column.

[327] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 25) and immunoglobulin Fc were reacted at a molar ratio of 1 : 5 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 4% 1 min B → 20% 80 min B(A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 10b) and a Source ISO purification column (column: SOURCE ISO, flow rate: 2.0 ml/min, gradient: B 0 → 100% 100 min A, (A: 20mM Tris-HCl, pH 7.5, B: A + 1.1M AS)) (FIG. 10c) to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 25) and immunoglobulin Fc. FIG. 10b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 25) and immunoglobulin Fc through a SOURCE 15Q purification column, and FIG. 10c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 25) and immunoglobulin Fc through a Source ISO purification column.

[328]

[329] **Example 13: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 28) and immunoglobulin Fc**

[330] Firstly, for PEGylation of lysine residue at position 20 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 28) with 3.4 K PropionALD(2) PEG, the oxyntomodulin derivative (SEQ ID NO. 28) and MAL-10K-ALD PEG were reacted at a molar ratio of 1 : 5 with the protein concentration of 3 mg/ml at 4°C for 3 hours. At this time, the reaction was conducted in 50 mM Na-Borate buffer (pH 9.0) and 2M guanidine was added thereto. After completion of the reaction, the reaction mixture

was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated lysine (column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →3% 1 min B → 40% 222 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)) (FIG. 11a). FIG. 11a is a graph showing the result of purifying a mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 28) through a SOURCE S purification column.

[331] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 28) and immunoglobulin Fc were reacted at a molar ratio of 1 : 10 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 4% 1 min B → 20% 80 min B(A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) (FIG. 11b) and a Source ISO purification column (column: SOURCE ISO, flow rate: 2.0 ml/min, gradient: B 0 → 100% 100 min A, (A: 20mM Tris-HCl, pH 7.5, B: A + 1.1M AS)) (FIG. 11c) to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 28) and immunoglobulin Fc. FIG. 11b is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 28) and immunoglobulin Fc through a SOURCE 15Q purification column, and FIG. 11c is a graph showing the result of purifying conjugates including oxyntomodulin derivative (SEQ ID NO. 28) and immunoglobulin Fc through a Source ISO purification column.

[332]

[333] **Example 14: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 32) and immunoglobulin Fc**

[334] Firstly, for PEGylation of cysteine residue at position 30 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 32) with MAL-10K-ALD PEG, the oxyntomodulin derivative (SEQ ID NO. 32) and MAL-10K-ALD PEG were reacted at a molar ratio of 1 : 3 with the protein concentration of 1 mg/ml at room temperature for 3 hours. At this time, the reaction was conducted in 50 mM Tris buffer (pH 8.0) and 2M guanidine was added thereto. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated cysteine (column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →100% 50 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)).

[335] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 32) and immunoglobulin Fc were reacted at a molar ratio of 1 : 8 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing

agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 4% 1 min B → 20% 80 min B(A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) and a Source ISO purification column (column: SOURCE ISO, flow rate: 2.0 ml/min, gradient: B 0 → 100% 100 min A, (A: 20mM Tris-HCl, pH 7.5, B: A + 1.1M AS)) to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 32) and immunoglobulin Fc.

[336]

[337] **Example 15: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 33) and immunoglobulin Fc**

[338] Firstly, for PEGylation of cysteine residue at position 30 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 33) with MAL-10K-ALD PEG, the oxyntomodulin derivative (SEQ ID NO. 33) and MAL-10K-ALD PEG were reacted at a molar ratio of 1 : 1 with the protein concentration of 1 mg/ml at room temperature for 3 hours. At this time, the reaction was conducted in 50 mM Tris buffer (pH 8.0) and 2M guanidine was added thereto. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated cysteine (column: SOURCE S, flow rate: 2.0 ml/min, gradient: A 0 →100% 50 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)).

[339] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 33) and immunoglobulin Fc were reacted at a molar ratio of 1 : 5 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 4% 1 min B → 20% 80 min B(A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) and a Source ISO purification column (column: SOURCE ISO, flow rate: 2.0 ml/min, gradient: B 0 → 100% 100 min A, (A: 20mM Tris-HCl, pH 7.5, B: A + 1.1M AS)) to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 33) and immunoglobulin Fc.

[340]

[341] **Example 16: Preparation of conjugates including oxyntomodulin derivative (SEQ ID NO. 34) and immunoglobulin Fc**

[342] Firstly, for PEGylation of cysteine residue at position 30 of the amino acid sequence of oxyntomodulin derivative (SEQ ID NO. 34) with MAL-10K-ALD PEG, the oxyntomodulin derivative (SEQ ID NO. 34) and MAL-10K-ALD PEG were reacted at a molar ratio of 1 : 1 with the protein concentration of 3 mg/ml at room temperature for

3 hours. At this time, the reaction was conducted in 50 mM Tris buffer (pH 8.0) and 1M guanidine was added thereto. After completion of the reaction, the reaction mixture was applied to a SOURCE Spurification column to purify the oxyntomodulin derivative having mono-pegylated cysteine (column: SOURCE S, flow rate: 2.0 ml/ min, gradient: A 0 →100% 50 min B (A: 20mM Na-citrate, pH 3.0 + 45% ethanol, B: A + 1M KCl)).

[343] Next, the purified mono-PEGylated oxyntomodulin derivative (SEQ ID NO. 34) and immunoglobulin Fc were reacted at a molar ratio of 1 : 5 with the protein concentration of 20 mg/ml at 4°C for 16 hours. At this time, the reaction was conducted in 100 mM potassium phosphate buffer (pH 6.0) and 20 mM SCB was added thereto as a reducing agent. After completion of the reaction, the reaction mixture was applied to a SOURCE 15Q purification column (column: SOURCE 15Q, flow rate: 2.0 ml/min, gradient: A 0 → 4% 1 min B → 20% 80 min B(A: 20mM Tris-HCl, pH 7.5, B: A + 1M NaCl)) and a Source ISO purification column (column: SOURCE ISO, flow rate: 2.0 ml/min, gradient: B 0 → 100% 100 min A, (A: 20mM Tris-HCl, pH 7.5, B: A + 1.1M AS)) to purify conjugates including oxyntomodulin derivative (SEQ ID NO. 34) and immunoglobulin Fc.

[344]

[345] **Example 17: In vitro activity of oxyntomodulin derivative-immunoglobulin Fc conjugates**

[346] In order to measure anti-obesity efficacies of the conjugates including the oxyntomodulin or oxyntomodulin derivative and the immunoglobulin Fc that were prepared in the above Examples, experiments were performed in the same manner as in Example 2-2.

[347] Specifically, each of the transformants prepared in Examples 1-1 and 1-2 was subcultured two or three times a week, and aliquoted in each well of a 96-well plate at a density of 1 X 10^5, followed by cultivation for 24 hours. Each of the cultured transformants was washed with KRB buffer and suspended in 40 ml of KRB buffer containing 1 mM IBMX, and left at room temperature for 5 minutes. GLP-1, glucagon, and oxyntomodulin derivative (SEQ ID NO. 23, 24, 25, 32, 33 or 34)-immunoglobulin Fc conjugates were diluted from 1000 nM to 0.02 nM by 5-fold serial dilution, and each 40 ml thereof was added to each transformant, and cultured at 37°C for 1 hour in a CO_2 incubator. Then, 20 ml of cell lysis buffer was added for cell lysis, and the cell lysates were applied to a cAMP assay kit (Molecular Device, USA) to measure cAMP concentrations using a Victor (Perkin Elmer, USA). EC_{50} values were calculated therefrom, and compared to each other (Table 3).

[348]

[349] Table 3

[Table 3]

In vitro activity of oxyntomodulin derivative-immunoglobulin Fc conjugates

SEQ ID NO.	EC_{50} (nM)	
	CHO/GLP-1R	CHO/GCGR
GLP-1	1.7±0.82	> 1,000
Glucagon	>1,000	1.7 ±1.69
SEQ ID NO. 23 - Fc conjugates	5.4	15.8
SEQ ID NO. 24 - Fc conjugates	8.4	76.8
SEQ ID NO. 25 - Fc conjugates	5.5	9.4
SEQ ID NO. 32 - Fc conjugates	68.7	11.9
SEQ ID NO. 33 - Fc conjugates	11.7	85.9
SEQ ID NO. 34 - Fc conjugates	168.0	8.0

[350] As shown in Table 3, the oxyntomodulin derivative-immunoglobulin Fc conjugates were found to show the in vitro activity to GLP-1 and glucagon receptors.

[351]

[352] **Example 18: In vivo activity of oxyntomodulin derivative-immunoglobulin conjugates**

[353] It was examined whether the oxyntomodulin derivative-immunoglobulin Fc conjugates show excellent body weight-reducing effects in vivo.

[354] Specifically, 6-week-old normal C57BL/6 mice were fed a high fat diet of 60 kcal for 24 weeks to increase their body weight by approximately 50 g on average, and subcutaneously administered with oxyntomodulin derivative (SEQ ID NO. 23, 24 or 25)-immunoglobulin Fc conjugates at a dose of 0.03 or 0.06 mg/kg/week for 3 weeks. Thereafter, changes in the body weight of the mice were measured (FIG. 12 and FIG. 13). FIG. 12 and FIG. 13 are graphs showing changes in body weight of mice according to the type and administration dose of oxyntomodulin derivative-immunoglobulin Fc conjugates. As shown in FIG. 12 and FIG. 13, as the administration dose of the oxyntomodulin derivative-immunoglobulin Fc conjugates was increased, the body weight was reduced in direct proportion, even though there were differences between the types of the oxyntomodulin derivative-immunoglobulin Fc conjugates, suggesting that the oxyntomodulin derivative-immunoglobulin Fc conjugates reduce the body weight in a dose-dependent manner.

[355]

[356]

[357]

[358]

【CLAIMS】

【Claim 1】

A long-acting oxyntomodulin conjugate in which an oxyntomodulin derivative and an immunoglobulin Fc region are linked via a non-peptidyl polymer, wherein the oxyntomodulin derivative comprises the amino acid sequence of following Formula 1:

R1-X1-X2-GTFTSD-X3-X4-X5-X6-X7-X8-X9-X10-X11-X12-X13-X14-X15-X16-X17-X18-X19-X20-X21-X22-X23-X24-R2 (Formula 1)

wherein, R1 is histidine;

X1 is Aib(aminoisobutyric acid);

X2 is glutamic acid or glutamine;

X3 is leucine or tyrosine;

X4 is serine or alanine;

X5 is lysine or arginine;

X6 is glutamine or tyrosine;

X7 is leucine or methionine;

X8 is aspartic acid or glutamic acid;

X9 is glutamic acid, serine, alpha-methyl-glutamic acid or is deleted;

X10 is glutamine, glutamic acid, lysine, arginine, serine or is deleted;

X11 is alanine, arginine, valine or is deleted;

X12 is alanine, arginine, serine, valine or is deleted;

X13 is lysine, glutamine, arginine, alpha-methyl-glutamic acid or is deleted;

X14 is aspartic acid, glutamic acid, leucine or is deleted;

X15 is phenylalanine or is deleted;

X16 is isoleucine, valine or is deleted;

X17 is alanine, cysteine, glutamic acid, lysine, glutamine, alpha-methyl-glutamic acid or is deleted

X18 is tryptophan or is deleted;

X19 is alanine, isoleucine, leucine, serine, valine or is deleted;

X20 is alanine, methionine, glutamine, arginine or is deleted;

X21 is asparagine or is deleted;

X22 is alanine, glycine, threonine or is deleted;

X23 is cysteine, lysine or is deleted;

X24 is a peptide having 2 to 10 amino acids consisting of combinations of alanine, glycine and serine, or is deleted; and
R2 is KRNRNNIA (SEQ ID NO. 32), HSQGTFTSDYSKYLD (SEQ ID NO. 35), HSQGTFTSDYSRYLDK (SEQ ID NO. 36), HGEGTFTSDLSKQMEEEAVK (SEQ ID NO. 37) or is deleted.

【Claim 2】
The long-acting oxyntomodulin conjugate according to claim 1, wherein X19 is leucine, X20 is methionine, X21 is asparagine, and X22 is threonine in the amino acid sequence of Formula 1.

【Claim 3】
The long-acting oxyntomodulin conjugate according to claim 1, wherein X2 is glutamine in the amino acid sequence of Formula 1.

【Claim 4】
The long-acting oxyntomodulin conjugate according to claim 1, wherein X24 and R2 are deleted in the amino acid sequence of Formula 1.

【Claim 5】
The long-acting oxyntomodulin conjugate according to claim 1, wherein the oxyntomodulin derivative comprises the amino acid sequence selected from the group consisting of SEQ ID NOs. 23 to 28 and 33.

【Claim 6】
The long-acting oxyntomodulin conjugate according to claim 1, wherein the non-peptidyl polymer is selected from the group consisting of polyethylene glycol, polypropylene glycol, copolymers of ethylene glycol and propylene glycol, polyoxyethylated polyols, polyvinyl alcohol, polysaccharides, dextran, polyvinyl ethyl ether, polylactic acid (PLA), polylactic-glycolic acid (PLGA), lipid polymers, chitins, hyaluronic acid, polysaccharide and combinations thereof.

【Claim 7】

The long-acting oxyntomodulin conjugate according to claim 1, wherein an amine group or a thiol group of the immunoglobulin Fc region and the oxyntomodulin derivative are linked at both ends of the non-peptidyl polymer, respectively.

【Claim 8】

The long-acting oxyntomodulin conjugate according to claim 1, wherein the non-peptidyl polymer has reactive groups capable of binding with the immunoglobulin Fc region and a protein drug at both ends.

【Claim 9】

The long-acting oxyntomodulin conjugate according to claim 8, wherein the reactive group is selected from the group consisting of an aldehyde group, a propionaldehyde group, a butyraldehyde group, a maleimide group and a succinimide derivative.

【Claim 10】

The long-acting oxyntomodulin conjugate according to claim 8, wherein the reactive groups at both ends are the same as or different from each other.

【Claim 11】

The long-acting oxyntomodulin conjugate according to claim 1, wherein the non-peptidyl polymer is linked to a cysteine residue of the oxyntomodulin derivative.

【Claim 12】

The long-acting oxyntomodulin conjugate according to claim 1, wherein the immunoglobulin Fc region is a non-glycosylated Fc region.

【Claim 13】

The long-acting oxyntomodulin conjugate according to claim 1, wherein

the immunoglobulin Fc region is selected from the group consisting of a CH1 domain, a CH2 domain, a CH3 domain and a CH4 domain; a CH1 domain and a CH2 domain; a CH1 domain and a CH3 domain; a CH2 domain and a CH3 domain; a combination of one or more domains and an immunoglobulin hinge region or a portion thereof; and a dimer of each domain of the heavy-chain constant regions and the light-chain constant region.

【Claim 14】

The long-acting oxyntomodulin conjugate according to claim 1, wherein the immunoglobulin Fc region is a derivative in which a region capable of forming a disulfide bond is deleted, certain amino acid residues are eliminated at the N-terminal end of a native Fc form, a methionine residue is added at the N-terminal end of a native Fc form, a complement-binding site is deleted, or an antibody dependent cell mediated cytotoxicity (ADCC) site is deleted.

【Claim 15】

The long-acting oxyntomodulin conjugate according to claim 1, wherein the immunoglobulin Fc region is an Fc region derived from an immunoglobulin selected from the group consisting of IgG, IgA, IgD, IgE, and IgM.

【Claim 16】

The long-acting oxyntomodulin conjugate according to claim 15, wherein the immunoglobulin Fc region is an IgG4 Fc region.

【Claim 17】

The long-acting oxyntomodulin conjugate according to claim 1, wherein the immunoglobulin Fc region is a human IgG4-derived non-glycosylated Fc region.

【Claim 18】

A pharmaceutical composition for the prevention or treatment of obesity, comprising the long-acting oxyntomodulin conjugate of any one of claims 1 to 17.

【Claim 19】

The pharmaceutical composition according to claim 18, further comprising a pharmaceutically acceptable carrier.

【Claim 20】

The pharmaceutical composition according to claim 18, wherein the composition is administered alone or in combination with other pharmaceutical formulations showing prophylactic or therapeutic effects on obesity.

【Claim 21】

The pharmaceutical composition according to claim 20, wherein the pharmaceutical formulation is selected from the group consisting of a GLP-1 receptor agonist, a leptin receptor agonist, a DPP-IV inhibitor, a Y5 receptor antagonist, a Melanin-concentrating hormone (MCH) receptor antagonist, a Y2/3 receptor agonist, a MC3/4 receptor agonist, a gastric/pancreatic lipase inhibitor, a 5HT2c agonist, a β3A receptor agonist, an Amylin receptor agonist, a Ghrelin antagonist, and a Ghrelin receptor antagonist.