Use of DPP IV inhibitors

The specification describes the use of selected DPP IV inhibitors for the treatment of physiological functional disorders and for reducing the risk of the occurrence of such functional disorders in at-risk patient groups. In addition, the use of the above-mentioned DPP IV inhibitors in conjunction with other active substances is described, by means of which improved treatment outcomes can be achieved. These applications may be used to prepare corresponding medicaments.

The enzyme DPP-IV, also known by the name CD26, is a serine protease which promotes the cleaving of dipeptides in proteins with a proline or alanine group at the N-terminal end. DPP-IV inhibitors thereby influence the plasma level of bioactive peptides including the peptide GLP-1 and are highly promising molecules for the treatment of diabetes mellitus.

Type 1 diabetes mellitus, which occurs mainly in juveniles under 30 years of age, is categorised as an autoimmune disease. With a corresponding genetic disposition and under the influence of various factors, insulitis occurs, followed by destruction of the B-cells, so that the pancreas is no longer able to produce much, if any, insulin.

Type 2 diabetes mellitus is not categorised as an autoimmune disease and manifests itself in a fasting blood sugar level exceeding 125 mg of glucose per dl of plasma; the measurement of blood glucose values is a standard procedure in routine medical analysis. Prediabetes is suspected if the fasting blood sugar level exceeds the maximum normal level of 99 mg of glucose per dl of plasma but does not exceed the threshold of 125 mg of glucose per dl of plasma, which is relevant for diabetes. This is also referred to as pathological fasting glucose (impaired fasting glucose). Another indication of prediabetes is a disrupted glucose tolerance, i.e. a blood sugar level of 140-199 mg of glucose per dl of plasma 2 hours after taking 75 mg of glucose on an empty stomach within the scope of an oral glucose tolerance test.

If a glucose tolerance test is carried out, the blood sugar level of a diabetic will be in excess of 199 mg of glucose per dl of plasma 2 hours after 75 g of glucose have been taken on an empty stomach. In a glucose tolerance test 75 g of glucose are administered orally to the patient being tested after 10-12 hours of fasting and the blood sugar level is recorded immediately before taking the glucose and 1 and 2 hours after taking it. In a healthy subject the blood sugar level will be between 60 and 99 mg per dl of plasma before taking the glucose, less than 200 mg per dl 1 hour after taking it and less than 140 mg per dl after 2 hours. If after 2 hours the value is between 140 and 199 mg this is regarded as abnormal glucose tolerance or in some cases glucose intolerance.

In the monitoring of the treatment of diabetes mellitus the HbA1c value, the product of a non-enzymatic glycation of the haemoglobin B chain, is of exceptional importance. As its formation depends essentially on the blood sugar level and the life time of the erythrocytes the HbA1c in the sense of a "blood sugar memory" reflects the average blood sugar level of the preceding 4-12 weeks. Diabetic patients whose HbA1c level has been well controlled over a long time by more intensive diabetes treatment (i.e. < 6.5 % of the total haemoglobin in the sample) are significantly better protected from diabetic microangiopathy. The available treatments for diabetes can give the diabetic an average improvement in their HbA1c level of the order of 1.0 – 1.5 %. This reduction in the HbA1C level is not sufficient in all diabetics to bring them into the desired target range of < 6.5 % and preferably < 6 % HbA1c.

If insulin resistance can be detected this is a particularly strong indication of the presence of the complex metabolic disorder of prediabetes. Thus, it may be that in order to maintain glucose homoeostasis a person needs 2-3 times as much insulin as another person. The most certain method of determining insulin resistance is the euglycaemic-hyperinsulinaemic clamp test. The ratio of insulin to glucose is determined within the scope of a combined insulin-glucose infusion technique. There is found to be insulin resistance if the glucose absorption is below the 25th percentile of the background population investigated (WHO definition). Rather less laborious than the clamp test are so called minimal models in which, during an intravenous

glucose tolerance test, the insulin and glucose concentrations in the blood are measured at fixed time intervals and from these the insulin resistance is calculated. Another method of measurement is the mathematical HOMA model. The insulin resistance is calculated by means of the fasting plasma glucose and the fasting insulin concentration. In this method it is not possible to distinguish between hepatic and peripheral insulin resistance. These processes are not really suitable for evaluating insulin resistance in daily practice. As a rule, other parameters are used in everyday clinical practice to assess insulin resistance. Preferably, the patient's triglyceride concentration is used, for example, as increased triglyceride levels correlate significantly with the presence of insulin resistance.

To simply somewhat, in practice it is assumed that people are insulin-resistant if they have at least 2 of the following characteristics:

1) overweight or obesity
2) high blood pressure
3) dyslipidaemia (an altered content of total lipids in the blood)
4) at least one close relative in whom abnormal glucose tolerance or type 2 diabetes has been diagnosed.

Overweight means in this instance that the Body Mass Index (BMI) is between 25 and 30 kg/m^2, the BMI being the quotient of the body weight in kg and the square of the height in metres. In manifest obesity the BMI is 30 kg/m^2 or more.

It is immediately apparent, from the above definition of insulin resistance, that hypotensive agents are suitable and indicated for treating it if, among other things, high blood pressure is found in the patient.

A similar indication of prediabetes is if the conditions for metabolic syndrome are met, the main feature of which is insulin resistance. According to the ATP IHINCEP Guidelines (Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) in the Journal of the American Medical Association 285:2486-2497, 2001) metabolic syndrome is present if a patient has at least 3 of the following characteristics:

1) Abdominal obesity, defined as a waist measurement of >40 inches or 102 cm in men and >35 inches or 94 cm in women
2) Triglyceride levels >150 mg/dl
3) HDL-cholesterol levels <40 mg/dl in men
4) High blood pressure >130/>85 mm Hg
5) Fasting blood sugar of >110 mg/dl

This definition of metabolic syndrome immediately shows that hypotensives are suitable for treating it if the patient is found to have high blood pressure, among other things.

A triglyceride blood level of more than 150 mg/dl also indicates the presence of pre-diabetes. This suspicion is confirmed by a low blood level for HDL cholesterol. In women, levels below 55 mg per dl of plasma are regarded as too low while in men levels below 45 mg per dl of plasma are regarded as too low. Triglycerides and HDL cholesterol in the blood can also be determined by standard methods in medical analysis and are described for example in Thomas L (Editor): "Labor und Diagnose", TH-Books Verlagsgesellschaft mbH, Frankfurt/Main, 2000. A suspicion of prediabetes is further confirmed if the fasting blood sugar levels also exceed 99 mg of glucose per dl of plasma.

The term gestational diabetes (diabetes of pregnancy) denotes a form of the sugar disease which develops during pregnancy and usually ceases again immediately after the birth. Gestational diabetes is diagnosed by a screening test which is carried out between the 24th and 28th weeks of pregnancy. It is usually a simple test in which the blood sugar level is measured one hour after the administration of 50 g of glucose solution. If this 1 h level is above 140 mg/dl, gestational diabetes is suspected. Final confirmation may be obtained by a standard glucose tolerance test with 75 g of glucose.

Hyperglycaemia describes a functional disorder in which an excessively high glucose level is measured in the blood, either in the fasting state (increased glucose level of 100-125 mg/dl or diabetic-hyperglycaemic level of >125 mg/dl compared with the

normal level of <100 mg/dl,) or in non-fasting state (elevated glucose level of >180 mg/dl).

By adrenergic postprandial syndrome (reactive hypoglycaemia) the clinician means a functional disorder in which a disproportionately high insulin level leads to a drop in the blood sugar level (hypoglycaemia) caused by an imbalance between rapidly digested carbohydrates and a high insulin level persisting after a meal.

The term diabetic foot refers to lesions on the foot caused by diabetes mellitus, the primary cause of which is a polyneuropathy that can be put down to inadequate metabolic control. A diabetic foot is diagnosed by the occurrence of typical lesions (e.g. ulcers) in an existing case of diabetes mellitus.

The term diabetes-associated ulcer refers to an ulcerous inflammatory skin defect in a patient with diabetes mellitus. A diabetes-associated ulcer is diagnosed by typical anamnesis and physical examination (e.g. inspection of the foot).

The term diabetic hyperlipidaemia is used if a patient with diabetes mellitus suffers an increase in total cholesterol or, more typically in diabetic hyperlipidaemia, an increase in the plasma triglycerides, with or without a reduction in HDL cholesterol.

The term diabetic dyslipidaemia is used if the total cholesterol is not raised but the distribution of HDL- and LDL-cholesterol is altered, i.e. the patient's HDL cholesterol level is too low (e.g. <55 mg/dl for women and <45 mg/dl for men).

The term heart failure is used if either subjective symptoms or objective findings indicate an inability of the heart to achieve the necessary ejection output. Subjective symptoms may be e.g. difficulty breathing under stress or at rest. Objective findings include a reduced ejection output of the heart according to ultrasound (reduced ejection volume), congestion of the lungs according to X-ray, and/or reduced walking distances.

Some selected DPP IV inhibitors are particularly suitable for the preparation of a medicament for the therapeutic treatment of patients who have been diagnosed with a medical or physiological functional disorder selected from among pre-diabetes, glucose intolerance (impaired glucose tolerance), pathological fasting glucose (impaired fasting glucose), diabetic foot, diabetes-associated ulcer, diabetic hyperlipidaemia, diabetic dyslipidaemia, newly diagnosed type 1 diabetes (to maintain a residual secretion of insulin from the pancreas), gestational diabetes (diabetes of pregnancy), hyperglycaemia, adrenergic postprandial syndrome (reactive hypoglycaemia) or heart failure.

These medicaments may also be used to reduce the risk that in spite of treatment the patient will suffer an impaired glucose metabolism, an elevated HbA1c value, an impaired fasting glucose value, manifest type 2 diabetes, a diabetic foot, a diabetes-associated ulcer, diabetic hyperlipidaemia or diabetic dyslipidaemia, and that in spite of the therapy insulin treatment will become necessary or macrovascular complications will occur.

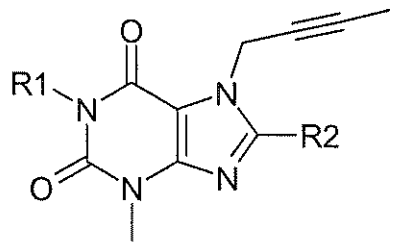
Examples of macrovascular complications of this kind are myocardial infarct, acute coronary syndrome, unstable angina pectoris, stable angina pectoris, haemorrhagic or ischaemic stroke, peripheral arterial occlusive disease, cardiomyopathy, left heart insufficiency, right heart insufficiency, global heart insufficiency, heart rhythm disorders and vascular restenosis. These macrovascular complications are known to the skilled man and described in detail in the standard textbooks.

In addition the substances are suitable for enhancing the vitality and secretion capacity of cells after the transplanting of islets of Langerhans or beta cells, and thereby ensuring a favourable outcome after transplantation. The substances may also be used during the isolation and transplantation phase of islets of Langerhans or beta cells, by adding the specified substances to the conventional isolation or storage medium in a suitable concentration of 1 nmol/l to 1 µmol/l, preferably in a concentration of 1 nmol/l to 100 nmol/l. This results in an improvement in the quality of the material to be transplanted. An improvement in quality is obtained particularly in combination with added amounts of GLP-1 (glucagon like peptide 1), preferably in

a concentration of 1-100 nmol/l. Corresponding isolation or storage media and corresponding methods of enhancing the vitality and secretion capacity of islets of Langerhans or beta cells by the addition of DPP IV inhibitors to the media used are a further object of the invention.

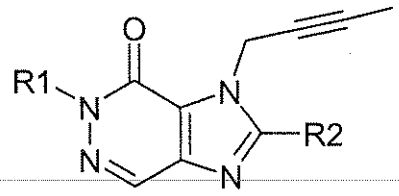
Finally, the above-mentioned inhibitors are suitable for the treatment of various forms of arthritis, but particularly rheumatoid arthritis.

DPP IV inhibitors selected according to the present invention can be described by formula (I)



(I)

or formula (II)

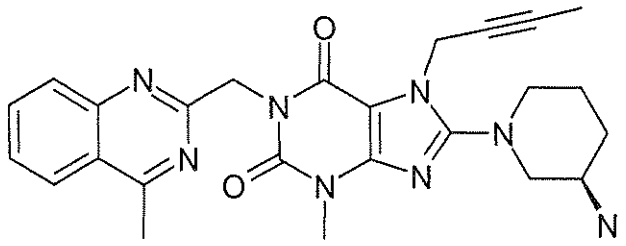


(II)

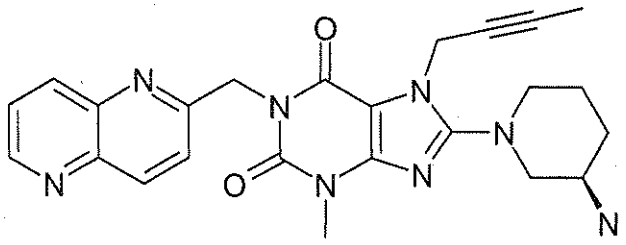
wherein **R1** denotes ([1,5]naphthyridin-2-yl)methyl, (quinazolin-2-yl)methyl, (quinoxalin-6-yl)methyl, (4-methyl-quinazolin-2-yl)methyl, 2-cyano-benzyl, (3-cyano-quinolin-2-yl)methyl, (3-cyano-pyridin-2-yl)methyl, (4-methyl-pyrimidin-2-yl)methyl, or (4,6-dimethyl-pyrimidin-2-yl)methyl and **R2** denotes 3-(*R*)-amino-piperidin-1-yl, (2-amino-2-methyl-propyl)-methylamino or (2-(S)-amino-propyl)-methylamino.

Particularly preferred DPP IV inhibitors are the following compounds and the therapeutically active salts thereof:

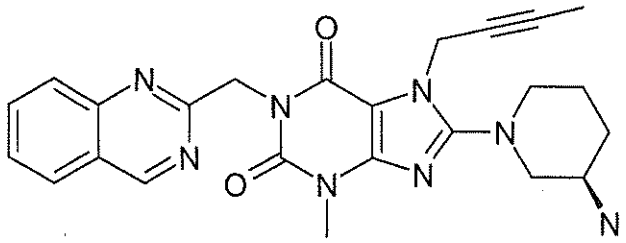
- 1-[(4-methyl-quinazolin-2-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-(3-(*R*)-amino-piperidin-1-yl)-xanthine (cf. WO 2004/018468, Example 2(142):



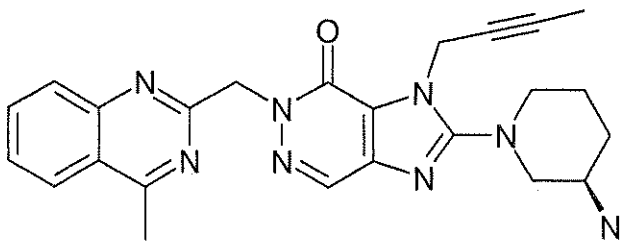
- 1-[([1,5]naphthyridin-2-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-((*R*)-3-amino-piperidin-1-yl)-xanthine (cf. WO 2004/018468, Example 2(252)):



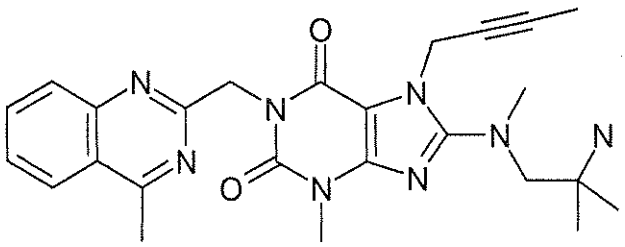
- 1-[(quinazolin-2-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-((*R*)-3-amino-piperidin-1-yl)-xanthine (cf. WO 2004/018468, Example 2(80)):



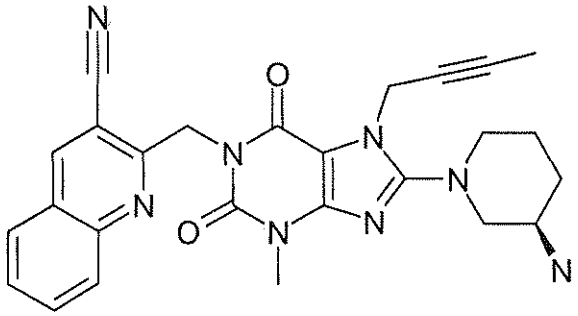
- 2-((R)-3-amino-piperidin-1-yl)-3-(but-2-ynyl)-5-(4-methyl-quinazolin-2-ylmethyl)-3.5-dihydro-imidazo[4,5-d]pyridazin-4-on (cf. WO 2004/050658, Example 136):



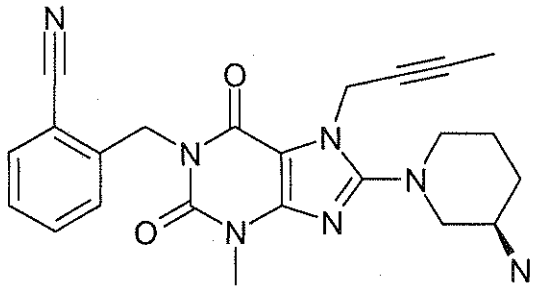
- 1-[(4-methyl-quinazolin-2-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-[(2-amino-2-methyl-propyl)-methylamino]-xanthine (cf. WO 2006/029769, Example 2(1)):



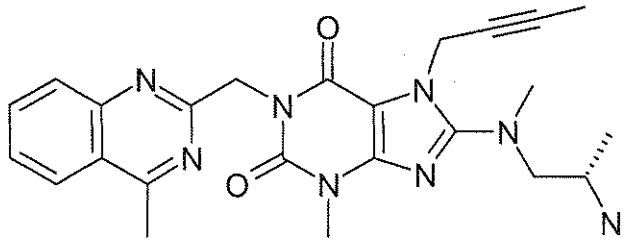
- 1-[(3-cyano-quinolin-2-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-((*R*)-3-amino-piperidin-1-yl)-xanthine (cf. WO 2005/085246, Example 1(30)):



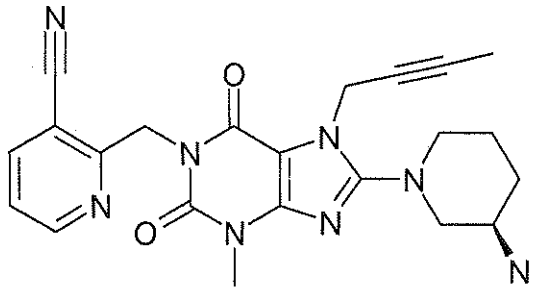
- 1-(2-cyano-benzyl)-3-methyl-7-(2-butyn-1-yl)-8-((*R*)-3-amino-piperidin-1-yl)-xanthine (cf. WO 2005/085246, Example 1(39)):



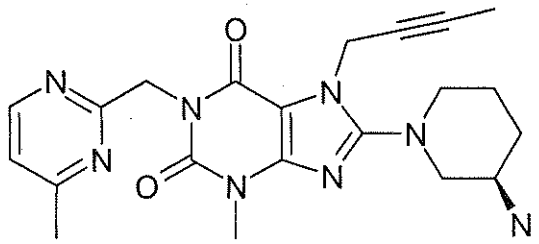
- 1-[(4-methyl-quinazolin-2-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-[(*S*)-(2-amino-propyl)-methylamino]-xanthine (cf. WO 2006/029769, Example 2(4)):



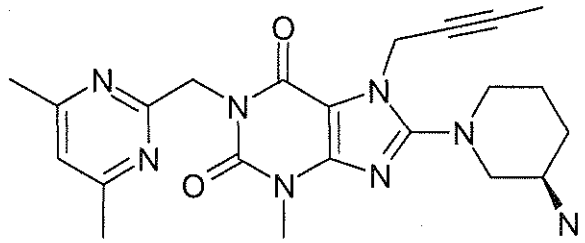
- 1-[(3-cyano-pyridin-2-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-((*R*)-3-amino-piperidin-1-yl)-xanthine (cf. WO 2005/085246, Example 1(52)):



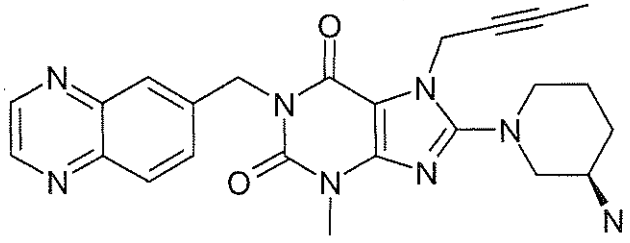
- 1-[(4-methyl-pyrimidin-2-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-((*R*)-3-amino-piperidin-1-yl)-xanthine (cf. WO 2005/085246, Example 1(81)):



- 1-[(4,6-dimethyl-pyrimidin-2-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-((*R*)-3-amino-piperidin-1-yl)-xanthine (cf. WO 2005/085246, Example 1(82)):



- 1-[(quinoxalin-6-yl)methyl]-3-methyl-7-(2-butyn-1-yl)-8-((*R*)-3-amino-piperidin-1-yl)-xanthine (cf. WO 2005/085246, Example 1(83)):



These DPP IV inhibitors are distinguished from structurally comparable DPP IV inhibitors, as they combine exceptional potency and a long-lasting effect with

favourable pharmacological properties, receptor selectivity and a favourable side-effect profile or bring about unexpected therapeutic advantages or improvements when combined with other pharmaceutical active substances. Their preparation is disclosed in the publications mentioned.

As different metabolic functional disorders often occur simultaneously, it is quite often indicated to combine a number of different active principles with one another. Thus, depending on the functional disorders diagnosed, improved treatment outcomes may be obtained if a DPP IV inhibitor is combined with an active substance selected from among the other antidiabetic substances, especially active substances that lower the blood sugar level or the lipid level in the blood, raise the HDL level in the blood, lower blood pressure or are indicated in the treatment of atherosclerosis or obesity.

The dosage required of the DPP IV inhibitors when administered intravenously is 0.1 mg to 10 mg, preferably 0.25 mg to 5 mg, and when administered orally 0.5 mg to 100 mg, preferably 2.5 mg to 50 mg, in each case 1 to 4 times a day. For this purpose the compounds, optionally in combination with another active substance, may be formulated together with one or more inert conventional carriers and/or diluents, e.g. with maize starch, lactose, glucose, microcrystalline cellulose, magnesium stearate, polyvinylpyrrolidone, citric acid, tartaric acid, water, water/ethanol, water/glycerol, water/sorbitol, water/polyethyleneglycol, propylene-glycol, cetylstearylalcohol, carboxymethylcellulose or fatty substances such as hard fat or suitable mixtures thereof, to form conventional galenic preparations such as tablets, coated tablets, capsules, powders, suspensions or suppositories.

The DPP IV inhibitors according to the invention are thus prepared by the skilled man using permitted formulation excipients as described in the prior art. Examples of such excipients are diluents, binders, carriers, fillers, lubricants, flow agents, crystallisation retardants, disintegrants, solubilisers, colourings, pH regulators, surfactants and emulsifiers.

Examples of suitable diluents include cellulose powder, calcium hydrogen phosphate, erythritol, (low-substituted) hydroxypropylcellulose, mannitol, pregelatinised starch or xylitol.

Examples of suitable binders include copolymers of vinylpyrrolidone with other vinyl derivatives (copovidone), hydroxypropylmethylcellulose (HPMC), hydroxypropyl-cellulose (HPC) polyvinylpyrrolidone (povidone), pregelatinised starch, or low-substituted hydroxypropylcellulose.

Examples of suitable lubricants include talc, polyethyleneglycol, calcium behenate, calcium stearate, hydrogenated castor oil or magnesium stearate.

Examples of suitable disintegrants include maize starch or crospovidone.

Suitable methods of preparing pharmaceutical formulations of the DPP IV inhibitors according to the invention are

- Direct tabletting of the active substance in powder mixtures with suitable tabletting excipients;
- Granulation with suitable excipients and subsequent mixing with suitable excipients and subsequent tabletting as well as film coating; or
- packing of powder mixtures or granules into capsules.

Suitable granulation methods are

- wet granulation in the intensive mixer followed by fluidised bed drying;
- one-pot granulation;
- fluidised bed granulation; or
- dry granulation (e.g. By roller compaction) with suitable excipients and subsequent tabletting or packing into capsules.

The DPP IV inhibitors mentioned above may also be used in conjunction with other active substances, by means of which improved treatment results can be obtained. Such a combined treatment may be given as a free combination of the substances or in the form of a fixed combination, for example in a tablet or capsule. Pharmaceutical

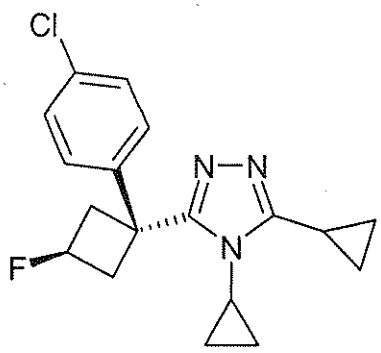
formulations of the combination partner needed for this may either be obtained commercially as pharmaceutical compositions or may be formulated by the skilled man using conventional methods. The active substances which may be obtained commercially as pharmaceutical compositions are described in numerous places in the prior art, for example in the list of drugs that appears annually, the "Rote Liste ®" of the federal association of the pharmaceutical industry, or in the annually updated compilation of manufacturers' information on prescription drugs known as the "Physicians' Desk Reference".

Examples of antidiabetic combination partners are metformin; sulphonylureas such as glibenclamide, tolbutamide, glimepiride, glipizide, gliquidon, glibornuride and gliclazide; nateglinide; repaglinide; thiazolidinediones such as rosiglitazone and pioglitazone; PPAR gamma modulators such as metaglidases; PPAR-gamma agonists such as GI 262570; PPAR-gamma antagonists; PPAR-gamma/alpha modulators such as tesaglitazar, muraglitazar and KRP297; PPAR-gamma/alpha/delta modulators; AMPK-activators such as AICAR; acetyl-CoA carboxylase (ACC1 and ACC2) inhibitors; diacylglycerol-acetyltransferase (DGAT) inhibitors; pancreatic beta cell GCRP agonists such as SMT3-receptor-agonists and GPR119; 11ß-HSD-inhibitors; FGF19 agonists or analogues; alpha-glucosidase blockers such as acarbose, voglibose and miglitol; alpha2-antagonists; insulin and insulin analogues such as human insulin, insulin lispro, insulin glusilin, r-DNA-insulinaspart, NPH insulin, insulin detemir, insulin zinc suspension and insulin glargin; Gastric inhibitory Peptide (GIP); pramlintide; amylin or GLP-1 and GLP-1 analogues such as Exendin-4; SGLT2-inhibitors such as KGT-1251; inhibitors of protein tyrosine-phosphatase; inhibitors of glucose-6-phosphatase; fructose-1,6-bisphosphatase modulators; glycogen phosphorylase modulators; glucagon receptor antagonists; phosphoenolpyruvatecarboxykinase (PEPCK) inhibitors; pyruvate dehydrogenasekinase (PDK) inhibitors; inhibitors of tyrosine-kinases (50 mg to 600 mg) such as PDGF-receptor-kinase (cf. EP-A-564409, WO 98/35958, US 5093330, WO 2004/005281, and WO 2006/041976); glucokinase/regulatory protein modulators incl. glucokinase activators; glycogen synthase kinase inhibitors; inhibitors of the SH2-domain-containing inositol 5-phosphatase type 2 (SHIP2) ; IKK inhibitors such as high-dose salicylate ; JNK1 inhibitors ; protein kinase C-theta

inhibitors; beta 3 agonists such as ritobegron, YM 178, solabegron, talibegron, N-5984, GRC-1087, rafabegron, FMP825; aldosereductase inhibitors such as AS 3201, zenarestat, fidarestat, epalrestat, ranirestat, NZ-314, CP-744809, and CT-112; SGLT-1 or SGLT-2 inhibitors; KV 1.3 channel inhibitors; GPR40 modulators; SCD-1 inhibitors; CCR-2 antagonists; and other DPP IV inhibitors.

Examples of 11ß-HSD1-inhibitors are described in
WO 2007/013929, WO 2007/007688, WO 2007/003521, WO 2006/138508, WO 2006/135795, WO 2006/135667, WO 2006/134481, WO 2006/134467, WO 2006/132436, WO 2006/132197, WO 2006/113261, WO 2006/106423, WO 2006/106052, WO 2006/105127, WO 2006/104280, WO 2006/100502, WO 2006/097337, WO 2006/095822, WO 2006/094633, WO 2006/080533, WO 2006/074330, WO 2006/074244, WO 2006/068992, WO 2006/068991, WO 2006/068199, WO 2006/066109, WO 2006/055752, WO 2006/053024, WO 2006/051662, WO 2006/050908, WO 2006/049952, WO 2006/048750, WO 2006/048331, WO 2006/048330, WO 2006/040329, WO 2006/037501, WO 2006/030805, WO 2006/030804, WO 2006/017542, WO 2006/024628, WO 2006/024627, WO 2006/020598, WO 2006/010546, WO 2006/002349, WO 2006/002350, WO 2006/012173, WO 2006/012227, WO 2006/012226, WO 2006/000371, WO 2005/118538, WO 2005/116002, WO 2005/110992, WO 2005/110980, WO 2005/108359, WO 2005/108361, WO 2005/108360, WO 2005/108368, WO 2005/103023, WO 2005/097764, WO 2005/097759, WO 2005/095350, WO 2005/075471, WO 2005/063247, WO 2005/060963, WO 2005/047250, WO 2005/046685, WO 2005/044192, WO 2005/042513, WO 2005/016877, WO 2004/113310, WO 2004/106294, WO 2004/103980, WO 2004/089896, WO 2004/089380, WO 2004/089471, WO 2004/089470, WO 2004/089367, WO 2005/073200, WO 2004/065351, WO 2004/058741, WO 2004/056745, WO 2004/056744, WO 2004/041264, WO 2004/037251, WO 2004/033427, WO 2004/011410, WO 2003/104208, WO 2003/104207, WO 2003/065983, WO 2003/059267, WO 2003/044009, WO 2003/044000, WO 2003/043999, WO 2002/076435, WO 2001/090094, WO 2001/090093, WO 2001/090092, WO 2001/090091, WO 2001/090090, US 2007/049632, US 2006/148871, US 2006/025445, US 2006/004049, US 2005/277647,

US 2005/261302, US 2005/245534, US 2005/245532, US 2005/245533 and JP 2005/170939. A representative example of an 11ß-HSD1-inhibitor is the compound:

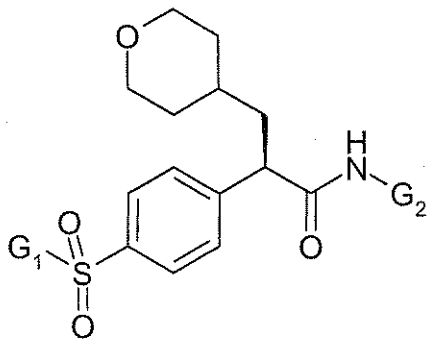


and the salts thereof.

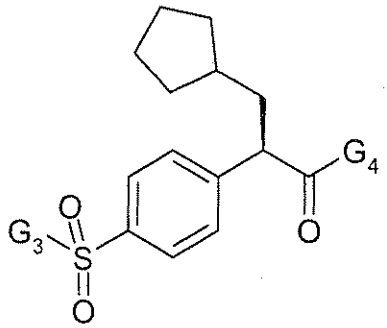
Examples of glycogen phosphorylase modulators are described in WO 2006/126695, WO 2006/082401, WO 2006/082400, WO 2006/059165, WO 2006/059164, WO 2006/059163, WO 2006/056815, WO 2006/055463, WO 2006/055462, WO 2006/055435, WO 2006/053274, WO 2006/052722, WO 2005/085245, WO 2005/085194, WO 2005/073231, WO 2005/073230, WO 2005/073229, WO 2005/067932, WO 2005/020987, WO 2005/020986, WO 2005/020985, WO 2005/019172, WO 2005/018637, WO 2005/013981, WO 2005/013975, WO 2005/012244, WO 2004/113345, WO 2004/104001, WO 2004/096768, WO 2004/092158, WO 2004/078743, WO 2004/072060, WO 2004/065356, WO 2004/041780, WO 2004/037233, WO 2004/033416, WO 2004/007455, WO 2004/007437, WO 2003/104188, WO 2003/091213, WO 2003/084923, WO 2003/084922, WO 2003/074532, WO 2003/074531, WO 2003/074517, WO 2003/074513, WO 2003/074485, WO 2003/074484, WO 2003/072570, WO 2003/059910, WO 2003/037864, WO 2002/096864, WO 2002/020530, WO 2001/094300, WO 2000/123347, WO 1996/39384, WO 1996/39385, EP 1391460, EP 1136071, EP 1125580, EP 1088824, EP 0978279, JP 2004196702, US 2004/002495, US 2003/195243, and US 5998463.

Examples of glucokinase-activators are described in WO 2007/017649, WO 2007/007910, WO 2007/007886, WO 2007/007042, WO 2007/007041, WO 2007/007040, WO 2007/006814, WO 2007/006761, WO 2007/006760, WO 2006/125972, WO 2006/125958, WO 2006/112549, WO 2006/059163, WO 2006/058923, WO 2006/049304, WO 2006/040529, WO 2006/040528, WO 2006/016194, WO 2006/016178, WO 2006/016174, WO 2005/121110, WO 2005/103021, WO 2005/095418, WO 2005/095417, WO 2005/090332, WO 2005/080360, WO 2005/080359, WO 2005/066145, WO 2005/063738, WO 2005/056530, WO 2005/054233, WO 2005/054200, WO 2005/049019, WO 2005/046139, WO 2005/045614, WO 2005/044801, WO 2004/081001, WO 2004/076420, WO 2004/072066, WO 2004/072031, WO 2004/063194, WO 2004/063179, WO 2004/052869, WO 2004/050645, WO 2004/031179, WO 2004/002481, WO 2003/095438, WO 2003/080585, WO 2003/055482, WO 2003/047626, WO 2003/015774, WO 2003/000267, WO 2003/000262, WO 2002/048106, WO 2002/046173, WO 2002/014312, WO 2002/008209, WO 2001/085707, WO 2001/085706, WO 2001/083478, WO 2001/083465, WO 2001/044216, and WO 2000/058293

Representative examples of glucokinase-activators are the compounds



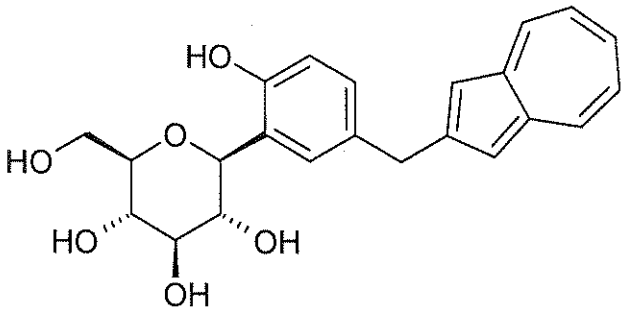
wherein G_1 denotes cyclopropyl or cyclobutyl and G_2 denotes 5-fluoro-thiazol-2-yl, 1-methyl-1*H*-pyrazol-3-yl, or pyrazin-2-yl; and



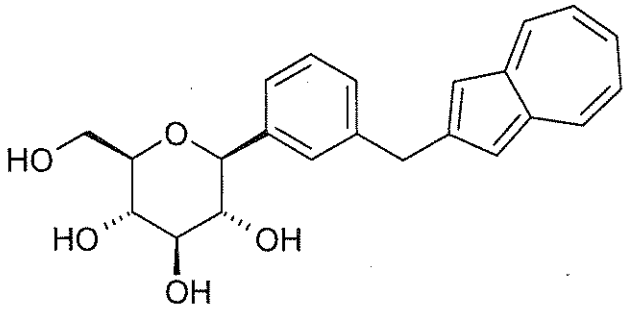
wherein G_3 denotes methyl or ethyl and G_4 denotes thiazol-2-yl, 4-methyl-thiazol-2-yl, 5-methyl-thiazol-2-yl, or pyrazin-2-yl and the salts thereof.

Examples of SGLT1 or SGLT2-inhibitors are described in WO 2006/108842, WO 2006/087997, WO 2006/080577, WO 2006/080421, WO 2006/073197, WO 2006/064033, WO 2006/062224, WO 2006/054629, WO 2006/037537, WO 2006/035796, WO 2006/018150, WO 2006/008038, WO 2006/002912, WO 2006/010557, WO 2006/011502, WO 2006/011469, WO 2005/121161, WO 2005/012326, WO 2005/095429, WO 2005/095372, WO 2005/095373, WO 2005/092877, WO 2005/085267, WO 2005/085265, WO 2005/085237, WO 2005/063785, WO 2005/021566, WO 2005/012243, WO 2005/012242, WO 2005/012326, WO 2005/012318, WO 2005/011592, WO 2004/113359, WO 2004/099230, WO 2004/089967, WO 2004/089966, WO 2004/087727, WO 2004/080990, WO 2004/058790, WO 2004/052903, WO 2004/052902, WO 2004/019958, WO 2004/018491, WO 2004/014932, WO 2004/014931, WO 2004/013118, WO 2003/099836, WO 2003/080635, WO 2003/020737, WO 2003/011880, WO 2003/000712, WO 2002/098893, WO 2002/088157, WO 2002/083066, WO 2002/068440, WO 2002/068439, WO 2002/064606, WO 2002/053573, WO 2002/044192, WO 2002/036602, WO 2002/028872, WO 2001/074835, WO 2001/074834, WO 2001/068660, WO 2001/027128, WO 2001/016147, JP 2005247834, JP 2004359630, JP 2004196788, JP 2003012686, and US 2006/063722.

Representative examples of SGLT1 or SGLT2-inhibitors are the following compounds and the salts or complexes thereof with natural amino acids

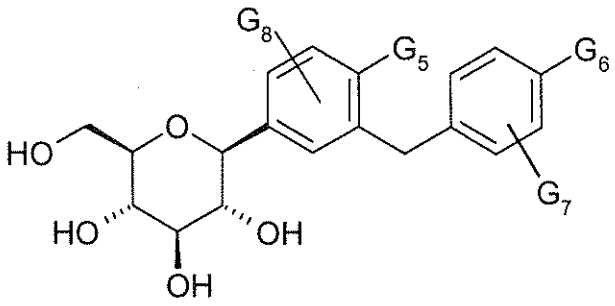


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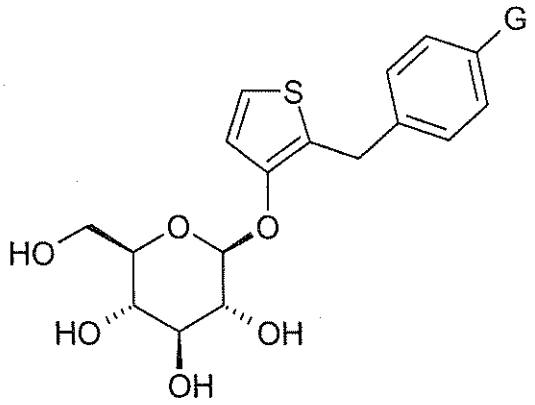
and



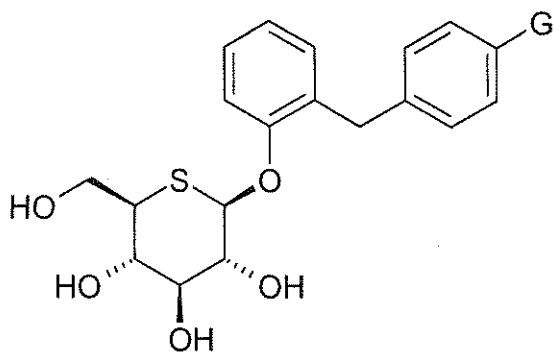
wherein G_5 and G_8 independently of one another denote hydrogen, fluorine, chlorine, bromine, cyano, methyl, ethyl, isopropyl, difluoromethyl, trifluoromethyl, ethynyl, prop-1-yn-1-yl, but-1-yn-1-yl, hydroxy, methoxy, ethoxy, difluoromethoxy, cyclopropyloxy, cyclobutyloxy, cyclopentyloxy or cyclohexyloxy; and

G_6 denotes fluorine, chlorine, methyl, ethyl, methoxy, ethoxy, difluoromethoxy, trifluoromethoxy, trimethylsilylethyl, ethynyl, 2-hydroxyprop-2-ylethynyl, 2-methoxyprop-2-ylethynyl, 3-hydroxy-1-propyn-1-yl, 3-methoxy-1-propyn-1-yl, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cyclopropyloxy, cyclobutyloxy, cyclopentyloxy, cyclohexyloxy, tetrahydrofuran-3-yloxy, tetrahydropyran-4-yloxy, piperidin-4-yloxy, N-methylpiperidin-4-yloxy and N-acetylpiperidin-4-yloxy; and

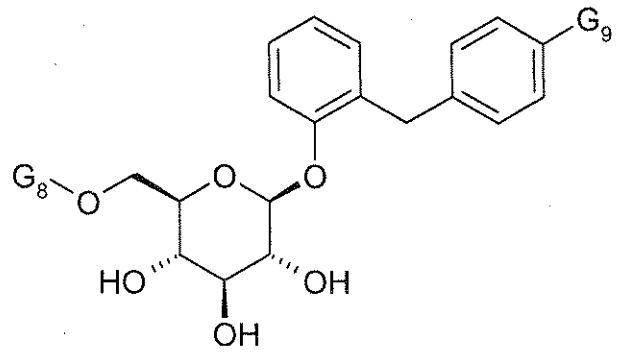
G_7 denotes hydrogen or fluorine;



wherein G denotes fluorine, chlorine, methyl, ethyl, ethynyl, methoxy, ethoxy, difluoromethoxy, trifluoromethoxy, cyclobutyloxy, cyclopentyloxy, 3-tetrahydrofuranyloxy, or 4-tetrahydropyranyloxy;

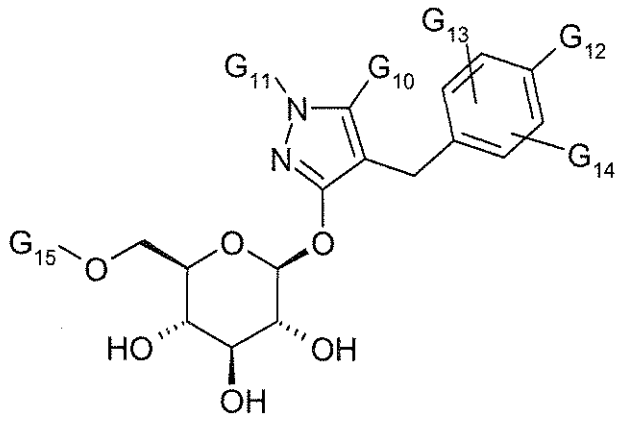


wherein G denotes fluorine, chlorine, methyl, ethyl, ethynyl, methoxy, ethoxy, difluoromethoxy, trifluoromethoxy, cyclobutyloxy, cyclopentyloxy, 3-tetrahydrofuranyloxy, or 4-tetrahydropyranyloxy;



wherein G_8 denotes hydrogen, methoxycarbonyl, or ethoxycarbonyl and

G_9 denotes fluorine, chlorine, methyl, ethyl, ethynyl, methoxy, ethoxy, difluoromethoxy, trifluoromethoxy, cyclobutyloxy, cyclopentyloxy, 3-tetrahydrofuranyloxy, or 4-tetrahydropyranyloxy; and



wherein:

G_{10} denotes C_{1-3}-alkyl or perfluoro-C_{1-3}-alkyl;

G_{11} denotes hydrogen, C_{1-3}-alkyl or perfluoro-C_{1-3}-alkyl;

G_{12} denotes fluorine, chlorine, bromine, C_{1-6}-alkyl, C_{1-6}-alkyl substituted by 1 to 3 fluorine atoms, C_{1-6}-alkoxy, C_{1-6}-alkoxy substituted by 1 to 3 fluorine atoms, C_{1-6}-alkylthio, C_{2-6}-alkenyl, C_{2-6}-alkynyl, perfluoro-C_{1-3}-alkyl, cyclobutyloxy, cyclopentyloxy, cyclohexyloxy, tetrahydrofuranyloxy, or 4-tetrahydropyranyloxy; and

G_{13} and G_{14} independently of one another denote hydrogen, fluorine, chlorine, bromine, C_{1-6}-alkyl, C_{1-6}-alkyl substituted by 1 to 3 fluorine atoms, C_{1-6}-alkoxy, C_{1-6}-alkoxy substituted by 1 to 3 fluorine atoms, C_{1-6}-alkylthio, C_{2-6}-alkenyl, C_{2-6}-alkynyl, perfluoro-C_{1-3}-alkyl; and

G_{15} denotes hydrogen, C_{2-20}-alkanoyl, C_{1-6}-alkoxycarbonyl or benzoyl.

A particularly preferred example of an antidiabetic combination partner is metformin in doses of about 100 mg to 500 mg or 200 mg to 850 mg (1-3 times a day), or about 300 mg to 1000 mg once or twice a day, or delayed-release metformin in doses of about 100 mg to 1000 mg or preferably 500 mg to 1000 mg once or twice a day or about 500 mg to 2000 mg once a day. Another particularly preferred example is pioglitazone in a dosage of about 1-10 mg, 15 mg, 30 mg, or 45 mg once a day.

Another particularly preferred example is miglitol in a dosage of about 10 mg to 50 mg or up to 100 mg 1-3 times a day.

Examples of combination partners that lower the lipid level in the blood are HMG-CoA-reductase inhibitors such as simvastatin, atorvastatin, lovastatin, fluvastatin, pravastatin and rosuvastatin; fibrates such as bezafibrate, fenofibrate, clofibrate, gemfibrozil, etofibrate and etofyllinclofibrate; nicotinic acid and the derivatives thereof such as acipimox; PPAR-alpha agonists; PPAR-delta agonists; inhibitors of acyl-coenzyme A:cholesterolacyltransferase (ACAT; EC 2.3.1.26) such as avasimibe; cholesterol resorption inhibitors such as ezetimib; substances that bind to bile acid, such as cholestyramine, colestipol and colesevelam; inhibitors of bile acid transport; HDL modulating active substances such as D4F, reverse D4F, LXR modulating active substances and FXR modulating active substances; CETP inhibitors such as torcetrapib, JTT-705 or compound 12 from WO 2007/005572; LDL receptor modulators; and ApoB100 antisense RNA. A particularly preferred example is atorvastatin in a dosage of about 1 mg to 40 mg or 10 mg to 80 mg once a day.

Examples of combination partners that lower blood pressure are beta-blockers such as atenolol, bisoprolol, celiprolol, metoprolol and carvedilol; diuretics such as hydrochlorothiazide, chlortalidon, xipamide, furosemide, piretanide, torasemide, spironolactone, eplerenone, amiloride and triamterene; calcium channel blockers such as amlodipine, nifedipine, nitrendipine, nisoldipine, nicardipine, felodipine, lacidipine, lercanipidine, manidipine, isradipine, nilvadipine, verapamil, gallopamil and diltiazem; ACE inhibitors such as ramipril, lisinopril, cilazapril, quinapril, captopril, enalapril, benazepril, perindopril, fosinopril and trandolapril; as well as angiotensin II receptor blockers (ARBs) such as telmisartan, candesartan, valsartan, losartan, irbesartan, olmesartan and eprosartan. Particularly preferred examples are metoprolol in a dosage of 50 mg to 200 mg per day, Amlodipin in a dosage of 2.5 mg to 10 mg per day, ramipril in a dosage of 2.5 mg to 15 mg per day, valsartan in a dosage of 80 to 160 mg per day, and telmisartan in a dosage of 20 mg to 320 mg or 40 mg to 160 mg per day.

Examples of combination partners which increase the HDL level in the blood are Cholesteryl Ester Transfer Protein (CETP) inhibitors; inhibitors of endothelial lipase; regulators of ABC1; LXRalpha antagonists; LXRbeta agonists; PPAR-delta agonists; LXRalpha/beta regulators, and substances that increase the expression and/or plasma concentration of apolipoprotein A-I.

Examples of combination partners for the treatment of obesity are sibutramine; tetrahydrolipstatin (orlistat); alizyme; dexfenfluramine; axokine; cannabinoid receptor 1 antagonists such as the CB1 antagonist rimonobant; MCH-1 receptor antagonists; MC4 receptor agonists; NPY5 as well as NPY2 antagonists; beta3-AR agonists such as SB-418790 and AD-9677; 5HT2c receptor agonists such as APD 356; myostatin inhibitors; Acrp30 and adiponectin; steroyl CoA desaturase (SCD1) inhibitors; fatty acid synthase (FAS) inhibitors; CCK receptor agonists; Ghrelin receptor modulators; Pyy 3-36; orexin receptor antagonists; and tesofensine.

Examples of combination partners for the treatment of atherosclerosis are phospholipase A2 inhibitors; inhibitors of tyrosine-kinases (50 mg to 600 mg) such as PDGF-receptor-kinase (cf. EP-A-564409, WO 98/35958, US 5093330, WO 2004/005281, and WO 2006/041976); oxLDL antibodies and oxLDL vaccines; apoA-1 Milano; ASA; and VCAM-1 inhibitors.

Examples of combination partners for the treatment of heart failure are beta-blockers such as atenolol, bisoprolol, celiprolol, and metoprolol; diuretics such as hydrochlorothiazide, chlortalidone, xipamide, furosemide, piretanide, torasemide, spironolactone, eplerenone, amiloride and triamterene; ACE inhibitors such as ramipril, lisinopril, cilazapril, quinapril, captopril, enalapril, benazepril, perindopril, fosinopril and trandolapril; as well as angiotensin II receptor blockers (ARBs) such as telmisartan, candesartan, valsartan, losartan, irbesartan, olmesartan and eprosartan; heart glycosides such as digoxin and digitoxin; combined alpha/beta-blockers such as carvedilol; B-type natriuretic peptide (BNP) and BNP-derived peptides and BNP-fusion products. Particularly preferred examples are metoprolol in a dosage of 50 mg to 200 mg per day, ramipril in a dosage of 2.5 mg to 15 mg per day, valsartan in a dosage of 80 to 160 mg per day, telmisartan in a dosage of 20 mg to 320 mg or

40 mg to 160 mg per day, eplereron in a dosage of 25-100 mg, digoxin in a dosage of 0.25 mg to 0.6 mg per day carvedilol in a dosage of 3.25 mg to 100 mg, BNP (e.g. nesiritide) in a dosage of 2 µg/kg as a bolus followed by 0.01 µg/kg/min.

Drug combinations comprising the selected DPP IV inhibitors contain for example 1.75 mg to 10.5 mg glibenclamide, 500 mg to 3000 mg tolbutamide, 0.5–6 g glimepiride, 2.5 mg to 40 mg glipizide, 1-4x 30 mg gliquidone, to 3 x 25 mg glibornuride, 80 mg to 160 mg gliclazide; 500 mg to 1000 mg, preferably 500 mg, 850 mg or 1000 mg metformin; 60 mg to 180 mg nateglinide; 0.25 mg to 4 mg repaglinide; 2 mg to 45 mg thiazolidinedione; 200 mg to 600 mg metaglidases; 2.5 mg to 5 mg PPAR gamma/alpha modulators; 0.1 mg to 100 mg alpha glucosidase blocker; 1-250 IU insulin; 15 µg to 120 µg Pramlintide; 5 mg to 80 mg statin; 50 mg to 1000 mg fibrate; 1000 mg to 3000 mg nicotinic acid or derivative; about 250 mg acipimox; about 10 mg of a cholesterol resorption inhibitor; 0.5 g to 30 g of a bile acid binding substance; 10 mg to 600 mg and preferably 10 mg to 120 mg CETP inhibitor; 2.5 mg to 100 mg beta-blocker; 3 mg to 200 mg diuretic; 2.5 mg to 500 mg calcium channel blocker; 1 mg to 40 mg ACE inhibitor; 5 mg to 600 mg angiotensin II receptor blocker; 10 mg to 15 mg sibutramine; about 120 mg orlistat; 15 mg to 30 mg dexfenfluramine; or 5 mg to 20 mg cannabinoid receptor antagonist, eplerenone in a dosage of 25 mg to 100 mg; digoxin in a dosage of 0.25 mg to 0.6 mg per day; carvedilol in a dosage of 3.25 mg to 100 mg; BNP (e.g. nesiritide) in a dosage of 2 µg/kg as a bolus followed by 0.01 µg/kg/min.

EXAMPLES

Example 1: **Treatment of pre-diabetes**

The efficacy of a DPPIV inhibitor according to the invention in the treatment of pre-diabetes characterised by pathological fasting glucose and/or impaired glucose tolerance can be tested using clinical studies. In studies over a shorter period (e.g. 2-4 weeks) the success of the treatment is examined by determining the fasting glucose values and/or the glucose values after a meal or after a loading test (oral glucose tolerance test or food tolerance test after a defined meal) after the end of the period of therapy for the study and comparing them with the values before the start of the study and/or with those of a placebo group. In addition, the fructosamine value can be determined before and after therapy and compared with the initial value and/or the placebo value. A significant drop in the fasting or non-fasting glucose levels demonstrates the efficacy of the treatment. In studies over a longer period (12 weeks or more) the success of the treatment is tested by determining the HbA1c value, by comparison with the initial value and/or with the value of the placebo group. A significant change in the HbA1c value compared with the initial value and/or the placebo value demonstrates the efficacy of the DPP IV inhibitor for treating pre-diabetes.

Example 2: **Preventing manifest type 2 diabetes**

Treating patients with pathological fasting glucose and/or impaired glucose tolerance (pre-diabetes) is also in pursuit of the goal of preventing the transition to manifest type 2 diabetes. The efficacy of a treatment can be investigated in a comparative clinical study in which pre-diabetes patients are treated over a lengthy period (e.g. 1-5 years) with either an active substance or a combination of active substances or with placebo or with a non-drug therapy or other medicaments. During and at the end of the therapy, by determining the fasting glucose and/or a loading test (e.g. oGTT), a check is made to determine how many patients exhibit manifest type 2 diabetes, i.e. a fasting glucose level of >125 mg/dl and/or a 2h value according to oGTT of >199 mg/dl. A significant reduction in the number of patients who exhibit manifest type 2 diabetes when treated with active substance or a combination of active substances as compared to one of the other forms of treatment, demonstrates

the efficacy of the active substance or combination of active substances in preventing a transition from pre-diabetes to manifest diabetes.

Example 3: **Treatment of type 2 diabetes**

Treating patients with type 2 diabetes with the active substances according to the invention, in addition to producing an acute improvement in the glucose metabolic situation, prevents a deterioration in the metabolic situation in the long term. This can be observed is patients are treated for a longer period, e.g. 1-6 years, with the active substances or combinations of active substances according to the invention and are compared with patients who have been treated with other antidiabetic medicaments. There is evidence of therapeutic success compared with patients treated with other antidiabetic medicaments if no or only a slight increase in the fasting glucose and/or HbA1c value is observed. Further evidence of therapeutic success is obtained if a significantly smaller percentage of the patients treated with an active substance according to the invention or a combination of active substances according to the invention, compared with patients who have been treated with other medicaments, undergo a deterioration in the glucose metabolic position (e.g. an increase in the HbA1c value to >6.5% or >7%) to the point where treatment with an additional oral antidiabetic medicament or with insulin or with an insulin analogue or with another antidiabetic agent (e.g. GLP-1 analogue) is indicated.

Example 4: **Treatment of insulin resistance**

In clinical studies running for different lengths of time (e.g. 2 weeks to 12 months) the success of the treatment is checked using a hyperinsulinaemic euglycaemic glucose clamp study. A significant rise in the glucose infusion rate at the end of the study, compared with the initial value or compared with a placebo group, or a group given a different therapy, proves the efficacy of an active substance or combination of active substances in the treatment of insulin resistance.

Example 5: **Treatment of diabetic hyper- or dyslipidaemia**

In clinical studies running for different lengths of time (e.g. 2 weeks to 60 months) on patients with type 2 diabetes the success of the treatment is checked by determining the total cholesterol, LDL-cholesterol, HDL-cholesterol, and plasma triglycerides. A

significant fall in the total cholesterol, LDL-cholesterol, or plasma triglycerides and/or a rise in the HDL-cholesterol levels during or at the end of the study, compared with the initial value or compared with a placebo group, or a group given a different therapy, proves the efficacy of an active substance or combination of active substances in the treatment of diabetic dys- or hyperlipidaemia.

Example 6: **Treatment of hyperglycaemia**

In clinical studies running for different lengths of time (e.g. 1 day to 24 months) the success of the treatment in patients with hyperglycaemia is checked by determining the fasting glucose or non-fasting glucose (e.g. after a meal or a loading test with oGTT or a defined meal). A significant fall in these glucose values during or at the end of the study, compared with the initial value or compared with a placebo group, or a group given a different therapy, proves the efficacy of an active substance or combination of active substances in the treatment of hyperglycaemia.

Example 7: **Treatment of gestational diabetes**

In clinical studies running for a shorter period (e.g. 2-4 weeks) the success of the treatment is checked by determining the fasting glucose values and/or the glucose values after a meal or after a loading test (oral glucose tolerance test or food tolerance test after a defined meal) at the end of the therapeutic period of the study and comparing them with the values before the start of the study and/or with those of a placebo group. In addition, the fructosamine value can be determined before and after treatment and compared with the initial value and/or a placebo value. A significant fall in the fasting or non-fasting glucose levels demonstrates the efficacy of an active substance or combination of active substances.

In longer-running studies (12 weeks or more) the success of the treatment is checked by determining the HbA1c value (compared with initial value and placebo group). A significant change in the HbA1c value compared with the starting value and/or placebo value demonstrates the efficacy of an active substance or combination of active substances in the treatment of gestational diabetes.

Example 8: **Treatment of women who have had gestational diabetes**

Patients with gestational diabetes have a significantly increased risk of contracting manifest type 2 diabetes after the pregnancy. Therapy may be provided with the objective of preventing the transition to manifest type 2. For this purpose, women with a history of gestational diabetes are treated either with an active substance according to the invention or a combination of active substances according to the invention or with placebo or with a non-drug therapy or with other medicaments, over a lengthy period (e.g. 1-4 years). During and at the end of the treatment a check is carried out by determining the fasting glucose and/or by a loading test (e.g. oGTT) to see how many patients have developed manifest type 2 diabetes (fasting glucose level >125 mg/dl and/or 2h value after oGTT >199 mg/dl). A significant reduction in the number of patients who develop manifest type 2 diabetes when treated with an active substance according to the invention or a combination of active substances according to the invention, compared with a different type of therapy, is proof of the efficacy of an active substance or a combination of active substances in preventing manifest diabetes in women with a history of gestational diabetes.

Example 9: **Prevention of micro- or macrovascular complications**

The treatment of type 2 diabetes or pre-diabetes patients with an active substance according to the invention or a combination of active substances according to the invention prevents or reduces microvascular complications (e.g. diabetic neuropathy, diabetic retinopathy, diabetic nephropathy, diabetic foot, diabetic ulcer) or macrovascular complications (e.g. myocardial infarct, acute coronary syndrome, unstable angina pectoris, stable angina pectoris, stroke, peripheral arterial occlusive disease, cardiomyopathy, heart failure, heart rhythm disorders, vascular restenosis). Type 2 diabetes or patients with pre-diabetes are treated long-term, e.g. for 1-6 years, with an active substance according to the invention or a combination of active substances according to the invention and compared with patients who have been treated with other antidiabetic medicaments or with placebo. Evidence of the therapeutic success compared with patients who have been treated with other antidiabetic medicaments or with placebo can be found in the smaller number of single or multiple complications. In the case of macrovascular events, diabetic foot and/or diabetic ulcer, the numbers are counted by anamnesis and various test

methods. In the case of diabetic retinopathy the success of the treatment is determined by computer-controlled illumination and evaluation of the background to the eye or other ophthalmic methods. In the case of diabetic neuropathy, in addition to anamnesis and clinical examination, the nerve conduction rate can be measured using a calibrated tuning fork, for example. With regard to diabetic nephropathy the following parameters may be investigated before the start, during and at the end of the study: secretion of albumin, creatinin clearance, serum creatinin values, time taken for the serum creatinin values to double, time taken until dialysis becomes necessary.

Example 10: **Treatment of Metabolic Syndrome**

The efficacy of the active substances or combinations of active substances according to the invention can be tested in clinical studies with varying run times (e.g. 12 weeks to 6 years) by determining the fasting glucose or non-fasting glucose (e.g. after a meal or a loading test with oGTT or a defined meal) or the HbA1c value. A significant fall in these glucose values or HbA1c values during or at the end of the study, compared with the initial value or compared with a placebo group, or a group given a different therapy, proves the efficacy of an active substance or combination of active substances in the treatment of Metabolic Syndrome. Examples of this are a reduction in systolic and/or diastolic blood pressure, a lowering of the plasma triglycerides, a reduction in total or LDL cholesterol, an increase in HDL cholesterol or a reduction in weight, either compared with the starting value at the beginning of the study or in comparison with a group of patients treated with placebo or a different therapy.

Example 11: **DPPIV inhibitor film-coated tablets**

In order to prepare a granulating solution, copovidone is dissolved in purified water at ambient temperature. DPP IV inhibitor, mannitol, pre-gelatinised starch and maize starch are mixed in a suitable mixer in order to prepare a premix. The premix is moistened with the granulating solution and then granulated in a mixer with a high shear rate. The moist granules are screened through a screen with a mesh size of 1.6 mm. The granules are dried at about 60°C in a fluidised bed dryer until a loss in

drying value of 2-4 % is obtained. The finished mixture is compressed to form tablet cores.

In a suitable mixer, hydroxypropylmethyl-cellulose, polyethyleneglycol, talc, titanium dioxide and iron oxide are suspended in purified water at ambient temperature to prepare a suspension for the tablet coating. The tablet cores are coated with this suspension until a weight increase of 3% is obtained. For example, the following tablet compositions may be obtained in this way:

Ingredient	**mg**	**mg**	**mg**	**mg**	**mg**
DPP IV inhibitor	0.500	1.000	2.500	5.000	10.000
mannitol	67.450	66.950	65.450	130.900	125.900
pre-gelatinised starch	9.000	9.000	9.000	18.000	18.000
maize starch	9.000	9.000	9.000	18.000	18.000
copovidone	2.700	2.700	2.700	5.400	5.400
magnesium stearate	1.350	1.350	1.350	2.700	2.700
Total mass (tablet core)	**90.000**	**90.000**	**90.000**	**180.000**	**180.000**
HPMC	1.500	1.500	1.500	2.500	2.500
PEG	0.150	0.150	0.150	0.250	0.250
titanium dioxide	0.750	0.750	0.750	1.250	1.250
talc	0.525	0.525	0.525	0.875	0.875
iron oxide, yellow	0.075	0.075	0.075	0.125	0.125
Total mass (film-coated tablet)	**93.000**	**93.000**	**93.000**	**185.000**	**185.000**

Example 12: **Enhancing the vitality and secretion capacity of islets of Langerhans or beta cells**

This is done after successful isolation of the islets of Langerhans or pancreatic beta cells, by storing them, transporting them or cultivating them in a medium which contains DPP IV inhibitors in a concentration of 1 nmol/l to 1 µmol/l, preferably in a concentration of 1 nmol/l and 100 nmol/l, for future transplantation.
In addition, after transplantation with islets of Langerhans or pancreatic beta cells, the patients (and these may also be animals) are treated with DPP IV inhibitors in a daily dosage of between 1 mg and 200 mg, preferably with a dose of 5 mg and 100 mg of a DPP IV inhibitor, in order to enhance the vitality and secretion capacity of the transplant. This is tested either by analysis of the insulin secretion after stimulation with glucose or another agent that increases insulin secretion. Moreover, the improvement in the quality may also be checked in vitro or in animal models using the TUNEL technique, which is described in Diabetologia 42:566, 1999 or Diabetes 48:738, 1999 (investigation of apoptosis and inhibition thereof).

Example 13: **Combined treatment with DPP IV inhibitor - metformin**

For treating type 2 diabetes or pre-diabetes a DPP IV inhibitor according to the invention may be combined with the anti-diabetically active substance metformin, either in a free combination or in a fixed combination in a tablet. A therapeutically effective dose of the DPP IV inhibitor (e.g. a dose of between 0.1 and 100 mg) may be combined with different doses of metformin, e.g. with 500 mg, 850 mg or 1000 mg metformin as a single dose with a total daily dose of metformin of 500 – 2850 mg, or with 500 mg, 1000 mg, 1500 mg, or 2000 mg metformin in delayed-release form. The clinical efficacy of such a combination with metformin can be tested in a clinical study. For this, patients with type 2 diabetes or with pre-diabetes are treated either with a DPP IV inhibitor on its own or with metformin on its own or with a combination von DPP IV inhibitor and metformin. The treatment lasts between 2 weeks and 6 years. Evidence that the combination is appropriate and effective can be found in the fact that the combination of a DPP-IV inhibitor with metformin leads to a significantly

greater reduction in the fasting glucose and/or non-fasting glucose and/or the HbA1c value than either the DPP IV inhibitor alone or metformin alone.

Example 14: **Combined treatment with DPP IV inhibitor - glitazone**

For treating type 2 diabetes or pre-diabetes a DPP IV inhibitor according to the invention may be combined with the anti-diabetically active substance group comprising the glitazones or thiazolidinediones (e.g. pioglitazone or rosiglitazone), either in a free combination or in a fixed combination in a tablet. A therapeutically effective dose of the DPP IV inhibitor (e.g. a dose of between 0.1 and 100 mg) may be combined with different doses of pioglitazone (15 mg, 30 mg, or 45 mg) or rosiglitazone (2 mg, 4 mg or 8 mg, given either once or twice a day). The clinical efficacy of such a combination with rosiglitazone or pioglitazone can be tested in a clinical study. For this, patients with type 2 diabetes or with pre-diabetes are treated either with a DPP IV inhibitor on its own or with rosiglitazone or pioglitazone alone or with a combination of DPP IV inhibitor and rosiglitazone or pioglitazone. The treatment lasts between 2 weeks and 6 years. Evidence that the combination is appropriate and effective can be found in the fact that the combination of a DPP-IV inhibitor with rosiglitazone or pioglitazone leads to a significantly greater reduction in the fasting glucose and/or non-fasting glucose and/or the HbA1c value than either the DPP IV inhibitor alone or rosiglitazone or pioglitazone alone.

Example 15: **Combined treatment with DPP IV inhibitor – SGLT2 inhibitor**

For treating type 2 diabetes or pre-diabetes a DPP IV inhibitor according to the invention may be combined with the anti-diabetically active substance group comprising the SGLT-2 inhibitors, either in a free combination or in a fixed combination in a tablet. A therapeutically effective dose of the DPP IV inhibitor (e.g. A dose of between 0.1 and 100 mg) may be combined with different doses of SGLT-2 inhibitor (0.5 mg to 1000 mg). The clinical efficacy of such a combination with SGLT-2 inhibitor can be tested in a clinical study. For this, patients with type 2 diabetes or with pre-diabetes are treated either with a DPP IV inhibitor on its own or with a SGLT-2 inhibitor on its own or with a combination of DPP IV inhibitor and SGLT-2 inhibitor. The treatment lasts between 2 weeks and 6 years. Evidence that

the combination is appropriate and effective can be found in the fact that the combination of a DPP-IV inhibitor with the SGLT-2 inhibitor leads to a significantly greater reduction in the fasting glucose and/or non-fasting glucose and/or the HbA1c value than either the DPP IV inhibitor alone or the SGLT-2 inhibitor alone.

Example 16: **Combined treatment with DPP IV inhibitor – antihypertensive**

For treating a patient with type 2 diabetes or pre-diabetes or with Metabolic Syndrome a DPP IV inhibitor according to the invention may be combined with an anti-hypertensively active substance, either in a free combination or in a fixed combination in a tablet. A therapeutically effective dose of the DPP IV inhibitor (e.g. a dose of between 0.1 and 100 mg) may be combined with different doses of ACE-inhibitors (e.g. 2.5 mg to 15 mg ramipril), AT1- receptor-antagonists (e.g. 20 mg to 160 mg telmisartan), beta-blockers (e.g. 50 mg to 200 mg metoprolol), or diuretics (e.g. 12.5 mg to 25 mg hydrochlorothiazide). The clinical efficacy of such a combination with antihypertensives can be tested in a clinical study. For this, patients with type 2 diabetes or with pre-diabetes or with Metabolic Syndrome are treated either with a DPP IV inhibitor on its own or with an antihypertensive on its own or with a combination of DPP IV inhibitor and antihypertensive. The treatment lasts between 2 weeks and 6 years. Evidence that the combination is appropriate and effective can be found in the fact that the combination of a DPP-IV inhibitor with the antihypertensive lowers the fasting glucose and/or non-fasting glucose and/or the HbA1c value at least as much as the DPP IV inhibitor alone, and if the combination of the DPP-IV inhibitor with the antihypertensive lowers the systolic and/or diastolic arterial blood pressure at least as much as the antihypertensive alone.

Example 17: **Combined treatment with DPP IV inhibitor – lipid lowering agent**

For treating a patient with type 2 diabetes or pre-diabetes or with Metabolic Syndrome or with diabetic dys- or hyperlipidaemia, a DPP IV inhibitor according to the invention may be combined with a lipid lowering agent / HDL-raising agent, either in a free combination or in a fixed combination in a tablet. A therapeutically effective dose of the DPP IV inhibitor (e.g. a dose of between 0.1 and 100 mg) may be combined with different doses of statins (e.g. 10 mg to 80 mg atorvastatin or 10 mg to 80 mg simvastatin), fibrates (e.g. fenofibrate), cholesterol absorption inhibitors, or

with HDL-raising substances such as CETP-inhibitors (e.g. Torcetrapib 10 mg to 120 mg once a day or 120 mg twice a day). The clinical efficacy of such a combination with lipid lowering agents / HDL-raising agents can be tested in a clinical study. For this, patients with type 2 diabetes or with pre-diabetes or with Metabolic Syndrome or with diabetic dys- or hyperlipidaemia are treated either with a DPP IV inhibitor on its own or with a lipid lowering agent / HDL-raising agent on its own or with a combination of DPP IV inhibitor and lipid lowering agent / HDL-raising agent. The treatment lasts between 2 weeks and 6 years. Evidence that the combination is appropriate and effective can be found in the fact that the combination of the DPP-IV inhibitor with the lipid lowering agent / HDL-raising agent lowers the fasting glucose and/or non-fasting glucose and/or the HbA1c value at least as much as the DPP IV inhibitor alone, and if the combination of the DPP-IV inhibitor with a lipid lowering agent / HDL-raising agent lowers the total cholesterol or LDL-cholesterol or plasma triglycerides at least as much or increases the HDL-cholesterol value at least as much as the lipid lowering agent / HDL-raising agent alone.

Example 18: **Combined treatment of DPP IV inhibitor – BNP / BNP-derived peptides or BNP-fusion peptides in patients with heart failure**

For treating a patient with acute heart failure, a DPP IV inhibitor according to the invention may be combined with a substance that favourably affects heart failure, either in a free combination or in a fixed combination in a tablet. A therapeutically effective dose of the DPP IV inhibitor (e.g. a dose of between 0.1 and 100 mg) may be combined with different doses of ACE-inhibitors (e.g. 2.5 mg to 15 mg ramipril), AT1- receptor-antagonists (e.g. 20 mg to 160 mg telmisartan), beta-blockers (e.g. 50 mg to 200 mg metoprolol), combined alpha/beta-blockers (e.g. 3.25 mg to 100 mg carvedilol), diuretics (e.g. 12.5 mg to 25 mg hydrochlorothiazide), mineralocorticoid receptor antagonists (e.g. 25 mg to 100 mg eplerenone; and/or B-type natriuretic peptide (BNP) (e.g. 2 µg/kg as a bolus followed by 0.01 µg/kg/min nesiritide), a BNP - derived peptide or a BNP-fusion product. The combination of BNP and DPP-IV inhibitor leads to a higher concentration of full length BNP (1-32) in vivo. The clinical efficacy of the combinations specified can be tested in clinical studies. The treatment lasts between 1 day and 6 years. Evidence that the combination is effective in treating acute heart failure can be found in the fact that compared with other therapies the combination leads to a significant improvement in the clinical situation

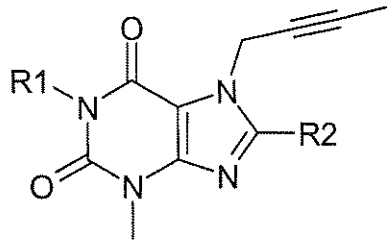
(higher cardiac ejection output and/or reversal of pulmonary congestion, and/or reversal of pulmonary wedge pressure, and/or a reduction in mortality caused by acute heart failure).

Example 19: **Treatment with DPP-IV inhibitor in patients with heart failure**

A DPP IV inhibitor according to the invention may be used to treat a patient with chronic heart failure. This treatment leads to a higher concentration of endogenous full length BNP (1-32) in vivo. The clinical efficacy of this treatment is tested in clinical studies. The treatment lasts between 2 weeks and 6 years. Evidence that the combination is effective in treating chronic heart failure can be found in the fact that a DPP-IV inhibitor according to the invention leads to a significant improvement in the clinical situation compared with a different treatment or placebo (less frequent hospitalisation due to acute heart failure, the ability to walk longer distances, a higher loadability in ergometrics, a higher cardiac ejection output and/or reversal of pulmonary congestion, and/or a reduction in mortality caused by heart failure).

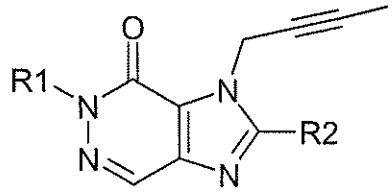
CLAIMS:

1. Use of a DPP IV inhibitor of formula (I)



(I)

or of formula (II)



(II)

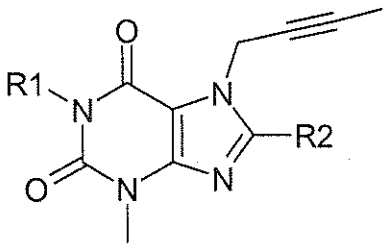
and one of the salts thereof, characterised in that

R1 denotes ([1,5]naphthyridin-2-yl)methyl, (quinazolin-2-yl)methyl], (quinoxalin-6-yl)methyl, (4-methyl-quinazolin-2-yl)methyl, 2-cyano-benzyl, (3-cyano-quinolin-2-yl)methyl, (3-cyano-pyridin-2-yl)methyl, (4-methyl-pyrimidin-2-yl)methyl, or (4,6-dimethyl-pyrimidin-2-yl)methyl and

R2 denotes 3-(R)-amino-piperidin-1-yl, (2-amino-2-methyl-propyl)-methylamino or (2-(S)-amino-propyl)-methylamino,

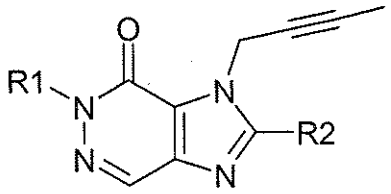
for preparing a medicament for the therapeutic treatment of a patient who has been diagnosed with a physiological functional disorder selected from among pre-diabetes, glucose intolerance, pathological fasting glucose, diabetic foot, diabetes-associated ulcer, diabetic hyperlipidaemia, diabetic dyslipidaemia, newly diagnosed type 1 diabetes, gestational diabetes, hyperglycaemia, adrenergic postprandial syndrome and heart failure, or for the therapeutic treatment of a patient with transplanted islets of Langerhans or beta cells.

2. Use of a DPP IV inhibitor of formula (I)



(I)

or of formula (II)



(II)

and one of the salts thereof, characterised in that

R1 denotes ([1,5]naphthyridin-2-yl)methyl, (quinazolin-2-yl)methyl, (quinoxalin-6-yl)methyl, (4-methyl-quinazolin-2-yl)methyl, 2-cyano-benzyl, (3-cyano-quinolin-2-yl)methyl, (3-cyano-pyridin-2-yl)methyl, (4-methyl-pyrimidin-2-yl)methyl, or (4,6-dimethyl-pyrimidin-2-yl)methyl and
R2 denotes 3-(*R*)-amino-piperidin-1-yl, (2-amino-2-methyl-propyl)-methylamino or (2-(S)-amino-propyl)-methylamino.

for preparing a medicament for the treatment of patients who have been diagnosed with pre-diabetes or manifest type 2 diabetes, characterised in that by using the pharmaceutical composition the risk of impaired glucose metabolism despite treatment, an elevated HbA1c value despite treatment, an impaired fasting glucose value despite treatment, the need for insulin treatment, manifest type 2 diabetes, a diabetic foot, a diabetes-associated ulcer, diabetic hyperlipidaemia, diabetic dyslipidaemia or a macrovascular complication is reduced.

3. Use according to claim 2, characterised in that the macrovascular complication is selected from among myocardial infarct, acute coronary syndrome, unstable angina pectoris, stable angina pectoris, haemorrhagic or ischaemic stroke,

peripheral arterial occlusive disease, cardiomyopathy, left heart insufficiency, right heart insufficiency, global heart failure, heart rhythm disorders and vascular restenosis.

4. Use according to claim 1, characterised in that the pharmaceutical composition is used for the therapeutic treatment of a patient in whom pre-diabetes, glucose intolerance or pathological fasting glucose has been diagnosed.

5. Use according to claim 1, characterised in that the pharmaceutical composition is used for the therapeutic treatment of a patient in whom diabetic hyperlipidaemia or diabetic dyslipidaemia has been diagnosed.

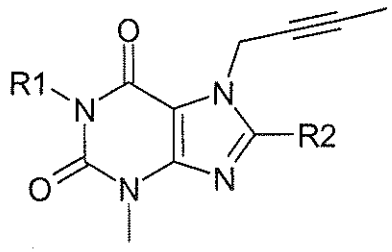
6. Use according to claim 1, characterised in that the pharmaceutical composition is used for the therapeutic treatment of a gestational diabetes.

7. Use according to claim 1, characterised in that the pharmaceutical composition is used for the therapeutic treatment of a hyperglycaemia or an adrenergic postprandial syndrome.

8. Use according to claim 1, characterised in that pharmaceutical composition is used for the therapeutic treatment of heart failure.

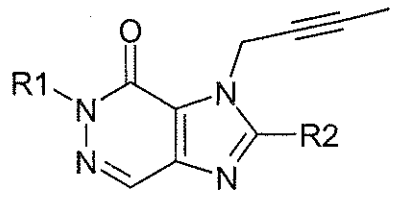
9. Use according to claim 2, characterised in that by using the pharmaceutical composition the risk of a further rise in the HbA1c value, a deterioration in the fasting glucose and the need for insulin treatment is reduced.

10. Use of a DPP IV inhibitor of formula (I)



(I)

or of formula (II)



(II)

and one of the salts thereof, characterised in that
R1 denotes ([1,5]naphthyridin-2-yl)methyl, (quinazolin-2-yl)methyl, (quinoxalin-6-yl)methyl, (4-methyl-quinazolin-2-yl)methyl, 2-cyano-benzyl, (3-cyano-quinolin-2-yl)methyl, (3-cyano-pyridin-2-yl)methyl, (4-methyl-pyrimidin-2-yl)methyl, or (4,6-dimethyl-pyrimidin-2-yl)methyl and
R2 denotes 3-(*R*)-amino-piperidin-1-yl, (2-amino-2-methyl-propyl)-methylamino or (2-(S)-amino-propyl)-methylamino,

for preparing a medicament combination with an active substance selected from among the other antidiabetics; active substances that lower the blood sugar level; active substances that lower the lipid level in the blood; active substances that raise the HDL level in the blood; active substances that lower blood pressure; and active substances that are indicated in the treatment of atherosclerosis or obesity.

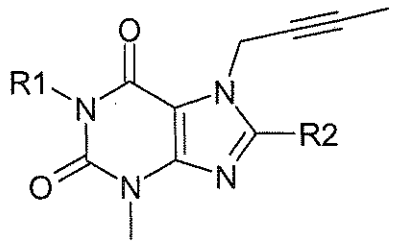
11. Use according to claim 10, characterised in that a medicament combination of a DPP IV inhibitors with another antidiabetic or a blood pressure-lowering active substance is prepared.

12. Use according to claim 10, characterised in that a medicament combination of a DPP IV inhibitor with metformin, miglitol, atorvastatin, valsartan or telmisartan is prepared.

13. Use according to claim 10, characterised in that the medicament combination is used for the therapeutic treatment of a patient in whom a physiological functional disorder has been diagnosed, selected from among pre-diabetes, glucose intolerance, pathological fasting glucose, diabetic foot, diabetes-associated ulcer, diabetic hyperlipidaemia, diabetic dyslipidaemia, newly diagnosed type 1 diabetes, gestational diabetes, heart failure, hyperglycaemia and adrenergic postprandial syndrome.

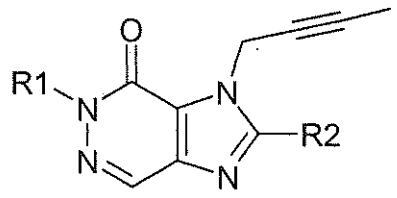
14. Isolation or storage medium for islets of Langerhans or beta cells, characterised in that the medium contains 1 nmol/l to 1 µmol/l of a DPP IV inhibitor for enhancing the vitality and secretion capacity of the cells.

15. Medium according to claim 14, characterised in that the structure of the DPP IV inhibitor is described by the formula (I)



(I)

or the formula (II)



(II)

and one of the salts thereof, characterised in that

R1 denotes ([1,5]naphthyridin-2-yl)methyl, (quinazolin-2-yl)methyl, (quinoxalin-6-yl)methyl, (4-methyl-quinazolin-2-yl)methyl, 2-cyano-benzyl, (3-cyano-

quinolin-2-yl)methyl, (3-cyano-pyridin-2-yl)methyl, (4-methyl-pyrimidin-2-yl)methyl, or (4,6-dimethyl-pyrimidin-2-yl)methyl and
R2 denotes 3-(*R*)-amino-piperidin-1-yl, (2-amino-2-methyl-propyl)-methylamino or (2-(S)-amino-propyl)-methylamino.

15. Method of enhancing the vitality and secretion capacity of islets of Langerhans or beta cells, characterised in that during the isolation and transplantation phase of the islets of Langerhans or beta cells a DPP IV inhibitor is added to the isolation and storage medium in a concentration of between 1 nmol/l and 1 µmol/l.

16. Method of treating a patient with a DPP IV inhibitor, characterised in that the patient has been diagnosed with a physiological functional disorder selected from among pre-diabetes, glucose intolerance, pathological fasting glucose, diabetic foot, diabetes-associated ulcer, diabetic hyperlipidaemia, diabetic dyslipidaemia, newly diagnosed type 1 diabetes, gestational diabetes, heart failure, hyperglycaemia and adrenergic postprandial syndrome, or of treating a patient with transplanted islets of Langerhans or beta cells.

17. Method of treating a pre-diabetes or type 2 diabetes patient with a DPP IV inhibitor, characterised in that the treatment reduces the risk of impaired glucose metabolism despite treatment, an elevated HbA1c value despite treatment, an impaired fasting glucose value despite treatment, the need for insulin treatment, manifest type 2 diabetes, a diabetic foot, a diabetes-associated ulcer, diabetic hyperlipidaemia, diabetic dyslipidaemia or a macrovascular complication.

18. Method of treating a patient with a DPP IV inhibitor, characterised in that the patient is suffering from heart failure.