



US006268343B1

(12) **United States Patent**
Knudsen et al.

(10) **Patent No.:** **US 6,268,343 B1**

(45) **Date of Patent:** **Jul. 31, 2001**

(54) **DERIVATIVES OF GLP-1 ANALOGS**

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(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) **Appl. No.:** **09/258,750**

(22) **Filed:** **Feb. 26, 1999**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/038,432, filed on Mar. 11, 1998, now abandoned, which is a continuation-in-part of application No. 08/918,810, filed on Aug. 26, 1997, now abandoned, and a continuation-in-part of application No. PCT/DK97/00340, filed on Aug. 22, 1997

(60) Provisional application No. 60/035,904, filed on Jan. 24, 1997, provisional application No. 60/036,226, filed on Jan. 25, 1997, provisional application No. 60/036,255, filed on Jan. 24, 1997, provisional application No. 60/082,478, filed on Apr. 21, 1998, provisional application No. 60/082,480, filed on Apr. 21, 1998, provisional application No. 60/082,802, filed on Apr. 23, 1998, and provisional application No. 60/084,357, filed on May 5, 1998.

(30) **Foreign Application Priority Data**

Aug. 30, 1996	(DK)	0931/96
Nov. 8, 1996	(DK)	1259/96
Dec. 20, 1996	(DK)	1470/96
Feb. 27, 1998	(DK)	0263/98
Feb. 27, 1998	(DK)	0264/98
Feb. 27, 1998	(DK)	0268/98
Feb. 27, 1998	(DK)	0272/98
Feb. 27, 1998	(DK)	0274/98
Apr. 8, 1998	(DK)	0508/98
Apr. 8, 1998	(DK)	0509/98

(51) **Int. Cl.⁷** **A61K 39/16; A61K 38/26; C07K 14/00; C07K 14/605**

(52) **U.S. Cl.** **514/12; 530/324**

(58) **Field of Search** **530/324; 514/12**

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Primary Examiner—Michael Borin

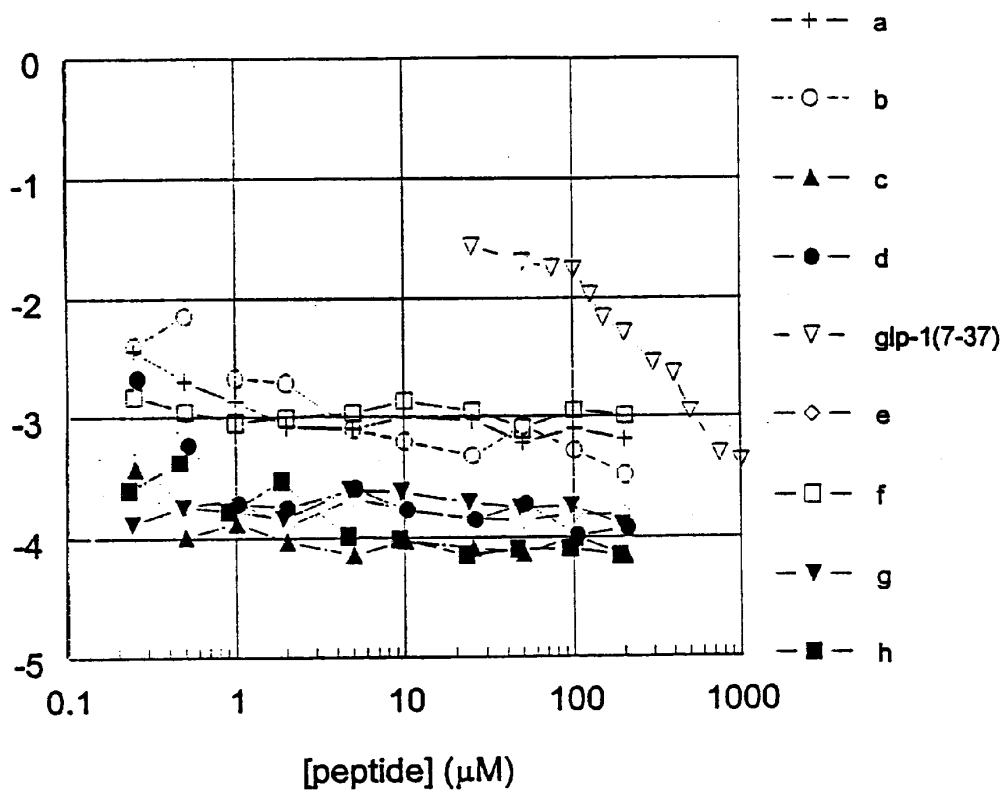
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(57) **ABSTRACT**

The present invention relates to GLP-1 derivatives having a lipophilic substituent, pharmaceutical compositions comprising same, and methods of making an using same. The GLP-1 derivatives of the present invention have a protracted profile of action.

40 Claims, 1 Drawing Sheet

Fig. 1



DERIVATIVES OF GLP-1 ANALOGS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of Ser. No. 09/038,432 filed Mar. 11, 1998, now abandoned which is a continuation-in-part of Ser. No. 08/918,810 filed Aug. 26, 1997 now abandoned and of PCT application serial no. PCT/DK97/00340 filed Aug. 22, 1997, and claims priority of U.S. provisional application Ser. Nos. 60/035,904, 60/036,226, 60/036,255, 60/082,478, 60/082,480, 60/082,802, and 60/084,357 filed Jan. 24, 1997, Jan. 25, 1997, Jan. 24, 1997, Apr. 21, 1998, Apr. 21, 1998, Apr. 23, 1998, and May 5, 1998, respectively, and of Danish application serial nos. 0931/96, 1259/96, 1470/96, 0263/98, 0264/98, 0268/98, 0272/98, 0274/98, 0508/98, and 0509/98 filed Aug. 30, 1996, Nov. 8, 1996, Dec. 20, 1996, Feb. 27, 1998, Feb. 27, 1998, Feb. 27, 1998, Feb. 27, 1998, Apr. 8, 1998, and Apr. 8, 1998, respectively, the contents of each of which is fully incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to novel derivatives of human glucagon-like peptide-1 (GLP-1) and fragments and/or analogues thereof which have a protracted profile of action and to methods of making and using them.

BACKGROUND OF THE INVENTION

Peptides are widely used in medical practice, and since they can be produced by recombinant DNA technology it can be expected that their importance will increase also in the years to come. When native peptides or analogues thereof are used in therapy it is generally found that they have a high clearance. A high clearance of a therapeutic agent is inconvenient in cases where it is desired to maintain a high blood level thereof over a prolonged period of time since repeated administrations will then be necessary. Examples of peptides which have a high clearance are: ACTH, corticotropin-releasing factor, angiotensin, calcitonin, insulin, glucagon, glucagon-like peptide-1, glucagon-like peptide-2, insulin-like growth factor-1, insulin-like growth factor-2, gastric inhibitory peptide, growth hormone-releasing factor, pituitary adenylate cyclase activating peptide, secretin, enterogastrin, somatostatin, somatotropin, somatomedin, parathyroid hormone, thrombopoietin, erythropoietin, hypothalamic releasing factors, prolactin, thyroid stimulating hormones, endorphins, enkephalins, vasopressin, oxytocin, opioids and analogues thereof, superoxide dismutase, interferon, asparaginase, arginase, arginine deaminase, adenosine deaminase and ribonuclease. In some cases it is possible to influence the release profile of peptides by applying suitable pharmaceutical compositions, but this approach has various shortcomings and is not generally applicable.

The hormones regulating insulin secretion belong to the so-called enteroinsular axis, designating a group of hormones, released from the gastrointestinal mucosa in response to the presence and absorption of nutrients in the gut, which promote an early and potentiated release of insulin. The enhancing effect on insulin secretion, the so-called incretin effect, is probably essential for a normal glucose tolerance. Many of the gastrointestinal hormones, including gastrin and secretin (choleystokinin is not insulinotropic in man), are insulinotropic, but the only physiologically important ones, those that are responsible for the incretin effect, are the glucose-dependent insulinotropic

polypeptide, GIP, and glucagon-like peptide-1 (GLP-1). Because of its insulinotropic effect, GIP, isolated in 1973 (1) immediately attracted considerable interest among diabetologists. However, numerous investigations carried out during the following years clearly indicated that a defective secretion of GIP was not involved in the pathogenesis of insulin dependent diabetes mellitus (IDDM) or non insulin-dependent diabetes mellitus (NIDDM)(2). Furthermore, as an insulinotropic hormone, GIP was found to be almost ineffective in NIDDM (2). The other incretin hormone, GLP-1 is the most potent insulinotropic substance known (3). Unlike GIP, it is surprisingly effective in stimulating insulin secretion in NIDDM patients. In addition, and in contrast to the other insulinotropic hormones (perhaps with the exception of secretin) it also potently inhibits glucagon secretion. Because of these actions it has pronounced blood glucose lowering effects particularly in patients with NIDDM.

GLP-1, a product of the proglucagon (4), is one of the youngest members of the secretin-VIP family of peptides, but is already established as an important gut hormone with regulatory function in glucose metabolism and gastrointestinal secretion and metabolism (5). The glucagon gene is processed differently in the pancreas and in the intestine. In the pancreas (9), the processing leads to the formation and parallel secretion of 1) glucagon itself, occupying positions 33–61 of proglucagon (PG); 2) an N-terminal peptide of 30 amino acids (PG (1–30)) often called glicentin-related pancreatic peptide, GRPP (10, 11); 3) a hexapeptide corresponding to PG (64–69); and, finally, the so-called major proglucagon fragment (PG (72–158)), in which the two glucagon-like sequences are buried (9). Glucagon seems to be the only biologically active product. In contrast, in the intestinal mucosa, it is glucagon that is buried in a larger molecule, while the two glucagon-like peptides are formed separately (8). The following products are formed and secreted in parallel: 1) glicentin, corresponding to PG (1–69), with the glucagon sequence occupying residues Nos. 33–61 (12); 2) GLP-1(7–36)amide (PG(78–107)amide (13), not as originally believed PG (72–107)amide or 108, which is inactive). Small amounts of C-terminally glycine-extended but equally bioactive GLP-1(7–37), (PG (78–108)) are also formed (14); 3) intervening peptide-2(PG (111–112)amide) (15); and 4) GLP-2 (PG(126–158))(15, 16). A fraction of glicentin is claved further into GRPP (PG (1–30)) and oxyntomodulin (PG (33–69)) (17, 18). Of these peptides, GLP-1, has the most conspicuous biological activities.

Being secreted in parallel with glicentin/enteroglucagon, it follows that the many studies of enteroglucagon secretion (6, 7) to some extent also apply to GLP-1 secretion, but GLP-1 is metabolised more quickly with a plasma half-life in humans of 2 min (19). Carbohydrate or fat-rich meals stimulate (20), presumably as a result of direct interaction of yet unabsorbed nutrients with the microvilli of the open-type L-cells of the gut mucosa. Endocrine or neural mechanisms promoting GLP-1 secretion may exist but have not yet been demonstrated in humans.

The incretin function of GLP-1 (29–31) has been clearly illustrated in experiments with the GLP-1 receptor antagonist, exendin 9–39, which dramatically reduces the incretin effect elicited by oral glucose in rats (21, 22). The hormone interacts directly with the β -cells via the GLP-1 receptor (23) which belongs to the glucagon/VIP/calcitonin family of G-protein-coupled- 7-transmembrane spanning

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receptors. The importance of the GLP-1 receptor in regulating insulin secretion was illustrated in recent experiments in which a targeted disruption of the GLP-1 receptor gene was carried out in mice. Animals homozygous for the disruption had greatly deteriorated glucose tolerance and fasting hyperglycaemia, and even heterozygous animals were glucose intolerant (24). The signal transduction mechanism (25) primarily involves activation of adenylate cyclase, but elevations of intracellular Ca^{2+} are also essential (25, 26). The action of the hormone is best described as a potentiation of glucose stimulated insulin release (25), but the mechanism that couples glucose and GLP-1 stimulation is not known. It may involve a calcium-induced calcium release (26, 27). As already mentioned, the insulinotropic action of GLP-1 is preserved in diabetic β -cells. The relation of the latter to its ability to convey "glucose competence" to isolated insulin-secreting cells (26, 28), which respond poorly to glucose or GLP-1 alone, but fully to a combination of the two, is also not known. Equally importantly, however, the hormone also potently inhibits glucagon secretion (29). The mechanism is not known, but seems to be paracrine, via neighbouring insulin or somatostatin cells (25). Also the glucagonostatic action is glucose-dependent, so that the inhibitory effect decreases as blood glucose decreases. Because of this dual effect, if the plasma GLP-1 concentrations increase either by increased secretion or by exogenous infusion the molar ratio of insulin to glucagon in the blood that reaches the liver via the portal circulation is greatly increased, whereby hepatic glucose production decreases (30). As a result blood glucose concentrations decrease. Because of the glucose dependency of the insulinotropic and glucagonostatic actions, the glucose lowering effect is self-limiting, and the hormone, therefore, does not cause hypoglycaemia regardless of dose (31). The effects are preserved in patients with diabetes mellitus (32), in whom infusions of slightly supraphysiological doses of GLP-1 may completely normalise blood glucose values in spite of poor metabolic control and secondary failure to sulphonylurea (33). The importance of the glucagonostatic effect is illustrated by the finding that GLP-1 also lowers blood glucose in type-1 diabetic patients without residual β -cell secretory capacity (34).

In addition to its effects on the pancreatic islets, GLP-1 has powerful actions on the gastrointestinal tract. Infused in physiological amounts GLP-1 potently inhibits pentagastrin-induced as well as meal-induced gastric acid secretion (35, 36). It also inhibits gastric emptying rate and pancreatic enzyme secretion (36). Similar inhibitory effects on gastric and pancreatic secretion and motility may be elicited in humans upon perfusion of the ileum with carbohydrate- or lipid-containing solutions (37, 38). Concomitantly, GLP-1 secretion is greatly stimulated, and it has been speculated that GLP-1 may be at least partly responsible for this so-called "ileal-brake" effect (38). In fact, recent studies suggest that, physiologically, the ileal-brake effects of GLP-1 may be more important than its effects on the pancreatic islets. Thus, in dose response studies GLP-1 influences gastric emptying rate at infusion rates at least as low as those required to influence islet secretion (39).

GLP-1 seems to have an effect on food intake. Intravenous administration of GLP-1 profoundly inhibits food intake in rats (40, 42). This effect seems to be highly specific. Thus, N-terminally extended GLP-1 (PG 72-107) amide is inactive and appropriate doses of the GLP-1 antagonist, exendin 9-39, abolish the effects of GLP-1 (41).

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Acute, peripheral administration of GLP-1 does not inhibit food intake acutely in rats (41, 42). However, it remains possible that GLP-1 secreted from the intestinal L-cells may also act as a satiety signal.

Not only the insulinotropic effects but also the effects of GLP-1 on the gastrointestinal tract are preserved in diabetic patients (43), and may help curtailing meal-induced glucose excursions, but, more importantly, may also influence food intake. Administered intravenously, continuously for one week, GLP-1 at 4 ng/kg/min has been demonstrated to dramatically improve glycaemic control in NIDDM patients without significant side effects (44). The peptide is fully active after subcutaneous administration (45), but is rapidly degraded mainly due to degradation by dipeptidyl peptidase IV-like enzymes (46, 47).

The amino acid sequence of GLP-1 is given i.a. by Schmidt et al. (*Diabetologia* 28 704-707 (1985)). Human GLP-1 is a 37 amino acid residue peptide originating from proglucagon which is synthesised, i.a. in the L-cells in the distal ileum, in the pancreas and in the brain. Processing of proglucagon to GLP-1 (7-36)amide, GLP-1 (7-37) and GLP-2 occurs mainly in the L-cells. Although the interesting pharmacological properties of GLP-1 (7-37) and analogues thereof have attracted much attention in recent years only little is known about the structure of these molecules. The secondary structure of GLP-1 in micelles have been described by Thornton et al. (*Biochemistry* 33 3532-3539 (1994)), but in normal solution, GLP-1 is considered a very flexible molecule. Surprisingly, we found that derivatisation of this relatively small and very flexible molecule resulted in compounds whose plasma profile were highly protracted and still had retained activity.

GLP-1 and analogues of GLP-1 and fragments thereof are useful i.a. in the treatment of Type 1 and Type 2 diabetes and obesity.

WO 87/06941 discloses GLP-1 fragments, including GLP-1 (7-37), and functional derivatives thereof and to their use as an insulinotropic agent.

WO 90/11296 discloses GLP-1 fragments, including GLP-1 (7-36), and functional derivatives thereof which have an insulinotropic activity which exceeds the insulinotropic activity of GLP-1 (1-36) or GLP-1 (1-37) and to their use as insulinotropic agents.

The amino acid sequence of GLP-1 (7-36) and GLP-1 (7-37) is (SEQ ID NO:1):

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7  8  9 10 11 12 13 14 15 16 17  (I)
His-Ala-Glu-Gly-Thr-Phe-Thr-Ser-Asp-Val-Ser-
18 19 20 21 22 23 24 25 26 27 28
Ser-Tyr-Leu-Glu-Gly-Gln-Ala-Ala-Lys-Glu-Phe-
29 30 31 32 33 34 35 36
Ile-Ala-Trp-Leu-Val-Lys-Gly-Arg-X

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wherein X is H₂ for GLP-1 (7-36) and X is Gly for GLP-1 (7-37).

WO 91/11457 discloses analogues of the active GLP-1 peptides 7-34, 7-35, 7-36, and 7-37 which can also be useful as GLP-1 moieties.

EP 0708179-A2 (Eli Lilly & Co.) discloses GLP-1 analogues and derivatives that include an N-terminal imidazole group and optionally an unbranched C₆-C₁₀ acyl group in attached to the lysine residue in position 34.

EP 0699686-A2 (Eli Lilly & Co.) discloses certain N-terminal truncated fragments of GLP-1 that are reported to be biologically active.

Unfortunately, the high clearance limits the usefulness of these compounds. Thus there still is a need for improvements in this field.

Accordingly, it is an object of the present invention to provide derivatives of GLP-1 and analogues thereof which have a protracted profile of action relative to GLP-1 (7-37).

It is a further object of the invention to provide derivatives of GLP-1 and analogues thereof which have a lower clearance than GLP-1 (7-37).

It is a further object of the invention to provide a pharmaceutical composition with improved solubility and stability.

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SUMMARY OF THE INVENTION

The present invention relates to derivatives of GLP-1 (1–45) and analogs and/or fragments thereof. The GLP-1 derivatives of the present invention have interesting pharmacological properties, in particular they have a more protracted profile of action than the parent peptides. The GLP-1 derivatives of the present invention also have insulinotropic activity, ability to decrease glucagon, ability to suppress gastric motility, ability to restore glucose competency to beta-cells, and/or ability to suppress appetite/reduce weight.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 shows the results of Circular Dichroism (CD) at 222 nm as a function of peptide concentration for native GLP-1 (7–37) and various GLP-1 derivatives of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

A simple system is used to describe fragments and analogues of GLP-1. For example, Gly⁸—GLP-1(7–37) designates a peptide which relates to GLP-1 by the deletion of the amino acid residues at positions. 1 to 6 and substituting the naturally occurring amino acid residue in position 8 (Ala) by Gly. Similarly, Lys³⁴(N^ε-tetradecanoyl)-GLP-1(7–37) designates GLP-1 (7–37) wherein the ϵ -amino group of the Lys residue in position 34 has been tetradecanoylated. Where reference in this text is made to C-terminally extended GLP-1 analogues, the amino acid residue in position 38 is Arg unless otherwise indicated, the amino acid residue in position 39 is also Arg unless otherwise indicated and the optional amino acid residue in position 40 is Asp unless otherwise indicated. Also, if a C-terminally extended analogue extends to position 41, 42, 43, 44 or 45, the amino acid sequence of this extension is as in the corresponding sequence in human proglucagon unless otherwise indicated.

GLP-1 Analogs

The term “an analogue” is defined herein as a peptide wherein one or more amino acid residues of the parent peptide have been substituted by another amino acid residue. In a preferred embodiment, the total number of different amino acids between the GLP-1 derivative and the corresponding native form of GLP-1 is up to fifteen, preferably up to ten amino acid residues, and most preferably up to six amino acid residues.

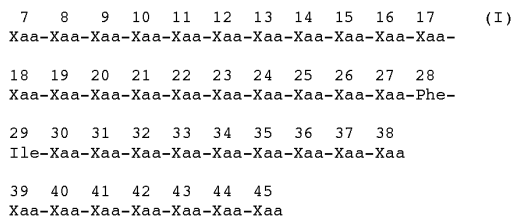
The total number of different amino acids between the derivative of the GLP-1 analog and the corresponding native form of GLP-1 preferably does not exceed six. Preferably, the number of different amino acids is five. More preferably, the number of different amino acids is four. Even more preferably, the number of different amino acids is three.

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Even more preferably, the number of different amino acids is two. Most preferably, the number of different amino acids is one. In order to determine the number of different amino acids, one should compare the amino acid sequence of the GLP-1 derivative of the present invention with the corresponding native GLP-1. For example, there are two different amino acids between the derivative Gly⁸Arg²⁶Lys³⁴(N^ε-(7-deoxycholoyl)-GLP-1(7-40)) and the corresponding native GLP-1 (i.e., GLP-1(7-40)). The differences are located at positions 8 and 26. Similarly, there is only one different amino acid between the derivative Lys²⁶(N^ε-(7-deoxycholoyl))Arg³⁴-GLP-1(7-40) and the corresponding native GLP-1. The difference is located at position 34.

In a preferred embodiment, the present invention relates to a GLP-1 derivative wherein the parent peptide is GLP-1(1-45) or an analogue thereof. In a further preferred embodiment, the parent peptide is GLP-1(1-35), GLP-1(1-36), GLP-1(1-36)amide, GLP-1(1-37), GLP-1(1-38), GLP-1(1-39), GLP-1(1-40), GLP-1(1-41) or an analogue thereof.

In a preferred embodiment, the present invention relates to derivatives of GLP-1 analogues of formula I (SEQ ID NO:2):



wherein

- Xaa at position 7 is His, a modified amino acid or is deleted,
- Xaa at position 8 is Ala, Gly, Ser, Thr, Leu, Ile, Val, Glu, Asp, or Lys, or is deleted,
- Xaa at position 9 is Glu, Asp, or Lys, or is deleted,
- Xaa at position 10 is Gly or is deleted,
- Xaa at position 11 is Thr, Ala, Gly, Ser, Leu, Ile, Val, Glu, Asp, or Lys or is deleted,
- Xaa at position 12 is Phe or is deleted,
- Xaa at position 13 is Thr or is deleted,
- Xaa at position 14 is Ser, Ala, Gly, Thr, Leu, Ile, Val, Glu, Asp, or Lys or is deleted,
- Xaa at position 15 is Asp or is deleted,
- Xaa at position 16 is Val, Ala, Gly, Ser, Thr, Leu, Ile, Glu, Asp, or Lys or is deleted,
- Xaa at position 17 is Ser, Ala, Gly, Thr, Leu, Ile, Val, Glu, Asp, or Lys, or is deleted,
- Xaa at position 18 is Ser, Ala, Gly, Thr, Leu, Ile, Val, Glu, Asp, or Lys,
- Xaa at position 19 is Tyr, Phe, Trp, Glu, Asp, or Lys,
- Xaa at position 20 is Leu, Ala, Gly, Ser, Thr, Leu, Ile, Val, Glu, Asp, or Lys,
- Xaa at position 21 is Glu, Asp, or Lys,
- Xaa at position 22 is Gly, Ala, Ser, Thr, Leu, Ile, Val, Glu, Asp, or Lys,
- Xaa at position 23 is Gln, Asn, Arg, Glu, Asp, or Lys,
- Xaa at position 24 is Ala, Gly, Ser, Tr, Leu, Ile, Val, Arg, Glu, Asp, or Lys,

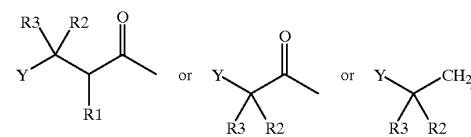
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- Xaa at position 25 is Ala, Gly, Ser, Thr, Leu, Ile, Val, Glu, Asp, or Lys,
- Xaa at position 26 is Lys, Arg, Gln, Glu, Asp, or His,
- Xaa at position 27 is Glu, Asp, or Lys,
- Xaa at position 30 is Ala, Gly, Ser, Thr, Leu, Ile, Val, Glu, Asp, or Lys,
- Xaa at position 31 is Trp, Phe, Tyr, Glu, Asp, or Lys,
- Xaa at position 32 is Leu, Gly, Ala, Ser, Thr, Ile, Val, Glu, Asp, or Lys,
- Xaa at position 33 is Val, Gly, Ala, Ser, Thr, Leu, Ile, Glu, Asp, or Lys,
- Xaa at position 34 is Lys, Arg, Glu, Asp, or His,
- Xaa at position 35 is Gly, Ala, Ser, Thr, Leu, Ile, Val, Glu, Asp, or Lys,
- Xaa at position 36 is Arg, Lys, Glu, Asp, or His,
- Xaa at position 37 is Gly, Ala, Ser, Thr, Leu, Ile, Val, Glu, Asp, or Lys, or is deleted,
- Xaa at position 38 is Arg, Lys, Glu, Asp, or His, or is deleted,
- Xaa at position 39 is Arg, Lys, Glu, Asp, or His, or is deleted,
- Xaa at position 40 is Asp, Glu, or Lys, or is deleted,
- Xaa at position 41 is Phe, Trp, Tyr, Glu, Asp, or Lys, or is deleted,
- Xaa at position 42 is Pro, Lys, Glu, or Asp, or is deleted,
- Xaa at position 43 is Glu, Asp, or Lys, or is deleted,
- Xaa at position 44 is Glu, Asp, or Lys, or is deleted, and
- Xaa at position 45 is Val, Glu, Asp, or Lys, or is deleted, or

(a) a C-1-6-ester thereof, (b) amide, C-1-6-alkylamide, or C-1-6-dialkylamide thereof and/or (c) a pharmaceutically acceptable salt thereof,

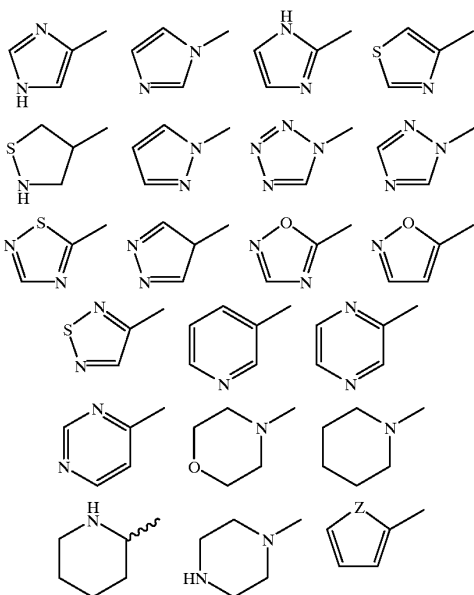
provided that when the amino acid at position 37, 38, 39, 41, 42, 43 or 44 is deleted, then each amino acid downstream of the amino acid is also deleted and when the amino acid at position 8, 9, 10, 11, 12, 13, 14, 15, 16 or 17 is deleted then each amino acid upstream of the amino acid is also deleted.

The term "modified amino acid" is defined herein as



wherein R¹, R² and R³ are independently H, lower alkyl, optionally substituted phenyl, NH₂, NH-CO-(lower alkyl), -OH, lower alkoxy, halogen, SO₂-(lower alkyl) or CF₃, wherein said phenyl is optionally substituted with at least one group selected from NH₂, -OH, lower alkyl or lower alkoxy having 1-6 carbon atoms, halogen, SO₂-(lower alkyl), NH-CO-(lower alkyl) or CF₃, or R¹ and R² may together form a bond; and Y is a five or six membered ring system selected from the group consisting of:

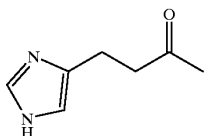
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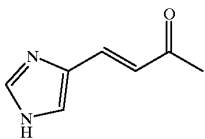
wherein Z is N, O or S, and said ring system is optionally substituted with one or more functional groups selected from the group consisting of NH₂, NO₂, OH, lower alkyl, lower alkoxy, halogen, CF₃ and aryl (i.e., optionally substituted phenyl, as define above), provided that A is not histidine;

The terms "lower alkyl" and "lower alkoxy" refer to an alkyl or alkoxy group, respectively, having 1-6 carbon atoms.

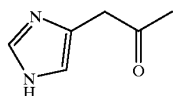
In a preferred embodiment, A is



In another preferred embodiment, A is:

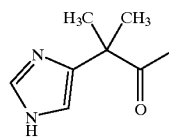


In another preferred embodiment, A is:

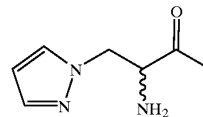


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In another preferred embodiment, A is:



In another preferred embodiment, A is:



In another preferred embodiment, A is 4-imidazopropionyl.

In another preferred embodiment, A is 4-imidazoacetyl.

In another preferred embodiment, A is 4-imidazo- α , α -dimethyl-acetyl,

The GLP-1 derivatives of the present invention preferably have only one or two Lys wherein the ϵ -amino group of one or both Lys is substituted with a lipophilic substituent. Preferably, the GLP-1 derivatives of the present invention have only one Lys. In a more preferred embodiment, there is only one Lys which is located at the carboxy terminus of the derivative of the GLP-1 analogs. In an even more preferred embodiment, the GLP-1 derivatives of the present invention have only one Lys and Glu or Asp is adjacent to Lys.

In a preferred environment, the amino acids at positions 37-45 are absent.

In a another preferred environment, the amino acids at positions 38-45 are absent.

In a another preferred environment, the amino acids at positions 39-45 are absent.

In a another preferred environment, the amino acids at position 7 is deleted.

In a another preferred environment, the amino acids at position 7 and 8 are deleted.

In a another preferred environment, the amino acids at position 7-9 are deleted.

In a another preferred environment, the amino acids at position 7-10 are deleted.

In a another preferred environment, the amino acids at position 7-11 are deleted.

In a another preferred environment, the amino acids at position 7-12 are deleted.

In a another preferred environment, the amino acids at position 7-13 are deleted.

In a another preferred environment, the amino acids at position 7-14 are deleted.

In a another preferred environment, the amino acids at position 7-15 are deleted.

In a another preferred environment, the amino acids at position 7-16 are deleted.

In a another preferred environment, the amino acids at position 7-17 are deleted.

In another preferred environment, Xaa at position 7 is His.

In another preferred environment, Xaa at position 8 is Ala, Gly, Ser, Thr, or Val.

In another preferred environment, Xaa at position 9 is Glu.

In another preferred environment, Xaa at position 10 is Gly.

In another preferred embodiment, Xaa at position 18, 23 or 27 is Lys, and Xaa at positions 26 and 34 is Arg, each of Xaa at positions 38–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(7-37).

In another preferred embodiment, Xaa at position 18, 23 or 27 is Lys, and Xaa at positions 26 and 34 is Arg, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(7-38).

In another preferred embodiment, Xaa at positions 8 is Thr, Ser, Gly or Val, Xaa at position 18, 23 or 27 is Lys, and Xaa at position 26 and 34 is Arg, each of Xaa at positions 37–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(7-36).

In another preferred embodiment, Xaa at positions 8 is Thr, Ser, Gly or Val, Xaa at position 18, 23 or 27 is Lys, and Xaa at position 26 and 34 is Arg, each of Xaa at positions 38–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(7-37).

In another preferred embodiment, Xaa at positions 8 is Thr, Ser, Gly or Val, Xaa at position 18, 23 or 27 is Lys, and Xaa at position 26 and 34 is Arg, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(7-38).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 26 is Arg, each of Xaa at positions 37–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-36).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 26 is Arg, each of Xaa at positions 38–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-37).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 26 is Arg, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-38).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 34 is Arg, each of Xaa at positions 37–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-36).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 34 is Arg, each of Xaa at positions 38–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-37).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 34 is Arg, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-38).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at positions 26 and 34 is Arg, Xaa at position 36 is Lys, each of Xaa at positions 37–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-36).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at positions 26 and 34 is Arg, Xaa at position 36 is Lys, each of Xaa at positions 38–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(1-37).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at positions 26 and 34 is Arg, Xaa at position 36 is Lys, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-38).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at positions 26 and 34 is Arg, Xaa at position 38 is Lys, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-38).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 8 is Thr, Ser, Gly or Val, Xaa at position 37 is Glu, Xaa at position 36 is Lys, each of Xaa at positions 38–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-37).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 8 is Thr, Ser, Gly or Val, Xaa at position 37 is Glu, Xaa at position 36 is Lys, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-38).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 8 is Thr, Ser, Gly or Val, Xaa at position 37 is Glu, Xaa at position 38 is Lys, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-38).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 18, 23 or 27 is Lys, and Xaa at positions 26 and 34 is Arg, each of Xaa at positions 37–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-36).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 18, 23 or 27 is Lys, and Xaa at positions 26 and 34 is Arg, each of Xaa at positions 38–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-37).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 18, 23 or 27 is Lys, and Xaa at positions 26 and 34 is Arg, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-38).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 8 is Thr, Ser, Gly or Val, Xaa at position 18, 23 or 27 is Lys, and Xaa at position 26 and 34 is Arg, each of Xaa at positions 37–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-36).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 8 is Thr, Ser, Gly or Val, Xaa at position 18, 23 or 27 is Lys, and Xaa at position 26 and 34 is Arg, each of Xaa at positions 38–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-37).

In another preferred embodiment, Xaa at position 7 is a modified amino acid or is deleted, Xaa at position 8 is Thr, Ser, Gly or Val, Xaa at position 18, 23 or 27 is Lys, and Xaa at position 26 and 34 is Arg, each of Xaa at positions 39–45 is deleted, and each of the other Xaa is the amino acid in native GLP-1(8-38).

Derivatives

The term “derivative” is defined as a modification of one or more amino acid residues of a peptide by chemical means, either with or without an enzyme, e.g., by alkylation, acylation, ester formation, or amide formation.

Lipophilic Substituents

To obtain a satisfactory protracted profile of action of the GLP-1 derivative, one or more lipophilic substituents are attached to a GLP-1 moiety. The lipophilic substituents preferably comprises 4–40 carbon atoms, in particular 8–25 carbon atoms. The lipophilic substituent may be attached to an amino group of the GLP-1 moiety by means of a carboxyl group of the lipophilic substituent which forms an amide bond with an amino group of the amino acid residue to which it is attached. Preferably, the GLP-1 derivatives have three, more preferably two, and most preferably one lipophilic substituent.

In a preferred embodiment, the present invention relates to a GLP-1 derivative wherein at least one amino acid residue of the parent peptide has a lipophilic substituent attached with the proviso that if only one lipophilic substituent is present and this substituent is attached to the N-terminal or to the C-terminal amino acid residue of the parent peptide then this substituent is an alkyl group or a group which has an ω -carboxylic acid group.

In another preferred embodiment, the present invention relates to a GLP-1 derivative having only one lipophilic substituent which substituent is an alkyl group or a group which has an ω -carboxylic acid group and is attached to the N-terminal amino acid residue of the parent peptide.

In another preferred embodiment, the present invention relates to a GLP-1 derivative having only one lipophilic substituent which substituent is an alkyl group or a group which has an ω -carboxylic acid group and is attached to the C-terminal amino acid residue of the parent peptide.

In another preferred embodiment, the present invention relates to a GLP-1 derivative having only one lipophilic substituent which substituent can be attached to any amino acid residue which is not the N-terminal or C-terminal amino acid residue of the parent peptide.

In another preferred embodiment, the present invention relates to a GLP-1 derivative wherein two lipophilic substituents are present, one being attached to the N-terminal amino acid residue while the other is attached to the C-terminal amino acid residue.

In another preferred embodiment, the present invention relates to a GLP-1 derivative wherein two lipophilic substituents are present, one being attached to the N-terminal amino acid residue while the other is attached to the amino acid residue which is not N-terminal or the C-terminal amino acid residue.

In another preferred embodiment, the present invention relates to a GLP-1 derivative wherein two lipophilic substituents are present, one being attached to the C-terminal amino acid residue while the other is attached to the amino acid residue which is not the N-terminal or the C-terminal amino acid residue.

A lipophilic substituent may be attached to an amino acid residue in such a way that a carboxyl group of the lipophilic substituent forms an amide bond with an amino group of the amino acid residue. Alternatively, a lipophilic substituent may be attached to an amino acid residue in such a way that an amino group of the lipophilic substituent forms an amide bond with a carboxyl group of the amino acid residue.

In a further preferred embodiment, the present invention relates to a GLP-1 derivative wherein a lipophilic substituent is attached to the parent peptide by means of a spacer. For example, the lipophilic substituent may be attached to the GLP-1 moiety by means of a spacer in such a way that a carboxyl group of the spacer forms an amide bond with an amino group of the GLP-1 moiety.

In a most preferred embodiment, the lipophilic substituent is attached—optionally via a spacer—to the ϵ -amino group of a Lys residue contained in the parent peptide.

In a preferred embodiment, the spacer is an α,ω -amino acid. Examples of suitable spacers are succinic acid, Lys, Glu or Asp, or a dipeptide such as Gly-Lys. When the spacer is succinic acid, one carboxyl group thereof may form an amide bond with an amino group of the amino acid residue, and the other carboxyl group thereof may form an amide bond with an amino group of the lipophilic substituent. When the spacer is Lys, Glu or Asp, the carboxyl group thereof may form an amide bond with an amino group of the amino acid residue, and the amino group thereof may form

an amide bond with a carboxyl group of the lipophilic substituent. When Lys is used as the spacer, a further spacer may in some instances be inserted between the ϵ -amino group of Lys and the lipophilic substituent. In one preferred embodiment, such a further spacer is succinic acid which forms an amide bond with the ϵ -amino group of Lys and with an amino group present in the lipophilic substituent. In another preferred embodiment such a further spacer is Glu or Asp which forms an amide bond with the ϵ -amino group of Lys and another amide bond with a carboxyl group present in the lipophilic substituent, that is, the lipophilic substituent is a N^ϵ -acylated lysine residue. Other preferred spacers are N^ϵ -(γ -L-glutamyl), N^ϵ -(β -L-asparagyl), N^ϵ -glycyl, and N^ϵ -(α -(γ -aminobutanoyl)).

In another preferred embodiment of the present invention, the lipophilic substituent has a group which can be negatively charged. One preferred such group is a carboxylic acid group.

In a further preferred embodiment, the lipophilic substituent is attached to the parent peptide by means of a spacer which is an unbranched alkane, α , Ω -dicarboxylic acid group having from 1 to 7 methylene groups, preferably two methylene groups which spacer forms a bridge between an amino group of the parent peptide and an amino group of the lipophilic substituent.

In a further preferred embodiment, the lipophilic substituent is attached to the parent peptide by means of a spacer which is an amino acid residue except Cys, or a dipeptide such as Gly-Lys. The expression “a dipeptide such as Gly-Lys” is defined herein as a dipeptide wherein the C-terminal amino acid residue is Lys, His or Trp, preferably Lys, and wherein the N-terminal amino acid residue is selected from the group comprising Ala, Arg, Asp, Asn, Gly, Glu, Gln, Ile, Leu, Val, Phe and Pro.

In a further preferred embodiment, the lipophilic substituent is attached to the parent peptide by means of a spacer which is an amino acid residue except Cys, or is a dipeptide such as Gly-Lys and wherein a carboxyl group of the parent peptide forms an amide bond with an amino group of a Lys residue or a dipeptide containing a Lys residue, and the other amino group of the Lys residue or a dipeptide containing a Lys residue forms an amide bond with a carboxyl group of the lipophilic substituent.

In a further preferred embodiment, the lipophilic substituent is attached to the parent peptide by means of a spacer which is an amino acid residue except Cys, or is a dipeptide such as Gly-Lys and wherein an amino group of the parent peptide forms an amide bond with a carboxylic group of the amino acid residue or dipeptide space, and an amino group of the amino acid residue or dipeptide spacer forms an amide bond with a carboxyl group of the lipophilic substituent.

In a further preferred embodiment, the lipophilic substituent is attached to the parent peptide by means of a spacer which is an amino acid residue except Cys, or is a dipeptide such as Gly-Lys and wherein a carboxyl group of the parent peptide forms an amide bond with an amino group of the amino acid residue spacer or dipeptide spacer, and the carboxyl group of the amino acid residue spacer or dipeptide spacer forms an amide bond with an amino group of the lipophilic substituent.

In a further embodiment, the lipophilic substituent is attached to the parent peptide by means of a spacer which is an amino acid residue except Cys, or is a dipeptide such as Gly-Lys, and wherein a carboxyl group of the parent peptide forms an amide bond with an amino group of a spacer which is Asp or Glu, or a dipeptide spacer containing an Asp or Glu residue, and a carboxyl group of the spacer forms an amide bond with an amino group of the lipophilic substituent.

In a further embodiment, the lipophilic substituent is a partially or completely hydrogenated cyclopentanophenathrene skeleton.

In a further embodiment, the lipophilic substituent is a straight-chain or branched alkyl group.

In a further embodiment, the lipophilic substituent is the acyl group of a straight-chain or branched fatty acid.

In a further embodiment, the lipophilic substituent is an acyl group of the formula $\text{CH}_3(\text{CH}_2)_n\text{CO}-$, wherein n is an integer from 4 to 38, preferably an integer from 4 to 24, more preferably $\text{CH}_3(\text{CH}_2)_6\text{CO}-$, $\text{CH}_3(\text{CH}_2)_8\text{CO}-$, $\text{CH}_3(\text{CH}_2)_{10}\text{CO}-$, $\text{CH}_3(\text{CH}_2)_{12}\text{CO}-$, $\text{CH}_3(\text{CH}_2)_{14}\text{CO}-$, $\text{CH}_3(\text{CH}_2)_{16}\text{CO}-$, $\text{CH}_3(\text{CH}_2)_{18}\text{CO}-$, $\text{CH}_3(\text{CH}_2)_{20}\text{CO}-$ or $\text{CH}_3(\text{CH}_2)_{22}\text{CO}-$.

In a further preferred embodiment, the lipophilic substituent is an acyl group of a straight-chain or branched alkane, α,ω -dicarboxylic acid.

In a further preferred embodiment, the lipophilic substituent is an acyl group of the formula $\text{HOOC}(\text{CH}_2)_m\text{CO}-$, wherein m is an integer from 4 to 38, preferably an integer from 4 to 24, more preferably $\text{HOOC}(\text{CH}_2)_{14}\text{CO}-$, $\text{HOOC}(\text{CH}_2)_{16}\text{CO}-$, $\text{HOOC}(\text{CH}_2)_{18}\text{CO}-$, $\text{HOOC}(\text{CH}_2)_{20}\text{CO}-$ or $\text{HOOC}(\text{CH}_2)_{22}\text{CO}-$.

In a further preferred embodiment, the lipophilic substituent is a group of the formula $\text{CH}_3(\text{CH}_2)_p((\text{CH}_2)_q\text{COOH})\text{CHNH}-\text{CO}(\text{CH}_2)_2\text{CO}-$, wherein p and q are integers and +q is an integer of from 8 to 33, preferably from 12 to 28.

In a further preferred embodiment, the lipophilic substituent is a group of the formula $\text{CH}_3(\text{CH}_2)_r\text{CO}-\text{NHCH}(\text{COOH})(\text{CH}_2)_2\text{CO}-$, wherein r is an integer of from 10 to 24.

In a further preferred embodiment, the lipophilic substituent is a group of the formula $\text{CH}_3(\text{CH}_2)_s\text{CO}-\text{NHCH}((\text{CH}_2)_2\text{COOH})\text{CO}-$, wherein s is an integer of from 8 to 24.

In a further preferred embodiment, the lipophilic substituent is a group of the formula $\text{COOH}(\text{CH}_2)_t\text{CO}-$ wherein t is an integer of from 8 to 24.

In a further preferred embodiment, the lipophilic substituent is a group of the formula $-\text{NHCH}(\text{COOH})(\text{CH}_2)_u\text{NH}-\text{CO}(\text{CH}_2)_2\text{CH}_3$, wherein u is an integer of from 8 to 18.

In a further preferred embodiment, the lipophilic substituent is a group of the formula $\text{CH}_3(\text{CH}_2)_v\text{CO}-\text{NH}-(\text{CH}_2)_z-\text{CO}$, wherein v is an integer of from 8 to 24 and z is an integer of from 1 to 6.

In a further preferred embodiment, the lipophilic substituent is a group of the formula $-\text{NHCH}(\text{COOH})(\text{CH}_2)_w\text{NH}-\text{COCH}((\text{CH}_2)_2\text{COOH})\text{NH}-\text{CO}(\text{CH}_2)_x\text{CH}_3$, wherein w is an integer of from 10 to 16.

In a further preferred embodiment, the lipophilic substituent is a group of the formula $-\text{NHCH}(\text{COOH})(\text{CH}_2)_y\text{NH}-\text{CO}(\text{CH}_2)_2\text{CH}(\text{COOH})\text{NH}-\text{CO}(\text{CH}_2)_x\text{CH}_3$, wherein x is an integer of from 10 to 16.

In a further preferred embodiment, the lipophilic substituent is a group of the formula $-\text{NHCH}(\text{COOH})(\text{CH}_2)_4\text{NH}-\text{CO}(\text{CH}_2)_2\text{CH}(\text{COOH})\text{NHCO}(\text{CH}_2)_y\text{CH}_3$, wherein y is zero or an integer of from 1 to 22.

In a further preferred embodiment, the lipophilic substituent contains a group that can be negatively charged. Such a lipophilic substituent can for example be a substituent which has a carboxyl group.

Other Derivatives

The derivatives of GLP-1 analogues of the present invention may be in the form of one or more of (a) a C-1-6-ester, (b) an amide, C-1-6-alkylamide, or C-1-6-dialkylamide, and (c) a pharmaceutical salt. In a preferred embodiment, the derivatives of GLP-1 analogues are in the form of an acid addition salt or a carboxylate salt, most preferably in the form of an acid addition salt.

Preferred Derivatives of GLP-1 Analogues of the Present Invention

In a preferred embodiment, a parent peptide for a derivative of the invention is

Arg²⁶-GLP-1(7-37); Arg³⁴-GLP-1(7-37); Lys³⁶-GLP-1(7-37); Arg^{26,34}Lys³⁶-GLP-1(7-37); Arg^{26,34}Lys³⁸GLP-1(7-38); Arg^{26,34}Lys³⁹-GLP-1(7-39); Arg^{26,34}Lys⁴⁰-GLP-1(7-40); Arg²⁶Lys³⁶-GLP-1(7-37); Arg³⁴Lys³⁶-GLP-1(7-37); Arg²⁶Lys³⁹-GLP-1(7-39); Arg³⁴Lys³⁶-GLP-1(7-40); Arg^{26,34}Lys^{36,39}-GLP-1(7-39); Arg^{26,34}Lys³⁹-GLP-1(7-40); Gly⁸Arg²⁶-GLP-1(7-37); Gly⁸Arg³⁴-GLP-1(7-37); Gly⁸Lys³⁶-GLP-1(7-37); Gly⁸Arg^{26,34}-Lys³⁶-GLP-1(7-37); Gly⁸Arg^{26,34}-Lys³⁹GLP-1(7-39); Gly⁸Lys^{26,34}-Lys⁴⁰GLP-1(7-40); Gly⁸Arg²⁶-Lys³⁶-GLP-1(7-37); Gly⁸Arg³⁴-Lys³⁶GLP-1(7-37); Gly⁸Lys²⁶-Lys³⁹GLP-1(7-39); Gly⁸Arg³⁴Lys⁴⁰-GLP-1(7-40); or Gly⁸Arg^{26,34}Lys^{37,39}-GLP-1(7-39); or Gly⁸Arg^{26,34}Lys^{36,40}-GLP-1(7-40).

In a further preferred embodiment, the parent peptide is Arg^{26,34}Lys³⁸GLP-1(7-38); Arg^{26,34}Lys³⁹GLP-1(7-39); Arg^{26,34}Lys⁴⁰GLP-1(7-40); Arg^{26,34}Lys⁴¹GLP-1(7-41); Arg^{26,34}Lys⁴²GLP-1(7-42); Arg^{26,34}Lys⁴³GLP-1(7-43); Arg^{26,34}Lys⁴⁴GLP-1(7-44); Arg^{26,34}Lys⁴⁵GLP-1(7-45); Arg^{26,34}Lys³⁸GLP-1(1-38); Arg^{26,34}Lys³⁹GLP-1(1-39); Arg^{26,34}Lys⁴⁰GLP-1(1-40); Arg^{26,34}Lys⁴¹GLP-1(1-41); Arg^{26,34}Lys⁴²GLP-1(1-42); Arg^{26,34}Lys⁴³GLP-1(1-43); Arg^{26,34}Lys⁴⁴GLP-1(1-44); Arg^{26,34}Lys⁴⁵GLP-1(1-45); Arg^{26,34}Lys³⁸GLP-1(2-38); Arg^{26,34}Lys³⁹GLP-1(2-39); Arg^{26,34}Lys⁴⁰GLP-1(2-40); Arg^{26,34}Lys⁴¹GLP-1(2-41); Arg^{26,34}Lys⁴²GLP-1(2-42); Arg^{26,34}Lys⁴³GLP-1(2-43); Arg^{26,34}Lys⁴⁴GLP-1(2-44); Arg^{26,34}Lys⁴⁵GLP-1(2-45); Arg^{26,34}Lys³⁸GLP-1(3-38); Arg^{26,34}Lys³⁹GLP-1(3-39); Arg^{26,34}Lys⁴⁰GLP-1(3-40); Arg^{26,34}Lys⁴¹GLP-1(3-41); Arg^{26,34}Lys⁴²GLP-1(3-42); Arg^{26,34}Lys⁴³GLP-1(3-43); Arg^{26,34}Lys⁴⁴GLP-1(3-44); Arg^{26,34}Lys⁴⁵GLP-1(3-45); Arg^{26,34}Lys³⁸GLP-1(4-38); Arg^{26,34}Lys³⁹GLP-1(4-39); Arg^{26,34}Lys⁴⁰GLP-1(4-40); Arg^{26,34}Lys⁴¹GLP-1(4-41); Arg^{26,34}Lys⁴²GLP-1(4-42); Arg^{26,34}Lys⁴³GLP-1(4-43); Arg^{26,34}Lys⁴⁴GLP-1(4-44); Arg^{26,34}Lys⁴⁵GLP-1(4-45); Arg^{26,34}Lys³⁸GLP-1(5-38); Arg^{26,34}Lys³⁹GLP-1(5-39); Arg^{26,34}Lys⁴⁰GLP-1(5-40); Arg^{26,34}Lys⁴¹GLP-1(5-41); Arg^{26,34}Lys⁴²GLP-1(5-42); Arg^{26,34}Lys⁴³GLP-1(5-43); Arg^{26,34}Lys⁴⁴GLP-1(5-44); Arg^{26,34}Lys⁴⁵GLP-1(5-45); Arg^{26,34}Lys³⁸GLP-1(6-39); Arg^{26,34}Lys³⁹GLP-1(6-39); Arg^{26,34}Lys⁴⁰GLP-1(6-40); Arg^{26,34}Lys⁴¹GLP-1(6-41); Arg^{26,34}Lys⁴²GLP-1(6-42); Arg^{26,34}Lys⁴³GLP-1(6-43); Arg^{26,34}Lys⁴⁴GLP-1(6-44); Arg^{26,34}Lys⁴⁵GLP-1(6-45); Arg²⁶Lys³⁸GLP-1(1-38); Arg³⁴Lys³⁸GLP-1(1-38); Arg^{26,34}Lys^{36,38}GLP-1(1-38); Arg²⁶Lys³⁸GLP-1(7-38); Arg³⁴Lys³⁸GLP-1(7-38); Arg^{26,34}Lys^{36,38}Lys^{36,38}GLP-1(7-38); Arg^{26,34}Lys³⁸GLP-1(7-38); Arg²⁶Lys³⁹GLP-1(1-39); Arg³⁴Lys³⁹GLP-1(1-39); Arg^{26,34}Lys^{36,39}GLP-1(1-39); Arg²⁶Lys³⁹GLP-1(7-39); Arg³⁴Lys³⁹GLP-1(7-39) or Arg^{26,34}Lys^{36,39}GLP-1(7-39).

In a further preferred embodiment, the present invention relates to a GLP-1 derivative wherein the parent peptide is Arg²⁶-GLP-1(7-37), Arg³⁴-GLP-1(7-37), Lys³⁶-GLP-1(7-37), Arg^{26,34}Lys³⁶-GLP-1(7-37), Arg²⁶Lys³⁶-GLP-1(7-37), Arg³⁴Lys³⁶-GLP-1(7-37), Gly⁸Arg²⁶-GLP-1(7-37), Gly⁸Arg³⁴-GLP-1(7-37), Gly⁸Lys³⁶-GLP-1(7-37), Gly⁸Arg^{26,34}-Lys³⁶-GLP-1(7-37), Gly⁸Arg^{26,34}-Lys³⁹GLP-1(7-39) or Gly⁸Arg³⁴Lys³⁶-GLP-1(7-37).

In a further preferred embodiment, the present invention relates to a GLP-1 derivative wherein the parent peptide is Arg²⁶Lys³⁸-GLP-1(7-38), Arg^{26,34}Lys³⁸-GLP-1(7-38), Arg^{26,34}Lys^{36,38}-GLP-1(7-38), Gly⁸Arg²⁶Lys³⁸-GLP-1(7-38) or Gly⁸Arg^{26,34}Lys^{36,38}-GLP-1(7-38).

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In a further preferred embodiment, the present invention relates to a GLP-1derivative wherein the parent peptide is Arg²⁶Lys³⁹-GLP-1(7-39), Arg^{26,34}Lys^{36,39}-GLP-1(7-39), Gly⁸Arg²⁶Lys³⁹-GLP-1(7-39) or Gly⁸Arg^{26,34}Lys^{36,39}-GLP-1(7-39).

In a further preferred embodiment, the present invention relates to a GLP-1derivative wherein the parent peptide is Arg³⁴Lys⁴⁰-GLP-1(7-40), Arg^{26,34}Lys^{36,40}-GLP-1(7-40), Gly⁸Arg³⁴Lys⁴⁰-GLP-1(7-40) or Gly⁸Arg^{26,34}Lys^{36,40}-GLP-1(7-40).

In a further preferred embodiment, the present invention relates to a GLP-1derivative wherein the parent peptide is: Arg²⁶-GLP-1(7-36); Arg³⁴-GLP-1(7-36); Arg^{26,34}Lys³⁶-GLP-1(7-36); Arg²⁶-GLP-1(7-36)amide; Arg³⁴-GLP-1(7-36)amide; Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Arg^{26,34}Lys³⁶-GLP-1(7-37); Arg³⁴-GLP-1(7-37); Arg^{26,34}Lys³⁶-GLP-1(7-37); Arg²⁶-GLP-1(7-38); Arg³⁴-GLP-1(7-38); Arg^{26,34}Lys³⁶-GLP-1(7-38); Arg²⁶-GLP-1(7-39); Arg³⁴-GLP-1(7-39); Arg^{26,34}Lys³⁶-GLP-1(7-39);

Gly⁸Arg²⁶-GLP-1(7-36); Gly⁸Arg³⁴-GLP-1(7-36); Gly⁸Arg^{26,34}Lys³⁶-GLP-1(7-36); Gly⁸Arg²⁶-GLP-1(7-36)amide; Gly⁸Arg³⁴-GLP-1(7-36)amide; Gly⁸Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Gly⁸Arg²⁶-GLP-1(7-37); Gly⁸Arg³⁴-GLP-1(7-37); Gly⁸Arg^{26,34}Lys³⁶-GLP-1(7-37); Gly⁸Arg²⁶-GLP-1(7-38); Gly⁸Arg³⁴-GLP-1(7-38); Gly⁸Arg^{26,34}Lys³⁶-GLP-1(7-38); Gly⁸Arg²⁶-GLP-1(7-39); Gly⁸Arg³⁴-GLP-1(7-39); Gly⁸Arg^{26,34}Lys³⁶-GLP-1(7-39);

Val⁸Arg²⁶-GLP-1(7-36); Val⁸Arg³⁴-GLP-1(7-36); Val⁸Arg^{26,34}Lys³⁶-GLP-1(7-36); Val⁸Arg²⁶-GLP-1(7-36)amide; Val⁸Arg³⁴-GLP-1(7-36)amide; Val⁸Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Val⁸Arg²⁶-GLP-1(7-37); Val⁸Arg³⁴-GLP-1(7-37); Val⁸Arg^{26,34}Lys³⁶-GLP-1(7-37); Val⁸Arg²⁶-GLP-1(7-38); Val⁸Arg³⁴-GLP-1(7-38); Val⁸Arg^{26,34}Lys³⁶-GLP-1(7-38); Val⁸Arg²⁶-GLP-1(7-39); Val⁸Arg³⁴-GLP-1(7-39); Val⁸Arg^{26,34}Lys³⁶-GLP-1(7-39);

Ser⁸Arg²⁶-GLP-1(7-36); Ser⁸Arg³⁴-GLP-1(7-36); Ser⁸Arg^{26,34}Lys³⁶-GLP-1(7-36); Ser⁸Arg²⁶-GLP-1(7-36)amide; Ser⁸Arg³⁴-GLP-1(7-36)amide; Ser⁸Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Ser⁸Arg²⁶-GLP-1(7-37); Ser⁸Arg³⁴-GLP-1(7-37); Ser⁸Arg^{26,34}Lys³⁶-GLP-1(7-37); Ser⁸Arg²⁶-GLP-1(7-38); Ser⁸Arg³⁴-GLP-1(7-38); Ser⁸Arg^{26,34}Lys³⁶-GLP-1(7-38); Ser⁸Arg²⁶-GLP-1(7-39); Ser⁸Arg³⁴-GLP-1(7-39); Ser⁸Arg^{26,34}Lys³⁶-GLP-1(7-39);

Thr⁸Arg²⁶-GLP-1(7-36); Thr⁸Arg³⁴-GLP-1(7-36); Thr⁸Arg^{26,34}Lys³⁶-GLP-1(7-36); Thr⁸Arg²⁶-GLP-1(7-36)amide; Thr⁸Arg³⁴-GLP-1(7-36)amide; Thr⁸Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Thr⁸Arg²⁶-GLP-1(7-37); Thr⁸Arg³⁴-GLP-1(7-37); Thr⁸Arg^{26,34}Lys³⁶-GLP-1(7-37); Thr⁸Arg²⁶-GLP-1(7-38); Thr⁸Arg³⁴-GLP-1(7-38); Thr⁸-38; Thr⁸Arg^{26,34}Lys³⁶-GLP-1(7-38); Thr⁸Arg²⁶-GLP-1(7-39); Thr⁸Arg³⁴-GLP-1(7-39); Thr⁸Arg^{26,34}Lys³⁶-GLP-1(7-39);

Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-37); Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-38); Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-39); Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-37); Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-38); Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-39);

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Val⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Val⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Val⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-37); Val⁸Asp³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Val⁸Asp³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39); Val⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Val⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Val⁸Asp³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Val⁸Asp³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Val⁸Asp³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39);

Ser⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Ser⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Ser⁸Glu³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Ser⁸Glu³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Ser⁸Glu³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39); Ser⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Ser⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Ser⁸Glu³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Ser⁸Glu³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Ser⁸Glu³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39);

Ser⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Ser⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Ser⁸Asp³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Ser⁸Asp³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Ser⁸Asp³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39); Ser⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Ser⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Ser⁸Asp³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Ser⁸Asp³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Ser⁸Asp³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39);

Thr⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Thr⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Thr⁸Glu³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Thr⁸Glu³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Thr⁸Glu³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39); Thr⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Thr⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Thr⁸Glu³⁶Arg^{25,34}Lys³⁷GLP-1(7-37); Thr⁸Glu³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Thr⁸Glu³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39);

Thr⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Thr⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Thr⁸Asp³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Thr⁸Asp³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Thr⁸Asp³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39); Thr⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Thr⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Thr⁸Asp³⁶Arg^{25,34}Lys³⁷GLP-1(7-37); Thr⁸Asp³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Thr⁸Glu³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39);

Gly⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Gly⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Gly⁸Glu³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Gly⁸Glu³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Gly⁸Glu³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39); Gly⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Gly⁸Glu³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Gly⁸Glu³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Gly⁸Glu³⁶Arg^{26,34}Lys³⁸GLP-1(7-38); Gly⁸Glu³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39);

Gly⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Gly⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Gly⁸Asp³⁶Arg^{26,34}Lys³⁷GLP-1(7-37); Gly⁸Asp³⁷Arg^{26,34}Lys³⁸GLP-1(7-38); Gly⁸Asp³⁸Arg^{26,34}Lys³⁹-GLP-1(7-39); Gly⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36); Gly⁸Asp³⁵Arg^{26,34}Lys³⁶-GLP-1(7-36)amide; Gly⁸Asp³⁶Arg^{26,34}Lys³⁷GLP-1(7-37);

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GLP-1(7-36); Gly⁸Arg³⁴Lys²⁷-GLP-1(7-36); Gly⁸Arg²⁶Lys²⁷GLP-1(7-37); Gly⁸Arg³⁴Lys²⁷GLP-1(7-37); Gly⁸Arg²⁶Lys²⁷GLP-1(7-38); Gly⁸Arg³⁴Lys²⁷GLP-1(7-39); Gly⁸Arg^{26,34}Lys^{18,37}GLP-1(7-37); Gly⁸Arg^{26,34}Lys^{18,37}GLP-1(7-38); Gly⁸Arg^{26,34}Lys^{18,39}GLP-1(7-39); Gly⁸Arg^{26,34}Lys^{23,36}GLP-1(7-36); Gly⁸Arg^{26,34}Lys^{23,37}GLP-1(7-37); Gly⁸Arg^{26,34}Lys^{23,38}GLP-1(7-38); Gly⁸Arg^{26,34}Lys^{23,39}GLP-1(7-39); Gly⁸Arg^{26,34}Lys^{27,36}GLP-1(7-36); Gly⁸Arg^{26,34}Lys^{27,37}GLP-1(7-37); Gly⁸Arg^{26,34}Lys^{27,38}GLP-1(7-38); Gly⁸Arg^{26,34}Lys^{27,39}GLP-1(7-39); Val⁸GLP-1(7-36); Val⁸GLP-1(7-37); Val⁸GLP-1(7-38); Val⁸GLP-1(7-39); Val⁸Arg²⁶Lys³⁶-GLP-1(7-36); Val⁸Arg³⁴Lys³⁶-GLP-1(7-37); Val⁸Arg²⁶Lys³⁶-GLP-1(7-37); Val⁸Arg³⁴Lys³⁶-GLP-1(7-37); Val⁸Arg²⁶Lys³⁶-GLP-1(7-39); Val⁸Arg³⁴Lys³⁶-GLP-1(7-39); Val⁸Arg^{26,34}Lys^{36,39}-GLP-1(7-39); Val⁸Arg²⁶Lys¹⁸-GLP-1(7-36); Val⁸Arg³⁴Lys¹⁸-GLP-1(7-37); Val⁸Arg²⁶Lys¹⁸GLP-1(7-37); Val⁸Arg³⁴Lys¹⁸GLP-1(7-38); Val⁸Arg³⁴Lys¹⁸GLP-1(7-39); Val⁸Arg²⁶Lys¹⁸GLP-1(7-39); Val⁸Arg²⁶Lys²³-GLP-1(7-36); Val⁸Arg³⁴Lys²³-GLP-1(7-36); Val⁸Arg²⁶Lys²³GLP-1(7-37); Val⁸Arg³⁴Lys²³GLP-1(7-37); Val⁸Arg²⁶Lys²³GLP-1(7-38); Val⁸Arg³⁴Lys²³GLP-1(7-38); Val⁸Arg²⁶Lys²³GLP-1(7-39); Val⁸Arg³⁴Lys²³GLP-1(7-39); Val⁸Arg²⁶Lys²⁷GLP-1(7-37); Val⁸Arg³⁴Lys²⁷GLP-1(7-37); Val⁸Arg²⁶Lys²⁷GLP-1(7-38); Val⁸Arg³⁴Lys²⁷GLP-1(7-38); Val⁸Arg²⁶Lys²⁷GLP-1(7-39); Val⁸Arg³⁴Lys²⁷GLP-1(7-39); Val⁸Arg^{26,34}Lys^{18,36}GLP-1(7-36); Val⁸Arg^{26,34}Lys^{18,37}GLP-1(7-37); Val⁸Arg^{26,34}Lys^{18,38}GLP-1(7-38); Val⁸Arg^{26,34}Lys^{18,39}GLP-1(7-39); Val⁸Arg^{26,34}Lys^{23,36}GLP-1(7-36); Val⁸Arg^{26,34}Lys^{23,37}GLP-1(7-37); Val⁸Arg^{26,34}Lys^{23,38}GLP-1(7-38); Val⁸Arg^{26,34}Lys^{23,39}GLP-1(7-39); Val⁸Arg^{26,34}Lys^{27,36}GLP-1(7-36); Val⁸Arg^{26,34}Lys^{27,37}GLP-1(7-37); Val⁸Arg^{26,34}Lys^{27,38}GLP-1(7-38); Val⁸Arg^{26,34}Lys^{27,39}GLP-1(7-39); or Val⁸Arg^{26,34}Lys^{27,39}GLP-1(7-39).

In a further preferred embodiment, the present invention relates to a GLP-1 derivative wherein the parent peptide is: Arg²⁶-GLP-1(8-37); Arg³⁴-GLP-1(8-37); Lys³⁶-GLP-1(8-37); Arg^{26,34}Lys³⁶-GLP-1(8-37); Arg^{26,34}Lys³⁸GLP-1(8-38); Arg^{26,34}Lys³⁹-GLP-1(8-39); Arg^{26,34}Lys⁴⁰-GLP-1(8-40); Arg²⁶Lys³⁶-GLP-1(8-37); Arg³⁴Lys³⁶-GLP-1(8-37); Arg²⁶Lys³⁹-GLP-1(8-39); Arg³⁴Lys⁴⁰-GLP-1(8-40); Arg^{26,34}Lys^{36,39}-GLP-1(8-39); Arg^{26,34}Lys^{36,40}-GLP-1(8-40); Gly⁸Arg²⁶-GLP-1(8-37); Gly⁸Arg³⁴-GLP-1(8-37); Gly⁸Lys³⁶-GLP-1(8-37); Gly⁸Arg^{26,34}Lys³⁶-GLP-1(8-37); Gly⁸Arg^{26,34}Lys³⁹-GLP-1(8-39); Gly⁸Arg^{26,34}Lys⁴⁰-GLP-1(8-40); Gly⁸Arg²⁶Lys³⁶-GLP-1(8-37); Gly⁸Arg³⁴-GLP-1(8-37); Gly⁸Arg²⁶Lys³⁹-GLP-1(8-39); Gly⁸Arg³⁴Lys⁴⁰-GLP-1(8-40); Gly⁸Arg^{26,34}Lys^{36,39}-GLP-1(8-39); or Gly⁸Arg^{26,34}Lys^{36,40}-GLP-1(8-40).

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In a further preferred embodiment, the parent peptide is: Arg^{26,34}Lys³⁸GLP-1(8-38); Arg^{26,34}Lys³⁹GLP-1(8-39); Arg^{26,34}Lys⁴⁰GLP-1(8-40); Arg^{26,34}Lys⁴¹GLP-1(8-41); Arg^{26,34}Lys⁴²GLP-1(8-42); Arg^{26,34}Lys⁴³GLP-1(8-43); Arg^{26,34}Lys⁴⁴GLP-1(8-44); Arg^{26,34}Lys⁴⁵GLP-1(8-45); Arg²⁶Lys³⁸GLP-1(8-38); Arg³⁴Lys³⁸GLP-1(8-38); Arg^{26,34}Lys^{36,38}GLP-1(8-38); Arg^{26,34}Lys³⁸GLP-1(8-38); Arg²⁶Lys³⁹GLP-1(8-39); Arg³⁴Lys³⁹GLP-1(8-39); or Arg^{26,34}Lys^{36,39}GLP-1(8-39).

In a further preferred embodiment, the parent peptide is Arg²⁶-GLP-1(8-37), Arg³⁴-GLP-1(8-37), Lys³⁶-GLP-1(8-37), Arg^{26,34}Lys³⁶-GLP-1(8-37), Arg²⁶Lys³⁶-GLP-1(8-37), Arg³⁴Lys³⁶-GLP-1(8-37), Gly⁸Arg²⁶-GLP-1(8-37), Gly⁸Arg³⁴-GLP-1(8-37), Gly⁸Lys³⁶-GLP-1(8-37), Gly⁸Arg^{26,34}Lys³⁶-GLP-1(8-37), Gly⁸Arg²⁶Lys³⁶-GLP-1(8-37), or Gly⁸Arg³⁴Lys³⁶-GLP-1(8-37).

In a further preferred embodiment, the parent peptide is Arg²⁶Lys³⁸-GLP-1(8-38), Arg^{26,34}Lys³⁸-GLP-1(8-38), Arg^{26,34}Lys^{36,38}-GLP-1(8-38), Gly⁸Arg²⁶Lys³⁸-GLP-1(8-38) or Gly⁸Arg^{26,34}Lys^{36,38}-GLP-1(8-38).

In a further preferred embodiment, the parent peptide is Arg²⁶Lys³⁹-GLP-1(8-39), Arg^{26,34}Lys^{36,39}-GLP-1(8-39), Gly⁸Arg²⁶Lys³⁹-GLP-1(8-39), or Gly⁸Arg^{26,34}Lys^{36,39}-GLP-1(8-39).

In a further preferred embodiment, the present invention relates to a GLP-1 derivative wherein the parent peptide is Arg³⁴Lys⁴⁰-GLP-1(8-40), Arg^{26,34}Lys^{36,40}-GLP-1(8-40), Gly⁸Arg³⁴Lys⁴⁰-GLP-1(8-40) or Gly⁸Arg^{26,34}Lys^{36,40}-GLP-1(8-40).

In a further preferred embodiment, the present invention relates to a GLP-1 derivative wherein the parent peptide is: Arg²⁶-GLP-1(8-36); Arg³⁴-GLP-1(8-36); Arg^{26,34}Lys³⁶-GLP-1(8-36); Arg²⁶-GLP-1(8-36)amide; Arg³⁴-GLP-1(8-36)amide; Arg^{26,34}Lys³⁶-GLP-1(8-36)amide; Arg²⁶-GLP-1(8-37); Arg³⁴-GLP-1(8-37); Arg^{26,34}Lys³⁶-GLP-1(8-37); Arg²⁶-GLP-1(8-38); Arg³⁴-GLP-1(8-38); Arg^{26,34}Lys³⁸GLP-1(8-38); Arg²⁶-GLP-1(8-39); Arg³⁴-GLP-1(8-39); Arg^{26,34}Lys³⁹-GLP-1(8-39); Gly⁸Arg²⁶-GLP-1(8-36); Gly⁸Arg³⁴-GLP-1(8-36); Gly⁸Arg^{26,34}Lys³⁶-GLP-1(8-36)amide; Gly⁸Arg³⁴-GLP-1(8-36)amide; Gly⁸Arg^{26,34}Lys³⁶-GLP-1(8-36); Gly⁸Arg²⁶-GLP-1(8-37); Gly⁸Arg³⁴-GLP-1(8-37); Gly⁸Arg^{26,34}Lys³⁶-GLP-1(8-38); Gly⁸Arg^{26,34}Lys³⁸GLP-1(8-38); Gly⁸Arg²⁶-GLP-1(8-39);

Gly⁸Arg³⁴-GLP-1(8-39); Gly⁸Arg^{26,34}Lys³⁹-GLP-1(8-39); Val⁸Arg²⁶-GLP-1(8-36); Val⁸Arg³⁴-GLP-1(8-36); Val⁸Arg^{26,34}Lys³⁶-GLP-1(8-36); Val⁸Arg²⁶-GLP-1(8-36)amide; Val⁸Arg³⁴-GLP-1(8-36)amide; Val⁸Arg^{26,34}Lys³⁶-GLP-1(8-36)amide; Val⁸Arg²⁶-GLP-1(8-37); Val⁸Arg³⁴-GLP-1(8-37); Val⁸Arg^{26,34}Lys³⁶-GLP-1(8-37); Val⁸Arg²⁶-GLP-1(8-38); Val⁸Arg³⁴-GLP-1(8-38); Val⁸Arg^{26,34}Lys³⁸GLP-1(8-38); Val⁸Arg²⁶-GLP-1(8-39); Val⁸Arg³⁴-GLP-1(8-39); Val⁸Arg^{26,34}Lys³⁹-GLP-1(8-39); Ser⁸Arg²⁶-GLP-1(8-36); Ser⁸Arg³⁴-GLP-1(8-36); Ser⁸Arg^{26,34}Lys³⁶-GLP-1(8-36); Ser⁸Arg²⁶-GLP-1(8-36)amide; Ser⁸Arg³⁴-GLP-1(8-36)amide; Ser⁸Arg^{26,34}Lys³⁶-GLP-1(8-36)amide; Ser⁸Arg²⁶-GLP-1(8-37); Ser⁸Arg³⁴-GLP-1(8-37); Ser⁸Arg^{26,34}Lys³⁶-GLP-1(8-37); Ser⁸Arg²⁶-GLP-1(8-38); Ser⁸Arg³⁴-GLP-1(8-38); Ser⁸Arg^{26,34}Lys³⁸GLP-1(8-38); Ser⁸Arg²⁶-GLP-1(8-39); Ser⁸Arg³⁴-GLP-1(8-39); Ser⁸Arg^{26,34}Lys³⁹-GLP-1(8-39); Thr⁸Arg²⁶-GLP-1

In a further preferred embodiment, the GLP-1 derivative is Arg²⁶Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-37).
 In a further preferred embodiment, the GLP-1 derivative is Lys²⁶(N^ε-lithocholoyl)-GLP-1(7-36).
 In a further preferred embodiment, the GLP-1 derivative is Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-36).
 In a further preferred embodiment, the GLP-1 derivative is Lys^{26,34}-bis(N^ε-lithocholoyl)-GLP-1(7-36).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys²⁶(N^ε-lithocholoyl)-GLP-1(7-36).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-36).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys^{26,34}-bis(N^ε-lithocholoyl)-GLP-1(7-36).
 In a further preferred embodiment, the GLP-1 derivative is Arg²⁶Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-36).
 In a further preferred embodiment, the GLP-1 derivative is Lys²⁶(N^ε-lithocholoyl)-GLP-1(7-35).
 In a further preferred embodiment, the GLP-1 derivative is Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-35).
 In a further preferred embodiment, the GLP-1 derivative is Lys^{26,34}-bis(N^ε-lithocholoyl)-GLP-1(7-35).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys²⁶(N^ε-lithocholoyl)-GLP-1(7-35).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-35).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys^{26,34}-bis(N^ε-lithocholoyl)-GLP-1(7-35).
 In a further preferred embodiment, the GLP-1 derivative is Arg²⁶Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-35).
 In a further preferred embodiment, the GLP-1 derivative is Lys²⁶(N^ε-lithocholoyl)-GLP-1(7-36)amide.
 In a further preferred embodiment, the GLP-1 derivative is Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-36)amide.
 In a further preferred embodiment, the GLP-1 derivative is Lys^{26,34}-bis(N^ε-lithocholoyl)-GLP-1(7-36)amide.
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys²⁶(N^ε-lithocholoyl)-GLP-1(7-36)amide.
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-36)amide.
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys^{26,34}-bis(N^ε-lithocholoyl)-GLP-1(7-36)amide.
 In a further preferred embodiment, the GLP-1 derivative is Arg²⁶Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-36)amide.
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Arg²⁶Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-37).
 In a further preferred embodiment, the GLP-1 derivative is Lys²⁶(N^ε-lithocholoyl)Arg³⁴-GLP-1(7-37).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys²⁶(N^ε-lithocholoyl)Arg³⁴-GLP-1(7-37).
 In a further preferred embodiment, the GLP-1 derivative is Arg^{26,34}Lys³⁶(N^ε-lithocholoyl)-GLP-1(7-37).
 In a further preferred embodiment, the GLP-1 derivative is Arg^{26,34}Lys³⁸(N^ε-lithocholoyl)-GLP-1(7-37).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Arg^{26,34}Lys³⁶(N^ε-lithocholoyl)-GLP-1(7-37).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Arg²⁶Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-38).
 In a further preferred embodiment, the GLP-1 derivative is Lys²⁶(N^ε-lithocholoyl)Arg³⁴-GLP-1(7-38).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys²⁶(N^ε-lithocholoyl)Arg³⁴-GLP-1(7-38).
 In a further preferred embodiment, the GLP-1 derivative is Arg^{26,34}Lys³⁶(N^ε-lithocholoyl)-GLP-1(7-38).
 In a further preferred embodiment, the GLP-1 derivative is Arg^{26,34}Lys³⁸(N^ε-lithocholoyl)-GLP-1(7-38).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Arg^{26,34}Lys³⁶(N^ε-lithocholoyl)-GLP-1(7-38).

In a further preferred embodiment, the GLP-1 derivative is Gly⁸Arg²⁶Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-39).
 In a further preferred embodiment, the GLP-1 derivative is Lys²⁶(N^ε-lithocholoyl)Arg³⁴-GLP-1(7-39).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys²⁶(N^ε-lithocholoyl)Arg³⁴-GLP-1(7-39).
 In a further preferred embodiment, the GLP-1 derivative is Arg^{26,34}Lys³⁶(N^ε-lithocholoyl)-GLP-1(7-39).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Arg^{26,34}Lys³⁶(N^ε-lithocholoyl)-GLP-1(7-39).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Arg²⁶Lys³⁴(N^ε-lithocholoyl)-GLP-1(7-40).
 In a further preferred embodiment, the GLP-1 derivative is Lys²⁶(N^ε-lithocholoyl)Arg³⁴-GLP-1(7-40).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Lys²⁶(N^ε-lithocholoyl)Arg³⁴-GLP-1(7-40).
 In a further preferred embodiment, the GLP-1 derivative is Arg^{26,34}Lys³⁶(N^ε-lithocholoyl)-GLP-1(7-40).
 In a further preferred embodiment, the GLP-1 derivative is Gly⁸Arg^{26,34}Lys³⁶(N^ε-lithocholoyl)-GLP-1(7-40).
 Other preferred embodiments will be described using the following abbreviations:
 Glut=N^ε-(γ-L-glutamyl)
 Aspa=N^ε-(β-L-asparagyl)
 Glyc=N^ε-glycyl
 GAB=N^ε-(α-(γ-aminobutanoyl))
 ADod=N^α-dodecanoyl
 ATet=N^α-tetradecanoyl
 AHex=N^α-hexadecanoyl
 AOct=N^α-octadecanoyl
 ALit=N^α-lithocholoyl
 GDod=N^γ-dodecanoyl
 GTet=N^γ-tetradecanoyl
 GHex=N^γ-hexadecanoyl
 GOct=N^γ-octadecanoyl
 GLit=N^γ-lithocholoyl
 Other preferred GLP-1 derivatives of the present invention are:
 Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-36); Arg³⁴Lys²⁶-(Glut-ADod)-GLP-1(7-36); Arg^{26,34}Lys³⁶-(Glut-ADod)-GLP-1(7-36); Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-36)amide; Arg³⁴Lys²⁶-(Glut-ADod)-GLP-1(7-36)amide; Arg^{26,34}Lys³⁶-(Glut-ADod)-GLP-1(7-36)amide; Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-37); Arg³⁴Lys²⁶-(Glut-ADod)-GLP-1(7-37); Arg^{26,34}Lys³⁶-(Glut-ADod)-GLP-1(7-37); Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-38); Arg³⁴Lys²⁶-(Glut-ADod)-GLP-1(7-38); Arg^{26,34}Lys³⁸-(Glut-ADod)-GLP-1(7-38); Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-39); Arg³⁴Lys²⁶-(Glut-ADod)-GLP-1(7-39); Arg^{26,34}Lys³⁹-(Glut-ADod)-GLP-1(7-39);
 Gly⁸Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-36); Gly⁸Arg³⁴Lys²⁶-(Glut-ADod)-GLP-1(7-36); Gly⁸Arg^{26,34}Lys³⁶-(Glut-ADod)-GLP-1(7-36); Gly⁸Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-36)amide; Gly⁸Arg³⁴Lys²⁶-(Glut-ADod)-GLP-1(7-36)amide; Gly⁸Arg^{26,34}Lys³⁶-(Glut-ADod)-GLP-1(7-36)amide; Gly⁸Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-37); Gly⁸Arg³⁴Lys²⁶-(Glut-ADod)-GLP-1(7-37); Gly⁸Arg^{26,34}Lys³⁶-(Glut-ADod)-GLP-1(7-37); Gly⁸Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-38); Gly⁸Arg³⁴Lys²⁶-(Glut-ADod)-GLP-1(7-38); Gly⁸Arg^{26,34}Lys³⁸-(Glut-ADod)-GLP-1(7-38); Gly⁸Arg²⁶Lys³⁴-(Glut-ADod)-GLP-1(7-39);

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Arg^{26,34}Lys²⁷-(GAB-GHex)-GLP-1(7-37);
 Arg^{26,34}Lys²⁷-(GAB-GHex)-GLP-1(7-38);
 Thr⁸Asp¹⁹Arg^{26,34}Lys²⁷-(GAB-GHex)-GLP-1(7-36);
 Thr⁸Asp¹⁷Arg^{26,34}Lys²⁷-(GAB-GHex)-GLP-1(7-36);
 Thr⁸Asp¹⁹Arg^{26,34}Lys²⁷-(GAB-GHex)-GLP-1(7-36) 5
 amide; Thr⁸Asp¹⁷Arg^{26,34}Lys²⁷-(GAB-GHex)-GLP-1
 (7-36)amide; Thr⁸Asp¹⁹Arg^{26,34}Lys²⁷-(GAB-GHex)-
 GLP-1(7-37); Thr⁸Asp¹⁹Arg^{26,34}Lys²⁷-(GAB-GHex)-
 GLP-1(7-38); Thr⁸Asp¹⁷Arg^{26,34}Lys²⁷-(GAB-GHex)-
 GLP-1(7-38); Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-36); Arg³⁴Lys²⁶- 10
 (GAB-GOct)-GLP-1(7-36); Arg^{26,34}Lys³⁶-(GAB-
 GOct)-GLP-1(7-36); Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1
 (7-36)amide; Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-36)
 amide; Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36)
 amide; Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-37); 15
 Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-37);
 Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-37);
 Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-38); Arg³⁴Lys²⁶-
 (GAB-GOct)-GLP-1(7-38); Arg^{26,34}Lys³⁸-(GAB-
 GOct)-GLP-1(7-38); Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1 20
 (7-39); Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-39);
 Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1(7-39);
 Gly⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-36);
 Gly⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-36);
 Gly⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36); 25
 Gly⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-36)amide;
 Gly⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-36)amide;
 Gly⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36)amide;
 Gly⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-37);
 Gly⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-37); 30
 Gly⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-37);
 Gly⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-38);
 Gly⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-38);
 Gly⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-38);
 Gly⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-39); 35
 Gly⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-39);
 Gly⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1(7-39);
 Val⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-36);
 Val⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-36);
 Val⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36); 40
 Val⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-36)amide;
 Val⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-36)amide;
 Val⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36)amide;
 Val⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-37);
 Val⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-37); 45
 Val⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-37);
 Val⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-38);
 Val⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-38);
 Val⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-38);
 Val⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-39); 50
 Val⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-39);
 Val⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1(7-39);
 Ser⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-36);
 Ser⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-36);
 Ser⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36); 55
 Ser⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-36)amide;
 Ser⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-36)amide;
 Ser⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36)amide;
 Ser⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-37);
 Ser⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-37); 60
 Ser⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-37);
 Ser⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-38);
 Ser⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-38);
 Ser⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-38);
 Ser⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-39); 65
 Ser⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-39);
 Ser⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1(7-39);

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Thr⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-36);
 Thr⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-36);
 Thr⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36);
 Thr⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-36)amide;
 Thr⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-36)amide;
 Thr⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36)amide;
 Thr⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-37);
 Thr⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-37);
 Thr⁸Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-37);
 Thr⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-38);
 Thr⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-38);
 Thr⁸Arg^{26,34}Lys³⁸-(GAB-GOct)-GLP-1(7-38);
 Thr⁸Arg²⁶Lys³⁴-(GAB-GOct)-GLP-1(7-39);
 Thr⁸Arg³⁴Lys²⁶-(GAB-GOct)-GLP-1(7-39);
 Thr⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1(7-39);
 Gly⁸Glu³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36);
 Gly⁸Glu³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36) 10
 amide; Gly⁸Glu³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-GLP-1
 (7-37); Gly⁸Glu³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-GLP-1
 (7-38); Gly⁸Glu³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1
 (7-39); Gly⁸Glu³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1
 (7-36)amide; Gly⁸Glu³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-
 GLP-1(7-37); Gly⁸Glu³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-
 GLP-1(7-38); Gly⁸Glu³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-
 GLP-1(7-39);
 Gly⁸Asp³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36);
 Gly⁸Asp³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36) 15
 amide; Gly⁸Asp³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-GLP-1
 (7-37); Gly⁸Asp³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-GLP-1
 (7-38); Gly⁸Asp³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1
 (7-39); Gly⁸Asp³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1
 (7-36); Gly⁸Asp³⁶Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1
 (7-36)amide; Gly⁸Asp³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-
 GLP-1(7-37); Gly⁸Asp³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-
 GLP-1(7-38); Gly⁸Asp³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-
 GLP-1(7-39);
 Val⁸Glu³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36);
 Val⁸Glu³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36) 20
 amide; Val⁸Glu³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-GLP-1
 (7-37); Val⁸Glu³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-GLP-1
 (7-38); Val⁸Glu³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1
 (7-39); Val⁸Glu³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1
 (7-36)amide; Val⁸Glu³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-
 GLP-1(7-37); Val⁸Glu³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-
 GLP-1(7-38); Val⁸Glu³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-
 GLP-1(7-39);
 Val⁸Asp³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36);
 Val⁸Asp³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36) 25
 amide; Val⁸Asp³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-GLP-1
 (7-37); Val⁸Asp³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-GLP-1
 (7-38); Val⁸Asp³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1
 (7-39); Val⁸Asp³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1
 (7-36); Val⁸Asp³⁶Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1
 (7-36)amide; Val⁸Asp³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-
 GLP-1(7-37); Val⁸Asp³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-
 GLP-1(7-38); Val⁸Asp³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-
 GLP-1(7-39);
 Ser⁸Glu³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36);
 Ser⁸Glu³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1(7-36) 30
 amide; Ser⁸Glu³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-GLP-1
 (7-37); Ser⁸Glu³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-GLP-1
 (7-38); Ser⁸Glu³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-GLP-1
 (7-39); Ser⁸Glu³⁵Arg^{26,34}Lys³⁶-(GAB-GOct)-GLP-1
 (7-36)amide; Ser⁸Glu³⁶Arg^{26,34}Lys³⁷-(GAB-GOct)-
 GLP-1(7-37); Ser⁸Glu³⁷Arg^{26,34}Lys³⁸-(GAB-GOct)-
 GLP-1(7-38); Ser⁸Glu³⁸Arg^{26,34}Lys³⁹-(GAB-GOct)-
 GLP-1(7-39);

Gly⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-38);
 Gly⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-39)
 Gly⁸Arg²⁶Lys^{34,36}-bis-(GAB-GLit)-GLP-1(7-36);
 Gly⁸Arg³⁴Lys^{26,36}-bis-(GAB-GLit)-GLP-1(7-36);
 Gly⁸Arg²⁶Lys^{34,36}-bis-(GAB-GLit)-GLP-1(7-37);
 Gly⁸Arg³⁴Lys^{26,36}-bis-(GAB-GLit)-GLP-1(7-37);
 Gly⁸Arg²⁶Lys^{34,37}-bis-(GAB-GLit)-GLP-1(7-37);
 Gly⁸Arg³⁴Lys^{26,37}-bis-(GAB-GLit)-GLP-1(7-37);
 Gly⁸Arg²⁶Lys^{34,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Gly⁸Arg³⁴Lys^{26,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Gly⁸Arg^{26,34}Lys^{36,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Gly⁸Arg²⁶Lys^{34,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Gly⁸Arg³⁴Lys^{26,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Gly⁸Arg^{26,34}Lys^{36,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Val⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-36);
 Val⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-37);
 Val⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-38);
 Val⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-39)
 Val⁸Arg²⁶Lys^{34,36}-bis-(GAB-GLit)-GLP-1(7-36);
 Val⁸Arg³⁴Lys^{26,36}-bis-(GAB-GLit)-GLP-1(7-36);
 Val⁸Arg²⁶Lys^{34,36}-bis-(GAB-GLit)-GLP-1(7-37);
 Val⁸Arg³⁴Lys^{26,36}-bis-(GAB-GLit)-GLP-1(7-37);
 Val⁸Arg²⁶Lys^{34,37}-bis-(GAB-GLit)-GLP-1(7-37);
 Val⁸Arg³⁴Lys^{26,37}-bis-(GAB-GLit)-GLP-1(7-37);
 Val⁸Arg²⁶Lys^{34,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Val⁸Arg³⁴Lys^{26,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Val⁸Arg^{26,34}Lys^{36,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Val⁸Arg²⁶Lys^{34,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Val⁸Arg³⁴Lys^{26,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Val⁸Arg^{26,34}Lys^{36,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Ser⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-36);
 Ser⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-37);
 Ser⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-38);
 Ser⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-39)
 Ser⁸Arg²⁶Lys^{34,36}-bis-(GAB-GLit)-GLP-1(7-36);
 Ser⁸Arg³⁴Lys^{26,36}-bis-(GAB-GLit)-GLP-1(7-36);
 Ser⁸Arg²⁶Lys^{34,36}-bis-(GAB-GLit)-GLP-1(7-37);
 Ser⁸Arg³⁴Lys^{26,36}-bis-(GAB-GLit)-GLP-1(7-37);
 Ser⁸Arg²⁶Lys^{34,37}-bis-(GAB-GLit)-GLP-1(7-37);
 Ser⁸Arg³⁴Lys^{26,37}-bis-(GAB-GLit)-GLP-1(7-37);
 Ser⁸Arg²⁶Lys^{34,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Ser⁸Arg³⁴Lys^{26,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Ser⁸Arg^{26,34}Lys^{36,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Ser⁸Arg²⁶Lys^{34,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Ser⁸Arg³⁴Lys^{26,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Ser⁸Arg^{26,34}Lys^{36,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Thr⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-36);
 Thr⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-37);
 Thr⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-38);
 Thr⁸Lys^{26,34}-bis-(GAB-GLit)-GLP-1(7-39)
 Thr⁸Arg²⁶Lys^{34,36}-bis-(GAB-GLit)-GLP-1(7-36);
 Thr⁸Arg³⁴Lys^{26,36}-bis-(GAB-GLit)-GLP-1(7-36);
 Thr⁸Arg²⁶Lys^{34,36}-bis-(GAB-GLit)-GLP-1(7-37);
 Thr⁸Arg³⁴Lys^{26,36}-bis-(GAB-GLit)-GLP-1(7-37);
 Thr⁸Arg²⁶Lys^{34,37}-bis-(GAB-GLit)-GLP-1(7-37);
 Thr⁸Arg³⁴Lys^{26,37}-bis-(GAB-GLit)-GLP-1(7-37);
 Thr⁸Arg²⁶Lys^{34,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Thr⁸Arg³⁴Lys^{26,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Thr⁸Arg^{26,34}Lys^{36,38}-bis-(GAB-GLit)-GLP-1(7-38);
 Thr⁸Arg²⁶Lys^{34,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Thr⁸Arg³⁴Lys^{26,39}-bis-(GAB-GLit)-GLP-1(7-39);
 Thr⁸Arg^{26,34}Lys^{36,39}-bis-(GAB-GLit)-GLP-1(7-39).

Pharmaceutical compositions

The present invention also related to pharmaceutical compositions comprising a GLP-1 derivative of the present invention and a pharmaceutically acceptable vehicle or carrier.

Preferably, the pharmaceutical compositions comprise an isotonic agent, a preservative and a buffer. Examples of isotonic agents are sodium chloride, mannitol and glycerol. Examples of preservatives are phenol, m-cresol, methyl p-hydroxybenzoate and benzyl alcohol. Suitable buffers include sodium acetate and sodium phosphate.

The pharmaceutical compositions preferably further comprise a surfactant in order to improve the solubility and/or the stability of the GLP-1 derivative.

The pharmaceutical compositions preferably also comprise zinc.

The pharmaceutical compositions preferably further comprise another antidiabetic agent. The term "antidiabetic agent" includes compounds for the treatment and/or prophylaxis of insulin resistance and diseases wherein insulin resistance is the pathophysiological mechanism.

In one embodiment of this invention, the antidiabetic agent is an insulin, more preferably human insulin.

In another embodiment the antidiabetic agent is a hypoglycaemic agent, preferably an oral hypoglycaemic agent. Oral hypoglycaemic agents are preferably selected from the group consisting of sulfonylureas, biguanides, thiazolidinediones, glucosidase inhibitors, glucagon antagonist, GLP-1 agonists, potassium channel openers, insulin sensitizers, hepatic enzyme inhibitors, glucose uptake modulators, compounds modifying the lipid metabolism, compounds lowering food intake, and agents acting on the ATP-dependent potassium channel of the β-cells. Preferred sulfonylureas are tolbutamide, glibenclamide, glipizide and gliclazide. A preferred biguanide is metformin. Preferred thiazolidinediones are troglitazone and ciglitazone. A preferred glucosidase inhibitors is acarbose. Preferred agents acting on the ATP-dependent potassium channel of the β-cells are: glibenclamide, glipizide, gliclazide, and repaglinide.

The pharmaceutical compositions of the present invention may further comprise another antiobesity agent.

In one embodiment of this invention, the antiobesity agent is leptin.

In another embodiment the antiobesity agent is amphetamine.

In another embodiment the antiobesity agent is dexfenfluramine.

In another embodiment the antiobesity agent is sibutramine.

In another embodiment the antiobesity agent is orlistat.

In another embodiment the antiobesity agent is selected from a group of CART agonists, NPY antagonists, orexin antagonists, H3-antagonists, TNF agonists, CRF agonists, CRF BP antagonists, urocortin agonists, β3 agonists, MSH agonists, CCK agonists, serotonin re-uptake inhibitors, mixed serotonin and noradrenergic compounds, 5HT agonists, bombesin agonists, galanin antagonists, growth hormone, growth hormone releasing compounds, glucagon, TRH agonists, uncoupling protein 2 or 3 modulators, leptin agonists, DA agonists (Bromocriptin, Dorexin), lipase/ amylase inhibitors, PPAR modulators, PXR modulators or TR β agonists.

The present invention also relates to pharmaceutical compositions comprising water and a GLP-1 derivative which has a helix content as measured by CD at 222 nm in H₂O at 22±2° C. exceeding 25%, preferably in the range of 25% to 50%, at a peptide concentration of about 10 μM. The size of the partially helical, micelle-like aggregates may be estimated by size-exclusion chromatography. Similarly, the apparent (critical micelle concentrations) CMC's of the

peptides may be estimated from the concentration dependent fluorescence in the presence of appropriate dyes (e.g. Brito, R. & Vaz, W. (1986) *Anal. Biochem.* 152, 250-255).

That the derivatives have a partially structured micellar-like aggregate conformation in aqueous solutions makes them more soluble and stable in solution as compared to the native peptide. The increased solubility and stability can be seen by comparing the solubility after 9 days of standing for a derivative and native GLP-1(7-37) in a pharmaceutical formulation, e.g. 5 mM phosphate buffer, pH 6.9 added 0.1 M NaCl.

Circular Dichroism (CD) can be used to show that the GLP-1 derivatives have a certain partially structured conformation independent of their concentration. In contrast, for native GLP-1(7-37) an increase in the helix content is seen with increasing concentration, from 10-15% to 30-35% (at 500 μ M concentration) in parallel with peptide self-association. For the GLP-1 derivatives forming partially structured micellar-like aggregates in aqueous solution the helix content remains constant above 30% at concentrations of 10 μ M. The aggregated structured conformation is an inherent property of the derivative present in water or dilute aqueous buffer without the need for any additional structure-inducing components.

The pharmaceutical compositions of the present invention may be prepared by conventional techniques, e.g. as described in Remington's *Pharmaceutical Sciences*, 1985 or in Reington: *The Science and Practice of Pharmacy*, 19th edition, 1995.

For example, injectable compositions of the GLP-1 derivative of the invention can be prepared using the conventional techniques of the pharmaceutical industry which involves dissolving and mixing the ingredients as appropriate to give the desired end product.

A composition for nasal administration of certain peptides may, for example, be prepared as described in European Patent No. 272097 (to Novo Nordisk A/S) or in WO 93/18785.

In a preferred embodiment of the present invention, the GLP-1 derivative is provided in the form of a composition suitable for administration by injection. Such a composition can either be an injectable solution ready for use or it can be an amount of a solid composition, e.g. a lyophilised product, which has to be dissolved in a solvent before it can be injected. The injectable solution preferably contains not less than about 2 mg/ml, preferably not less than about 5 mg/ml, more preferred not less than about 10 mg/ml of the GLP-1 derivative and, preferably, not more than about 100 mg/ml of the GLP-1 derivative.

Uses

The present invention also relates to the use of a GLP-1 derivative of the invention for the preparation of a medicament which has a protracted profile of action relative to GLP-1(7-37).

The present invention relates also to the use of a GLP-1 derivative of the invention for the preparation of a medicament with protracted effect for the treatment of non-insulin dependent diabetes mellitus.

The present invention also relates to the use of a GLP-1 derivative of the invention for the preparation of a medicament with protracted effect for the treatment of insulin dependent diabetes mellitus.

The present invention also relates to the use of a GLP-1 derivative of the invention for the preparation of a medicament with protracted effect for the treatment of obesity.

The present invention also relates to the use of a GLP-1 derivative of the present invention for treating insulin resistance.

The present invention also relates to the use of a GLP-1 derivative of the present invention for the preparation of a medicament with protracted effect for the treatment of obesity.

The present invention relates to a method of treating insulin dependent or non-insulin dependent diabetes mellitus in a patient in need of such a treatment, comprising administering to the patient a therapeutically effective amount of a GLP-1 derivative of the present invention together with a pharmaceutically acceptable carrier.

The present invention relates to a method of treating obesity in a patient in need of such a treatment, comprising administering to the patient a therapeutically effective amount of a GLP-1 derivative of the present invention together with a pharmaceutically acceptable carrier.

The particular GLP-1 derivative to be used and the optimal dose level for any patient will depend on the disease to be treated and on a variety of factors including the efficacy of the specific peptide derivative employed, the age, body weight, physical activity, and diet of the patient, on a possible combination with other drugs, and on the severity of the case.

The pharmaceutical compositions of the present invention may be administered parenterally to patients in need of such a treatment. Parenteral administration may be performed by subcutaneous, intramuscular or intravenous injection by means of a syringe, optionally a pen-like syringe. Alternatively, parenteral administration can be performed by means of an infusion pump. A further option is a composition which may be a powder or a liquid for the administration of the GLP-1 derivative in the form of a nasal or pulmonary spray. As a still further option, the GLP-1 derivatives of the invention can also be administered transdermally, e.g. from a patch, optionally a iontophoretic patch, or transmucosally, e.g. buccally.

Methods of Production

The parent peptide can be produced by a method which comprises culturing a host cell containing a DNA sequence encoding the polypeptide and capable of expressing the polypeptide in a suitable nutrient medium under conditions permitting the expression of the peptide, after which the resulting peptide is recovered from the culture.

The medium used to culture the cells may be any conventional medium suitable for growing the host cells, such as minimal or complex media containing appropriate supplements. Suitable media are available from commercial suppliers or may be prepared of published recipes (e.g. in catalogues of the American Type Culture Collection). The peptide produced by the cells may then be recovered from the culture medium by conventional procedures including separating the host cells from the medium by centrifugation or filtration, precipitating the proteinaceous components of the supernatant or filtrate by means of a salt, e.g. ammonium sulphate, purification by a variety of chromatographic procedures, e.g. ion exchange chromatography, gel filtration chromatography, affinity chromatography, or the like, dependent on the type of peptide in question.

The DNA sequence encoding the parent peptide may suitably be of genomic or cDNA origin, for instance obtained by preparing a genomic or cDNA library and screening for DNA sequences coding for all or part of the peptide by hybridisation using synthetic oligonucleotide probes in accordance with standard techniques (see, for example, Sambrook, J, Fritsch, EF and Maniatis, T, *Molecular Cloning: A Laboratory Manual*, Cold Spring Harbor Laboratory Press, New York, 1989). The DNA sequence encoding the peptide may also be prepared synthetically by

established standard methods, e.g. the phosphoramidite method described by Beaucage and Caruthers, *Tetrahedron Letters* 22 (1981), 1859–1869, or the method described by Matthes et al., *EMBO Journal* 3 (1984), 801–805. The DNA sequence may also be prepared by polymerase chain reaction using specific primers, for instance as described in U.S. Pat. No. 4,683,202 or Saiki et al., *Science* 239 (1988), 487–491.

The DNA sequence may be inserted into any vector which may conveniently be subjected to recombinant DNA procedures, and the choice of vector will often depend on the host cell into which it is to be introduced. Thus, the vector may be an autonomously replicating vector, i.e. a vector which exists as an extrachromosomal entity, the replication of which is independent of chromosomal replication, e.g. a plasmid. Alternatively, the vector may be one which, when introduced into a host cell, is integrated into the host cell genome and replicated together with the chromosome(s) into which it has been integrated.

The vector is preferably an expression vector in which the DNA sequence encoding the peptide is operably linked to additional segments required for transcription of the DNA, such as a promoter. The promoter may be any DNA sequence which shows transcriptional activity in the host cell of choice and may be derived from genes encoding proteins either homologous or heterologous to the host cell. Examples of suitable promoters for directing the transcription of the DNA encoding the peptide of the invention in a variety of host cells are well known in the art, cf. for instance Sambrook et al., *supra*.

The DNA sequence encoding the peptide may also, if necessary, be operably connected to a suitable terminator, polyadenylation signals, transcriptional enhancer sequences, and translational enhancer sequences. The recombinant vector of the invention may further comprise a DNA sequence enabling the vector to replicate in the host cell in question.

The vector may also comprise a selectable marker, e.g. a gene the product of which complements a defect in the host cell or one which confers resistance to a drug, e.g. ampicillin, kanamycin, tetracyclin, chloramphenicol, neomycin, hygromycin or methotrexate.

To direct a parent peptide of the present invention into the secretory pathway of the host cells, a secretory signal sequence (also known as a leader sequence, prepro sequence or pre sequence) may be provided in the recombinant vector. The secretory signal sequence is joined to the DNA sequence encoding the peptide in the correct reading frame. Secretory signal sequences are commonly positioned 5' to the DNA sequence encoding the peptide. The secretory signal sequence may be that normally associated with the peptide or may be from a gene encoding another secreted protein.

The procedures used to ligate the DNA sequences coding for the present peptide, the promoter and optionally the terminator and/or secretory signal sequence, respectively, and to insert them into suitable vectors containing the information necessary for replication are well known to persons skilled in the art (cf., for instance, Sambrook et al., *supra*).

The host cell into which the DNA sequence or the recombinant vector is introduced may be any cell which is capable of producing the present peptide and includes bacteria, yeast, fungi and higher eukaryotic cells. Examples of suitable host cells well known and used in the art are, without limitation, *E. coli*, *Saccharomyces cerevisiae*, or mammalian BHK or CHO cell lines.

The GLP-1 derivatives of this invention can be used in the treatment of various diseases. The particular GLP-1 derivative to be used and the optimal dose level for any patient will depend on the disease to be treated and on a variety of factors including the efficacy of the specific peptide derivative employed, the age, body weight, physical activity, and diet of the patient, on a possible combination with other drugs, and on the severity of the case. It is recommended that the dosage of the GLP-1 derivative of this invention be determined for each individual patient by those skilled in the art.

In particular, it is envisaged that the GLP-1 derivative will be useful for the preparation of a medicament with a protracted profile of action for the treatment of non-insulin dependent diabetes mellitus and/or for the treatment of obesity.

The present invention is further illustrated by the following examples which, however, are not to be construed as limiting the scope of protection. The features disclosed in the foregoing description and in the following examples may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

EXAMPLES

The following acronyms for commercially available chemicals are used:

DMF: N,N-Dimethylformamide

DCC: N,N-Dicyclohexylcarbodiimide

NMP: N-Methyl-2-pyrrolidone

EDPA: N-Ethyl-N,N-diisopropylamine

EGTA: Ethylene glycol-bis(β -aminoethyl ether)-N,N,N',N'-tetraacetic acid

GTP: Guanosine 5'-triphosphate

TFA: Trifluoroacetic acid

THF: Tetrahydrofuran

H-Glu(OH)-OBu^t: L-Glutamic acid α -tert-butyl ester

Cac-ONSu: Decanoic acid 2,5-dioxopyrrolidin-1-yl ester

Cap-ONSu: Octanoic acid 2,5-dioxopyrrolidin-1-yl ester

Lau-ONSu: Dodecanoic acid 2,5-dioxopyrrolidin-1-yl ester

Myr-ONSu: Tetradecanoic acid 2,5-dioxopyrrolidin-1-yl ester

Pal-ONSu: Hexadecanoic acid 2,5-dioxopyrrolidin-1-yl ester

Ste-ONSu: Octadecanoic acid 2,5-dioxopyrrolidin-1-yl ester

Abbreviations:

PDMS: Plasma Desorption Mass Spectrometry

MALDI-MS: Matrix Assisted Laser Desorption/Ionisation Mass Spectrometry

HPLC: High Performance Liquid Chromatography

amu: atomic mass units

Lit-Glu(ONSu)-OBu^t: N ^{α} -Lithochoyl-L-glutamic acid α -t-butyl ester γ -2,5-dioxopyrrolidin-1-yl ester

Cap-Glu(ONSu)-OBu^t: N ^{α} -Octanoyl-L-glutamic acid α -t-butyl ester γ -2,5-dioxopyrrolidin-1-yl ester

Cac-Glu(ONSu)-OBu^t: N ^{α} -Decanoyl-L-glutamic acid α -t-butyl ester γ -2,5-dioxopyrrolidin-1-yl ester

Lau-Glu(ONSu)-OBu^t: N ^{α} -Dodecanoyl-L-glutamic acid α -t-butyl ester γ -2,5-dioxopyrrolidin-1-yl ester

Myr-Glu(ONSu)-OBu^t: N ^{α} -Tetradecanoyl-L-glutamic acid α -t-butyl ester γ -2,5-dioxopyrrolidin-1-yl ester

Pal-Glu(ONSu)-OBu^t: N^α-Hexadecanoyl-(L)-glutamic acid α-t-butyl-γ-2,5-dioxopyrrolidin-1-yl diester
 Ste-Glu(ONSu)-OBu^t: N^α-Octadecanoyl-(L)-glutamic acid α-t-butyl-γ-2,5-dioxopyrrolidin-1-yl diester
 Lau-β-Ala-ONSu: N^β-Dodecanoyl-β-alanine 2,5-dioxopyrrolidin-1-yl ester
 Pal-β-Ala-ONSu: N^β-Hexadecanoyl-β-alanine 2,5-dioxopyrrolidin-1-yl ester
 Lau-GABA-ONSu: N^γ-Dodecanoyl-γ-aminobutyric acid 2,5-dioxopyrrolidin-1-yl ester
 Myr-GABA-ONSu: N^γ-Tetradecanoyl-γ-aminobutyric acid 2,5-dioxopyrrolidin-1-yl ester
 Pal-GABA-ONSu: N^γ-Hexadecanoyl-γ-aminobutyric acid 2,5-dioxopyrrolidin-1-yl ester
 Ste-GABA-ONSu: N^γ-Octadecanoyl-γ-aminobutyric acid 2,5-dioxopyrrolidin-1-yl ester
 Pal-Isonip-ONSu: N-Hexadecanoyl-piperidine-4-carboxylic acid 2,5-dioxopyrrolidin-1-yl ester
 Pal-Glu(OBu^t)-ONSu: N^α-Hexadecanoyl-L-glutamic acid α-2,5-dioxopyrrolidin-1-yl ester γ-t-butyl ester
 HOOC-(CH₂)₆-COONSu: ω-Carboxyheptanoic acid 2,5-dioxopyrrolidin-1-yl ester
 HOOC-(CH₂)₁₀-COONSu: ω-Carboxyundecanoic acid 2,5-dioxopyrrolidin-1-yl ester
 HOOC-(CH₂)₁₂-COONSu: ω-Carboxytridecanoic acid 2,5-dioxopyrrolidin-1-yl ester
 HOOC-(CH₂)₁₄-COONSu: ω-Carboxypentadecanoic acid 2,5-dioxopyrrolidin-1-yl ester
 HOOC-(CH₂)₁₆-COONSu: ω-Carboxyheptadecanoic acid 2,5-dioxopyrrolidin-1-yl ester
 HOOC-(CH₂)₁₈-COONSu: ω-Carboxynonadecanoic acid 2,5-dioxopyrrolidin-1-yl ester
 N^α-alkanoyl-Glu(ONSu)-OBu^t: N^α-Alkanoyl-(L)-glutamic acid α-t-butyl-γ-2,5-dioxopyrrolidin-1-yl diester

Analytical

Plasma Desorption Mass Spectrometry

Sample preparation:

The sample is dissolved in 0.1% TFA/EtOH (1:1) at a concentration of 1 μg/μl. The sample solution (5–10 μl) is placed on a nitrocellulose target (Bio-ion AB, Uppsala, Sweden) and allowed to absorb to the target surface for 2 minutes. The target is subsequently rinsed with 2×25 μl 0.1% TFA and spin-dried. Finally, the nitrocellulose target is placed in a target carousel and introduced into the mass spectrometer.

MS analysis:

PDMS analysis was carried out using a Bio-ion 20 time-of-flight instrument (Bio-ion Nordic AB, Uppsala, Sweden). An acceleration voltage of 15 kV was applied and molecular ions formed by bombardment of the nitrocellulose surface with 252-Cf fission fragments were accelerated towards a stop detector. The resulting time-of-flight spectrum was calibrated into a true mass spectrum using the H⁺ and NO⁺ ions at m/z 1 and 30, respectively. Mass spectra were generally accumulated for 1.0×10⁶ fission events corresponding to 15–20 minutes. Resulting assigned masses all correspond to isotopically averaged molecular masses. The accuracy of mass assignment is generally better than 0.1%.

MALDI-MS

MALDI-TOF MS analysis was carried out using a Voyager RP instrument (PerSeptive Biosystems Inc., Framingham, Mass.) equipped with delayed extraction and operated in linear mode. Alpha-cyano-4-hydroxy-cinnamic acid was used as matrix, and mass assignments were based on external calibration.

Example 1

Synthesis of Lys²⁶(N^ε-tetradecanoyl)-GLP-1(7-37).

The title compound was synthesised from GLP-1(7-37). A mixture of GLP-1(7-37) (25 mg, 7.45 μm), EDPA (26.7 mg, 208 μm), NMP (520 μl) and water (260 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of Myr-ONSu (2.5 mg, 7.67 μm) in NMP (62.5 μl), the reaction mixture was gently shaken for 5 min. at room temperature and then allowed to stand for 20 min. An additional amount of Myr-ONSu (2.5 mg, 7.67 μm) in NMP (62.5 μl) was added and the resulting mixture gently shaken for 5 min. After a total reaction time of 40 min. the reaction was quenched by the addition of a solution of glycine (12.5 mg, 166 μmol) in 50% aqueous ethanol (12.5 ml). The title compound was isolated from the reaction mixture by HPLC using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system, yield: 1.3 mg (corresponding to 4.9% of the theoretical yield). The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The isolated product was analysed by PDMS and the m/z value for the protonated molecular ion was found to be 3567.9±3. The resulting molecular weight was thus 3566.9±3 amu (theoretical value: 3565.9 amu). The position of acylation (Lys26) was verified by enzymatic cleavage of the title compound with Staphylococcus aureus V8 protease and subsequent mass determination of the peptide fragments by PDMS.

In addition to the title compound two other GLP-1 derivatives were isolated from the reaction mixture by using the same chromatographic column and a more shallow gradient (35–38% acetonitrile in 60 minutes), see Examples 2 and 3.

Example 2

Synthesis of Lys³⁴(N^ε-tetradecanoyl)-GLP-1(7-37).

The title compound was isolated by HPLC from the reaction mixture described in Example 1. PDMS analysis yielded a protonated molecular ion at m/z 3567.7±3. The molecular weight was found to be 3566.7±3 amu (theoretical value: 3565.9 amu). The acylation site was determined on the basis of the fragmentation pattern.

Example 3

Synthesis of Lys^{26,34}-bis(N^ε-tetradecanoyl)-GLP-1(7-37).

The title compound was isolated by HPLC from the reaction mixture described in Example 1. PDMS analysis yielded a protonated molecular ion at m/z 3778.4±3. The molecular weight was found to be 3777.4±3 amu (theoretical value: 3776.1 amu).

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Example 4

Synthesis of Lys²⁶(N^ε-tetradecanoyl)Arg³⁴-GLP-1(7-37).

The title compound was synthesised from Arg³⁴-GLP-1(7-37). A mixture of Arg³⁴-GLP-1(7-37) (5 mg, 1.47 μm), EDPA (5.3 mg, 41.1 μm), NMP (105 μl) and water (50 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of Myr-ONSu (0.71 mg, 2.2 μm) in NMP (17.8 μl), the reaction mixture was gently shaken for 5 min. at room temperature and then allowed to stand for 20 min. After a total reaction time of 30 min. the reaction was quenched by the addition of a solution of glycine (25 mg, 33.3 μm) in 50% aqueous ethanol (2.5 ml). The reaction mixture was purified by HPLC as described in Example 1. PDMS analysis yielded a protonated molecular ion at m/z 3594.9±3. The molecular weight was found to be 3593.9±3 amu (theoretical value: 3593.9 amu).

Example 5

Synthesis of Gly⁸Arg^{26,34}Lys³⁶(N^ε-tetradecanoyl)-GLP-1(7-37).

The title compound was synthesised from Gly⁸Arg^{26,34}Lys³⁶-GLP-1(7-37) which was purchased from QCB. A mixture of Gly⁸Arg^{26,34}Lys³⁶-GLP-1(7-37) (1.3 mg, 0.39 μm), EDPA (1.3 mg, 10 μm), NMP (125 μl) and water (30 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of Myr-ONSu (0.14 mg, 0.44 μm) in NMP (3.6 ml), the reaction mixture was gently shaken for 15 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (0.1 mg, 1.33 μm) in 50% aqueous ethanol (10 μl). The reaction mixture was purified by HPLC, and the title compound (60 μg, 4%) was isolated.

Example 6

Synthesis of Arg^{26,34}Lys³⁶(N^ε-tetradecanoyl)-GLP-1(7-37)-OH.

A mixture of Arg^{26,34}Lys³⁶-GLP-1(7-37)-OH (5.0 mg, 1.477 μmol), EDPA (5.4 mg, 41.78 μmol), NMP (105 μl) and water (50 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of Myr-ONSu (0.721 mg, 2.215 μmol) in NMP (18 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 45 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.5 mg, 33.3 μmol) in 50% aqueous ethanol (250 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (1.49 mg, 28%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3595±3. The resulting molecular weight was thus 3594±3 amu (theoretical value 3594 amu).

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Example 7

Synthesis of Lys^{26,34}bis(N^ε-(ω-carboxynonadecanoyl))-GLP-1(7-37)-OH.

A mixture of GLP-1(7-37)-OH (70 mg, 20.85 μmol), EDPA (75.71 mg, 585.8 μmol), NMP (1.47 ml) and water (700 μL) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution of HOOC-(CH₂)₁₈-COONSu (27.44 mg, 62.42 μmol) in NMP (686 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 50 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (34.43 mg, 458.7 μmol) in 50% aqueous ethanol (3.44 ml). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (8.6 mg, 10%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 4006±3. The resulting molecular weight was thus 4005±3 amu (theoretical value 4005 amu).

Example 8

Synthesis of Arg^{26,34}Lys³⁶(N^ε-(ω-carboxynonadecanoyl))-GLP-1(7-36)-OH.

A mixture of Arg^{26,34}Lys³⁶-GLP-1(7-36)-OH (5.06 mg, 1.52 μmol), EDPA (5.5 mg, 42.58 μmol), NMP (106 μl) and water (100 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of HOOC-(CH₂)₁₈-COONSu (1.33 mg, 3.04 μmol) in NMP (33.2 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2.5 h at room temperature. The reaction was quenched by the addition of a solution of glycine (2.50 mg, 33.34 μmol) in 50% aqueous ethanol (250 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.46 mg, 8%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3652±3. The resulting molecular weight was thus 3651±3 amu (theoretical value 3651 amu).

Example 9

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(ω-carboxynonadecanoyl))-GLP-1(7-38)-OH.

A mixture of Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (5.556 mg, 1.57 μmol), EDPA (5.68 mg, 43.96 μmol), NMP (116.6 μl) and water (50 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₈-COONSu (1.38 mg, 3.14 μmol) in NMP (34.5 μl), the reaction mixture was gently shaken 5 min. at room temperature, and then allowed to stand for an additional 2.5 h at room temperature. The reaction was quenched by the addition of a solution of glycine (2.5 mg, 33.3 μmol) in 50% aqueous ethanol (250 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title

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compound (0.7 mg, 12%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3866 ± 3 . The resulting molecular weight was thus 3865 ± 3 amu (theoretical value 3865 amu).

Example 10

Synthesis of Arg³⁴Lys²⁶ (N^ε-(ω-carboxynonadecanoyl))-GLP-1(7-37)-OH.

A mixture of Arg³⁴-GLP-1(7-37)-OH (5.04 mg, 1.489 μmol), EDPA (5.39 mg, 41.70 μmol), NMP (105 μl) and water (50 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₈-COONSu (1.31 mg, 2.97 μmol) in NMP (32.8 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 30 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.46 mg, 32.75 μmol) in 50% aqueous ethanol (246 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (1.2 mg, 22%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3709 ± 3 . The resulting molecular weight was thus 3708 ± 3 amu (theoretical value 3708 amu).

Example 11

Synthesis of Arg³⁴Lys²⁶ (N^ε-(ω-carboxyheptadecanoyl))-GLP-1(7-37)-OH.

A mixture of Arg³⁴-GLP-1(7-37)-OH (5.8 mg, 1.714 μmol), EDPA (6.20 mg, 47.99 μmol), NMP (121.8 μl) and water (58 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₆-COONSu (2.11 mg, 5.142 μmol) in NMP (52.8 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (2.83 mg, 37.70 μmol) in 50% aqueous ethanol (283 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.81 mg, 13%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3681 ± 3 . The resulting molecular weight was thus 3680 ± 3 amu (theoretical value 3680 amu).

Example 12

Synthesis of Arg^{26,34}Lys³⁶ (N^ε-(ω-carboxyheptadecanoyl))-GLP-1(7-37)-OH.

A mixture of Arg^{26,34}Lys³⁶-GLP-1(7-37)-OH (3.51 mg, 1.036 μmol), EDPA (3.75 mg, 29.03 μmol), NMP (73.8 μl) and water (35 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution

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HOOC-(CH₂)₁₆-COONSu (1.27 mg, 3.10 μmol) in NMP (31.8 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2 h and 10 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (1.71 mg, 22.79 μmol) in 50% aqueous ethanol (171 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.8 mg, 21%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3682 ± 3 . The resulting molecular weight was thus 3681 ± 3 amu (theoretical value 3681 amu).

Example 13

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(ω-carboxyheptadecanoyl))-GLP-1(7-38)-OH.

A mixture of Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (5.168 mg, 1.459 μmol), EDPA (5.28 mg, 40.85 μmol), NMP (108.6 μl) and water (51.8 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₆-COONSu (1.80 mg, 4.37 μmol) in NMP (45 μl), the reaction mixture was gently shaken for 10 min. at room temperature, and then allowed to stand for an additional 2 h and 15 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.41 mg, 32.09 μmol) in 50% aqueous ethanol (241 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.8 mg, 14%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3838 ± 3 . The resulting molecular weight was thus 3837 ± 3 amu (theoretical value 3837 amu).

Example 14

Synthesis of Arg^{26,34}Lys³⁶ (N^ε-(ω-carboxyheptadecanoyl))-GLP-1(7-36)-OH.

A mixture of Arg^{26,34}Lys³⁶-GLP-1(7-36)-OH (24.44 mg, 7.34 μmol), EDPA (26.56 mg, 205.52 μmol), NMP (513 μl) and water (244.4 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₆-COONSu (9.06 mg, 22.02 μmol) in NMP (1.21 ml), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 30 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (12.12 mg, 161.48 μmol) in 50% aqueous ethanol (1.21 ml). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (7.5 mg, 28%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3625 ± 3 . The resulting molecular weight was thus 3624 ± 3 amu (theoretical value 3624 amu).

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Example 15

Synthesis of Arg^{26,34}Lys³⁶(N^ε-(ω-carboxyundecanoyl))-GLP-1(7-37)-OH.

A mixture of Arg^{26,34}Lys³⁶-GLP-1(7-37)-OH (4.2 mg, 1.24 μmol), EDPA (4.49 mg, 34.72 μmol), NMP (88.2 μl) and water (42 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₀-COONSu (1.21 mg, 3.72 μmol) in NMP (30.25 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 40 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.04 mg, 27.28 μmol) in 50% aqueous ethanol (204 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.8 mg, 18%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3598±3. The resulting molecular weight was thus 3597±3 amu (theoretical value 3597 amu).

Example 16

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(ω-carboxyundecanoyl))-GLP-1(7-38)-OH.

A mixture of Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (5.168 mg, 1.46 μmol), EDPA (5.28 mg, 40.88 μmol), NMP (108.6 μl) and water (51.7 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₀-COONSu (1.43 mg, 4.38 μmol) in NMP (35.8 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 50 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.41 mg, 32.12 μmol) in 50% aqueous ethanol (241 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.85 mg, 16%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3753±3. The resulting molecular weight was thus 3752±3 amu (theoretical value 3752 amu).

Example 17

Synthesis of Lys^{26,34}bis(N^ε-(ω-carboxyundecanoyl))-GLP-1(7-37)-OH.

A mixture of GLP-1(7-37)-OH (10.0 mg, 2.98 μmol), EDPA (10.8 mg, 83.43 μmol), NMP (210 μl) and water (100 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₀-COONSu (2.92 mg, 8.94 μmol) in NMP (73 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 50 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (4.92 mg, 65.56 μmol) in 50% aqueous ethanol (492 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound

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Example 18

Synthesis of Arg^{26,34}Lys³⁶(N^ε-(ω-carboxyundecanoyl))-GLP-1(7-36)-OH.

A mixture of Arg^{26,34}Lys³⁶-GLP-1(7-36)-OH (15.04 mg, 4.52 μmol), EDPA (16.35 mg, 126.56 μmol), NMP (315.8 μl) and water (150.4 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₀-COONSu (4.44 mg, 13.56 μmol) in NMP (111 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 40 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (7.5 mg, 99.44 μmol) in 50% aqueous ethanol (750 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (3.45 mg, 22%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3540±3. The resulting molecular weight was thus 3539±3 amu (theoretical value 3539 amu).

Example 19

Synthesis of Arg³⁴Lys²⁶(N^ε-(ω-carboxyundecanoyl))-GLP-1(7-37)-OH.

A mixture of Arg³⁴-GLP-1(7-37)-OH (5.87 mg, 1.73 μmol), EDPA (6.27 mg, 48.57 μmol), NMP (123.3 μl) and water (58.7 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution of HOOC-(CH₂)₁₀-COONSu (1.70 mg, 5.20 μmol) in NMP (42.5 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 40 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.86 mg, 286 μmol) in 50% aqueous ethanol (286 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (1.27 mg, 20%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3597±3. The resulting molecular weight was thus 3596±3 amu (theoretical value 3596 amu).

Example 20

Synthesis of Arg³⁴Lys²⁶(N^ε-(ω-carboxyheptanoyl))-GLP-1(7-37)-OH.

A mixture of Arg³⁴-GLP-1(7-37)-OH (4.472 mg, 1.32 μmol), EDPA (4.78 mg, 36.96 μmol), NMP (94 μl) and water (44.8 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₆-COONSu (1.07 mg, 3.96 μmol) in NMP (26.8 μl), the

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reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 1 h and 50 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.18 mg, 29.04 μ mol) in 50% aqueous ethanol (218 μ l). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.5 mg, 11%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3540 \pm 3. The resulting molecular weight was thus 3539 \pm 3 amu (theoretical value 3539 amu).

Example 21

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(ω-carboxyheptanoyl))-GLP-1(7-38)-OH.

A mixture of Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (5.168 mg, 1.459 μ mol), EDPA (5.28 mg, 40.85 μ mol), NMP (108.6 μ l) and water (51.6 μ l) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₆-COONSu (1.18 mg, 4.37 μ mol) in NMP (29.5 μ l), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 1 h and 50 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.40 mg, 32.09 μ mol) in 50% aqueous ethanol (240 μ l). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.5 mg, 9%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3697 \pm 3. The resulting molecular weight was thus 3695 \pm 3 amu (theoretical value 3695 amu).

Example 22

Synthesis of Arg^{26,34}Lys³⁶(N^ε-(ω-carboxyheptanoyl))-GLP-1(7-37)-OH.

A mixture of Arg^{26,34}Lys³⁶-GLP-1(7-37)-OH (5.00 mg, 1.47 μ mol), EDPA (5.32 mg, 41.16 μ mol), NMP (105 μ l) and water (50 μ l) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₆-COONSu (1.19 mg, 4.41 μ mol) in NMP (29.8 μ l), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (2.42 mg, 32.34 μ mol) in 50% aqueous ethanol (242 μ l). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.78 mg, 15%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3542 \pm 3. The resulting molecular weight was thus 3541 \pm 3 amu (theoretical value 3541 amu).

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Example 23

Synthesis of Arg^{26,34}Lys³⁶(N^ε-(ω-carboxyheptanoyl))-GLP-1(7-36)-OH.

A mixture of Arg^{26,34}Lys³⁶-GLP-1(7-36)-OH (5.00 mg, 1.50 μ mol), EDPA (5.44 mg, 42.08 μ mol), NMP (210 μ l) and water (50 μ l) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₆-COONSu (1.22 mg, 4.5 μ mol) in NMP (30.5 μ l), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (2.47 mg, 33.0 μ mol) in 50% aqueous ethanol (242 μ l). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.71 mg, 14%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3484 \pm 3. The resulting molecular weight was thus 3483 \pm 3 amu (theoretical value 3483 amu).

Example 24

Synthesis of Lys^{26,34}bis(N^ε-(ω-carboxyheptanoyl))-GLP-1(7-37)-OH.

A mixture of GLP-1(7-37)-OH (10 mg, 2.5 μ mol), EDPA (10.8 mg, 83.56 μ mol), NMP (210 μ l) and water (100 μ l) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₆-COONSu (2.42 mg, 8.92 μ mol) in NMP (60.5 μ l), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2 h and 35 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (4.92 mg, 65.54 μ mol) in 50% aqueous ethanol (492 μ l). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (2.16 mg, 24%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3669 \pm 3. The resulting molecular weight was thus 3668 \pm 3 amu (theoretical value 3668 amu).

Example 25

Synthesis of Arg³⁴Lys²⁶(N^ε-(ω-carboxypentadecanoyl))-GLP-1(7-37)-OH.

A mixture of Arg³⁴-GLP-1(7-37)-OH (4.472 mg, 1.321 μ mol), EDPA (4.78 mg, 36.99 μ mol), NMP (93.9 μ l) and water (44.7 μ l) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₄-COONSu (1.519 mg, 3.963 μ mol) in NMP (38 μ l), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 1 h at room temperature. The reaction was quenched by the addition of a solution of glycine (2.18 mg, 29.06 μ mol) in 50% aqueous ethanol (218 μ l). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The

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title compound (0.58 mg, 12%) was isolated, and the product was analysed by PDMS. The *m/z* value for the protonated molecular ion was found to be 3654±3. The resulting molecular weight was thus 3653±3 amu (theoretical value 3653 amu).

Example 26

Synthesis of Arg^{26,34}Lys³⁶ (N^ε-(ω-carboxyheptanoyl))-GLP-1(7-36)-OH.

A mixture of Arg^{26,34}Lys³⁶-GLP-1(7-36)-OH (5.00 mg, 1.50 μmol), EDPA (5.44 mg, 42.08 μmol), NMP (210 μl) and water (50 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₄-COONSu (1.72 mg, 4.5 μmol) in NMP (43 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 1 h at room temperature. The reaction was quenched by the addition of a solution of glycine (2.48 mg, 33 μmol) in 50% aqueous ethanol (248 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.58 mg, 11%) was isolated, and the product was analysed by PDMS. The *m/z* value for the protonated molecular ion was found to be 3596±3. The resulting molecular weight was thus 3595±3 amu (theoretical value 3595 amu).

Example 27

Synthesis of lithocholic acid 2,5-dioxo-pyrrolidin-1-yl ester.

To a mixture of lithocholic acid (5.44 g, 14.34 mmol), N-hydroxysuccinimide (1.78 g, 15.0 mmol), anhydrous THF (120 ml) and anhydrous acetonitrile (30 ml), kept at to 10° C., was added a solution of N,N'-dicyclohexylcarbodiimide (3.44 g, 16.67 mmol) in anhydrous THF. The reaction mixture was stirred at ambient temperature for 16 h, filtered and concentrated in vacuo. The residue was dissolved in dichloromethane (450 ml), washed with a 10% aqueous Na₂CO₃ solution (2×150 ml) and water (2×150 ml), and dried (MgSO₄). Filtered and the filtrate concentrated in vacuo to give a crystalline residue. The residue was recrystallised from a mixture of dichloromethane (30 ml) and n-heptane (30 ml) to give the title compound (3.46 g, 51%) as a crystalline solid.

Example 28

Synthesis of Arg³⁴Lys²⁶(N^ε-lithocholyl)-GLP-1(7-37)-OH.

A mixture of Arg³⁴-GLP-1(7-37)-OH (4.472 mg, 1.32 μmol), EDPA (4.78 mg, 36.96 μmol), NMP (94 μl) and water (44.8 μl) was gently shaken for 10 min. at room temperature. To the resulting mixture was added a solution of lithocholic acid 2,5-dioxo-pyrrolidin-1-yl ester (1.87 mg, 3.96 μmol) in NMP (46.8 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 1 h at room temperature. The reaction was quenched by the addition of a solution of glycine (2.18 mg, 29.04 μmol) in 50% aqueous ethanol (218 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard

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acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (1.25 mg, 25%) was isolated, and the product was analysed by PDMS. The *m/z* value for the protonated molecular ion was found to be 3744±3. The resulting molecular weight was thus 3743±3 amu (theoretical value 3743 amu).

Example 29

Synthesis of N^α-tetradecanoyl-Glu(ONSu)-OBu^t.

To a suspension of H-Glu(OH)-OBu^t (2.5 g, 12.3 mmol), DMF (283 ml) and EDPA (1.58 g, 12.3 mmol) was added drop by drop a solution of Myr-ONSu (4.0 g, 12.3 mmol) in DMF (59 ml). The reaction mixture was stirred for 16 h at room temperature and then concentrated in vacuo to a total volume of 20 ml. The residue was partitioned between 5% aqueous citric acid (250 ml) and ethyl acetate (150 ml), and the phases were separated. The organic phase was concentrated in vacuo and the residue dissolved in DMP (40 ml). The resulting solution was added drop by drop to a 10% aqueous solution of citric acid (300 ml) kept at 0° C. The precipitated compound was collected and washed with iced water and dried in a vacuum drying oven. The dried compound was dissolved in DMF (23 ml) and HONSu (1.5 g, 13 mmol) was added. To the resulting mixture was added a solution of N,N'-dicyclohexylcarbodiimide (2.44 g, 11.9 mmol) in dichloromethane (47 ml). The reaction mixture was stirred for 16 h at room temperature, and the precipitated compound was filtered off. The precipitate was recrystallised from n-heptane/2-propanol to give the title compound (3.03 g, 50%).

Example 30

Synthesis of Glu^{22,23,30}Arg^{26,34}Lys³⁸(N^ε-(γ-glutamyl(N^α-tetradecanoyl)))-GLP-1(7-38)-OH.

A mixture of Glu^{22,23,30}Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (1.0 mg, 0.272 μmol), EDPA (0.98 mg, 7.62 μmol), NMP (70 μl) and water (70 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of N^α-tetradecanoyl-Glu(ONSu)-OBu^t, prepared as described in Example 29, (0.41 mg, 0.816 μmol) in NMP (10.4 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 45 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (0.448 mg, 5.98 μmol) in 50% aqueous ethanol (45 μl). A 0.5% aqueous solution of ammonium acetate (0.9 ml) was added, and the resulting mixture was immobilised on a Varian 500 mg C8 Mega Bond Elut® cartridge, the immobilised compound washed with 5% aqueous acetonitrile (10 ml), and finally liberated from the cartridge by elution with TFA (10 ml). The eluate was concentrated in vacuo, and the reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.35 mg, 32%) was isolated, and the product was analysed by PDMS. The *m/z* value for the protonated molecular ion was found to be 4012±3. The resulting molecular weight was thus 4011±3 amu (theoretical value 4011 amu).

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Example 31

Synthesis of Glu^{23,26}Arg³⁴Lys³⁸(N^ε-(γ-glutamyl(N^α-tetradecanoyl)))-GLP-1(7-38)-OH.

A mixture of Glu^{23,26}Arg³⁴Lys³⁸-GLP-1(7-38)-OH (6.07 mg, 1.727 μmol), EDPA (6.25 mg, 48.36 μmol), NMP (425 μl) and water (425 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of N^α-tetradecanoyl-Glu(ONSu)-OBu^t, prepared as described in example 29, (2.65 mg, 5.18 μmol) in NMP (66.3 μl), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 45 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.85 mg, 38.0 μmol) in 50% aqueous ethanol (285 μl). A 0.5% aqueous solution of ammonium acetate (5.4 ml) was added, and the resulting mixture was immobilised on a Varian 500 mg C8 Mega Bond Elut® cartridge, the immobilised compound washed with 5% aqueous acetonitrile (10 ml), and finally liberated from the cartridge by elution with TFA (10 ml). The eluate was concentrated in vacuo, and the reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.78 mg, 12%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3854±3. The resulting molecular weight was thus 3853±3 amu (theoretical value 3853 amu).

Example 32

Synthesis of Lys^{26,34}-bis(N^ε-(ω-carboxytridecanoyl)))-GLP-1(7-37)-OH.

A mixture of GLP-1(7-37)-OH (30 mg, 8.9 μmol), EDPA (32.3 mg, 250 μmol), NMP (2.1 ml) and water (2.1 ml) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₂-COONSu (12.7 mg, 35.8 μmol) in NMP (318 μl), the reaction mixture was gently shaken for 1 h and 40 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (3.4 mg, 44.7 μmol) in 50% aqueous ethanol (335 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (10 mg, 29%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3840±3. The resulting molecular weight was thus 3839±3 amu (theoretical value 3839 amu).

Example 33

Synthesis of Lys^{26,34}-bis(N^ε-(γ-glutamyl(N^α-tetradecanoyl)))-GLP-1(7-37)-OH.

A mixture of GLP-1(7-37)-OH (300 mg, 79.8 μmol), EDPA (288.9 mg, 2.24 mmol), NMP (21 ml) and water (21 ml) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of N^α-tetradecanoyl-Glu(ONSu)-OBu^t, prepared as described in Example 29, (163 mg, 319.3 μmol) in NMP (4.08 ml), the reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 1 h at room temperature. The reaction was quenched by the addition of

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a solution of glycine (131.8 mg, 1.76 mmol) in 50% aqueous ethanol (13.2 ml). A 0.5% aqueous solution of ammonium-acetate (250 ml) was added, and the resulting mixture was divided into four equal portions. Each portion was eluted onto a Varian 500 mg C8 Mega Bond Elut® cartridge, the immobilised compound washed with 0.1% aqueous TFA (3.5 ml), and finally liberated from the cartridge by elution with 70% aqueous acetonitrile (4 ml). The combined eluates were diluted with 0.1% aqueous TFA (300 ml). The precipitated compound was collected by centrifugation, washed with 0.1% aqueous TFA (50 ml), and finally isolated by centrifugation. To the precipitate was added TFA (60 ml), and the resulting reaction mixture was stirred for 1 h and 30 min. at room temperature. Excess TFA was removed in vacuo, and the residue was poured into water (50 ml). The precipitated compound was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (27.3 mg, 8%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 4036±3. the resulting molecular weight was thus 4035±3 amu (theoretical value 4035 amu).

Example 34

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(ω-carboxypentadecanoyl)))-GLP-1(7-38)-OH.

A mixture of Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (30 mg, 8.9 μmol), EDPA (32.3 mg, 250 μmol), NMP (2.1 ml) and water (2.1 ml) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution HOOC-(CH₂)₁₄-COONSu (13.7 mg, 35.8 μmol) in NMP (343 μl), the reaction mixture was gently shaken for 1 h at room temperature. The reaction was quenched by the addition of a solution of glycine (3.4 mg, 44.7 μmol) in 50% aqueous ethanol (335 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (4.8 mg, 14%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3894±3. The resulting molecular weight was thus 3893±3 amu (theoretical value 3893 amu).

Example 35

Synthesis of N^α-hexadecanoyl-Glu(ONSu)-OBu^t.

To a suspension of H-Glu(OH)-OBu^t (4.2 g, 20.6 mmol), DMF (500 ml) and EDPA (2.65 g, 20.6 mmol) was added drop by drop a solution of Pal-ONSu (7.3 g, 20.6 mmol) in DMF (100 ml). The reaction mixture was stirred for 64 h at room temperature and then concentrated in vacuo to a total volume of 20 ml. The residue was partitioned between 10% aqueous citric acid (300 ml) and ethyl acetate (250 ml), and the phases were separated. The organic phase was concentrated in vacuo and the residue dissolved in DMF (50 ml). The resulting solution was added drop by drop to a 10% aqueous solution of citric acid (500 ml) kept at 0° C. The precipitated compound was collected and washed with iced water and dried in a vacuum drying oven. The dried compound was dissolved in DMF (45 ml) and HONSu (2.15 g,

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18.7 mmol) was added. To the resulting mixture was added a solution of N,N'-dicyclohexylcarbodiimide (3.5 g, 17 mmol) in dichloromethane (67 ml). The reaction mixture was stirred for 16 h at room temperature, and the precipitated compound was filtered off. The precipitate was recrystallised from n-heptane/2-propanol to give the title compound (6.6 g, 72%).

Example 36

Synthesis of Lys^{26,34}-bis(N^ε-(γ-glutamyl(N^α-hexadecanoyl)))-GLP-1(7-37)-OH.

A mixture of GLP-1(7-37)-OH (10 mg, 2.9 μmol), EDPA (10.8 mg, 83.4 μmol), NMP (0.7 ml) and water (0.7 ml) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of N^α-hexadecanoyl-Glu(ONSu)-OBu^t, prepared as described in Example 33, (163 mg, 319.3 μmol) in NMP (4.08 ml), the reaction mixture was gently shaken 1 h and 20 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (4.9 mg, 65.6 μmol) in 50% aqueous ethanol (492 μl). A 0.5% aqueous solution of ammonium-acetate (9 ml) was added, and the resulting mixture eluted onto a Varian 1 g C8 Mega Bond Elut® cartridge, the immobilised compound washed with 5% aqueous acetonitrile (10 ml), and finally liberated from the cartridge by elution with TFA (10 ml). The eluate was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (2.4 mg, 20%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 4092±3. The resulting molecular weight was thus 4091±3 amu (theoretical value 4091 amu).

Example 37

Synthesis of Arg³⁴Lys²⁶(N^ε-(γ-glutamyl(N^α-hexadecanoyl)))-GLP-1(7-37)-OH.

A mixture of Arg³⁴-GLP-1(7-37)-OH (3.7 mg, 1.1 μmol), EDPA (4.0 mg, 30.8 μmol), acetonitrile (260 μl) and water (260 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of N^α-hexadecanoyl-Glu(ONSu)-OBu^t, prepared as described in Example 35, (1.8 mg, 3.3 μmol) in acetonitrile (44.2 μl), and the reaction mixture was gently shaken for 1 h and 20 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (1.8 mg, 24.2 μmol) in 50% aqueous ethanol (181 μl). A 0.5% aqueous solution of ammonium-acetate (12 ml) and NMP (300 μl) were added, and the resulting mixture eluted onto a Varian 1 g C8 Mega Bond Elut® cartridge, the immobilised compound washed with 5% aqueous acetonitrile (10 ml), and finally liberated from the cartridge by elution with TFA (6 ml). The eluate was allowed to stand for 2 h at room temperature and then concentrated in vacuo. The residue was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.23 mg,

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6%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3752±3. The resulting molecular weight was thus 3751±3 amu (theoretical value 3751 amu).

Example 38

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(γ-glutamyl(N^α-tetradecanoyl)))-GLP-1(7-38)-OH.

A mixture of Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (14 mg, 4.0 μmol), EDPA (14.3 mg, 110.6 μmol), NMP (980 μl) and water (980 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of N^α-tetradecanoyl-Glu(ONSu)-OBu^t, prepared as described in Example 29, (12.1 mg, 23.7 μmol) in NMP (303 μl), and the reaction mixture was gently shaken for 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (6.5 mg, 86.9 mmol) in 50% aqueous ethanol (652 μl). A 0.5% aqueous solution of ammonium-acetate (50 ml) was added and the resulting mixture eluted onto a Varian 1 g C8 Mega Bond Elut® cartridge, the immobilised compound washed with 5% aqueous acetonitrile (15 ml), and finally liberated from the cartridge by elution with TFA (6 ml). The eluate was allowed to stand for 1 h and 45 min. at room temperature and then concentrated in vacuo. The residue was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (3.9 mg, 26%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3881±3. The resulting molecular weight was thus 3880±3 amu (theoretical value 3880 amu).

Example 39

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(ω-carboxypentadecanoyl)))-GLP-1(7-38)-OH.

A mixture of Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (14 mg, 4.0 μmol), EDPA (14.3 mg, 111 μmol), NMP (980 μl) and water (980 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of HOOC-(CH₂)₁₄-COONSu (4.5 mg, 11.9 μmol) in NMP (114 μl), the reaction mixture was gently shaken for 1 h and 45 min. at room temperature. An additional solution of HOOC-(CH₂)₁₄-COONSu (4.0 mg, 10.4 μmol) in NMP (100 μl) was added and the resulting mixture was gently shaken for an additional 1 h and 30 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (1.5 mg, 19.8 μmol) in 50% aqueous ethanol (148 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (3.9 mg, 26%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3809±3. The resulting molecular weight was thus 3808±3 amu (theoretical value 3808 amu).

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Example 40

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(γ-glutamyl(N^α-hexadecanoyl)))-GLP-1(7-38)-OH.

A mixture of Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (14 mg, 4.0 μmol), EDPA (14.3 mg, 110.6 μmol), NMP (980 μl) and water (980 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of N^α-hexadecanoyl-Glu(ONSu)-OBu^t, prepared as described in Example 35, (6.4 mg, 11.9 μmol) in NMP (160 μl), and the reaction mixture was gently shaken for 1 h and 20 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (6.5 mg, 87 mmol) in 50% aqueous ethanol (653 μl). A 0.5% aqueous solution of ammonium-acetate (50 ml) was added, and the resulting mixture eluted onto a Varian 1 g C8 Mega Bond Elut® cartridge, the immobilised compound washed with 5% aqueous acetonitrile (10 ml), and finally liberated from the cartridge by elution with TFA (6 ml). The eluate was allowed to stand for 1 h and 30 min. at room temperature and then concentrated in vacuo. The residue was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (7.2 mg, 47%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3881±3. The resulting molecular weight was thus 3880±3 amu (theoretical value 3880 amu).

Example 41

Synthesis of Arg^{18,23,26,30,34}Lys³⁸(N^ε-hexadecanoyl)-GLP-1(7-38)-OH.

A mixture of Arg^{18,23,26,30,34}Lys³⁸-GLP-1(7-38)-OH (1.0 mg, 0.27 μmol), EDPA (0.34 mg, 2.7 μmol) and DMSO (600 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of Pal-ONSu (0.28 mg, 0.8 μmol) in NMP (7 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 6 h at room temperature. The reaction was quenched by the addition of a solution of glycine (1.6 mg, 21.7 μmol) in 50% aqueous ethanol (163 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (0.17 mg, 16%) was isolated, and the product was analysed by MALDI-MS. The m/z value for the protonated molecular ion was found to be 3961±3. The resulting molecular weight was thus 3960±3 amu (theoretical value 3960 amu).

Example 42

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(ω-carboxytridecanoyl)))-GLP-1(7-38)-OH.

A mixture of Arg^{26,34}Lys³⁸-GLP-1(7-38)-OH (14 mg, 4.0 μmol), EDPA (14.3 mg, 111 μmol), NMP (980 μl) and water (980 μl) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of HOOC-(CH₂)₁₂-COONSu (4.2 mg, 11.9 μmol) in NMP (105 μl), the reaction mixture was gently shaken for 1 h and 50 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (6.5 mg, 87 μmol) in 50%

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aqueous ethanol (652 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (5.8 mg, 39%) was isolated, and the product was analysed by MALDI-MS. The m/z value for the protonated molecular ion was found to be 3780±3. The resulting molecular weight was thus 3779±3 amu (theoretical value 3781 amu).

Example 43

Synthesis of Arg³⁴Lys²⁶(N^ε-(γ-glutamyl(N^α-tetradecanoyl)))-GLP-1(7-37)-OH.

A mixture of Arg³⁴-GLP-1(7-37)-OH (15 mg, 4.4 μmol), EDPA (16 mg, 124 μmol), NMP (2 ml) and water (4.8 ml) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of N^α-tetradecanoyl-Glu(ONSu)-OBu^t, prepared as described in Example 29, (12.1 mg, 23.7 μmol) in NMP (303 μl), and the reaction mixture was gently shaken for 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (6.5 mg, 86.9 μmol) in 50% aqueous ethanol (652 μl). A 0.5% aqueous solution of ammonium-acetate (50 ml) was added, and the resulting mixture eluted onto a Varian 1 g C8 Mega Bond Elut® cartridge, the immobilised compound washed with 5% aqueous acetonitrile (15 ml), and finally liberated from the cartridge by elution with TFA (6 ml). The eluate was allowed to stand for 1 h and 45 min. at room temperature and then concentrated in vacuo. The residue was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (3.9 mg, 26%) was isolated, and the product was analysed by MALDI-MS. The m/z value for the protonated molecular ion was found to be 3723±3. The resulting molecular weight was thus 3722±3 amu (theoretical value 3723 amu).

Example 44

Synthesis of N^ε-octadecanoyl-Glu(ONSu)-OBu^t

To a suspension of H-Glu(OH)-OBu^t (2.82 g, 13.9 mmol), DMF (370 ml) and EDPA (1.79 g, 13.9 mmol) was added drop by drop a solution of Ste-ONSu (5.3 g, 13.9 mmol) in DMF (60 ml). Dichloromethane (35 ml) was added, and the reaction mixture was stirred for 24 h at room temperature and then concentrated in vacuo. The residue was partitioned between 10% aqueous citric acid (330 ml) and ethyl acetate (200 ml), and the phases were separated. The organic phase was concentrated in vacuo and the residue dissolved in DMF (60 ml). The resulting solution was added drop by drop to a 10% aqueous solution of citric acid (400 ml) kept at 0° C. The precipitated compound was collected and washed with iced water and dried in a vacuum drying oven. The dried compound was dissolved in DMF (40 ml) and HONSu (1.63 g, 14.2 mmol) was added. To the resulting mixture was added a solution of DCC (2.66 g, 12.9 mmol) in dichloromethane (51 ml). The reaction mixture was stirred for 64 h at room temperature, and the precipitated compound was filtered off. The precipitate was recrystallized from n-heptane/2-propane to give the title compound (4.96 g, 68%).

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Example 45

Synthesis of Arg^{26,34}Lys³⁸(N^ε-(γ-glutamyl(N^α-octadecanoyl)))-GLP-1(7-38)-OH

A mixture of Arg^{26,34}-GLP-1(7-38)-OH (28 mg, 7.9 μmol), EDPA (28.6 mg, 221.5 μmol), NMP (1.96 ml) and water (1.96 ml) was gently shaken for 5 min. at room temperature. To the resulting mixture was added a solution of N^α-octadecanoyl-Glu(ONSu)-OBu^t (17.93 g, 31.6 μmol), prepared as described in Example 44, in NMP (448 μl), and the reaction mixture was gently shaken for 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (13.1 mg, 174 μmol) in 50% aqueous ethanol (1.3 ml). A 0.5% aqueous solution of ammonium-acetate (120 ml) was added, and the resulting mixture was divided into two equal portions. Each portion was eluted onto a Varian 5 g C8 Mega Bond Elut® cartridge, the immobilised compound washed with 5% aqueous acetonitrile (25 ml), and finally liberated from the cartridge by elution TFA (25 ml). The combined elutes were allowed to stand for 1 h and 25 min. at room temperature and then concentrated in vacuo. The residue was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (3.6 mg, 11%) was isolated, and the product was analysed by MALDI-MS. The m/z value for the protonated molecular ion was found to be 3940±3. The resulting molecular weight was thus 3939±3 amu (theoretical value 3937 amu).

Biological Findings

Protraction of GLP-1 derivatives after s.c. administration

The protraction of a number GLP-1 derivatives of the invention was determined by monitoring the concentration thereof in plasma after sc administration to healthy pigs, using the method described below. For comparison also the concentration in plasma of GLP-1(7-37) after sc. administration was followed. The results are given in Table 1. The protraction of other GLP-1 derivatives of the invention can be determined in the same way.

Pigs (50% Duroc, 25% Yorkshire, 25% Danish Landrace, app 40 kg) were fasted from the beginning of the experiment. To each pig 0.5 nmol of test compound per kg body weight was administered in a 50 μM isotonic solution (5 mM phosphate, pH 7.4, 0.02% Tween®-20 (Merck), 45 mg/ml mannitol (pyrogen free, Novo Nordisk). Blood samples were drawn from a catheter in vena jugular is at the hours indicated in Table 1. 5 ml of the blood samples were poured into chilled glasses containing 175 μl of the following solution: 0.18 M EDTA, 1500 KIE/ml aprotinin (Novo Nordisk) and 3% bacitracin (Sigma), pH 7.4. Within 30 min, the samples were centrifuged for 10 min at 5–6000*g. Temperature was kept at 4° C. The supernatant was pipetted into different glasses and kept at minus 20° C. until use.

The plasma concentrations of the peptides were determined by RIA using a monoclonal antibody specific for the N-terminal region of GLP-1(7-37). The cross-reactivities were less than 1% with GLP-1(1-37) and GLP-1(8-36)amide and <0.1% with GLP-1(9-37), GLP-1(10-36)amide and GLP-1(11-36)amide. The entire procedure was carried out at 4° C.

The assay was carried out as follows: 100 μl plasma was mixed with 271 μl 96% ethanol, mixed using a vortex mixer and centrifuged at 2600*g for 30 min. The supernatant was decanted into Minisorp tubes and evaporated completely

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(Savant Speedvac AS290). The evaporation residue was reconstituted in the assay buffer consisting of 80 mM NaH₂PO₄/Na₂HPO₄, 0.1% HSA (Orpha 20/21, Behring), 10 mM EDTA, 0.6 mM thiomersal (Sigma), pH 7.5. Samples were reconstituted in volumes suitable for their expected concentrations, and were allowed to reconstitute for 30 min. To 300 μl sample, 100 μl antibody solution in dilution buffer containing 40 mM NaH₂PO₄/Na₂HPO₄, 0.1% HSA, 0.6 mM thiomersal, pH 7.5, was added. A non-specific sample was prepared by mixing 300 μl buffer with 100 μl dilution buffer. Individual standards were prepared from freeze dried stocks, dissolved in 300 μl assay buffer. All samples were pre-incubated in Minisorp tubes with antibody was described above for 72 h. 200 μl tracer in dilution buffer containing 6–7000 CPM was added, samples were mixed and incubated for 48 h. 1.5 ml of a suspension of 200 ml per liter of heparin-stabilised bovine plasma and 18 g per liter of activated carbon (Merck) in 40 mM NaH₂PO₄/Na₂HPO₄, 0.6 mM thiomersal, pH 7.5, was added to each tube. Before use, the suspension was mixed and allowed to stand for 2 h at 4° C. All samples were incubated for 1 h at 4° C. and then centrifuged at 3400*g for 25 min. Immediately after the centrifugation, the supernatant was decanted and counted in a γ-counter. The concentration in the samples was calculated from individual standard curves. The following plasma concentrations were found, calculated as % of the maximum concentration for the individual compounds (n=2):

TABLE 1

Test com- pound ^{a)}	Hours after sc. Administration								
	0.75	1	2	4	6	8	10	12	24
GLP-1 (7-37)		100	9	1					
Example 25	73	92	100	98	82	24	16	16	16
Example 17	76	71	91	100	84	68	30		9
Example 43		39	71	93	100	91	59	50	17
Example 37		26	38	97	100	71	81	80	45
Example 11	24	47	59	71	100	94	100		94
Example 12	36	54	65	94	80	100	85		93
Example 32	55	53	90	83	88	70	98	100	100
Example 14	18	25	32	47	98	83	97		100
Example 13	15	22	38	59	97	85	100		76
Example 38	60	53	100	66	48	39	25	29	0
Example 39	38	100	70	47	33	33	18	27	14
Example 40	47	19	50	100	51	56	34	14	0
Example 34	19	32	44	84	59	66	83	84	100

^{a)}The test compounds are the title compounds of the examples with the numbers given

Table 1 shows that the GLP-1 derivatives of the invention have a protracted profile of action relative to GLP-1(7-37) and are much more persistent in plasma than GLP-1(7-37). It also appears from Table 1 that the time at which the peak concentration in plasma is achieved varies within wide limits, depending on the particular GLP-1 derivative selected.

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Stimulation of cAMP formation in a cell line expressing the cloned human GLP-1 receptor

In order to demonstrate efficacy of the GLP-1 derivatives, their ability to stimulate formation of cAMP in a cell line expressing the cloned human GLP-1 receptor was tested. An EC_{50} was calculated from the dose-response curve.

Baby hamster kidney (BHK) cells expressing the human pancreatic GLP-1 receptor were used (Knudsen and Pridal, 1996, Eur. J. Pharm. 318, 429–435). Plasma membranes were prepared (Adelhorst et al., 1994, J. Biol. Chem. 269, 6275) by homogenisation in buffer (10 mmol/l Tris-HCl and 30 mmol/l NaCl pH 7.4, containing, in addition, 1 mmol/l diithiothreitol, 5 mg/l leupeptin (Sigma, St. Louis, Mo., USA), 5 mg/l pepstatin (Sigma, St. Louis, Mo., USA), 100 mg/l bacitracin (Sigma, St. Louis, Mo., USA), and 16 mg/l aprotinin (Novo Nordisk A/S, Bagsvaerd, Denmark)). The homogenate was centrifuged on top of a layer of 41 w/v % sucrose. The white band between the two layers was diluted in buffer and centrifuged. Plasma membranes were stored at -80°C . until used.

The assay was carried out in 96-well microtiter plates in a total volume of 140 μl . The buffer used was 50 mmol/l Tris-HCl, pH 7.4 with the addition of 1 mmol/l EGTA, 1.5 mmol/l MgSO_4 , 1.7 mmol/l ATP, 20 mM GTP, 2 mmol/l 3-isobutyl-1-methylxanthine, 0.01% Tween-20 and 0.1% human serum albumin (Reinst, Behringwerke AG, Marburg, Germany). Compounds to be tested for agonist activity were dissolved and diluted in buffer, added to the membrane preparation and the mixture was incubated for 2 h at 37°C . The reaction was stopped by the addition of 25 μl of 0.05 mol/l HCl. Samples were diluted 10 fold before analysis for cAMP by a scintillation proximity assay (RPA 538, Amersham, UK). The following results were obtained:

Test Compound ^{a)}	EC_{50} , pM	Test Compound ^{a)}	EC_{50} , pM
GLP-1(7–37)	61	Example 31	96
Example 45	120	Example 30	41
Example 43	24	Example 26	8.8
Example 40	55	Example 25	99
Example 39	5.1	Example 19	79
Example 38	54	Example 16	3.5
Example 37	60		

^{a)}The test compounds are the title compounds of the examples with the numbers given.

Example 46

Synthesis of Arg^{26,34}, Lys³⁶(N^ε-(γ-glutamyl(N^α-hexadecanoyl)))-GLP-1(7-36)-OH

To a mixture of Arg^{26,34}, Lys³⁶ GLP-1 (7-36)-OH (12.2 mg, 3.67 μmol), EDPA (13.3 mg, 103 μmol), NMP (1.71 ml) and water (855 μl) was added a solution of Pal-Glu(ONSu)-OBu^t (5.94 mg, 11 μmol), prepared as described in PCT application no. PCT/DK97/00340, in NMP (148 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (6 mg, 81 μmol) in water (0.6 ml). A 0.5% aqueous solution of ammonium-acetate (38 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (20 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl

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column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65°C . and the acetonitril gradient was 0–100% in 60 minutes. The title compound (3.1 mg, 23%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3695 ± 3 . The resulting molecular weight was thus 3694 ± 3 amu (theoretical value 3694 amu).

Example 47

Synthesis of Arg^{26,34}, Lys³⁶(N^ε-(γ-glutamyl(N^α-octadecanoyl)))-GLP-1(7-36)-OH

To a mixture of Arg^{26,34}, Lys³⁶ GLP-1 (7-36)-OH (12.2 mg, 3.7 μmol), EDPA (13.3 mg, 103 μmol), NMP (1.71 ml) and water (855 μl) was added a solution of Ste-Glu(ONSu)-OBu^t (6.25 mg, 11 μmol), prepared as described in PCT application no. PCT/DK97/00340, in NMP (1 ml). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (6 mg, 81 μmol) in water (0.6 ml). A 0.5% aqueous solution of ammonium acetate (54 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (20 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65°C . and the acetonitril gradient was 0–100% in 60 minutes. The title compound (3.7 mg, 27%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3723 ± 3 . The resulting molecular weight was thus 3722 ± 3 amu (theoretical value 3722 amu).

Example 48

Synthesis of Lithocholic Acid 2,5-dioxopyrrolidin-1-yl Ester

To a solution of lithocholic acid (5.44 g, 14.3 mmol) in a mixture of anhydrous THF (120 ml) and anhydrous acetonitril (30 ml) was added N-hydroxysuccinimide (1.78 g, 15 mmol). The mixture was cooled to 10°C ., a solution of DCC (3.44 g, 16.7 mmol) in anhydrous THF (30 ml) was added drop wise, and the resulting reaction mixture stirred for 16 h at room temperature. The reaction mixture was filtered and partitioned between dichloromethane (450 ml) and 10% aqueous Na_2CO_3 (150 ml). The phases were separated, and the organic phase washed with 10% aqueous Na_2CO_3 (150 ml), water (2×150 ml), and dried (MgSO_4). The solvent was concentrated in vacuo. The residue was crystallised from a mixture of dichloromethane (30 ml) and n-heptane (30 ml). The precipitate was dried in a vacuum drying oven for 36 h to give the title compound (3.46 g, 51%).

Example 49

Synthesis of Lit-Glu(ONSu)-OBu^t

A suspension of H-Glu(OH)-OBu^t (1.28 g, 6.33 mmol), DMF (88 ml) and EDPA (0.82 g, 6.33 mmol) and lithocholic acid 2,5-dioxopyrrolidin-1-yl ester, prepared as described in example 48, was stirred for 16 h at room temperature. The reaction mixture was concentrated in vacuo and the residue dissolved in ethyl acetate (40 ml). The resulting solution was washed with 5% aqueous citric acid (2×25 ml), brine (10

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ml), and filtered). The solvent was concentrated in vacuo and the residue dissolved in DMF (12 ml). The resulting solution was added drop wise to a 10% aqueous solution of citric acid whereby the product precipitates. The precipitate was collected and washed with iced water, and dried in vacuo. The crude product was recrystallized from a mixture of n-heptane (40 ml) and 2-propanol (17 ml). The precipitate was dried in a vacuum drying oven for 4 h to give the free acid intermediate.

To a solution of the free acid intermediate in DMF (18 ml) was added hydroxysuccinimide (0.45 g, 3.91 mmol), followed by a solution of DCC (0.73 g, 3.56 mmol) in dichloromethane (18 ml). The resulting mixture was stirred at ambient temperature for 18 h, and then filtered. The filtrate was concentrated in vacuo to a solid, and the residue was dissolved in dichloromethane (25 ml), and the filtration repeated, the solvent removed in vacuo to give a foam. The residue was dissolved in refluxing n-heptane (35 ml), and the product crystallized by addition of 2-propanol. The precipitate was collected, washed with cold n-heptane, dried at 35° C. in vacuo to give the title compound (1.34 g, 57%).

Example 50

Synthesis of Arg³⁴,Lys³⁶(N^ε-(γ-glutamyl(N^α-lithocholyl)))-GLP-1(7-37)-OH

To a mixture of Arg³⁴,Lys²⁶ GLP-1 (7-37)-OH (41.1 mg, 12.2 μmol), EDPA (44 mg, 340 μmol), NMP (5.76 ml) and water (2.88 ml) was added a solution of Lit-Glu(ONSu)-OBu^t (24 mg, 37 μmol), prepared as described in example 49, in NMP (600 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 75 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (20 mg, 268 μmol) in water (2 ml). A 0.5% aqueous solution of ammonium acetate (128 ml) was added, and the resulting mixture divided into two equal portions, and each portion eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (2×25 ml), and finally liberated from the cartridge by elution with TFA (2×25 ml). The combined eluates were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (5 mg, 11%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3872±3. The resulting molecular weight was thus 3871±3 amu (theoretical value 3871 amu).

Example 51

Synthesis of Arg²⁶,Lys³⁴(N^ε-(γ-glutamyl(N^α-hexadecanoyl)))-GLP-1(7-37)-OH

To a mixture of Arg²⁶,Lys³⁴ GLP-1 (7-37)-OH (18 mg, 5.3 μmol), EDPA (19.3 mg, 149 μmol), NMP (2.52 ml) and water (1.26 ml) was added a solution of Pal-Glu(ONSu)-OBu^t (8.6 mg, 16 μmol) in NMP (215 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (8.8 mg, 117 μmol) in water (0.88 ml). A 0.5% aqueous solution of ammonium acetate (50 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with

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5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluates were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (6 mg, 30%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3752±3. The resulting molecular weight was thus 3751±3 amu (theoretical value 3751 amu).

Example 52

Synthesis of desamino-His⁷,Arg²⁶,Lys³⁴ (N^ε-(γ-glutamyl(N^α-hexadecanoyl)))-GLP-1 (7-37)-OH

To a mixture of desamino-His⁷,Arg²⁶,Lys³⁴ GLP-1 (7-37)-OH (14.3 mg, 4.2 μmol), EDPA (15.3 mg, 119 μmol), NMP (2 ml) and water (1 ml) was added a solution of Pal-Glu(ONSu)-OBu^t (6.84 mg, 12.7 μmol) in NMP (171 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 50 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (7 mg, 99 μmol) in water (700 μl). A 0.5% aqueous solution of ammonium acetate (42 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (5.6 mg, 35%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3738±3. The resulting molecular weight was thus 3737±3 amu (theoretical value 3737 amu).

Example 53

Synthesis of Gly⁸,Arg^{26,34},Lys³⁸ (N^ε-(γ-glutamyl(N^α-hexadecanoyl)))-GLP-1 (7-38)-OH

To a mixture of Gly⁸,Arg^{26,34},Lys³⁸ GLP-1 (7-38)-OH (11.8 mg, 3.4 μmol), EDPA (12.1 mg, 94 μmol), NMP (1.65 ml) and water (0.83 ml) was added a solution of Pal-Glu(ONSu)-OBu^t (5.4 mg, 10 μmol) in NMP (135 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 75 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (5.5 mg, 73.7 μmol) in water (553 μl). A 0.5% aqueous solution of ammonium acetate (36 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (5 mg, 38%) was isolated, and the product was analysed by

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PDMS. The m/z value for the protonated molecular ion was found to be 3895±3. The resulting molecular weight was thus 3894±3 amu (theoretical value 3894 amu).

Example 54

Synthesis of Gly⁸,Glu³⁷,Arg^{26,34},Lys³⁸ (N^ε-(γ-glutamyl(N^α-hexadecanoyl))) GLP-1 (7-38)-OH

To a mixture of Gly⁸,Glu³⁷,Arg^{26,34},Lys³⁸ GLP-1 (7-38)-OH (9 mg, 2.48 μmol), EDPA (9 mg, 69.4 μmol), NMP (1.25 ml) and water (0.63 ml) was added a solution of Pal-Glu (ONSu)-OBU^t (4 mg, 7.4 μmol) in NMP (100 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 105 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (4.1 mg, 54.6 μmol) in water (410 μl). A 0.5% aqueous solution of ammonium acetate (27 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (15 ml), and finally liberated from the cartridge by elution with TFA (15 ml). The eluate were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (2.9 mg, 29%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3967±3. The resulting molecular weight was thus 3966±3 amu (theoretical value 3967 amu).

Example 55

Synthesis of Gly⁸,Glu³⁷,Arg^{26,34},Lys³⁸ (N^ε-(γ-glutamyl(N^α-octadecanoyl))) GLP-1 (7-38)-OH

To a mixture of Gly⁸,Glu³⁷,Arg^{26,34},Lys³⁸ GLP-1 (7-38)-OH (9 mg, 2.5 μmol), EDPA (9 mg, 69.4 μmol), NMP (1.25 ml) and water (0.63 ml) was added a solution of Ste-Glu (ONSu)-OBU^t (4.2 mg, 7.4 μmol) in NMP (105 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 105 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (4.1 mg, 54.6 μmol) in water (409 μl). A 0.5% aqueous solution of ammonium acetate (27 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (15 ml), and finally liberated from the cartridge by elution with TFA (15 ml). The eluate were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (3.2 mg, 32%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3995±3. The resulting molecular weight was thus 3994±3 amu (theoretical value 3995 amu).

Example 56

Synthesis of Cap-Glu(ONSu)-OBU^t

To a solution of octanoic acid (5 g, 34.7 mmol) and N-hydroxysuccinimide (4 g, 34.7 mmol) in anhydrous acetonitril (10 ml) was added a solution of DCC (7.15 g, 34.7 mmol) in anhydrous dichloromethane (15 ml), and the resulting reaction mixture stirred for 16 h at room tempera-

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ture. The precipitated solid was filtered off and recrystallised from a mixture of n-heptane (40 ml) and 2-propanol (2 ml). The precipitate was dried in a vacuum drying oven for 16 h to give the intermediate Cap-ONSu. A suspension of the crude ester intermediate (3.9 g, 16.2 mmol), (L)-H-Glu (OH)-OBU^t (3.28 g, 16.2 mmol), DMF (268 ml) and EDPA (2.1 g, 16.2 mmol) was stirred for 64 h at room temperature. The reaction mixture was concentrated in vacuo and the residue dissolved in ethyl acetate (50 ml). The resulting solution was washed with 5% aqueous citric acid (2×25 ml). The solvent was concentrated in vacuo and the residue dissolved in DMF (36 ml). The resulting solution was added drop wise to a 10% aqueous solution of citric acid (357 ml) and extracted with ethyl acetate (200 ml), and dried (MgSO₄). The solvent was concentrated in vacuo to give the crude glutamic acid intermediate. To a mixture of the crude glutamic acid intermediate, N-hydroxysuccinimide (1.85 g, 16.1 mmol) and DMF (25 ml) was added a solution of DCC (3.32 g, 16.1 mmol) in dichloromethane (15 ml). The resulting mixture was stirred at ambient temperature for 20 h. The reaction mixture was filtered and the solvent concentrated in vacuo. The residue was purified on a silica gel column (40–63μ), eluted with a mixture of dichloromethane and acetonitril (1:1) to give the title compound (0.63 g, 6% over all).

Example 57

Synthesis of desamino-His⁷,Arg²⁶,Lys³⁴ (N^ε-(γ-glutamyl(N^α-octanoyl))) GLP-1 (7-37)-OH

To a mixture of desamino-His⁷,Arg²⁶,Lys³⁴ GLP-1 (7-37)-OH (14.3 mg, 4.2 μmol), EDPA (15.3 mg, 119 μmol), NMP (2 ml) and water (1 ml) was added a solution of Cap-Glu(ONSu)-OBU^t (6.8 mg, 12.7 μmol), prepared as described in example 56, in NMP (135 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (7 mg, 93 μmol) in water (698 μl). A 0.5% aqueous solution of ammonium acetate (42 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (4.1 mg, 27%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3626±3. The resulting molecular weight was thus 3625±3 amu (theoretical value 3625 amu).

Example 58

Synthesis of Glu³⁷,Arg^{26,34},Lys³⁸ (N^ε-(γ-glutamyl(N^α-hexadecanoyl))) GLP-1 (7-38)-OH

To a mixture of Glu³⁷,Arg^{26,34},Lys³⁸ GLP-1 (7-38)-OH (17.6mg, 4.9 μmol), EDPA (17.6 mg, 136 μmol), NMP (1.23 ml) and water (2.46 ml) was added a solution of Pal-Glu (ONSu)-OBU^t (7.9 mg, 14.6 μmol) in NMP (197 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (8 mg, 107 μmol) in water

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(804 μ l). A 0.5% aqueous solution of ammonium acetate (49 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (5.1 mg, 26%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3981 \pm 3. The resulting molecular weight was thus 3980 \pm 3 amu (theoretical value 3981 amu).

Example 59

Synthesis of Arg³⁴,Lys²⁶ (N^ε-(γ -glutamyl(N^ε-octadecanoyl))) GLP-1 (7-37)-OH

To a mixture of Arg³⁴ GLP-1 (7-37)-OH (41.1 mg, 12.2 μ mol), EDPA (44 mg, 341 μ mol), NMP (5.76 ml) and water (2.88 ml) was added a solution of Ste-Glu(ONSu)-OBu^t (20.7 mg, 36.5 μ mol in NMP (517 μ l)). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (20.1 mg, 268 μ mol) in water (2.01 ml). A 0.5% aqueous solution of ammonium-acetate (120 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (15.4 mg, 34%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3781 \pm 3. The resulting molecular weight was thus 3780 \pm 3 amu (theoretical value 3779 amu).

Example 60

Synthesis of Arg³⁴,Lys²⁶(N^ε-decanoyl) GLP-1 (7-37)

To a mixture of Arg³⁴-GLP-1 (7-37)-OH (20 mg, 5.9 μ mol), EDPA (21.4 mg, 165 μ mol), NMP (2.8 ml) and water (1.4 ml) was added a solution of Cac-(ONSu) (4.8 mg, 17.7 μ mol) in NMP (119 μ l). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (9.8 mg, 130 μ mol) in water (98 μ l). The resulting mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (7.4 mg, 35%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3539.6 \pm 3. The resulting molecular weight was thus 3538.6 \pm 3 amu (theoretical value 3538 amu).

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Example 61

Synthesis of Arg³⁴,Lys²⁶(N^ε-hexadecanoyl) GLP-1 (7-37)-OH

To a mixture of Arg³⁴ GLP-1 (7-37)-OH (41.1 mg, 12.2 μ mol), EDPA (44 mg, 340 μ mol), NMP (2.88 ml) and water (2.88 ml) was added a solution of Pal-ONSu (12.9 mg, 36.5 μ mol) in NMP (3.3 ml). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 110 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (20.1 mg, 268 μ mol) in water (201 μ l). The solvent was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (15 mg, 34%) was isolated, and the product was analysed by PDMS.

Example 62

Synthesis of Arg^{26,34},Lys²⁷ (N^ε-(γ -glutamyl(N^ε-hexadecanoyl))) GLP-1 (7-37)-OH

To a mixture of Arg^{26,34}, Lys²⁷ GLP-1 (7-37)-OH (11.6 mg, 3.4 μ mol), EDPA (12.3 mg, 94.9 μ mol), NMP (1.6 ml) and water (0.8 ml) was added a solution of Pal-Glu(ONSu)-OBu^t (5.5 mg, 10.2 μ mol in NMP (137 μ l)). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (5.6 mg, 74.6 μ mol) in water (560 ml). A 0.5% aqueous solution of ammonium acetate (34 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (15 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The solvent was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (2.1 mg, 16%) was isolated, and the product was analysed by PDMS.

Example 63

Synthesis of Arg^{26,34},Lys²³ (N^ε-(γ -glutamyl(N^ε-hexadecanoyl))) GLP-1 (7-37)-OH

To a mixture of Arg^{26,34}, Lys²³ GLP-1 (7-37)-OH (11.6 mg, 3.4 μ mol), EDPA (12.3 mg, 94.9 μ mol), NMP (1.6 ml) and water (0.8 ml) was added a solution of Pal-Glu(ONSu)-OBu^t (5.5 mg, 10.2 μ mol in NMP (137 μ l)). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (5.6 mg, 74.6 μ mol) in water (560 μ l). A 0.5% aqueous solution of ammonium acetate (34 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (15 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The solvent was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (3.1 mg, 16%) was isolated, and the product was analysed by PDMS.

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Example 64

Synthesis of Arg^{26,34},Lys¹⁸ (N^ε-(γ-glutamyl(N^ε-hexadecanoyl))) GLP-1 (7-37)-OH

To a mixture of Arg^{26,34}, Lys¹⁸ GLP-1 (7-37)-OH (11.7 mg, 3.4 μmol), EDPA (12.2 mg, 94.6 μmol), NMP (1.6 ml) and water (0.8 ml) was added a solution of Pal-Glu(ONSu)-OBu^t (5.5 mg, 10.2 μmol in NMP (137 μl)). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (5.6 mg, 74.6 μmol) in water (560 μl). A 0.5% aqueous solution of ammonium acetate (34 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The solvent was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (1.9 mg, 15%) was isolated, and the product was analysed by PDMS.

Example 65

Synthesis of Arg³⁴,Lys²⁶ (N^ε-octanoyl)) GLP-1 (7-37)-OH

To a mixture of Arg³⁴ GLP-1 (7-37)-OH (41.1 mg, 12.2 μmol), EDPA (44 mg, 341 μmol), NMP (5.76 ml) and water (2.88 ml) was added a solution of Cap-(ONSu)-OBu^t (8.8 mg, 36.5 μmol), prepared as described in example 56, in NMP (106 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 115 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (20 mg, 268 μmol) in water (200 ml). The solvent was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (18.8 mg, 44%) was isolated, and the product was analysed by PDMS.

Example 66

Synthesis of Arg³⁴,Lys²⁶ (N^ε-(dodecanoyl)) GLP-1 (7-37)-OH

To a mixture of Arg³⁴ GLP-1 (7-37)-OH (41.1 mg, 12.2 μmol), EDPA (44 mg, 341 μmol), NMP (5.76 ml) and water (2.88 ml) was added a solution of Lau-ONSu (8.8 mg, 36.5 μmol), prepared in a similar manner as described for Cap-ONSu in example 56, in NMP (271 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 100 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (20.1 mg, 268 μmol) in water (200 ml). The solvent was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (18 mg, 42%) was isolated, and the product was analysed by PDMS.

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Example 67

Synthesis of Pal-GABA-ONSu

A mixture of Pal-ONSu (3 g, 8.48 mmol), γ-aminobutyric acid (0.87 g, 8.48 mmol) in DMF (200 ml) was stirred at room temperature for 60 h. The reaction mixture was filtered and the filtrate was added drop wise to 10% aqueous citric acid (500 ml). The precipitated N-acylated intermediate was collected and dried in vacuo. To a suspension of the dried intermediate in DMF (35 ml) was added a solution of DCC (1.45 g, 7.0 mmol) in dichloromethane (20 ml). The resulting mixture was stirred at room temperature for 20 h, and then filtered. The solvent was removed in vacuo to give a solid residue. The residue was recrystallised from a mixture of n-heptane (50 ml) and 2-propanol (2.5 ml) to give the title compound (2.5 g, 75%).

Example 68

Synthesis of Arg³⁴,Lys²⁶ (N^ε-(γ-aminobutyroyl(N^ε-hexadecanoyl))) GLP-1 (7-37)-OH

To a mixture of Arg³⁴, Lys²⁶ GLP-1 (7-37)-OH (41.1 mg, 12.2 μmol), EDPA (44 mg, 341 μmol), NMP (5.76 ml) and water (2.88 ml) was added a solution of Pal-GABA-ONSu (16 mg, 36.5 μmol), prepared as described in example 67) in NMP (400 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 100 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (20 mg, 268 μmol) in water (200 ml). The solvent was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (15.8 mg, 35%) was isolated, and the product was analysed by PDMS.

Example 69

Synthesis of N^ε-hexadecanoyl-D-glutamic acid α-tert-butyl ester-γ-2,5-dioxopyrrolidin-1-yl ester

A mixture of Pal-ONSu (6.64 g, 18.8 mmol), D-glutamic acid α-tert-butyl ester (4.5 g, 18.8 mmol) and EDPA (4.85 g, 37.5 mmol) in DMF (538 ml) was stirred at room temperature for 60 h. The solvent was removed and the residue dissolved in ethyl acetate (175 ml). The resulting solution was extracted with 10% aqueous citric acid (2×125 ml), and the organic phase concentrated in vacuo. The residue was dissolved in DMF (60 ml), and the resulting mixture slowly added to 10% aqueous citric acid (500 ml). The precipitated compound was collected and dried in vacuo, to give the crude N-acylated glutamic acid intermediate. The crude intermediate was dissolved in DMF (35 ml), and a solution of DCC (3.5 g, 17 mmol) in dichloromethane (70 ml) was added. The resulting mixture was stirred at room temperature for 20 h, and then filtered. The filtrate was concentrated in vacuo, and the solid residue recrystallised from a mixture of n-heptane (75 ml) and 2-propanol (5 ml), to give the title compound (5.2 g, 50%).

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Example 70

Synthesis of Arg³⁴,Lys²⁶(N^ε-(γ-D-glutamyl(N^α-hexadecanoyl))) GLP-1 (7-37)-OH

To a mixture of Arg³⁴, Lys²⁶ GLP-1 (7-37)-OH (41.1 mg, 12.2 μmol), EDPA (44 mg, 341 μmol), NMP (5.76 ml) and water (2.88 ml) was added a solution of N^α-hexadecanoyl-D-glutamic acid α-t-butyl ester-γ-2,5-dioxopyrrolidin-1-yl ester (19.7 mg, 36.5 μmol) in NMP (491 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 95 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (20 mg, 268 μmol) in water (2 ml). A solvent 0.5% aqueous solution of ammonium acetate (120 ml) was added, and the resulting mixture divided into to equal portions, and each portion eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The combined eluates were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (10.5 mg, 23%) was isolated, and the product was analysed by PDMS.

Example 71

Synthesis of Lys³⁴(N^ε-(γ-glutamyl(N^α-tetradecanoyl))) GLP-1 (7-37)

To a mixture of GLP-1 (7-37)-OH (33.6 mg, 8.9 μmol), EDPA (32.4 mg, 250 μmol), NMP (2.1 ml) and water (2.1 ml) was added a solution of Myr-Glu(ONSu)-OBu^t (9.1 mg, 17.9 μmol), prepared as described above, in NMP (228 μl). The reaction mixture was gently shaken for 5 min., and the allowed to stand for an additional 80 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (14.8 mg, 197 μmol) in water (1.47 ml). A 0.5% aqueous solution of ammonium acetate (100 ml) was added, and the resulting mixture divided into two equal portions, and each portion eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitrile (2×25 ml). The combined eluates were concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (0.19 mg, 0.6%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3693±3. The resulting molecular weight was thus 3692±3 amu (theoretical value 3695 amu).

Example 72

Synthesis of Arg^{26,34},Lys⁸(N^ε-(γ-glutamyl(N^α-hexadecaonyl))) GLP-1 (7-37)

To a mixture of Arg^{26,34}, Lys⁸-GLP-1 (7-37)-OH (10.3 mg, 3 μmol), EDPA (10.8 mg, 83 μmol), NMP (1.44 ml) and water (0.72 ml) was added a solution of Pal-Glu(ONSu)-OBu^t (4.8 mg, 8.9 μmol), prepared as described above, in NMP (120 μl). The reaction mixture was gently shaken for 5 min., and the allowed to stand for an additional 70 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (4.9 mg, 65.3 μmol) in water (490 μl). A 0.5% aqueous solution of ammonium acetate (30

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ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (3.2 mg, 28%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3836±3. The resulting molecular weight was thus 3835±3 AMU (theoretical value 3836 AMU).

Example 73

Synthesis of Lau-Glu(ONSu)-OBu^t

To a solution of H-Glu-OBu^t (3 g, 15 mmol) in DMF (344 ml) was added EDPA (2.58 ml, 15 mmol) and a solution of Lau-ONSu (4.5 g, 15 mmol), prepared in a similar manner as described for Cap-ONSu in example 56, in DMF (74 ml). The resulting mixture was stirred at ambient temperature for 18 h, and the solvent removed in vacuo. The oily residue was partitioned between ethyl acetate (150 ml) and 5% aqueous citric acid (250 ml). The organic phase was concentrated in vacuo. The residue was dissolved in DMF (40 ml) and the solution added drop by drop to a 10% aqueous citric acid solution (350 ml). The precipitated product was collected, washed with water and dried in vacuo for 18 h to give the intermediate free acid. To solution of the free acid intermediate in DMF (25 ml) was added N-hydroxysuccinimide (1.7 g, 14.8 mmol) and a solution of N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide (2.58 g, 13.5 mmol) in dichloromethane (52 ml). The resulting mixture was stirred at room temperature for 18 h, and the solvents removed in vacuo. The oily residue was partitioned between dichloromethane (80 ml) and water (80 ml). The organic phase was washed with 5% aqueous citric acid, dried (MgSO₄), and concentrated in vacuo to a solid. The solid residue was crystallised from a mixture of n-heptane (77 ml) and 2-propanol (50 ml), and finally recrystallised from n-heptane (76 ml) to give the title compound (2.96 g, 46%).

Example 74

Synthesis of Arg³⁴,Lys²⁶(N^ε-(γ-glutamyl(N^α-dodecanoyl))) GLP-1 (7-37)

To a mixture of Arg³⁴-GLP-1 (7-37)-OH (20.6 mg, 6.1 μmol), EDPA (22 mg, 171 μmol), NMP (2.88 ml) and water (1.44 ml) was added a solution Lau-Glu(ONSu)-OBu^t (10.2 mg, 21.2 μmol), prepared as described in example 73, in NMP (255 μl). The reaction mixture was gently shaken for 5 min., and the allowed to stand for an additional 75 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (10 mg, 134 μmol) in water (100 μl). A 0.5% aqueous solution of ammonium acetate (62 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (8.2 mg,

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36%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3693 ± 3 . The resulting molecular weight was thus 3692 ± 3 AMU (theoretical value 3693 AMU).

Example 75

Synthesis of Lau- β -Ala-ONSu

To a solution of Lau-ONSu (4.25 g, 14.3 mmol), prepared in a similar manner to in DMF (400 ml) was added EDPA (1.84 g, 14.3 mmol) and β -alanine (1.27 g, 14.3 mmol). The resulting mixture was stirred at ambient temperature for 18 h. Water (250 ml) and DMF (50 ml) were added and the solution stirred for 1 h at room temperature. The solvents were removed in vacuo to give a solid. The solid residue was dissolved in DMF (50 ml) and the solution added drop by drop to a 5% aqueous solution of citric acid (200 ml). The precipitate collected, washed with water (50 ml) and dried in vacuo to give the title compound (3.6 g, 93%).

Example 76

Synthesis of Pal- β -Ala-ONSu

To a solution of Pal-ONSu (4.25 g, 14.3 mmol) in DMF (400 ml) was added EDPA (1.84 g, 14.3 mmol) and β -alanine (1.27 g, 14.3 mmol). The resulting mixture was stirred at ambient temperature for 18 h. Water (250 ml) and DMF (50 ml) were added and the solution stirred for 1 h at room temperature. The solvents were removed in vacuo to give a solid. The solid residue was dissolved in DMF (50 ml) and the solution added drop by drop to a 5% aqueous solution of citric acid (200 ml). The precipitate collected, washed with water (50 ml) and dried in vacuo to give the title compound (3.6 g, 93%).

Example 77

Synthesis of Myr-GABA-ONSu

To a solution of Myr-ONSu (4 g, 12.3 mmol) in DMF (350 ml) was added EDPA (1.58 g, 12.3 mmol) and γ -aminobutyric acid (1.26 g, 12.3 mmol). The resulting mixture was stirred at ambient temperature for 18 h. Water (50 ml) was added and the solution stirred for 1 h at room temperature. The solvent were removed in vacuo to give a solid. The solid residue was dissolved in DMF (75 ml) and the solution added drop by drop to a 5% aqueous solution of citric acid (250 ml). The precipitate collected, washed with water (100 ml) and dried in vacuo to give the free acid intermediate (3.65 g, 95%). To a solution of the free acid intermediate (3 g, 9.6 mmol), N-hydroxysuccinimide (1.65 g, 14.4 mmol) and N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride (3.67 g, 19.1 mmol) in DMF (350 ml) was stirred for 18 h at room temperature, and the solvent removed in vacuo to give a solid. The solid residue was dissolved in dichloromethane (100 ml) and washed with brine (100 ml). The organic phase was dried (MgSO_4) and concentrated in vacuo to give a solid. The solid residue was recrystallised from n-heptane (75 ml) to give the title compound (2.8 g, 71%).

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Example 78

Synthesis of Pal- β -Ala-ONSu

To a solution of Pal-ONSu (0.9 g, 2.8 mmol) in DMF (100 ml) were added N-hydroxysuccinimide (0.35 g, 3 mmol) and N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide (0.79 g, 4.1 mmol). The resulting mixture was stirred at ambient temperature for 40 h, and the solvent removed in vacuo. The solid residue was partitioned between water (50 ml) and dichloromethane (50 ml). The organic phase was separated, dried (MgSO_4) and the solvent removed in vacuo to give the title compound (1.1 g, 94%).

Example 79

Synthesis of Arg³⁴,Lys²⁶(N^ε-(β -alanyl(N^α-hexadecanoyl))) GLP-1 (7-37)

To a mixture of Arg³⁴-GLP-1 (7-37)-OH (19.2 mg, 5.7 μmol), EDPA (20.5 mg, 159 μmol), NMP (2.7 ml) and water (1.35 ml) was added a solution of Pal- β -Ala-ONSu (7.2 mg, 17 μmol), prepared as described in example 79, in NMP (181 μl). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (9.3 mg, 125 μmol) in water (93 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (11.6 mg, 55%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3694 ± 3 . The resulting molecular weight was thus 3693 ± 3 AMU (theoretical value 3693 amu).

Example 80

Synthesis of Pal-Glu(OBu⁵)-ONSu

To a solution of H-Glu(OH-OBu^t) (2.7 g, 11.3 mmol) and Pal-ONSu (3.98 g, 11.3 mmol) in DMF (300 ml) was added EDPA (3.2 g, 24.8 mmol). The resulting mixture was stirred at ambient temperature for 18 h, and the solvent concentrated in vacuo to give an oil. The oily residue was dissolved in DMF (60 ml) and the solution added drop by drop to a 10% aqueous solution of citric acid (300 ml) whereby a precipitate was formed. The precipitate was collected, washed with cold water (25 ml), and dried in vacuo to give free acid intermediate (4.44 g, 89%). The free acid intermediate (4 g, 9.1 mmol) was dissolved in DMF (50 ml) and N-hydroxysuccinimide (1.15 g, 10 mmol) and N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride (2.6 g, 13.6 mmol) were added. The resulting mixture was stirred at room temperature for 60 h, the solvent concentrated in vacuo to give the crude title compound (8.2 g).

Example 81

Synthesis of Arg³⁴,Lys²⁶(N^ε-(α -glutamyl(N^α-hexadecanoyl))) GLP-1 (7-37)

To a mixture of Arg³⁴-GLP-1 (7-37)-OH (25.6 mg, 7.6 μmol), EDPA (27.4 mg, 212 μmol), NMP (3.5 ml) and water (1.75 ml) was added a solution of Pal-Glu(OBu^t)-ONSu (12.2 mg, 22.7 μmol), prepared as described in example 80, in NMP (305 μl). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 100 min. at room temperature. The reaction was quenched by the

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addition of a solution of glycine (12.5 mg, 168 μ mol) in water (125 μ l). A 0.5% aqueous solution of ammonium acetate (72.5 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (30 ml). The eluate was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (6.1 mg, 22%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3751 \pm 3. The resulting molecular weight was thus 3750 \pm 3 AMU (theoretical value 3751 AMU).

Example 82

Synthesis of Ste-GABA-ONSu

To a solution of Ste-ONSu (3 g, 7.9 mmol) in DMF (270 ml) was added EDPA (1 g, 7.9 mmol) and a solution of γ -aminobutyric acid (0.81 g, 7.9 mmol) in water (40 ml). The resulting suspension was stirred at ambient temperature for 18 h, and then concentrated in vacuo to a final volume of 50 ml. The resulting suspension was added to a 5% aqueous solution of citric acid (500 ml) whereby a precipitate is formed. The precipitate was collected and washed with water (50 ml), and dried in vacuo for 4 h to give the free acid intermediate (2.8 g, 97%). To a mixture of the free acid intermediate (2.6 g, 7 mmol), N-hydroxysuccinimide (1.21 g, 10.5 mmol) and N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride (2.69 g, 14 mmol) in NMP (300 ml) was stirred for 70 h, and the solvent removed in vacuo to give a solid. The solid residue was dissolved in dichloromethane (100 ml) and washed with brine (2 \times 100 ml). The organic phase was dried (MgSO₄) and concentrated in vacuo to give a solid. The solid residue was recrystallised from n-heptane (75 ml) to give the title compound (2.2 g, 67%).

Example 83

Synthesis of Pal-Isonip-ONSu

To a suspension of 1-hexadecanoylbenzotriazole (3 g, 8.4 mmol), prepared as described in the literature (Kreutzberger; van der Goot, Arch.Pharm., 307, 1974), in DMF (350 ml) were added EDPA (1.08 g, 8.4 mmol) and a solution of piperidine-4-carboxylic acid in water (20 ml). The resulting suspension was stirred at room temperature for 12d, and then concentrated in vacuo to an oil. The oily residue was added drop by drop to a 5% aqueous solution of citric acid (300 ml) whereby a precipitate was formed. The precipitate was collected and washed with water (50 ml), dried in vacuo for 2 h to give the free acid intermediate (3 g, 97%). To a solution of the free acid intermediate (2.8 g, 7.6 mmol), N-hydroxysuccinimide (1.31 g, 11.4 mmol) in DMF (250 ml) was added N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride (2.92 g, 15.2 mmol). The resulting mixture was stirred at ambient temperature for 18 h, and the solvent removed in vacuo to give an oil. The oily residue was dissolved in dichloromethane (100 ml), washed with brine (50 ml), dried (MgSO₄) and concentrated in vacuo to give the crude title compound (4.1 g, quant.).

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Example 84

Synthesis of Arg³⁴,Lys²⁶(N^ε-(piperidinyl-4-carbonyl (N-hexadecanoyl))) GLP-1 (7-37)

To a mixture of Arg³⁴-GLP-1 (7-37)-OH (25 mg, 7.4 μ mol), EDPA (26.7 mg, 207 μ mol), NMP (3.5 ml) and water (1.75 ml) was added a solution Pal-Isonip-ONSu (13.7 mg, 30 μ mol), prepared as described in example 83 in NMP (343 μ l). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (12.2 mg, 163 μ mol) in water (122 μ l). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (12 mg, 44%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3734 \pm 3. The resulting molecular weight was thus 3733 \pm 3 amu (theoretical value 3733 amu).

Example 85

Synthesis of Arg³⁴,Lys²⁶(N^ε-(γ -glutamyl(N^α-decanoyl))) GLP-1 (7-37)

To a mixture of Arg³⁴-GLP-1 (7-37)-OH (25 mg, 7.4 μ mol), EDPA (26.7 mg, 207 μ mol), NMP (3.5 ml) and water (1.75 ml) was added a solution of Cac-Glu(ONSu)-OB' (10 mg, 22.1 μ mol) in NMP (252 μ l). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 140 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (12.2 mg, 162 μ mol) in water (122 μ l). A 0.5% aqueous solution of ammonium acetate (73 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (12.2 mg, 45%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3669.7 \pm 3. The resulting molecular weight was thus 3668.7 \pm 3 amu (theoretical value 3667 amu).

Example 86

General method A

Synthesis of Alkanoic Acid 2,5-dioxopyrrolidin-1-yl Ester

To a solution of the alkanolic acid (34.7 mmol) and N-hydroxysuccinimide. (4 g, 34.7 mmol) in anhydrous acetonitril (10 ml) was added a solution of DCC (7.15 g, 34.7 mmol) in anhydrous dichloromethane (15 ml), and the resulting reaction mixture was stirred for 16 h at room temperature. The precipitated solid was filtered off and recrystallised from a mixture of n-heptane and 2-propanol. The precipitate was dried in vacuo for 16 h to give the title compound.

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Synthesis of Lys(N^ε-alkanoyl)-peptide

To a mixture of the peptide (5.9 μmol), EDPA (21 mg, 164 μmol), NMP (5.8 ml) and water (2.9 ml) was added a solution of the alkanoyl acid 2,5-dioxopyrrolidin-1-yl ester (37 μmol), prepared as described above, in NMP (0.5 ml). The reaction mixture was gently shaken for 5 min. at room temperature, and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (9.7 mg, 129 μmol) in water (97 μl). The solvent was removed in vacuo, and the residue was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% for 60 minutes.

Coupling of a desired group A comprising the 5- or 6-membered ring system Y to the N-terminal end of the peptide may be performed using solid phase protein synthesis techniques as explained above.

Example 87

General Method B

Synthesis of N^ε-alkanoyl-(L)-glutamic acid α-tert-butyl-γ-(2,5-dioxopyrrolidin-1-yl) Diester

A suspension of the alkanoyl acid 2,5-dioxopyrrolidin-1-yl ester (16.2 mmol), prepared as described under General method A, (L)-glutamic acid α-tert-butyl ester (3.28 g, 16.2 mmol), DMF (268 ml) and EDPA (2.1 g, 16.2 mmol) was stirred for 64 h at room temperature. The reaction mixture was concentrated in vacuo and the residue was dissolved in ethyl acetate (50 ml). The resulting solution was washed with 5% aqueous citric acid (2×25 ml). The solvent was concentrated removed in vacuo and the residue dissolved in DMF (36 ml). The resulting solution was carefully added to a 10% aqueous solution of citric acid (357 ml) and extracted with ethyl acetate (200 ml) and dried (MgSO₄). The solvent was concentrated removed in vacuo to give the crude glutamic diester intermediate. To a mixture of the crude diester, N-hydroxysuccinimide (1.85 g, 16.1 mmol) and anhydrous DMF (25 ml) was added a solution of DCC (3.32 g, 16.1 mmol) in anhydrous dichloromethane (15 ml). The resulting mixture was stirred at ambient temperature for 20 h. The reaction mixture was filtered and the solvent was concentrated removed in vacuo. The residue was purified on a silica gel column (40–63 μM) and eluted with a mixture of dichloromethane and acetonitril (1:1) to give the title compound.

Synthesis of Lys(N^ε-(γ-glutamyl(N^ε-alkanoyl))) Peptide

To a mixture of the peptide (4.2 μmol), EDPA (15.3 mg, 119 μmol), NMP (2 ml) and water (1 ml) was added a solution of N^ε-alkanoyl-(L)-glutamic acid α-tert-butyl-γ-(2,5-dioxopyrrolidin-1-yl) diester (12.7 μmol), prepared as described above, in NMP (135 ml). The reaction mixture was gently shaken for 5 min at room temperature and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (7 mg, 93 μmol) in water (698 μl), A 0.5% aqueous solution of ammonium acetate (42 ml) was added, and the resulting mixture was eluted onto a Varian 5 g C8Mega Bond Elut® cartridge, the immobilised compound was washed with 5% aqueous acetonitril (25 ml) and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo, and the residue was

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purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% for 60 minutes.

Coupling of a desired group A comprising the 5- or 6-membered ring system Y to the N-terminal end of the peptide may be performed using solid phase protein synthesis techniques as explained above.

Example 88

Synthesis of N-terminal Modified Peptides

Peptides were synthesised according to the Fmoc strategy on an Applied Biosystems, 431A peptide synthesiser on 0.25 mmol scale using the manufacturer supplied FastMoc UV protocols starting with a Fmoc-Gly-Wang resin (NovaBiochem). The protected amino acid derivatives used were commercially obtained Fmoc amino acids, and Adoc-Imidazolylpropionic acid. The derivatives used where side chain protection was needed were: Fmoc-Arg(Pmc), Fmoc-Trp(Boc), Fmoc-Glu(OBut), Fmoc-Lys(Boc), Fmoc-Gln(Trt), Fmoc-Tyr(But), Fmoc-Ser(But), Fmoc-Thr(But), Fmoc-His(Trt) and Fmoc-Asp(OBut), and Adoc-Imidazolylpropionic acid

The peptides were cleaved from the resin and side chain deprotected in TFA/phenol/thioanisole/water/ethanedithiol (83.25:6.25:4.25:4.25:2.00) for 180 min. The cleavage mixture was filtered and the filtrate was concentrated by a stream of nitrogen. The crude peptide was precipitated from this oil with diethyl ether and, washed twice with diethyl ether. After drying the crude peptide was dissolved in 50% aqueous acetic acid and diluted to 10% acetic acid with water and purified by semipreparative HPLC on a 25 mm×250 mm column packed with 7 μm C-18 silica. The column was eluted with a gradient of acetonitril against, 0.05 M (NH₄)₂SO₄, pH 2.5 at 10 ml/min. at 40° C. The peptide-containing fractions were collected, diluted with 3 volumes of water and applied to a Sep-Pak® C18 cartridge (Waters part. 51910) which was equilibrated with 0.1% TFA. The peptide was eluted from the Sep-Pak® cartridge with 70% acetonitrile/0.1% TFA, water and isolated from the eluate by lyophilization after dilution with water. The final product obtained was characterised by amino acid analysis, analytical RP-HPLC and by PDMS. Amino acid analysis and mass spectrometry agreed with the expected structure within the experimental error of the method (mass spectrometry +/- 2 amu, amino acid analysis +/- 10%, RP-HPLC showed a peptide purity > 95%).

The RP-HPLC analysis was performed using UV detection at 214 nm and a Vydac 218TP54 4.6 mm×250 mm, 5 μm C-18 silica column which was eluted at 1 ml/min. at 42° C. Two different elution conditions were used: a gradient of 5–60% acetonitrile, 0.1 M aninision sulfate, water pH 2.5; and a gradient of 5–60% acetonitrile, 0.1% TFA/0.1% TFA, water.

Example 89

Synthesis of Cap-Glu(ONSu)-OBu^f

To a solution of octanoic acid (5 g, 34.7 mmol) and N-hydroxysuccinimide (4 g, 34.7 mmol) in anhydrous acetonitril (10 ml) was added a solution of DCC (7.15 g, 34.7 mmol) in anhydrous dichloromethane (15 ml), and the resulting reaction mixture stirred for 16 h at room temperature. The precipitated solid was filtered off and recrystallised from a mixture of n-heptane (40 ml) and 2-propanol (2 ml).

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The precipitate was dried in a vacuum drying oven for 16 h to give the intermediate Cap-ONSu. A suspension of the crude ester intermediate (3.9 g, 16.2 mmol), (L)-H-Glu (OH)-OBu^t (3.28 g, 16.2 mmol), DMF (268 ml) and EDPA (2.1 g, 16.2 mmol) was stirred for 64 h at room temperature. The reaction mixture was concentrated in vacuo and the residue dissolved in ethyl acetate (50 ml). The resulting solution was washed with 5% aqueous citric acid (2×25 ml). The solvent was concentrated in vacuo and the residue dissolved in DMF (36 ml). The resulting solution was added drop wise to a 10% aqueous solution of citric acid (357 ml) and extracted with ethyl acetate (200 ml), and dried (MgSO₄). The solvent was concentrated in vacuo to give the crude glutamic acid intermediate. To a mixture of the crude glutamic acid intermediate, N-hydroxysuccinimide (1.85 g, 16.1 mmol) and DMF (25 ml) was added a solution of DCC (3.32 g, 16.1 mmol) in dichloromethane (15 ml). The resulting mixture was stirred at ambient temperature for 20 h. The reaction mixture was filtered and the solvent concentrated in vacuo. The residue was purified on a silica gel column (40–63 μm), eluted with a mixture of dichloromethane and acetonitril (1:1) to give the title compound (0.63 g, 6% over all).

Example 90

Synthesis of Desamino-His⁷,Arg³⁴,Lys²⁶(N^ε-(γ-glutamyl(N^ε-hexadecanoyl))) GLP-1 (7-37)

To a mixture of desamino-His⁷,Arg³⁴-GLP-1 (7-37)-OH (20 mg, 5.9 μmol), EDPA (21.5 mg, 166 μmol), NMP (2.8 ml) and water (1.4 ml) was added a solution Pal-Glu (ONSu)-OBu^t (9.6 mg, 17.8 μmol in NMP (240 μl)). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 75 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (9.8 mg, 130 μmol) in water (979 μl). A 0.5% aqueous solution of ammonium acetate (58 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the immobilised compound washed with 5% aqueous acetonitril (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo; and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (9.1 mg, 41%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3739±3. The resulting molecular weight was thus 3738±3 amu (theoretical value 3736 amu).

Example 91

Synthesis of Myr-GABA-ONSu

To a solution of Myr-ONSu (4 g, 12.3 mmol) in DMF (350 ml) was added EDPA (1.58 g, 12.3 mmol) and γ-aminobutyric acid (1.26 g, 12.3 mmol). The resulting mixture was stirred at ambient temperature for 18 h. Water (50 ml) was added and the solution stirred for 1 h at room temperature. The solvents were removed in vacuo to give a solid. The solid residue was dissolved in DMF (75 ml) and the solution added drop by drop to a 5% aqueous solution of citric acid (250 ml). The precipitate collected, washed with water (100 ml) and dried in vacuo to give the free acid intermediate (3.65 g, 95%). To a solution of the free acid intermediate (3 g, 9.6 mmol), N-hydroxysuccinimide (1.65 g, 14.4 mmol) and N-(3-dimethylaminopropyl)-N'-

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ethyleubodiimide hydrochloride (3.67 g, 19.1 mmol) in DMF (330 ml) was stirred for 18 h at room temperature, and the solvent removed in vacuo to give a solid. The solid residue was dissolved in dichloromethane (100 ml) and washed with brine (100 ml). The organic phase was dried (MgSO₄) and concentrated in vacuo to give a solid. The solid residue was recrystallised from n-heptane (75 ml) to give the title compound (2.8 g, 71%).

Example 92

Synthesis of Desamino-His⁷,Arg³⁴,Lys²⁶(N^ε-(γ-aminobutyryl(N^ε-hexadecanoyl))) GLP-1 (7-37)

To a mixture of desamino-His⁷,Arg³⁴-GLP-1 (7-37)-OH (20 mg, 8.9 μmol), EDPA (21.5 mg, 166 μmol), NMP (2.8 ml) and water (1.4 ml) was added a solution Pal-GABA-ONSu (7.8 mg, 17.8 μmol) in NMP (181 μl). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (9.3 mg, 125 μmol) in water (93 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (11.6 mg, 55%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3692±3. The resulting molecular weight was thus 3691±3 amu (theoretical value 3693 amu).

Example 93

Synthesis of Desamino-His⁷,Arg³⁴,Lys²⁶(N^ε-(β-alanyl(N^ε-hexadecanoyl))) GLP-1 (7-37)

To a mixture of desamino-His⁷,Arg³⁴-GLP-1 (7-37)-OH (25 mg, 7.4 μmol), EDPA (26.8 mg, 208 μmol), NMP (3.5 ml) and water (1.75 ml) was added a solution Pal-β-Ala-ONSu (9.4 mg, 22.2 μmol) in NMP (236 μl). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 130 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (12.2 mg, 163 μmol) in water (122 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (13.4 mg, 49%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3681±3. The resulting molecular weight was thus 3680±3 amu (theoretical value 3678 amu).

Example 94

Synthesis of Ste-GABA-ONSu

To a solution of Ste-ONSu (3 g, 7.9 mmol) in DMF (270 ml) was added EDPA (1 g, 7.9 mmol) and a solution of γ-aminobutyric acid (0.81 g, 7.9 mmol) in water (40 ml). The resulting suspension was stirred at ambient temperature for 18 h, and then concentrated in vacuo to a final volume of 50 ml. The resulting suspension was added to a 5% aqueous solution of citric acid (500 ml) whereby a precipitate is formed. The precipitate was collected and washed with water (50 ml), and dried in vacuo for 4 h to give the free acid intermediate (2.8 g, 97%). To a mixture of the free acid

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intermediate (2.6 g, 7 mmol), N-hydroxysuccinimide (1.21 g, 10.5 mmol) and N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride (2.69 g, 14 mmol) in NMT (300 ml) was stirred for 70 h, and the solvent removed in vacuo to give a solid. The solid residue was dissolved in dichloromethane (100 ml) and washed with brine (2x100 ml). The organic phase was dried (MgSO₄) and concentrated in vacuo to give a solid. The solid residue was recrystallised from n-heptane (75 ml) to give the title compound (2.2 g, 67%).

Example 95

Synthesis of Arg³⁴,Ala⁸(N^α-(imidazol-4-ylprop-2-enoyl),Lys²⁶(N^ε-(γ-aminobutyroyl(N^γ-hexadecanoyl))) GLP-1 (8-37)

To a mixture of Arg³⁴,Ala⁸(N^α-(imidazol-4-ylprop-2-enoyl)-GLP-1 (8-37)-OH (5.6 mg, 1.7 μmol), EDPA (6 mg, 46.2 μmol), NMP (0.78 ml) and water (0.39 ml) was added a solution Pal-GABA-ONSu (2.2 mg, 5 μmol) in NMP (54 μl). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 80 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.7 mg, 36 μmol) in water (27 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (1.9 mg, 31%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3690±3. The resulting molecular weight was thus 3689±3 amu (theoretical value 3690 amu).

Example 96

Synthesis of Arg³⁴,Ala⁸(N^α-(imidazol-4-ylacetyl),Lys²⁶(N^ε-(γ-aminobutyroyl(N^γ-hexadecanoyl))) GLP-1 (8-37)

To a mixture of Arg³⁴,Ala⁸(N^α-(imidazol-4-ylacetyl)-GLP-1 (8-37)-OH (5.3 mg, 1.6 μmol), EDPA (5.7 mg, 43.9 μmol), NMP (0.74 ml) and water (0.37 ml) was added a solution Pal-GABA-ONSu (2 mg, 4.7 μmol) in NMP (52 μl). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 80 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (2.6 mg, 34 μmol) in water (26 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (2.2 mg, 38%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3676±3. The resulting molecular weight was thus be 3675±3 amu (theoretical value 3678 amu).

Example 97

Synthesis of desamino-His⁷,Arg³⁴,Lys²⁶(N^ε-(γ-aminobutyroyl(N^γ-tetradecanoyl))) GLP-1 (7-37)

To a mixture of desamino-His⁷,Arg³⁴-GLP-1 (7-37)-OH (25 mg, 7.4 μmol), EDPA (26.9 mg, 208 μmol), NMP (3.5 ml) and water (1.75 ml) was added a solution Myr-GABA-ONSu (9.1 mg, 22.2 μmol), prepared as described in example 91, in NMP (228 μl). The reaction mixture was

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gently shaken for 5 min., and then allowed to stand for an additional 90 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (12.2 mg, 163 μmol) in water (122 μl). The reaction mixture was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (10.5 mg, 39%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3667±3. The resulting molecular weight was thus 3664±3 amu (theoretical value 3662 amu).

Example 98

Synthesis of Desamino-His⁷,Arg³⁴,Lys²⁶(N^ε-(γ-aminobutyroyl(N^γ-octadecanoyl))) GLP-1 (7-37)

To a mixture of desamino-His⁷,Arg³⁴-GLP-1 (7-37)-OH (25 mg, 7.4 μmol), EDPA (26.8 mg, 207 μmol), NMP (3.5 ml) and water (1.75 ml) was added a solution Ste-GABA-ONSu (10.4 mg, 22.2 μmol), prepared as described in example 94, in NMP (259 μl). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 170 min. at room temperature. The reaction was quenched by the addition of a solution of glycine (12.2 mg, 163 μmol) in water (122 μl) and the reaction mixture purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient was 0–100% in 60 minutes. The title compound (7 mg, 25%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3719±3. The resulting molecular weight was thus 3718±3 amu (theoretical value 3720 amu).

Example 99

General Method A

Synthesis of Alkanoic Acid 2,5-dioxopyrrolidin-1-yl Ester

To a solution of the alkanolic acid (34.7 mmol) and N-hydroxysuccinimide (4 g, 34.7 mmol) in anhydrous acetonitril (10 ml) was added a solution of DCC (7.15 g, 34.7 mmol) in anhydrous dichloromethane (15 ml), and the resulting reaction mixture was stirred for 16 h at room temperature. The precipitated solid was filtered off and recrystallised from a mixture of n-heptane and 2-propanol. The precipitate was dried in vacuo for 16 h to give the title compound.

Synthesis of Lys(N-alkanoyl)-peptide

To a mixture of the desired parent peptide (5.9 μmol), EDPA (21 mg, 164 μmol), NMP (5.8 ml) and water (2.9 ml) was added a solution of the alkanolic acid 2,5-dioxopyrrolidin-1-yl ester (37 μmol), prepared as described above, in NMEP (0.5 ml). The reaction mixture was gently shaken for 5 min at room temperature, and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (9.7 mg, 129 μmol) in water (97 μl). The solvent was removed in vacuo, and the residue was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitril/TFA system. The column was heated to 65° C. and the acetonitril gradient is 0–100% for 60 minutes.

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General method B

Synthesis of N^α-alkanoyl-(L)-glutamic Acid α-tert-butyl-γ-(2,5-dioxopyrrolidin-1-yl) Diester

A suspension of the alkanoyl acid 2,5-dioxopyrrolidin-1-yl ester (16.2 mmol), prepared as described under General method A, (L)-glutamic acid α-tert-butyl ester (3.28 g, 16.2 mmol), DMF (268 ml) and EDPA (2.1 g, 16.2 mmol) was stirred for 64 h at room temperature. The reaction mixture was concentrated in vacuo and the residue was dissolved in ethyl acetate (50 ml). The resulting solution was washed with 5% aqueous citric acid (2×25 ml). The solvent was removed in vacuo and the residue dissolved in DMF (36 ml). The resulting solution was carefully added to a 10% aqueous solution of citric acid (357 ml) and extracted with ethyl acetate (200 ml) and dried (MgSO₄). The solvent was removed in vacuo to give the crude glutamic diester intermediate. To a mixture of the crude diester, N-hydroxysuccinimide (1.85 g, 16.1 mmol) and anhydrous DMF (25 ml) was added a solution of DCC (3.32 g, 16.1 mmol) in anhydrous dichloromethane (15 ml). The resulting mixture was stirred at ambient temperature for 20 h. The reaction mixture was filtered and the solvent was removed in vacuo. The residue was purified on a silica gel column (40–63 μm) and eluted with a mixture of dichloromethane and acetonitrile (1:1) to give the title compound.

Synthesis of Lys(N^ε-(γ-glutamyl(N^α-alkanoyl))) Peptide

To a mixture of the desired parent peptide (4.2 μmol), EDPA (15.3 mg, 119 μmol), NMP (2 ml) and water (1 ml) was added a solution of N^α-alkanoyl-(L)-glutamic acid α-tert-butyl-γ-(2,5-dioxopyrrolidin-1-yl) diester (12.7 μmol), prepared as described above, in NMP (135 ml). The reaction mixture was gently shaken for 5 min at room temperature and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (7 mg, 93 μmol) in water (698 μl). A 0.5% aqueous solution of ammonium acetate (42 ml) was added, and the resulting mixture was eluted onto a Varian 5 g C8 Mega Bond Elut® cartridge, the immobilised compound was washed with 5% aqueous acetonitrile (25 ml) and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo, and the residue was purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient is 0–100% for 60 minutes.

Example 100

Synthesis of Arg³⁴,Lys²⁶(N^ε-(γ-glutamyl(N^α-tetradecanoyl))) GLP-1 (9-37)

To a mixture of Arg³⁴,GLP-1 (9-37)-OH (22.4 mg, 7.1 μmol), EDPA (25.5 mg, 197 μmol), NMP (3.14 ml) and water (1.57 ml) was added a solution of Myr-Glu(ONSu)-OBU^t (10.8 mg, 21.2 μmol) in NMP (270 μl). The reaction mixture was gently shaken for 5 min., and then allowed to stand for an additional 2 h at room temperature. The reaction was quenched by the addition of a solution of glycine (11.6 mg, 155 μmol) in water (116 μl). A 0.5% aqueous solution of ammonium acetate (67 ml) was added, and the resulting mixture eluted onto a Varian 5 g C8 Mega Bond Elut®, the

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immobilised compound washed with 5% aqueous acetonitrile (25 ml), and finally liberated from the cartridge by elution with TFA (25 ml). The eluate was concentrated in vacuo, and the residue purified by column chromatography using a cyanopropyl column (Zorbax 300SB-CN) and a standard acetonitrile/TFA system. The column was heated to 65° C. and the acetonitrile gradient was 0–100% in 60 minutes. The title compound (2.3 mg, 9.2%) was isolated, and the product was analysed by PDMS. The m/z value for the protonated molecular ion was found to be 3516.0±3. The resulting molecular weight was thus 3515.0±3 amu (theoretical value 3515 amu).

Example 101

In this example and examples 102 and 103,

the phrase “8 mM phosphate buffer of pH 7.4” means 4 mM NaH₂PO₄, 2H₂O and 4 mM Na₂HPO₄, 2H₂O pH adjusted to 7.4 (using Sodium Hydroxide and/or Hydrochloric acid).

the term “Compound 1” means Arg³⁴,Lys²⁶(N^ε-(γ-Glu(N^α-tetradecanoyl))) GLP-1 (7-37).

the term “Compound 2” means Arg³⁴,Lys²⁶(N^ε-(γ-Glu(N^α-hexadecanoyl))) GLP-1 (7-37).

the term “Compound 3” means Arg^{26,34},Lys³⁶(N^ε-(γ-Glu(N^α-hexadecanoyl))) GLP-1 (7-36).

the term “Compound 4” means Arg²⁶,Lys³⁴(N^ε-(γ-Glu(N^α-hexadecanoyl))) GLP-1 (7-37).

the term “Compound 5” means Gly⁸,Glu³⁷,Arg^{26,34},Lys³⁸(N^ε-(γ-Glu(N^α-hexadecanoyl))) GLP-1 (7-37).

General Example 101

Compound	2–7.5 mg/ml
Mannitol	34–50 mg/ml
Phenol	5–7.5 mg/ml
8 mM phosphate buffer of pH 7.4	

Mannitol and phenol were dissolved in the phosphate buffer preadjusted to PH 7.4. The compound was then dissolved under slow stirring. The pH was adjusted to 7.4 using sodium hydroxide and/or hydrochloric acid. Finally, the formulation was sterilised by filtration through an appropriate filter.

The following specific formulations were produced using this procedure:

Example 101-A

Compound 1	2.0 mg/ml
Mannitol	38 mg/ml
Phenol	5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

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Example 101-B

Compound 1	5 mg/ml
Mannitol	36.9 mg/ml
Phenol	5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Compound 3	5 mg/ml
Mannitol	36.9 mg/ml
Phenol	5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

10

Example 101-C

Compound 1	7.5 mg/ml
Mannitol	34 mg/ml
Phenol	7.5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Compound 3	7.5 mg/ml
Mannitol	34 mg/ml
Phenol	7.5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

20

Example 101-D

Compound 2	2.0 mg/ml
Mannitol	38 mg/ml
Phenol	5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Compound 4	2.0 mg/ml
Mannitol	38 mg/ml
Phenol	5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

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Example 101-E

Compound 2	5 mg/ml
Mannitol	36.9 mg/ml
Phenol	5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Compound 4	5 mg/ml
Mannitol	36.9 mg/ml
Phenol	5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

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Example 101-F

Compound 2	7.5 mg/ml
Mannitol	34 mg/ml
Phenol	7.5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Compound 4	7.5 mg/ml
Mannitol	34 mg/ml
Phenol	7.5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

50

Example 101-G

Compound 3	2.0 mg/ml
Mannitol	38 mg/ml
Phenol	5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Compound	2-7.5 mg/ml
Mannitol	19-25 mg/ml
Benzyl Alcohol	14-18 mg/ml
8 mM phosphate buffer of pH 7.4	

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Mannitol and benzyl alcohol were dissolved in the phosphate buffer preadjusted to pH 7.4. The compound was then dissolved under slow stirring. The pH was adjusted to 7.4 using sodium hydroxide and/or hydrochloric acid. Finally, the formulation was sterilised by filtration through an appropriate filter.

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The following specific formulations were produced using this procedure:

Example 102-A

Compound 1	2.0 mg/ml
Mannitol	25 mg/ml
Benzyl alcohol	14 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Example 102-B

Compound 1	7.5 mg/ml
Mannitol	19 mg/ml
Benzyl alcohol	18 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Example 102-C

Compound 2	2.0 mg/ml
Mannitol	25 mg/ml
Benzyl alcohol	14 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Example 102-D

Compound 2	7.5 mg/ml
Mannitol	19 mg/ml
Benzyl alcohol	18 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Example 102-E

Compound 3	2.0 mg/ml
Mannitol	25 mg/ml
Benzyl alcohol	14 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Example 102-F

Compound 3	7.5 mg/ml
Mannitol	19 mg/ml
Benzyl alcohol	18 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

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Example 102-G

Compound 5	2.0 mg/ml
Mannitol	25 mg/ml
Benzyl alcohol	14 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Example 102-H

Compound 5	7.5 mg/ml
Mannitol	19 mg/ml
Benzyl alcohol	18 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Example 103

Compound	2-7.5 mg/ml
Mannitol	42-44 mg/ml
Metacresol	2.5-4.0 mg/ml
8 mM phosphate buffer of pH 7.4	

Mannitol and metacresol were dissolved in the phosphate buffer preadjusted to pH 7.4. The compound was then dissolved under slow stirring. The pH was adjusted to 7.4 using sodium hydroxide and/or hydrochloric acid. Finally, the formulation was sterilised by filtration through an appropriate filter.

The following specific formulations were produced using this:

Example 103-A

Compound 1	2.0 mg/ml
Mannitol	44 mg/ml
Metacresol	2.5 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Example 103-B

Compound 1	7.5 mg/ml
Mannitol	42 mg/ml
Metacresol	4 mg/ml
8 mM phosphate buffer of pH 7.4	ad 100 ml

Example 103-C

Compound 2	2.0 mg/ml
Mannitol	44 mg/ml

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Example 103-G

-continued

<p>Metacresol 2.5 mg/ml 8 mM phosphate ad 100 ml buffer of pH 7.4</p>	5	<p>Compound 5 2.0 mg/ml Mannitol 44 mg/ml Metacresol 2.5 mg/ml 8 mM phosphate ad 100 ml buffer of pH 7.4</p>
Example 103-D	10	Example 103-H
<p>Compound 2 7.5 mg/ml Mannitol 42 mg/ml Metacresol 4 mg/ml 8 mM phosphate ad 100 ml buffer of pH 7.4</p>	15	<p>Compound 5 7.5 mg/ml Mannitol 42 mg/ml Metacresol 4 mg/ml 8 mM phosphate ad 100 ml buffer of pH 7.4</p>

Example 103-E

<p>Compound 3 2.0 mg/ml Mannitol 44 mg/ml Metacresol 2.5 mg/ml 8 mM phosphate ad 100 ml buffer of pH 7.4</p>	25
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Example 103-F

<p>Compound 3 7.5 mg/ml Mannitol 42 mg/ml Metacresol 4 mg/ml 8 mM phosphate ad 100 ml buffer of pH 7.4</p>	40
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20 Example 104
Circular Dichroism (CD) at 222 nm as a function of peptide concentration for peptides dissolved in 10 mM tris buffer, pH 8, and 23° C. was measured for native GLP-1(7-37) and the following eight GLP-1 derivatives of the present invention:
25 Example 37
Example 50
Example 63
Example 51
Example 55
Example 61
30 Example 68
Example 64

The results are shown in FIG. 1. Note that the CD signal is proportional to the average content of α -helix in the peptides, i.e., a CD value of -1 corresponds to 10% α -helix content under these conditions. The figure shows that, as the concentration of native GLP-1(7-37) is raised between 25 and 1000 μ M, the content of α -helix increases from about 15% to about 30-35% in parallel with the formation of higher oligomers. In contrast with this concentration dependent behaviour, the figure shows that the helix content remains high and essentially independent of the concentration in the 1-200 μ M range for the GLP-1 derivatives of the present invention forming partially structured micelle-like aggregates under the same conditions.

SEQUENCE LISTING

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<220> FEATURE:
<223> OTHER INFORMATION: derivatives of human GLP-1

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<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
    
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<220> FEATURE:
 <223> OTHER INFORMATION: mutagen

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 1 5 10 15

Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly
 20 25 30

<210> SEQ ID NO 3
 <211> LENGTH: 31
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 3

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Lys Gly
 20 25 30

<210> SEQ ID NO 4
 <211> LENGTH: 31
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 4

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly
 20 25 30

<210> SEQ ID NO 5
 <211> LENGTH: 32
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 5

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly Arg
 20 25 30

<210> SEQ ID NO 6
 <211> LENGTH: 33
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 6

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Lys

<210> SEQ ID NO 7

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-continued

<211> LENGTH: 34
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 7

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Arg Lys

<210> SEQ ID NO 8
 <211> LENGTH: 31
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 8

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Lys Gly Lys Gly
 20 25 30

<210> SEQ ID NO 9
 <211> LENGTH: 31
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 9

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 1 5 10 15

Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly
 20 25 30

<210> SEQ ID NO 10
 <211> LENGTH: 33
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 10

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly Arg
 20 25 30

Lys

<210> SEQ ID NO 11
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 <223> OTHER INFORMATION: mutagen

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His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

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<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 16

His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15
 Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Lys Gly
 20 25 30

<210> SEQ ID NO 17

<211> LENGTH: 31

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 17

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 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly
 20 25 30

<210> SEQ ID NO 18

<211> LENGTH: 33

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 18

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 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Lys

<210> SEQ ID NO 19

<211> LENGTH: 34

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 19

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 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Arg Lys

<210> SEQ ID NO 20

<211> LENGTH: 31

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 20

His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Lys Gly Lys Gly
 20 25 30

M

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<210> SEQ ID NO 21
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<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

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His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1           5           10           15

Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly
      20           25           30

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<210> SEQ ID NO 22
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<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 22

His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1           5           10           15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly Arg
      20           25           30

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Lys

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<210> SEQ ID NO 23
<211> LENGTH: 34
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 23

His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1           5           10           15

Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
      20           25           30

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Arg Lys

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<210> SEQ ID NO 24
<211> LENGTH: 33
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 24

His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1           5           10           15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly Arg
      20           25           30

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Lys

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<210> SEQ ID NO 25
<211> LENGTH: 34
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 25

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-continued

His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly Arg
 20 25 30

Arg Lys

<210> SEQ ID NO 26
 <211> LENGTH: 32
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 26

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 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Lys
 20 25 30

<210> SEQ ID NO 27
 <211> LENGTH: 33
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 27

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Lys

<210> SEQ ID NO 28
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 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 28

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 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Arg Lys

<210> SEQ ID NO 29
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 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 29

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Arg Glu Lys
 35

M

-continued

<210> SEQ ID NO 30
 <211> LENGTH: 36
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 30

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Arg Glu Phe Lys
 35

<210> SEQ ID NO 31
 <211> LENGTH: 37
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 31

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Arg Glu Phe Pro Lys
 35

<210> SEQ ID NO 32
 <211> LENGTH: 38
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 32

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Arg Glu Phe Pro Glu Lys
 35

<210> SEQ ID NO 33
 <211> LENGTH: 39
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 33

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15

Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
 20 25 30

Arg Glu Phe Pro Glu Glu Lys
 35

<210> SEQ ID NO 34
 <211> LENGTH: 38

M

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<212> TYPE: PRT
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<223> OTHER INFORMATION: mutagen

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His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1             5             10             15
Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20             25             30
Val Arg Gly Arg Gly Lys
 35

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<210> SEQ ID NO 35
<211> LENGTH: 39
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 35
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 1             5             10             15
Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20             25             30
Val Arg Gly Arg Gly Arg Lys
 35

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<210> SEQ ID NO 36
<211> LENGTH: 40
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 36
His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1             5             10             15
Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20             25             30
Val Arg Gly Arg Gly Arg Arg Lys
 35             40

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<210> SEQ ID NO 37
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<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 37
His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1             5             10             15
Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20             25             30
Val Arg Gly Arg Gly Arg Arg Glu Lys
 35             40

```

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<210> SEQ ID NO 38
<211> LENGTH: 42
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:

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-continued

<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 38

His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1 5 10 15
 Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20 25 30
 Val Arg Gly Arg Gly Arg Arg Glu Phe Lys
 35 40

<210> SEQ ID NO 39

<211> LENGTH: 43

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 39

His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1 5 10 15
 Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20 25 30
 Val Arg Gly Arg Gly Arg Arg Glu Phe Pro Lys
 35 40

<210> SEQ ID NO 40

<211> LENGTH: 44

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 40

His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1 5 10 15
 Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20 25 30
 Val Arg Gly Arg Gly Arg Arg Glu Phe Pro Glu Lys
 35 40

<210> SEQ ID NO 41

<211> LENGTH: 45

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 41

His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1 5 10 15
 Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20 25 30
 Val Arg Gly Arg Gly Arg Arg Glu Phe Pro Glu Glu Lys
 35 40 45

<210> SEQ ID NO 42

<211> LENGTH: 37

<212> TYPE: PRT

<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 42

M

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Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser
 1           5           10           15
Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val
           20           25           30
Arg Gly Arg Gly Lys
           35

```

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<210> SEQ ID NO 43
<211> LENGTH: 38
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

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<400> SEQUENCE: 43

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Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser
 1           5           10           15
Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val
           20           25           30
Arg Gly Arg Gly Arg Lys
           35

```

```

<210> SEQ ID NO 44
<211> LENGTH: 39
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

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<400> SEQUENCE: 44

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Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser
 1           5           10           15
Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val
           20           25           30
Arg Gly Arg Gly Arg Arg Lys
           35

```

```

<210> SEQ ID NO 45
<211> LENGTH: 40
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

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<400> SEQUENCE: 45

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Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser
 1           5           10           15
Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val
           20           25           30
Arg Gly Arg Gly Arg Arg Glu Lys
           35           40

```

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<210> SEQ ID NO 46
<211> LENGTH: 41
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

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<400> SEQUENCE: 46

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Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser
 1           5           10           15

```

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Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val
 20 25 30

Arg Gly Arg Gly Arg Arg Glu Phe Lys
 35 40

<210> SEQ ID NO 47
 <211> LENGTH: 42
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 47

Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser
 1 5 10 15

Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val
 20 25 30

Arg Gly Arg Gly Arg Arg Glu Phe Pro Lys
 35 40

<210> SEQ ID NO 48
 <211> LENGTH: 43
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 48

Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser
 1 5 10 15

Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val
 20 25 30

Arg Gly Arg Gly Arg Arg Glu Phe Pro Glu Lys
 35 40

<210> SEQ ID NO 49
 <211> LENGTH: 44
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 49

Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser
 1 5 10 15

Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val
 20 25 30

Arg Gly Arg Gly Arg Arg Glu Phe Pro Glu Glu Lys
 35 40

<210> SEQ ID NO 50
 <211> LENGTH: 36
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 50

Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser
 1 5 10 15

Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg
 20 25 30

M

-continued

Gly Arg Gly Lys
35

<210> SEQ ID NO 51
<211> LENGTH: 37
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 51

Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser
1 5 10 15
Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg
20 25 30

Gly Arg Gly Arg Lys
35

<210> SEQ ID NO 52
<211> LENGTH: 38
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 52

Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser
1 5 10 15
Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg
20 25 30

Gly Arg Gly Arg Arg Lys
35

<210> SEQ ID NO 53
<211> LENGTH: 39
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 53

Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser
1 5 10 15
Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg
20 25 30

Gly Arg Gly Arg Arg Glu Lys
35

<210> SEQ ID NO 54
<211> LENGTH: 40
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 54

Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser
1 5 10 15
Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg
20 25 30

Gly Arg Gly Arg Arg Glu Phe Lys
35 40

M

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<210> SEQ ID NO 55
 <211> LENGTH: 41
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

 <400> SEQUENCE: 55

 Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser
 1 5 10 15

 Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg
 20 25 30

 Gly Arg Gly Arg Arg Glu Phe Pro Lys
 35 40

<210> SEQ ID NO 56
 <211> LENGTH: 42
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

 <400> SEQUENCE: 56

 Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser
 1 5 10 15

 Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg
 20 25 30

 Gly Arg Gly Arg Arg Glu Phe Pro Glu Lys
 35 40

<210> SEQ ID NO 57
 <211> LENGTH: 43
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

 <400> SEQUENCE: 57

 Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser
 1 5 10 15

 Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg
 20 25 30

 Gly Arg Gly Arg Arg Glu Phe Pro Glu Glu Lys
 35 40

<210> SEQ ID NO 58
 <211> LENGTH: 35
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

 <400> SEQUENCE: 58

 Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr
 1 5 10 15

 Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly
 20 25 30

 Arg Gly Lys
 35

<210> SEQ ID NO 59

M

-continued

<211> LENGTH: 36
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 59

Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr
 1 5 10 15

Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly
 20 25 30

Arg Gly Arg Lys
 35

<210> SEQ ID NO 60
 <211> LENGTH: 37
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 60

Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr
 1 5 10 15

Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly
 20 25 30

Arg Gly Arg Arg Lys
 35

<210> SEQ ID NO 61
 <211> LENGTH: 38
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 61

Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr
 1 5 10 15

Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly
 20 25 30

Arg Gly Arg Arg Glu Lys
 35

<210> SEQ ID NO 62
 <211> LENGTH: 39
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 62

Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr
 1 5 10 15

Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly
 20 25 30

Arg Gly Arg Arg Glu Phe Lys
 35

<210> SEQ ID NO 63
 <211> LENGTH: 40
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence

M

-continued

<220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 63

Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr
 1 5 10 15
 Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly
 20 25 30
 Arg Gly Arg Arg Glu Phe Pro Lys
 35 40

<210> SEQ ID NO 64
 <211> LENGTH: 41
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 64

Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr
 1 5 10 15
 Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly
 20 25 30
 Arg Gly Arg Arg Glu Phe Pro Glu Lys
 35 40

<210> SEQ ID NO 65
 <211> LENGTH: 42
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 65

Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr
 1 5 10 15
 Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly
 20 25 30
 Arg Gly Arg Arg Glu Phe Pro Glu Glu Lys
 35 40

<210> SEQ ID NO 66
 <211> LENGTH: 34
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 66

Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu
 1 5 10 15
 Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg
 20 25 30
 Gly Lys

<210> SEQ ID NO 67
 <211> LENGTH: 35
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 67

M

-continued

Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu
1 5 10 15

Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg
20 25 30

Gly Arg Lys
35

<210> SEQ ID NO 68
<211> LENGTH: 36
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 68

Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu
1 5 10 15

Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg
20 25 30

Gly Arg Arg Lys
35

<210> SEQ ID NO 69
<211> LENGTH: 37
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 69

Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu
1 5 10 15

Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg
20 25 30

Gly Arg Arg Glu Lys
35

<210> SEQ ID NO 70
<211> LENGTH: 38
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 70

Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu
1 5 10 15

Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg
20 25 30

Gly Arg Arg Glu Phe Lys
35

<210> SEQ ID NO 71
<211> LENGTH: 39
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 71

Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu
1 5 10 15

M

-continued

Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg
 20 25 30

Gly Arg Arg Glu Phe Pro Lys
 35

<210> SEQ ID NO 72
 <211> LENGTH: 40
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 72

Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu
 1 5 10 15

Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg
 20 25 30

Gly Arg Arg Glu Phe Pro Glu Lys
 35 40

<210> SEQ ID NO 73
 <211> LENGTH: 41
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 73

Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu
 1 5 10 15

Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg
 20 25 30

Gly Arg Arg Glu Phe Pro Glu Lys
 35 40

<210> SEQ ID NO 74
 <211> LENGTH: 33
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 74

Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu
 1 5 10 15

Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly
 20 25 30

Lys

<210> SEQ ID NO 75
 <211> LENGTH: 34
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 75

Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu
 1 5 10 15

Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly
 20 25 30

M

-continued

Arg Lys

<210> SEQ ID NO 76
 <211> LENGTH: 35
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 76

Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu
 1 5 10 15

Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly
 20 25 30

Arg Arg Lys
 35

<210> SEQ ID NO 77
 <211> LENGTH: 36
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 77

Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu
 1 5 10 15

Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly
 20 25 30

Arg Arg Glu Lys
 35

<210> SEQ ID NO 78
 <211> LENGTH: 37
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 78

Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu
 1 5 10 15

Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly
 20 25 30

Arg Arg Glu Phe Lys
 35

<210> SEQ ID NO 79
 <211> LENGTH: 38
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 79

Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu
 1 5 10 15

Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly
 20 25 30

Arg Arg Glu Phe Pro Lys
 35

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<210> SEQ ID NO 80
<211> LENGTH: 39
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 80
Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu
 1             5             10             15
Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly
 20             25             30
Arg Arg Glu Phe Pro Glu Lys
 35

```

```

<210> SEQ ID NO 81
<211> LENGTH: 40
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 81
Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu
 1             5             10             15
Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly
 20             25             30
Arg Arg Glu Phe Pro Glu Lys
 35             40

```

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<210> SEQ ID NO 82
<211> LENGTH: 38
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 82
His Asp Glu Phe Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1             5             10             15
Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20             25             30
Val Lys Gly Arg Gly Lys
 35

```

```

<210> SEQ ID NO 83
<211> LENGTH: 38
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 83
His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1             5             10             15
Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu
 20             25             30
Val Arg Gly Arg Gly Lys
 35

```

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<210> SEQ ID NO 84
<211> LENGTH: 38
<212> TYPE: PRT

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<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 84

His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1           5           10           15
Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
           20           25           30
Val Arg Gly Lys Gly Lys
           35

```

```

<210> SEQ ID NO 85
<211> LENGTH: 32
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 85

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1           5           10           15
Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly Lys
           20           25           30

```

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<210> SEQ ID NO 86
<211> LENGTH: 32
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 86

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1           5           10           15
Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Lys
           20           25           30

```

```

<210> SEQ ID NO 87
<211> LENGTH: 32
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 87

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1           5           10           15
Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly Lys
           20           25           30

```

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<210> SEQ ID NO 88
<211> LENGTH: 32
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 88

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1           5           10           15
Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Lys
           20           25           30

```

M

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<210> SEQ ID NO 89
 <211> LENGTH: 39
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 89

His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1 5 10 15
 Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20 25 30
 Val Lys Gly Arg Gly Arg Lys
 35

<210> SEQ ID NO 90
 <211> LENGTH: 39
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 90

His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1 5 10 15
 Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu
 20 25 30
 Val Arg Gly Arg Gly Arg Lys
 35

<210> SEQ ID NO 91
 <211> LENGTH: 39
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 91

His Asp Glu Phe Glu Arg His Ala Glu Gly Thr Phe Thr Ser Asp Val
 1 5 10 15
 Ser Ser Tyr Leu Glu Gly Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu
 20 25 30
 Val Arg Gly Lys Gly Arg Lys
 35

<210> SEQ ID NO 92
 <211> LENGTH: 33
 <212> TYPE: PRT
 <213> ORGANISM: Artificial Sequence
 <220> FEATURE:
 <223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 92

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1 5 10 15
 Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly Arg
 20 25 30
 Lys

<210> SEQ ID NO 93
 <211> LENGTH: 33
 <212> TYPE: PRT

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<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

<400> SEQUENCE: 93

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1      5      10      15
Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Arg Gly Arg Gly Arg
      20      25      30

```

Lys

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<210> SEQ ID NO 94
<211> LENGTH: 33
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

```

<400> SEQUENCE: 94

```

His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1      5      10      15
Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly Arg
      20      25      30

```

Lys

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<210> SEQ ID NO 95
<211> LENGTH: 32
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

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<400> SEQUENCE: 95

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His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1      5      10      15
Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly Lys
      20      25      30

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<210> SEQ ID NO 96
<211> LENGTH: 32
<212> TYPE: PRT
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: mutagen

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<400> SEQUENCE: 96

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His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly
 1      5      10      15
Gln Ala Ala Arg Glu Phe Ile Ala Trp Leu Val Arg Gly Lys Gly Lys
      20      25      30

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What is claimed is:

1. A GLP-1 derivative of formula I (SEQ ID NO:2):

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 7  8  9 10 11 12 13 14 15 16 17
His-Xaa-Xaa-Gly-Xaa-Phe-Thr-Xaa-Asp-Xaa-Xaa-
18 19 20 21 22 23 24 25 26 27 28
Xaa-Xaa-Xaa-Xaa-Xaa-Xaa-Xaa-Xaa-Xaa-Phe-
29 30 31 32 33 34 35 36 37
Ile-Xaa-Xaa-Xaa-Xaa-Xaa-Xaa-Xaa

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wherein

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60 Xaa at position 8 is Ala,
    Xaa at position 9 is Glu,
    Xaa at position 11 is Thr,
    Xaa at position 14 is Ser,
    Xaa at position 16 is Val,
    Xaa at position 17 is Ser,
65 Xaa at position 18 is Ser,
    Xaa at position 19 is Tyr,
    Xaa at position 20 is Leu,

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Xaa at position 21 is Glu,
 Xaa at position 22 is Gly,
 Xaa at position 23 is Gln,
 Xaa at position 24 is Ala,
 Xaa at position 25 is Ala,
 Xaa at position 26 is Lys,
 Xaa at position 27 is Glu,
 Xaa at position 30 is Ala,
 Xaa at position 31 is Trp,
 Xaa at position 32 is Leu,
 Xaa at position 33 is Val,
 Xaa at position 34 is Arg,
 Xaa at position 35 is Gly,
 Xaa at position 36 is Arg, and
 Xaa at position 37 is Gly,

wherein

- (a) the ϵ -amino group of Lys at position 26 is substituted with a lipophilic substituent, optionally via a spacer,
 - (b) the lipophilic substituent is (i) $\text{CH}_2(\text{CH}_2)_n\text{CO}$ — wherein n is 6, 8, 10, 12, 14, 16, 18, 20 or 22, (ii) $\text{HOOC}(\text{CH}_2)_m\text{CO}$ — wherein m is 10, 12, 14, 16, 18, 20 or 22, or (iii) lithochoyl, and
 - (c) the spacer is (i) an unbranched alkane α,ω -dicarboxylic acid group having from 1 to 7 methylene groups, (ii) an amino acid residue except Cys, or (iii) γ -aminobutanoyl.
2. The GLP-1 derivative of claim 1, wherein the lipophilic substituent is linked to the ϵ -amino group of Lys via a spacer.
 3. The GLP-1 derivative of claim 2, wherein the spacer is γ -glutamyl.
 4. The GLP-1 derivative of claim 2, wherein the spacer is β -asparagyl.
 5. The GLP-1 derivative of claim 2, wherein the spacer is glycylyl.
 6. The GLP-1 derivative of claim 2, wherein the spacer is γ -aminobutanoyl.
 7. The GLP-1 derivative of claim 2, wherein the β -alanyl.
 8. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} -tetradecanoyl), Arg³⁴-GLP-1(7-37).
 9. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - ω -carboxynonadecanoyl), Arg³⁴-GLP-1(7-37).
 10. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - ω -carboxyheptadecanoyl), Arg³⁴-GLP-1(7-37).
 11. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - ω -carboxyundecanoyl), Arg³⁴-GLP-1(7-37).
 12. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - ω -carboxypentadecanoyl), Arg³⁴-GLP-1(7-37).
 13. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} -lithochoyl), Arg³⁴-GLP-1(7-37).
 14. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - γ -glutamyl(N ^{α} -hexadecanoyl)), Arg³⁴-GLP-1(7-37).
 15. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - γ -glutamyl(N ^{α} -tetradecanoyl)), Arg³⁴-GLP-1(7-37).

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16. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - γ -glutamyl(N ^{α} -lithochoyl)), Arg³⁴-GLP-1(7-37).
17. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - γ -glutamyl(N ^{α} -octadecanoyl)), Arg³⁴-GLP-1(7-37).
18. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} -decanoyl), Arg³⁴-GLP-1(7-37).
19. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} -hexadecanoyl), Arg³⁴-GLP-1(7-37).
20. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} -octanoyl), Arg³⁴-GLP-1(7-37).
21. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} -dodecanoyl), Arg³⁴-GLP-1(7-37).
22. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} -N⁶⁸ (γ -aminobutyryl-(N ^{γ} -hexadecanoyl))), Arg³⁴-GLP-1(7-37).
23. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - γ -D-glutamyl(N ^{α} -hexadecanoyl)), Arg³⁴-GLP-1(7-37).
24. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - γ -glutamyl(N ^{α} -dodecanoyl)), Arg³⁴-GLP-1(7-37).
25. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - β -alanyl(N ^{α} -hexadecanoyl)), Arg³⁴-GLP-1(7-37).
26. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - α -glutamyl(N ^{α} -hexadecanoyl)), Arg³⁴-GLP-1(7-37).
27. The GLP-1 derivative of claim 1, which is Lys²⁶(N ^{ϵ} - γ -glutamyl(N ^{α} -decanoyl)), Arg³⁴-GLP-1(7-37).
28. A pharmaceutical composition comprising a GLP-1 derivative of claim 1 and a pharmaceutically acceptable vehicle or carrier.
29. A pharmaceutical composition of claim 28, further comprising an isotonic agent, a preservative and a buffer.
30. A pharmaceutical composition of claim 29, wherein the isotonic agent is sodium chloride, mannitol and glycerol.
31. A pharmaceutical composition of claim 29, wherein the preservative is phenol, m-cresol, methyl p-hydroxybenzoate or benzyl alcohol.
32. A pharmaceutical composition of claim 29, wherein the buffer is sodium acetate or sodium phosphate.
33. A pharmaceutical composition of claim 28, further comprising a surfactant.
34. A pharmaceutical composition of claim 28, further comprising zinc.
35. A pharmaceutical composition of claim 28, further comprising another antidiabetic agent.
36. A pharmaceutical composition of claim 35, wherein the antidiabetic agent is human insulin.
37. A pharmaceutical composition of claim 35, wherein the antidiabetic agent is a hypoglycemic agent.
38. A pharmaceutical composition of claim 28, further comprising another antiobesity agent.
39. A method of treating diabetes, comprising administering to a patient a therapeutically effective amount of a GLP-1 derivative of claim 1.
40. A method of treating obesity, comprising administering to a patient a therapeutically effective amount of a GLP-1 derivative of claim 1.

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UNITED STATES PATENT AND TRADEMARK OFFICE
Certificate

Patent No. 6,268,343 B1

Patented: July 31, 2001

On petition requesting issuance of a certificate for correction of inventorship pursuant to 35 U.S.C. 256, it has been found that the above identified patent, through error and without any deceptive intent, improperly sets forth the inventorship.

Accordingly, it is hereby certified that the correct inventorship of this patent is: Liselotte Bjerre Knudsen, Valby, Denmark; Per Olaf Huusfeldt, Kbenhavn K, Denmark; and Per Franklin Nielsen, Vaelose, Denmark.

Signed and Sealed this Eleventh Day of May 2004.

M. P. Woodward
Supervisory Patent Examiner
Art Unit 1631

Disclaimer

6,268,343 B1 — Liselotte Bjerre Knudsen, Valby (DK); Per Olaf Huusfeldt, Kobenhavn K (DK); Per Franklin Nielsen, Vaerlose (DK); Niels C. Kaarsholm, Vanlose (DK); Helle Birk Olsen, Allerod (DK); Soren Erik Bjorn, Lyngby (DK); Freddy Zimmerdahl Pedersen, Vaerlose (DK); Kjeld Madsen, Vaerlose (DK). DERIVATIVES OF GLP-1 ANALOGS. Patent dated July 31, 2001. Disclaimer filed July 19, 2017, by the assignee, Novo Nordisk A/S.

Hereby disclaims the term of this patent which would extend beyond Patent Nos. 6,458,924, 8,097,698, and 7,235,627.

(Official Gazette, August 15, 2017)