(19) DANMARK

(10) **DK/EP 3212218 T3**

Patent- og Varemærkestyrelsen

(12) Oversættelse af europæisk patentskrift

(51) Int.Cl.: ***A 61 K 38/26 (2006.01)*** ***C 07 K 14/575 (2006.01)*** ***C 07 K 14/605 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2021-08-30**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2021-06-30**

(86) Europæisk ansøgning nr.: **15794490.1**

(86) Europæisk indleveringsdag: **2015-10-29**

(87) Den europæiske ansøgnings publiceringsdag: **2017-09-06**

(86) International ansøgning nr.: **EP2015075120**

(87) Internationalt publikationsnr.: **WO2016066744**

(30) Prioritet: **2014-10-29 DK 201400629** **2015-07-04 DK 201500381**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(54) Benævnelse: **GIP-agonistforbindelser og fremgangsmåder**

(56) Fremdragne publikationer:
WO-A1-2011/094337
WO-A1-2012/167744
WO-A1-2013/164483
WO-A2-03/082898
None

DESCRIPTION

Field of the Invention

[0001] The invention relates to compounds having agonist activity at the GIP receptor, and to their use in the treatment of metabolic disorders.

Background of the Invention

[0002] Diabetes and obesity are increasing health problems globally and are associated with various other diseases, particularly cardiovascular diseases (CVD), obstructive sleep apnea, stroke, peripheral artery disease, microvascular complications and osteoarthritis. There are 246 million people worldwide with diabetes, and by 2025 it is estimated that 380 million will have diabetes. Many have additional cardiovascular risk factors including high/aberrant LDL and triglycerides and low HDL. Cardiovascular diseases account for about 50% of the mortality in people with diabetes, and the morbidity and mortality rates relating to obesity and diabetes underscore the medical need for efficacious treatment options.

[0003] Glucose-dependent insulinotropic polypeptide ("GIP", also known as "gastric inhibitory polypeptide") is a 42-residue peptide secreted by enteroendocrine K-cells of the small intestine into the bloodstream in response to oral nutrient ingestion. GIP inhibits the secretion of gastric acid, and it has been shown to be a potent stimulant for the secretion of insulin from pancreatic beta cells after oral glucose ingestion (the "incretin effect") (Creutzfeldt, W., et al, 1979, Diabetologia, 16:75-85).

[0004] Insulin release induced by the ingestion of glucose and other nutrients is due to both hormonal and neural factors (Creutzfeldt, W., et al, 1985, Diabetologia, 28:565-573). Several gastrointestinal regulatory peptides have been proposed as incretins, and among these candidates, only GIP and glucagon-like peptide 1 ("GLP-1") appear to fulfill the requirements to be considered physiological stimulants of postprandial insulin release (Nauck, et al, 1989, J. Clin. Endocrinol Metab., 69:654- 662). It has been shown that the combined effects of GIP and GLP-1 are sufficient to explain the full incretin effect of the enteroinsular axis (Fehmann, H. C, et al, 1989, FEBS Lett, 252: 109-112).

[0005] As is well known to those skilled in the art, the known and potential uses of GIP are varied and multitudinous. Thus, the administration of the compounds of this invention for purposes of eliciting an agonist effect can have the same effects and uses as GIP itself. These varied uses of GIP may be summarized as follows: treating a disease selected from the group consisting of type 1 diabetes, type 2 diabetes (Visboll, T., 2004, Dan. Med. Bull, 51 :364-70), insulin resistance (WO 2005/082928), obesity (Green, B. D., et al, 2004, Current Pharmaceutical Design, 10:3651-3662), metabolic disorder (Gault, V. A., et al, 2003, Biochem.

Biophys. Res. Commun., 308:207-213), central nervous system disease, neurodegenerative disease, congestive heart failure, hypoglycemia, and disorders wherein the reduction of food intake and weight loss are desired. In pancreatic islets, GIP not only enhances insulin secretion acutely, but it also stimulates insulin production through enhancement of proinsulin transcription and translation (Wang, et al, 1996, Mol Cell. Endocrinol, 116:81-87) and enhances the growth and survival of pancreatic beta cells (Trumper, et al, 2003, Diabetes, 52:741-750). In addition to effects on the pancreas to enhance insulin secretion, GIP also has effects on insulin target tissues directly to lower plasma glucose: enhancement of glucose uptake in adipose (Eckel, et al, 1979, Diabetes, 28: 1141-1142) and muscle (O'Harte, et al, 1998, J. Endocrinol, 156:237-243), and inhibition of hepatic glucose production (Elahi, D., et al, 1986, Can. J. Physiol. Pharmacol, 65:A18).

[0006] Recently, it has been reported that body weight loss associated with GLP-1 agonist treatment, is enhanced when GLP-1 and GIP are co-administered (Finan, Sci Transl Med. 2013; 5(209):209ra151. Irwin N et al, 2009, Regul Pept; 153: 70-76. Gault et al, 2011, Clin Sci (Lond); 121:107-117). For instance, Finan and colleges demonstrated significant body weight loss in diet-induced obese (DIO) mice after sub-chronic co-administration with an acylated GIP agonist and an acylated GLP-1 agonist. The co-administration decreased body weight and fat mass to a greater extent than either mono-agonist alone. Evidence also suggests that GLP-1 and GIP have additive effects on glycemic control (Gault et al, 2011, Clin Sci (Lond); 121:107-117). A study by Gault et al showed that sub-chronic co-administration with a GLP-1 analogue, and an acylated GIP analogue resulted in greater glucose-lowering and insulinotropic actions during an intraperitoneal glucose tolerance test in ob/ob mice than injection with the GLP-1 agonist or the GIP agonist alone. Thus, GIP agonists may be particular effective in improving glycaemic control and reducing body weight when they are administered in combination with a GLP-1 receptor agonist (as part of the same pharmaceutical formulation or as separate formulations).

Compounds having dual GIP and GLP-1 agonist activity are described in WO 2013/164483. The use of unmodified GIP as a therapeutic, however, is limited by the short *in vivo* half-life of about 2 minutes (Said and Mutt, 1970, Science, 169:1217-1218). In serum, both incretins, GIP and GLP-1, are degraded by dipeptidyl peptidase IV ("DPPIV"). Improving the stability of GIP to proteolysis not only maintains the activity of GIP at its receptor but, more importantly, prevents the production of GIP fragments, some of which act as GIP receptor antagonists (Gault, et al., 2002, J. Endocrinol, 175:525-533). Reported modifications have included protection of the N-terminus of GIP from proteolysis by DPPIV through modification of the N-terminal tyrosine (O'Harte, et al, 2002, Diabetologia, 45: 1281-1291), mutation of the alanine at position 2 (Hinke, et al, 2002, Diabetes, 51:656-661), mutation of glutamic acid at position 3 (Gault, et al, 2003, Biochem. Biophys. Res. Commun., 308:207-213), and mutation of alanine at position 13 (Gault, et al, 2003, Cell Biol. International, 27:41-46),

The following patent applications have been filed related to the effects of GIP analogues on the function of various target organs and their potential use as therapeutic agents:

PCT publication WO 00/58360 discloses peptidyl analogues of GIP which stimulate the release of insulin. In particular, this application discloses specific peptidyl analogues comprising at least 15 amino acid residues from the N-terminal end of GIP(I -42.

PCT publication WO 03/082898 discloses C-terminal truncated fragments and N-terminal modified analogues of GIP, as well as various GIP analogues with a reduced peptide bond or alterations of the amino acids close to the DPPFV-specific cleavage site. This application further discloses analogues with different linkers between potential receptor binding sites of GIP. The compounds of this application are alleged to be useful in treating GIP-receptor mediated conditions, such as non-insulin dependent diabetes mellitus and obesity. Moreover, among other therapeutic effects of the compounds of the present invention as illustrated herein, tighter control of plasma glucose levels may prevent long-term diabetic complications, thereby providing an improved quality of life for patients. In addition to improving blood glucose control, GIP may also enhance GLP-1-mediated body weight loss.
Conjugation of GIP analogues to e.g, PEG(poly ethylene glycol) has been shown to extent *in vivo* half-life, but potential side-effects of pegylated pharmaceutical products such as inteferon-beta and ribavirin has been reported (J Clin Gastroenterol. 2004 Sep;38(8):717-22, Gut 2006;55:1350-1359 doi:10.1136/gut.2005.076646).
Further GIP analogues are described in WO 2012/167744.

[0007] Thus, there still exists a need for improved and safe analogues of GIP, which are stable in formulation and have long *in vivo* half-life, resulting from decreased susceptibility to proteolysis and decreased clearance, while maintaining binding affinity to a GIP receptor to elicit agonistic effects.

Summary of the Invention

[0008] The present invention concerns GIP analogues which may have the property of an altered GIP activity, as assessed in *in vitro* efficacy assays and an altered, preferably increased terminal elimination half-life (T½), as assessed in *in vivo* studies in mice.

[0009] It has been found that GIP receptor agonists of the present invention are superior to existing GIP analogues because the GIP agonists offer long terminal half-lifes. The GIP analogues may thus be used as therapeutics for metabolic disorders including, but not limited to, type 2 diabetes mellitus, obesity and related disorders.

[0010] The invention provides in a first aspect a GIP analogue represented by the general Formula I:

R^1-Tyr-X2-Glu-Gly-Thr-Phe-Ile-Ser-Asp-X10-X11-X12-Glu-Leu-X15-X16-X17-X18-X19-X20-X21-Phe-X23-X24-X25-Leu-X27-X28-X29-Y1-Y2-R^2 (I)

wherein

R^1 is H-, Ac or pGlu pyroglutamic acid (pGlu; (S)-(-)-2-pyrrolidone-5-carboxylic acid), C_{1-4} alkyl, acetyl, formyl, benzoyl and trifluoroacetyl,

X2 is Aib, Ala, D-Ala, Gly, Ser, N-Me-Ser, Ac3c, Ac4c or Ac5c;

X10 is Tyr, Leu or Ser;

X11 is Ser or Leu;

X12 is Lys, Ψ or Ile;

X15 is Asp or Glu;

X16 is Ser, Glu, Lys or Ψ;

X17 is Ile, Lys, Gln, Arg or Ψ;

X18 is His, Arg or Ala;

X19 is Gin, Lys, Ala or Glu;

X20 is Gin, Lys, Ala, His or Arg;

X21 is Ala, Leu, Asp or Glu;

X23 is Val or Ile;

X24 is Asn or Glu;

X25 is Tyr or Trp;

X27 is Leu, Glu, Ser, Lys or Val;

X28 is Ala, Ser or Arg;

X29 is Aib, Gly, Ala, Gin, Thr, Ser or Lys or is absent;

Y1 is Lys-Gly, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Gly-Lys-Lys-Asn-Asp-Trp-Lys-His-Asn-Ile-Thr-Gln or absent;

Y2 is Ψ or is absent;

R^2 is $-NH_2$ or -OH;

wherein Ψ is a residue independently selected from Lys, Arg, Orn and Cys and wherein the side chain of said residue is conjugated to a lipophilic substituent;

and wherein the GIP analogue contains one and only one residue Ψ;

or a pharmaceutically acceptable salt or solvate thereof;
and wherein the GIP analogue has agonist activity at the GIP receptor.

In one aspect, R^1 is H-, Ac or pGlu.

[0011] Combinations of residues which may be present at some of the variable positions of

Formula I include:

Aib2, Asp15, Lys20;

Aib2, Asp15, Arg20;

Aib2, Asp15, Arg20, Ile23;

Aib2, Ile12, Asp15, Arg20, Ile23, Glu24;

Ile12, Asp15, Ile23;

Ile12, Asp15, Ile23, Glu24;

Ile12, Asp15, Ala21, Ile23;

Aib2, Ala21, Ile23, Glu24;

Aib2, Asp15, Ile23;

Aib2, Asp15, Arg20, Ile23, Gln29;

Aib2, Asp15, Arg20, Gly29;

Aib2, Asp15, Ile17, Arg20, Gly29;

Aib2, Asp15, Ile17, Lys20, Gly29;

DAla2, Asp15, Ile23;

DAla2, Asp15, Ile23, Ala28;

Aib2, Asp15, Ile17, Lys20, Ala28;

Asp15, Ile23, Glu24;

N-Me-Ser2, Asp15, Lys20;

N-Me-Ser2, Asp15, Arg20;

N-Me-Ser2, Asp15, Arg20, Ile23;

N-Me-Ser2, Ile12, Asp15, Arg20, Ile23, Glu24;

N-Me-Ser2, Ala21, Ile23, Glu24;

N-Me-Ser2, Asp15, Ile23;

N-Me-Ser2, Asp15, Arg20, Ile23, Gln29;

N-Me-Ser2, Asp15, Arg20, Gly29;

N-Me-Ser2, Asp15, Ile17, Arg20, Gly29;

N-Me-Ser2, Asp15, Ile17, Lys20, Gly29;

N-Me-Ser2, Asp15, Ile23;

N-Me-Ser2, Asp15, Ile23, Ala28;

Ac3c2, Asp15, Lys20;

Ac3c2, Asp15, Arg20;

Ac3c2, Asp15, Arg20, Ile23;

Ac3c2, Ile12, Asp15, Arg20, Ile23, Glu24;

Ac3c2, Ala21, Ile23, Glu24;

Ac3c2, Asp15, Ile23;

Ac3c2, Asp15, Arg20, Ile23, Gln29;

Ac3c2, Asp15, Arg20, Gly29;

Ac3c2, Asp15, Ile17, Arg20, Gly29;

Ac3c2, Asp15, Ile17, Lys20, Gly29;

Ac3c2, Asp15, Ile23;

Ac3c2, Asp15, Ile23, Ala28;

Ac4c2, Asp15, Lys20;

Ac4c2, Asp15, Arg20;

Ac4c2, Asp15, Arg20, Ile23;

Ac4c2, Ile12, Asp15, Arg20, Ile23, Glu24;

Ac4c2, Ala21, Ile23, Glu24;

Ac4c2, Asp15, Ile23;

Ac4c2, Asp15, Arg20, Ile23, Gln29;

Ac4c2, Asp15, Arg20, Gly29;

Ac4c2, Asp15, Ile17, Arg20, Gly29;

Ac4c2, Asp15, Ile17, Lys20, Gly29;

Ac4c2, Asp15, Ile23;

Ac4c2, Asp15, Ile23, Ala28;

Ac5c2, Asp15, Lys20;

Ac5c2, Asp15, Arg20;

Ac5c2, Asp15, Arg20, Ile23;

Ac5c2, Ile12, Asp15, Arg20, Ile23, Glu24;

Ac5c2, Ala21, Ile23, Glu24;

Ac5c2, Asp15, Ile23;

Ac5c2, Asp15, Arg20, Ile23, Gln29;

Ac5c2, Asp15, Arg20, Gly29;

Ac5c2, Asp15, Ile17, Arg20, Gly29;

Ac5c2, Asp15, Ile17, Lys20, Gly29;

Ac5c2, Asp15, Ile23; or

Ac5c2, Asp15, Ile23, Ala28.

[0012] The invention provides in a further aspect a GIP analogue represented by the general Formula II:

R^1-Tyr-X2-Glu-Gly-Thr-Phe-Ile-Ser-Asp-Tyr-Ser-X12-Glu-Leu-X15-X16-X17-X18-X19-X20-X21-Phe-X23-X24-X25-Leu-X27-X28-X29-Y1-Y2-R^2 (II)

wherein

R^1 is H-, Ac or pGlu;

X2 is Aib, Ala, D-Ala or Gly;

X12 is Lys, Ψ or Ile;

X15 is Asp or Glu;

X16 is Ser, Glu, Lys or Ψ;

X17 is Ile, Lys, Gln, Arg or Ψ;

X18 is His, Arg or Ala;

X19 is Gin or Ala;

X20 is Gln, Lys, Ala, His or Arg;

X21 is Ala, Asp or Glu;

X23 is Ile or Val;

X24 is Asn or Glu;

X25 is Tyr or Trp;

X27 is Leu, Glu, Ser, Lys or Val;

X28 is Ala, Ser or Arg;

X29 is Aib, Gly, Ala, Gln, Thr, Ser or Lys or is absent;

Y1 is Lys-Gly , Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Gly-Lys-Lys-Asn-Asp-Trp-Lys-His-Asn-Ile-Thr-Gln or absent;

Y2 is Ψ or is absent;

R^2 is $-NH_2$ or-OH;

wherein Ψ is a Lys residue wherein the side chain of said Lys residue is conjugated to a lipophilic substituent;

and wherein the GIP analogue contains one and only one residue Ψ;

or a pharmaceutically acceptable salt or solvate thereof;
and wherein the GIP analogue has agonist activity at the GIP receptor.
Combinations of residues which may be present at some of the variable positions of Formula II include:

Aib2, Lys12, Asp15, Lys20;

Aib2, Lys12, Asp15, Arg20;

Aib2, Asp15, Arg20;

Aib2, Ile12, Asp15, Arg20, Glu24;

Ile12, Asp15, Ile23;

Ile12, Asp15, Glu24;

Ile12, Asp15, Ala21;

Aib2, Lys12, Ala21, Glu24;

Aib2, Lys12, Asp15;

Aib2, Lys,12, Asp15, Arg20, Gln29;

Aib2, Lys, 12, Asp15, Arg20, Gly29;

Aib2, Lys12, Asp15, Ile17, Arg20, Gly29;

Aib2, Asp15, Ile17, Lys20, Gly29;

DAla2, Asp15;

DAla2, Asp15, Ala28;

Aib2, Asp15, Ile17, Lys20, Ala28;

Asp15, Glu24;

Ala2, Lys12, Asp15, Lys20;

Ala2, Lys12, Asp15, Arg20;

Ala2, Asp15, Arg20;

Ala2, Ile12, Asp15, Arg20, Glu24;

Ala2, Ile12, Asp15, Ile23;

Ala2, Ile12, Asp15, Glu24;

Ala2, Ile12, Asp15, Ala21;

Ala2, Lys12, Ala21, Glu24;

Ala2, lys12, Asp15;

Ala2, Lys12, Asp15, Arg20, Gln29;

Ala2, Lys12, Asp15, Arg20, Gly29;

Ala2, Lys12, Asp15, Ile17, Arg20, Gly29;

Ala2, Asp15, Ile17, Lys20, Gly29;

Ala2, Asp15;

Ala2, Asp15, Ala28;

Ala2, Asp15, Ile17, Lys20, Ala28;

Gly2, Lys12, Asp15, Lys20;

Gly2, Lys12, Asp15, Arg20;

Gly2, Asp15, Arg20;

Gly2, Ile12, Asp15, Arg20, Glu24;

Gly2, Ile12, Asp15, Ile23;

Gly2, Ile12, Asp15, Glu24;

Gly2, Ile12, Asp15, Ala21;

Gly2, Lys12, Ala21, Glu24;

Gly2, Lys12, Asp15;

Gly2, Lys12, Asp15, Arg20, Gln29;

Gly2, Lys 12, Asp15, Arg20, Gly29;

Gly2, Lys12, Asp15, Ile17, Arg20, Gly29;

Gly2, Asp15, Ile17, Lys20, Gly29;

Gly2, Asp15;

Gly2, Asp15, Ala28;

Gly2, Asp15, Ile17, Lys20, Ala28; or

Gly2, Asp15, Glu24.

[0013] The invention provides in a further aspect a GIP analogue represented by the general Formula III:

R^1-Tyr-Aib-Glu-Gly-Thr-Phe-Ile-Ser-Asp-Tyr-Ser-Ile-Glu-Leu-X15-X16-X17-X18-X19-X20-X21-Phe-Val-X24-X25-Leu-Leu-Ala-X29-Y1-Y2-R^2 (III)

wherein

R^1 is H-, Ac or pGlu;

X15 is Asp or Glu;

X16 is Lys or Ψ;

X17 is Ile or Ψ;

X18 is His or Ala;

X19 is Gin or Ala;

X20 is Gin, Lys or Arg;

X21 is Ala, Asp or Glu;

X24 is Asn or Glu;

X25 is Tyr or Trp;

X28 is Ala, Ser or Arg;

X29 is Gln or is absent;

Y1 is Lys-Gly, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Gly-Lys-Lys-Asn-Asp-Trp-Lys-His-Asn-Ile-Thr-Gln or absent;

Y2 is Ψ or is absent;

R^2 is $-NH_2$ or-OH;

wherein Ψ is a residue independently selected from Lys, Arg, Orn and Cys and wherein the side chain of said residue is conjugated to a lipophilic substituent;

and wherein the GIP analogue contains one and only one residue Ψ;

or a pharmaceutically acceptable salt or solvate thereof;
and wherein the GIP analogue has agonist activity at the GIP receptor.

[0014] Combinations of residues which may be present at some of the variable positions of Formula III include:

Asp15, Lys20;

Asp15, Arg20;

Asp15, Arg20, Glu24;

Asp15, Lys 16;

Asp15, Lys 16, Glu24;

Asp15, Ψ16, Ala21;

Ala21,Glu24;

Asp15, Arg20, Gln29;

Asp15, Arg20, Gly29;

Asp15, Ile17, Arg20, Gly29;

Asp15, Ile17, Lys20, Gly29;

Asp15Ala28;

Asp15, Ile17, Lys20, Ala28;

Asp15, Ile23, Glu24;

Asp15, Ψ17, Lys20;

Asp15, Ψ17, Arg20;

Asp15, Ψ17, Arg20

Asp15, Ψ17, Arg20, Glu24;

Asp15, Lys16, Ψ17;

Asp15, Lys16, Ψ17, Glu24;

Asp15, Ψ17, Ala21;

Ala21, Ψ17, Glu24;

Asp15, Asp15, Ψ17, Arg20, Gln29;

Asp15, Ψ17, Arg20, Gly29;

Asp15, Ile17, Arg20, Gly29;

Asp15, Ile17, Lys20, Gly29;

Asp15; Ψ17;

Asp15, Ψ17, Ala28;

Asp15, Ile17, Lys20, Ala28; or

Asp15, Ψ17, Ile23, Glu24.

[0015] The GIP-analogue may have the formula R1-Z-R2 where R1 and R2 are as defined above and Z has the sequence:

Y-Aib-EGTFISDYSIELDKΨHQQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDΨIHQQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELEKΨHQQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPSΨ;

Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPSΨ;

Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQΨ;

Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQKGΨ;

Y-Aib-EGTFISDYSIELDKΨHQQDFVNYLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDKΨHQQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDKΨAAQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELEKΨAAKEFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELEKΨAQRAFVEWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQGPSSGAPPPSΨ;

Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQΨ;

Y-Aib-EGTFISDYSIELDKΨAAQDFVNWLLAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDKIAAQDFVNWLLAGPSSGAPPPSΨ;

Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAGPSSGAPPPSKΨ;

Y-Aib-EGTFISDYSIELDKIAQKEFIEWLLAGPSSGAPPPSKΨ;

Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPSKΨ;

Y-Aib-EGTFISDYSIELDKIAAQDFVEWLLAGPSSGAPPPSKΨ;

Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAQGPSSGAPPPSKΨ;

Y-Aib-EGTFISDYSIELDKΨIAQRAFIEWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSKΨELDKIAQRAFIEWLLAQGPSSGAPPPS; or

Y-DAla-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPSKΨ,

[0016] The GIP-analogue may have the formula R1-Z-R2 where R1 and R2 are as defined above and Z has the sequence

Y-Aib-EGTFISDYSIELDK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELD-K(Hexadecanoyl-isoGlu)-IHQQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELEK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K(Hexadecanoyl-isoGlu);

Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQ-K(Hexadecanoyl-isoGlu);

Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQKG-K(Hexadecanoyl-isoGlu);

Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNYLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAKEFVNWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQ-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDKIAAQDFVNWLLAGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDKIAQKEFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDKIAAQDFVEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAQGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQAFVNWLLAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELD-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-IAQRAFIEWLLAQGPSSGAPPPS-;

Y-Aib-EGTFISDYS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-ELDKIAQRAFIEWLLAQGPSSGAPPPS;

Y-DAla-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS;

Y-DAla-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-

AAQAFIEWLLAQGPSSGAPPPS; or

Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AAQAFIEWLLAQGPSSGAPPPS.

[0017] The GIP-analogue may be:

H-Y-Aib-EGTFISDYSIELDK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS-NH_2 (Compound 1);

H-Y-Aib-EGTFISDYSIELD-K(Hexadecanoyl-isoGlu)-IHQQDFVNWLLAQGPSSGAPPPS-NH_2 (Compound 2);

H-Y-Aib-EGTFISDYSIELEK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS-NH_2 (Compound 3);

H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2 (Compound 4);

H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K(Hexadecanoyl-isoGlu)-NH_2 (Compound 5);

H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQ-K(Hexadecanoyl-isoGlu)-NH_2 (Compound 6);

H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQKG-K(Hexadecanoyl-isoGlu)-NH_2 (Compound 7);

H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNYLLAQGPSSGAPPPS-NH_2 (Compound 8);

H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNWLLAQGPSSGAPPPS-NH_2 (Compound 9);

H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAQGPSSGAPPPS-NH_2 (Compound 10);

H-Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAKEFVNWLLAQGPSSGAPPPS-NH_2 (Compound 11);

H-Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS-NH_2 (Compound 12);

H-Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2 (Compound 13);

H-Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQ-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2 (Compound 14);

H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAGPSSGAPPPS-NH_2 (Compound 15);

H-Y-Aib-EGTFISDYSIELDKIAAQDFVNWLLAGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2 (Compound 16);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS-NH_2 (Compound 17);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS-NH_2 (Compound 18);

H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS-NHz (Compound 19);

H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS-NH_2 (Compound 20);

H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS-NH_2 (Compound 21);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS-NH_2 (Compound 22);

H-Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2 (Compound 23);

H-Y-Aib-EGTFISDYSIELDKIAQKEFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2 (Compound 24);

H-Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2 (Compound 25);

H-Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-NH_2 (Compound 26);

H-Y-Aib-EGTFISDYSIELDKIAAQDFVEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2 (Compound 27);

H-Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAQGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2 (Compound 28);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQAFVNWLLAGPSSGAPPPS-NH_2 (Compound 29);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAAGPSSGAPPPS-NH_2 (Compound 30);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAGPSSGAPPPS-NH_2 (Compound 31);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS-NH_2 (Compound 32);

H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS-NH_2 (Compound 33);

H-Y-Aib-EGTFISDYSIELD-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-IAQRAFIEWLLAQGPSSGAPPPS-NH_2 (Compound 34);

H-Y-Aib-EGTFISDYS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-ELDKIAQRAFIEWLLAQGPSSGAPPPS-NH_2;; (Compound 35);

H-Y-DAla-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS-NH_2 (Compound 36);

H-Y-DAla-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-NH_2 (Compound 37);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAQGPSSGAPPPS-NH_2 (Compound 38);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAQGPSSGAPPPS-NH_2 (Compound 39);

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQAFIEWLLAQGPSSGAPPPS-NH_2 (Compound 40); and

or

H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AAQAFIEWLLAQGPSSGAPPPS-NH_2 (Compound 41).

[0018] The invention further provides a pharmaceutical composition comprising a GIP analogue as described herein, or a pharmaceutically acceptable salt or solvate thereof, in admixture with a carrier, preferably a pharmaceutically acceptable carrier. The GIP analogue may, for example, be a pharmaceutically acceptable acid addition salt.

[0019] The pharmaceutical composition may be formulated as a liquid suitable for administration by injection or infusion. The pharmaceutical composition may be formulated to

cause controlled, e.g., slow release of said GIP analogue.

[0020] The invention further provides a therapeutic kit comprising a GIP analogue as descibed herein, and a device comprising a GIP analogue as described herein.

[0021] The invention further provides a GIP analogue as described herein, or a pharmaceutically acceptable salt or solvate thereof, for use in a method of medical treatment, e.g. for use in the treatment and/or prevention of a metabolic disorder.

[0022] The metabolic disorder may be diabetes or a diabetes related disorder, or obesity or an obesity related disorder. The link between obesity and diabetes is well known, so these conditions may be but are not necessarily separate or mutually exclusive.

[0023] Diabetes related disorders include insulin resistance, glucose intolerance, increased fasting glucose, pre-diabetes, type 1 diabetes, type 2 diabetes, gestational diabetes hypertension, dyslipidemia, and combinations thereof.

[0024] Diabetes related disorders also include atherosclerosis, arteriosclerosis, coronary heart disease, peripheral artery disease and stroke; or conditions associated with atherogenic dyslipidemia, blood fat disorders, elevated blood pressure, hypertension, a prothrombotic state, a proinflammatory state, and bone related disorders such as osteoporosis.

[0025] The blood fat disorder may be selected from high triglycerides, low HDL cholesterol, high LDL cholesterol, and plaque buildup in artery walls, or a combination thereof.

[0026] The prothrombotic state may be selected from high fibrinogen levels in the blood and high plasminogen activator inhibitor-1 levels in the blood.

[0027] The proinflammatory state may be an elevated C-reactive protein level in the blood.

[0028] Obesity related disorders include obesity linked inflammation, obesity linked gallbladder disease and obesity induced sleep apnea, or may be associated with a condition selected from atherogenic dyslipidemia, blood fat disorders, elevated blood pressure, hypertension, a prothrombotic state, and a proinflammatory state, or a combination thereof.

Brief Description of the Drawings

[0029]

Figure 1: Blood glucose levels (**A-C**) and area under the blood glucose curves (AUC) (**D**) in an OGTT in 5-hour fasted mice. The mice were injected s.c. with vehicle, the GLP-1 analogue liraglutide (10nmol/kg), and GIP receptor agonists (compound 12, 13, 17, and 21 at 3-300 nmol/kg) 4 hours prior to the oral gavage of glucose (t = 0). Data are means ± SEM; n = 6.

Statistical differences vs vehicle: *p<0.05, **p<0.01, ***p<0.001.

Figure 2: Blood glucose levels (**A-D**) and area under the blood glucose curves (AUC) (E) in an OGTT in 5-hour fasted mice. The mice were injected s.c. with vehicle and GIP receptor agonists (compounds 12, 18, 41, 33, and 35 at 3-300 nmol/kg) 4 hours prior to the oral gavage of glucose (t = 0). Data are means ± SEM; n = 6. Statistical differences vs vehicle: ***p<0.001.

Figure 3: Relative body weight changes (delta Δ bodyweight = body weight at each study day - body weight at day 1) in DIO mice during three weeks of treatment. Animals were treated once daily with two separate s.c. injections. The first injection was with vehicle 1 or GLP-1 analogue liraglutide (20 nmol/kg). The second injection was with vehicle 2 or Compound 12 (3 and 30 nmol/kg). The GIP agonist was only dosed every third day of the study (starting on day 1). On other days, GIP agonist was replaced with vehicle 2. Data are means ± SEM; n = 8-9. Statistical differences vs vehicle on day 22: ***p<0.001. Statistical difference (p<0.05) between liraglutide and liraglutide co-treated GIP agonist is shown with a line.

Figure 4: Relative body weight changes (delta Δ body weight = body weight at each study day - body weight at day 0) in DIO mice during four weeks of treatment with vehicle, GLP-1 analogue liraglutide, liraglutide + Compound 10 or 12 (**A**), liraglutide + Compound 17 (**B**), liraglutide + Compound 18 (**C**), liraglutide + compound 35 (**D**) or liraglutide + Compound 41 (**E**). Animals were treated once daily with two separate s.c. injections. The first injection was with vehicle 1 or liraglutide (20 nmol/kg). The second injection was with vehicle 2 or GIP agonists (30 and/or 300 nmol/kg). The GIP agonists were only dosed every third day of the study (starting on day 0). On other days, GIP agonists were replaced with vehicle 2. Data are means ± SEM; n = 9. Statistical differences vs vehicle on day 27: ***p<0.001. Statistical differences (p<0.05) between liraglutide and liraglutide co-treated with GIP agonist are shown with lines.

Detailed Description of the Invention

[0030] Unless otherwise defined herein, scientific and technical terms used in this application shall have the meanings that are commonly understood by those of ordinary skill in the art. Generally, nomenclature used in connection with, and techniques of, chemistry, molecular biology, cell and cancer biology, immunology, microbiology, pharmacology, and protein and nucleic acid chemistry, described herein, are those well known and commonly used in the art.

Definitions

[0031] Unless specified otherwise, the following definitions are provided for specific terms, which are used in the above written description.

[0032] Throughout this specification, the word "comprise" or variations such as "comprises" or "comprising" will be understood to imply the inclusion of a stated integer (or components) or group of integers (or components), but not the exclusion of any other integer (or components) or group of integers (or components).

[0033] The singular forms "a," "an," and "the" include the plurals unless the context clearly dictates otherwise.

[0034] The term "including" is used to mean "including but not limited to." "Including" and "including but not limited to" are used interchangeably.

[0035] The terms "patient," "subject," and "individual" may be used interchangeably and refer to either a human or a non-human animal. These terms include mammals such as humans, primates, livestock animals (e.g., bovines, porcines), companion animals (e.g., canines, felines) and rodents (e.g., mice and rats).

[0036] The term "solvate" in the context of the present invention refers to a complex of defined stoichiometry formed between a solute (*in casu,* a peptide conjugate or pharmaceutically acceptable salt thereof according to the invention) and a solvent. The solvent in this connection may, for example, be water, ethanol or another pharmaceutically acceptable, typically small-molecular organic species, such as, but not limited to, acetic acid or lactic acid. When the solvent in question is water, such a solvate is normally referred to as a hydrate.

[0037] The term "agonist" as employed in the context of the invention refers to a substance (ligand) that activates signaling by the receptor type in question.. The term "antagonist" as employed in the context of the invention refers to a substance (ligand) that decreases signaling by the receptor type in question.

[0038] Throughout the description and claims the conventional one-letter and three-letter codes for natural (or "proteinogenic") amino acids are used, as well as generally accepted three letter codes for other (non-natural or "non-proteinogenic") α-amino acids, such as Aib (α-aminoisobutyric acid), Orn (ornithine) and D-Ala (D-alanine). All amino acid residues in peptides of the invention are preferably of the L-configuration except where explicitly stated.

[0039] Among sequences disclosed herein are sequences incorporating an "H-" moiety at the amino terminus (N-terminus) of the sequence, and either an "-OH" moiety or an "-NH_2" moiety at the carboxy terminus (C-terminus) of the sequence. In such cases, and unless otherwise indicated, an "H-" moiety at the N-terminus of the sequence in question indicates a hydrogen atom (i.e. R^1 = H), corresponding to the presence of a free primary or secondary amino group at the N-terminus, while an "-OH" or an "-NH_2" moiety at the C-terminus of the sequence (i.e. R^2 = OH or NH_2) indicates a carboxy (COOH) group or an amido ($CONH_2$) group at the C-terminus, respectively.

[0040] The compounds of the present invention have GIP biological activity, in particular in treatment of metabolic diseases such as diabetes and obesity. This can be assessed, e.g., in *in vivo* assays, in which the blood glucose level or another biological activity is determined after a test animal has been treated or exposed to a GIP analogue. The compounds of the present invention may be particular effective in improving glycaemic control and reducing body weight when administered together with a GLP-1 receptor agonist to a diabetic patient and/or an overweight or obese subject. The effect obtained with this combination therapy may be superior to that obtained with the administration of a GLP-1 receptor agonist alone in comparable subjects when given according to a comparable dosing regime. The compounds of the present invention may also be capable of improving glycaemic control and reducing bodyweight when administered alone.. The Y1 and Y2 group has a stabilizing effect on the GIP analogues. Without being bound to any theory it is believed that group comprising the C-terminus part of exendin-4 and GIP compounds has impact on the folding of the peptide.
In either the treatment of a diabetic subject or an overweight subject, the effect of treating with a GIP analogue of the present invention may be superior to that obtained with an equivalent quantity (by mass, or molar ratio) of wild type human GIP in comparable subjects when given according to a comparable dosing regime, alone or in combination with another anti-diabetic or anti-obesity agent.

[0041] Activity in *in vitro* assays may also be used as a measure of the compounds' activity. Typically the compounds have activity (i.e. agonist activity) at the GIP receptor (designated GIP-R). EC_{50} values may be used as a numerical measure of agonist potency at a given receptor. An EC_{50} value is a measure of the concentration of a compound required to achieve half of that compound's maximal activity in a particular assay. In any given assay, the EC_{50} value of a compound in a given assay may be assessed relative to the EC_{50} of human GIP. Thus, the ratio of the EC_{50} value of the test compound to the EC_{50} value of wild type human GIP (EC_{50}[test compound] / EC_{50}[GIP]) at the human GIP receptor may be less than 10, less than 5, less than 1, less than 0.1, less than 0.05 or less than 0.01. EC_{50} values may be determined using the human GIP receptor assay described in the Examples below. In such an assay, the compounds may, for example, have an EC_{50} value of 0.001-0.050 nM, 0.001-0.030 nM, 0.001-0.020 nM, or 0.001-0.010 nM.

[0042] The compounds typically have minimal or no agonist activity at the GLP-1 receptor. For example, the ratio of the EC_{50} value of the test compound to the EC_{50} value of the GLP-1 agonist Exendin-4 (EC_{50}[test compound] / EC_{50}[Ex4]) at the human GIP receptor may be at least about 100, at least about 250, at least about 500, at least about 750, at least about 1000, at least about 5000, or at least about 10,000. ("About" is used here to signify +/- 10%.) EC_{50} values may be determined using the human GLP-1 receptor assay described in the Examples below. In such an assay, the compounds may, for example, have an EC_{50} value of at least 1 nM, at least 3 nM, at least 5 nM or at least 10 nM.

Lipophilic group

[0043] The compound of the invention comprises a residue Ψ, i.e. a residue selected from Lys, Arg, Orn and Cys in which the side chain is conjugated to a lipophilic substituent.

[0044] Without wishing to be bound by any particular theory, it is thought that the substituent binds plasma proteins (e.g. albumin) in the blood stream, thus shielding the compounds of the invention from enzymatic degradation and thereby enhancing the half-life of the compounds. It may also modulate the potency of the compound, e.g. with respect to the GIP receptor.

[0045] The substituent is conjugated to the functional group at the distal end of the side chain from the alpha-carbon. The normal ability of the Lys, Arg, Orn or Cys side chain to participate in interactions mediated by that functional group (e.g. intra- and inter-molecular interactions) may therefore be reduced or completely eliminated by the presence of the substituent. Thus, the overall properties of the compound may be relatively insensitive to changes in the actual amino acid present as residue Ψ. Consequently, it is believed that any of the residues Lys, Arg, Orn and Cys may be present at any position where Ψ is permitted. However, in certain embodiments, it may be advantageous that the amino acid component of Ψ is Lys.

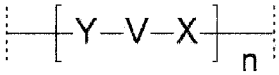
[0046] Thus, Ψ is a residue of Lys, Arg, Orn or Cys in which the side chain is conjugated to a substituent having the formula $-Z^1$ or $-Z^2-Z^1$.

$-Z^1$ is a fatty chain having at a terminus a connection -X- to Ψ or to Z^2;
wherein

-X- is a bond, -CO-, -SO-, or $-SO_2-$;

and, optionally, Z^1 has a polar group at the end of the chain distal from connection -X-; said polar group comprising a carboxylic acid or a carboxylic acid bioisostere, a phosphonic acid, or a sulfonic acid group;

and wherein $-Z^2-$, if present, is a spacer of formula:



connecting Z^1 to Ψ;
wherein:

each Y is independently -NH, -NR, -S or -O, where R is alkyl, a protecting group or forms a linkage to another part of the spacer Z^2;

each X is independently a bond, CO-, SO-, or SO_2-;

with the proviso that when Y is -S, the X to which it is bound is a bond;

each V is independently a bivalent organic moiety linking Y and X;

and n is 1-10.

The group Z^1

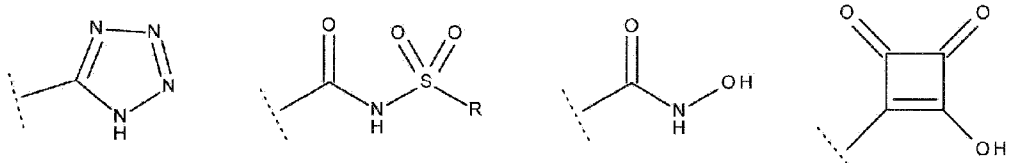
[0047] Z^1 is a fatty chain having a connection to Ψ or to Z^2, referred to herein as -X-. -X- may be, for example, a bond, acyl (-CO-), sulfinyl (-SO-), or sulfonyl ($-SO_2-$). When Z^1 is bound directly to Ψ, that is, when Z^2 is not present, preferably -X- is acyl (-CO-), sulfinyl (-SO-), or sulfonyl ($-SO_2-$). Most preferably, -X- is acyl (-CO-).

Z^1 may further have a polar group, said polar group being located at the end of the chain distal from the connection -X-. In other words, the connection is located at the ω-position with respect to the polar group. The polar group may be bound directly to the terminus of the fatty chain, or may be bound via a linker.

[0048] Preferably, the polar group is an acidic or weakly acid group, for example a carboxylic acid or a carboxylic acid bioisostere, a phosphonate, or a sulfonate. The polar group may have a pK_a of between -2 and 12 in water, more preferably between 1 and 7, more preferably between 3 and 6. Certain preferred polar groups have a pK_a of between 4 and 5.

For example, and not by way of limitation, the polar group may comprise a carboxylic acid (-COOH) or a carboxylic acid bioisostere, a phosphonic acid ($-P(O)(OH)_2$), or a sulfonic acid ($-SO_2OH$) group.

[0049] Preferably the polar group, if present, comprises a carboxylic acid or carboxylic acid bioisostere. Suitable carboxylic acid bioisosteres are known in the art. Preferably the bioisostere has a proton having a pK_a similar to the corresponding carboxylic acid. Examples of suitable bioisoteres may include, not by way of limitation, tetrazole, acylsulfomides, acylhydroxylamine, and squaric acid derivatives, as shown below (--- indicates the point of attachment):



R is e.g. Me, CF_3

[0050] Fatty chain as used herein refers to a moiety comprising a chain of carbon atoms, the carbon atoms being predominantly substituted with hydrogen or hydrogen-like atoms, for example, a hydrocarbon chain. Such fatty chains are often referred to as lipophilic, although it will be appreciated that substitution may alter the lipophilic properties of the overall molecule.

[0051] The fatty chain may by aliphatic. It may be entirely saturated or may include one or more double or triple bonds. Each double bond, if present, may be in the E or Z configuration. The fatty chain may also have one or more cycloalkylene or heterocycloalkylene moieties in its length, and additionally or alternatively may have one or more arylene or heteroarylene moieties in its length. For example, the fatty chain may incorporate a phenylene or piperazinylene moiety in its length as, for example, shown below (wherein --- represents the points of attachment within the chain).

[0052] The fatty chain may be derived from a fatty acid, for example, it may be derived from a medium-chain fatty acid (MCFA) with an aliphatic tail of 6-12 carbon atoms, a long-chain fatty acid (LCFA) with an aliphatic tail of 13-21 carbon atoms, or a very long-chain fatty acid (LCFA) with an aliphatic tail of 22 carbon atoms or more. Examples of linear saturated fatty acids from which suitable fatty chains may be derived include tridecylic (tridecanoic) acid, myristic (tetradecanoic) acid, pentadecylic (pentadecanoic) acid, palmitic (hexadecanoic) acid, and margaric (heptadecanoic) acid. Examples of linear unsaturated fatty acids from which suitable fatty chains may be derived include myristoleic acid, palmitoleic acid, sapienic acid and oleic acid.

[0053] The fatty chain may be connected to Ψ or to Z^2 by an amide linkage, a sulfinamide linkage, a sulfonamide linkage, or by an ester linkage, or by an ether, thioether or amine linkage. Accordingly, the fatty chain may have, a bond to Ψ or to Z^2 or an acyl (-CO-), sulfinyl (-SO-), or sulfonyl (-SO_2-) group. Preferably, the fatty chain has a terminus having an acyl (-CO-) group and is connected to Ψ or Z^2 by an amide or ester linkage.

[0054] In some embodiments, Z^1 is a group of formula:

A-B-Alk-X-

wherein

A is hydrogen or a carboxylic acid, a carboxylic acid bioisostere, a phosphonic acid, or a sulfonic acid group;

B is a bond or a linker;

X is a bond, acyl (-CO-), sulfinyl (-SO-), or sulfonyl (-SO_2-); and

Alk is a fatty chain that may be optionally substituted with one or more substituents. The fatty chain is preferably 6 to 28 carbon atoms in length (e.g. a C_{6-28}alkylene), more preferably, 12 to 26 carbons in length (e.g. a C_{12-26}alkylene), more preferably, 16 to 22 carbons in length (e.g. C_{16-22}alkylene), and may be saturated or unsaturated. Preferably, Alk is saturated, that is,

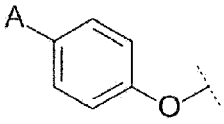
preferably Alk is alkylene.

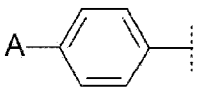
[0055] Optional substituents on the fatty chain may be independently selected from fluoro, C_{1-4}alkyl, preferably methyl; trifluoromethyl, hydroxymethyl, amino, hydroxyl, C_{1-4}alkoxy, preferably methoxy; oxo, and carboxyl, and may be independently located at any point along the chain. In some embodiments, each optional substituent is selected from fluoro, methyl, and hydroxyl. Where more than one substituent is present, substituents may be the same or different. Preferably, the number of substituents is 0 to 3; more preferably the fatty chain is unsubstituted.

[0056] B may be a bond or a linker. When B is a linker, it may be a cycloalkylene, heterocycloalkylene, C_6arylene, or C_{5-6}heteroarylene, or C_6arylene-O- or C_{5-6}heteroarylene-O-.

[0057] When B is phenylene it may, for example, be selected from 1,2-phenylene, 1,3-phenylene, 1,4-phenylene, preferably 1,4-phenylene (so that A-B- is a 4-benzoic acid substituent or 4-benzoic acid bioisostere). When B is phenylene-O-, it may, for example, be selected from 1,2-phenylene-O-, 1,3-phenylene-O-, 1,4-phenylene-O-, preferably 1,4-phenylene-O. Each phenylene of B may be optionally substituted with one or more substituents selected from fluoro, methyl, trifluoromethyl, amino, hydroxyl, and C_{1-4}alkoxy, preferably methoxy. It will be appreciated that substituent identity and position may be selected to subtly alter the pK_a of the polar group. Suitable inductively or mesomerically electron-withdrawing or donating groups and their positional effects are known in the art. In some embodiments, B may be C_{5-6}heteroarylene, for example, pyridinylene or thiofuranylene, and may be optionally substituted as described.

[0058] For example, in some embodiments, A-B- may be selected from:



or


[0059] Preferably, A is H- or HOOC- and B is a bond.
It will be understood that when A is hydrogen, B is a bond and Alk is unsubstituted alkylene, A-B-Alk- is an alkyl chain of formula $H_3C-(CH_2)_n-$.

[0060] In some embodiments, Z^1 is an acyl group of formula:

A-B-Alk-(CO)-

or a sulfonyl group of formula:

A-B-Alk-(SO_2)-.

[0061] Preferably, Z^1 is an acyl group of formula:

A-B-alkylene-(CO)-

where A and B are as defined above.

[0062] In some embodiments, A is -COOH and B is a bond. Accordingly, certain preferred Z^1 are derived from long-chain saturated α,ω-dicarboxytic acids of formula HOOC-$(CH_2)_{12-22}$-COOH, preferably, long-chain saturated α,ω-dicarboxylic acids having an even number of carbon atoms in the aliphatic chain. In some other embodiments, A is H and B is a bond. Accordingly, certain preferred Z^1 are derived from long-chain saturated carboxylic acids of formula HOOC-$(CH_2)_{12-22}$-CH_3, preferably, long-chain saturated carboxylic acids having an even number of carbon atoms in the aliphatic chain.

[0063] For example, and not by way of limitation, Z^1 may be:
A-B-C_{16-20}alkylene-(CO)- wherein A is H or -COOH and B is a bond, for example:

17-carboxy-heptadecanoyl HOOC-$(CH_2)_{16}$-(CO)-;

19-carboxy-nonadecanoyl HOOC-$(CH_2)_{18}$-(CO)-;

Octadecanoyl H_3C-$(CH_2)_{16}$-(CO)-;

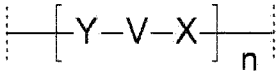
Eicosanoyl H_3C-$(CH_2)_{18}$-(CO)-;

[0064] The carboxylic acid group, if present, may be replaced by a bioisotere as detailed herein.

The group Z^2

[0065] Z^2 is an optional spacer that connects Z^1 to the side chain of the amino acid component of Ψ. At its most general, Z^2, if present, is a spacer bound at one terminus by Y, which may be a nitrogen, oxygen or sulfur atom, and at the other terminus by X, which may be a bond or an acyl (-CO-), sulfinyl (-SO-), sulfonyl (-SO_2-)or absent. Accordingly, Z^2 may be a spacer of

formula (--- indicate points of attachment):



wherein:

Y may be -NH, -NR, -S or -O, where R may be alkyl, a protecting group or may form a linkage to another part of the spacer, with the remaining valency forming a linkage to Z^1;

X may be a bond, CO-, SO-, or SO_2-, with the remaining valency forming a linkage to the side chain of the amino acid component of Ψ;

V is a bivalent organic moiety linking Y and X;

and n may be 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10. Where n is 2 or more, each Y, V, and X is independent of every other Y, V, and X.

[0066] Accordingly, Z^2 may be bound at each side by amide, sulfinamide, sulfonamide, or ester linkages or by amino, ether, or thioether linkages depending upon the nature of Y and X and the corresponding linking groups on Z^1 and the side chain. Where n is 2 or greater, each V may also be bound to each adjacent V by linkages as described. Preferably, linkages are amides, esters or sulfonamides, most preferably amides. Accordingly, in some embodiments, each Y is -NH or -NR and each X is CO- or SO_2-. Most preferably, -X- is acyl (-CO-).

[0067] In some embodiments, Z^2 is a spacer of formula -S_A-, -S_B-, -S_A-S_B- or-S_B-S_A-, wherein S_A and S_B are as defined below.

[0068] In some embodiments, Z^2 is selected from -S_A- or -S_B-S_A- that is, [side chain]-Z^2Z^1 is [side chain]-S_A-Z^1 or [side chain]-S_B-S_A-Z^1.

The group S_A

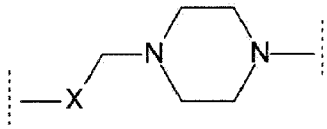
[0069] S_A may be a single amino acid residue or a residue of an amino acid derivative, especially an amino acid derivative residue having a sulfinyl or sulfonyl in place of the carboxy moiety at the C terminus. Additionally or alternatively, the single amino acid residue may have an oxygen or sulfur atom in place of the nitrogen atom at the N terminus.

[0070] S_A may be or may comprise a nitrogen-containing heterocycle, said nitrogen-containing heterocycle being bound within the lipophilic group at one end via a bond, a carboxy, a sulfinyl, or a sulfonyl group and at the other via a ring nitrogen atom. For example, S_A may comprise a piperazine ring.

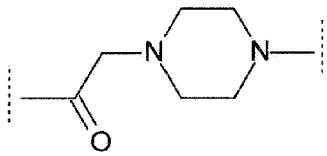
[0071] Suitably, S_A is a 5-8-membered heterocycle having 1 or 2 nitrogen atoms and substituted with an X group, where X is a bond, CO-, SO-, or SO_2-, and where L, if present, is C_{1-4}alkylene (-denotes a point of attachment within the lipophilic group).

[0072] Preferably, S_A is a 6-membered heterocycle having 1 or 2 nitrogen atoms, preferably 2, and substituted with a $-CH_2CO-$, $-CH_2SO-$, or $-CH_2SO_2-$ group.

[0073] For example, S_A may be:



[0074] For example, S_A may be:



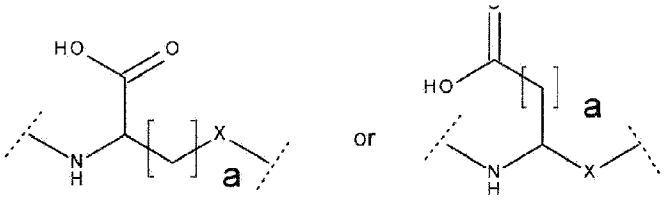
(referred to herein as piperazine-1-yl-acetyl).

[0075] Preferably, S_A is a single amino acid residue or piperazine-1-yl-acetyl. More preferably S_A is a single amino acid residue.

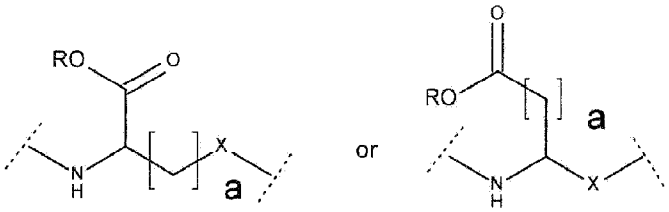
[0076] In some embodiments, the amino acid may be selected from γ-Glu, α-Glu, α-Asp, β-Asp, Ala, β-Ala (3-aminopropanoic acid), Dapa (2,3-diaminopropanoic acid), Dab (2,4-diaminobutanoic acid), and Gaba (4-aminobutanoic acid). It will be understood that where more than one carboxylic acid or amino moiety is present, connection may be at any moiety as appropriate. Any carboxylic acid or amino resides not bound within the residue may be free, that is, present as a free carboxylic acid or primary amine, or may be derivatised. Suitable derivatisation is known in the art. For example, carboxylic acid moieties may be present in S_A amino acid residues as esters, for example, as methyl esters. Amino moieties may be present as alkylated amines, for example, methylated, or may be protected as amide or carbamate moieties. Other suitable amino acids include β-Ala (3-aminopropanoic acid) and Gaba (4-aminobutanoic acid) and similar ω amino acids.

[0077] It will be understood that amino acids may be D or L, or a racemic or enantioenriched mixture. In some embodiments, the amino acid is an L-amino acid. In some embodiments, the amino acid is a D-amino acid.

[0078] In some preferred embodiments, S_A has a carboxylic acid substituent, with γ-Glu, α-Glu, α-Asp, and β-Asp, and sulfinyl and sulfonyl derivatives thereof, being preferred. Accordingly, in some embodiments, the amino acid residue is:



where -X- is -CO-, -SO-, -SO_2-, preferably -CO-, and a is 1 or 2, preferably 2. In some embodiments, the carboxylic acid is an ester, and the amino acid residue is:



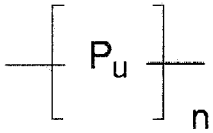
where -X- is -CO-, -SO-, -SO_2-, preferably -CO-, and a is 1 or 2, preferably 2, and R is C_{1-4}alkyl or C_6aryl. Preferably R is C_{1-4}alkyl, preferably methyl or ethyl, more preferably ethyl.

[0079] A preferred S_A group bearing a carboxylic acid is γ-Glu.

[0080] Preferably, S_A is selected from Dapa or γ-Glu. Most preferably, S_A is γ-Glu.

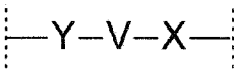
The group S_B

[0081] S_B may be a linker of general formula:



wherein Pu is a polymeric unit and n is 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10. One terminus of the linker S_B is an -NH, -NR, -S or -O, wherein R may be alkyl, a protecting group or may form a linkage to another part of the polymeric unit; while the other is a bond or CO-, SO- or SO_2-. Accordingly, each polymeric unit P_U may be bound at each side by amide, sulfinamide, sulfonamide, or ester linkages or by amino, ether, or thioether linkages depending upon the nature of Y and X and the corresponding linking groups on Z^1, S_A, and Lys.

[0082] In some embodiments, each P_U may be independently a unit of formula:



wherein:

Y may be -NH, -NR, -S or -O, wherein R may be alkyl, a protecting group or may form a linkage to another part of the spacer, with the remaining valency forming a linkage to Z^1;

X may be a bond, CO-, SO-, or SO_2-, with the remaining valency forming a linkage to the Ψ

side chain;

and V is a bivalent organic moiety linking Y and X.

[0083] In some embodiments, V is the α-carbon of a natural or unnatural amino acid, that is V is - CHR^{AA}-, wherein R^{AA} is an amino acid side chain; or V is an optionally substituted C_{1-6}alkylene, or V is a chain comprising one or more units of ethylene glycol in series, also known as PEG chain, for example, -CH_2CH_2-$(OCH_2CH_2)_m$-O-$(CH_2)_p$- where m is 0, 1, 2, 3, 4, or 5, and p is 1, 2, 3, 4, or 5; when X is CO-, p is preferably 1, 3, 4, or 5. Optional alkylene substituents include fluoro, methyl, hydroxy, hydroxymethy, and amino.

[0084] Preferred Pu units include:

1. (i). Single amino acid residues: P_U^i;
2. (ii). Dipeptide residues: P_U^{ii}; and
3. (iii). Amino-$(PEG)_m$-carboxylic acid residues: P_U^{iii},

and may be present in any combination or order. For example, S_B may comprise one or more of each of P_U^i, P_U^{ii}, and P_U^{iii} in any order, or may comprise one or more units of P_U^i, P_U^{ii}, and P_U^{iii} only, or one of more units selected from P_U^i and P_U^{ii}, P_U^i and P_U^{iii}, or P_U^{ii} and P_U^{iii}.

(i).* P_U^i *single amino acid residues

[0085] Each P_U^i may be independently selected from any natural or unnatural amino acid residue and, for example, may be selected from Gly, Pro, Ala, Val, Leu, Ile, Met, Cys, Phe, Tyr, Trp, His, Lys, Arg, Gin, Asn, α-Glu, γ-Glu, Asp, Ser Thr, Dapa, Gaba, Aib, β-Ala, 5-aminopentanoyl, 6-aminohexanoyl, 7-aminoheptanoyl, 8-aminooctanoyl, 9-aminononanoyl, and 10-aminodecanoyl. Preferably, P_U^i amino acid residues are selected from Gly, Ser, Ala, Thr, and Cys, more preferably from Gly and Ser.

[0086] In some embodiments, S_B is -$(P_U^i)_n$-, wherein n is 1 to 8, more preferably 5 to 7, most preferably 6. In some preferred embodiments, S_B is -$(P_U^i)_n$-, n is 6 and each P_U^i is independently selected from Gly or Ser, with a preferred sequence being -Gly-Ser-Gly-Ser-Gly-Gly-.

(ii).* P_U^{ii} *dipeptide residues

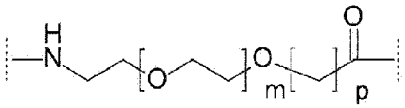
[0087] Each P_U^{ii} may be independently selected from any dipeptide residue comprising two natural or unnatural amino acid residues bound by an amide linkage. Preferred P_U^{ii} dipeptide residues include Gly-Gly, Gly-Ser, Ser-Gly, Gly-Ala, Ala-Gly, and Ala-Ala, more preferably Gly-Ser and Gly-Gly.

[0088] In some embodiments, S_B is $-(P_U^{ii})_n-$, wherein n is 2 to 4, more preferably 3, and each P_U^{ii} is independently selected from Gly-Ser and Gly-Gly. In some preferred embodiments S_B is $-(P_U^{ii})_n-$, n is 3 and each P_U^{ii} is independently selected from Gly-Ser and Gly-Gly, with a preferred sequence being -(Gly-Ser)-(Gly-Ser)-(Gly-Gly).

[0089] Amino acids having stereogenic centres within P_U^{i} and P_U^{ii} may be racemic, enantioenriched, or enantiopure. In some embodiments, the or each amino acid is independently an L-amino acid. In some embodiments, the or each amino acid is independently a D-amino acid.

(iii). P_U^{iii} amino-$(PEG)_m$-carboxylic acid residues

[0090] Each P_U^{iii} may be independently a residue of general formula:



wherein m is 0, 1, 2, 3, 4, or 5, preferably 1 or 2, and p is 1, 3, 4, or 5, preferably 1.

In some embodiments, m is 1 and p is 1, that is, P_U^{iii} is a residue of 8-amino-3,6-dioxaoctanoic acid (also known as {2-[2-aminoethoxy]ethoxy}acetic acid and H_2N-PEG_3-COOH). This residue is referred to herein as -PEG_3-.

[0091] Other, longer, PEG chains are also known in the art. For example, 11-amino-3,6,9-trioxaundecanoic acid (also known as H_2N-PEG_4-COOH or -PEG_4-).

[0092] In some embodiments, S_B is $-(P_U^{iii})_{n-}$, wherein n is 1 to 3, more preferably 2.

[0093] Most preferably, S_B is -PEG_3-PEG_3-.

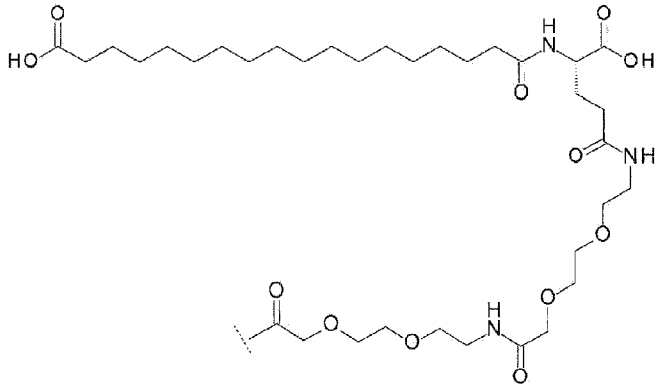
Preferred Combinations

[0094] It will be understood that the above preferences may be independently combined to

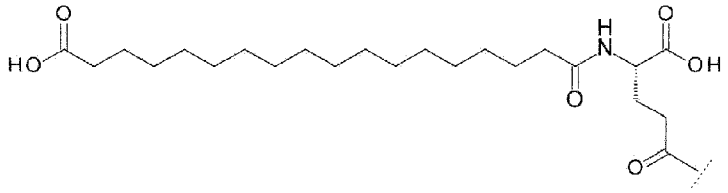
give preferred -Z^1 and -Z^2-Z^1 moieties.

[0095] Some preferred -Z^1 and -Z^2-Z^1 moieties are shown below (in each case, --- indicates the point of attachment to the side chain of the amino acid component of Ψ:

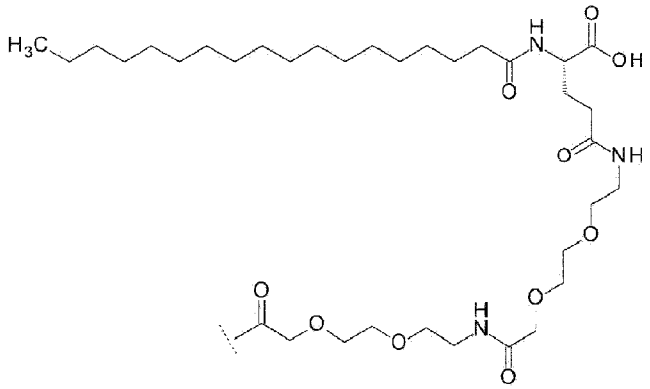
1. (i) [17-carboxy-heptadecanoyl]-isoGlu-Peg3-Peg3



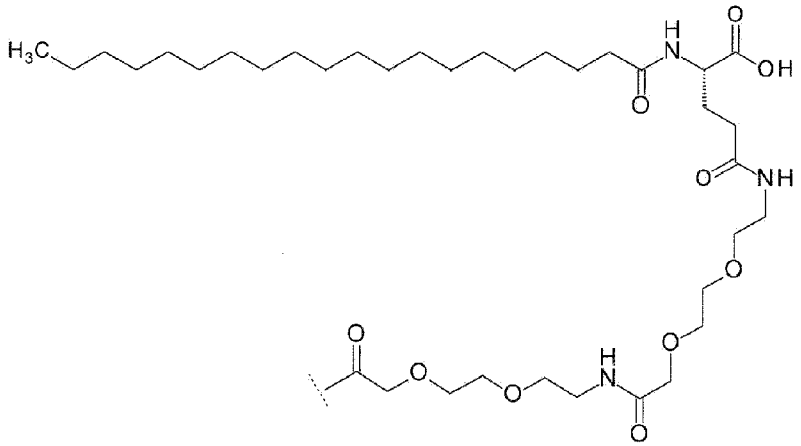
2. (ii) [17-carboxy-heptadecanoyl]-isoGlu



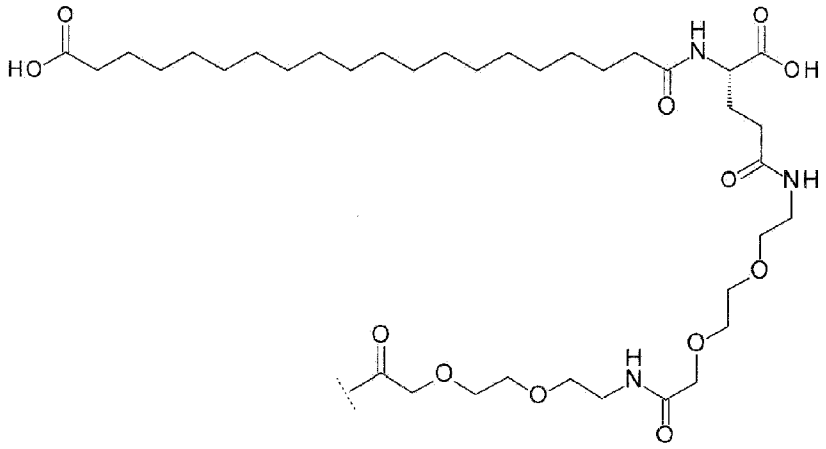
3. (iii) Octadecanoyl-isoGlu-Peg3-Peg3



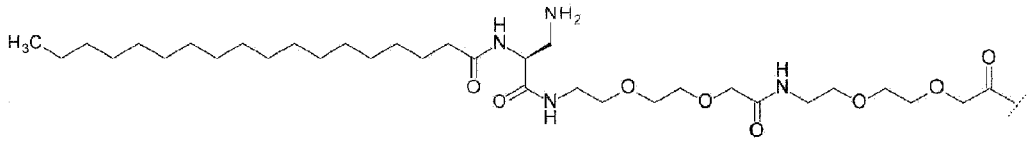
4. (iv) Eicosanoyl-isoGlu-Peg3-Peg3



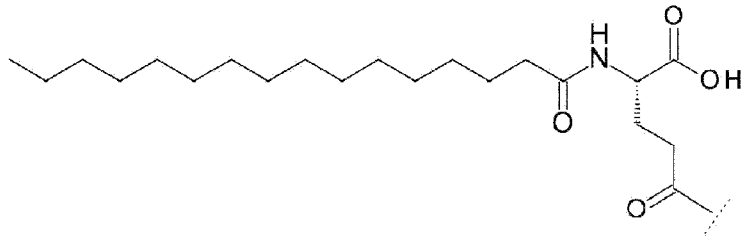
5. (v) [19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3



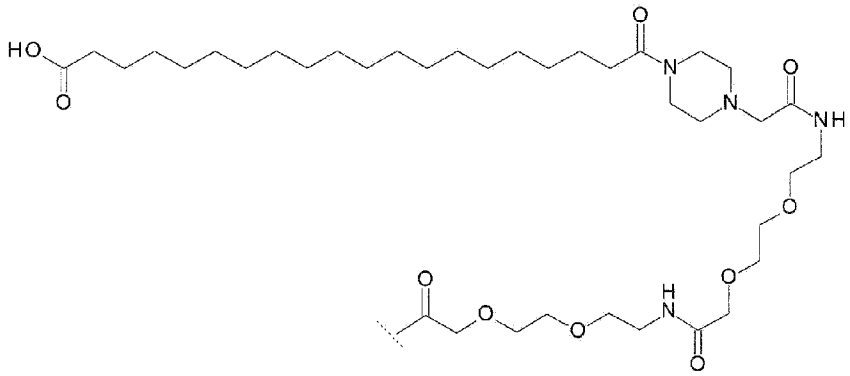
6. (vi) Octadecanoyl-Dapa-Peg3-Peg3



7. (vii) Hexadecanoyl-isoGlu



8. (viii) (19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3



[0096] The skilled person will be well aware of suitable techniques for preparing the compounds employed in the context of the invention. For examples of suitable chemistry, see, e.g., WO98/08871, WO00/55184, WO00/55119, Madsen et al. (J. Med. Chem. 2007, 50, 6126-32), and Knudsen et al. 2000 (J. Med Chem. 43, 1664-1669).

Clinical utility

[0097] The GIP analogue compounds employed in the context of the invention may provide an

attractive treatment option for metabolic diseases including obesity, diabetes mellitus (diabetes), obesity-related disorders, and diabetes-related disorders. The GIP analogue compounds of the present invention may be particular effective in improving glycaemic control and reducing body weight when they are administered in combination with a GLP-1 receptor agonist (as part of the same pharmaceutical formulation or as separate formulations). Glucagon-like peptide-1 receptor agonists also known as GLP-1 receptor agonists or incretin mimetics are agonists of the GLP-1 receptor. One of their advantages over older insulin secretagogues, such as sulfonylureas or meglitinides, is that they have a lower risk of causing hypoglycemia.
Examples of GLP-1 agonists include but are not limited to exenatide (Byetta®/Bydureon®), liraglutide (Victoza®), semaglutide, lixisenatide (Lyxumia®), albiglutide (Tanzeum®) and Taspoglutide.

[0098] Diabetes comprises a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Diabetes is classified into type 1 diabetes, type 2 diabetes and gestational diabetes on the basis on pathogenic characteristics. Type 1 diabetes accounts for 5-10% of all diabetes cases and is caused by auto-immune destruction of insulin-secreting pancreatic β-cells. Acute signs of diabetes include excessive urine production, resulting compensatory thirst and increased fluid intake, blurred vision, unexplained weight loss, lethargy, and changes in energy metabolism. However, in type 2 diabetes symptoms are often not severe or may be absent. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, notably the eyes, kidneys, nerves, heart and blood vessels.

[0099] Type 2 diabetes accounts for 90-95% of diabetes cases and is a result of a complex set of metabolic disorders. However, symptoms are often not severe or may be absent. Type 2 diabetes is the consequence of endogenous insulin production becoming insufficient to maintain plasma glucose levels below diagnostic thresholds.

[0100] Gestational diabetes refers to any degree of glucose intolerance identified during pregnancy.

[0101] Pre-diabetes includes impaired fasting glucose and impaired glucose tolerance and refers to those states that occur when blood glucose levels are elevated but below the levels that are established for the clinical diagnosis for diabetes.

[0102] A large proportion of people with type 2 diabetes and pre-diabetes are at increased risk of morbidity and mortality due to the high prevalence of additional metabolic risk factors, including abdominal obesity (excessive fat tissue around the abdominal internal organs), atherogenic dyslipidemia (blood fat disorders including high triglycerides, low HDL cholesterol and/or high LDL cholesterol, which foster plaque buildup in artery walls), elevated blood pressure (hypertension) a prothrombotic state (e.g. high fibrinogen or plasminogen activator inhibitor- 1 in the blood), and/or a proinflammatory state (e.g., elevated C-reactive protein in the blood).

[0103] Conversely, obesity confers an increased risk of developing pre-diabetes, type 2 diabetes as well as, e.g., certain types of cancer, obstructive sleep apnea and gall-bladder disease. Dyslipidemia is associated with increased risk of cardiovascular disease. High Density Lipoprotein (HDL) is of clinical importance since an inverse correlation exists between plasma HDL concentrations and risk of atherosclerotic disease. The majority of cholesterol stored in atherosclerotic plaques originates from LDL and hence an elevated concentration of Low Density Lipoproteins (LDL) is closely associated with atherosclerosis. The HDL/LDL ratio is a clinical risk indictor for atherosclerosis and coronary atherosclerosis in particular.

[0104] The GIP analogues of the present invention may be used as pharmaceutical agents for preventing weight gain, promoting weight loss, reducing excess body weight or treating obesity (e.g., by control of appetite, feeding, food intake, calorie intake, and/or energy expenditure and lipolysis), including morbid obesity, as well as associated diseases and health conditions including but not limited to obesity linked inflammation, obesity linked gallbladder disease and obesity induced sleep apnea. The GIP analogues employed in the context of the invention may also be used for treatment of insulin resistance, glucose intolerance, pre-diabetes, increased fasting glucose, type 2 diabetes, hypertension, dyslipidemia (or a combination of these metabolic risk factors), atherosclerosis, arteriosclerosis, coronary heart disease, peripheral artery disease and stroke. These are all conditions which may be associated with obesity. However, the effects of the compounds employed in the context of the invention on these conditions may be mediated in whole or in part via an effect on body weight, or may be independent thereof.

[0105] The GIP analogues of the present invention may thus be used for the treatment and/or prevention of any of the diseases, disorders, or conditions described herein, including insulin resistance, glucose intolerance, increased fasting glucose, pre-diabetes, type 1 diabetes, type 2 diabetes, gestational diabetes hypertension, dyslipidemia, or a combination thereof. In certain embodiments, the diabetes related disorder is selected from atherosclerosis, arteriosclerosis, coronary heart disease, peripheral artery disease and stroke; or associated with a condition selected from atherogenic dyslipidemia, blood fat disorders, elevated blood pressure, hypertension, a prothrombotic state, and proinflammatory state, or a combination thereof. In certain embodiments, the blood fat disorder is selected from high triglycerides, low HDL cholesterol, high LDL cholesterol, plaque buildup in artery walls, or a combination thereof. In certain embodiments, the prothrombotic state is selected from high fibrinogen levels in the blood and high plasminogen activator inhibitor-1 levels in the blood. In certain embodiments, the proinflammatory state is an elevated C-reactive protein level in the blood. In certain embodiments, the obesity related disorder is selected from obesity linked inflammation, obesity linked gallbladder disease and obesity induced sleep apnea.

[0106] The GIP analogues of the present invention may also be used for the treatment and/or prevention of any of the diseases, disorders, or conditions associated with diabetes related osteoporosis including increased risk of bone fractures (Khazai N.B. et al, 2009, Current Opinion in Endocrinology, Diabetes and Obesity, vol. 16, no. 6, 435-445). The increase in

fracture risk is likely to be related to impaired bone quality rather than to bone mineral density. The related mechanisms, due at least in part to hyperglycemia, neuropathy, and higher incidence of hypovitaminosis D, are not yet fully understood (Takiishi T et al, 2010, Endocrinology and Metabolism Clinics of North America, vol. 39, no. 2, 419-446).

[0107] In some embodiments, the invention also provides a therapeutic kit comprising a GIP analogue (e.g., GIP agonist compound) of the present invention, optionally in combination with a pharmaceutically acceptable carrier. In some embodiments, the invention provides a device comprising a GIP analogue of the invention for delivery of the GIP analogue to a subject.

Pharmaceutical compositions

[0108] The GIP analogues (e.g., GIP agonist compounds) of the present invention, or salts or solvates thereof, may be formulated as pharmaceutical compositions prepared for storage or administration, which typically comprise a therapeutically effective amount of a compound employed in the context of the invention, or a salt or solvate thereof, in a pharmaceutically acceptable carrier. In some embodiments, the pharmaceutical composition is formulated as a liquid suitable for administration by injection or infusion, or which is formulated to cause slow release of the GIP analogue.

[0109] The therapeutically effective amount of a compound of the present invention will depend, e.g., on the route of administration, the type of mammal being treated, and the physical characteristics of the specific mammal under consideration. These factors and their relationship to determining this amount are well known to skilled practitioners in the medical arts. This amount and the method of administration can be tailored to achieve optimal efficacy, and may depend on such factors as weight, diet, concurrent medication and other factors, well known to those skilled in the medical arts. The dosage sizes and dosing regimen most appropriate for human use may be guided by the results obtained by the present invention, and may be confirmed in properly designed clinical trials.

[0110] An effective dosage and treatment protocol may be determined by conventional means, starting with a low dose in laboratory animals and then increasing the dosage while monitoring the effects, and systematically varying the dosage regimen as well. Numerous factors may be taken into consideration by a clinician when determining an optimal dosage for a given subject. Such considerations are known to the skilled person. The term "pharmaceutically acceptable carrier" includes any of the standard pharmaceutical carriers. Pharmaceutically acceptable carriers for therapeutic use are well known in the pharmaceutical art, and are described, for example, in Remington's Pharmaceutical Sciences, Mack Publishing Co. (A. R. Gennaro edit. 1985). For example, sterile saline and phosphate-buffered saline at slightly acidic or physiological pH may be used. Suitable pH buffering agents may be, e.g., phosphate, citrate, acetate, lactate, maleate, tris/hydroxymethyl)aminomethane (TRIS), *N*-Tris(hydroxymethyl)methyl-3-aminopropanesulphonic acid (TAPS), ammonium bicarbonate, diethanolamine, histidine, which in certain embodiments is a preferred buffer, arginine, lysine,

or acetate or mixtures thereof. The term further encompasses any agents listed in the US Pharmacopeia for use in animals, including humans.

[0111] The term "pharmaceutically acceptable salt" refers to a salt of the compound. Salts include pharmaceutically acceptable salts, such as, e.g., acid addition salts and basic salts. Examples of acid addition salts include hydrochloride salts, citrate salts and acetate salts. Examples of basic salts include salts where the cation is selected from alkali metals, such as sodium and potassium, alkaline earth metals such as calcium, and ammonium ions $^{+}N(R^3)_3(R^4)$, where R^3 and R^4 independently designate optionally substituted C_{1-6}-alkyl, optionally substituted C_{2-6}-alkenyl, optionally substituted aryl, or optionally substituted heteroaryl. Other examples of pharmaceutically acceptable salts are described in "Remington's Pharmaceutical Sciences" ,17th edition. Ed. Alfonso R. Gennaro (Ed.), Mark Publishing Company, Easton, PA, U.S.A., 1985 and more recent editions, and in the Encyclopaedia of Pharmaceutical Technology.

[0112] "Treatment" is an approach for obtaining beneficial or desired clinical results. For purposes of this invention, beneficial or desired clinical results include, but are not limited to, alleviation of symptoms, diminishment of extent of disease, stabilized (i.e., not worsening) state of disease, delay or slowing of disease progression, amelioration or palliation of the disease state, and remission (whether partial or total), whether detectable or undetectable. "Treatment" may also mean prolonging survival as compared to expected survival if not receiving treatment. "Treatment" is an intervention performed with the intention of preventing the development or altering the pathology of a disorder. Accordingly, "treatment" refers to both therapeutic treatment and prophylactic or preventative measures in certain embodiments. Those in need of treatment include those already with the disorder as well as those in which the disorder is to be prevented. By treatment is meant inhibiting or reducing an increase in pathology or symptoms (e.g. weight gain, hyperglycemia) when compared to the absence of treatment, and is not necessarily meant to imply complete cessation of the relevant condition.

[0113] The pharmaceutical compositions of the invention may be in unit dosage form. In such form, the composition is divided into unit doses containing appropriate quantities of the active component. The unit dosage form can be a packaged preparation, the package containing discrete quantities of the preparations, for example, packeted tablets, capsules, and powders in vials or ampoules. The unit dosage form can also be a capsule, cachet, or tablet itself, or it can be the appropriate number of any of these packaged forms. It may be provided in single dose injectable form, for example in the form of an injection pen. Compositions may be formulated for any suitable route and means of administration. Pharmaceutically acceptable carriers or diluents include those used in formulations suitable for oral, rectal, nasal or parenteral (including subcutaneous, intramuscular, intravenous, intradermal, and transdermal) administration. The formulations may conveniently be presented in unit dosage form and may be prepared by any of the methods well known in the art of pharmacy. Subcutaneous or transdermal modes of administration may be particularly suitable for certain of the compounds described herein.

Combination therapy

[0114] In certain embodiments, a GIP- analogue employed in the context of the invention may be administered as part of a combination therapy with at least one other agent for treatment of diabetes, obesity, dyslipidemia, or hypertension.

[0115] In such cases, the at least two active agents may be given together or separately, and as part of the same pharmaceutical formulation or as separate formulations. Thus, the GIP analogue employed in the context of the invention (or the salt or solvate thereof) may be used in combination with an antidiabetic agent including but not limited to a glucagon-like peptide receptor 1 agonist, metformin, a sulfonylurea, a glinide, a DPP-IV inhibitor, a glitazone, or insulin. In certain embodiments, the compound or salt or solvate thereof is used in combination with insulin, DPP-IV inhibitor, sulfonylurea or metformin, particularly sulfonylurea or metformin, for achieving adequate glycemic control. In certain preferred embodiments, the compound or salt or solvate thereof is used in combination with insulin or an insulin analogue for achieving adequate glycemic control. Examples of insulin analogues include but are not limited to Lantus®, NovoRapid®, Humalog®, NovoMix®, Actraphane HM®, Levemir® and Apidra®.

[0116] In certain embodiments, the GIP analogue or salt or solvate thereof may further be used in combination with one or more of an anti-obesity agent, including but not limited to a glucagon-like peptide receptor 1 agonist, peptide YY or analogue thereof, cannabinoid receptor 1 antagonist, lipase inhibitor, melanocortin receptor 4 agonist, or melanin concentrating hormone receptor 1 antagonist.

[0117] In certain embodiments, the GIP analogue or salt or solvate thereof may be used in combination with an anti-hypertension agent, including but not limited to an angiotensin-converting enzyme inhibitor, angiotensin II receptor blocker, diuretics, beta-blocker, or calcium channel blocker.

[0118] In certain embodiments, the GIP analogue or salt thereof may be used in combination with an anti-dyslipidemia agent, including but not limited to a statin, a fibrate, a niacin and/or a cholesterol absorption inhibitor.

Synthesis of compounds of the invention

[0119] A nucleic acid molecule may encode the amino acid sequence of any of Formula I to III or a precursor thereof. The amino acid sequence encoded can be regarded as a precursor of a compound of the invention.

[0120] Typically, such nucleic acid sequences will be provided as expression constructs wherein the encoding nucleic acid is in functional linkage with appropriate control sequences to

direct its expression. The expression construct may be provided in the context of a host cell capable of expressing (and optionally also secreting) the amio acid precursor, or ina cell-free expression system.

[0121] The invention provides a method of producing a GIP analogue of the invention, the method comprising expressing an amino acid precursor of the GIP analogue and modifying the precursor to provide the GIP analogue. The modification may comprise chemical modification of a Lys, Arg or Cys residue present at position 17 to introduce the lipophilic moiety, modification of the N- or C- terminus, and/or modification of any other amino acid side chains in the molecule (e.g. to introduce a non-naturally occurring amino acid residue).

[0122] The compounds of the invention may also be manufactured by standard peptide synthetic methods, e.g. by standard solid-phase or liquid-phase methodology, either stepwise or by fragment assembly, and isolating and purifying the final peptide compound product, or by any combinations of recombinant and synthetic methods.

[0123] It may be preferable to synthesize the peptide compounds of the invention by means of solid-phase or liquid-phase peptide synthesis. In this context, reference may be made to WO 98/11125 or, *inter alia,* Fields, G.B. et al., "Principles and Practice of Solid-Phase Peptide Synthesis"; in: Synthetic Peptides, Gregory A. Grant (ed.), Oxford University Press (2nd edition, 2002) and the synthesis examples herein.

Examples

[0124] The following examples demonstrate certain embodiments of the present invention. However, it is to be understood that these examples neither purport nor are they intended to be wholly definitive as to conditions and scope of this invention. The examples were carried out using standard techniques, which are well known and routine to those of skill in the art, except where otherwise described in detail. The following examples are presented for illustrative purposes only, and should not be construed in any way as limiting the scope of this invention.

[0125] Disclosed are GIP analogues that exhibit signaling selectivity, and methods for screening these compounds. Signaling selectivity may be, for example, preferential pathway activation or preferential pathway inhibition, or both. The analogue, administered alone or in combination with a GLP-1 agonist, may be useful for the treatment and/or prevention of diseases or conditions caused or characterized by excess body weight, including, but not limited to, obesity, morbid obesity, obesity linked inflammation, obesity linked gallbladder disease, obesity induced sleep apnea, metabolic syndrome, pre-diabetes, insulin resistance, glucose intolerance, type 2 diabetes, type I diabetes, hypertension, atherogenic dyslipidaemia, atherosclerosis, arteriosclerosis, coronary heart disease, peripheral artery disease, and stroke or microvascular disease.

[0126] While some embodiments of the invention have been described by way of illustration, it

will be apparent that the invention can be put into practice with many different modifications, variations and adaptations, and with the use of numerous equivalents or alternative solutions that are within the scope of persons skilled in the art, without departing from the spirit of the invention or exceeding the scope of the claims.

[0127] The methods used in the instant invention are described below, except where expressly indicated otherwise.

Example 1

General synthesis of acylated GIP analogues

[0128] Solid phase peptide synthesis was performed on a CEM Liberty Peptide Synthesizer using standard Fmoc chemistry. TentaGel S Ram resin (1 g; 0.25 mmol/g) was swelled in NMP (10 ml) prior to use and transferred between tube and reaction vessel using DCM and NMP.

Coupling

[0129] An Fmoc-amino acid in DMF/DCM (2:1 ; 0.2 M; 5 ml) was added to the resin in a CEM Discover microwave unit together with HATU/DMF or COMU/DMF (0.5 M; 2 ml) and DIPEA-DMF/DCM (2:1) (2.0 M; 1 ml). The coupling mixture was heated to 75°C for 5 min while nitrogen was bubbled through the mixture. The resin was then washed with DMF (4 x 10 ml).

Deprotection

[0130] Piperidine/DMF (20%; 10 ml) was added to the resin for initial deprotection and the mixture was heated by microwaves (30 sec; 40°C). The reaction vessel was drained and a second portion of piperidine/NMP (20%; 10 ml) was added and heated (75°C; 3 min.) again. The resin was then washed with DMF (6 x 10 ml).

Side chain acylation

[0131] Fmoc-Lys(ivDde)-OH or alternatively another amino acid with an orthogonal side chain protective group was introduced at the position of the acylation. The N-terminal of the peptide backbone was then Boc-protected using Boc2O or alternatively by using a Boc-protected amino acid in the last coupling. While the peptide was still attached to the resin, the orthogonal side chain protective group was selectively cleaved using freshly prepared hydrazine hydrate

(2-4%) in NMP for 2 x 15 min. The unprotected lysine side chain was first coupled with Fmoc-Glu-OtBu or another spacer amino acid, which was deprotected with piperidine and acylated with a lipophilic moiety using the peptide coupling methodology as described above.

[0132] Abbreviations employed are as follows:

COMU: 1-[(1-(cyano-2-ethoxy-2-oxoethylideneaminooxy)-dimethylamino-morpholinomethylene)]methanaminium hexaflourophosphate

ivDde: 1-(4,4-dimethyl-2,6-dioxocyclohexylidene)3-methyl-butyl

Dde: 1-(4,4-dimethyl-2,6-dioxocyclohexylidene)-ethyl

DCM: dichloromethane

DMF: *N*,*N*-dimethylformamide

DIPEA: diisopropylethylamine

EtOH: ethanol

Et_2O: diethyl ether

HATU: *N*-[(dimethylamino)-1H-1,2,3-triazol[4,5-b]pyridine-1-ylmethylene]-*N*-methylmethanaminium hexafluorophosphate *N*-oxide

MeCN: acetonitrile

NMP: *N*-methylpyrrolidone

TFA: trifluoroacetic acid

TIS: triisopropylsilane

Cleavage

[0133] The resin was washed with EtOH (3 x 10 ml) and Et_2O (3 x 10 ml) and dried to constant weight at room temperature (r.t.). The crude peptide was cleaved from the resin by treatment with TFA/TIS/water (95/2.5/2.5; 40 ml, 2 h; r.t.). Most of the TFA was removed at reduced pressure and the crude peptide was precipitated and washed three times with diethylether and dried to constant weight at room temperature.

HPLC purification of the crude peptide

[0134] The crude peptide was purified to greater than 90% by preparative reverse phase HPLC using a PerSeptive Biosystems VISION Workstation equipped with a C-18 column (5 cm; 10 µm) and a fraction collector and run at 35 ml/min with a gradient of buffer A (0.1% TFA, aq.) and buffer B (0.1% TFA, 90% MeCN, aq.). Fractions were analyzed by analytical HPLC and MS and relevant fractions were pooled and lyophilized. The final product was characterized by HPLC and MS.

[0135] The synthesized compounds are shown in Table 1.

Table 1.

Compound No.	Sequence
1	H-Y-Aib-EGTFISDYSIELDK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS-NH_2
2	H-Y-Aib-EGTFISDYSIELD-K(Hexadecanoyl-isoGlu)-IHQQDFVNWLLAQGPSSGAPPPS-NH_2
3	H-Y-Aib-EGTFISDYSIELEK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS-NH_2
4	H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2
5	H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K(Hexadecanoyl-isoGlu)-NH_2
6	H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQ-K(Hexadecanoyl-isoGlu)-NH_2
7	H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQKG-K(Hexadecanoyl-isoGlu)-NH_2
8	H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNYLLAQGPSSGAPPPS-NH_2
9	H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNWLLAQGPSSGAPPPS-NH_2
10	H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAQGPSSGAPPPS-NH_2
11	H-Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAKEFVNWLLAQGPSSGAPPPS-NH_2
12	H-Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS-NH_2
13	H-Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2
14	H-Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQ-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2
	H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-

Compound No.	Sequence
15	Peg3-Peg3)-AAQDFVNWLLAGPSSGAPPPS-NH_2
16	H-Y-Aib-EGTFISDYSIELDKIAAQDFVNWLLAGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2
17	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS-NH_2
18	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS-NH_2
19	H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS-NH_2
20	H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS-NH_2
21	H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS-NH_2
22	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS-NH_2
23	H-Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2
24	H-Y-Aib-EGTFISDYSIELDKIAQKEFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2
25	H-Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2
26	H-Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-NH_2
27	H-Y-Aib-EGTFISDYSIELDKIAAQDFVEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2
28	H-Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAQGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2
29	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQAFVNWLLAGPSSGAPPPS-NH_2
30	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAAGPSSGAPPPS-NH_2
31	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAGPSSGAPPPS-NH_2
32	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS-NH_2

Compound No.	Sequence
33	H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS-NH_2
34	H-Y-Aib-EGTFISDYSIELD-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-IAQRAFIEWLLAQGPSSGAPPPS-NH_2
35	H-Y-Aib-EGTFISDYS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-ELDKIAQRAFIEWLLAQGPSSGAPPPS-NH_2
36	H-Y-DAla-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS-NH_2
37	H-Y-DAla-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-NH_2
38	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAQGPSSGAPPPS-NH_2
39	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAQGPSSGAPPPS-NH_2
40	H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQAFIEWLLAQGPSSGAPPPS-NH_2
41	H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazine-1-yl)-acetyl]-Peg3-Peg3)-AAQAFIEWLLAQGPSSGAPPPS-NH_2

Synthesis of compound no. 9

[0136] Solid phase peptide synthesis was performed on a CEM Liberty Peptide Synthesizer using standard Fmoc chemistry. TentaGel S Ram S resin (1,05 g; 0.23 mmol/g) was swelled in DMF (10 ml) prior to use and transferred between tube and reaction vessel using DCM and DMF.

Coupling

[0137] An Fmoc-amino acid in DMF/DCM (2:1 ; 0.2 M; 5 ml) was added to the resin in a CEM Discover microwave unit together with COMU/DMF (0.5 M; 2 ml) and DIPEA-DMF/DCM (2:1) (2.0 M; 1 ml). The coupling mixture was heated to 75°C for 5 min while nitrogen was bubbled through the mixture. The resin was then washed with DMF (4 x 10 ml). Fmoc-Tyr(OtBu)-Ser(Psi Me,Me)-OH pseudoproline was used for amino acid number 29 and 30 counting from the C-terminal. Lys17 was incorporated as Fmoc-Lys(Dde)-OH for orthogonal coupling. The

first 9 amino acids and amino acid number 24 (counting from the C-terminal) was double couple meaning the building block was coupled twice before deprotection. Boc-Tyr(tBu)-OH was incorporated as the final building block in the N-terminal.

Deprotection

[0138] Piperidine/DMF (20%; 10 ml) was added to the resin for initial deprotection and the mixture was heated by microwaves (30 sec; 40°C). The reaction vessel was drained and a second portion of piperidine/DMF (20%; 10 ml) was added and heated (75°C; 3 min.) again. The resin was then washed with DMF (6 x 10 ml).

Side chain acylation

[0139] While the peptide was still attached to the resin, the orthogonal side chain protective group was selectively cleaved using freshly prepared hydrazine hydrate (2-4%) in NMP for 2 x 15 min. The unprotected lysine side chain was first coupled with Fmoc-Glu-OtBu and the two Peg3 buildingblocks using standard coupling and deprotection conditions as explained above. Lastly the lipophilic moiety was incorporated as a 19-carboxy-nonadecanoic acid mono tert butyl ester again using standard coupling conditions.

Cleavage

[0140] The resin was washed with EtOH (3 x 10 ml) and Et2O (3 x 10 ml) and dried to constant weight at room temperature (r.t.). The crude peptide was cleaved from the resin by treatment with TFA/TIS/H_2O (95/2.5/2.5; 60 ml, 2 h; r.t.). Most of the TFA was removed at reduced pressure and the crude peptide was precipitated and washed three times with diethylether and dried to constant weight at room temperature.

HPLC purification of the crude peptide

[0141] The crude peptide was first purified from 30% by preparative reverse phase HPLC using a Gilson 331 pump with a Gilson GX281 fraction collector equipped with a Gemini NX 5µ C-18 110A, 10x250 mm column and run at 47 ml/min with a gradient of buffer A (0.1% TFA, aq.) and buffer B (0.1% TFA, 90% MeCN, aq.). Fractions were analyzed by analytical HPLC and MS and relevant fractions were pooled and lyophilized. A second purification was performed using the same method to obtain the product in 96% purify (53 mg) as characterized by HPLC and MS. Calculated monoisotopic mass = 5025,54 found 5025,72.

Example 2

Human GIP receptor (GIP R) activity assay

[0142] *In vitro* effects of peptide conjugates of the invention were assessed by measuring the induction of cAMP following stimulation of the respective receptor by GIP or analogues of these, as outlined in the invention, using the AlphaSceen® cAMP kit from Perkin-Elmer according to instructions. Briefly, HEK293 cells expressing the human GIP R (stable cell lines generated through transfection of the cDNA for human GIP R and selection of stable clones) were seeded at 30,000 cells/well in 96-well microtiter plates coated with 0.01 % poly-L-lysine, and grown for 1 day in culture in 200 µl growth medium (DMEM, 10% FCS, Penicillin (100 IU/ml), Streptomycin (100 µg/ml)). On the day of analysis, growth medium was removed and the cells were washed once with 150 µl Tyrode's buffer (Tyrode's Salts (9.6 g/l), 10 mM HEPES, pH 7.4). Cells were then incubated in 100 µl Assay buffer (0.1% W/V Alkali-treated Casein and 100 µM IBMX in Tyrode's Buffer) containing increasing concentrations of control and test compounds for 15 min at 37° C. The Assay buffer was removed and cells are lysed in 80 µl Lysis buffer (0.1 % w/v BSA, 5 mM HEPES, 0.3 % v/v Tween-20) per well. From each well 10 µl lysed cells was transferred to a 384-well plate and mixed with 15 µl bead-mix (1 Unit/15 µl anti-cAMP Acceptor Beads, 1 Unit/15 µl Donor Beads, and 1 Unit/15 µl Biotinylated cAMP in Assay Buffer). The plates were mixed and incubated in the dark for an hour at room temperature before measuring using an Envision™ plate reader (Perkin-Elmer).

[0143] Results were converted into cAMP concentrations using a cAMP standard curve prepared in KRBH buffer containing 0.1% (v/v) DMSO. The resulting cAMP curves were plotted as absolute cAMP concentrations (nM) over log (test compound concentration) and analyzed using the curve fitting program XLfit.

[0144] Parameter calculated to describe both the potency as well as the agonistic activity of each test compound on the receptors were:
EC50, a concentration resulting in a half-maximal elevation of cAMP levels, reflecting the potency of the test compound. The results are summarized in Table 2.

Table 2: EC_{50} average values of the compounds on the GIP-R compared to control peptide.

Compound	hGIP-R level of cAMP (nM)
hGIP	0.003
1	0.008
2	0.013
3	0.014
4	0.013
5	0.014
6	0.032

Compound	hGIP-R level of cAMP (nM)
7	0.018
8	0.009
9	0.008
10	0.007
11	0.009
12	0.009
13	0.014
14	0.024
15	0.012
16	0.016
17	0.007
18	0.006
19	0.006
20	0.007
21	0.007
22	0.005
23	0.010
24	0.008
25	0.032
26	0.017
27	0.013
28	0.007
29	0.014
30	0.009
31	0.012
32	0.020
33	0.014
34	0.011
35	0.008
36	0.006
37	0.016
38	0.001
39	0.007
40	0.010
41	0.014

Compound	hGIP-R level of cAMP (nM)

Example 3

Activity assays at human GIP receptor (GIP R) and human GLP-1 receptor (GLP-1R)

[0145] *In vitro* effects of peptide conjugates were assessed by measuring the induction of cAMP following stimulation of the respective receptor using the AlphaScreen® cAMP kit from Perkin-Elmer according to instructions. Briefly, HEK293 cells expressing the GIP R or the GLP-1 R (stable cell lines generated through transfection of expression vector containing the cDNA for the receptor in question and selection of stable clones) were seeded at 30,000 cells/well in 96-well microtiter plates coated with 0.01 % poly-L-lysine, and grown for 1 day in culture in 200 µl growth medium (DMEM, 10% FCS, Penicillin (100 IU/ml), Streptomycin (100 µg/ml)). On the day of analysis, growth medium was removed and the cells were washed once with 150 µl Tyrode's buffer (Tyrode's Salts (9.6 g/l), 10 mM HEPES, pH 7.4). Cells were then incubated in 100 µl Assay buffer (0.05% W/V Alkali-treated Casein and 100 µM IBMX in Tyrode's Buffer) containing increasing concentrations of control and test compounds for 15 min at 37° C. The Assay buffer was removed and cells are lysed in 80 µl Lysis buffer (0.1 % w/v BSA, 5 mM HEPES, 0.3 % v/v Tween-20) per well. From each well 10 µl lysed cells was transferred to a 384-well plate and mixed with 15 µl bead-mix (1 Unit/15 µl anti-cAMP Acceptor Beads, 1 Unit/15 µl Donor Beads, and 1 Unit/15 µl Biotinylated cAMP in Assay Buffer). The plates were mixed and incubated in the dark for an hour at room temperature before measuring using an Envision™ plate reader (Perkin-Elmer).

[0146] The cAMP response was normalized relative to a positive and negative control (reference agonist (0.1 nM human GIP or 1 nM Exendin-4) and assay buffer, respectively) to calculate the EC50 and maximal response from the concentration response curve using 4 parameter logistic (4PL) nonlinear regression model for curve fitting.

[0147] The EC50s, a concentration resulting in a half-maximal elevation of cAMP levels, reflecting the potencies of the test agonist compounds are summarized in Table 2a.

Table 2a: EC_{50} average values of the compounds compared to control peptides. NT = Not tested, NA = No activity

Compound	EC50 hGIP R (nM)	EC50 hGLP1 R (nM)
Exendin-4	NT	0,004
hGIP	NT	>100
1	0,003	NA
2	0,008	NT

Compound	EC50 hGIP R (nM)	EC50 hGLP1 R (nM)
3	0,014	NA
4	0,014	NT
5	0,014	NT
6	0,014	NT
7	0,032	NA
8	0,019	>10
9	0,009	>3
10	0,008	>10
11	0,008	>3
12	0,009	>3
13	0,008	>10
14	0,014	>10
15	0,024	>100
16	0,012	>10
17	0,016	>3
18	0,007	>3
19	0,005	>3
20	0,006	>3
21	0,006	>3
22	0,007	>10
23	0,005	>10
24	0,010	>10
25	0,008	>100
26	0,032	>10
27	0,017	>10
28	0,013	>3
29	0,007	>100
30	0,014	>10
31	0,009	>100
32	0,012	>100
33	0,020	>10
34	0,017	>10
35	0,011	>3
36	0,006	>10
37	0,006	>10

Compound	EC50 hGIP R (nM)	EC50 hGLP1 R (nM)
38	0,017	>100
39	0,001	>100
40	0,007	>10
41	0,010	>10

Example 4

Pharmacokinetics of selected compounds in mice

Method

[0148] C57BL/6J mice (males with a body weight of approximately 25 g) were given either a single subcutaneous (*s.c.*) bolus or a single intravenous (*i.v.*) bolus of each peptide to be tested.

[0149] Following s.c. administration of the selected compounds (50, 100 or 200 nmol/kg), blood samples were drawn at 8 (eight) timepoints up to 96 hours post-dose. Following *i.v.* administration of the selected compounds (50, 100 or 200 nmol/kg), blood samples were drawn at 8 (eight) timepoints up to 72 hours post-dose. Blood samples were drawn by sublingual bleeding. The dosing vehicle was a phosphate buffer containing mannitol (pH 7.5).

[0150] At each sampling time point, samples from two mice were drawn, i.e. 16 mice were included for each compound and each administration route. The mice were euthanized immediately after blood sampling by cervical dislocation. Plasma samples were analyzed after solid phase extraction (SPE) or protein precipitation followed by liquid chromatography mass spectrometry (LC-MS/MS). Mean plasma concentrations were used for calculation of the pharmacokinetic parameters using the non-compartmental approach in Phoenix WinNonlin 6.3. Plasma terminal elimination half-life (T½) was determined as ln(2)/λz where λz is the magnitude of the slope of the log linear regression of the log concentration versus time profile during the terminal phase. Bioavailability was determined as AUC_{inf} (*s.c.*) / AUC_{inf} (*i.v.*) x 100, where AUC_{inf} is the area under the plasma concentration - time curve extrapolated to infinity (AUC_{inf} = AUC_{last} + Clast/λz, where C_{last} is the last observed plasma concentration). T_{max} is the post-dose time where the maximal plasma concentration was observed. The results are summarized in Table 3.

Table 3. Terminal elimination half-life (h) and bioavailability in mice following s.c. and *i.v.* administration of selected compounds.

Compound	T½(h.)		Tmax (h.)	Bioavailability
	i.v.	*s.c.*	*s.c*	*s.c.*
hGIP	0.1	-	-	-
10	16.9	21.1	4	100%*^
12	14.7	16.8	8	77%^
15	19.2	16.7	8	87%
16	23.3	23.6	8	81%
13	14.4	13.7	8	75%
16	19.2	16.7	8	88%
17	16.3	19.9	8	56%
18	17.6	15.1	4	78%
21	24.8	21.0	8	67%
33	21.7	18.7	8	78%
35	14.5	14.5	4	73%
41	17.6	16.5	8	70%
*: The bioavailability was capped to 100% ^: In a repeated test the bioavalability of Compound 10 was 77% and the bioavailability of Compound 12 was 98%.				

Example 5

OGTT (Oral Glucose Tolerance Test) in normal mice.

[0151] Male C57BL/6J mice (Charles River, Germany) were maintained on normal chow (Altromin 1324, Brogaarden A/S, Gentofte, Denmark) and domestic quality water with added citric acid to pH ~ 3.6. The animals were housed in groups of n = 3 in a light-, temperature-, and humidity-controlled room (12:12 h light-dark cycle, with lights on at 06.00-18.00 hr; 21 ± 1°C; 50-80% relative humidity). Mice, 10-12 weeks old, were fasted 5 hours before the OGTT. GIP receptor agonists (3 - 300 nmol/kg), the GLP-1 analogue liraglutide (10 nmol/kg) and vehicle were administered (5 mL/kg) subcutaneously (s.c.) 4 hours before the oral gavage of glucose (t = 0 min; 2 g/kg; 5 mL/kg). Tail vein blood was sampled at time t = 0 (before glucose administration), 15, 30, 60, and 120 min for measurements of blood glucose. Results (blood glucose levels and area under the blood glucose curves (AUC). Data are means ± SEM; n = 6) from 2 experiments are shown in Figure 1 (A - D) and 2 (A - E).

[0152] Statistical analyses were performed using Graph Pad Prism version 5. The blood glucose AUCs were compared using one-way ANOVA followed by Dunnett's Multiple

Comparison Tests vs. vehicle group. Differences were considered statistically significant at $p < 0.05$. Statistical differences vs vehicle: *p<0.05, **p<0.01, ***p<0.001.

Example 6

Sub-chronic effects of co-treatment of GIP receptor agonist and GLP-1 receptor agonist on body weight in diet-induced obese (DIO) C57BL/6J mice

[0153] Male C57BL/6J (JAX) mice (Charles River, UK) fed high-fat diet (45% of total energy from fat, D12451 Research Diet Inc.) for approximately 4 months were used. The animals were housed in groups of n = 3 in a light-, temperature-, and humidity-controlled room (12:12 h light-dark cycle, with lights on at 07.00-19.00 hr; 21 ± 2°C; 55 ± 20% relative humidity). Mice were single-housed two weeks prior to start of the mock phase. All mice were mock-treated (once daily s.c. injection of vehicle) for a week to acclimatize the animals to handling and injections. Subsequently, the mice were stratified according to body weight into treatment groups (n = 8-9). The average starting body weight was 39-40 grams. Animals were thereafter treated once daily with two separate s.c. injections (3 mL/kg of each injection) from day 1 to day 22. The first injection was with vehicle 1 (25 mM phosphate, 125 mM sodium chloride buffer, pH 7.4) or GLP-1 analogue liraglutide (20 nmol/kg). The second injection was with vehicle 2 (25 mM phosphate, 205 mM D-Mannitol, pH 7.5) or GIP agonist (3 and 30 nmol/kg). The GIP agonist was only dosed every third day of the study (starting on day 1). On other days, GIP agonist was replaced with vehicle 2. The daily injections were given in the morning (at 9.00-10.00). Body weight was determined daily throughout the study. Changes in body weight during the study are shown in Figure 3 (delta Δ = body weight at each study day - body weight at day 1. Data are means ± SEM).

[0154] Statistical analyses were performed using Graph Pad Prism version 5. The change in body weight of liraglutide-treated mice was compared with mice co-administered liraglutide and GIP agonist by two-way ANOVA followed by Bonferroni posttests. P<0.05 was considered statistically significant. The change in body weight of vehicle-treated control mice was compared with compound-treated mice by two-way ANOVA followed by Bonferroni posttests; ***p<0.001 vs. vehicle. Statistical differences vs vehicle are shown for day 22 in Figure 3.

Example 7

Sub-chronic effects of co-treatment of GIP receptor agonists and GLP-1 receptor agonist on body weight in diet-induced obese (DIO) C57BL/6J mice

[0155] Male C57BL/6J mice (Charles River, Germany) fed high-fat diet (60% of total energy

from fat, DIO Rodent Purified 58Y1 - 58126 from TestDiet) for approximately 5 months were used. The animals were housed in groups of n = 3 in a light-, temperature-, and humidity-controlled room (12:12 h light-dark cycle, with lights on at 06.00-18.00 hr; 21 ± 1°C; 65 ± 15% relative humidity). All mice were mock-treated (once daily s.c. injection of vehicle) for a week to acclimatize the animals to handling and injections. Subsequently, the mice were stratified according to body weight into treatment groups (n = 9). The average starting body weight was 40-41 grams. Animals were thereafter treated once daily with two separate s.c. injections (5 mL/kg of each injection) from day 0 to day 27. The first injection was with vehicle 1 (25 mM phosphate, 125 mM sodium chloride buffer, pH 7.4) or GLP-1 analogue liraglutide (20 nmol/kg). The second injection was with vehicle 2 (25 mM phosphate, 205 mM D-Mannitol, pH 7.5) or GIP agonist (30 and/or 300 nmol/kg). The GIP agonist was only dosed every third day of the study (starting on day 0). On other days, GIP agonist was replaced with vehicle 2. The daily injections were given in the morning (at 9.00-10.00). Body weight was determined daily throughout the study. Changes in body weight during the study (delta Δ body weight = body weight at each study day - body weight at day 0. Data are means ± SEM) are shown in Figure 4 A (Compound 10 and 12), B (Compound 17), C (Compound 18), D (compound 35) and E (Compound 41).

[0156] Statistical analyses were performed for using Graph Pad Prism version 5. The change in body weight of liraglutide-treated mice was compared with mice co-administered liraglutide and GIP agonist by two-way ANOVA followed by Bonferroni posttests. $P<0.05$ was considered statistically significant (illustrated with lines below the body weight curves). The change in body weight of vehicle-treated control mice was compared with compound-treated mice by two-way ANOVA followed by Bonferroni posttests; ***$p<0.001$ vs. vehicle. Statistical differences vs vehicle are shown for day 27 (Figure 4 A-E).

REFERENCES CITED IN THE DESCRIPTION

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Patentkrav

1. GIP-analog, der er repræsenteret ved den generelle Formel I:
R^1-Tyr-X2-Glu-Gly-Thr-Phe-Ile-Ser-Asp-X10-X11-X12-Glu-Leu-X15-X16-X17-X18-X19-X20-X21-Phe-X23-X24-X25-Leu-X27-X28-X29-Y1-Y2-R^2 (I)

hvor

R^1 er H-, Ac eller pGlu;

X2 er Aib, Ala, D-Ala, Gly, Ser, N-Me-Ser, Ac3c, Ac4c eller Ac5c;

X10 er Tyr, Leu eller Ser;

X11 er Ser eller Leu;

X12 er Lys, Ψ eller Ile;

X15 er Asp eller Glu;

X16 er Ser, Glu, Lys eller Ψ;

X17 er Ile, Lys, Gln, Arg eller Ψ;

X18 er His, Arg eller Ala;

X19 er Gln, Lys, Ala eller Glu;

X20 er Gin, Lys, Ala, His eller Arg;

X21 er Ala, Leu, Asp eller Glu;

X23 er Val eller Ile;

X24 er Asn eller Glu;

X25 er Tyr eller Trp;

X27 er Leu, Glu, Ser, Lys eller Val;

X28 er Ala, Ser eller Arg;

X29 er Aib, Gly, Ala, Gin, Thr, Ser eller Lys eller er fraværende;

Y1 er Lys-Gly, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Gly-Lys-Lys-Asn-Asp-Trp-Lys-His-Asn-Ile-Thr-Gln eller fraværende;

Y2 er Ψ eller er fraværende;

R^2 er $-NH_2$ eller -OH;

hvor Ψ er en rest uafhængigt udvalgt blandt Lys, Arg, Orn og Cys, og hvor sidekæden af resten er konjugeret til en lipofil substituent;

hvor GIP-analogen indeholder en og kun en rest Ψ;

og hvor GIP-analogen har agonistaktivitet ved GIP-receptoren;

eller et farmaceutisk acceptabelt salt eller solvat deraf.

2. GIP-analog, salt eller solvat ifølge krav 1, omfattende en af følgende rester eller kombinationer af rester:

Aib2, Asp15, Lys20;
Aib2, Asp15, Arg20;
Aib2, Asp15, Arg20, Ile23;
Aib2, Ile12, Asp15, Arg20, Ile23, Glu24;
Ile12, Asp15, Ile23;
Ile12, Asp15, Ile23 Glu24;
Ile12, Asp15, Ala21, Ile23;
Aib2, Ala21, Ile23, Glu24;
Aib2, Asp15, Ile23;
Aib2, Asp15, Arg20, Ile23, Gln29;
Aib2, Asp15, Arg20, Gly29;
Aib2, Asp15, Ile17, Arg20, Gly29;
Aib2, Asp15, Ile17, Lys20, Gly29;
DAla2, Asp15, Ile23;
DAla2, Asp15, Ile23, Ala28;
Aib2, Asp15, Ile17, Lys20, Ala28;
Asp15, Ile23, Glu24;
N-Me-Ser2, Asp15, Lys20;
N-Me-Ser2, Asp15, Arg20;
N-Me-Ser2, Asp15, Arg20, Ile23;
N-Me-Ser2, Ile12, Asp15, Arg20, Ile23, Glu24;
N-Me-Ser2, Ala21, Ile23, Glu24;
N-Me-Ser2, Asp15, Ile23;
N-Me-Ser2, Asp15, Arg20, Ile23, Gln29;
N-Me-Ser2, Asp15, Arg20, Gly29;
N-Me-Ser2, Asp15, Ile17, Arg20, Gly29;
N-Me-Ser2, Asp15, Ile17, Lys20, Gly29;
N-Me-Ser2, Asp15, Ile23;
N-Me-Ser2, Asp15, Ile23, Ala28;
Ac3c2, Asp15, Lys20;

Ac3c2, Asp15, Arg20;
Ac3c2, Asp15, Arg20, Ile23;
Ac3c2, Ile12, Asp15, Arg20, Ile23, Glu24;
Ac3c2, Ala21, Ile23, Glu24;
Ac3c2, Asp15, Ile23;
Ac3c2, Asp15, Arg20, Ile23, Gln29;
Ac3c2, Asp15, Arg20, Gly29;
Ac3c2, Asp15, Ile17, Arg20, Gly29;
Ac3c2, Asp15, Ile17, Lys20, Gly29;
Ac3c2, Asp15, Ile23;
Ac3c2, Asp15, Ile23, Ala28
Ac4c2, Asp15, Lys20;
Ac4c2, Asp15, Arg20;
Ac4c2, Asp15, Arg20, Ile23;
Ac4c2, Ile12, Asp15, Arg20, Ile23, Glu24;
Ac4c2, Ala21, Ile23, Glu24;
Ac4c2, Asp15, Ile23;
Ac4c2, Asp15, Arg20, Ile23, Gln29;
Ac4c2, Asp15, Arg20, Gly29;
Ac4c2, Asp15, Ile17, Arg20, Gly29;
Ac4c2, Asp15, Ile17, Lys20, Gly29;
Ac4c2, Asp15, Ile23;
Ac4c2, Asp15, Ile23, Ala28
Ac5c2, Asp15, Lys20;
Ac5c2, Asp15, Arg20;
Ac5c2, Asp15, Arg20, Ile23;
Ac5c2, Ile12, Asp15, Arg20, Ile23, Glu24;
Ac5c2, Ala21, Ile23, Glu24;
Ac5c2, Asp15, Ile23;
Ac5c2, Asp15, Arg20, Ile23, Gln29;
Ac5c2, Asp15, Arg20, Gly29;
Ac5c2, Asp15, Ile17, Arg20, Gly29;
Ac5c2, Asp15, Ile17, Lys20, Gly29;
Ac5c2, Asp15, Ile23;

Ac5c2, Asp15, Ile23, Ala28.

3. GIP-analog ifølge krav 1, der er repræsenteret ved den generelle Formel II:
R^1-Tyr-X2-Glu-Gly-Thr-Phe-Ile-Ser-Asp-Tyr-Ser-X12-Glu-Leu-X15-X16-X17-X18-X19-X20-X21-Phe-X23-X24-X25-Leu-X27-X28-X29-Y1-Y2-R^2 (II)

hvor

R^1 er H-, Ac eller pGlu;

X2 er Aib, Ala, D-Ala, Gly;

X12 er Lys, Ψ eller Ile;

X15 er Asp eller Glu;

X16 er Ser, Glu, Lys eller Ψ;

X17 er Ile, Lys, Gln, Arg eller Ψ;

X18 er His, Arg eller Ala;

X19 er Gln eller Ala;

X20 er Gin, Lys, Ala, His eller Arg;

X21 er Ala, Asp eller Glu;

X23 er Ile eller Val;

X24 er Asn eller Glu;

X25 er Tyr eller Trp;

X27 er Leu, Glu, Ser, Lys eller Val;

X28 er Ala, Ser eller Arg;

X29 er Aib, Gly, Ala, Gin, Thr, Ser eller Lys eller er fraværende;

Y1 er Lys-Gly, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Gly-Lys-Lys-Asn-Asp-Trp-Lys-His-Asn-Ile-Thr-Gln eller fraværende;

Y2 er Ψ eller er fraværende;

R^2 er $-NH_2$ eller -OH;

hvor Ψ er en Lys-rest, hvor sidekæden af Lys-resten er konjugeret til en lipofil substituent;

og hvor GIP-analogen indeholder en og kun en rest Ψ;

og hvor GIP-analogen har agonistaktivitet ved GIP-receptoren;

eller et farmaceutisk acceptabelt salt eller solvat deraf.

4. GIP-analog, salt eller solvat ifølge krav 3, omfattende en af følgende rester eller kombinationer af rester

Aib2, Lys12, Asp15, Lys20;
Aib2, Lys12, Asp15, Arg20;
Aib2, Asp15, Arg20;
Aib2, Ile12, Asp15, Arg20, Glu24;
Ile12, Asp15, Ile23;
Ile12, Asp15, Glu24;
Ile12, Asp15, Ala21;
Aib2, Lys12, Ala21, Glu24;
Aib2, Lys12, Asp15;
Aib2, Lys,12, Asp15, Arg20, Gln29;
Aib2, Lys, 12, Asp15, Arg20, Gly29;
Aib2, Lys12, Asp15, Ile17, Arg20, Gly29;
Aib2, Asp15, Ile17, Lys20, Gly29;
DAla2, Asp15;
DAla2, Asp15, Ala28;
Aib2, Asp15, Ile17, Lys20, Ala28;
Asp15, Glu24;
Ala2, Lys12, Asp15, Lys20;
Ala2, Lys12, Asp15, Arg20;
Ala2, Asp15, Arg20;
Ala2, Ile12, Asp15, Arg20, Glu24;
Ala2, Ile12, Asp15, Ile23;
Ala2, Ile12, Asp15, Glu24;
Ala2, Ile12, Asp15, Ala21;
Ala2, Lys12, Ala21, Glu24;
Ala2, Lys12, Asp15;
Ala2, Lys12, Asp15, Arg20, Gln29;
Ala2, Lys12, Asp15, Arg20, Gly29;
Ala2, Lys12, Asp15, Ile17, Arg20, Gly29;
Ala2, Asp15, Ile17, Lys20, Gly29;
Ala2, Asp15;
Ala2, Asp15, Ala28;

Ala2, Asp15, Ile17, Lys20, Ala28;
Gly2, Lys12, Asp15, Lys20;
Gly2, Lys12, Asp15, Arg20;
Gly2, Asp15, Arg20;
Gly2, Ile12, Asp15, Arg20, Glu24;
Gly2, Ile12, Asp15, Ile23;
Gly2, Ile12, Asp15, Glu24;
Gly2, Ile12, Asp15, Ala21;
Gly2, Lys12, Ala21, Glu24;
Gly2, Lys12, Asp15;
Gly2, Lys12, Asp15, Arg20, Gln29;
Gly2, Lys12, Asp15, Arg20, Gly29;
Gly2, Lys12, Asp15, Ile17, Arg20, Gly29;
Gly2, Asp15, Ile17, Lys20, Gly29;
Gly2, Asp15;
Gly2, Asp15, Ala28;
Gly2, Asp15, Ile17, Lys20, Ala28;
Gly2, Asp15, Glu24.

5. GIP-analog ifølge krav 1, der er repræsenteret ved den generelle Formel III:

R^1-Tyr-Aib-Glu-Gly-Thr-Phe-Ile-Ser-Asp-Tyr-Ser-Ile-Glu-Leu-X15-X16-X17-X18-X19-X20-X21-Phe-Val-X24-X25-Leu-Leu-Ala-X29-Y1-Y2-R^2 (III)

hvor

R^1 er H-, Ac eller pGlu;
X15 er Asp eller Glu;
X16 er Lys eller Ψ;
X17 er Ile eller Ψ;
X18 er His eller Ala;
X19 er Gln eller Ala;
X20 er Gin, Lys eller Arg;
X21 er Ala, Asp eller Glu;
X24 er Asn eller Glu;
X25 er Tyr eller Trp
X28 er Ala, Ser eller Arg;

X29 er Gin eller er fraværende;
Y1 er Lys-Gly, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Gly-Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Pro-Ser, Pro-Ser-Ser-Gly-Ala-Pro-Pro-Ser, Gly-Lys-Lys-Asn-Asp-Trp-Lys-His-Asn-Ile-Thr-Gln eller fraværende;
Y2 er Ψ eller er fraværende;
R^2 er $-NH_2$ eller -OH;
hvor Ψ er en rest uafhængigt udvalgt blandt Lys, Arg, Orn og Cys, og hvor sidekæden af resten er konjugeret til en lipofil substituent;
og hvor GIP-analogen indeholder en og kun en rest Ψ;
og hvor GIP-analogen har agonistaktivitet ved GIP-receptoren;
eller et farmaceutisk acceptabelt salt eller solvat deraf.

6. GIP-analog, salt eller solvat ifølge krav 5, omfattende en af følgende rester eller kombinationer af rester:
Asp15, Lys20;
Asp15, Arg20;
Asp15, Arg20, Glu24;
Asp15, Lys16;
Asp15, Lys16, Glu24;
Asp15, Ψ16, Ala21;;
Ala21Glu24;
Asp15, Arg20, Gln29;
Asp15, Arg20, Gly29;
Asp15, Ile17, Arg20, Gly29;
Asp15, Ile17, Lys20, Gly29;
Asp15Ala28;
Asp15, Ile17, Lys20, Ala28;
Asp15, Ile23, Glu24;
Asp15, Ψ17, Lys20;
Asp15, Ψ17, Arg20;
Asp15, Ψ17, Arg20
Asp15, Ψ17, Arg20, Glu24;
Asp15, Lys 16, Ψ17;

Asp15, Lys 16, Ψ17, Glu24;
Asp15, Ψ17, Ala21;
Ala21, Ψ17, Glu24;
Asp15, Asp15, Ψ17, Arg20, Gln29;
Asp15, Ψ17, Arg20, Gly29;
Asp15, Ile17, Arg20, Gly29;
Asp15, Ile17, Lys20, Gly29;
Asp15; Ψ17;
Asp15, Ψ17, Ala28;
Asp15, Ile17, Lys20, Ala28;
Asp15, Ψ17, Ile23, Glu24.

7. GIP-analog, salt eller solvat ifølge et af kravene 1 til 6, hvor Ψ er en rest af Lys, Arg, Orn eller Cys, hvori sidekæden er konjugeret til en substituent med formlen $-Z^1$ eller $-Z^2-Z^1$.

8. GIP-analog, salt eller solvat ifølge krav 7, hvor:
(i) $-Z^1$ er en fedtkæde med, ved en terminus, en forbindelse -X- til Ψ eller til Z^2; hvor -X- er en binding, -CO-, -SO- eller $-SO_2-$;
og eventuelt har Z^1 en polær gruppe i enden af kæden distalt fra forbindelse -X-; idet den polære gruppe omfatter en carboxylsyre eller en carboxylsyre-bioisoster, en phosphonsyre eller en sulfonsyregruppe;
(ii) Z^1 er en gruppe med formel:

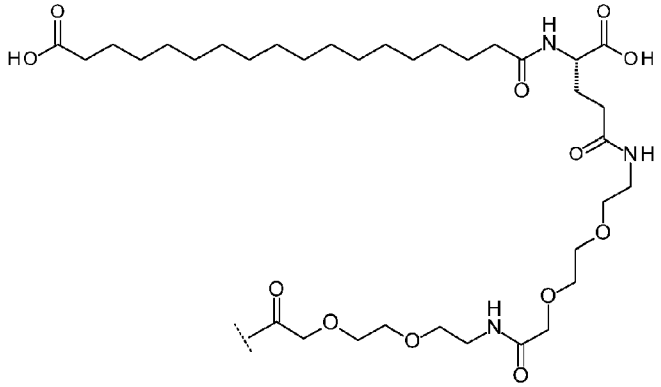
A-B-Alk-X- hvor
A er hydrogen eller en carboxylsyre, en carboxylsyrebioisoster, en phosphonsyre eller en sulfonsyresyregruppe;
B er en binding eller en linker;
X er en binding, acyl (-CO-), sulfinyl (-SO-) eller sulfonyl ($-SO_2-$); og
Alk er en fedtkæde, der eventuelt kan være substitueret med en eller flere substituenter;
(iii) Z^1 er:
A-B-C_{16-20}alkylen-(CO)-, hvor A er H eller -COOH, og B er en binding, f.eks.:
17-carboxy-heptadecanoyl HOOC-$(CH_2)_{16}$-(CO)-;

19-carboxy-nonadecanoyl	$HOOC-(CH_2)_{18}-(CO)-$;
Octadecanoyl	$H_3C-(CH_2)_{16}-(CO)-$; eller
Eicosanoyl	$H_3C-(CH_2)_{18}-(CO)-$; og/eller

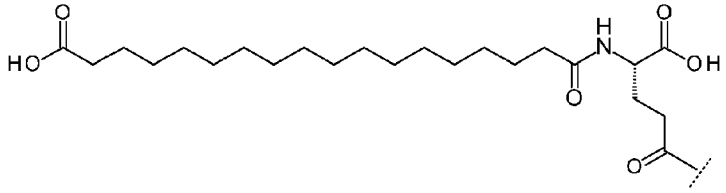
(iv) Z^2 er en spacer bundet ved en terminus med Y, som er et nitrogen-, oxygen- eller svovlatom, og ved den anden terminus med X, som er en binding eller en acyl (-CO-), sulfinyl (-SO-), sulfonyl ($-SO_2-$) eller fraværende.

9. GIP-analog, salt eller solvat ifølge krav 7 eller krav 8, hvor $-Z^{1-}$ Z^2 er:

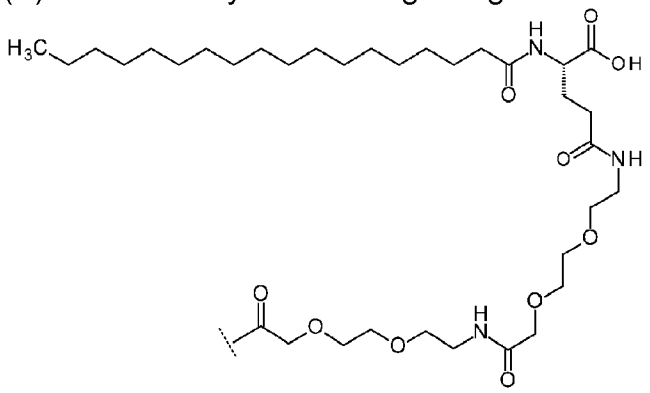
(i) [17-carboxy-heptadecanoyl]-isoGlu-Peg3-Peg3



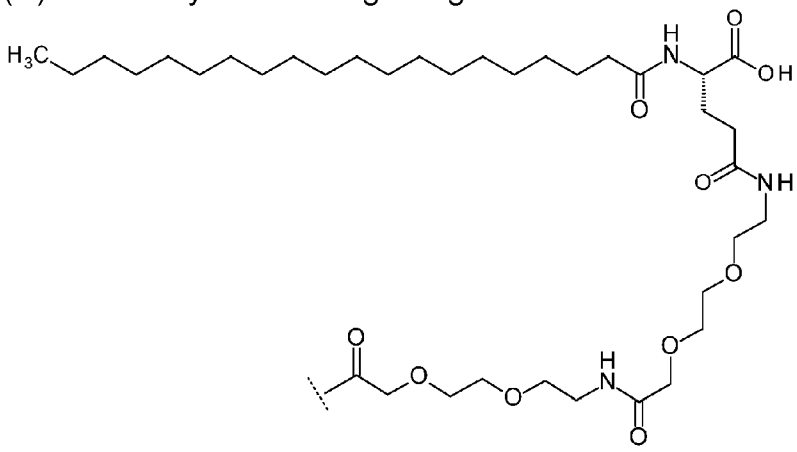
(ii) [17-carboxy-heptadecanoyl]-isoGlu



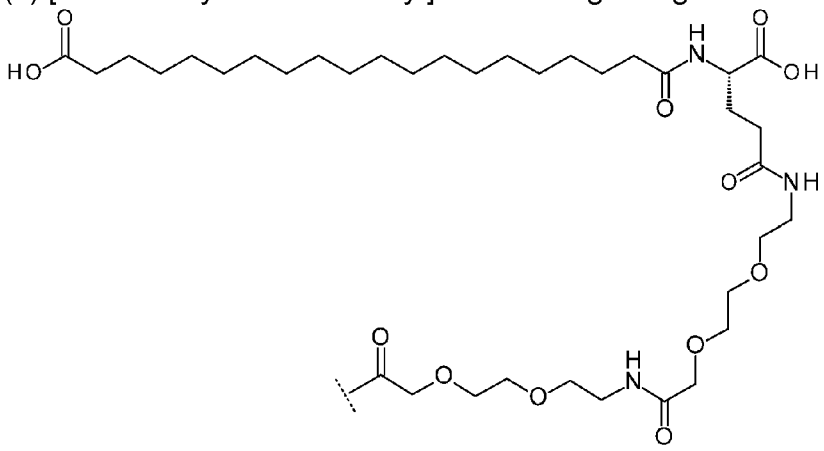
(iii) Octadecanoyl-isoGlu-Peg3-Peg3



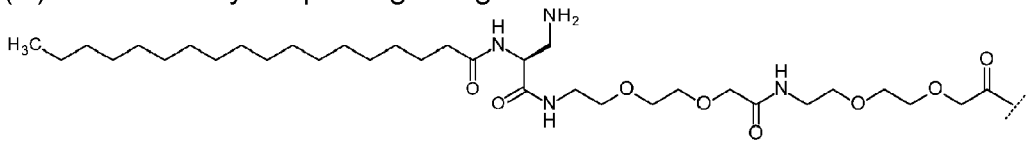
(iv) Eicosanoyl-isoGlu-Peg3-Peg3



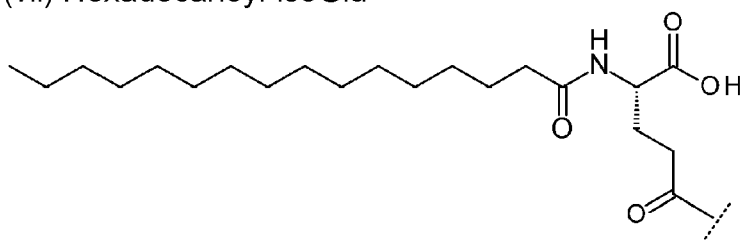
(v) [19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3



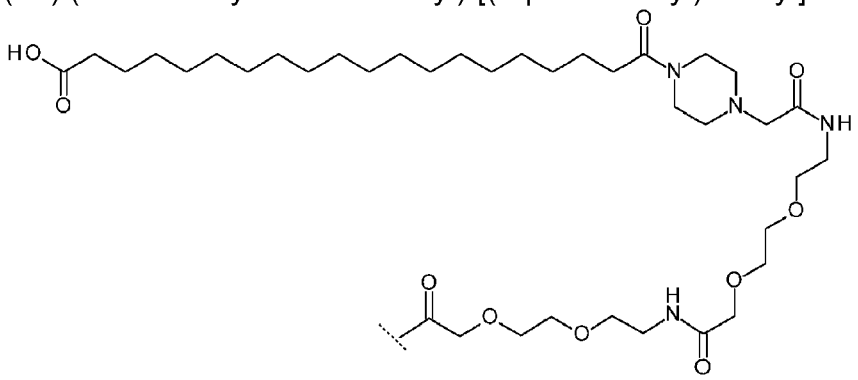
(vi) Octadecanoyl-Dapa-Peg3-Peg3



(vii) Hexadecanoyl-isoGlu



(viii) (19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3



10. GIP-analog, salt eller solvat ifølge et af kravene 1 til 3 med sekvensen:
Y-Aib-EGTFISDYSIELDKΨHQQDFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDΨIHQQDFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELEKΨHQQDFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPSΨ;
Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPSΨ;
Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQΨ;
Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQKGΨ;
Y-Aib-EGTFISDYSIELDKΨHQQDFVNYLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDKΨHQQDFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDKΨAAQDFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELEKΨAAKEFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELEKΨAQRAFVEWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQGPSSGAPPPSΨ;
Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQΨ;
Y-Aib-EGTFISDYSIELDKΨAAQDFVNWLLAGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDKIAAQDFVNWLLAGPSSGAPPPSΨ;
Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAGPSSGAPPPSKΨ;
Y-Aib-EGTFISDYSIELDKIAQKEFIEWLLAGPSSGAPPPSKΨ;
Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPSKΨ;
Y-Aib-EGTFISDYSIELDKIAAQDFVEWLLAGPSSGAPPPSKΨ;
Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAQGPSSGAPPPSKΨ;
Y-Aib-EGTFISDYSIELDKΨIAQRAFIEWLLAQGPSSGAPPPS;

Y-Aib-EGTFISDYSKΨELDKIAQRAFIEWLLAQGPSSGAPPPS; eller
Y-DAIa-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPSKΨ.

11. GIP-analog, salt eller solvat ifølge et af kravene 1 til 3 med sekvensen:
Y-Aib-EGTFISDYSIELDK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELD-K(Hexadecanoyl-isoGlu)-IHQQDFVNWLLAQGPSS-GAPPPS;
Y-Aib-EGTFISDYSIELEK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);
Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K(Hexadeca-noyl-isoGlu);
Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQ-K(Hexadecanoyl-isoGlu);
Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQKG-K(Hexadecanoyl-isoGlu);
Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNYLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAKEFVNWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);
Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQ-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);
Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDKIAAQDFVNWLLAGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);

Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);
Y-Aib-EGTFISDYSIELDKIAQKEFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);
Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);
Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3);
Y-Aib-EGTFISDYSIELDKIAAQDFVEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);
Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAQGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3);
Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQAFVNWLLAGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAAGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS;

Y-Aib-EGTFISDYSIELD-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-IAQRAFIEWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-ELD-KIAQRAFIEWLLAQGPSSGAPPPS;
Y-DAIa-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS;
Y-DAIa-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3);
Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAQGPSSGAPPPS;
Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQAFIEWLLAQGPSSGAPPPS; eller
Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AAQAFIEWLLAQGPSSGAPPPS.

12. GIP-analog, salt eller solvat ifølge et af kravene 1 til 3, som er:
H-Y-Aib-EGTFISDYSIELDK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELD-K(Hexadecanoyl-isoGlu)-IHQQDFVNWLLAQGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELEK-K(Hexadecanoyl-isoGlu)-HQQDFVNWLLAQGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2;
H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQGPSSGAPPPS-K(Hexadecanoyl-isoGlu)-NH_2;
H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQ-K(Hexadecanoyl-isoGlu)-NH_2;
H-Y-Aib-EGTFISDYSIELDKIHQQDFVNWLLAQKG-K(Hexadecanoyl-isoGlu)-NH_2;
H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNYLLAQGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-HQQDFVNWLLAQGPSSGAPPPS-NH_2

H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAQGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAKEFVNWLLAQGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELEK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2;

H-Y-Aib-EGTFISDYSIELEKIAQRAFVEWLLAQ-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2;

H-Y-Aib-EGTFISDYSIELDK-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELDKIAAQDFVNWLLAGPSSGAPPPS-K([19-carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2;

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AQRAFVEWLLAQGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQKEFVEWLLAAGPSSGAPPPS-NH_2;

H-Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2;

H-Y-Aib-EGTFISDYSIELDKIAQKEFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2;

H-Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2;

H-Y-Aib-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-NH_2;
H-Y-Aib-EGTFISDYSIELDKIAAQDFVEWLLAGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2;
H-Y-Aib-EGTFISDYSIELDKIAQRAFIEWLLAQGPSSGAPPPS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-NH_2;
H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQAFVNWLLAGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFVNWLLAAGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AAQDFIEWLLAGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELD-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-IAQRAFIEWLLAQGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYS-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-ELDKIAQRAFIEWLLAQGPSSGAPPPS-NH_2;
H-Y-DAla-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AQRAFIEWLLAQGPSSGAPPPS-NH_2;
H-Y-DAla-EGTFISDYSIELDKIAAQDFIEWLLAGPSSGAPPPS-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-NH_2;
H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFIEWLLAQGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQDFINWLLAQGPSSGAPPPS-NH_2;
H-Y-Aib-EGTFISDYSIELDK-K([19-Carboxy-nonadecanoyl]-isoGlu-Peg3-Peg3)-AAQAFIEWLLAQGPSSGAPPPS-NH_2; eller
H-Y-Aib-EGTFISDYSIELDK-K((19-Carboxy-nonadecanoyl)-[(Piperazin-1-yl)-acetyl]-Peg3-Peg3)-AAQAFIEWLLAQGPSSGAPPPS-NH_2.

13. Farmaceutisk sammensætning, omfattende en GIP-analog ifølge et af kravene 1 til 12, eller et farmaceutisk acceptabelt salt eller solvat deraf, blandet med en bærer.

14. GIP-analog ifølge et af kravene 1 til 12, eller et farmaceutisk acceptabelt salt eller solvat deraf, til anvendelse i en fremgangsmåde til medicinsk behandling.

15. GIP-analog ifølge et af kravene 1 til 12, eller et farmaceutisk acceptabelt salt eller solvat deraf, til anvendelse i en fremgangsmåde til behandling og/eller forebyggelse af en metabolisk lidelse, hvor den metaboliske lidelse eventuelt er diabetes, en diabetesrelateret lidelse, obesitet eller en obesitetsrelateret lidelse.

16. GIP-analog, salt eller solvat til anvendelse ifølge krav 15, hvor den diabetesrelaterede lidelse er insulinresistens, glucoseintolerance, øget fasteglucose, hyperglykæmi (f.eks. induceret af insulinbehandling), prædiabetes, type 1-diabetes, type 2-diabetes, gestationel diabetes-hypertension, dyslipidæmi, aterosklerose, arteriosklerose, koronar hjertesygdom, perifer arteriessygdom, slagtilfælde; eller er en tilstand associeret med aterogen dyslipidæmi, en blodfedtlidelse, forhøjet blodtryk, hypertension, en protrombotisk tilstand eller en proinflammatorisk tilstand eller osteoporose.

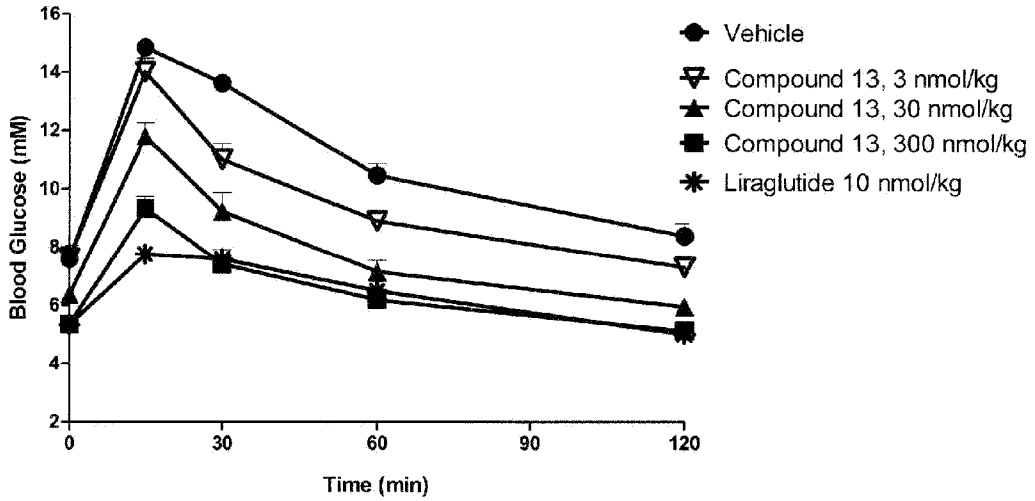
17. GIP-analog, salt eller solvat til anvendelse ifølge krav 16, hvor blodfedtlidelsen er høje triglycerider, lavt HDL-kolesterol, højt LDL-kolesterol, plakopbygning i aterievægge eller en kombination deraf.

18. GIP-analog, salt eller solvat til anvendelse ifølge krav 15, hvor den obesitetsrelaterede lidelse er obesitetsforbundet inflammation, obesitetsforbundet galdeblæresygdom, obesitetsinduceret søvnapnø, aterogen dyslipidæmi, blodfedtlidelser, forhøjet blodtryk, hypertension, en protrombotisk tilstand eller en proinflammatorisk tilstand eller en kombination deraf.

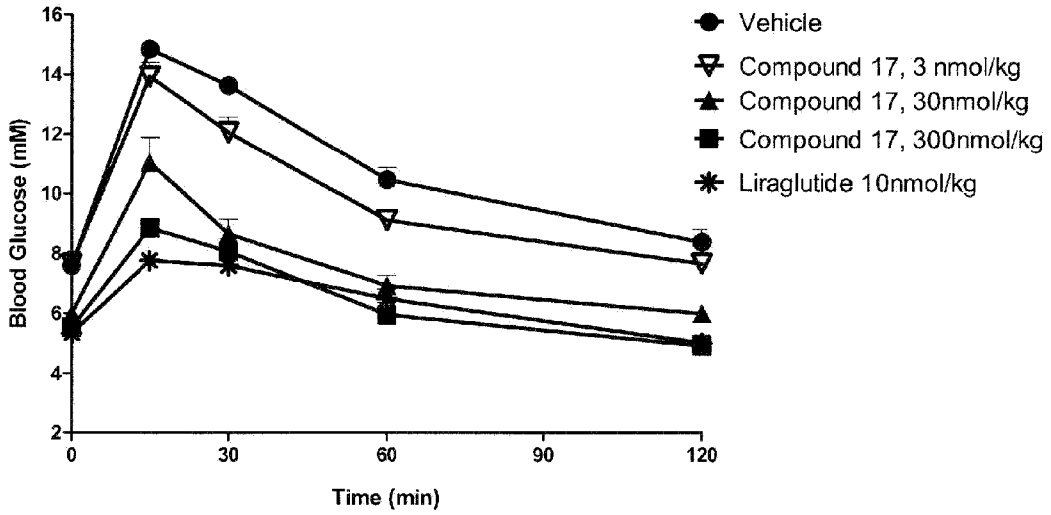
DRAWINGS

Figure 1

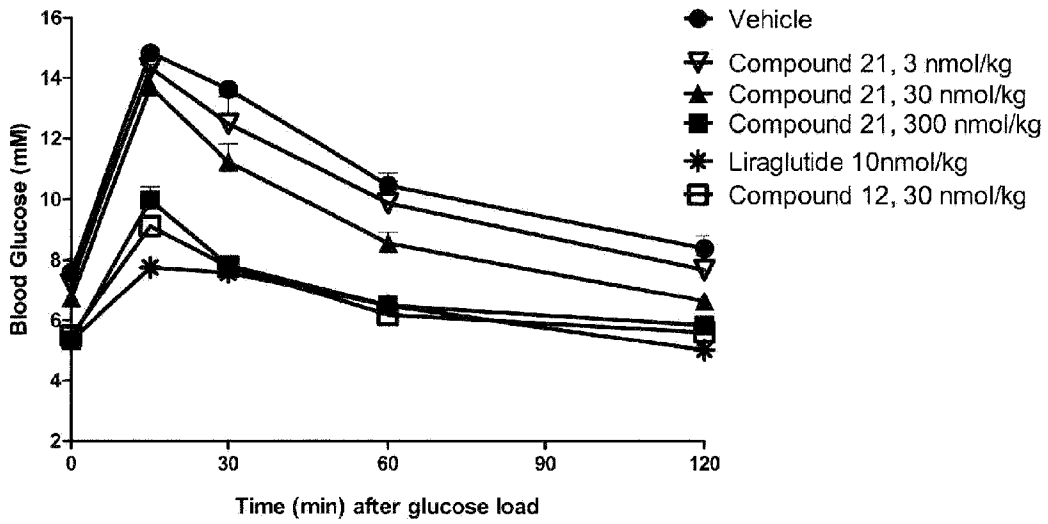
A



B



C


Blood Glucose (mM)
16
14
12
10
8
6
4
2
0
30
60
90
120
Time (min) after glucose load
Vehicle
Compound 21, 3 nmol/kg
Compound 21, 30 nmol/kg
Compound 21, 300 nmol/kg
Liraglutide 10nmol/kg
Compound 12, 30 nmol/kg

D

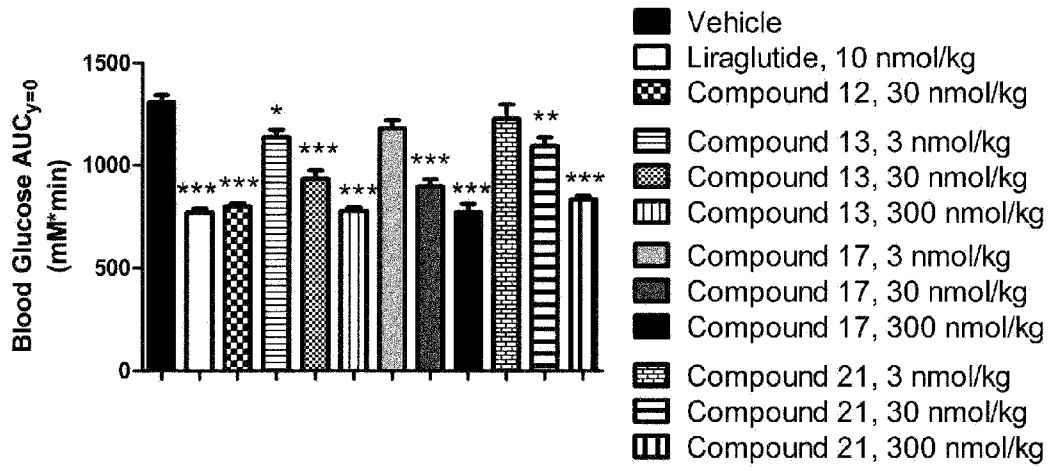
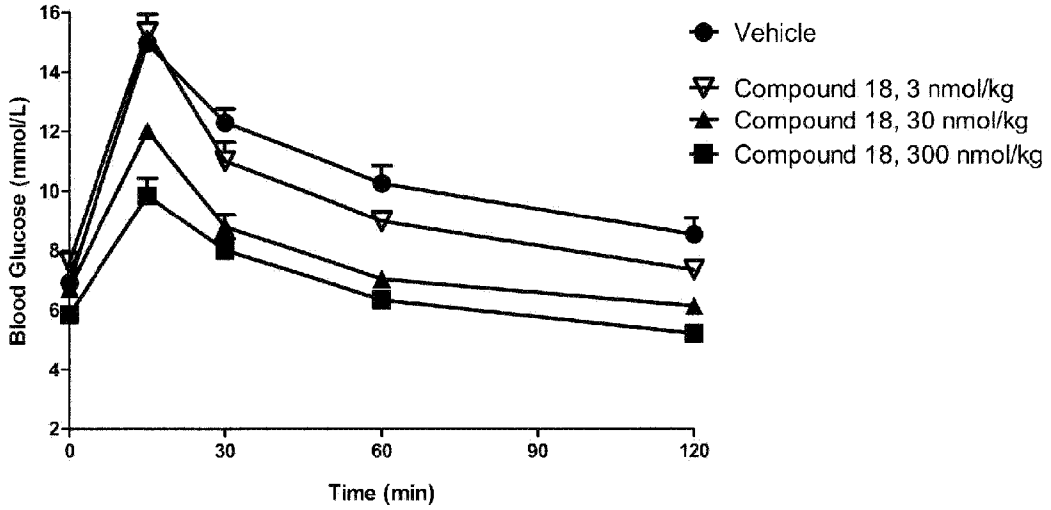
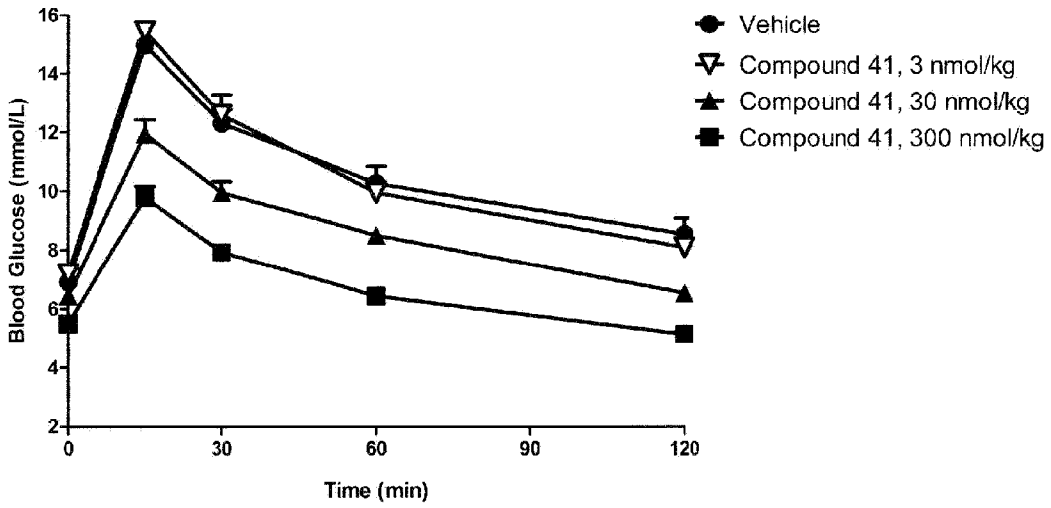

Blood Glucose AUC y=0
(mM*min)
1500
1000
500
0
***
***
***
*
***
***
***
***
**
***
Vehicle
Liraglutide, 10 nmol/kg
Compound 12, 30 nmol/kg
Compound 13, 3 nmol/kg
Compound 13, 30 nmol/kg
Compound 13, 300 nmol/kg
Compound 17, 3 nmol/kg
Compound 17, 30 nmol/kg
Compound 17, 300 nmol/kg
Compound 21, 3 nmol/kg
Compound 21, 30 nmol/kg
Compound 21, 300 nmol/kg

Figure 2

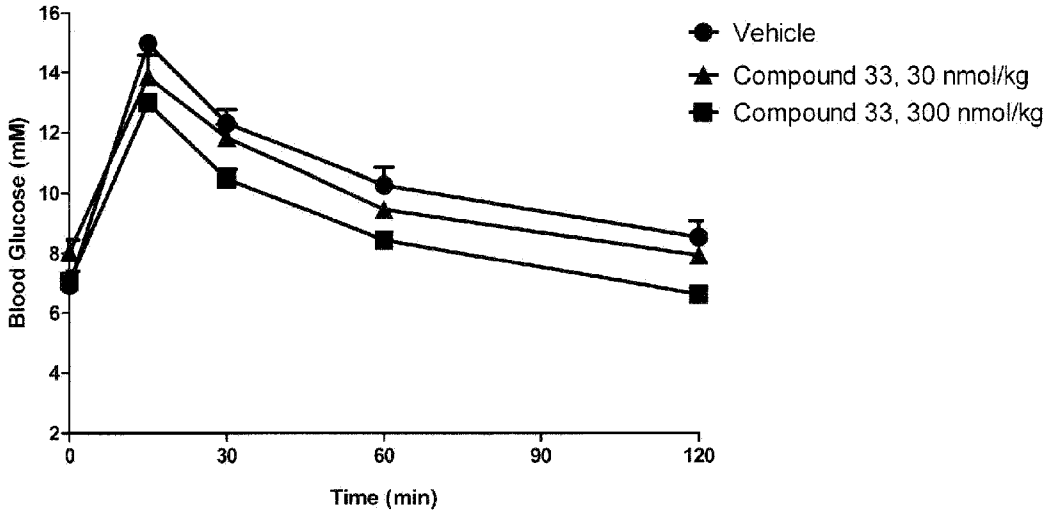
A


Blood Glucose (mmol/L)
16
14
12
10
8
6
4
2
0
30
60
90
120
Time (min)
Vehicle
Compound 18, 3 nmol/kg
Compound 18, 30 nmol/kg
Compound 18, 300 nmol/kg

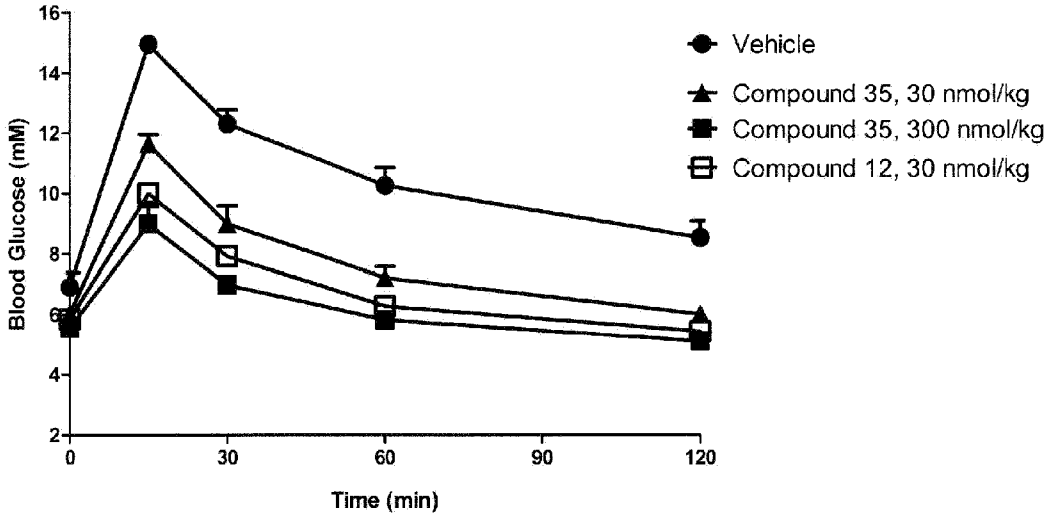
B


Blood Glucose (mmol/L)
16
14
12
10
8
6
4
2
0
30
60
90
120
Time (min)
Vehicle
Compound 41, 3 nmol/kg
Compound 41, 30 nmol/kg
Compound 41, 300 nmol/kg

C


Blood Glucose (mM)
16
14
12
10
8
6
4
2
0
30
60
90
120
Time (min)
Vehicle
Compound 33, 30 nmol/kg
Compound 33, 300 nmol/kg

D


Blood Glucose (mM)
16
14
12
10
8
6
4
2
0
30
60
90
120
Time (min)
Vehicle
Compound 35, 30 nmol/kg
Compound 35, 300 nmol/kg
Compound 12, 30 nmol/kg

E

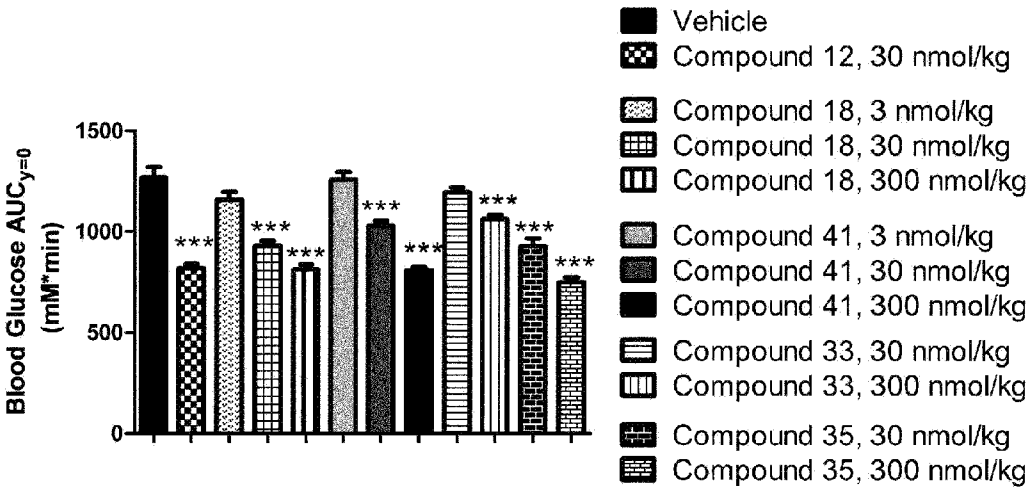

Blood Glucose AUC$_{y=0}$ (mM*min)
1500
1000
500
0
***
Vehicle
Compound 12, 30 nmol/kg
Compound 18, 3 nmol/kg
Compound 18, 30 nmol/kg
Compound 18, 300 nmol/kg
Compound 41, 3 nmol/kg
Compound 41, 30 nmol/kg
Compound 41, 300 nmol/kg
Compound 33, 30 nmol/kg
Compound 33, 300 nmol/kg
Compound 35, 30 nmol/kg
Compound 35, 300 nmol/kg

Figure 3:

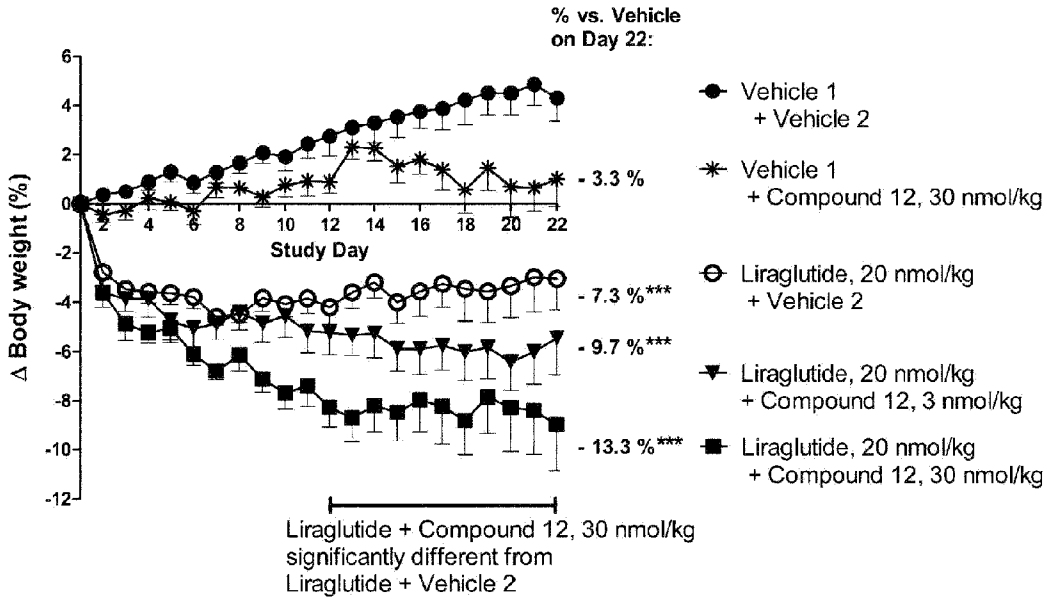
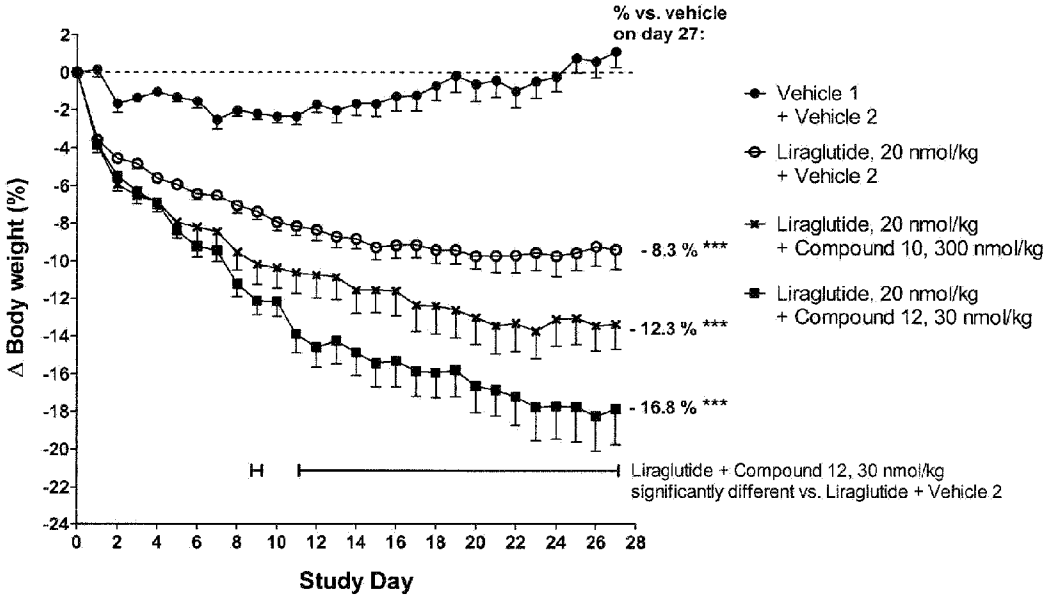
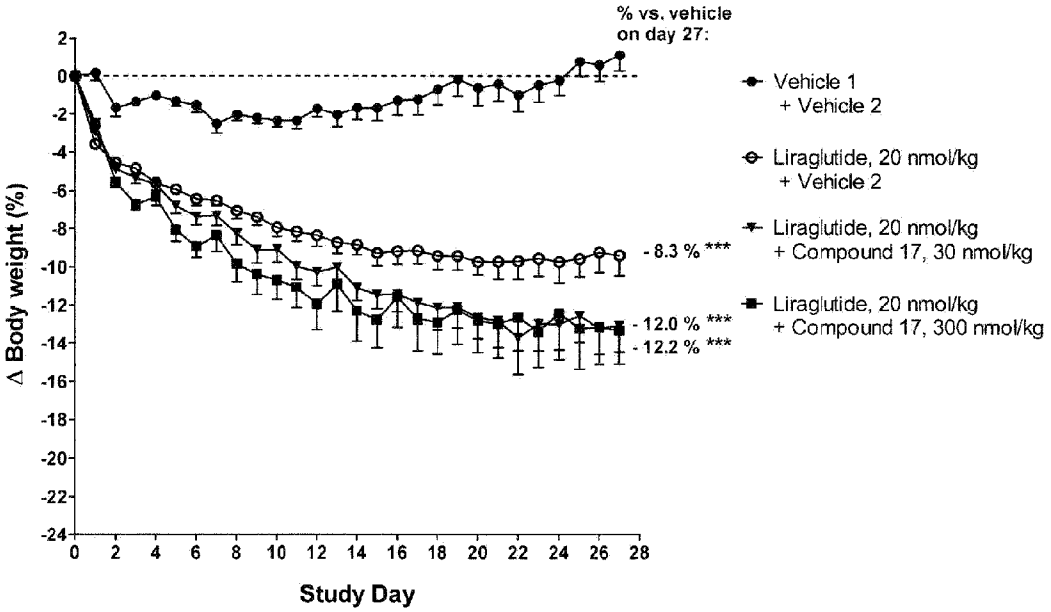

% vs. Vehicle on Day 22:
Δ Body weight (%)
Study Day
- 3.3 %
- 7.3 %***
- 9.7 %***
- 13.3 %***
Vehicle 1 + Vehicle 2
Vehicle 1 + Compound 12, 30 nmol/kg
Liraglutide, 20 nmol/kg + Vehicle 2
Liraglutide, 20 nmol/kg + Compound 12, 3 nmol/kg
Liraglutide, 20 nmol/kg + Compound 12, 30 nmol/kg
Liraglutide + Compound 12, 30 nmol/kg significantly different from Liraglutide + Vehicle 2

Figure 4:

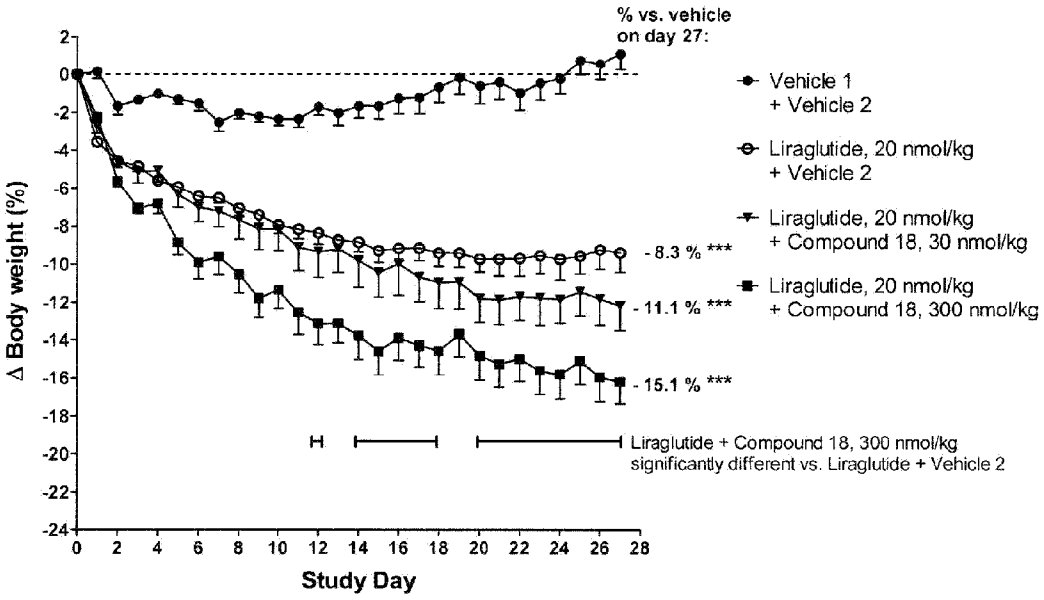
A


% vs. vehicle on day 27:
Vehicle 1 + Vehicle 2
Liraglutide, 20 nmol/kg + Vehicle 2
Liraglutide, 20 nmol/kg + Compound 10, 300 nmol/kg
Liraglutide, 20 nmol/kg + Compound 12, 30 nmol/kg
- 8.3 % ***
- 12.3 % ***
- 16.8 % ***
H
Liraglutide + Compound 12, 30 nmol/kg significantly different vs. Liraglutide + Vehicle 2
Δ Body weight (%)
Study Day

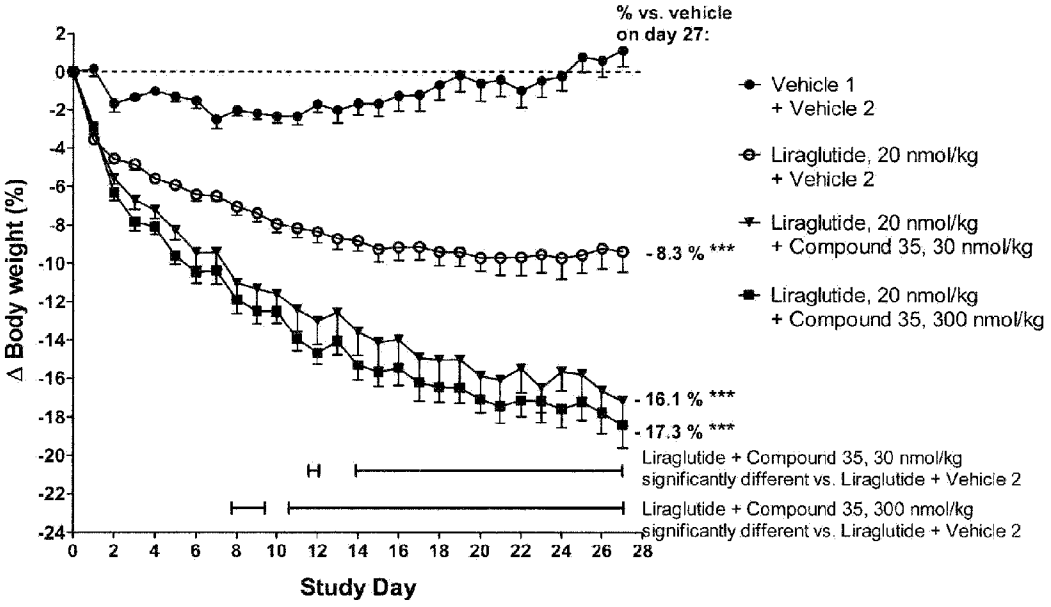
B


% vs. vehicle on day 27:
Vehicle 1 + Vehicle 2
Liraglutide, 20 nmol/kg + Vehicle 2
Liraglutide, 20 nmol/kg + Compound 17, 30 nmol/kg
Liraglutide, 20 nmol/kg + Compound 17, 300 nmol/kg
- 8.3 % ***
- 12.0 % ***
- 12.2 % ***
Δ Body weight (%)
Study Day

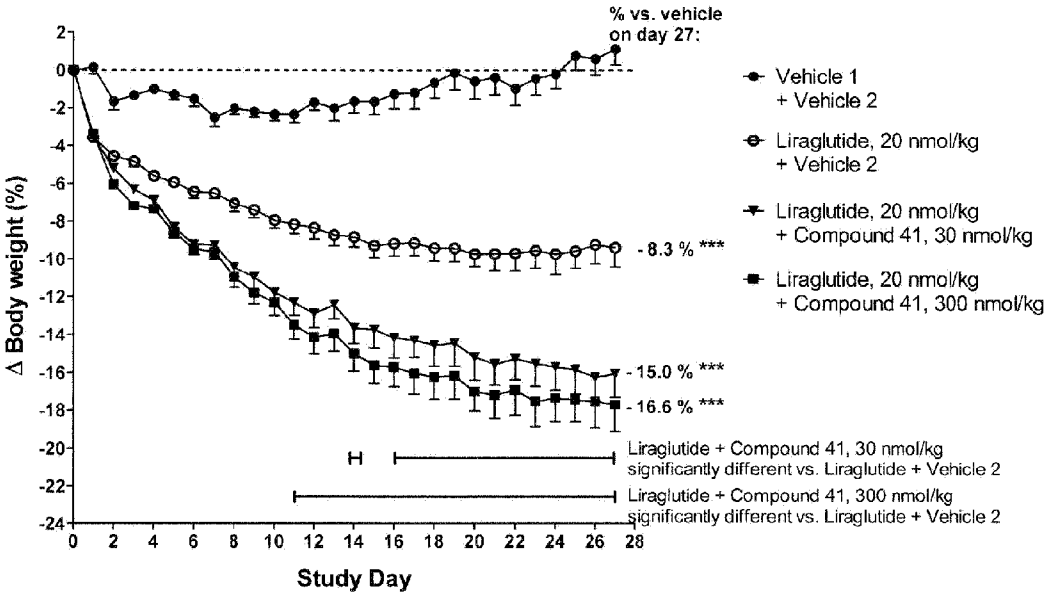
C


% vs. vehicle
on day 27:
Vehicle 1
+ Vehicle 2
Liraglutide, 20 nmol/kg
+ Vehicle 2
Liraglutide, 20 nmol/kg
+ Compound 18, 30 nmol/kg
Liraglutide, 20 nmol/kg
+ Compound 18, 300 nmol/kg
- 8.3 % ***
- 11.1 % ***
- 15.1 % ***
H
Liraglutide + Compound 18, 300 nmol/kg
significantly different vs. Liraglutide + Vehicle 2
Δ Body weight (%)
Study Day

D


% vs. vehicle
on day 27:
Vehicle 1
+ Vehicle 2
Liraglutide, 20 nmol/kg
+ Vehicle 2
Liraglutide, 20 nmol/kg
+ Compound 35, 30 nmol/kg
Liraglutide, 20 nmol/kg
+ Compound 35, 300 nmol/kg
- 8.3 % ***
- 16.1 % ***
- 17.3 % ***
H
Liraglutide + Compound 35, 30 nmol/kg
significantly different vs. Liraglutide + Vehicle 2
Liraglutide + Compound 35, 300 nmol/kg
significantly different vs. Liraglutide + Vehicle 2
Δ Body weight (%)
Study Day

E


% vs. vehicle on day 27:
Vehicle 1 + Vehicle 2
Liraglutide, 20 nmol/kg + Vehicle 2
Liraglutide, 20 nmol/kg + Compound 41, 30 nmol/kg
Liraglutide, 20 nmol/kg + Compound 41, 300 nmol/kg
- 8.3 % ***
- 15.0 % ***
- 16.6 % ***
H
Liraglutide + Compound 41, 30 nmol/kg significantly different vs. Liraglutide + Vehicle 2
Liraglutide + Compound 41, 300 nmol/kg significantly different vs. Liraglutide + Vehicle 2
Δ Body weight (%)
Study Day
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28