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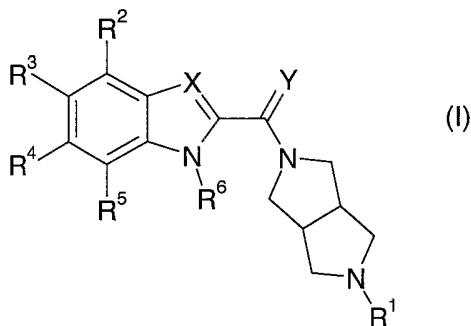
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(54) Title: OCTAHYDROPYRROLO[3,4-C]PYRROLE DERIVATIVES



(57) Abstract: The present invention relates to octahydropyrrolo[3,4-c]pyrrole derivatives of formula (I): and to processes for the preparation thereof, compositions containing the same and the uses thereof.

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**OCTAHYDROPYRROLO[3,4-c]PYRROLE DERIVATIVES**

This invention relates to octahydropyrrolo[3,4-c]pyrrole derivatives and to processes for the preparation  
5 of, compositions containing and the uses of, such derivatives.

The octahydropyrrolo[3,4-c]pyrrole derivatives of the present invention are histamine H<sub>4</sub> receptor ligands  
and have therefore a number of therapeutic applications, particularly in the treatment of asthma and  
allergic rhinitis.

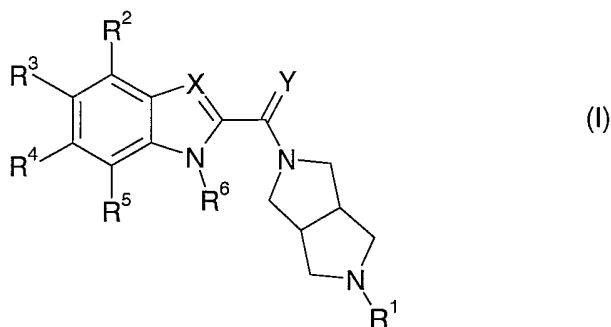
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The histamine H<sub>4</sub> receptor is a 390 amino-acid, seven-transmembrane G protein coupled receptor with  
approximately 40 % homology to the histamine H<sub>3</sub> receptor. In contrast to the H<sub>3</sub> receptor, which is  
primarily located in the brain, the H<sub>4</sub> receptor is expressed at greater levels in eosinophils and mast cells,  
among other inflammatory cells. H<sub>4</sub> receptor ligands should thus be suitable for the treatment of various  
15 inflammatory disorders. Examples of diseases where treatment with H<sub>4</sub> ligands is particularly appropriate  
are inflammatory bowel disease, Crohn's disease, colitis ulcerosa, dermatitis, psoriasis, conjunctivitis,  
rheumatoid arthritis, respiratory diseases such as adult respiratory distress syndrome, acute respiratory  
distress syndrome, bronchitis, chronic bronchitis, chronic obstructive pulmonary disease, cystic fibrosis,  
asthma, emphysema, rhinitis, chronic sinusitis, allergy, allergy-induced airway responses, allergic rhinitis,  
20 viral rhinitis, non-allergic rhinitis, perennial and seasonal rhinitis, nasal congestion and allergic  
congestion.

Recently some histamine H<sub>4</sub> receptor ligands have been developed. An overview of the current advance  
in H<sub>4</sub> ligand research and patenting is given in *Expert Opin. Ther. Patents* (2003) **13**(6). Examples of  
25 Histamine H<sub>4</sub> receptor ligands can be found in WO 02/07548, WO 04/022537 and in Terzioglu et al., *J.*  
*Bioorg. Med. Chem. Lett.* **14** (2004), 5251-5256.

Although H<sub>4</sub> ligands are known there is still a need to further provide new H<sub>4</sub> ligands that are good drug  
candidates. In particular, preferred compounds should bind potently to the histamine H<sub>4</sub> receptor whilst  
30 showing little affinity for other receptors. They should be well absorbed from the gastrointestinal tract, be  
metabolically stable and possess favourable pharmacokinetic properties. They should be non-toxic and  
demonstrate few side-effects.

The present invention thus relates to octahydropyrrolo[3,4-c]pyrrole derivatives of formula (I):



or pharmaceutically acceptable salts and solvates thereof, wherein:

- R<sup>1</sup> is H or (C<sub>1</sub>-C<sub>4</sub>) alkyl optionally substituted with a hydroxy;
- X is N or C-R<sup>9</sup> wherein R<sup>9</sup> is H or methyl;
- Y is O or NH;
- R<sup>6</sup> is H or methyl; and
- R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are independently selected from H, halo, cyano, (C<sub>1</sub>-C<sub>4</sub>)alkyl, (C<sub>1</sub>-C<sub>4</sub>)alkoxy, trifluoromethyl, trifluoromethoxy, hydroxy, (CH<sub>2</sub>)<sub>n</sub>-C(O)O-R<sup>7</sup>, (CH<sub>2</sub>)<sub>n</sub>-O-(CH<sub>2</sub>)<sub>m</sub>-R<sup>8</sup> and (CH<sub>2</sub>)<sub>n</sub>-R<sup>8</sup>, wherein n and m are both independently 0 or 1, R<sup>7</sup> is H or (C<sub>1</sub>-C<sub>4</sub>)alkyl and R<sup>8</sup> is phenyl.

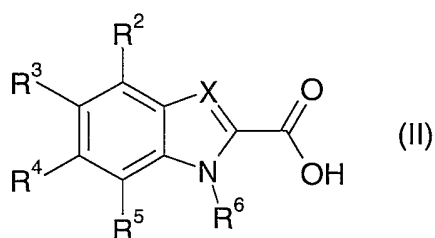
It has been demonstrated that these compounds are ligands of the Histamine H<sub>4</sub> receptor.

In the here above formula "halo" denotes a halogen atom selected from the group consisting of fluoro, chloro, bromo and iodo, in particular fluoro or chloro.

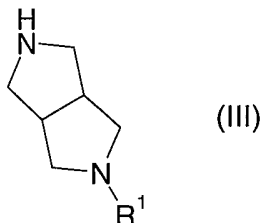
- (C<sub>1</sub>-C<sub>4</sub>)alkyl radicals denote a straight-chain or branched group containing 1, 2, 3 or 4 carbon atoms. This also applies if they carry substituents such as a hydroxy substituent or occur as substituents of other radicals, for example in (C<sub>1</sub>-C<sub>4</sub>)alkoxy radicals. Examples of suitable (C<sub>1</sub>-C<sub>4</sub>)alkyl radicals are methyl, ethyl, *n*-propyl, *iso*-propyl, *n*-butyl, *iso*-butyl, *sec*-butyl and *tert*-butyl. Examples of suitable (C<sub>1</sub>-C<sub>4</sub>)alkoxy radicals are methoxy, ethoxy, *n*-propyloxy, *iso*-propyloxy, *n*-butyloxy, *iso*-butyloxy, *sec*-butyloxy and *tert*-butyloxy. Examples of suitable (C<sub>1</sub>-C<sub>4</sub>)alkyl radicals substituted by a hydroxy radical are hydroxymethyl, 1-hydroxyethyl, 2-hydroxyethyl, 1-hydroxypropyl, 2-hydroxypropyl, 3-hydroxypropyl etc.

The Compounds of the general formula (I) according to the present invention may be prepared using conventional procedures such as by the following illustrative methods in which R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup>, X and Y are as previously defined unless otherwise stated.

The compound of formula (I) where Y is O may be prepared by coupling an acid of formula (II) :



with an amine of formula (III):



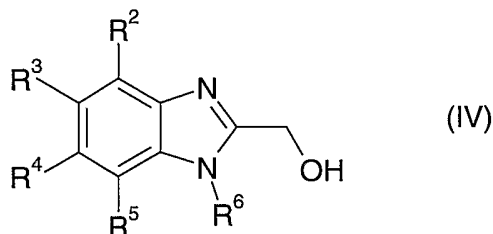
wherein  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$ ,  $R^5$ ,  $R^6$  and X are as previously defined.

- 5 The coupling of the acid (II) to the amine (III) is generally carried out in an excess of said amine, with a conventional coupling agent (e.g. 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride, O-benzotriazo-1-yl-*N,N,N'*-tetramethyluronium hexafluorophosphate or *N,N'*-dicyclohexylcarbodiimide), optionally in the presence of a catalyst (e.g. 1-hydroxybenzotriazole hydrate or 1-hydroxy-7-azabenzotriazole), and optionally in the presence of a tertiary amine base (e.g. *N*-methylmorpholine, triethylamine or *N,N*-diisopropylethylamine). The reaction may be undertaken in a suitable solvent such as pyridine, *N,N*-dimethylformamide, tetrahydrofuran, dimethylsulfoxide, dichloromethane or ethyl acetate, and at temperature comprised between 10°C and 40°C (room temperature). Preferably, the coupling is carried out using an excess of the amine (1.2-1.5 equivalents), with O-benzotriazo-1-yl-*N,N,N'*-tetramethyluronium hexafluorophosphate as the coupling agent. The reaction is also preferably undertaken using *N,N*-dimethylformamide as solvent.
- 10
- 15

The amine of formula (III) may be prepared as described in the literature (*J. Heterocyclic. Chem* 1983, **20**, 321).

- 20 The acids of formula (II) where X is C- $R^9$ , wherein  $R^9$  is as previously defined, are either commercially available or may be prepared according to well-known methods described in the literature.

The acids of formula (II) where X is N may be prepared by oxidation of an alcohol of formula (IV) :



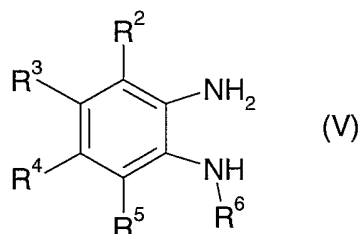
- 25 wherein  $R^2$ ,  $R^3$ ,  $R^4$ ,  $R^5$  and  $R^6$  are as previously defined.

The oxidation is generally carried out using a conventional oxidising agent (e.g. potassium permanganate) optionally in the presence of a base (e.g. NaOH) in a suitable solvent (e.g. water) at a temperature comprised between 40°C and 100°C.

- 30 Preferably the oxidation is carried out using potassium permanganate in the presence of sodium hydroxide using water as solvent with a reaction temperature of 100°C for 1 hour and 30 minutes.

4

The alcohol of formula (IV) may be prepared by condensation of an aniline of formula (V) with glycolic acid :



5 wherein R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup> are as previously defined.

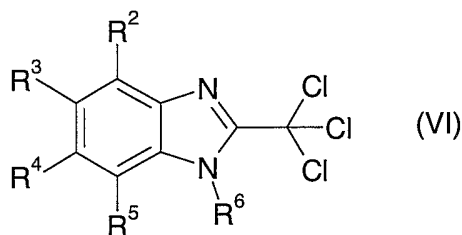
The condensation is generally carried out in the presence of an acid catalyst (e.g. HCl) in a suitable solvent (e.g. water) at a temperature comprised between 40°C and 100°C.

10 Preferably the condensation is carried out using 6N aqueous hydrochloric acid as solvent at a temperature of 100°C with a reaction time of 16 hours.

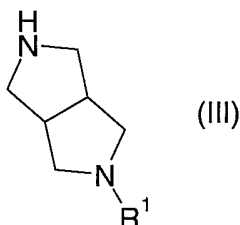
The aniline of formula (V) is either commercially available or may be prepared by conventional methods well known to the one skilled in the art (e.g. nitration, reduction, alkylation, chlorination) from commercially available material as detailed in the experimental section.

15

Alternatively the compound of formula (I) where X is N and Y is O may be prepared by coupling a trichloromethylbenzimidazole of formula (VI):



with an amine of formula (III) :



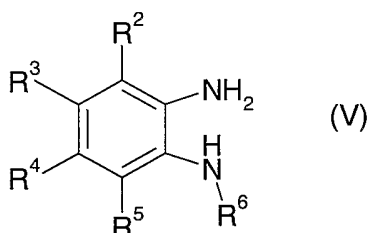
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wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup> are as previously defined.

The coupling is generally carried out with an excess of the amine (III), optionally in the presence of a base (e.g. triethylamine, N,N-diethylisopropylamine, potassium carbonate) in a suitable aqueous solvent or

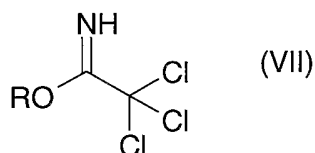
mixture of solvents (e.g. acetonitrile, tetrahydrofuran, water) at a temperature comprised between 10°C and 40°C (room temperature).

The compound of formula (VI) may be prepared by condensation of an aniline of formula (V):



5

with a trichloroacetimidate ester of formula (VII):



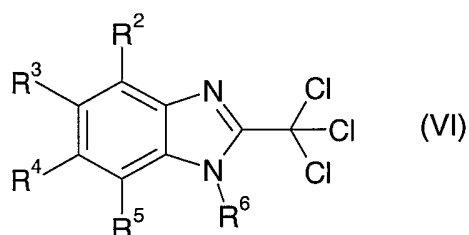
wherein R is methyl or ethyl and R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup> are as previously defined.

- 10 The coupling is generally carried out with an excess of the acetimidate in a suitable solvent (e.g. AcOH) at a temperature comprised between 10°C and 40°C (room temperature).

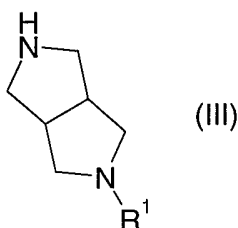
The aniline of formula (V) is prepared as described previously and the trichloroacetimidate of formula (VII) is commercially available.

15

The compound of formula (I) where Y is NH and X is N may be prepared by condensing a trichloromethylbenzimidazole of formula (VI):



with a source of ammonia and an amine of formula (III):



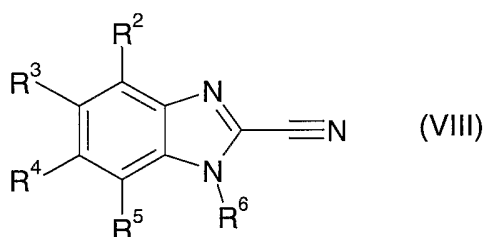
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wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup> are as previously defined.

The condensation is generally carried out with equimolar amounts of the amine (III) and the source of ammonia (e.g. ammonia in dioxan, ammonium acetate), optionally in the presence of a base (e.g. triethylamine, N,N-diisopropylethylamine, potassium carbonate) in a suitable solvent (e.g. acetonitrile, tetrahydrofuran) at a temperature comprised between 10°C and 40°C (room temperature).

- 5 Preferably the amine of formula (III) is allowed to react with the trichloromethylbenzimidazole (VI) for a period of 0.5 to 2 hours prior to the addition of the ammonia equivalent.

Alternatively, the compound of formula (I) where X is N and Y is NH may be prepared by reaction of an amine of formula (III) with a nitrile of formula (VIII):



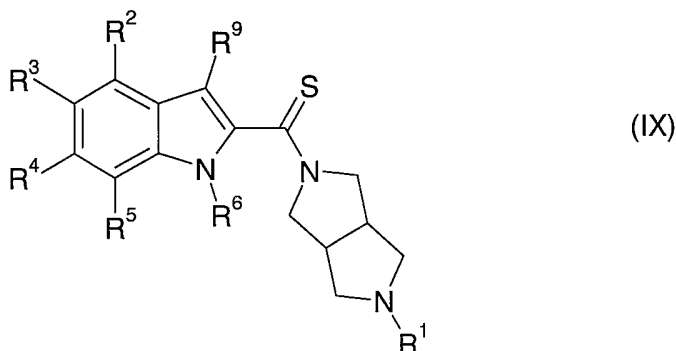
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wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup> are as previously defined.

- The reaction is generally carried out with an excess of the amine (III) in a suitable solvent (isopropanol, methanol, tetrahydrofuran) and a temperature comprised between 60°C and 85°C (reflux temperature of solvent). Preferably the reaction is carried out with 1.2 equivalents of the amine in isopropanol at reflux for a period of 3 hours.

- The nitrile of formula (VIII) may be prepared by reacting the trichloromethylbenzimidazole of formula (VI) with aqueous ammonia followed by treatment with aqueous acid. The reaction is generally carried out with an excess of aqueous ammonia in a suitable solvent (e.g. ethanol, tetrahydrofuran) at a temperature comprised between -7°C and 0°C for a period of 0.5-2 hours. The resulting intermediate is then treated with aqueous hydrochloric acid at a temperature comprised between 0°C and 5°C. Preferably the reaction is carried out using tetrahydrofuran as solvent.

- 25 The compound of formula (I) where X is CR<sup>9</sup> and Y is NH may be prepared by condensation of a thioamide of formula (IX) :



with ammonia or an ammonia equivalent  
wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup> are as previously defined.

The condensation is generally carried out in the presence of an activating agent (e.g. methyl iodide,  
5 mercuric acetate) with an excess of ammonia in a suitable solvent (acetonitrile, tetrahydrofuran) at a  
temperature between -78°C and 50°.

The thioamide of formula (IX) may be prepared from an amide of formula (I) where X is CR<sup>9</sup> and Y is O.

10 The conversion is generally carried out using an excess of Lawesson's reagent (2,4-bis(4-  
methoxyphenyl)-1,3-dithia-2,4-diphosphetane-2,4-disulfide) in suitable solvent (toluene, tetrahydrofuran)  
at a temperature comprised between 50°C and 110°C

All of the above reactions and the preparations of starting materials used in the preceding methods are  
15 conventional and appropriate reagents and reaction conditions for their performance or preparation as  
well as procedures for isolating the desired products will be well-known to those skilled in the art with  
reference to literature precedents and the examples and preparations described below.

For some of the steps of the here above described process of preparation of the compounds of formula  
20 (I), it can be necessary to protect the potential reactive functions that are not wished to react, and to  
cleave said protecting groups in consequence. In such a case, any compatible protecting radical can be  
used. In particular methods of protection and deprotection such as those described by T.W. GREENE  
(*Protective Groups in Organic Synthesis*, A. Wiley-Interscience Publication, 1981) or by P. J. Kocienski  
(*Protecting groups*, Georg Thieme Verlag, 1994), can be used.

25

According to the present invention, the preferred compounds are those of formula (I) wherein:

- R<sup>1</sup> is H or methyl, preferably methyl; and/or
- R<sup>6</sup> is H; and/or
- X is N or CH; and/or
- 30 - R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are independently selected from H, halo, methyl, hydroxy, phenyl, and COOH,  
preferably from H, fluoro, chloro, bromo, methyl, hydroxy, phenyl, and COOH and more  
preferably from H, fluoro, chloro, bromo, hydroxy and methyl.

According to a further aspect, the compounds of formula (I) wherein R<sup>1</sup> is H or methyl and R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and  
35 R<sup>5</sup> are independently selected from H, halo, methyl, hydroxy, phenyl, and COOH are preferred.

According to a further aspect, the compounds of formula (I) wherein R<sup>1</sup> is methyl, R<sup>6</sup> is H, X is N or CH  
and R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are independently selected from H, fluoro, chloro, bromo, hydroxy and methyl are  
more preferred.

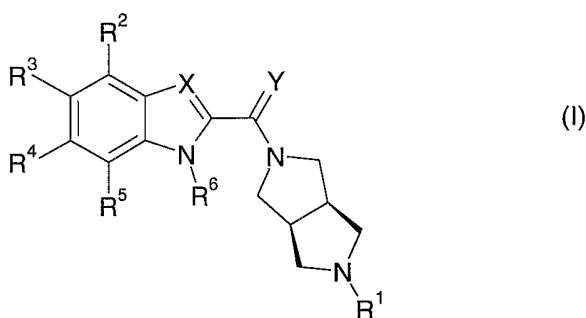
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According to a further aspect, the compounds of formula (I) wherein Y is NH, R<sup>1</sup> is methyl, R<sup>6</sup> is H, X is N or CH and R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are independently selected from H, fluoro, chloro, bromo, hydroxy and methyl are most preferred.

- 5 According to another aspect, the compounds of formula (I) as here above described, wherein at least two of R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are H are preferred.

According to another preferred aspect, the compounds of formula (I) as here above described have the *cis* configuration, i.e. the (3*aR*,6*aS*) configuration as follows:



10

wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup>, X and Y are as defined above.

- More preferred compounds are those selected from the examples 1 to 68 and 6-bromo-4-methyl-2-  
 15 {[(3*aR*,6*aS*)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl}-1H-benzimidazole and 6-fluoro-4-methyl-2-  
 {[(3*aR*,6*aS*)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl}-1H-benzimidazole.

Most preferred compounds are those selected from the compounds of examples 1, 3, 7, 15, 16, 17, 21, 22, 25, 26, 27, 41, 48, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67 and 68.

- 20 Pharmaceutically acceptable salts of the compounds of formula (I) include the acid addition and base salts thereof.

Suitable acid addition salts are formed from acids which form non-toxic salts. Examples include the acetate, aspartate, benzoate, besylate, bicarbonate/carbonate, bisulphate/sulphate, borate, camsylate, citrate, edisylate, esylate, formate, fumarate, gluceptate, gluconate, glucuronate, hexafluorophosphate, hibenzoate, hydrochloride/chloride, hydrobromide/bromide, hydroiodide/iodide, isethionate, lactate, malate, maleate, malonate, mesylate, methylsulphate, naphthylate, 2-napsylate, nicotinate, nitrate, orotate, oxalate, palmitate, pamoate, phosphate/hydrogen phosphate/dihydrogen phosphate, saccharate, stearate, succinate, tartrate, tosylate and trifluoroacetate salts.

30

Suitable base salts are formed from bases which form non-toxic salts. Examples include the aluminium, arginine, benzathine, calcium, choline, diethylamine, diolamine, glycine, lysine, magnesium, meglumine, olamine, potassium, sodium, tromethamine and zinc salts.

Hemisalts of acids and bases may also be formed, for example, hemisulphate and hemicalcium salts.

For a review on suitable salts, see Handbook of Pharmaceutical Salts: Properties, Selection, and Use by Stahl and Wermuth (Wiley-VCH, Weinheim, Germany, 2002).

5

Pharmaceutically acceptable salts of the compounds of formula (I) may be prepared by one or more of three methods:

(i) by reacting the compound of formula (I) with the desired acid or base;

10 (ii) by removing an acid- or base-labile protecting group from a suitable precursor of the compound of formula (I) or by ring-opening a suitable cyclic precursor, for example, a lactone or lactam, using the desired acid or base; or

(iii) by converting one salt of the compound of formula (I) to another by reaction with an appropriate acid or base or by means of a suitable ion exchange column.

15 All three reactions are typically carried out in solution. The resulting salt may precipitate out and be collected by filtration or may be recovered by evaporation of the solvent. The degree of ionisation in the resulting salt may vary from completely ionised to almost non-ionised.

20 The compounds of the invention may exist in both unsolvated and solvated forms. The term 'solvate' is used herein to describe a molecular complex comprising the compound of the invention and a stoichiometric amount of one or more pharmaceutically acceptable solvent molecules, for example, ethanol. The term 'hydrate' is employed when said solvent is water.

25 Included within the scope of the invention are complexes such as clathrates, drug-host inclusion complexes wherein, in contrast to the aforementioned solvates, the drug and host are present in stoichiometric or non-stoichiometric amounts. Also included are complexes of the drug containing two or more organic and/or inorganic components which may be in stoichiometric or non-stoichiometric amounts. The resulting complexes may be ionised, partially ionised, or non-ionised. For a review of such complexes, see *J Pharm Sci*, 64 (8), 1269-1288, by Haleblian (August 1975).

30

Hereinafter all references to compounds of formula (I) include references to salts, solvates and complexes thereof and to solvates and complexes of salts thereof.

35 The compounds of the invention include compounds of formula (I) as hereinbefore defined, including all polymorphs and crystal habits thereof, prodrugs and isomers thereof (including optical, geometric and tautomeric isomers) as hereinafter defined and isotopically-labeled compounds of formula (I).

40 As indicated, so-called 'pro-drugs' of the compounds of formula (I) are also within the scope of the invention. Thus certain derivatives of compounds of formula (I) which may have little or no pharmacological activity themselves can, when administered into or onto the body, be converted into compounds of formula (I) having the desired activity, for example, by hydrolytic cleavage. Such

derivatives are referred to as 'prodrugs'. Further information on the use of prodrugs may be found in Prodrugs as Novel Delivery Systems, Vol. 14, ACS Symposium Series (T. Higuchi and W. Stella) and Bioreversible Carriers in Drug Design, Pergamon Press, 1987 (ed. E. B. Roche, American Pharmaceutical Association).

5

Prodrugs in accordance with the invention can, for example, be produced by replacing appropriate functionalities present in the compounds of formula (I) with certain moieties known to those skilled in the art as 'pro-moieties' as described, for example, in Design of Prodrugs by H. Bundgaard (Elsevier, 1985).

10 Some examples of prodrugs in accordance with the invention include:

(i) where the compound of formula (I) contains a carboxylic acid functionality (-COOH), an ester thereof, for example, a compound wherein the hydrogen of the carboxylic acid functionality of the compound of formula (I) is replaced by (C<sub>1</sub>-C<sub>8</sub>)alkyl;

15

(ii) where the compound of formula (I) contains an alcohol functionality (-OH), an ether thereof, for example, a compound wherein the hydrogen of the alcohol functionality of the compound of formula (I) is replaced by (C<sub>1</sub>-C<sub>6</sub>)alkanoyloxymethyl; and

(iii) where the compound of formula (I) contains a primary or secondary amino functionality (-NH<sub>2</sub> or -NHR where R is not H), an amide thereof, for example, a compound wherein, as the case may be, one or both hydrogens of the amino functionality of the compound of formula (I) is/are replaced by

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(C<sub>1</sub>-C<sub>10</sub>)alkanoyl.

Further examples of replacement groups in accordance with the foregoing examples and examples of other prodrug types may be found in the aforementioned references.

25

Moreover, certain compounds of formula (I) may themselves act as prodrugs of other compounds of formula (I).

Also included within the scope of the invention are metabolites of compounds of formula (I), that is, compounds formed *in vivo* upon administration of the drug. Some examples of metabolites in accordance with the invention include:

30

(i) where the compound of formula (I) contains a methyl group, an hydroxymethyl derivative thereof (-CH<sub>3</sub> → -CH<sub>2</sub>OH):

(ii) where the compound of formula (I) contains an alkoxy group, an hydroxy derivative thereof (-OR → -OH);

35

(iii) where the compound of formula (I) contains a tertiary amino group, a secondary amino derivative thereof (-NR<sup>a</sup>R<sup>b</sup> → -NHR<sup>a</sup> or -NHR<sup>b</sup>);

(iv) where the compound of formula (I) contains a secondary amino group, a primary derivative thereof (-NHR<sup>a</sup> → -NH<sub>2</sub>);

(v) where the compound of formula (I) contains a phenyl moiety, a phenol derivative thereof (-Ph → -PhOH); and

40

(vi) where the compound of formula (I) contains an amide group, a carboxylic acid derivative thereof (-CONR<sup>c</sup>R<sup>d</sup> → COOH).

5 Compounds of formula (I) containing one or more asymmetric carbon atoms can exist as two or more stereoisomers. Where structural isomers are interconvertible *via* a low energy barrier, tautomeric isomerism ('tautomerism') can occur. This can take the form of proton tautomerism in compounds of formula (I) containing, for example, an imino, keto, or oxime group, or so-called valence tautomerism in compounds which contain an aromatic moiety. It follows that a single compound may exhibit more than one type of isomerism.

10

Included within the scope of the present invention are all stereoisomers, geometric isomers and tautomeric forms of the compounds of formula (I), including compounds exhibiting more than one type of isomerism, and mixtures of one or more thereof. Also included are acid addition or base salts wherein the counterion is optically active, for example, *d*-lactate or *l*-lysine, or racemic, for example, *dl*-tartrate or *dl*-arginine.

15

Conventional techniques for the preparation/isolation of individual enantiomers include chiral synthesis from a suitable optically pure precursor or resolution of the racemate (or the racemate of a salt or derivative) using, for example, chiral high pressure liquid chromatography (HPLC).

20

Alternatively, the racemate (or a racemic precursor) may be reacted with a suitable optically active compound, for example, an alcohol, or, in the case where the compound of formula (I) contains an acidic or basic moiety, a base or acid such as 1-phenylethylamine or tartaric acid. The resulting diastereomeric mixture may be separated by chromatography and/or fractional crystallization and one or both of the diastereoisomers converted to the corresponding pure enantiomer(s) by means well known to a skilled person.

25

Chiral compounds of the invention (and chiral precursors thereof) may be obtained in enantiomerically-enriched form using chromatography, typically HPLC, on an asymmetric resin with a mobile phase consisting of a hydrocarbon, typically heptane or hexane, containing from 0 to 50% by volume of isopropanol, typically from 2% to 20%, and from 0 to 5% by volume of an alkylamine, typically 0.1% diethylamine. Concentration of the eluate affords the enriched mixture.

30

Stereoisomeric conglomerates may be separated by conventional techniques known to those skilled in the art - see, for example, Stereochemistry of Organic Compounds by E. L. Eliel and S. H. Wilen (Wiley, New York, 1994).

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The present invention includes all pharmaceutically acceptable isotopically-labelled compounds of formula (I) wherein one or more atoms are replaced by atoms having the same atomic number, but an atomic mass or mass number different from the atomic mass or mass number which predominates in nature.

40

Examples of isotopes suitable for inclusion in the compounds of the invention include isotopes of hydrogen, such as  $^2\text{H}$  and  $^3\text{H}$ , carbon, such as  $^{11}\text{C}$ ,  $^{13}\text{C}$  and  $^{14}\text{C}$ , chlorine, such as  $^{36}\text{Cl}$ , fluorine, such as  $^{18}\text{F}$ , iodine, such as  $^{123}\text{I}$  and  $^{125}\text{I}$ , nitrogen, such as  $^{13}\text{N}$  and  $^{15}\text{N}$ , oxygen, such as  $^{15}\text{O}$ ,  $^{17}\text{O}$  and  $^{18}\text{O}$ , phosphorus, such as  $^{32}\text{P}$ , and sulphur, such as  $^{35}\text{S}$ .

Certain isotopically labelled compounds of formula (I), for example, those incorporating a radioactive isotope, are useful in drug and/or substrate tissue distribution studies. The radioactive isotopes tritium, *i.e.*  $^3\text{H}$ , and carbon-14, *i.e.*  $^{14}\text{C}$ , are particularly useful for this purpose in view of their ease of incorporation and ready means of detection.

Substitution with heavier isotopes such as deuterium, *i.e.*  $^2\text{H}$ , may afford certain therapeutic advantages resulting from greater metabolic stability, for example, increased *in vivo* half-life or reduced dosage requirements, and hence may be preferred in some circumstances.

Substitution with positron emitting isotopes, such as  $^{11}\text{C}$ ,  $^{18}\text{F}$ ,  $^{15}\text{O}$  and  $^{13}\text{N}$ , can be useful in Positron Emission Topography (PET) studies for examining substrate receptor occupancy.

Isotopically labelled compounds of formula (I) can generally be prepared by conventional techniques known to those skilled in the art or by processes analogous to those described in the accompanying Examples and Preparations using an appropriate isotopically labelled reagent in place of the non-labelled reagent previously employed.

Pharmaceutically acceptable solvates in accordance with the invention include those wherein the solvent of crystallization may be isotopically substituted, *e.g.*  $\text{D}_2\text{O}$ ,  $\text{d}_6$ -acetone,  $\text{d}_6$ -DMSO.

The compounds of the invention intended for pharmaceutical use may be administered as crystalline or amorphous products. They may be obtained, for example, as solid plugs, powders, or films by methods such as precipitation, crystallization, freeze drying, spray drying, or evaporative drying. Microwave or radio frequency drying may be used for this purpose.

They may be administered alone or in combination with one or more other compounds of the invention or in combination with one or more other drugs (or as any combination thereof). Generally, they will be administered as a formulation in association with one or more pharmaceutically acceptable excipients. The term 'excipient' is used herein to describe any ingredient other than the compound(s) of the invention. The choice of excipient will to a large extent depend on factors such as the particular mode of administration, the effect of the excipient on solubility and stability, and the nature of the dosage form.

Pharmaceutical compositions suitable for the delivery of compounds of the present invention and methods for their preparation will be readily apparent to those skilled in the art. Such compositions and

methods for their preparation may be found, for example, in Remington's Pharmaceutical Sciences, 19th Edition (Mack Publishing Company, 1995).

5 The compounds of the invention may be administered orally. Oral administration may involve swallowing, so that the compound enters the gastrointestinal tract, or buccal or sublingual administration may be employed by which the compound enters the blood stream directly from the mouth.

10 Formulations suitable for oral administration include solid formulations such as tablets, capsules containing particulates, liquids, or powders, lozenges (including liquid-filled), chews, multi- and nano-particulates, gels, solid solution, liposome, films, ovules, sprays and liquid formulations.

15 Liquid formulations include suspensions, solutions, syrups and elixirs. Such formulations may be employed as fillers in soft or hard capsules and typically comprise a carrier, for example, water, ethanol, polyethylene glycol, propylene glycol, methylcellulose, or a suitable oil, and one or more emulsifying agents and/or suspending agents. Liquid formulations may also be prepared by the reconstitution of a solid, for example, from a sachet.

20 The compounds of the invention may also be used in fast-dissolving, fast-disintegrating dosage forms such as those described in Expert Opinion in Therapeutic Patents, 11 (6), 981-986, by Liang and Chen (2001).

25 For tablet dosage forms, depending on dose, the drug may make up from 1 weight % to 80 weight % of the dosage form, more typically from 5 weight % to 60 weight % of the dosage form. In addition to the drug, tablets generally contain a disintegrant. Examples of disintegrants include sodium starch glycolate, sodium carboxymethyl cellulose, calcium carboxymethyl cellulose, croscarmellose sodium, crospovidone, polyvinylpyrrolidone, methyl cellulose, microcrystalline cellulose, lower alkyl-substituted hydroxypropyl cellulose, starch, pregelatinised starch and sodium alginate. Generally, the disintegrant will comprise from 1 weight % to 25 weight %, preferably from 5 weight % to 20 weight % of the dosage form.

30 Binders are generally used to impart cohesive qualities to a tablet formulation. Suitable binders include microcrystalline cellulose, gelatin, sugars, polyethylene glycol, natural and synthetic gums, polyvinylpyrrolidone, pregelatinised starch, hydroxypropyl cellulose and hydroxypropyl methylcellulose. Tablets may also contain diluents, such as lactose (monohydrate, spray-dried monohydrate, anhydrous and the like), mannitol, xylitol, dextrose, sucrose, sorbitol, microcrystalline cellulose, starch and dibasic calcium phosphate dihydrate.

40 Tablets may also optionally comprise surface active agents, such as sodium lauryl sulfate and polysorbate 80, and glidants such as silicon dioxide and talc. When present, surface active agents may comprise from 0.2 weight % to 5 weight % of the tablet, and glidants may comprise from 0.2 weight % to 1 weight % of the tablet.

Tablets also generally contain lubricants such as magnesium stearate, calcium stearate, zinc stearate, sodium stearyl fumarate, and mixtures of magnesium stearate with sodium lauryl sulphate. Lubricants generally comprise from 0.25 weight % to 10 weight %, preferably from 0.5 weight % to 3 weight % of the  
5 tablet.

Other possible ingredients include anti-oxidants, colorants, flavouring agents, preservatives and taste-  
masking agents.

10 Exemplary tablets contain up to about 80% drug, from about 10 weight % to about 90 weight % binder, from about 0 weight % to about 85 weight % diluent, from about 2 weight % to about 10 weight % disintegrant, and from about 0.25 weight % to about 10 weight % lubricant.

Tablet blends may be compressed directly or by roller to form tablets. Tablet blends or portions of blends  
15 may alternatively be wet-, dry-, or melt-granulated, melt congealed, or extruded before tableting. The final formulation may comprise one or more layers and may be coated or uncoated; it may even be encapsulated.

The formulation of tablets is discussed in Pharmaceutical Dosage Forms: Tablets, Vol. 1, by H.  
20 Lieberman and L. Lachman (Marcel Dekker, New York, 1980).

Consumable oral films for human or veterinary use are typically pliable water-soluble or water-swelling thin film dosage forms which may be rapidly dissolving or mucoadhesive and typically comprise a compound of formula (I), a film-forming polymer, a binder, a solvent, a humectant, a plasticiser, a  
25 stabiliser or emulsifier, a viscosity-modifying agent and a solvent. Some components of the formulation may perform more than one function.

The compound of formula (I) may be water-soluble or insoluble. A water-soluble compound typically comprises from 1 weight % to 80 weight %, more typically from 20 weight % to 50 weight %, of the  
30 solutes. Less soluble compounds may comprise a greater proportion of the composition, typically up to 88 weight % of the solutes. Alternatively, the compound of formula (I) may be in the form of multiparticulate beads.

The film-forming polymer may be selected from natural polysaccharides, proteins, or synthetic  
35 hydrocolloids and is typically present in the range 0.01 to 99 weight %, more typically in the range 30 to 80 weight %.

Other possible ingredients include anti-oxidants, colorants, flavourings and flavour enhancers, preservatives, salivary stimulating agents, cooling agents, co-solvents (including oils), emollients, bulking  
40 agents, anti-foaming agents, surfactants and taste-masking agents.

Films in accordance with the invention are typically prepared by evaporative drying of thin aqueous films coated onto a peelable backing support or paper. This may be done in a drying oven or tunnel, typically a combined coater dryer, or by freeze-drying or vacuuming.

- 5 Solid formulations for oral administration may be formulated to be immediate and/or modified release. Modified release formulations include delayed-, sustained-, pulsed-, controlled-, targeted and programmed release.

Suitable modified release formulations for the purposes of the invention are described in US Patent No. 10 6,106,864. Details of other suitable release technologies such as high energy dispersions and osmotic and coated particles are to be found in Pharmaceutical Technology On-line, 25(2), 1-14, by Verma *et al* (2001). The use of chewing gum to achieve controlled release is described in WO 00/35298.

15 The compounds of the invention may also be administered directly into the blood stream, into muscle, or into an internal organ. Suitable means for parenteral administration include intravenous, intraarterial, intraperitoneal, intrathecal, intraventricular, intraurethral, intrasternal, intracranial, intramuscular and subcutaneous. Suitable devices for parenteral administration include needle (including microneedle) injectors, needle-free injectors and infusion techniques.

20 Parenteral formulations are typically aqueous solutions which may contain excipients such as salts, carbohydrates and buffering agents (preferably to a pH of from 3 to 9), but, for some applications, they may be more suitably formulated as a sterile non-aqueous solution or as a dried form to be used in conjunction with a suitable vehicle such as sterile, pyrogen-free water.

25 The preparation of parenteral formulations under sterile conditions, for example, by lyophilisation, may readily be accomplished using standard pharmaceutical techniques well known to those skilled in the art.

The solubility of compounds of formula (I) used in the preparation of parenteral solutions may be increased by the use of appropriate formulation techniques, such as the incorporation of solubility- 30 enhancing agents.

Formulations for parenteral administration may be formulated to be immediate and/or modified release. Modified release formulations include delayed-, sustained-, pulsed-, controlled-, targeted and programmed release. Thus compounds of the invention may be formulated as a solid, semi-solid, or 35 thixotropic liquid for administration as an implanted depot providing modified release of the active compound. Examples of such formulations include drug-coated stents and poly(*dl*-lactic-coglycolic)acid (PGLA) microspheres.

40 The compounds of the invention may also be administered topically to the skin or mucosa, that is, dermally or transdermally. Typical formulations for this purpose include gels, hydrogels, lotions, solutions, creams, ointments, dusting powders, dressings, foams, films, skin patches, wafers, implants, sponges,



fibres, bandages and microemulsions. Liposomes may also be used. Typical carriers include alcohol, water, mineral oil, liquid petrolatum, white petrolatum, glycerin, polyethylene glycol and propylene glycol. Penetration enhancers may be incorporated - see, for example, J Pharm Sci, 88 (10), 955-958, by Finnin and Morgan (October 1999).

5

Other means of topical administration include delivery by electroporation, iontophoresis, phonophoresis, sonophoresis and microneedle or needle-free (e.g. Powderject™, Bioject™, etc.) injection.

Formulations for topical administration may be formulated to be immediate and/or modified release.

10 Modified release formulations include delayed-, sustained-, pulsed-, controlled-, targeted and programmed release.

The compounds of the invention can also be administered intranasally or by inhalation, typically in the form of a dry powder (either alone, as a mixture, for example, in a dry blend with lactose, or as a mixed component particle, for example, mixed with phospholipids, such as phosphatidylcholine) from a dry powder inhaler or as an aerosol spray from a pressurised container, pump, spray, atomiser (preferably an atomiser using electrohydrodynamics to produce a fine mist), or nebuliser, with or without the use of a suitable propellant, such as 1,1,1,2-tetrafluoroethane or 1,1,1,2,3,3,3-heptafluoropropane. For intranasal use, the powder may comprise a bioadhesive agent, for example, chitosan or cyclodextrin.

15

The pressurised container, pump, spray, atomizer, or nebuliser contains a solution or suspension of the compound(s) of the invention comprising, for example, ethanol, aqueous ethanol, or a suitable alternative agent for dispersing, solubilising, or extending release of the active, a propellant(s) as solvent and an optional surfactant, such as sorbitan trioleate, oleic acid, or an oligolactic acid.

20

Prior to use in a dry powder or suspension formulation, the drug product is micronised to a size suitable for delivery by inhalation (typically less than 5 microns). This may be achieved by any appropriate comminuting method, such as spiral jet milling, fluid bed jet milling, supercritical fluid processing to form nanoparticles, high pressure homogenisation, or spray drying.

25

Capsules (made, for example, from gelatin or hydroxypropyl-methylcellulose), blisters and cartridges for use in an inhaler or insufflator may be formulated to contain a powder mix of the compound of the invention, a suitable powder base such as lactose or starch and a performance modifier such as *L*-leucine, mannitol, or magnesium stearate. The lactose may be anhydrous or in the form of the monohydrate, preferably the latter. Other suitable excipients include dextran, glucose, maltose, sorbitol, xylitol, fructose, sucrose and trehalose.

30

A suitable solution formulation for use in an atomiser using electrohydrodynamics to produce a fine mist may contain from 1µg to 20mg of the compound of the invention per actuation and the actuation volume may vary from 1µl to 100µl. A typical formulation may comprise a compound of formula (I), propylene

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glycol, sterile water, ethanol and sodium chloride. Alternative solvents which may be used instead of propylene glycol include glycerol and polyethylene glycol.

5 Suitable flavours, such as menthol and levomenthol, or sweeteners, such as saccharin or saccharin sodium, may be added to those formulations of the invention intended for inhaled/intranasal administration.

10 Formulations for inhaled/intranasal administration may be formulated to be immediate and/or modified release using, for example, PGLA. Modified release formulations include delayed-, sustained-, pulsed-, controlled-, targeted and programmed release.

15 In the case of dry powder inhalers and aerosols, the dosage unit is determined by means of a valve, which delivers a metered amount. Units in accordance with the invention are typically arranged to administer a metered dose or "puff" containing from 1 µg to 4000 µg of the compound of formula (I). The overall daily dose will typically be in the range 1 µg to 20 mg which may be administered in a single dose or, more usually, as divided doses throughout the day.

The compounds of the invention may be administered rectally or vaginally, for example, in the form of a suppository, pessary, or enema. Cocoa butter is a traditional suppository base, but various alternatives may be used as appropriate.

20 Formulations for rectal/vaginal administration may be formulated to be immediate and/or modified release. Modified release formulations include delayed-, sustained-, pulsed-, controlled-, targeted and programmed release.

25 The compounds of the invention may also be administered directly to the eye or ear, typically in the form of drops of a micronised suspension or solution in isotonic, pH-adjusted, sterile saline. Other formulations suitable for ocular and aural administration include ointments, biodegradable (*e.g.* absorbable gel sponges, collagen) and non-biodegradable (*e.g.* silicone) implants, wafers, lenses and particulate or vesicular systems, such as niosomes or liposomes. A polymer such as crossed-linked polyacrylic acid, polyvinylalcohol, hyaluronic acid, a cellulosic polymer, for example, hydroxypropylmethylcellulose, 30 hydroxyethylcellulose, or methyl cellulose, or a heteropolysaccharide polymer, for example, gelatin gum, may be incorporated together with a preservative, such as benzalkonium chloride. Such formulations may also be delivered by iontophoresis.

35 Formulations for ocular/aural administration may be formulated to be immediate and/or modified release. Modified release formulations include delayed-, sustained-, pulsed-, controlled-, targeted, or programmed release.

40 The compounds of the invention may be combined with soluble macromolecular entities, such as cyclodextrin and suitable derivatives thereof or polyethylene glycol-containing polymers, in order to

improve their solubility, dissolution rate, taste-masking, bioavailability and/or stability for use in any of the aforementioned modes of administration.

5 Drug-cyclodextrin complexes, for example, are found to be generally useful for most dosage forms and administration routes. Both inclusion and non-inclusion complexes may be used. As an alternative to direct complexation with the drug, the cyclodextrin may be used as an auxiliary additive, *i.e.* as a carrier, diluent, or solubiliser. Most commonly used for these purposes are alpha-, beta- and gamma-cyclodextrins, examples of which may be found in International Patent Applications Nos. WO 91/11172, WO 94/02518 and WO 98/55148.

10

Inasmuch as it may be desirable to administer a combination of active compounds, for example, for the purpose of treating a particular disease or condition, it is within the scope of the present invention that two or more pharmaceutical compositions, at least one of which contains a compound in accordance with the invention, may conveniently be combined in the form of a kit suitable for coadministration of the compositions.

15

Thus the kit of the invention comprises two or more separate pharmaceutical compositions, at least one of which contains a compound of formula (I) in accordance with the invention, and means for separately retaining said compositions, such as a container, divided bottle, or divided foil packet. An example of such a kit is the familiar blister pack used for the packaging of tablets, capsules and the like.

20

The kit of the invention is particularly suitable for administering different dosage forms, for example, oral and parenteral, for administering the separate compositions at different dosage intervals, or for titrating the separate compositions against one another. To assist compliance, the kit typically comprises directions for administration and may be provided with a so-called memory aid.

25

For administration to human patients, the total daily dose of the compounds of the invention is typically in the 0.001 mg to 2000 mg depending, of course, on the mode of administration. For example, oral administration may require a total daily dose of from 0.1 mg to 2000 mg, while an intravenous dose may only require from 0.01 mg to 100 mg. The total daily dose may be administered in single or divided doses and may, at the physician's discretion, fall outside of the typical range given herein.

30

These dosages are based on an average human subject having a weight of about 60 kg to 70 kg. The physician will readily be able to determine doses for subjects whose weight falls outside this range, such as infants and the elderly.

35

For the avoidance of doubt, references herein to "treatment" include references to curative, palliative and prophylactic treatment.

40 According to another embodiment of the present invention, the compounds of the formula (I) or pharmaceutically acceptable salts, derived forms or compositions thereof, can also be used as a

combination with one or more additional therapeutic agents to be co-administered to a patient to obtain some particularly desired therapeutic end result. The second and more additional therapeutic agents may also be a compound of the formula (I) or a pharmaceutically acceptable salt, derived forms or compositions thereof, or one or more histamine H<sub>4</sub> receptor ligands known in the art. More typically, the  
5 second and more therapeutic agents will be selected from a different class of therapeutic agents.

As used herein, the terms "co-administration", "co-administered" and "in combination with", referring to the compounds of formula (I) and one or more other therapeutic agents, is intended to mean, and does refer to and include the following:

- 10 • simultaneous administration of such combination of compound(s) of formula (I) and therapeutic agent(s) to a patient in need of treatment, when such components are formulated together into a single dosage form which releases said components at substantially the same time to said patient,
- substantially simultaneous administration of such combination of compound(s) of formula (I) and therapeutic agent(s) to a patient in need of treatment, when such components are formulated apart  
15 from each other into separate dosage forms which are taken at substantially the same time by said patient, whereupon said components are released at substantially the same time to said patient,
- sequential administration of such combination compound(s) of formula (I) and therapeutic agent(s) to a patient in need of treatment, when such components are formulated apart from each other into separate dosage forms which are taken at consecutive times by said patient with a significant time  
20 interval between each administration, whereupon said components are released at substantially different times to said patient; and
- sequential administration of such combination of compound(s) of formula (I) and therapeutic agent(s) to a patient in need of treatment, when such components are formulated together into a single dosage form which releases said components in a controlled manner whereupon they are  
25 concurrently, consecutively, and/or overlappingly administered at the same and/or different times by said patient,

where each part may be administered by either the same or different route.

Suitable examples of other therapeutic agents which may be used in combination with the compound(s)  
30 of formula (I), or pharmaceutically acceptable salts, derived forms or compositions thereof, include, but are by no means limited to :

- Histamine H<sub>1</sub> receptor antagonists, in particular loratidine, desloratidine, fexofenadine and cetirizine
- Histamine H<sub>3</sub> receptor antagonists
- Histamine H<sub>2</sub> receptor antagonists
- 35 • Leukotriene antagonists, including antagonists of LTB<sub>4</sub>, LTC<sub>4</sub>, LTD<sub>4</sub>, and LTE<sub>4</sub>, in particular Montelukast
- Phosphodiesterase inhibitors, namely PDE4 inhibitors and PDE5 inhibitors
- neurotransmitter re-uptake inhibitors, in particular fluoxetine, setraline, paroxetine, ziprasidone
- 5-Lipoxygenase (5-LO) inhibitors or 5-lipoxygenase activating protein (FLAP) antagonists,
- 40 •  $\alpha_1$ - and  $\alpha_2$ -adrenoceptor agonist vasoconstrictor sympathomimetic agents for decongestant use,

- Muscarinic M3 receptor antagonists or anticholinergic agents,
- $\beta_2$ -adrenoceptor agonists,
- Theophylline,
- Sodium cromoglycate,
- 5 • COX-1 inhibitors (NSAIDs) and COX-2 selective inhibitors,
- Oral or inhaled Glucocorticosteroids,
- Monoclonal antibodies active against endogenous inflammatory entities,
- Anti-tumor necrosis factor (anti-TNF- $\alpha$ ) agents,
- Adhesion molecule inhibitors including VLA-4 antagonists,
- 10 • Kinin-B<sub>1</sub> - and B<sub>2</sub> -receptor antagonists,
- Immunosuppressive agents,
- Inhibitors of matrix metalloproteases (MMPs),
- Tachykinin NK<sub>1</sub>, NK<sub>2</sub> and NK<sub>3</sub> receptor antagonists,
- Elastase inhibitors,
- 15 • Adenosine A2a receptor agonists,
- Inhibitors of urokinase,
- Compounds that act on dopamine receptors, e.g. D2 agonists,
- Modulators of the NF $\kappa$ b pathway, e.g. IKK inhibitors,
- Agents that can be classed as mucolytics or anti-tussive,
- 20 • Antibiotics,
- Modulators of cytokine signaling pathways such as p38 MAP kinase inhibitors, syk tyrosine kinase inhibitors or JAK kinase inhibitors
- Prostaglandin D2 receptor antagonists (DP1 and CRTH2)
- Inhibition of Prostaglandin D synthase (PGDS)
- 25 • Inhibitors of phosphoinositide-3-kinase, and
- HDAC inhibitors.

According to the present invention, combination of the compounds of formula (I) with:

- Histamine H<sub>1</sub> receptor antagonists, in particular loratidine, desloratidine, fexofenadine and cetirizine,
- 30 • Histamine H<sub>3</sub> receptor antagonists,
- Histamine H<sub>2</sub> receptor antagonists,
- Leukotriene antagonists, including antagonists of LTB<sub>4</sub>, LTC<sub>4</sub>, LTD<sub>4</sub>, and LTE<sub>4</sub>, in particular Montelukast, and
- Phosphodiesterase PDE4 inhibitors
- 35 are preferred.

The compounds of formula (I) have the ability to interact with the H<sub>4</sub> receptor and thereby have a wide range of therapeutic applications, as described further below, because of the essential role, which the H<sub>4</sub> receptor plays in the physiology of all mammals. According to this invention H<sub>4</sub> ligands are meant to

include H<sub>4</sub> receptor antagonists, agonists and inverse agonists. For the preferred indications to be treated according to the invention, H<sub>4</sub> antagonists are believed to be most suitable.

Therefore, a further aspect of the present invention relates to the compounds of formula (I) or  
5 pharmaceutically acceptable salts, derived forms or compositions thereof, for use as medicaments, more particularly in the treatment of diseases, disorders, and conditions in which the H<sub>4</sub> receptor is involved. More specifically, the present invention also concerns the compounds of formula (I), or pharmaceutically acceptable salts, derived forms or compositions thereof, for use in the treatment of diseases, disorders, and conditions selected from the group consisting of:

- 10 • inflammatory diseases;
- respiratory diseases (e.g. adult respiratory distress syndrome, acute respiratory distress syndrome, bronchitis, chronic bronchitis, chronic obstructive pulmonary disease, cystic fibrosis, asthma, emphysema, rhinitis, chronic sinusitis), allergy, allergy-induced airway responses, allergic rhinitis, viral rhinitis, non-allergic rhinitis, perennial and seasonal rhinitis, nasal congestion, allergic  
15 congestion;
- female and male sexual dysfunction;
- skin diseases such as dermatitis and psoriasis;
- cardiac dysfunctions such as myocardial ischaemia and arrhythmia;
- diseases of the gastrointestinal tract such as inflammatory bowel disease, Crohn's disease and colitis  
20 ulcerosa;
- cancer;
- rheumatoid arthritis;
- hypotension;
- pain and  
25 • overactive bladder conditions.

The compounds of formula (I) according to the present invention are particularly suitable for the treatment of asthma, allergy, allergy-induced airway responses, allergic rhinitis, viral rhinitis, non-allergic rhinitis, perennial and seasonal rhinitis, nasal congestion and allergic congestion.

30

A still further aspect of the present invention also relates to the use of the compounds of formula (I), or pharmaceutically acceptable salts, derived forms or compositions thereof, for the manufacture of a drug being a H<sub>4</sub> ligand. In particular, the present inventions concerns the use of the compounds of formula (I), or pharmaceutically acceptable salts, derived forms or compositions thereof, for the manufacture of a  
35 drug for the treatment of H<sub>4</sub> mediated diseases and/or conditions, in particular the diseases and/or conditions listed above.

As a consequence, the present invention provides a particularly interesting method to treat a mammal, including a human being, with an effective amount of a compound of formula (I), or a pharmaceutically  
40 acceptable salt, derived form or composition thereof. More precisely, the present invention provides a

particularly interesting method for the treatment of a H<sub>4</sub> mediated diseases and/or conditions in a mammal, including a human being, in particular the diseases and/or conditions listed above, comprising administering to said mammal an effective amount of a compound of formula (I), its pharmaceutically acceptable salts and/or derived forms.

5

The following examples illustrate the preparation of compounds of formula (I) according to the present invention

<sup>1</sup>H Nuclear magnetic resonance (NMR) spectra were in all cases consistent with the proposed structures. Characteristic chemical shifts ( $\delta$ ) are given in parts-per-million (ppm) downfield from tetramethylsilane using conventional abbreviations for designation of major peaks: e.g. s (singlet), d (doublet), t (triplet), q (quartet) m (multiplet) and br (broad). The mass spectra (m/z) were recorded using either electrospray ionisation (ESI) or atmospheric pressure chemical ionisation (APCI). Purification by SCX indicates use of strong cation exchange resin.

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#### **EXAMPLES SECTION**

##### **Preparation 1: (5-Methoxy-1H-benzimidazol-2-yl)methanol**

A solution of 4-methoxybenzene-1,2-diamine (1.13g, 8.18mmol) and hydroxyacetic acid (1.85g, 24.5mmol) in 6N hydrochloric acid (25ml) was heated at reflux for 16 hours. The reaction mixture was cooled to room temperature and neutralised by addition of solid sodium hydroxide. The resulting precipitate was filtered off and dried *in vacuo* to give the title compound as a pale yellow solid (638mg).

##### **Preparation 2: (5-Fluoro-1H-benzimidazol-2-yl)methanol**

Prepared from 4-fluorobenzene-1,2-diamine using the method of preparation 1 to give the title compound as a brown crystalline solid.

##### **Preparation 3: (5-Methyl-1H-benzimidazol-2-yl)methanol**

Prepared from 4-methyl-1,2-diamine using the method of preparation 1 to give the title compound as a pale yellow solid.

##### **Preparation 4: (5-Chloro-1H-benzimidazol-2-yl)methanol**

Prepared from 4-chloro-1,2-diamine using the method of preparation 1 to give the title compound as a pale yellow solid.

35

##### **Preparation 5: 5-Methoxy-1H-benzimidazole-2-carboxylic acid**

A suspension of (5-Methoxy-1H-benzimidazol-2-yl)methanol (preparation 1) (638mg, 3.58mmol) in 1N aqueous sodium hydroxide (0.95ml) and water (40ml) was heated to reflux and a solution of potassium permanganate (848mg, 5.36mmol) in water was added drop wise over a period of 30 minutes. The reaction mixture was refluxed for a further hour and then cooled to room temperature. The reaction

40

mixture was acidified to pH4 by addition of acetic acid and the resulting solid filtered and dried *in vacuo* to give the title compound as a pale yellow solid (332mg).

**Preparation 6: 5-Fluoro-1H-benzimidazole-2-carboxylic acid**

5 Prepared from the alcohol of preparation 2 using the method of preparation 5 to give the title compound as a pale brown solid.

**Preparation 7: 5-Methyl-1H-benzimidazole-2-carboxylic acid**

10 Prepared from the alcohol of preparation 3 using the method of preparation 5 to give the title compound as a pale yellow solid.

**Preparation 8: 5-Chloro-1H-benzimidazole-2-carboxylic acid**

15 Prepared from the alcohol of preparation 4 using the method of preparation 5 to give the title compound as a pale yellow solid.

**Preparation 9: 6,7-Dimethyl-2-(trichloromethyl)-1H-benzimidazole**

20 A solution of 3,4-dimethylbenzene-1,2-diamine (1.0g, 7.34mmol) in acetic acid (10ml) was treated with methyl-2,2,2-trichloroacetimidate (1.0ml, 8.07mmol) and the resulting solution was left to stir at room temperature for 16 hours. The reaction mixture was poured onto ice (~100g) and then extracted with dichloromethane (100ml). The organic phase was separated, dried (sodium sulfate) and the solvent removed *in vacuo*. The residue was triturated with diethyl ether and the title compound isolated by filtration (360mg) as a brown solid. The material was used crude in the next step with no further characterization.

25 **Preparation 10: 6,7-Difluoro-2-(trichloromethyl)-1H-benzimidazole**

30 A solution of 3,4-difluorobenzene-1,2-diamine (274mg, 1.90mmol) in acetic acid (4ml) was treated with methyl-2,2,2-trichloroacetimidate (0.25ml, 2.09mmol) and the resulting solution was left to stir at room temperature for 16 hours. The reaction mixture was poured onto ice (~50g) and the resulting precipitate was filtered and dried *in vacuo* to give the title compound as a brown solid (496mg). The material was used crude in the next step with no further characterization.

**Preparation 11: 7-Methyl-2-(trichloromethyl)-1H-benzimidazole**

35 Prepared from 3-methylbenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown solid. The material was used crude in the next step with no further characterization.

**Preparation 12: 5,6-Difluoro-2-(trichloromethyl)-1H-benzimidazole**

40 Prepared from 5,6-difluorobenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown solid. The material was used crude in the next step with no further characterization.



**Preparation 13: 5,7-Difluoro-2-(trichloromethyl)-1H-benzimidazole**

Prepared from 3,5-difluorobenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown solid. The material was used crude in the next step with no further characterization.

5

**Preparation 14: 5-Chloro-7-methyl-2-(trichloromethyl)-1H-benzimidazole**

Prepared from 5-chloro-3-methylbenzene-1,2-diamine using the method of preparation 10 to give the title compound as a yellow solid. The material was used crude in the next step with no further characterization.

10

**Preparation 15: 7-Chloro-5-methyl-2-(trichloromethyl)-1H-benzimidazole**

Prepared from 3-chloro-5-methylbenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown solid. The material was used crude in the next step with no further characterization.

15

**Preparation 16: 5-Iodo-2-(trichloromethyl)-1H-benzimidazole**

Prepared from 4-iodobenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown solid. The material was used crude in the next step.

20

**Preparation 17: Methyl 2-(trichloromethyl)-1H-benzimidazole-5-carboxylate**

Prepared from methyl 3,4-diaminobenzoate using the method of preparation 10 to give the title compound as a brown solid. The material was used crude in the next step.

**Preparation 18: 5-Chloro-6-fluoro-2-(trichloromethyl)-1H-benzimidazole**

25 Prepared from 4-chloro-5-fluorobenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown solid. The material was used crude in the next step with no further characterisation.

**Preparation 19: 5,6-Dimethyl-2-(trichloromethyl)-1H-benzimidazole**

30 Prepared from 4,5-dimethylbenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown solid. The material was used crude in the next step with no further characterisation.

**Preparation 20: 5,6-Dichloro-2-(trichloromethyl)-1H-benzimidazole**

35 Prepared from 4,5-dichlorobenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown solid. The material was used crude in the next step with no further characterisation.

**Preparation 21: 2-(Trichloromethyl)-5-(trifluoromethyl)-1H-benzimidazole**

40 Prepared from 4-(trifluoromethyl)benzene-1,2-diamine using the method of preparation 10 to give the title compound as a pale yellow solid. The material was used crude in the next step.

**Preparation 22: 4-Chloro-6-fluoro-2-(trichloromethyl)-1H-benzimidazole**

Prepared from 3-chloro-5-fluorobenzene-1,2-diamine using the method of preparation 10 to give the title compound as an orange solid. The material was used crude in the next step with no further  
5 characterization.

**Preparation 23: 4,6-Dichloro-2-(trichloromethyl)-1H-benzimidazole**

Prepared from 3,5-dichlorobenzene-1,2-diamine using the method of preparation 10 to give the title compound as a yellow solid. The material was used crude in the next step with no further  
10 characterization.

**Preparation 24: 5-Phenyl-2-(trichloromethyl)-1H-benzimidazole**

Prepared from biphenyl-3,4-diamine using the method of preparation 10 to give the title compound as a brown oil. The material was used crude in the next step with no further characterization.  
15

**Preparation 25: 5-Fluoro-4-methyl-2-(trichloromethyl)-1H-benzimidazole**

Prepared from 4-fluoro-3-methylbenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown oil. The material was used crude in the next step with no further characterization.

**Preparation 26: N-(2-Fluoro-4-methylphenyl)acetamide**

A solution of 2-fluoro-4-methylaniline (2.0g, 15.9mmol) in dichloromethane (25ml) was cooled to 0°C and treated with a solution of acetic anhydride (1.50ml, 15.9mmol) in dichloromethane (50ml). The resulting mixture was allowed to warm gradually to room temperature over a period of an hour. Saturated aqueous sodium bicarbonate solution (50ml) was added and the organic phase separated, washed with further  
25 saturated aqueous sodium bicarbonate solution (50ml), dried (sodium sulphate) and the solvent reduced *in vacuo* to give the title compound as a colourless solid (2.26g).

**Preparation 27: 2-Fluoro-4-methyl-6-nitroaniline**

A solution of the acetamide from preparation 26 (1.0g, 5.9mmol) in nitric acid (70%, 10ml) was cooled to  
30 0°C and treated with fuming nitric acid (90%, 10ml) maintaining the reaction temperature <0°C. The reaction was left to stir for one hour at 0°C and then poured onto ice and allowed to warm gradually to room temperature. The resulting precipitate was collected by filtration and dried *in vacuo* to give a colourless solid (1g, mixture of isomers). The solid was dissolved in methanol (20ml) and solid KOH added to adjust the pH to 10. The solution was left to stir at room temperature for 16 hours and then the  
35 solvent was removed *in vacuo*. Water (50ml) and dichloromethane (50ml) were added and the organic phase separated. The aqueous phase was extracted with further dichloromethane (50ml) and the combined organics dried (sodium sulphate) and reduced *in vacuo*. Purification by flash column chromatography on silica gel eluting with pentane:ethyl acetate (80:20 changing to 20:80, by volume) gave the title compound as a yellow solid (124mg).  
40

**Preparation 28: 3-Fluoro-5-methylbenzene-1,2-diamine**

A solution of the nitroaniline from preparation 27 (124mg, 0.72mmol) in ethanol (5ml) was treated with 10%Pd/C and hydrogenated at 50psi for 4 hours at room temperature. The reactions mixture was filtered and the solvent removed *in vacuo* to give a colourless solid (79mg).

5 **Preparation 29: 4-Chloro-3-methylbenzene-1,2-diamine**

A solution of 3-chloro-2-methyl-6-nitroaniline (500mg, 2.67mmol) in a mixture of acetic acid (5ml) and water (1ml) was heated to 90°C and treated with iron powder (900mg, 16.0mmol). The reaction mixture was heated at 90°C for a further 2 hours and then cooled to room temperature and poured onto ice. The pH was adjusted to 8 and ethyl acetate (50ml) was added. The resulting mixture was filtered and the organic phase separated, dried (sodium sulfate) and the solvent reduced *in vacuo*. Purification by flash column chromatography on silica gel eluting with pentane:ethyl acetate (70:30 changing to 30:70, by volume) gave the title compound as a brown oil (213mg).

**Preparation 30: Methyl 5,6-difluoro-1H-benzimidazole-2-carboxylate**

15 A solution of 5,6-difluorobenzene-1,2-diamine (1.76g, 12.2mmol) in acetic acid (70ml) was treated with methyl-2,2,2-trichloroacetimidate (1.5ml, 12.2mmol) and the resulting solution left to stir at room temperature for 16 hours. The solvent was removed *in vacuo* and the residue was dissolved in methanol (100ml) and heated to reflux for 4 hours. The solvent was removed *in vacuo* and the residue partitioned between saturated aqueous sodium bicarbonate (100ml) and ethyl acetate (100ml). The organic phase was separated, dried (sodium sulphate) and reduced *in vacuo*. Purification by flash column chromatography on silica gel eluting with pentane:ethyl acetate (90:10 changing to 50:50, by volume) gave the title compound as a yellow solid (963mg).

**Preparation 31: 5,6-Difluoro-1H-benzimidazole-2-carboxylic acid**

25 A solution of the ester of preparation 30 (963mg, 4.53mmol) in tetrahydrofuran (10ml) was treated with lithium hydroxide (9.0ml of a 1M aqueous solution, 9.0mmol) and left to stir at room temperature for 16 hours. Hydrochloric acid (9.0ml of a 1M aqueous solution, 9.0mmol) was added and the resulting precipitate was filtered, washed with water (10ml) and dried *in vacuo* to give the title compound as a pale yellow solid (700mg).

30 **Preparation 32: 5,6-Difluoro-2-(trichloromethyl)-1H-benzimidazole**

Prepared from 4-fluorobenzene-1,2-diamine using the method of preparation 10 to give the title compound as a brown solid which was used crude in the next step with no further characterization.

35 **Preparation 33 : 5,6-difluoro-1H-benzimidazole-2-carbonitrile**

A solution of the trichloromethylbenzimidazole of preparation 12 (5g, 18.4mmol) in tetrahydrofuran (25ml) was added dropwise to a cooled solution of 880 ammonia (10ml) in water (30ml) maintaining an internal temperature <-5°C. The reaction mixture was left to stir at 0°C for 2 hours and then poured onto ice and acidified to pH5 by slow addition of concentrated hydrochloric acid. The resulting solid was filtered and washed with water (50ml). The residue was partitioned between diethyl ether (50ml) and aqueous sodium carbonate (2.5g in 50ml water). The aqueous phase was separated, poured onto ice and acidified to pH5

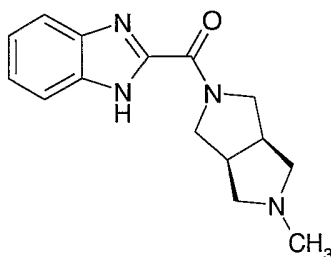
by slow addition of concentrated hydrochloric acid, The resulting solid was filtered off and dried *in vacuo* to give the title compound as a pale brown solid (2.63g).

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.62-7.58 (2H, m) ppm.

MS (APCI):  $m/z$  180  $[\text{M}+\text{H}]^+$ , 178  $[\text{M}-\text{H}]^-$

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**Example 1: 2-[[[(3aR,6aS)-5-Methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-benzimidazole**



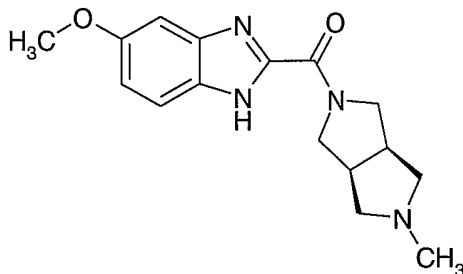
A solution of 1*H*-benzimidazole-2-carboxylic acid (456mg, 2.81mmol) in *N,N*-dimethylacetamide (5ml) was treated with (3*aR*,6*aS*)-2-methyloctahydropyrrolo[3,4-*c*]pyrrole (322mg, 2.55mmol), triethylamine (0.71ml, 5.11mmol) and *O*-benzotriazo-1-yl-*N,N,N'*-tetramethyluronium hexafluorophosphate (1.16g, 3.06mmol) and the resulting solution left to stir at room temperature for 16 hours. The reaction mixture was purified directly by SCX resin, eluting non-basic compounds with methanol and the basic compounds with 1*N* ammonia in methanol. The basic washings were concentrated *in vacuo* and purified by flash column chromatography on silica gel eluting with dichloromethane : methanol : 880 ammonia (99:1:0.1 changing to 90:10:1, by volume) to give the title compound as a pale yellow solid (499mg).

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.71-7.69 (2H, m), 7.39-7.34 (2H, m), 4.42-4.30 (2H, m), 3.95-3.77 (2H, m), 3.15-2.98 (2H, m), 2.84-2.77 (2H, m), 2.56-2.52 (2H, m), 2.37 (3H, s) ppm.

MS (electrospray):  $m/z$  271  $[\text{M}+\text{H}]^+$ , 269  $[\text{M}-\text{H}]^-$

20

**Example 2: 5-Methoxy-2-[[[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-benzimidazole**



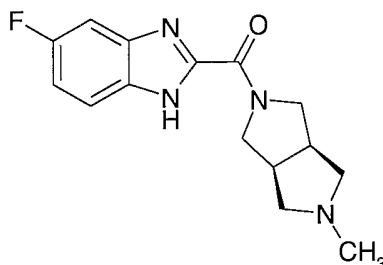
Prepared from 5-methoxy-1*H*-benzimidazole-2-carboxylic acid (preparation 5) using the method from example 1 to give the title compound as a pale brown solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.55 (1H, d), 7.09 (1H, s), 6.95 (1H, d), 4.36-4.24 (2H, m), 3.89-3.71 (5H, m), 3.10-2.89 (2H, m), 2.79-2.72 (2H, m), 2.49-2.46 (2H, m), 2.32 (3H, s) ppm.

MS (APCI)  $m/z$  301  $[\text{M}+\text{H}]^+$ , 299  $[\text{M}-\text{H}]^-$

25

**Example 3: 5-Fluoro-2-[[[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**

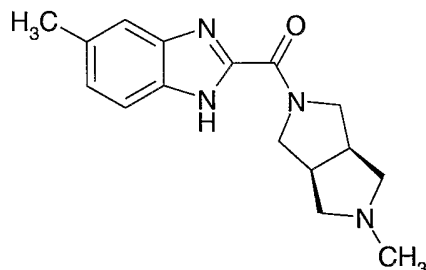


Prepared from 5-fluoro-1*H*-benzimidazole-2-carboxylic acid (preparation 6) using the method from example 1 to give the title compound as a pale brown solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.65 (1H, dd), 7.33 (1H, dd), 7.13-7.07 (1H, m), 4.37-4.26 (2H, m), 3.90-3.74 (2H, m), 3.10-2.92 (2H, m), 2.79-2.71 (2H, m), 2.51-2.48 (2H, m), 2.32 (3H, s) ppm.

MS (APCI) m/z 289 [M+H]<sup>+</sup>, 287 [M-H]<sup>-</sup>

**Example 4: 5-Methyl-2-[[[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**

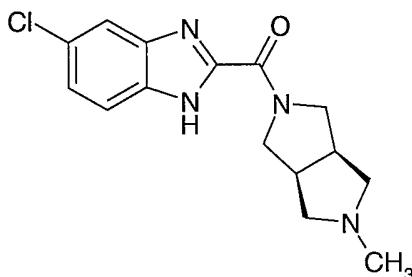


Prepared from 5-methyl-1*H*-benzimidazole-2-carboxylic acid (preparation 7) using the method from example 1 to give the title compound as a pale yellow solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.54 (1H, d), 7.42 (1H, s), 7.15 (1H, d), 4.35-4.23 (2H, m), 3.89-3.72 (2H, m), 3.11-2.91 (2H, m), 2.79-2.71 (2H, m), 2.50-2.47 (2H, m), 2.32 (3H, s) ppm.

MS (APCI) m/z 285 [M+H]<sup>+</sup>, 283 [M-H]<sup>-</sup>

**Example 5: 5-Chloro-2-[[[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**

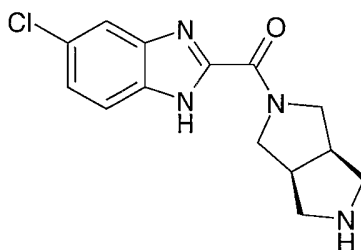


Prepared from 5-chloro-1*H*-benzimidazole-2-carboxylic acid (preparation 8) using the method from example 1 to give the title compound as a pale yellow solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.64 (1H, d), 7.60 (1H, s), 7.29 (1H, d), 4.37-4.25 (2H, m), 3.88-3.71 (2H, m), 3.11-2.91 (2H, m), 2.78-2.70 (2H, m), 2.51-2.48 (2H, m), 2.32 (s, 3H) ppm.

MS (APCI)  $m/z$  305/307  $[\text{M}+\text{H}]^+$ , 303/305  $[\text{M}-\text{H}]^-$

5 **Example 6: 5-chloro-2-[(3a*R*,6a*S*)-hexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-ylcarbonyl]-1*H*-benzimidazole**

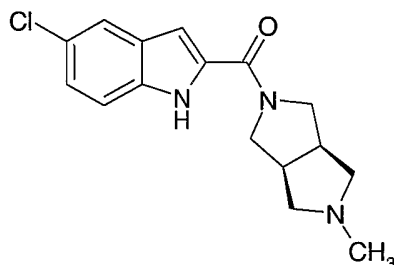


A solution of 5-chloro-1*H*-benzimidazole-2-carboxylic acid (preparation 8) (100mg, 0.50mmol) in *N,N*-dimethylacetamide (5ml) was treated with *tert*-butyl (3a*R*,6a*S*)-hexahydropyrrolo[3,4-*c*]pyrrole-2(1*H*)-carboxylate (108mg, 0.51mmol) and *O*-benzotriazo-1-yl-*N,N,N,N*-tetramethyluronium hexafluorophosphate (256mg, 0.67mmol) and the resulting solution left to stir at room temperature for 16 hours. The reaction mixture was diluted with ethyl acetate (20ml) and water (20ml) and the organic phase separated, dried (sodium sulphate) and the solvent reduced in vacuo. The residue was treated with a 1M solution of HCl in methanol (15ml) and left to stir at room temperature for 16 hours. The solvent was removed in vacuo and the residue purified by flash column chromatography on silica gel eluting with dichloromethane : methanol : 880 ammonia (99:1:0.1 changing to 90:10:1, by volume) to give the title compound as a colourless solid (50mg).

10  $^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.69-7.65 (2H, m), 7.34(1H, d), 4.45-4.40 (1H, m), 4.24-4.20 (1H, m), 3.99-3.94 (1H, m), 3.71-3.66 (1H, m), 3.19-3.11 (2H, m), 3.09-2.92 (2H, m), 2.83-2.79 (2H, m) ppm.

20 MS (APCI)  $m/z$  291/293  $[\text{M}+\text{H}]^+$ , 289/291  $[\text{M}-\text{H}]^-$

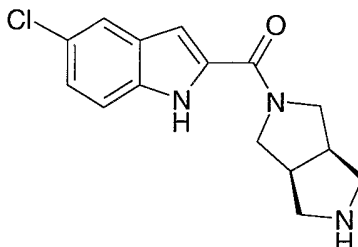
**Example 7: 5-Chloro-2-[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-indole**



25 Prepared from 5-chloro-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

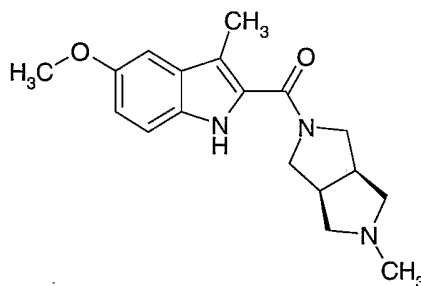
$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.67 (1H, s), 7.46 (1H, d), 7.24 (1H, dd), 6.97 (1H, s), 4.20-3.73 (4H, m), 3.17-2.96 (2H, m), 2.82-2.75 (2H, m), 2.61-2.54 (2H, m), 2.38 (3H, s) ppm.

MS (APCI)  $m/z$  304/306  $[\text{M}+\text{H}]^+$ , 302/304  $[\text{M}-\text{H}]^-$

**Example 8: 5-Chloro-2-[[*(3aR,6aS)*-hexahydropyrrolo[3,4-*c*]pyrrol-2(*1H*)-yl]carbonyl]-1*H*-indole**

A solution of 5-chloro-1*H*-indole-2-carboxylic acid (100mg, 0.51mmol) in *N,N*-dimethylacetamide (5ml) was treated with *tert*-butyl (*3aR,6aS*)-hexahydropyrrolo[3,4-*c*]pyrrole-2(*1H*)-carboxylate (108mg, 0.51mmol) and *O*-benzotriazo-1-yl-*N,N,N,N*-tetramethyluronium hexafluorophosphate (256mg, 0.67mmol) and the resulting solution left to stir at room temperature for 16 hours. The reaction mixture was diluted with ethyl acetate (20ml) and water (20ml) and the organic phase separated, dried (sodium sulphate) and the solvent reduced in vacuo. The residue was treated with a 1M solution of HCl in methanol (15ml) and left to stir at room temperature for 16 hours. The solvent was removed in vacuo and the residue purified by flash column chromatography on silica gel eluting with dichloromethane : methanol : 880 ammonia (99:1:0.1 changing to 90:10:1, by volume) to give the title compound as a pale yellow solid (42mg).

<sup>1</sup>H NMR (400MHz, DMSO<sub>d6</sub>): δ 11.77 (1H, bs), 7.69 (1H, bs), 7.45 (1H, d), 7.20 (1H, d), 6.93 (1H, s), 4.13-3.45 (4H, m), 2.99-2.63 (6H, m), 2.52 (3H, s) ppm (poorly resolved spectrum).  
MS (APCI) *m/z* 290/292 [M+H]<sup>+</sup>, 288/290 [M-H]<sup>-</sup>

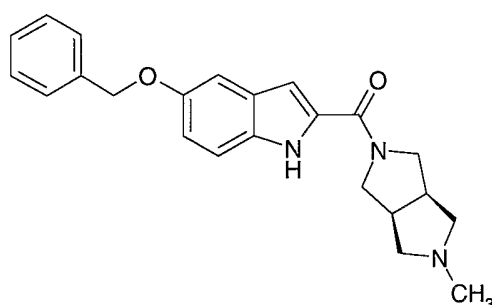
**Example 9: 5-Methoxy-3-methyl-2-[[*(3aR,6aS)*-5-methylhexahydro-pyrrolo[3,4-*c*]pyrrol-2(*1H*)-yl]carbonyl]-1*H*-indole**

Prepared from 5-methoxy-3-methyl-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a pale yellow solid.

<sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>): δ 9.42 (1H, bs), 7.28 (1H, d), 6.99 (1H, s), 6.92 (1H, d), 3.88-3.58 (7H, m), 2.91-2.78 (2H, m), 2.56-2.46 (4H, m), 2.37 (3H, s), 2.32 (3H, s) ppm.  
MS (APCI) *m/z* 314 [M+H]<sup>+</sup>, 312 [M-H]<sup>-</sup>

**Example 10: 5-(Benzyloxy)-2-[[*(3aR,6aS)*-5-methylhexahydro-pyrrolo[3,4-*c*]pyrrol-2(*1H*)-yl]carbonyl]-1*H*-indole**

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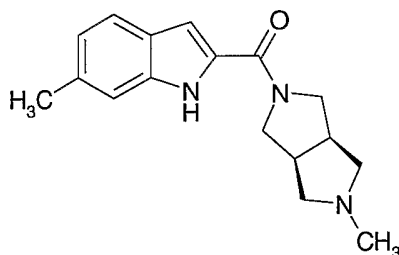


Prepared from 5-(benzyloxy)-3-methyl-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>): δ 9.39 (1H, bs), 7.47 (2H, d), 7.39 (2H, dd), 7.30 (2H, d), 7.13 (1H, s), 7.05 (1H, d), 6.76 (1H, s), 5.10 (2H, s), 4.15-4.03 (2H, m), 3.83-3.72 (2H, m), 3.11-2.91 (2H, m), 2.75-2.69 (2H, m), 2.59-2.54 (2H, m), 2.38 (s, 3H) ppm.

MS (APCI) m/z 376 [M+H]<sup>+</sup>

**Example 11: 6-Methyl-2-[[[(3*R*,6*aS*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-indole**

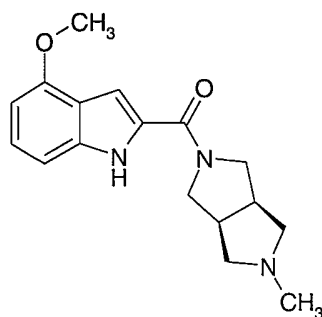


Prepared from 5-methyl-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a pale yellow solid.

<sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>): δ 9.69 (1H, bs), 7.54 (1H, d), 7.23 (1H, s), 6.98 (1H, d), 6.81 (1H, s), 4.19-4.02 (2H, m), 3.86-3.72 (2H, m), 3.11-2.85 (2H, m), 2.68-2.64 (2H, m), 2.57-2.55 (2H, m), 2.47 (3H, s), 2.35 (3H, s) ppm.

MS (APCI) m/z 284 [M+H]<sup>+</sup>, 282 [M-H]<sup>-</sup>

**Example 12: 4-Methoxy-2-[[[(3*R*,6*aS*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-indole**



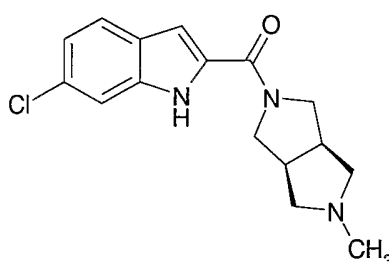


Prepared from 4-methoxy-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>): δ 9.38 (1H, bs), 7.21 (1H, t), 7.05 (1H, d), 6.96 (1H, s), 6.51 (1H, s), 4.14-4.04 (2H, m), 3.97 (3H, s), 3.89-3.78 (2H, m), 3.12-3.00 (2H, m), 2.90-2.75 (2H, m), 2.60-2.57 (2H, m), 2.42 (3H, s) ppm.

MS (APCI) m/z 300 [M+H]<sup>+</sup>, 298 [M-H]<sup>-</sup>

**Example 13: 6-Chloro-2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-indole**

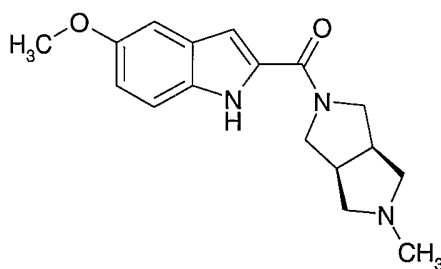


Prepared from 6-chloro-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a pale yellow solid.

<sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>): δ 10.24 (1H, bs), 7.55 (1H, d), 7.46 (1H, s), 7.06 (1H, d), 6.81 (1H, s), 4.16-4.08 (m, 2H), 3.83-3.76 (m, 2H), 3.14-2.91 (m, 2H), 2.68-2.59 (4H, m), 2.36 (s, 3H) ppm.

MS (APCI) m/z 304/306 [M+H]<sup>+</sup>, 302/304 [M-H]<sup>-</sup>

**Example 14: 5-Methoxy-2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-indole**



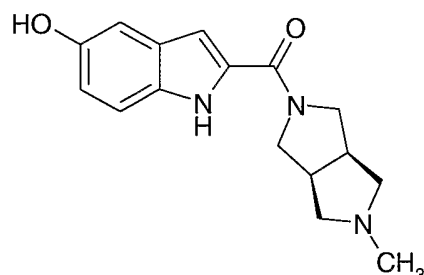
Prepared from 5-methoxy-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>): δ 9.68 (1H, bs), 7.34 (1H, d), 7.06 (1H, s), 6.96 (1H, dd), 6.77 (1H, s), 4.15-4.02 (2H, m), 3.85 (3H, s), 3.83-3.75 (2H, m), 3.11-2.91 (2H, m), 2.71-2.65 (2H, m), 2.59-2.53 (2H, m), 2.35 (3H, s) ppm.

MS (APCI) m/z 300 [M+H]<sup>+</sup>, 298 [M-H]<sup>-</sup>

**Example 15: 2-[[*(3aR,6aS)*-5-Methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-indol-5-ol**

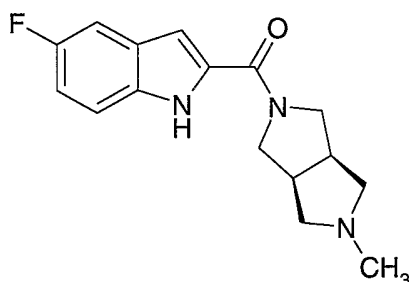
33



Prepared from 5-hydroxy-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.33 (1H, d), 7.02 (1H, d), 6.86 (1H, dd), 6.83 (1H, s), 4.20-3.72 (4H, m),  
 5 3.17-2.95 (2H, m), 2.83-2.79 (2H, m), 2.57-2.54 (2H, m), 2.39 (s, 3H) ppm.  
 MS (APCI) m/z 286 [M+H]<sup>+</sup>, 284 [M-H]<sup>-</sup>

**Example 16: 5-Fluoro-2-[[[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-indole**

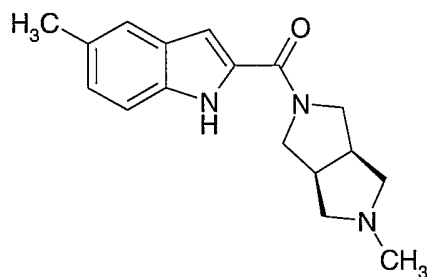


10

Prepared from 5-fluoro-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, CDCl<sub>3</sub>): δ 7.37 (1H, dd), 7.28 (1H, dd), 7.08-7.02 (1H, m), 6.81 (1H, s), 4.14-4.02 (2H, m),  
 15 3.84-3.74 (2H, m), 3.09-2.95 (2H, m), 2.74-2.70 (2H, m), 2.59-2.56 (2H, m), 2.37 (3H, s) ppm.  
 MS (APCI) m/z 288 [M+H]<sup>+</sup>, 286 [M-H]<sup>-</sup>

**Example 17: 5-Methyl-2-[[[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-indole**



20

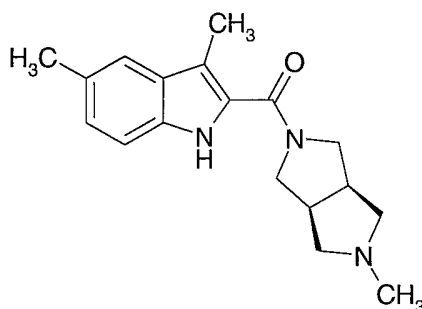
Prepared from 5-methyl-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CDCl}_3$ ):  $\delta$  7.43 (1H, s), 7.33 (1H, d), 7.12 (1H, d), 6.77 (1H, s), 4.15-4.03 (2H, m), 3.84-3.74 (2H, m), 3.09-2.94 (2H, m), 2.80-2.71 (2H, m), 2.60-2.55 (2H, m), 2.44 (3H, s), 2.38 (3H, s) ppm.

MS (APCI)  $m/z$  284  $[\text{M}+\text{H}]^+$ , 282  $[\text{M}-\text{H}]^-$

5

**Example 18: 3,5-Dimethyl-2-[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-indole**



Prepared from 3,5-dimethyl-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a pale yellow solid.

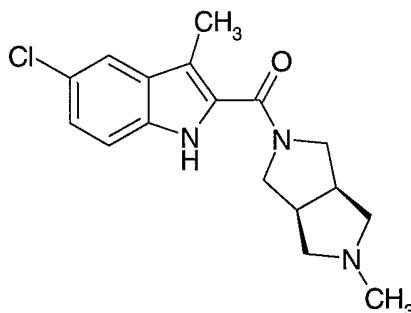
10

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.32 (1H, s), 7.23 (1H, d), 7.03 (1H, d), 3.79-3.74 (2H, m), 3.65-3.50 (2H, m), 2.95-2.90 (2H, m), 2.79-2.67 (2H, m), 2.41-2.33 (1H, m) ppm.

MS (APCI)  $m/z$  298  $[\text{M}+\text{H}]^+$ , 296  $[\text{M}-\text{H}]^-$

15

**Example 19: 5-Chloro-3-methyl-2-[(3a*R*,6a*S*)-5-methylhexahydro-pyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-indole**



Prepared from 5-chloro-3-methyl-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

20

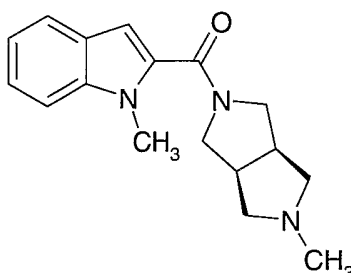
$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.53 (1H, s), 7.32 (1H, d), 7.15 (1H, d), 3.82-3.46 (4H, m), 2.98-2.89 (m, 2H), 2.76-2.66 (2H, m), 2.43-2.34 (2H, m), 2.33 (3H, s), 2.32 (3H, s) ppm.

MS (APCI)  $m/z$  318/320  $[\text{M}+\text{H}]^+$ , 316/318  $[\text{M}-\text{H}]^-$

25

**Example 20: 1-Methyl-2-[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-indole**

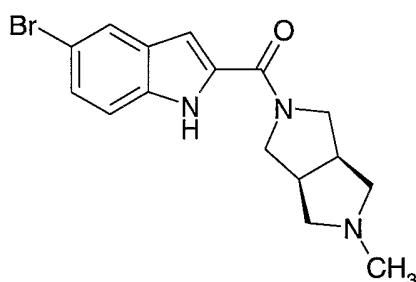
35



Prepared from 1-methyl-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.60 (1H, d), 7.42 (1H, d), 7.28 (1H, t), 7.10 (1H, t), 6.76 (1H, s), 3.89-3.83 (5H, m), 3.73-59 (2H, m), 2.96-2.89 (2H, m), 2.79-2.56 (2H, m), 2.55-2.33 (2H, m), 2.32 (3H, m) ppm.  
MS (APCI) m/z 284 [M+H]<sup>+</sup>

**Example 21: 5-Bromo-2-[[[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-indole**



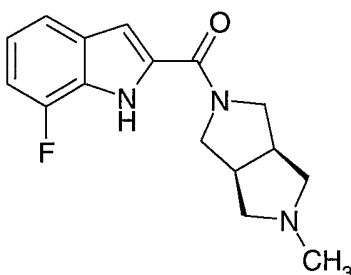
10

Prepared from 5-bromo-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.79 (1H, s), 7.37 (1H, d), 7.31 (1H, dd), 6.92 (1H, s), 4.18-3.72 (4H, m), 3.15-2.96 (2H, m), 2.86-2.78 (2H, m), 2.62-2.54 (2H, m), 2.39 (3H, s) ppm.  
MS (APCI) m/z 348/350 [M+H]<sup>+</sup>, 346/348 [M-H]<sup>-</sup>

15

**Example 22: 7-Fluoro-2-[[[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-indole**



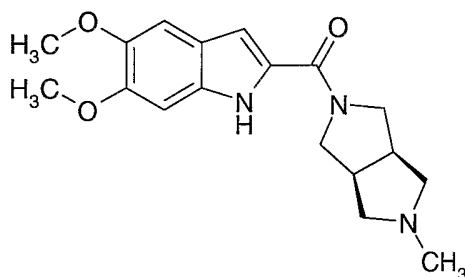
20

Prepared from 7-fluoro-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.47 (1H, d), 7.08-6.97 (3H, m), 4.18-3.68 (4H, m), 3.16-2.92 (2H, m), 2.79-2.75 (2H, m), 2.57-2.53 (2H, m), 2.38 (3H, s) ppm.

MS (APCI)  $m/z$  288  $[M+H]^+$ , 286  $[M-H]^-$

**Example 23: 5,6-Dimethoxy-2-[[*(3aR,6aS)*-5-methylhexahydro-pyrrolo[3,4-*c*]pyrrol-2(*1H*)-yl]carbonyl]-1*H*-indole**



5

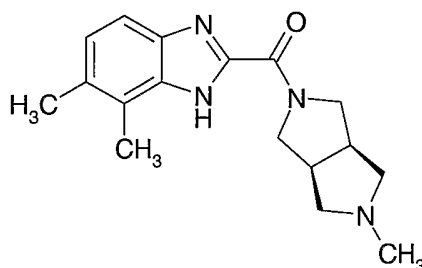
Prepared from 5,6-dimethoxy-1*H*-indole-2-carboxylic acid according to the method of example 1 to give the title compound as a colourless solid.

$^1H$  NMR (400MHz,  $CD_3OD$ ):  $\delta$  7.16 (1H, s), 7.04 (1H, s), 6.91 (1H, s), 4.20-3.93 (2H, m), 3.92 (3H, s), 3.89 (3H, s), 3.86-3.77 (2H, m), 3.15-2.98 (2H, m), 2.83-2.79 (2H, m), 2.57-2.53 (2H, m), 2.38 (s, 3H) ppm.

10

MS (APCI)  $m/z$  330  $[M+H]^+$ , 328  $[M-H]^-$

**Example 24: 6,7-Dimethyl-2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(*1H*)-yl]carbonyl]-1*H*-benzimidazole**



15

A solution of the trichloromethylbenzimidazole of preparation 9 (100mg, 0.37mmol) in a mixture of acetonitrile (3ml) and water (1ml) was treated with a solution of (*3aR,6aS*)-2-methyloctahydropyrrolo[3,4-*c*]pyrrole (95mg, 0.76mmol) in a mixture of acetonitrile (0.75ml) and water (0.25ml). The resulting solution was left to stir at room temperature for 2 hours. The solvent was removed *in vacuo* and the residue partitioned between dichloromethane (5ml) and saturated aqueous sodium bicarbonate (5ml). The organic phase was separated, dried (sodium sulfate) and the solvent removed *in vacuo*. Purification by flash column chromatography on silica gel eluting with dichloromethane : methanol : 880 ammonia (100:0:0 changing to 93:7:0.7, by volume) gave the title compound as a pale brown solid (48mg).

20

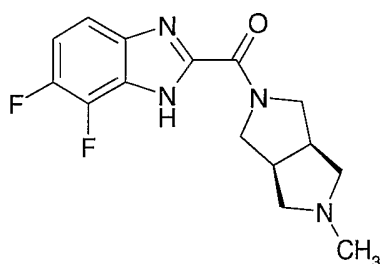
$^1H$  NMR (400MHz,  $CD_3OD$ ):  $\delta$  7.43-7.35 (1H, m), 7.17 (1H, d), 4.43-4.27 (2H, m), 3.94-3.76 (2H, m), 3.15-2.98 (2H, m), 2.86-2.78 (2H, m), 2.56 (3H, s), 2.54-2.49 (2H, m), 2.43 (3H, s), 2.37 (3H, s) ppm.

25

MS (electrospray):  $m/z$  299  $[M+H]^+$ , 297  $[M-H]^-$

**Example 25: 6,7-Difluoro-2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(*1H*)-yl]carbonyl]-1*H*-benzimidazole**

37

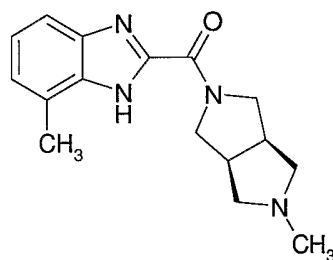


Prepared from the trichloromethylbenzimidazole of preparation 10 according to the method of example 24 with a reaction time of 2 hours to give the title compound as a pale brown solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.43-7.39 (1H, m), 7.32-7.25 (1H, m), 4.45-4.33 (2H, m), 3.95-3.76 (2H, m), 3.15-2.98 (2H, m), 2.83-2.76 (2H, m), 2.58-2.53 (2H, m), 2.37 (3H, s) ppm.

MS (electrospray): m/z 307 [M+H]<sup>+</sup>, 305 [M-H]<sup>-</sup>

**Example 26: 7-Methyl-2-[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl-1H-benzimidazole**



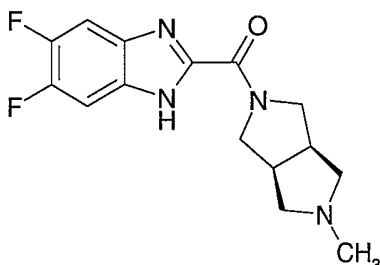
10

Prepared from the trichloromethylbenzimidazole of preparation 11 according to the method of example 24 with a reaction time of 2 hours to give the title compound as a pale brown solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.45 (1H, d), 7.20 (1H, t), 7.09 (1H, d), 4.37-4.24 (2H, m), 3.90-3.71 (2H, m), 3.09-2.91 (2H, m), 2.79-2.71 (2H, m), 2.59 (3H, s), 2.49-2.44 (2H, m), 2.32 (3H, s) ppm.

15 MS (APCI): m/z 285 [M+H]<sup>+</sup>, 283 [M-H]<sup>-</sup>

**Example 27: 5,6-Difluoro-2-[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl-1H-benzimidazole**



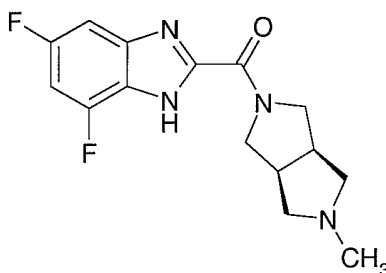
20 A solution of the acid from preparation 31 (700mg, 3.53mmol) and (3aR,6aS)-2-methyloctahydropyrrolo[3,4-c]pyrrole (490mg, 3.88mmol) in N,N-dimethylformamide (35ml) was treated with O-benzotriazo-1-yl-N,N,N,N-tetramethyluronium hexafluorophosphate (1.60g, 4.24mmol) and the resulting solution left to stir at room temperature for 16 hours. The solvent was removed *in vacuo* and the residue partitioned between ethyl acetate (100ml) and saturated aqueous sodium bicarbonate

*in vacuo*

<sup>1</sup>H NMR (400MHz, DMSO<sub>d6</sub>): δ 13.29 (1H, bs), 7.74-7.58 (2H, m), 4.34-4.29 (1H, m), 4.15-4.11 (1H, m), 3.83-3.78 (1H, m), 3.55-3.50 (1H, m), 2.95-2.87 (1H, m), 2.83-2.75 (1H, m), 2.49-2.38 (4H, m), 2.18 (3H, s) ppm.

5 MS (APCI): m/z 307 [M+H]<sup>+</sup>, 305 [M-H]<sup>-</sup>

**Example 28: 5,7-Difluoro-2-[[[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



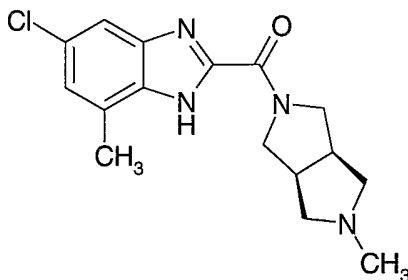
10 Prepared from the trichloromethylbenzimidazole of preparation 13 according to the method of example 24 with a reaction time of 2 hours to give the title compound as a pale brown solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.15-7.12 (1H, m), 6.93-6.88 (1H, m), 4.40-4.29 (2H, m), 3.90-3.71 (2H, m), 3.12-2.94 (2H, m), 2.79-2.72 (2H, m), 2.53-2.49 (2H, m), 2.33 (3H, s) ppm.

MS (APCI): m/z 307 [M+H]<sup>+</sup>

15

**Example 29: 5-Chloro-7-methyl-2-[[[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



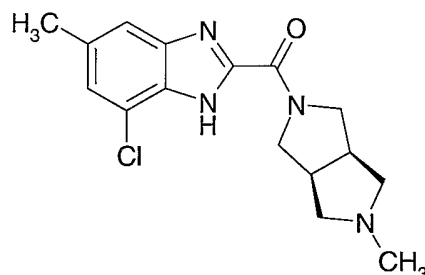
20 Prepared from the trichloromethylbenzimidazole of preparation 14 according to the method of example 24 with a reaction time of 2 hours to give the title compound as a pale brown solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.44 (1H, s), 7.10 (1H, s), 4.39-4.27 (2H, m), 3.90-3.71 (2H, m), 3.10-2.94 (2H, m), 2.80-2.73 (2H, m), 2.58 (3H, m), 2.51-2.47 (m, 2H), 2.33 (3H, s) ppm.

MS (APCI): m/z 319/321 [M+H]<sup>+</sup>, 317/319 [M-H]<sup>-</sup>

25 **Example 30: 7-Chloro-5-methyl-2-[[[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**

39

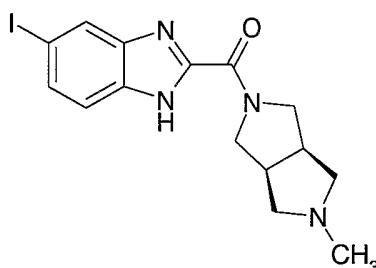


Prepared from the trichloromethylbenzimidazole of preparation 15 according to the method of example 24 with a reaction time of 16 hours to give the title compound as a pale orange solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.31 (1H, s), 7.19 (s, 1H), 4.42-4.26 (2H, m), 3.92-3.71 (2H, m), 3.15-3.03 (2H, m), 2.82-2.72 (2H, m), 2.55-2.44 (2H, m), 2.35 (3H, s) ppm.

MS (APCI):  $m/z$  319/321  $[\text{M}+\text{H}]^+$ , 317/319  $[\text{M}-\text{H}]^-$

**Example 31: 5-Iodo-2-[(3*R*,6*a*S)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



10

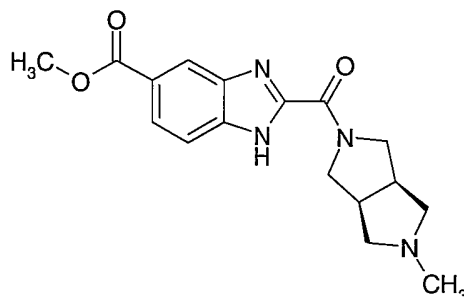
Prepared from the trichloromethylbenzimidazole of preparation 16 according to the method of example 24 with a reaction time of 3 hours to give the title compound as a pale brown solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  8.07 (1H, s), 7.65 (1H, d), 7.51 (1H, d), 4.42-4.31 (2H, m), 3.95-3.76 (2H, m), 3.17-2.98 (2H, m), 2.84-2.77 (2H, m), 2.58-2.54 (2H, m), 2.38 (3H, s) ppm.

MS (APCI):  $m/z$  397  $[\text{M}+\text{H}]^+$ , 395  $[\text{M}-\text{H}]^-$

15

**Example 32: Methyl 2-[(3*R*,6*a*S)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole-5-carboxylate**



20

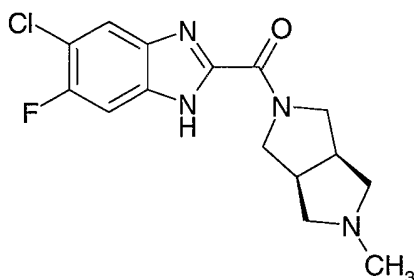
Prepared from the trichloromethylbenzimidazole of preparation 17 according to the method of example 24 with a reaction time of 3 hours to give the title compound as a pale brown solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  8.41 (1H, s), 8.03 (1H, d), 7.73 (1H, d), 4.44-4.34 (2H, m), 3.97 (3H, s), 3.96-3.77 (2H, m), 3.18-3.00 (2H, m), 2.87-2.80 (2H, m), 2.62-2.59 (2H, m), 2.37 (3H, s) ppm.



MS (APCI):  $m/z$  329  $[M+H]^+$ , 327  $[M-H]^-$

**Example 33: 5-Chloro-6-fluoro-2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo [3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



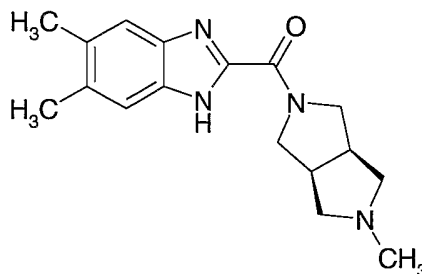
5

Prepared from the trichloromethylbenzimidazole of preparation 18 according to the method of example 24 with a reaction time of 1.5 hours to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.76 (1H, d), 7.48 (1H, d), 4.38-4.28 (2H, m), 3.90-3.71 (2H, m), 3.10-2.93 (2H, m), 2.78-2.71 (2H, m), 2.53-2.49 (2H, m), 2.33 (3H, s) ppm.

10 MS (APCI):  $m/z$  323  $[M+H]^+$ , 321  $[M-H]^-$

**Example 34: 5,6-Dimethyl-2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



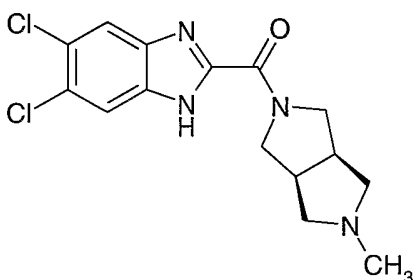
15 Prepared from the trichloromethylbenzimidazole of preparation 19 according to the method of example 24 with a reaction time of 1.5 hours to give the title compound as a pale yellow solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.41 (2H, s), 4.34-4.21 (2H, m), 3.88-3.70 (2H, m), 3.08-2.92 (2H, m), 2.79-2.72 (2H, m), 2.49-2.45 (2H, m), 2.37 (6H, s), 2.32 (3H, s) ppm.

MS (APCI):  $m/z$  297  $[M+H]^+$ , 299  $[M-H]^-$

20

**Example 35: 5,6-Dichloro-2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**

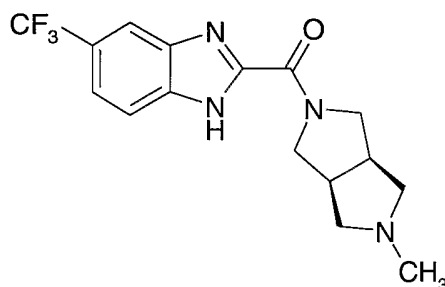


Prepared from the trichloromethylbenzimidazole of preparation 20 according to the method of example 24 with a reaction time of 16 hours to give the title compound as a pale brown solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 7.81 (2H, s), 4.39-4.28 (2H, m), 3.92-3.72 (2H, m), 3.15-2.94 (2H, m), 2.79-2.70 (2H, m), 2.56-2.48 (2H, m), 2.35 (3H, s) ppm.

5 MS (APCI): m/z 339/341 [M+H]<sup>+</sup>, 337/339 [M-H]<sup>-</sup>

**Example 36: 2-[[[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-5-(trifluoromethyl)-1*H*-benzimidazole**



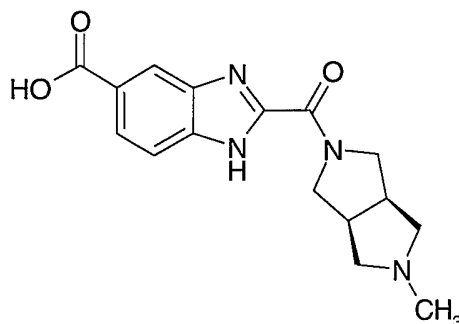
10 A solution of 2-(trichloromethyl)-5-(trifluoromethyl)-1*H*-benzimidazole (preparation 21) (100mg, 0.33mmol) in a mixture of acetonitrile and water (3.2ml, 3:1 by volume) was treated with (3a*R*,6a*S*)-2-methyloctahydropyrrolo[3,4-*c*]pyrrole (83mg, 0.66mmol) and potassium carbonate (0.24ml of a 4M solution, 0.96mmol). The resulting mixture was stirred at room temperature for 16 hours. Dichloromethane (30ml) and water (30ml) were added and the organic phase was separated, dried

15 (sodium sulfate) and the solvent removed *in vacuo*. Purification by flash column chromatography on silica gel eluting with dichloromethane : methanol : 880 ammonia (95:5:0.5, by volume) gave the title compound as a colourless solid (20mg).

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD): δ 8.00 (1H, s), 7.80 (1H, d), 7.59 (1H, d), 4.42-4.30 (2H, m), 3.93-3.74 (2H, m), 3.14-2.95 (2H, m), 2.79-2.72 (2H, m), 2.55-2.51 (2H, m), 2.34 (3H, s) ppm.

20 MS (APCI): m/z 339 [M+H]<sup>+</sup>, 337 [M-H]<sup>-</sup>

**Example 37: 2-[[[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1*H*-benzimidazole-5-carboxylic acid**



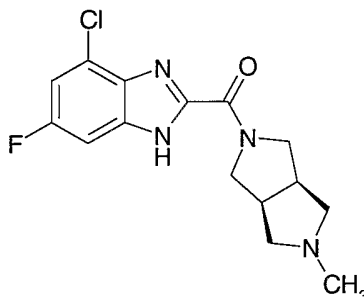
25 Methyl 2-[[[(3a*R*,6a*S*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole-5-carboxylate (1.6g, 5.0mmol) in a mixture of water (8ml) and 1,4-dioxan (60ml) was treated with sodium hydroxide (0.6g, 15.0mmol) and the resulting suspension was heated to reflux for 16 hours. The reaction mixture was cooled to 10°C and neutralized with concentrated hydrochloric acid. The solvent was

removed in vacuo and the residue solubilised in methanol, filtered and the solvent removed in vacuo to give the title compound as a colourless solid (1.41g).

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  8.33 (1H, bs), 7.98 (1H, d), 7.64-7.60 (1H, m), 3.50-3.41 (2H, m), 3.20-3.12 (4H, m), 2.90-2.88 (2H, m), 2.68-2.60 (2H, m), 2.48 (3H, s) ppm.

5 MS (APCI):  $m/z$  315  $[\text{M}+\text{H}]^+$ , 313  $[\text{M}-\text{H}]^-$

**Example 38: 4-chloro-6-fluoro-2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



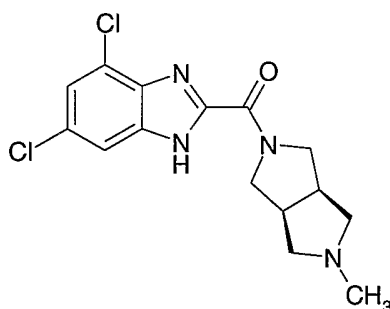
10 Prepared from the trichloromethylbenzimidazole of preparation 22 according to the method of example 24 with a reaction time of 16 hours to give the title compound as a pale yellow foam.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.32-7.29 (1H, dd), 7.24-7.22 (1H, dd), 4.45-4.33 (2H, m), 3.94-3.75 (2H, m), 3.16-2.99 (2H, m), 2.84-2.77 (2H, m), 2.57-2.54 (2H, m), 2.37 (3H, s) ppm.

MS (APCI):  $m/z$  323/325  $[\text{M}+\text{H}]^+$ , 321/323  $[\text{M}-\text{H}]^-$

15

**Example 39: 4,6-dichloro-2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



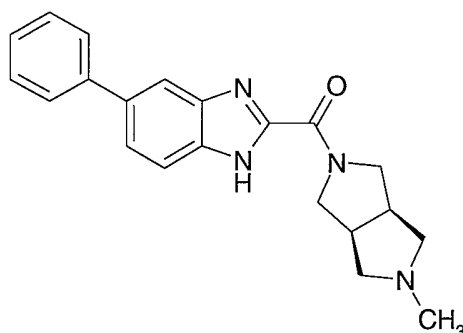
20 Prepared from the trichloromethylbenzimidazole of preparation 23 according to the method of example 24 with a reaction time of 16 hours to give the title compound as a pale yellow foam.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.60 (1H, s), 7.38 (1H, s), 4.44-4.32 (2H, m), 3.95-3.75 (2H, m), 3.17-2.99 (2H, m), 2.84-2.77 (2H, m), 2.58-2.54 (2H, m), 2.37 (3H, s) ppm.

MS (APCI):  $m/z$  339/341  $[\text{M}+\text{H}]^+$ , 337/339  $[\text{M}-\text{H}]^-$

25 **Example 40: 2-[[*(3aR,6aS)*-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1*H*)-yl]carbonyl]-5-phenyl-1*H*-benzimidazole**

43

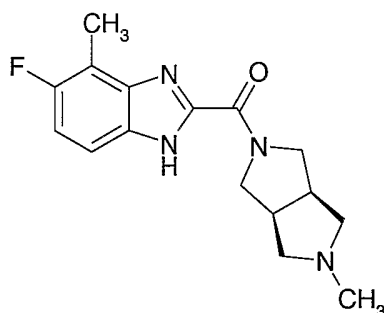


Prepared from the trichloromethylbenzimidazole of preparation 24 according to the method of example 24 with a reaction time of 16 hours to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.88 (1H, s), 7.75 (1H, d), 7.69-7.67 (2H, m), 7.63-7.61 (1H, m), 7.49-7.45 (2H, m), 7.38-7.34 (1H, m), 4.43-4.31 (2H, m), 3.94-3.76 (2H, m), 3.13-2.97 (2H, m), 2.82-2.75 (2H, m), 2.55-2.51 (2H, m), 2.36 (3H, s) ppm.

MS (APCI):  $m/z$  347  $[\text{M}+\text{H}]^+$ , 345  $[\text{M}-\text{H}]^-$

**Example 41: 5-fluoro-4-methyl-2-((3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl)carbonyl-1H-benzimidazole**

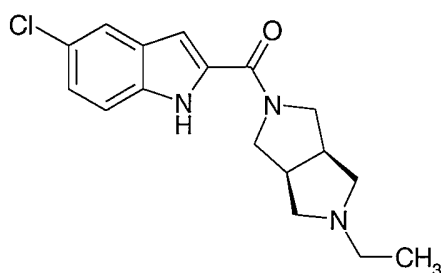


Prepared from the trichloromethylbenzimidazole of preparation 25 according to the method of example 24 with a reaction time of 16 hours to give the title compound as a yellow foam.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.49-7.46 (1H, m), 7.13-7.08 (1H, m), 4.43-4.31 (2H, m), 3.95-3.76 (2H, m), 3.15-2.98 (2H, m), 2.85-2.77 (2H, m), 2.53 (3H, s), 2.37 (3H, s) ppm.

MS (APCI):  $m/z$  303  $[\text{M}+\text{H}]^+$ , 301  $[\text{M}-\text{H}]^-$

**Example 42: 5-Chloro-2-((3aR,6aS)-5-ethylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl)carbonyl-1H-indole**



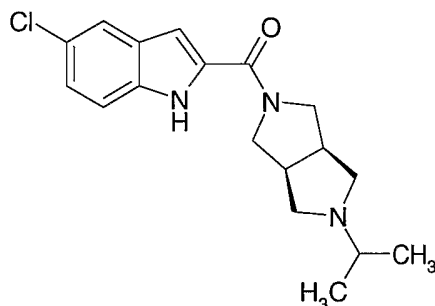
20

A solution of the compound of example 8 (170mg, 0.58mmol) in dichloromethane (5ml) was treated with acetaldehyde (66 $\mu$ l, 1.18mmol), acetic acid (33 $\mu$ l, 0.58mmol) and sodium triacetoxy borohydride (147mg, 70mmol) and the resulting mixture left to stir at room temperature for 16 hours. Further dichloromethane (20ml) and sat. aq. sodium hydrogen carbonate (20ml) was added and the organic phase separated. The aqueous phase was extracted with further dichloromethane (20ml) and the combined organics dried (sodium sulphate) and the solvent removed in vacuo. The residue was purified by flash column chromatography on silica gel eluting with dichloromethane : methanol : 880 ammonia (99:1:0.1 changing to 90:10:1, by volume) to give the title compound as a pale yellow solid (60mg).

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD):  $\delta$  7.67 (1H, s), 7.46 (1H, d), 7.23 (1H, dd), 6.97 (1H, d), 4.19-3.74 (4H, bm), 3.19-2.97 (2H, m), 2.92-2.85 (2H, m), 2.58-2.51 (4H, m), 1.16 (3H, t) ppm.

MS (APCI): m/z 318/320 [M+H]<sup>+</sup>, 316/318 [M-H]<sup>-</sup>

**Example 43: 5-Chloro-2-[[[(3aR,6aS)-5-isopropylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-indole**

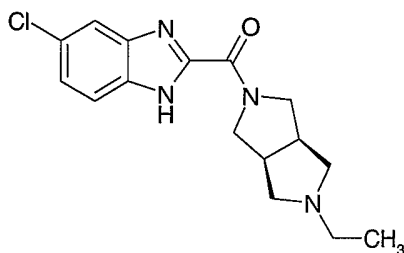


Prepared according to the method for example 42 using the compound of example 8 and acetone to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, DMSO-d<sub>6</sub>):  $\delta$  11.75 (1H, s), 7.69 (1H, s), 7.46 (1H, dd), 7.21 (1H, dd), 6.93 (1H, dd), 4.16-4.01 (1H, m), 3.94-3.84 (1H, m), 3.73-3.64 (1H, m), 3.59-3.50 (1H, m), 2.98-2.77 (2H, m), 2.63-2.53 (4H, m), 2.34 (1H, m), 1.02 (6H, d) ppm.

MS (APCI): m/z 332/334 [M+H]<sup>+</sup>, 330/332 [M-H]<sup>-</sup>

**Example 44: 5-Chloro-2-[[[(3aR,6aS)-5-ethylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-benzimidazole**

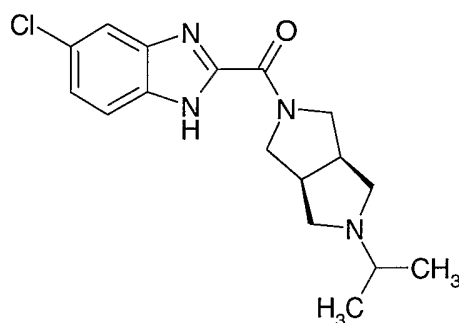


Prepared according to the method for example 42 using the compound of example 6 and acetaldehyde to give the title compound as a colourless solid.

<sup>1</sup>H NMR (400MHz, CD<sub>3</sub>OD):  $\delta$  7.70-7.68 (1H, m), 7.66 (1H, s), 7.30 (1H, d), 4.42-4.33 (2H, m), 3.93-3.79 (2H, m), 3.13-2.90 (4H, m), 2.61-2.53 (4H, m), 1.17 (3H, t) ppm.

MS (APCI):  $m/z$  319/321  $[M+H]^+$ , 317/319  $[M-H]^-$

**Example 45: 5-Chloro-2-[[[(3*R*,6*aS*)-5-isopropylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



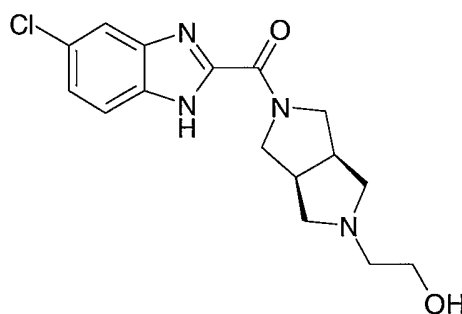
5

Prepared according to the method for example 42 using the compound of example 6 and acetone to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.70-7.67 (2H, m), 7.36-7.34 (1H, m), 4.43-4.31 (2H, m), 3.92-3.80 (2H, m), 3.13-2.98 (4H, m), 2.56-2.46 (3H, m), 1.17 (6H, d) ppm.

10 MS (APCI):  $m/z$  333/335  $[M+H]^+$ , 331/333  $[M-H]^-$

**Example 46: 2-[[[(3*R*,6*aS*)-5-[(5-Chloro-1*H*-benzimidazol-2-yl)carbonyl] hexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]ethanol**



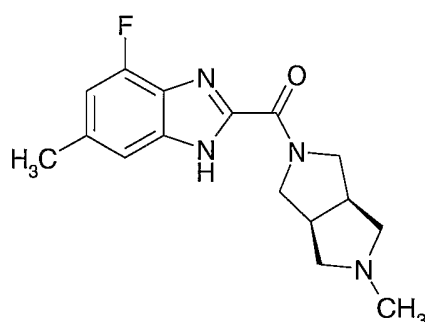
15 Prepared according to the method for example 42 using the compound of example 6 and 1,4-dioxane-2,5-diol to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.70-7.65 (2H, m), 7.36-7.33 (1H, m), 4.38-4.36 (2H, m), 3.94-3.78 (2H, m), 3.70 (2H, t), 3.13-2.92 (4H, m), 2.73-2.65 (4H, m) ppm.

MS (APCI):  $m/z$  335/337  $[M+H]^+$ , 333/335  $[M-H]^-$

20

**Example 47: 7-Fluoro-5-methyl-2-[[[(3*R*,6*aS*)-5-methylhexahydro pyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



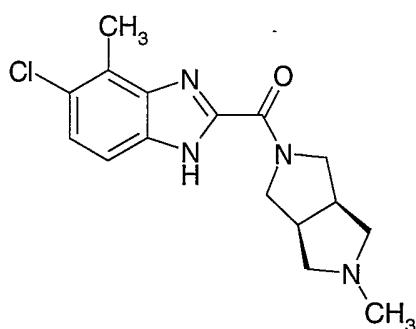
A solution of aniline of preparation 28 (79mg, 0.56mmol) in acetic acid (3ml) was treated with methyl-2,2,2-trichloroacetimidate (77 $\mu$ l, 0.62mmol) and the resulting solution was left to stir at room temperature for 16 hours. Water (10ml) was added and the reaction stirred for a further hour. The precipitate was filtered off and dried *in vacuo*. The resulting solid was suspended in a mixture of acetonitrile and water (3:1 by volume, 4ml) and treated with a solution of (3*aR*,6*aS*)-2-methyloctahydropyrrolo[3,4-*c*]pyrrole (148mg, 1.17mmol) in a mixture of acetonitrile (0.75ml) and water (0.25ml). After 3 hours the solvent was removed *in vacuo* and the residue dissolved in dichloromethane (15ml), washed with saturated sodium bicarbonate (2 x 15ml), dried (sodium sulfate) and concentrated *in vacuo*. Purification by flash column chromatography on silica gel eluting with dichloromethane : methanol : 880 ammonia (99:1:0.1 changing to 93:7:0.7, by volume) gave the title compound as a colourless solid (133mg).

$^1\text{H NMR}$  (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.19 (1H, s), 6.87-6.84 (1H, d), 4.39-4.27 (2H, m), 3.90-3.84 (1H, m), 3.75-3.71 (1H, m), 3.09-2.95 (2H, m), 2.79-2.72 (2H, m), 2.51-2.40 (2H, m), 2.46 (3H, s), 2.33 (3H, s) ppm.

MS (APCI):  $m/z$  303  $[\text{M}+\text{H}]^+$ , 301  $[\text{M}-\text{H}]^-$

15

**Example 48: 5-Chloro-4-methyl-2-[(3*aR*,6*aS*)-5-methylhexahydro pyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



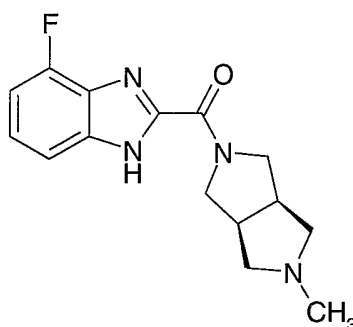
Prepared from the diamine of preparation 29 using the method of example 47 to give the title compound as a colourless solid.

$^1\text{H NMR}$  (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.43 (1H, d), 7.30 (1H, d), 4.40-4.29 (2H, m), 3.90-3.85 (1H, m), 3.76-3.72 (1H, m), 3.08-2.95 (2H, m), 2.80-2.73 (2H, m), 2.62 (3H, s), 2.51-2.47 (2H, m), 2.33 (3H, s) ppm.

MS (APCI):  $m/z$  319  $[\text{M}+\text{H}]^+$ , 317  $[\text{M}-\text{H}]^-$

**Example 49: 4-Fluoro-2-[(3*aR*,6*aS*)-5-methylhexahydropyrrolo[3,4-*c*]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**

47



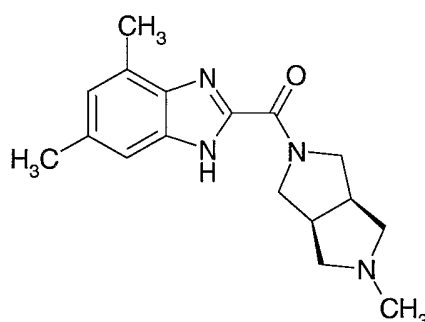
Prepared from 3-fluorobenzene-1,2-diamine using the method of example 47 to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.41 (1H, d), 7.31-7.26 (1H, m), 7.03-6.98 (1H, m), 4.40-4.28 (2H, m),  
 5 3.91-3.85 (1H, m), 3.77-3.73 (1H, m), 3.11-2.95 (2H, m), 2.80-2.73 (m, 2H), 2.52-2.49 (m, 2H), 2.33 (3H, s) ppm.

MS (APCI):  $m/z$  289  $[\text{M}+\text{H}]^+$ , 287  $[\text{M}-\text{H}]^-$

**Example 50: 4,6-Dimethyl-2-[[*(3aR,6aS)*-5-methylhexahydro-pyrrolo[3,4-*c*]pyrrol-2(*1H*)-yl]carbonyl]-*1H*-benzimidazole**

10



Prepared from 3,5-dimethylbenzene-1,2-diamine using the method of example 47 to give the title compound as a pale yellow solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.22 (1H, s), 6.94 (1H, s), 4.37-4.24 (2H, m), 3.89-3.84 (1H, m), 3.76-3.71  
 15 (1H, m), 3.09-2.92 (2H, m), 2.81-2.73 (2H, m), 2.55 (3H, s), 2.49-2.44 (2H, m), 2.42 (3H, s), 2.33 (3H, s) ppm.

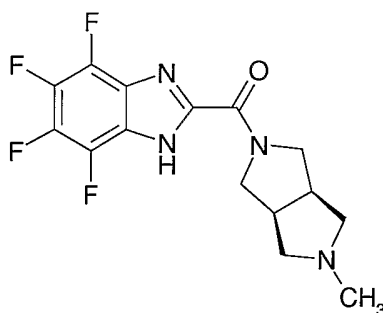
MS (APCI):  $m/z$  299  $[\text{M}+\text{H}]^+$ , 297  $[\text{M}-\text{H}]^-$

**Example 51: 4,5,6,7-Tetrafluoro-2-[[*(3aR,6aS)*-5-methylhexahydro pyrrolo[3,4-*c*]pyrrol-2(*1H*)-yl]carbonyl]-*1H*-benzimidazole**

20



48

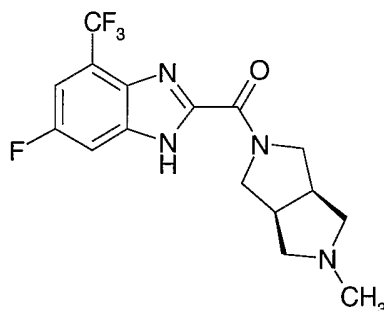


Prepared from 3,4,5,6-tetrafluorobenzene-1,2-diamine using the method of example 47 to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{DMSO-d}_6$ ):  $\delta$  4.22-4.17 (1H, m), 4.05-4.01 (1H, m), 3.79-3.74 (1H, m), 3.58-3.54 (1H, m), 2.93-2.83 (2H, m), 2.64-2.53 (4H, m), 2.28 (3H, s) ppm.

MS (APCI):  $m/z$  343  $[\text{M}+\text{H}]^+$ , 341  $[\text{M}-\text{H}]^-$

**Example 52 : 6-Fluoro-2-[[3aR,6aS]-5-methylhexahydropyrrolo[3,4-c] pyrrol-2(1H)-yl]carbonyl]-4-(trifluoromethyl)-1H-benzimidazole**



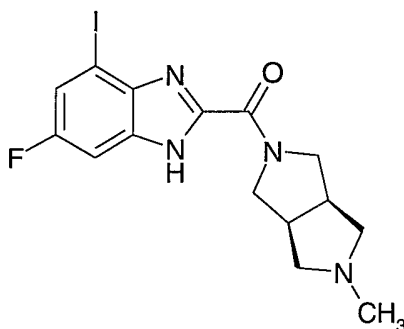
10

Prepared from 5-fluoro-3-(trifluoromethyl)benzene-1,2-diamine using the method of example 47 to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.57 (1H, d), 7.42 (1H, d), 4.39-4.33 (2H, m), 3.91-3.72 (2H, m), 3.10-2.97 (2H, m), 2.80-2.73 (2H, m), 2.54-2.50 (2H, m), 2.34 (3H, s) ppm.

MS (APCI):  $m/z$  357  $[\text{M}+\text{H}]^+$ , 355  $[\text{M}-\text{H}]^-$

**Example 53: 6-Fluoro-4-iodo-2-[[3aR,6aS]-5-methylhexahydropyrrolo [3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-benzimidazole**

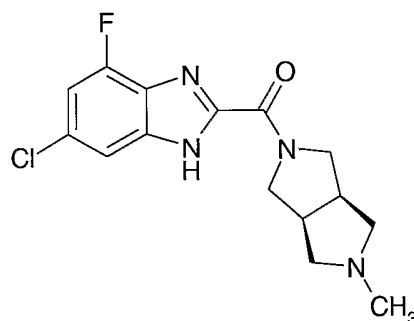


Prepared from 5-fluoro-3-iodobenzene-1,2-diamine using the method of example 47 to give the title compound as a yellow solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.53 (1H, d), 7.31-7.28 (1H, m), 4.44-4.35 (2H, m), 3.90-3.85 (1H, m), 3.76-3.71 (1H, m), 3.12-2.96 (2H, m), 2.80-2.74 (2H, m), 2.54-2.50 (2H, m), 2.34 (3H, s) ppm.

5 MS (APCI):  $m/z$  415  $[\text{M}+\text{H}]^+$ , 413  $[\text{M}-\text{H}]^-$

**Example 54: 6-Chloro-4-fluoro-2-[[*(3aR,6aS)*-5-methylhexahydro pyrrolo[3,4-c]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



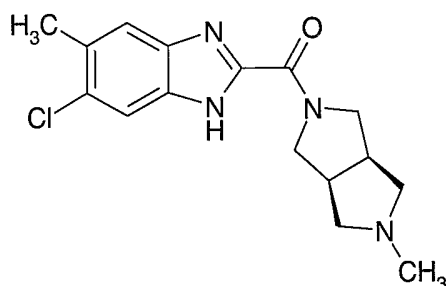
10 Prepared from 5-chloro-3-fluorobenzene-1,2-diamine using the method for example 47 to give the title compound as a yellow solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.76 (1H, d), 7.50-7.48 (1H, m), 4.38-4.28 (2H, m), 3.90-3.83 (1H, m), 3.75-3.71 (1H, m), 3.12-2.96 (2H, m), 2.78-2.71 (2H, m), 2.52-2.49 (2H, m), 2.33 (3H, s) ppm.

MS (APCI):  $m/z$  323  $[\text{M}+\text{H}]^+$ , 321  $[\text{M}-\text{H}]^-$

15

**Example 55: 6-Chloro-5-methyl-2-[[*(3aR,6aS)*-5-methylhexahydro pyrrolo[3,4-c]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole**



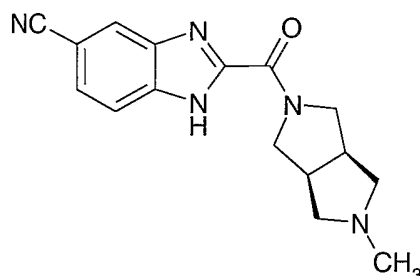
20 Prepared from 4-chloro-5-methylbenzene-1,2-diamine using the method for example 47 to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.67 (1H, s), 7.55 (1H, s), 4.37-4.25 (2H, m), 3.90-3.84 (1H, m), 3.75-3.71 (1H, m), 3.09-2.95 (2H, m), 2.79-2.72 (2H, m), 2.51-2.49 (2H, m), 2.47 (3H, s), 2.33 (3H, s) ppm.

MS (APCI):  $m/z$  319  $[\text{M}+\text{H}]^+$ , 317  $[\text{M}-\text{H}]^-$

25 **Example 56: 2-[[*(3aR,6aS)*-5-Methylhexahydropyrrolo[3,4-c]pyrrol-2(1*H*)-yl]carbonyl]-1*H*-benzimidazole-5-carbonitrile**

50

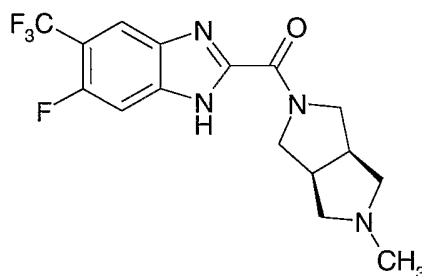


Prepared from 3,4-diaminobenzonitrile using the method for example 47 to give the title compound as a pale brown solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  8.09 (1H, s), 7.78-7.76 (1H, d), 7.62-7.59 (1H, d), 4.40-4.29 (2H, m), 3.92-3.86 (1H, m), 3.77-3.73 (1H, m), 3.13-2.94 (2H, m), 2.79-2.72 (2H, m), 2.55-2.51 (2H, m), 2.34 (3H, s) ppm.

MS (APCI):  $m/z$  296  $[\text{M}+\text{H}]^+$ , 294  $[\text{M}-\text{H}]^-$

**Example 57: 6-Fluoro-2-((3aR,6aS)-5-methylhexahydro[3,4-c]pyrrolo[2,1-h]pyrrol-2(1H)-yl)carbonyl-5-(trifluoromethyl)-1H-benzimidazole**

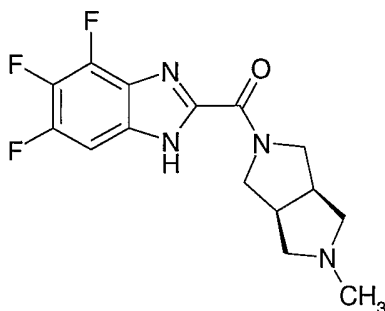


Prepared from 4-fluoro-5-(trifluoromethyl)benzene-1,2-diamine using the method for example 47 to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  8.01-8.00 (1H, d), 7.54-7.51 (1H, d), 4.41-4.30 (2H, m), 3.92-3.86 (1H, m), 3.77-3.72 (1H, m), 3.10-2.96 (2H, m), 2.79-2.72 (2H, m), 2.55-2.51 (2H, m), 2.34 (3H, s) ppm.

MS (APCI):  $m/z$  357  $[\text{M}+\text{H}]^+$ , 355  $[\text{M}-\text{H}]^-$

**Example 58: 4,5,6-Trifluoro-2-((3aR,6aS)-5-methylhexahydro[3,4-c]pyrrolo[2,1-h]pyrrol-2(1H)-yl)carbonyl-1H-benzimidazole**



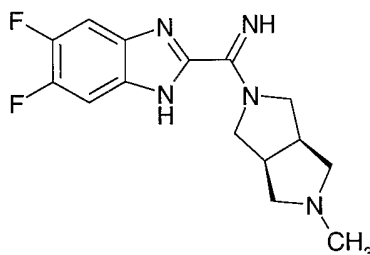
20

Prepared from 3,4,5-trifluorobenzene-1,2-diamine using the method for example 47 to give the title compound as a colourless solid.

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.33-7.30 (1H, m), 4.40-4.30 (2H, m), 3.90-3.71 (2H, m), 3.11-2.95 (2H, m), 2.79-2.73 (2H, m), 2.55-2.50 (2H, m), 2.34 (3H, s) ppm.

MS (APCI):  $m/z$  325  $[\text{M}+\text{H}]^+$ , 323  $[\text{M}-\text{H}]^-$

5 **Example 59: 1-(5,6-Difluoro-1H-benzimidazol-2-yl)-1-[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine**



A suspension of the trichloromethylbenzimidazole of preparation 12 (1.17g, 4.3mmol) and 4Å molecular sieves (1g) in acetonitrile (15ml) was treated with a solution of (3aR,6aS)-2-methyloctahydropyrrolo[3,4-c]pyrrole (598mg, 4.74mmol) in acetonitrile 2ml). The resulting mixture was left to stir at room temperature for 30 minutes prior to the addition of ammonium acetate (397mg, 5.16mmol). The reaction mixture was left to stir at room temperature for 16 hours. Saturated sodium hydrogen carbonate (20ml) and the mixture was extracted with dichloromethane (3 x 20ml). The combined organics were dried (sodium sulfate) and reduced *in vacuo*. Purification by flash column chromatography on silica gel eluting with dichloromethane : methanol : 880 ammonia (98:2:0.2 changing to 90:10:1, by volume) gave the title compound as a pale brown solid (155mg).

$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.37 (2H, t), 4.26-4.10 (2H, bm), 3.96-3.78 (2H, m), 3.13-3.06 (2H, m), 2.68-2.59 (4H, m), 2.34 (3H, s) ppm.

MS (APCI):  $m/z$  306  $[\text{M}+\text{H}]^+$ , 304  $[\text{M}-\text{H}]^-$

20

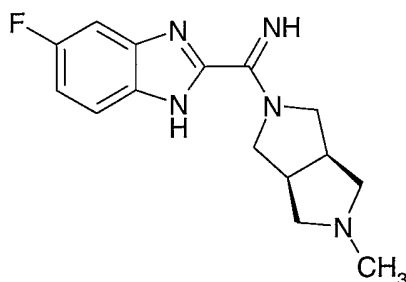
**Alternative method for Example 59 : 1-(5,6-Difluoro-1H-benzimidazol-2-yl)-1-[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine**

A solution of the nitrile from preparation 33 (8.66g, 48.3mmol) and (3aR,6aS)-2-methyloctahydropyrrolo[3,4-c]pyrrole (7.32g, 58.0mmol) in isopropanol (100ml) was heated to reflux for 3 hours. The reaction mixture was allowed to cool gradually to room temperature and the resulting precipitate was filtered off, washed with further isopropanol (20ml) and dried *in vacuo* to give the title compound as a colourless crystalline solid (13.57g).

25

30 **Example 60: 1-(5-Fluoro-1H-benzimidazol-2-yl)-1-[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine**

52



Prepared from the trichloromethylbenzimidazole of preparation 32 using the method of example 59 to give the title compound as a pale yellow solid.

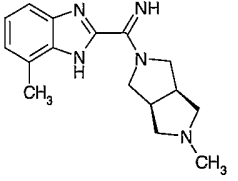
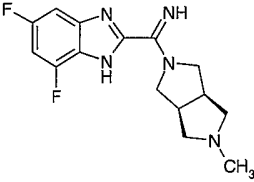
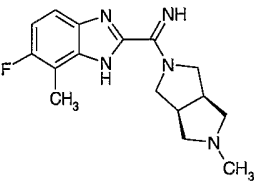
$^1\text{H}$  NMR (400MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  7.58-7.54 (1H, dd), 7.25-7.22 (1H, dd), 6.93-6.88 (1H, m), 4.15 (2H, bs),  
 5 3.85 (2H, bs), 3.14-3.07 (2H, m), 2.70-2.59 (4H, m), 2.35 (3H, s) ppm.

MS (APCI):  $m/z$  288  $[\text{M}+\text{H}]^+$ , 286  $[\text{M}-\text{H}]^-$

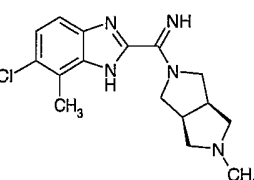
6-bromo-4-methyl-2-[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-benzimidazole and 6-fluoro-4-methyl-2-[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]carbonyl]-1H-benzimidazole have also been prepared using identical or similar methods.  
 10

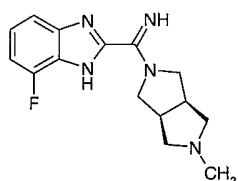
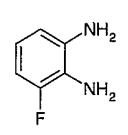
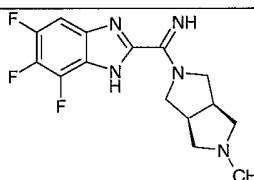
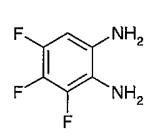
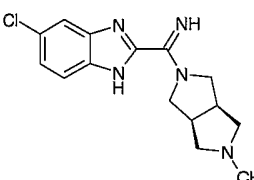
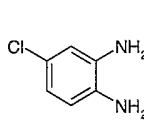
Examples **61-64** were prepared from the trichloromethylbenzimidazole precursors indicated in the table below according to the following procedure : A solution of the trichloromethylbenzimidazole (0.75mmol) in ethanol (3ml) was cooled to  $0^\circ\text{C}$  and treated with a solution of 880 ammonia (3ml) in water (3ml). The resulting mixture was then allowed to warm gradually to room temperature. After 2 hours the pH was adjusted to pH1 by addition of 2N hydrochloric acid. The reaction mixture was extracted with dichloromethane (2 x 20ml) and the combined extracts reduced *in vacuo*. The resulting solid was dissolved in methanol (3ml) and treated with N-acetyl cysteine (1mmol) and (3aR,6aS)-2-methyloctahydropyrrolo[3,4-c]pyrrole (0.8mmol) and heated to  $40^\circ\text{C}$  for 2.5 hours. The reaction was cooled to room temperature and purified on a strong cation exchange resin, eluting non-basic impurities with methanol, and basic products with 2M ammonia in methanol. The solvent was removed *in vacuo* and the residue purified by flash column chromatography on silica gel eluting with dichloromethane : methanol : 880 ammonia (95:5:0.5 changing to 90:10:1, by volume) to give the desired compounds.  
 15  
 20

e.g.	Structure	Precursor	MS Data (APCI)	$^1\text{H}$ NMR (400MHz, $\text{CD}_3\text{OD}$ )
<b>61</b>	1-(4,5-Difluoro-1H-benzimidazol-2-yl)-1-[(3aR, 6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine			
		<b>Prep. 10</b>	$m/z$ 306 $[\text{M}+\text{H}]^+$ , 304 $[\text{M}-\text{H}]^-$	$\delta$ 7.33-7.30 (1H, m), 6.97-6.90 (1H, m), 4.27-4.05 (2H, bm), 3.95-3.77 (2H, bm), 3.14-3.04 (2H, bm), 2.70-2.57 (4H, m), 2.32 (3H, s) ppm.
<b>62</b>	1-(4-Methyl-1H-benzimidazol-2-yl)-1-[(3aR, 6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine			

		<b>Prep. 11</b>	m/z 284 [M+H] <sup>+</sup> , 282 [M-H] <sup>-</sup>	δ 7.44 (1H, d), 7.10-7.04 (1H, m), 6.99-6.95 (1H, m), 4.01-3.96 (2H, m), 3.71-3.68 (2H, m), 3.08-3.06 (2H, m), 2.73-7.68 (2H, m), 2.61- 2.57 (5H, m), 2.35 (3H, s) ppm.
<b>63</b>	1-(4,6-Difluoro-1H-benzimidazol-2-yl)-1-[(3aR, 6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine			
		<b>Prep. 13</b>	m/z 288 [M+H] <sup>+</sup> , 286 [M-H] <sup>-</sup>	δ 7.14-7.11 (1H, m), 6.73-6.67 (1H, m), 4.38-3.70 (4H, m), 3.19-3.10 (2H, bm), 2.73-2.63 (4H, m), 2.38 (3H, s) ppm.
<b>64</b>	1-(6-Fluoro-7-methyl-1H-benzimidazol-2-yl)-1-[(3aR, 6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine			
		<b>Prep. 25</b>	m/z 302 [M+H] <sup>+</sup> , 300 [M-H] <sup>-</sup>	δ 7.40-7.37 (1H, m), 6.90-6.85 (1H, m), 4.16-4.08 (2H, m), 3.85-3.75 (2H, m), 3.12-3.06 (2H, m), 2.71- 2.67 (2H, m), 2.60-2.56 (2H, m), 2.48 (3H, s), 2.34 (3H, s) ppm.

Examples **65-68** were prepared from the bis-aniline precursors indicated in the table below according to the following procedure : A solution of the aniline precursor (79mg, 0.50mmol) in acetic acid (3ml) was treated with methyl-2,2,2-trichloroacetimidate (0.55mmol) and the resulting solution was left to stir at room temperature for 16 hours. Water (10ml) was added and the reaction stirred for a further hour. The trichloromethylbenzimidazole intermediate was filtered off and dried *in vacuo*, prior to processing as described for examples 61-64 to give the desired compounds.

e.g.	Structure	Precursor	MS data(APCI)	<sup>1</sup> HNMR (400MHz, CD <sub>3</sub> OD)
<b>65</b>	1-(6-Chloro-7-methyl-1H-benzimidazol-2-yl)-1-[(3aR, 6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine			
		<b>Prep. 29</b>	m/z 318/320 [M+H] <sup>+</sup> , 316/318 [M-H] <sup>-</sup>	δ 7.39 (1H, d), 7.08 (1H, d), 4.21-4.08 (2H, m), 3.89- 3.78 (2H, m), 3.12-3.06 (2H, m), 2.71-2.58 (7H, m), 2.35 (3H, s) ppm.
<b>66</b>	1-(7-Fluoro-1H-benzimidazol-2-yl)-1-[(3aR, 6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine			

			m/z 306 [M+H] <sup>+</sup> , 304 [M-H] <sup>-</sup>	δ 7.45 (1H, d), 7.10-7.04 (1H, m), 6.84-6.79 (1H, m), 4.31-4.13 (2H, m), 3.97-3.83 (2H, m), 3.20-3.11 (2H, m), 2.75-2.63 (4H, m), 2.39 (3H, s) ppm.
67	1-[(3aR,6aS)-5-Methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]-1-(4,5,6-trifluoro-1H-benzimidazol-2-yl)methanimine			
			m/z 324 [M+H] <sup>+</sup> , 322 [M-H] <sup>-</sup>	δ 7.24-7.20 (1H, m), 4.47-3.44 (4H, m), 3.16-3.04 (2H, m), 2.69-2.60 (4H, m), 2.34 (3H, s) ppm.
68	1-(5-Chloro-1H-benzimidazol-2-yl)-1-[(3aR,6aS)-5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl]methanimine			
			m/z 304/306 [M+H] <sup>+</sup> , 302/304 [M-H] <sup>-</sup>	δ 7.57 (1H,d), 7.54 (1H, s), 7.08 (1H, dd), 4.16 (2H, bm), 3.86 (2H, m), 3.11 (2H, m), 2.62 (4H, m), 2.35 (3H, s) ppm.

## BIOLOGY SECTION

### H<sub>4</sub> Binding

Cell pellets from CHO cells expressing the histamine H<sub>4</sub> receptor were homogenised in ice-cold 50mM Tris-HCl/0.5mM CaCl<sub>2</sub> buffer containing a protease inhibitor cocktail (Roche®, United Kingdom) using a ground glass homogeniser. Homogenates were centrifuged at 48000g for 30min at 4°C. The membrane pellet was resuspended in fresh buffer and the centrifugation step was repeated as described above. The membrane pellet was resuspended in 50mM Tris-HCl in the same volume as the original cell pellet. Aliquots of membrane preparations were stored at -80°C and were used for [<sup>3</sup>H]-Histamine binding experiments.

Cell membranes (20-35µg/well) were incubated for 90min shaking at room temperature with 3nM [<sup>3</sup>H]-Histamine (23Ci/mmol) in 50mM Tris-HCl (pH 7.4), with or without competing H<sub>4</sub> ligands. The reaction was terminated by rapid filtration through 0.5% polyethylenimine-soaked Unifilter GF/B plates (Packard) followed by three washes with 1ml ice-cold 50mM Tris-HCl. Filters were dried for 45min at 45°C and bound radiolabel was determined using scintillation counting techniques. Non-specific binding was defined with 5µM clobenpropit. For competition binding studies, K<sub>i</sub> values were calculated from the IC<sub>50</sub> value based on an experimentally determined ligand K<sub>d</sub> of 3.5nM and a ligand concentration of 3nM according to the Cheng-Prussoff equation where;  $K_i = (IC_{50}) / (1 + ([L] / K_d))$

The compounds of the Examples have been tested in the H<sub>4</sub> binding assay described above and were found to have a K<sub>i</sub> value of less than 13 μM in the H<sub>4</sub> cell based binding assay. Preferred examples have a K<sub>i</sub> value of less than 1 μM in the H<sub>4</sub> binding assay. Most preferred examples have a K<sub>i</sub> value of less than 120 nM in the H<sub>4</sub> cell based binding assay as indicated in the table below:

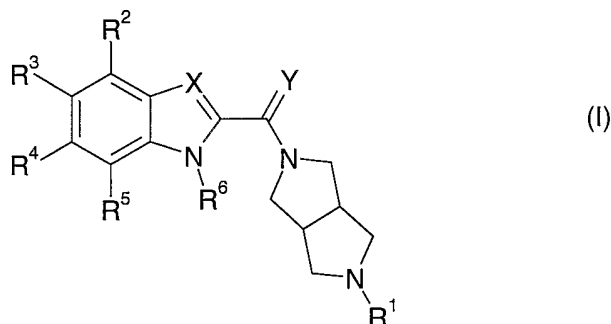
5

<b>Example No.</b>	<b>Ki (nM)</b>	<b>Example No.</b>	<b>Ki (nM)</b>
1	91	48	91
3	82	58	100
7	16	59	7
15	28	60	6
16	20	61	24
17	84	62	7
21	43	63	47
22	20	64	4
25	67	65	12
26	110	66	24
27	117	67	60
41	53	68	26



CLAIMS

1. A compound of formula (I)



- 5 or pharmaceutically acceptable salts and solvates thereof, wherein:
- R<sup>1</sup> is H or (C<sub>1</sub>-C<sub>4</sub>) alkyl optionally substituted with a hydroxy;
  - X is N or C-R<sup>9</sup> wherein R<sup>9</sup> is H or methyl;
  - Y is O or NH;
  - R<sup>6</sup> is H or methyl; and
- 10 • R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are independently selected from H, halo, cyano, (C<sub>1</sub>-C<sub>4</sub>)alkyl, (C<sub>1</sub>-C<sub>4</sub>)alkoxy, trifluoromethyl, trifluoromethoxy, hydroxy, (CH<sub>2</sub>)<sub>n</sub>-C(O)O-R<sup>7</sup>, (CH<sub>2</sub>)<sub>n</sub>-O-(CH<sub>2</sub>)<sub>m</sub>-R<sup>8</sup> and (CH<sub>2</sub>)<sub>n</sub>-R<sup>8</sup>, wherein n and m are both independently 0 or 1, R<sup>7</sup> is H or (C<sub>1</sub>-C<sub>4</sub>)alkyl and R<sup>8</sup> is phenyl.
2. A compound of formula (I) or salts and solvates thereof according to claim 1 wherein R<sup>1</sup> is H or  
15 methyl.
3. A compound of formula (I) or salts and solvates thereof according to claims 1 or 2 wherein R<sup>6</sup> is H.
- 20 4. A compound of formula (I) or salts and solvates thereof according to any one of claims 1 to 3 wherein X is N or CH.
5. A compound of formula (I) or salts and solvates thereof according to any one of claims 1 to 4  
25 wherein R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are independently selected from H, halo, methyl, hydroxy, phenyl, and COOH.
6. A compound of formula (I) or salts and solvates thereof according to claim 5 wherein R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>  
and R<sup>5</sup> are independently selected from H, fluoro, chloro, bromo, methyl, hydroxy, phenyl, and COOH.
7. A compound of formula (I) or salts and solvates thereof according to any one of claims 1 to 6  
30 wherein at least two of R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are H.
8. A compound of formula (I) or salts and solvates thereof according to any one of claims 1 to 7  
which has the *cis* configuration (3*aR*,6*aS*).

9. A pharmaceutical composition including a compound of the formula (I) or a pharmaceutically acceptable salt or solvate thereof, as defined in any one of claims 1 to 8, together with a pharmaceutically acceptable excipient.

5 10. A compound of the formula (I) as defined in any one of claims 1 to 8 or a pharmaceutically acceptable salt or solvate thereof, for use as a medicament.

11. The use of a compound of the formula (I) as defined in any one of claims 1 to 8 or a pharmaceutically acceptable salt or solvate thereof, for the manufacture of a medicament to treat a  
10 disease for which a H<sub>4</sub> ligand is indicated.

12. The use of a compound of the formula (I) according to claim 11, for the manufacture of a medicament to treat a disease selected from inflammatory diseases, respiratory diseases (e.g. adult respiratory distress syndrome, acute respiratory distress syndrome, bronchitis, chronic bronchitis, chronic  
15 obstructive pulmonary disease, cystic fibrosis, asthma, emphysema, rhinitis, chronic sinusitis), allergy; allergy-induced airway responses, allergic rhinitis, viral rhinitis, non-allergic rhinitis, perennial and seasonal rhinitis, nasal congestion, allergic congestion, female and male sexual dysfunction, skin diseases such as dermatitis and psoriasis, cardiac dysfunctions such as myocardial ischaemia and arrhythmia, diseases of the gastrointestinal tract such as inflammatory bowel disease, Crohn's disease and  
20 colitis ulcerosa, cancer, rheumatoid arthritis, hypotension, pain and overactive bladder conditions.

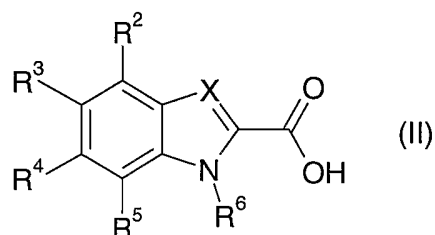
13. A method of treatment of a mammal, including a human being, suffering from a disease for which a H<sub>4</sub> ligand is indicated, comprising administering to said mammal an effective amount of a compound of the formula (I) as defined in any one of claims 1 to 8 or a pharmaceutically acceptable salt, solvate or  
25 composition thereof.

14. A method according to claim 13 wherein the disease is selected from those of claim 12.

15. A process to obtain a compound of formula (I) and salts or solvates thereof as defined in any one  
30 of claims 1 to 8, comprising the steps of:

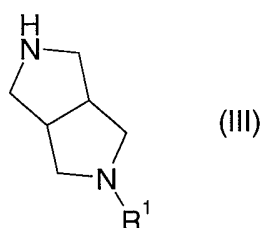
1) when Y is O :

coupling an acid of formula (II) :



with an amine of formula (III):

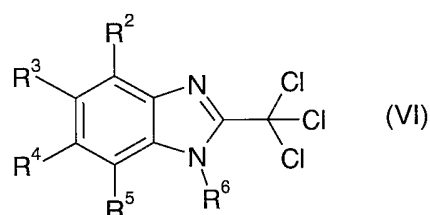
58



wherein  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$ ,  $R^5$ ,  $R^6$  and  $X$  are as defined in any one of claims 1 to 10; or

2) when  $Y$  is  $NH$  and  $X$  is  $N$

condensing a trichloromethylbenzimidazole of formula (VI):

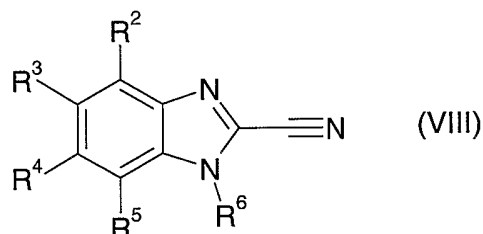


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with a source of ammonia and an amine of formula (III) wherein  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$ ,  $R^5$  and  $R^6$  are as defined in any one of claims 1 to 10; or

3) when  $Y$  is  $NH$  and  $X$  is  $N$

reacting an amine of formula (III) with a nitrile of formula (VIII)

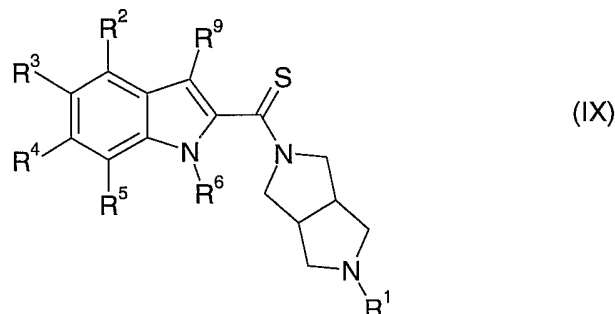


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wherein  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$ ,  $R^5$  and  $R^6$  are as defined in any one of claims 1 to 10

4) when  $Y$  is  $NH$  and  $X$  is  $CR^9$

condensing a thioamide of formula (VIII):



15

with ammonia or an ammonia equivalent wherein  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$ ,  $R^5$  and  $R^6$  are as defined in any one of claims 1 to 10.

16. A combination of a compound of formula (I) as defined in any one of claims 1 to 10 and another pharmacologically active agent selected from:

- Histamine H<sub>1</sub> receptor antagonists, in particular loratidine, desloratidine, fexofenadine and cetirizine
- Histamine H<sub>3</sub> receptor antagonists
- Histamine H<sub>2</sub> receptor antagonists
- Leukotriene antagonists, including antagonists of LTB<sub>4</sub>, LTC<sub>4</sub>, LTD<sub>4</sub>, and LTE<sub>4</sub>, in particular  
5 Montelukast
- Phosphodiesterase inhibitors, namely PDE4 inhibitors and PDE5 inhibitors
- neurotransmitter re-uptake inhibitors, in particular fluoxetine, setraline, paroxetine, ziprasidone
- 5-Lipoxygenase (5-LO) inhibitors or 5-lipoxygenase activating protein (FLAP) antagonists,
- $\alpha_1$ - and  $\alpha_2$ -adrenoceptor agonist vasoconstrictor sympathomimetic agents for decongestant use,
- 10 • Muscarinic M3 receptor antagonists or anticholinergic agents,
- $\beta_2$ -adrenoceptor agonists,
- Theophylline,
- Sodium cromoglycate,
- COX-1 inhibitors (NSAIDs) and COX-2 selective inhibitors,
- 15 • Oral or inhaled Glucocorticosteroids,
- Monoclonal antibodies active against endogenous inflammatory entities,
- Anti-tumor necrosis factor (anti-TNF- $\alpha$ ) agents,
- Adhesion molecule inhibitors including VLA-4 antagonists,
- Kinin-B<sub>1</sub> - and B<sub>2</sub> -receptor antagonists,
- 20 • Immunosuppressive agents,
- Inhibitors of matrix metalloproteases (MMPs),
- Tachykinin NK<sub>1</sub>, NK<sub>2</sub> and NK<sub>3</sub> receptor antagonists,
- Elastase inhibitors,
- Adenosine A2a receptor agonists,
- 25 • Inhibitors of urokinase,
- Compounds that act on dopamine receptors, e.g. D2 agonists,
- Modulators of the NF $\kappa$ B pathway, e.g. IKK inhibitors,
- Agents that can be classed as mucolytics or anti-tussive,
- Antibiotics,
- 30 • Modulators of cytokine signaling pathways such as p38 MAP kinase inhibitors, syk tyrosine kinase inhibitors or JAK kinase inhibitors
- Prostaglandin D2 receptor antagonists (DP1 and CRTH2)
- Inhibition of Prostaglandin D synthase (PGDS)
- Inhibitors of phosphoinositide-3-kinase, and
- 35 • HDAC inhibitors.

**INTERNATIONAL SEARCH REPORT**

International application No

/IB2005/003478

**A. CLASSIFICATION OF SUBJECT MATTER**

C07D487/04 A61K31/407 A61K31/4184 A61P11/06 A61P37/08

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

C07D A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, BIOSIS, INSPEC, CHEM ABS Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

16 March 2006

Date of mailing of the international search report

03/04/2006

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International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	FAGHIH RAMIN ET AL: "Aminoalkoxybiphenylnitriles as histamine-3 receptor ligands." BIOORGANIC & MEDICINAL CHEMISTRY LETTERS. 4 NOV 2002, vol. 12, no. 21, 4 November 2002 (2002-11-04), pages 3077-3079, XP002333102 ISSN: 0960-894X abstract; tables 2,3; compound 34 -----	1-16
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A	WO 96/35691 A (PHARMACIA & UPJOHN COMPANY; BARBACHYN, MICHAEL, ROBERT; BRICKNER, STEV) 14 November 1996 (1996-11-14) abstract; example 5 -----	1-16
A	WO 2004/022060 A (JANSSEN PHARMACEUTICA, N.V; CARRUTHERS, NICHOLAS, I.,; DVORAK, CURT, A) 18 March 2004 (2004-03-18) example 45 -----	15
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International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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