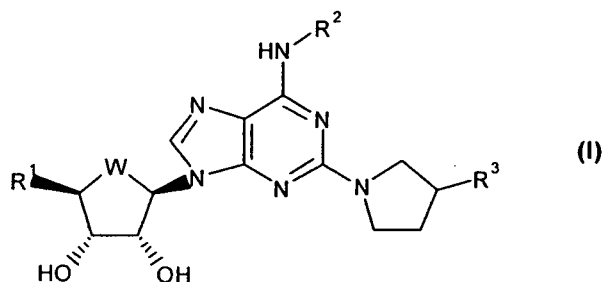


PURINE DERIVATIVES AS A2A AGONISTS

This invention relates to organic compounds, their preparation and use as pharmaceuticals.

An aspect of the present invention provides compounds of formula (I)



or stereoisomers or pharmaceutically acceptable salts thereof,
wherein

W is CH₂ or O, with the proviso that when W is O, then R¹ is not a N-bonded substituent;

R¹ is a 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, that group being optionally substituted by oxo, C₁-C₈-alkoxy, C₆-C₁₀-aryl, R^{1a} or by C₁-C₈-alkyl optionally substituted by hydroxyl;

R^{1a} is a 3- or 12-membered heterocyclic ring containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, said 3- or 12-membered heterocyclic ring being optionally substituted by halo, cyano, oxo, hydroxy, carboxy, amino, nitro, C₁-C₈-alkyl, C₁-C₈-alkylsulfonyl, aminocarbonyl, C₁-C₈-alkylcarbonyl or C₁-C₈-alkoxy optionally substituted by aminocarbonyl;

R² is C₁-C₈-alkyl substituted by OH, halogen C₆-C₁₀-aryl optionally substituted by OH, SO₂R⁵, SC₁-C₈-alkyl, CN, halogen, O-C₇-C₁₄-aralkyl, or O-C₁-C₈-alkyl, a C₃-C₁₅-carbocyclic group optionally substituted by O-C₇-C₁₄-aralkyl, C₃-C₁₅-carbocyclic group, O-C₁-C₈-alkyl, C₂-C₈-alkenyl, C₂-C₈-alkynyl or C₁-C₈-alkyl, O-C₁-C₈-alkyl, -SO₂-C₁-C₈-alkyl, a 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, that group being optionally substituted by 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected

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from the group consisting of oxygen and sulfur, C₇-C₁₄-alkyl, or C₆-C₁₄-aryl optionally substituted by O-C₇-C₁₄-alkyl, or

R² is a C₃-C₁₅-carbocyclic group optionally substituted by O-C₇-C₁₄-alkyl, C₃-C₁₅-carbocyclic group, O-C₁-C₈-alkyl, or C₁-C₈-alkyl, or

R² is a 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, that group being optionally substituted by 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, C₇-C₁₄-alkyl, or C₆-C₁₄-aryl optionally substituted by O-C₇-C₁₄-alkyl;

R³ is selected from NR^{3a}R^{3b}, NR³C(O)NR^{3g}R^{3h}, NHC(O)R^{3q}, and NHC(=NR^{3m})N(R³ⁿ)R^{3o}, R^{3a}, R^{3g} and R^{3h} are, independently, H, C₁-C₈-alkyl or C₆-C₁₀-aryl;

R^{3b} is H, C₁-C₈-alkyl a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by 0-3R⁴ or C₆-C₁₀-aryl;

R^{3g} is C₁-C₈-alkyl optionally substituted by a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted with SO₂R⁵, CN, or 0-3R⁴, or

R^{3g} is a C₆-C₁₀-aryl optionally substituted by OH, C₁-C₈-alkyl, O-C₁-C₈-alkyl, CN, -C(=NH)NH₂, SO₂R⁵, -halogen, or a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by 0-3R⁴, or

R^{3g} is a C₇-C₁₄-alkyl optionally substituted by OH, O-C₁-C₈-alkyl, halogen, C₆-C₁₀-aryl, SO₂R⁵, CN, -C(=NH)NH₂ or O-C₆-C₁₀-aryl, or

R^{3g} is a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by 0-3R⁴;

R^{3m} is CN;

R³ⁿ is H or C₁-C₈-alkyl;

R^{3o} is H, C₁-C₈-alkyl optionally substituted by OH or by a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted with SO₂R⁵, CN, or 0-3R⁴, C₁-C₈-alkoxy, C₇-C₁₄-alkyl optionally substituted with OH,

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O-C₁₋₈-alkyl, halogen C₆-C₁₀-aryl, or O-C₆-C₁₀-aryl, C₁-C₈-alkoxy, C₆-C₁₀-aryl optionally substituted by OH, C₁₋₈-alkyl, O-C₁₋₈-alkyl SO₂R⁵ or -halogen;
R^{3p} is H, C₁-C₈-alkyl or C₇-C₁₄-aralkyl;
R^{3q} is a C₆-C₁₀-aryl optionally substituted by OH, C₁₋₈-alkyl, C₁₋₈-alkoxy, SO₂R⁵ or -halogen, or
R^{3q} is a C₇-C₁₄-aralkyl optionally substituted by OH, C₁₋₈-alkyl, C₁₋₈-alkoxy, SO₂R⁵ or -halogen, or
R^{3q} is a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur optionally substituted by 0-3R⁴ or a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by 0-3R⁴;
R⁴ is selected from OH, C₁-C₈-alkyl optionally substituted by OH, CN, SO₂R⁵ or halogen, C(O)NHR^{3a}, O-C₁-C₈-alkyl optionally substituted by halogen, NR^{4a}R^{4b}, NHC(O)R^{4c}, a C(O)-C₆-C₁₀-aryl optionally substituted by OH, C₁₋₈-alkyl, O-C₁₋₈-alkyl, -halogen, or SO₂R⁵;
R^{4a}, R^{4b} and R^{4c} are, independently, H, C₁-C₈-alkyl or C₆-C₁₀-aryl; and
R⁵ is C₁-C₈-alkyl optionally substituted by halogen, C₆-C₁₀-aryl optionally substituted by OH, C₁₋₈-alkyl, O-C₁₋₈-alkyl, or NR^{3a}R^{3b}.

Definitions

Terms used in the specification have the following meanings:

"Optionally substituted" or "substituted" means the group referred to can be substituted at one or more positions by any one or any combination of the radicals listed thereafter.

"Halo" or "halogen", as used herein, may be fluorine, chlorine, bromine or iodine.

"C₁-C₈-Alkyl", as used herein, denotes straight chain or branched alkyl having 1 to 8 carbon atoms.

"C₁-C₈-Alkoxy", as used herein, denotes straight chain or branched alkoxy having 1 to 8 carbon atoms.

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"C₃-C₈-Cycloalkyl", as used here in, denotes cycloalkyl having 3 to 8 ring carbon atoms, e.g., a monocyclic group, such as a cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl or cyclooctyl, any of which can be substituted by one or more, usually one or two, C₁-C₄-alkyl groups; or a bicyclic group, such as bicycloheptyl or bicyclooctyl.

"C₁-C₈-Alkylamino" and "di(C₁-C₈-alkyl)amino", as used herein, denote amino substituted respectively by one or two C₁-C₈-alkyl groups as hereinbefore defined, which may be the same or different.

"C₁-C₈-Alkylcarbonyl" and "C₁-C₈-alkoxycarbonyl", as used herein, denote C₁-C₈-alkyl or C₁-C₈-alkoxy, respectively, as hereinbefore defined attached by a carbon atom to a carbonyl group.

"C₆-C₁₀-Aryl", as used herein, denotes a monovalent carbocyclic aromatic group that contains 6 to 10 carbon atoms and which may be, e.g., a monocyclic group, such as phenyl; or a bicyclic group, such as naphthyl.

"C₇-C₁₄-Aralkyl", as used herein, denotes alkyl, e.g., C₁-C₄-alkyl, as hereinbefore defined, substituted by C₆-C₁₀-aryl as hereinbefore defined.

"C₁-C₈-Alkylaminocarbonyl" and "C₃-C₈-cycloalkylaminocarbonyl", as used herein, denote C₁-C₈-alkylamino and C₃-C₈-cycloalkylamino respectively as hereinbefore defined attached by a carbon atom to a carbonyl group.

"C₃-C₁₅-Carbocyclic group", as used herein, denotes a carbocyclic group having 3 to 15 ring carbon atoms, e.g., a monocyclic group, either aromatic or non-aromatic, such as a cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl or phenyl; or a bicyclic group, such as bicyclooctyl, bicyclononyl, bicyclodecyl, indanyl or indenyl, again any of which can be substituted by one or more, usually one or two, C₁-C₄-alkyl groups.

"3- to 12-Membered heterocyclic ring containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur", as used herein, may be, e.g., furan, pyrrole, pyrrolidine, pyrazole, imidazole, triazole, isotriazole, tetrazole, thiadiazole, isothiazole, oxadiazole, pyridine, piperidine, pyrazine, oxazole, isoxazole, pyrazine, pyridazine, pyrimidine, piperazine, pyrrolidine, morpholino, triazine, oxazine or thiazole.

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"5- or 6-Membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur" as used herein may be, e.g., a saturated or unsaturated heterocyclic group, such as furanyl, pyrrolyl, pyrrolidinyl, pyrazolyl, imidazolyl, triazolyl, isotriazolyl, tetrazolyl, thiadiazolyl, isothiazolyl, oxadiazolyl, pyridinyl, piperidinyl, pyrazinyl, oxazolyl, isoxazolyl, pyrazinyl, pyridazinyl, pyrimidinyl, piperazinyl, pyrrolidinyl, morpholinyl, triazinyl, oxazinyl or thiazolyl.

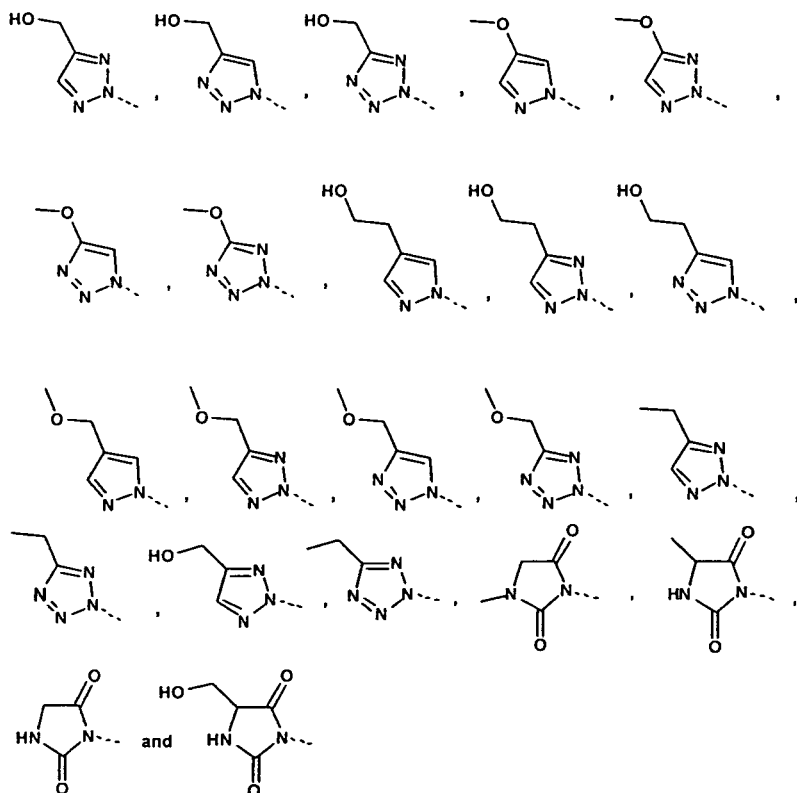
Throughout this specification and in the claims that follow, unless the context requires otherwise, the word "comprise", or variations, such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

Throughout this specification and in the claims that follow, unless the context requires otherwise, the word "comprise", or variations, such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps. As understood by one skilled in the art only combinations of substituents that are chemically possible are embodiments of the invention.

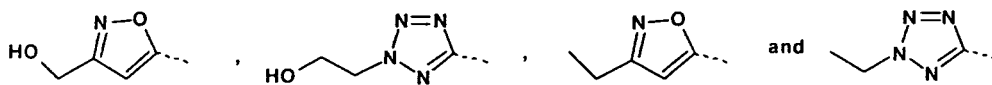
According to formula (I), R^1 is suitably a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur. Preferably R^1 is a 5-membered heterocyclic group, such as pyrazole, triazole, tetrazole, isoxazole and imidazole-2,4-dione. These heterocyclic groups are suitably substituted by a C_{1-8} alkyl optionally substituted by OH.

The heterocyclic groups can be either N-bonded or C-bonded. For example, the heterocyclic groups pyrazole, triazole, tetrazole and imidazole-2,4-dione are suitably N-bonded when attached to a cyclopentane group (e.g., when W is CH_2). These N-bonded heterocyclic groups can also be suitably substituted by groups such as methanol, methyl, ethyl, methoxy and methoxy-methyl. Preferably, the R^1 groups attached to the cyclopentane group are

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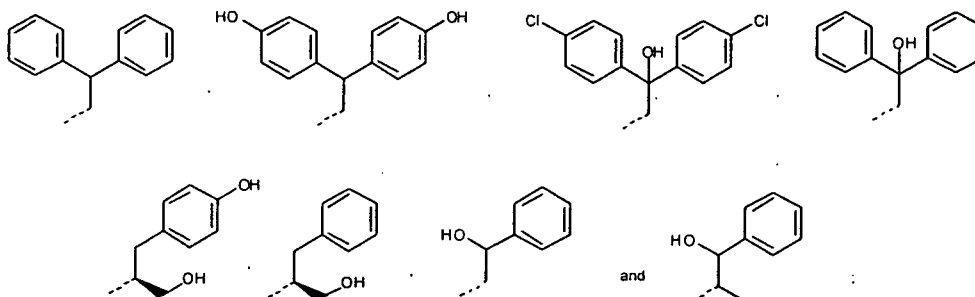


The heterocyclic groups isoxazole and tetrazole are C-bonded when attached to a furan group (e.g., when W is O). These C-bonded heterocyclic groups are suitably substituted by C₁-C₈-alkyl optionally substituted by OH such as hydroxymethyl, hydroxyethyl, an ethyl group or a methyl group. Preferably, The R¹ groups attached to the furan group are



According to formula (I), R² is suitably selected from C₁-C₈-alkyl optionally substituted by OH, halogen or C₆-C₁₀-aryl optionally substituted by OH, halogen, such as Cl or O-C₁-C₈-alkyl, preferably C₆-C₁₀-aryl is phenyl. Also, preferably, the C₁-C₈-alkyl is substituted by two phenyl rings and the phenyl rings are unsubstituted or substituted by OH. Preferred R² groups are

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According to formula (I), R^3 is suitably $NR^{3f}C(O)NR^{3g}R^{3h}$. R^{3f} and R^{3h} are suitably H.

R^{3g} is suitably C_6-C_{10} -aryl optionally substituted by OH, C_1-C_8 -alkyl, $O-C_1-C_8$ -alkyl, SO_2R^5 , -halogen, CN, $-C(=NH)NH_2$, or a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by $O-3R^4$. Preferably this 3- to 12-membered heterocyclic group is a 5-membered heterocyclic group, such as tetrazole.

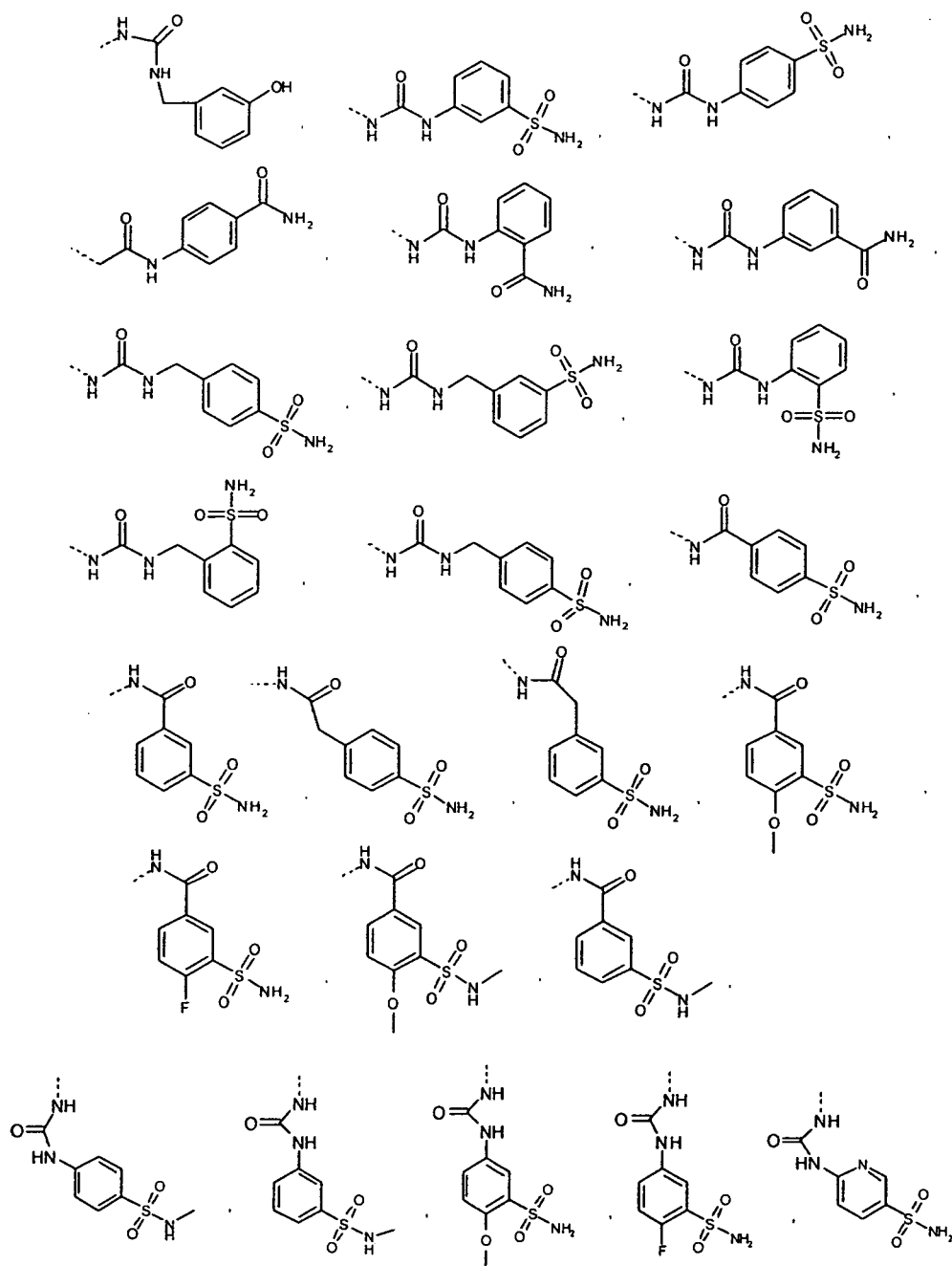
According to formula (I), R^{3g} is also suitably C_7-C_{14} -aralkyl optionally substituted by OH, $O-C_1-C_8$ -alkyl, halogen, C_6-C_{10} -aryl, SO_2R^5 , CN, $-C(=NH)NH_2$, or $O-C_6-C_{10}$ -aryl.

According to formula (I), R^{3g} is also suitably 3- to 12-membered heterocyclic group, preferably a pyridine, containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by $O-3R^4$.

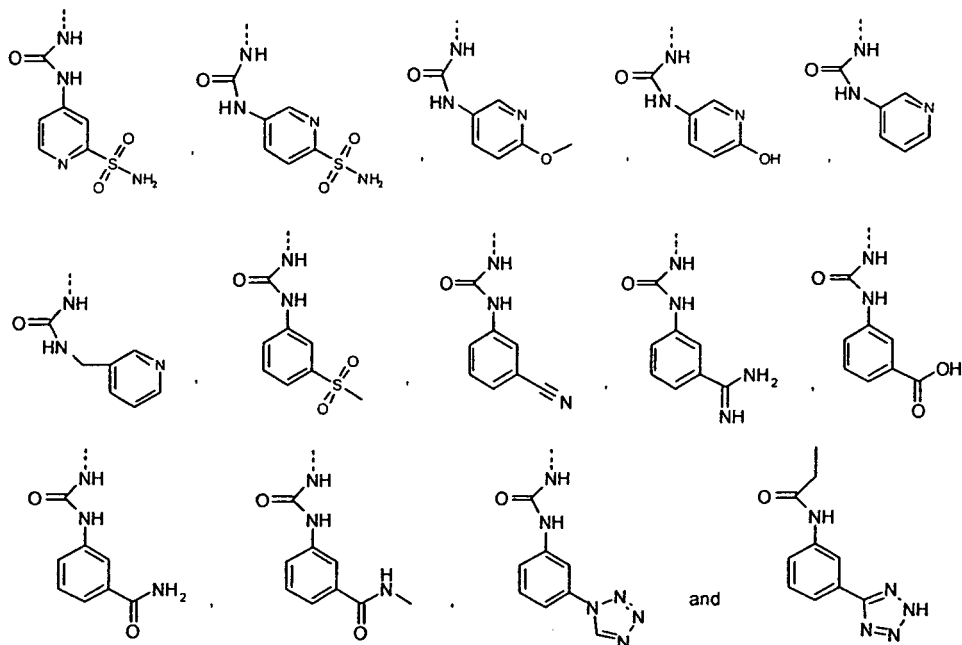
According to formula (I), R^3 is also suitably $NHC(O)R^{3q}$, where R^{3q} is a C_6-C_{10} -aryl optionally substituted by OH, C_1-C_8 -alkyl, C_1-C_8 -alkoxy, SO_2R^5 or -halogen.

R^{3q} is also suitably a C_7-C_{14} -aralkyl optionally substituted by OH, C_1-C_8 -alkyl, C_1-C_8 -alkoxy, SO_2R^5 or -halogen.

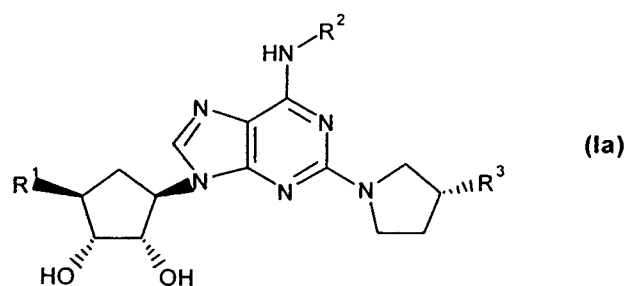
- 8 -

Preferred R³ groups are

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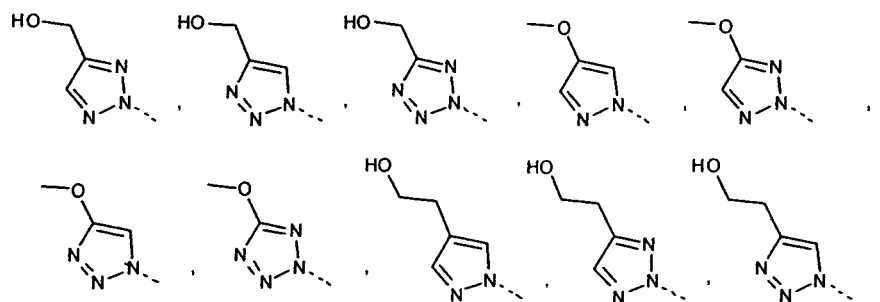


Another aspect of the invention provides compounds of formula (I) wherein the compound is of formula (Ia)

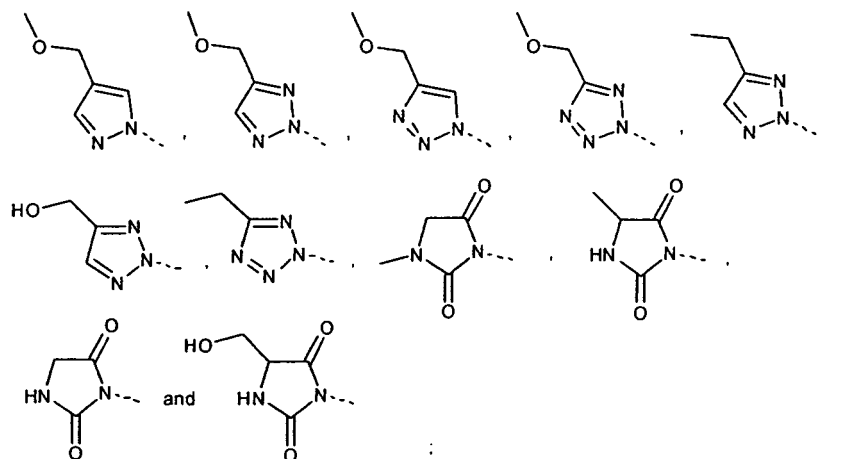
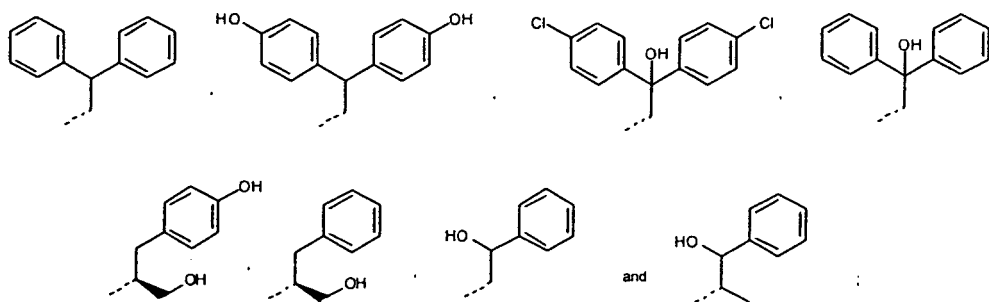


where

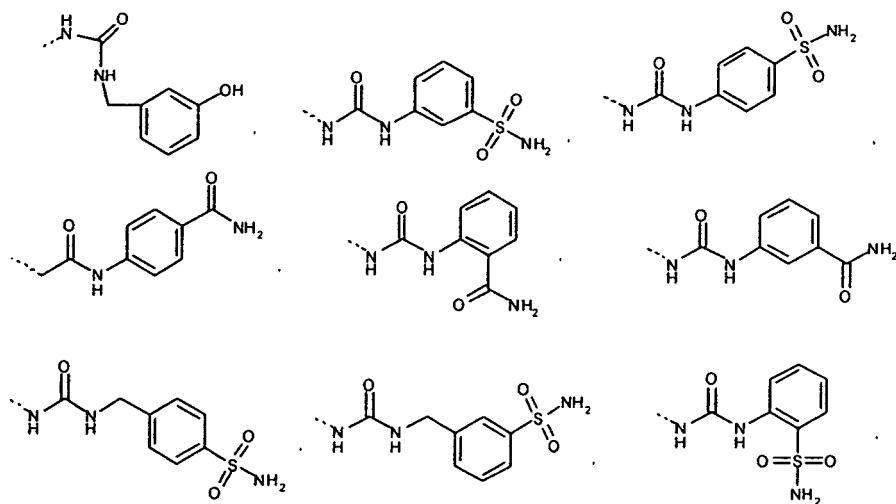
R^1 is selected from



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R² is selected from

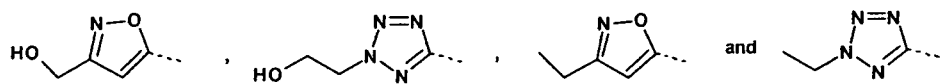
and

R³ is selected from

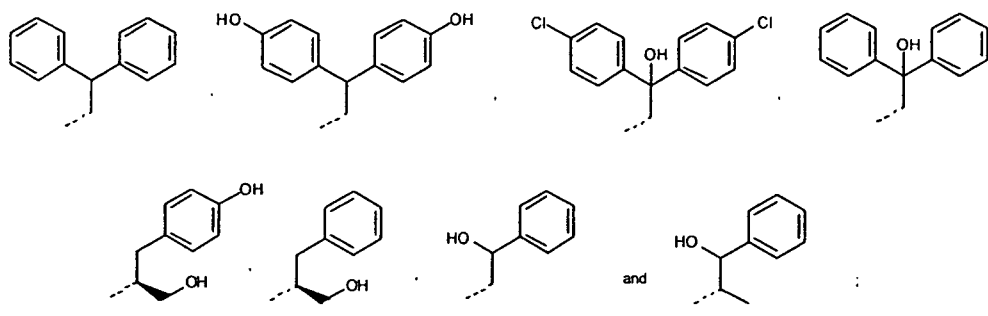
(1b)

where

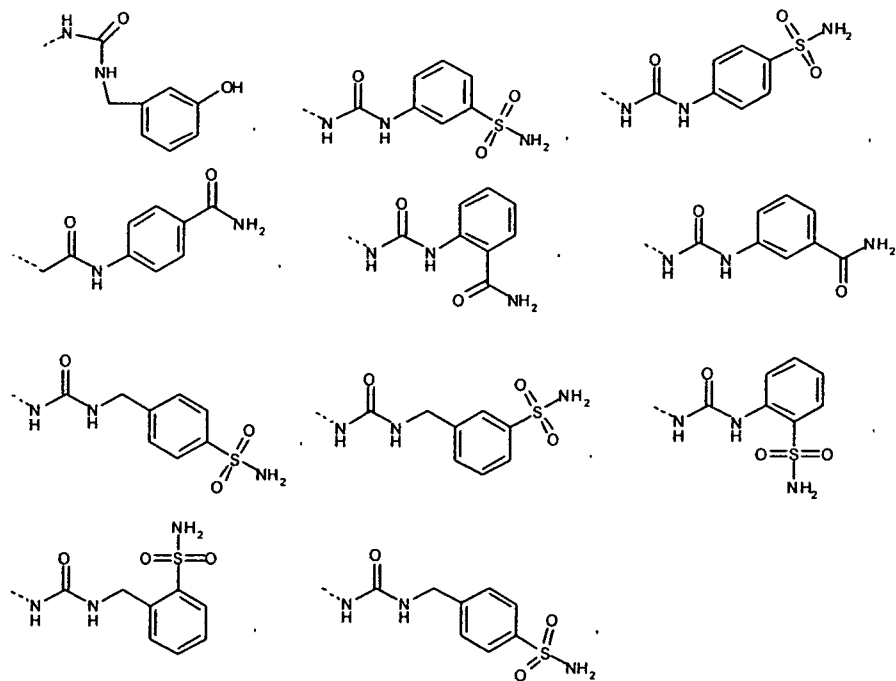
R^1 is selected from



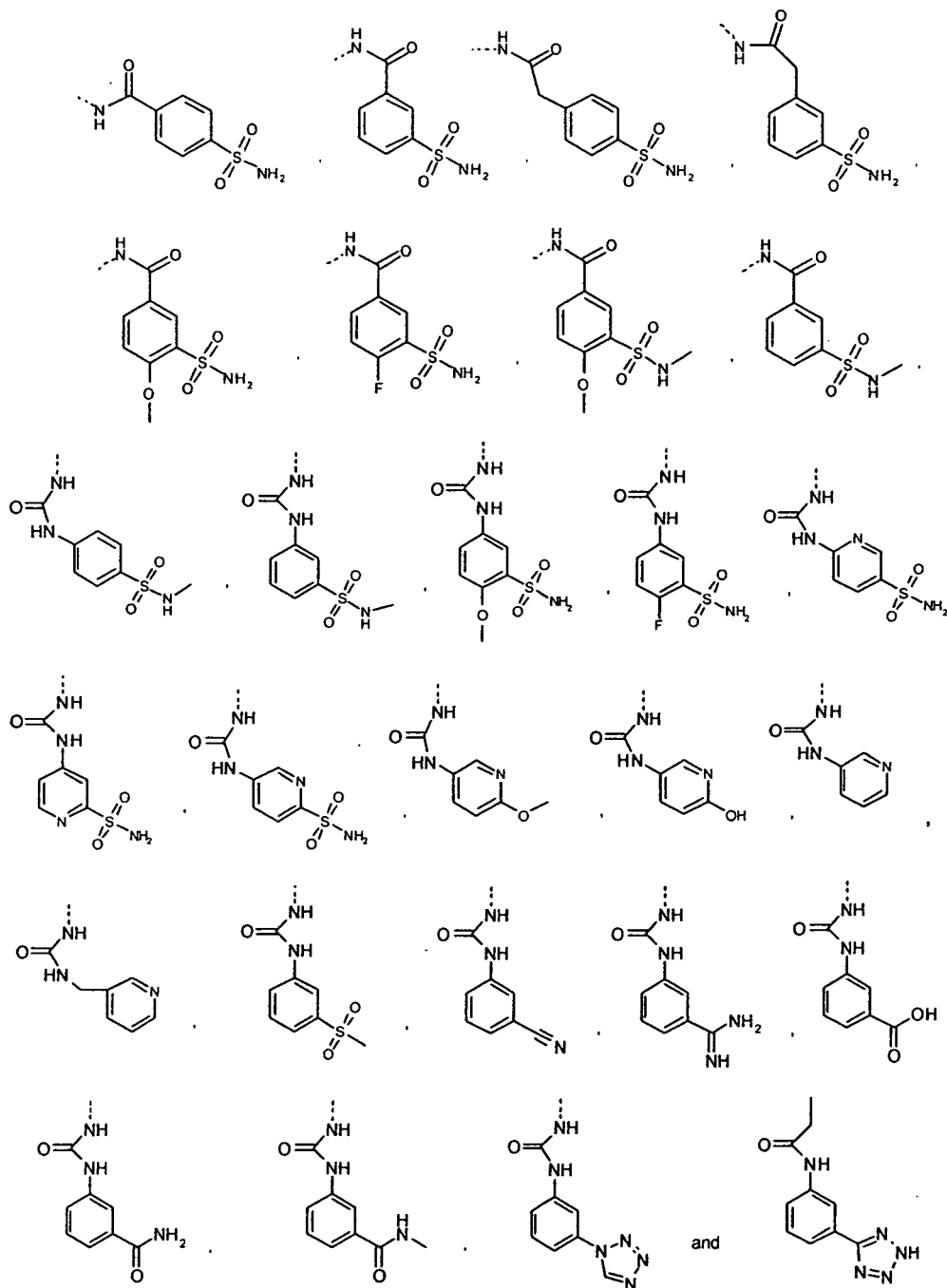
R^2 is selected from



R^3 is selected from



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Especially preferred specific compounds of formula (I) are those described hereinafter in the Examples.

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Stereoisomers are those compounds where there is an asymmetric carbon atom. The compounds exist in individual optically active isomeric forms or as mixtures thereof, e.g., as diastereomeric mixtures. The present invention embraces both individual optically active *R* and *S* isomers, as well as mixtures thereof. Individual isomers can be separated by methods well-known to those skilled in the art, e.g. chiral high performance liquid chromatography (HPLC).

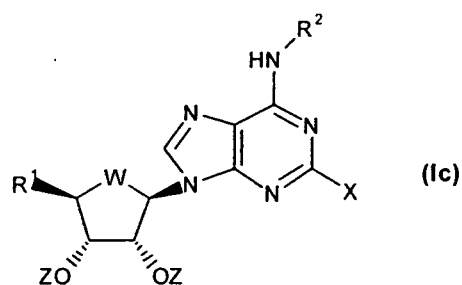
Tautomers are one of two or more structural isomers that exist in equilibrium and are readily converted from one isomeric form to another.

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 one or more pharmaceutically acceptable solvent molecules, e.g., ethanol. The term "hydrate" is employed when said solvent is water.

Synthesis

Another embodiment of the present invention provides a process for the preparation of compounds of formula (I) in free or pharmaceutically acceptable salt form, which comprises the steps of:

- (i) reacting a compound of formula (Ic)



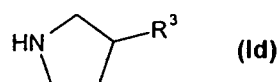
wherein

R^1 , W and R^2 are as defined hereinbefore;

Z is H or a protecting group; and

X is a leaving group,

with a compound of formula (Id)



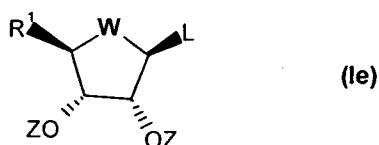
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wherein

R^3 is as defined in hereinbefore; and

removing any protecting groups and recovering the resultant compound of formula (I), in free or pharmaceutically acceptable salt form.

The compound of formula (Ic) may be prepared by reacting a compound of formula (Ie)

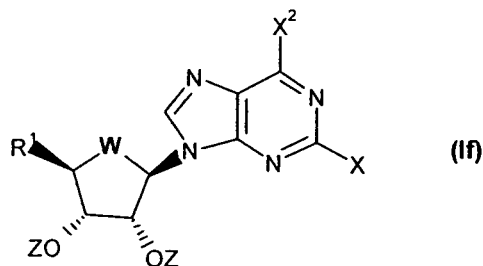


wherein

R^1 and Z are as defined hereinbefore; and

L represents a leaving group or a protected derivative thereof with a 2,6-dihalopurine, e.g., 2,6-dichloropurine,

to provide a compound of formula (If)



wherein

R^1 and Z are defined hereinbefore; and

X and X^2 are halogen.

Compound of formula (If) can be reacted with R^2NH_2 under conventional conditions to provide compound of formula (Ic).

The compounds of formula (I) can be prepared, e.g., using the reactions and techniques described below and in the Examples. The compounds of formula (I) can be prepared analogously to the preparations described in Applicant's patent applications PCT/EP2005/011344, GB 0500785.1, and GB 0505219.6. The reactions may be performed in a solvent appropriate to the reagents and materials employed and suitable for the transformations being effected. It will be understood by those skilled in the art of organic

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synthesis that the functionality present on the molecule should be consistent with the transformations proposed. This will sometimes require a judgment to modify the order of the synthetic steps or to select one particular process scheme over another in order to obtain a desired compound of the invention.

The various substituents on the synthetic intermediates and final products shown in the following reaction schemes can be present in their fully elaborated forms, with suitable protecting groups where required as understood by one skilled in the art, or in precursor forms which can later be elaborated into their final forms by methods familiar to one skilled in the art. The substituents can also be added at various stages throughout the synthetic sequence or after completion of the synthetic sequence. In many cases, commonly used functional group manipulations can be used to transform one intermediate into another intermediate, or one compound of formula (I) into another compound of formula (I). Examples of such manipulations are conversion of an ester or a ketone to an alcohol; conversion of an ester to a ketone; interconversions of esters, acids and amides; alkylation, acylation and sulfonylation of alcohols and amines; and many others. Substituents can also be added using common reactions, such as alkylation, acylation, halogenation or oxidation. Such manipulations are well-known in the art, and many reference works summarize procedures and methods for such manipulations. Some reference works which gives examples and references to the primary literature of organic synthesis for many functional group manipulations, as well as other transformations commonly used in the art of organic synthesis are *March's Organic Chemistry*, 5th Edition, Wiley and Chichester, Eds. (2001); *Comprehensive Organic Transformations*, Larock, Ed., VCH (1989); *Comprehensive Organic Functional Group Transformations*, Katritzky et al. (series editors), Pergamon (1995); and *Comprehensive Organic Synthesis*, Trost and Fleming (series editors), Pergamon (1991). It will also be recognized that another major consideration in the planning of any synthetic route in this field is the judicious choice of the protecting group used for protection of the reactive functional groups present in the compounds described in this invention. Multiple protecting groups within the same molecule can be chosen such that each of these protecting groups can either be removed without removal of other protecting groups in the same molecule, or several protecting groups can be removed using the same reaction step, depending upon the outcome desired. An authoritative account describing many alternatives to the trained practitioner is T. W. Greene and P. G. M. Wuts, *Protective Groups In Organic Synthesis*, Wiley and Sons (1999). It is understood by those skilled in the art that only

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combinations of substituents that are chemically possible are embodiments of the present invention.

Compounds of formula (I) in free form may be converted into salt form, and vice versa, in a conventional manner. The compounds in free or salt form can be obtained in the form of hydrates or solvates containing a solvent used for crystallization. Compounds of formula (I) can be recovered from reaction mixtures and purified in a conventional manner. Isomers, such as stereoisomers, may be obtained in a conventional manner, e.g., by fractional crystallization or asymmetric synthesis from correspondingly asymmetrically substituted, e.g., optically active, starting materials.

Compounds of formula (I) and their pharmaceutically acceptable salts are useful as pharmaceuticals. In particular, they activate the adenosine A_{2A} receptor, i.e., they act as A_{2A} receptor agonists. Their properties as A_{2A} agonists may be demonstrated using the method described by L. J. Murphree *et al* in *Mol Pharmacol*, Vol. 61, pp. 455-462 (2002).

Compounds of the Examples herein below have K_i values below 1.0 μM in the above assay. For example, the compounds of Examples C1 and C2 have K_i values of 0.089 μM and 0.033 μM respectively.

Having regard to their activation of the adenosine A_{2A} receptor, compounds of formula (I), in free or pharmaceutically acceptable salt form, hereinafter alternately referred to as "agents of the invention", are useful in the treatment of conditions which respond to the activation of the adenosine A_{2A} receptor, particularly inflammatory or allergic conditions. Treatment in accordance with the invention may be symptomatic or prophylactic.

Accordingly, agents of the invention are useful in the treatment of inflammatory or obstructive airways diseases, resulting, e.g., in reduction of tissue damage, airways inflammation, bronchial hyperreactivity, remodelling or disease progression. Inflammatory or obstructive airways diseases and conditions to which the present invention is applicable include acute lung injury (ALI), adult/acute respiratory distress syndrome (ARDS), chronic obstructive pulmonary, airways or lung disease (COPD, COAD or COLD), including chronic bronchitis or dyspnea associated therewith, emphysema, as well as exacerbation of airways hyperreactivity consequent to other drug therapy, in particular, other inhaled drug therapy. The invention is also applicable to the treatment of bronchitis of whatever type or genesis including, e.g., acute, arachidic, catarrhal, croupus, chronic or phthinoic bronchitis. Further

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inflammatory or obstructive airways diseases to which the present invention is applicable include pneumoconiosis (an inflammatory, commonly occupational, disease of the lungs, frequently accompanied by airways obstruction, whether chronic or acute, and occasioned by repeated inhalation of dusts) of whatever type or genesis including, e.g., aluminosis, anthracosis, asbestosis, chalicosis, ptilosis, siderosis, silicosis, tabacosis and byssinosis.

Other inflammatory or obstructive airways diseases to which the present invention is applicable include asthma of whatever type or genesis including both intrinsic (non-allergic) asthma and extrinsic (allergic) asthma, mild asthma, moderate asthma, severe asthma, bronchitic asthma, exercise-induced asthma, occupational asthma and asthma induced following bacterial infection. Treatment of asthma is also to be understood as embracing treatment of subjects, e.g., of less than 4 or 5 years of age, exhibiting wheezing symptoms and diagnosed or diagnosable as "wheezy infants", an established patient category of major medical concern and now often identified as incipient or early-phase asthmatics. (For convenience this particular asthmatic condition is referred to as "wheezy-infant syndrome".)

Prophylactic efficacy in the treatment of asthma will be evidenced by reduced frequency or severity of symptomatic attack, e.g., of acute asthmatic or bronchoconstrictor attack, improvement in lung function or improved airways hyperreactivity. It may further be evidenced by reduced requirement for other, symptomatic therapy, i.e., therapy for or intended to restrict or abort symptomatic attack when it occurs, e.g., anti-inflammatory (e.g., cortico-steroid) or bronchodilatory. Prophylactic benefit in asthma may, in particular, be apparent in subjects prone to "morning dipping". "Morning dipping" is a recognized asthmatic syndrome, common to a substantial percentage of asthmatics and characterized by asthma attack, e.g., between the hours of about 4 to 6 am, i.e. at a time normally substantially distant from any previously administered symptomatic asthma therapy.

Having regard to their anti-inflammatory activity, in particular, in relation to inhibition of eosinophil activation, agents of the invention are also useful in the treatment of eosinophil related disorders, e.g., eosinophilia, in particular, eosinophil-related disorders of the airways (e.g., involving morbid eosinophilic infiltration of pulmonary tissues) including hypereosinophilia as it effects the airways and/or lungs, as well as, e.g., eosinophil-related disorders of the airways consequential or concomitant to Löffler's syndrome, eosinophilic pneumonia, parasitic (in particular metazoan) infestation (including tropical eosinophilia), bronchopulmonary aspergillosis, polyarteritis nodosa (including Churg -Strauss syndrome),

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eosinophilic granuloma and eosinophil-related disorders affecting the airways occasioned by drug-reaction.

Agents of the invention are also useful in the treatment of inflammatory or allergic conditions of the skin, e.g., psoriasis, contact dermatitis, atopic dermatitis, alopecia areata, erythema multiforma, dermatitis herpetiformis, scleroderma, vitiligo, hypersensitivity angiitis, urticaria, bullous pemphigoid, lupus erythematosus, pemphigus, epidermolysis bullosa acquisita, and other inflammatory or allergic conditions of the skin.

Agents of the invention may also be used for the treatment of other diseases or conditions, in particular, diseases or conditions having an inflammatory component, e.g., treatment of diseases and conditions of the eye, such as conjunctivitis, keratoconjunctivitis sicca, and vernal conjunctivitis, diseases affecting the nose including allergic rhinitis, and inflammatory disease in which autoimmune reactions are implicated or having an autoimmune component or aetiology, including autoimmune haematological disorders (e.g., haemolytic anaemia, aplastic anaemia, pure red cell anaemia and idiopathic thrombocytopenia), systemic lupus erythematosus, polychondritis, scleroderma, Wegener granulomatosis, dermatomyositis, chronic active hepatitis, myasthenia gravis, Steven-Johnson syndrome, idiopathic sprue, autoimmune inflammatory bowel disease (e.g., ulcerative colitis and Crohn's disease), endocrine ophthalmopathy, Grave's disease, sarcoidosis, alveolitis, chronic hypersensitivity pneumonitis, multiple sclerosis, primary biliary cirrhosis, uveitis (anterior and posterior), keratoconjunctivitis sicca and vernal keratoconjunctivitis, interstitial lung fibrosis, psoriatic arthritis and glomerulonephritis (with and without nephrotic syndrome, e.g., including idiopathic nephrotic syndrome or minimal change nephropathy).

Further, agents of the invention may also be used for the treatment of cystic fibrosis, pulmonary hypertension, pulmonary fibrosis, inflammatory bowel syndrome, wound healing, diabetic nephropathy as described in WO 05/107463, reduction of inflammation in transplanted tissue as described in US 2005/182018, inflammatory diseases caused by pathogenic organisms as described in WO 03/086408, and cardiovascular conditions as described in WO 03/029264.

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Also, the agents of the invention may be used to assess the severity of coronary artery stenosis as described in WO 00/078774 and useful in conjunction with radioactive imaging agents to image coronary activity and useful in adjunctive therapy with angioplasty as described in WO 00/78779.

Agents of the invention are also useful in combination with a protease inhibitor for prevention of organ ischemia and reperfusion injury as described in WO 05/003150, and in combination with an integrin antagonist for treating platelet aggregation as described in WO 03/090733.

Agents of the invention are also useful in promoting wound healing in bronchial epithelial cells as described in *AJP-Lung*, Vol. 290, pp. 849-855.

Other diseases or conditions which may be treated with agents of the invention include diabetes, e.g., diabetes mellitus type I (juvenile diabetes) and diabetes mellitus type II, diarrheal diseases, ischemia/reperfusion injuries, retinopathy, such as diabetic retinopathy or hyperbaric oxygen-induced retinopathy, conditions characterised by elevated intraocular pressure or secretion of ocular aqueous humor, such as glaucoma, ischemic tissue/organ damage from reperfusion and bedsores.

The effectiveness of an agent of the invention in inhibiting inflammatory conditions, for example in inflammatory airways diseases, may be demonstrated in an animal model, e.g., a mouse or rat model, of airways inflammation or other inflammatory conditions, e.g., as described by Szarka et al, *J Immunol Methods*, Vol. 202, pp. 49-57 (1997); Renzi et al, *Am Rev Respir Dis*, Vol. 148, pp. 932-939 (1993); Tsuyuki et al., *J Clin Invest*, Vol. 96, pp. 2924-2931 (1995); Cernadas et al., *Am J Respir Cell Mol Biol*, Vol. 20, pp. 1-8 (1999); and Fozard et al, *Eur J Pharmacol*, Vol. 438, pp. 183-188 (2002).

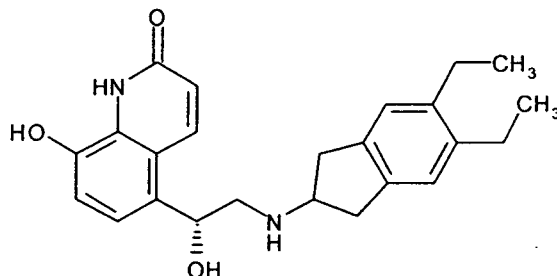
The agents of the invention are also useful as co-therapeutic agents for use in combination with other drug substances such as anti-inflammatory, bronchodilatory, antihistamine or anti-tussive drug substances, particularly in the treatment of obstructive or inflammatory airways diseases such as those mentioned hereinbefore, for example as potentiators of therapeutic activity of such drugs or as a means of reducing required dosaging or potential side effects of such drugs. An agent of the invention may be mixed with the other drug substance in a fixed pharmaceutical composition or it may be administered separately, before, simultaneously with or after the other drug substance.

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Accordingly the invention includes a combination of an agent of the invention as hereinbefore described with an anti-inflammatory, bronchodilatory, antihistamine or anti-tussive drug substance, said agent of the invention and said drug substance being in the same or different pharmaceutical composition.

Suitable anti-inflammatory drugs include steroids, in particular, glucocorticosteroids such as budesonide, beclamethasone dipropionate, fluticasone propionate, ciclesonide or mometasone furoate, or steroids described in WO 02/88167, WO 02/12266, WO 02/100879, WO 02/00679 (especially those of Examples 3, 11, 14, 17, 19, 26, 34, 37, 39, 51, 60, 67, 72, 73, 90, 99 and 101), WO 03/35668, WO 03/48181, WO 03/62259, WO 03/64445, WO 03/72592, WO 04/39827 and WO 04/66920; non-steroidal glucocorticoid receptor agonists, such as those described in DE 10261874, WO 00/00531, WO 02/10143, WO 03/82280, WO 03/82787, WO 03/86294, WO 03/104195, WO 03/101932, WO 04/05229, WO 04/18429, WO 04/19935 and WO 04/26248; LTB₄ antagonists, such as BIIL 284, CP-195543, DPC11870, LTB₄ ethanolamide, LY 293111, LY 255283, CGS025019C, CP-195543, ONO-4057, SB 209247, SC-53228 and those described in US 5451700; LTD₄ antagonists include montelukast, pranlukast, zafirlukast, accolate, SR2640, Wy-48,252, ICI 198615, MK-571, LY-171883, Ro 24-5913 and L-648051; PDE4 inhibitors such as cilomilast (Ariflo® GlaxoSmithKline), Roflumilast (Byk Gulden), V-11294A (Napp), BAY19-8004 (Bayer), SCH-351591 (Schering-Plough), Arofyline (Almirall Prodesfarma), PD189659 / PD168787 (Parke-Davis), AWD-12-281 (Asta Medica), CDC-801 (Celgene), SelCID(TM) CC-10004 (Celgene), VM554/UM565 (Vernalis), T-440 (Tanabe), KW-4490 (Kyowa Hakko Kogyo) and those disclosed in WO 92/19594, WO 93/19749, WO 93/19750, WO 93/19751, WO 98/18796, WO 99/16766, WO 01/13953, WO 03/104204, WO 03/104205, WO 03/39544, WO 04/000814, WO 04/000839, WO 04/005258, WO 04/018450, WO 04/018451, WO 04/018457, WO 04/018465, WO 04/018431, WO 04/018449, WO 04/018450, WO 04/018451, WO 04/018457, WO 04/018465, WO 04/019944, WO 04/019945, WO 04/045607 and WO 04/037805; adenosine A_{2B} receptor antagonists, such as those described in WO 02/42298; and beta-2 adrenoceptor agonists, such as albuterol (salbutamol), metaproterenol, terbutaline, salmeterol fenoterol, procaterol, and especially, formoterol, carmoterol and pharmaceutically acceptable salts thereof, and compounds (in free or salt or solvate form) of formula (I) of WO 0075114, which document is incorporated herein by reference, preferably compounds of the Examples thereof, especially a compound of formula

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and pharmaceutically acceptable salts thereof, as well as compounds (in free or salt or solvate form) of formula (I) of WO 04/16601, and also compounds of EP 1440966, JP 05025045, WO 93/18007, WO 99/64035, US 2002/0055651, US 2005/0133417, US 2005/5159448, WO 01/42193, WO 01/83462, WO 02/66422, WO 02/70490, WO 02/76933, WO 03/24439, WO 03/42160, WO 03/42164, WO 03/72539, WO 03/91204, WO 03/99764, WO 04/16578, WO 04/22547, WO 04/32921, WO 04/33412, WO 04/37768, WO 04/37773, WO 04/37807, WO 04/39762, WO 04/39766, WO 04/45618, WO 04/46083, WO 04/80964, EP 1460064, WO 04/087142, WO 04/089892, EP 01477167, US 2004/0242622, US 2004/0229904, WO 04/108675, WO 04/108676, WO 05/033121, WO 05/040103, WO 05/044787, WO 05/058867, WO 05/065650, WO 05/066140 and WO 05/07908.

Suitable bronchodilatory drugs include anticholinergic or antimuscarinic agents, in particular, ipratropium bromide, oxitropium bromide, tiotropium salts and CHF 4226 (Chiesi), and glycopyrrolate, but also those described in EP 424021, US 3714357, US 5171744, US 2005/171147, US 2005/182091, WO 01/04118, WO 02/00652, WO 02/51841, WO 02/53564, WO 03/00840, WO 03/33495, WO 03/53966, WO 03/87094, WO 04/018422, WO 04/05285 and WO 05/077361.

Suitable dual anti-inflammatory and bronchodilatory drugs include dual beta-2 adrenoceptor agonist/muscarinic antagonists such as those disclosed in US 2004/0167167, US 2004/0242622, US 2005/182092, WO 04/74246 and WO 04/74812.

Suitable antihistamine drug substances include cetirizine hydrochloride, acetaminophen, clemastine fumarate, promethazine, loratidine, desloratidine, diphenhydramine and fexofenadine hydrochloride, activastine, astemizole, azelastine, ebastine, epinastine, mizolastine and tefenadine, as well as those disclosed in JP 2004107299, WO 03/099807 and WO 04/026841.

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Other useful combinations of agents of the invention with anti-inflammatory drugs are those with antagonists of chemokine receptors, e.g., CCR-1, CCR-2, CCR-3, CCR-4, CCR-5, CCR-6, CCR-7, CCR-8, CCR-9 and CCR10, CXCR1, CXCR2, CXCR3, CXCR4, CXCR5, particularly CCR-5 antagonists, such as Schering-Plough antagonists SC-351125, SCH-55700 and SCH-D, Takeda antagonists, such as *N*-[[4-[[[6,7-dihydro-2-(4-methylphenyl)-5*H*-benzo-cyclohepten-8-yl]carbonyl]amino]phenyl]-methyl]tetrahydro-*N,N*-dimethyl-2*H*-pyran-4-amin-ium chloride (TAK-770), and CCR-5 antagonists described in US 6166037 (particularly claims 18 and 19), WO 00/66558 (particularly claim 8), WO 00/66559 (particularly claim 9), WO 04/018425 and WO 04/026873.

In accordance with the foregoing, the invention also provides a method for the treatment of a condition responsive to activation of the adenosine A_{2A} receptor, e.g., an inflammatory or allergic condition, particularly an inflammatory or obstructive airways disease, which comprises administering to a subject, particularly a human subject, in need thereof a compound of formula (I) in free form or in the form of a pharmaceutically acceptable salt. In another aspect the invention provides a compound of formula (I), in free form or in the form of a pharmaceutically acceptable salt, for use in the manufacture of a medicament for the treatment of a condition responsive to activation of the adenosine A_{2A} receptor, particularly an inflammatory or obstructive airways disease.

The agents of the invention may be administered by any appropriate route, e.g., orally, e.g., in the form of a tablet or capsule; parenterally, e.g., intravenously; by inhalation, e.g., in the treatment of inflammatory or obstructive airways disease; intranasally, e.g., in the treatment of allergic rhinitis; topically to the skin, e.g., in the treatment of atopic dermatitis; or rectally, e.g., in the treatment of inflammatory bowel disease.

In a further aspect, the invention also provides a pharmaceutical composition comprising a compounds of formula (I) in free form or in the form of a pharmaceutically acceptable salt, optionally together with a pharmaceutically acceptable diluent or carrier therefor. The composition may contain a co-therapeutic agent, such as an anti-inflammatory, broncho-dilatory, antihistamine or anti-tussive drug as hereinbefore described. Such compositions may be prepared using conventional diluents or excipients and techniques known in the galenic art. Thus oral dosage forms may include tablets and capsules. Formulations for topical administration may take the form of creams, ointments, gels or transdermal delivery systems, e.g., patches. Compositions for inhalation may comprise aerosol or other atomizable formulations or dry powder formulations.

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When the composition comprises an aerosol formulation, it preferably contains, e.g., a hydro-fluoro-alkane (HFA) propellant, such as HFA134a or HFA227 or a mixture of these, and may contain one or more co-solvents known in the art, such as ethanol (up to 20% by weight), and/or one or more surfactants, such as oleic acid or sorbitan trioleate, and/or one or more bulking agents, such as lactose. When the composition comprises a dry powder formulation, it preferably contains, e.g., the compounds of formula (I) having a particle diameter up to 10 microns, optionally together with a diluent or carrier, such as lactose, of the desired particle size distribution and a compound that helps to protect against product performance deterioration due to moisture, e.g., magnesium stearate. When the composition comprises a nebulised formulation, it preferably contains, e.g., the compound of formula (I) either dissolved, or suspended, in a vehicle containing water, a co-solvent, such as ethanol or propylene glycol and a stabilizer, which may be a surfactant.

The invention includes:

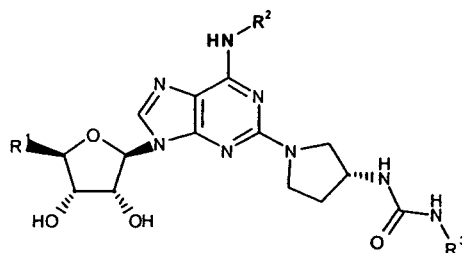
- (a) a compounds of formula (I) in inhalable form, e.g., in an aerosol or other atomisable composition or in inhalable particulate, e.g., micronized, form;
- (b) an inhalable medicament comprising a compounds of formula (I) in inhalable form;
- (c) a pharmaceutical product comprising a compounds of formula (I) in inhalable form in association with an inhalation device; and
- (d) an inhalation device containing a compounds of formula (I) in inhalable form.

Dosages of compounds of formula (I) employed in practicing the present invention will of course vary depending, e.g., on the particular condition to be treated, the effect desired and the mode of administration. In general, suitable daily dosages for administration by inhalation are of the order of 0.005-10 mg, while for oral administration suitable daily doses are of the order of 0.05-100 mg.

The invention is illustrated by the following Examples.

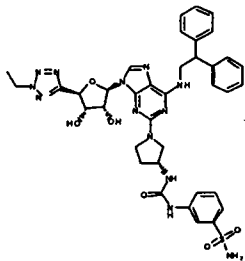
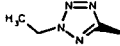
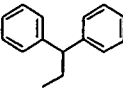
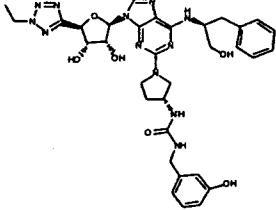
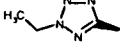
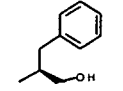
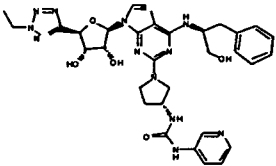
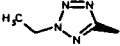
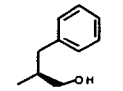
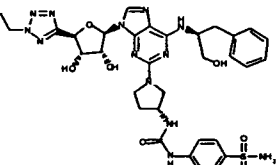
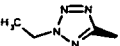
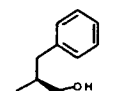
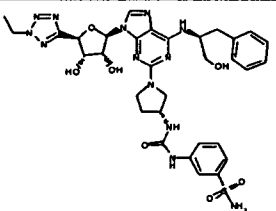
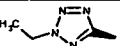
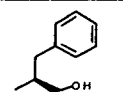
EXAMPLES**Examples 1-48**

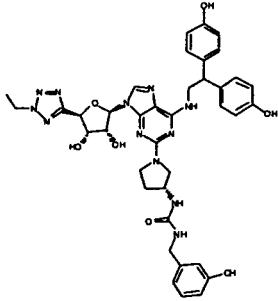
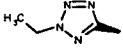
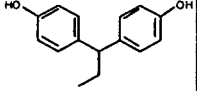
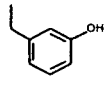
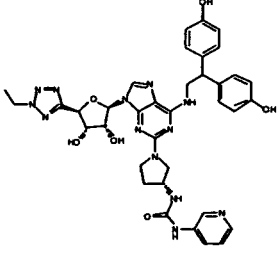
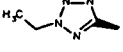
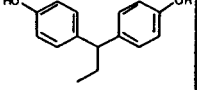
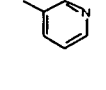
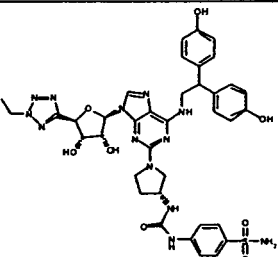
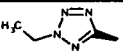
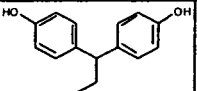
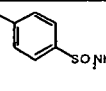
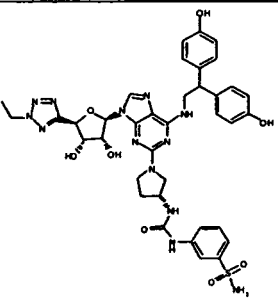
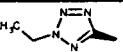
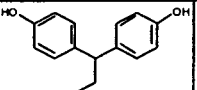
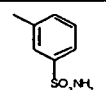
Compounds of formula (I)



are shown in the following table. Methods for preparing such compounds are described hereinafter.

Ex.	Structure	R ¹	R ²	R ³	Name
1					1-((R)-1-(6-(2,2-Diphenyl-ethylamino)-9-(2R,3R,4S,5R)-5-(2-ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl)-9H-purin-2-yl)-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
2					1-((R)-1-(6-(2,2-Diphenyl-ethylamino)-9-[(2R,3R,4S,5R)-5-(2-ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-9H-purin-2-yl)-pyrrolidin-3-yl)-3-pyridin-3-yl)-urea
3					4-[3-((R)-1-(6-(2,2-Diphenyl-ethylamino)-9-[(2R,3R,4S,5R)-5-(2-ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-9H-purin-2-yl)-pyrrolidin-3-yl)-ureido]-benzenesulfonamide

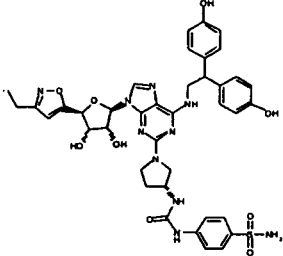
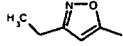
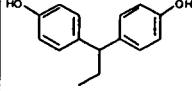
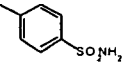
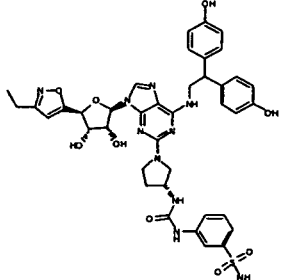
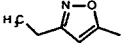
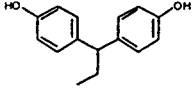
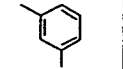
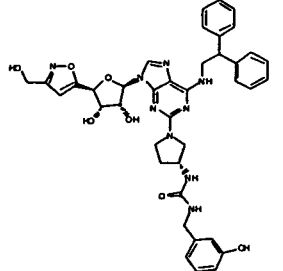
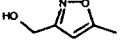
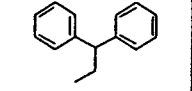
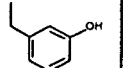
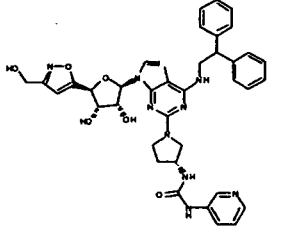
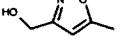
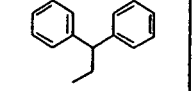
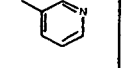
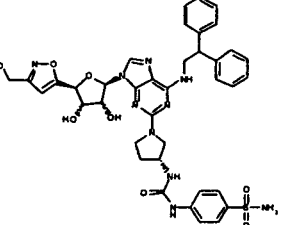
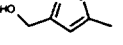
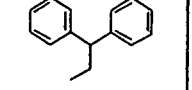
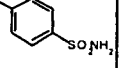
Ex.	Structure	R ¹	R ²	R ³	Name
4					3-{3-[(R)-1-{6-(2,2-Diphenyl-ethylamino)-9-[(2R,3R,4S,5R)-5-(2-ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-9H-purin-2-yl]-pyrrolidin-3-yl}-ureido]-benzenesulfonamide
5					1-[(R)-1-[9-[(2R,3R,4S,5R)-5-(2-Ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-6-[(S)-1-hydroxymethyl-2-phenyl-ethylamino]-9H-purin-2-yl]-pyrrolidin-3-yl]-3-(3-hydroxy-benzyl)-urea
6					1-[(R)-1-[9-[(2R,3R,4S,5R)-5-(2-Ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-6-[(S)-1-hydroxymethyl-2-phenyl-ethylamino]-9H-purin-2-yl]-pyrrolidin-3-yl]-3-pyridin-3-yl-urea
7					4-{3-[(R)-1-[9-[(2R,3R,4S,5R)-5-(2-Ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-6-[(S)-1-hydroxymethyl-2-phenyl-ethylamino]-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido)-benzenesulfonamide
8					3-{3-[(R)-1-[9-[(2R,3R,4S,5R)-5-(2-Ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-6-[(S)-1-hydroxymethyl-2-phenyl-ethylamino]-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido)-benzenesulfonamide

Ex.	Structure	R ¹	R ²	R ³	Name
9					1-((R) - 1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5R)-5-(2-ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydro-furan-2-yl]-9H-purin-2-yl}-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
10					1-((R) - 1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5R)-5-(2-ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydro-furan-2-yl]-9H-purin-2-yl}-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
11					4-{3-((R) - 1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5R)-5-(2-ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydro-furan-2-yl]-9H-purin-2-yl}-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
12					3-{3-((R) - 1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5R)-5-(2-ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydro-furan-2-yl]-9H-purin-2-yl}-pyrrolidin-3-yl)-ureido]-benzenesulfonamide

- 28 -

Ex.	Structure	R ¹	R ²	R ³	Name
13					1-((R)-1-(6-(2,2-Diphenyl-ethylamino)-9-[(2R,3R,4S,5S)-5-(3-ethyl-isoxazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-9H-purin-2-yl)-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
14					1-((R)-1-(6-(2,2-Diphenyl-ethylamino)-9-[(2R,3R,4S,5S)-5-(3-ethyl-isoxazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-9H-purin-2-yl)-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
15					4-{3-((R)-1-(6-(2,2-Diphenyl-ethylamino)-9-[(2R,3R,4S,5S)-5-(3-ethyl-isoxazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-9H-purin-2-yl)-pyrrolidin-3-yl)-ureido}-benzenesulfonamide
16					3-{3-((R)-1-(6-(2,2-Diphenyl-ethylamino)-9-[(2R,3R,4S,5S)-5-(3-ethyl-isoxazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-9H-purin-2-yl)-pyrrolidin-3-yl)-ureido}-benzenesulfonamide
17					1-((R)-1-[9-[(2R,3R,4S,5S)-5-(3-ethyl-isoxazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea

Ex.	Structure	R ¹	R ²	R ³	Name
18					1-((R)-1-[9- [(2R,3R,4S,5S)-5-(3- Ethyl-isoxazol-5-yl)-3,4- dihydroxy-tetrahydro- furan-2-yl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)-9H- purin-2-yl]-pyrrolidin-3- yl]-3-pyridin-3-yl-urea
19					4-(3-((R)-1-[9- [(2R,3R,4S,5S)-5-(3- Ethyl-isoxazol-5-yl)-3,4- dihydroxy-tetrahydro- furan-2-yl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)-9H- purin-2-yl]-pyrrolidin-3- yl)-ureido)- benzenesulfonamide
20					3-(3-((R)-1-[9- [(2R,3R,4S,5S)-5-(3- Ethyl-isoxazol-5-yl)-3,4- dihydroxy-tetrahydro- furan-2-yl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)-9H- purin-2-yl]-pyrrolidin-3- yl)-ureido)- benzenesulfonamide
21					1-((R)-1-[6-[2,2-Bis-(4- hydroxy-phenyl)- ethylamino]-9- [(2R,3R,4S,5S)-5-(3- ethyl-isoxazol-5-yl)-3,4- dihydroxy-tetrahydro- furan-2-yl]-9H-purin-2- yl]-pyrrolidin-3-yl]-3-(3- hydroxy-benzyl)-urea
22					1-((R)-1-[6-[2,2-Bis-(4- hydroxy-phenyl)- ethylamino]-9- [(2R,3R,4S,5S)-5-(3- ethyl-isoxazol-5-yl)-3,4- dihydroxy-tetrahydro- furan-2-yl]-9H-purin-2- yl]-pyrrolidin-3-yl]-3- pyridin-3-yl-urea

Ex.	Structure	R ¹	R ²	R ³	Name
23					4-{3-((R)-1-[6-{2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5S)-5-(3-ethyl-isoxazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido}-benzenesulfonamide
24					3-{3-((R)-1-[6-{2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5S)-5-(3-ethyl-isoxazol-5-yl)-3,4-dihydroxy-tetrahydrofuran-2-yl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido}-benzenesulfonamide
25					1-((R)-1-[9-[(2R,3R,4S,5S)-3,4-Dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydrofuran-2-yl]-6-(2,2-diphenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
26					1-((R)-1-[9-[(2R,3R,4S,5S)-3,4-Dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydrofuran-2-yl]-6-(2,2-diphenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
27					4-{3-((R)-1-[9-[(2R,3R,4S,5S)-3,4-Dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydrofuran-2-yl]-6-(2,2-diphenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide

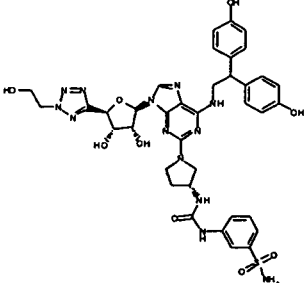
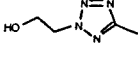
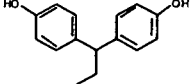
Ex.	Structure	R ¹	R ²	R ³	Name
28					3-(3-((R)-1-[9-[(2R,3R,4S,5S)-3,4-dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-2-yl]-6-(2,2-diphenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide
29					1-((R)-1-[9-[(2R,3R,4S,5S)-3,4-dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-2-yl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
30					1-((R)-1-[9-[(2R,3R,4S,5S)-3,4-dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-2-yl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
31					4-(3-((R)-1-[9-[(2R,3R,4S,5S)-3,4-dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-2-yl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide
32					3-(3-((R)-1-[9-[(2R,3R,4S,5S)-3,4-dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-2-yl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide

Ex.	Structure	R ¹	R ²	R ³	Name
33					1-((R)-1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5S)-3,4-dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-2-yl]-9H-purin-2-yl}-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
34					1-((R)-1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5S)-3,4-dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-2-yl]-9H-purin-2-yl}-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
35					4-{3-((R)-1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5S)-3,4-dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-2-yl]-9H-purin-2-yl}-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
36					3-{3-((R)-1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(2R,3R,4S,5S)-3,4-dihydroxy-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-2-yl]-9H-purin-2-yl}-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
37					1-((R)-1-[9-[(2R,3R,4S,5R)-3,4-dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydro-furan-2-yl]-6-(2,2-diphenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea

Ex.	Structure	R ¹	R ²	R ³	Name
38					1-((R)-1-[9-((2R,3R,4S,5R)-3,4-Dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
39					4-(3-((R)-1-[9-((2R,3R,4S,5R)-3,4-Dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureid)-benzenesulfonamide
40					3-(3-((R)-1-[9-((2R,3R,4S,5R)-3,4-Dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureid)-benzenesulfonamide
41					1-((R)-1-[9-((2R,3R,4S,5R)-3,4-Dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-6-((S)-1-hydroxymethyl-2-phenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
42					1-((R)-1-[9-((2R,3R,4S,5R)-3,4-Dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-6-((S)-1-hydroxymethyl-2-phenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea

Ex.	Structure	R ¹	R ²	R ³	Name
43					4-{3-[(R)-1-[9-((2R,3R,4S,5R)-3,4-dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido)-benzenesulfonamide
44					3-{3-[(R)-1-[9-((2R,3R,4S,5R)-3,4-dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido)-benzenesulfonamide
45					1-[(R)-1-(6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-((2R,3R,4S,5R)-3,4-dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
46					1-[(R)-1-(6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-((2R,3R,4S,5R)-3,4-dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
47					4-{3-[(R)-1-(6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-((2R,3R,4S,5R)-3,4-dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido)-benzenesulfonamide

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Ex.	Structure	R ¹	R ²	R ³	Name
48					3-{3-[(R)-1-(6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-((2R,3R,4S,5R)-3,4-dihydroxy-5-[2-(2-hydroxy-ethyl)-2H-tetrazol-5-yl]-tetrahydrofuran-2-yl)-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido)-benzenesulfonamide

Preparation of intermediate compounds

Intermediate A 4,4'-(2-Aminoethylidene)bis-phenol

This compound is prepared by the procedure of R.M.Schelkun et al., *Bioorg Med Chem Lett*, Vol. 9,p p. 2447-2452 (1999).

Intermediate BA (3-Hydroxy-benzyl)-carbamic acid phenyl ester

3-Hydroxybenzylamine (200 mg, 1.62 mmol) and sodium hydrogen carbonate (273 mg, 3.25 mmol) suspended in water/DCM (4 mL, 1:1) is treated with phenyl chloroformate (0.204 mL, 1.62 mmol). After stirring at RT overnight, the reaction mixture is diluted with more DCM/water and the organic phase is separated. The organic portion is concentrated *in vacuo* to afford the titled compound. (MH⁺ 244)

Intermediate BB Pyridin-3-yl-carbamic acid phenyl ester

Phenyl chloroformate (0.733 mL, 5.84 mmol) is suspended in pyridine/DCM (3 mL, 2:1). The solution is stirred at 0°C, and 3-aminopyridine (500 mg, 5.31 mmol) dissolved in DCM (1 mL) is added dropwise. The reaction mixture is at 0°C for 1 hour. The solvent is removed *in vacuo* and the residue is dissolved in ethyl acetate. This organic portion is washed with 0.1 M HCl and then concentrated *in vacuo* to afford the titled compound. (MH⁺ 215)

Intermediates BC and BD

These compounds namely,

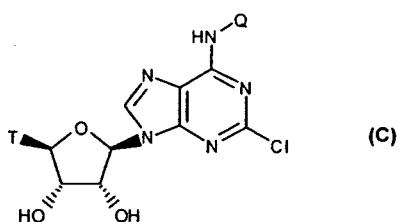
- 36 -

- (3-Sulfamoyl-phenyl)-carbamic acid phenyl ester (Intermediate **BC**); and

- (4-Sulfamoyl-phenyl)-carbamic acid phenyl ester (Intermediate **BD**),

are prepared analogously to Intermediate **BB** by replacing 3-aminopyridine with the appropriate amine.

The following intermediates of formula (C)

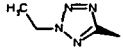
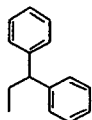
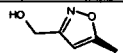
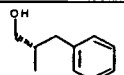
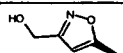
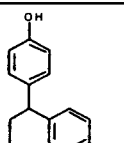
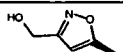
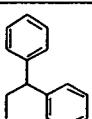
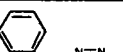
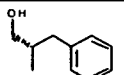
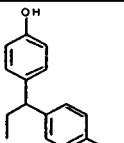


are shown below in Table 1a, the methods of preparation being described hereinafter.

TABLE 1

Intermediate	T	Q
CA		
CB		
CC		
CD		
CE		

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Intermediate	T	Q
CF		
CG		
CH		
CI		
CJ		
CK		

Intermediate CA (2R,3R,4S,5S)-2-[6-((S)-1-Benzyl-2-hydroxyethylamino)-2-chloro-purin-9-yl]-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol

Step CA1: Acetic acid (2R,3R,4R,5S)-4-acetoxy-2-[6-((S)-1-benzyl-2-hydroxy-ethyl amino)-2-chloro-purin-9-yl]-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3-yl ester hydrochloride

A mixture comprising acetic acid (2R,3R,4R,5S)-4-acetoxy-2-(2,6-dichloro-purin-9-yl)-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3-yl ester (WO 99/38877) (1 g, 2.13 mmol), (S)-2-amino-3-phenyl-propan-1-ol (0.321 g, 2.13 mmol) and DIPEA (0.275 g, 2.13 mmol) in DCE (5 mL) is stirred under an inert atmosphere of argon overnight. After cooling to room temperature (RT), 1 M HCl is added, the organic portion is separated and concentrated

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in vacuo to afford the title compound which is used in the next step without further purification. (MH+ 585.1)

Step CA2: (2*R*,3*R*,4*S*,5*S*)-2-[6-((*S*)-1-Benzyl-2-hydroxy-ethylamino)-2-chloro-purin-9-yl]-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol

A solution of acetic acid (2*R*,3*R*,4*R*,5*S*)-4-acetoxy-2-[6-((*S*)-1-benzyl-2-hydroxy-ethyl amino)-2-chloro-purin-9-yl]-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3-yl ester hydrochloride (Step AC1) (1.194 g, 2.02 mmol) in MeOH/chloroform (4 mL, 3:1 MeOH/ chloroform) is treated with saturated potassium carbonate solution (10 mL). After stirring at RT overnight, the reaction mixture is diluted with DCM/water and the organic portion is separated. The organic portion is concentrated *in vacuo* to afford the title compound. (MH+ 501)

Intermediate CB-CC

These intermediates namely,

- (2*R*,3*R*,4*S*,5*S*)-2-[6-[2,2-*bis*-(4-Hydroxy-phenyl)-ethylamino]-2-chloro-purin-9-yl]-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol (Intermediate CB); and
- (2*R*,3*R*,4*S*,5*S*)-2-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol (Intermediate CC),

are prepared analogously to Intermediate CA by replacing (*S*)-2-amino-3-phenyl-propan-1-ol with the appropriate amine.

Intermediate CD (2*R*,3*R*,4*S*,5*R*)-2-[6-((*S*)-1-Benzyl-2-hydroxyethylamino)-2-chloro-purin-9-yl]-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3,4-diol

Step CD1: Acetic acid (2*R*,3*R*,4*R*,5*R*)-4-acetoxy-2-[6-((*S*)-1-benzyl-2-hydroxy-ethyl amino)-2-chloro-purin-9-yl]-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3-yl ester

The title compound is prepared analogously to a cetic acid (2*R*,3*R*,4*R*,5*S*)-4-acetoxy-2-[6-((*S*)-1-benzyl-2-hydroxy-ethyl amino)-2-chloro-purin-9-yl]-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3-yl ester hydrochloride (Step CA1) by replacing acetic acid (2*R*,3*R*,4*R*,5*S*)-

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4-acetoxy-2-(2,6-dichloro-purin-9-yl)-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3-yl ester (WO 99/38877) with acetic acid (2*R*,3*R*,4*R*,5*R*)-4-acetoxy-2-(2,6-dichloro-purin-9-yl)-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3-yl ester (WO 98/28319).

Step CD2: (2*R*,3*R*,4*S*,5*R*)-2-[6-((*S*)-1-Benzyl-2-hydroxy-ethylamino)-2-chloro-purin-9-yl]-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3,4-diol

The title compound is prepared from acetic acid (2*R*,3*R*,4*R*,5*R*)-4-acetoxy-2-[6-((*S*)-1-benzyl-2-hydroxy-ethylamino)-2-chloro-purin-9-yl]-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3-yl ester (*Step CD1*) analogously to (2*R*,3*R*,4*S*,5*S*)-2-[6-((*S*)-1-benzyl-2-hydroxy-ethylamino)-2-chloro-purin-9-yl]-5-(3-ethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol (*Step CA2*).

Intermediates CE and CF

These intermediates namely,

- (2*R*,3*R*,4*S*,5*R*)-2-[6-[2,2-*bis*-(4-Hydroxy-phenyl)-ethylamino]-2-chloro-purin-9-yl]-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3,4-diol (Intermediate **CE**); and
- (2*R*,3*R*,4*S*,5*R*)-2-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3,4-diol (Intermediate **CF**),

are prepared analogously to Intermediate **CD** by replacing (*S*)-2-amino-3-phenyl-propan-1-ol with the appropriate amine.

Intermediate CG (2*R*,3*R*,4*S*,5*S*)-2-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol

Step CG1: Acetic acid (2*R*,3*R*,4*R*,5*S*)-4-acetoxy-5-(3-acetoxymethyl-isoxazol-5-yl)-2-[2-chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-tetrahydro-furan-3-yl ester

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A mixture containing acetic acid (2*R*,3*R*,4*R*,5*S*)-4-acetoxy-5-(3-acetoxymethyl-isoxazol-5-yl)-2-(2,6-dichloro-purin-9-yl)-tetrahydro-furan-3-yl ester (WO 99/38877), 2,2-diphenylethylamine and DIPEA in DCE is stirred under an inert atmosphere of argon at 50°C overnight. After cooling to RT, 0.1 M HCl is added, the organic portion separated and concentrated *in vacuo* to afford the titled compound which is used in the next step without further purification.

Step CG2: (2*R*,3*R*,4*S*,5*S*)-2-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol

A solution of acetic acid (2*R*,3*R*,4*S*,5*S*)-4-acetoxy-5-(3-acetoxymethyl-isoxazol-5-yl)-2-[2-chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-tetrahydro-furan-3-yl ester (Step CG1) in MeOH/chloroform (3:1 MeOH/chloroform) is treated with saturated potassium carbonate solution. After stirring at RT overnight, the reaction is diluted with DCM/water and the organic portion is separated. The organic portion is concentrated *in vacuo* to afford the titled compound.

Intermediate CH (2*R*,3*R*,4*S*,5*S*)-2-[6-[2,2-bis-(4-Hydroxy-phenyl)-ethylamino]-2-chloro-purin-9-yl]-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydrofuran-3,4-diol

The title compound is prepared from acetic acid (2*R*,3*R*,4*R*,5*S*)-4-acetoxy-5-(3-acetoxymethyl-isoxazol-5-yl)-2-(2,6-dichloro-purin-9-yl)-tetrahydro-furan-3-yl ester (WO 99/38877) analogously to (2*R*,3*R*,4*S*,5*S*)-2-[2-chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol (Intermediate CG) by replacing 2,2-diphenylethylamine with 4,4'-(2-aminoethylidene)bis-phenol (Intermediate A).

Intermediate CI (2*R*,3*R*,4*S*,5*S*)-2-[2-Chloro-6-((*S*)-1-hydroxymethyl)-2-phenyl-ethylamino]-purin-9-yl]-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol

The title compound is prepared from acetic acid (2*R*,3*R*,4*R*,5*S*)-4-acetoxy-5-(3-acetoxymethyl-isoxazol-5-yl)-2-(2,6-dichloro-purin-9-yl)-tetrahydro-furan-3-yl ester (WO 99/38877) analogously to (2*R*,3*R*,4*S*,5*S*)-2-[2-chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(3-hydroxymethyl-isoxazol-5-yl)-tetrahydro-furan-3,4-diol (Intermediate CG) by replacing 2,2-diphenylethylamine with (*S*)-2-amino-3-phenyl-propan-1-ol.

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Intermediate CJ (2R,3R,4S,5R)-2-[6-((S)-1-Benzyl-2-hydroxyethylamino)-2-chloro-purin-9-yl]-5-(2-benzyl-2H-tetrazol-5-yl)-tetrahydro-furan-3,4-diol

The title compound is prepared in an analogous fashion to (2R,3S,4R,5R)-2-(2-benzyl-2H-tetrazol-5-yl)-5-[2-chloro-6-(2,2-diphenylethylamino)-purin-9-yl]-tetrahydro-furan-3,4-diol (WO 99/38877) by replacing 2,2-diphenylethylamine with (S)-2-amino-3-phenylpropan-1-ol.

Intermediate CK (2R,3S,4R,5R)-2-(2-Benzyl-2H-tetrazol-5-yl)-5-[6-[2,2-bis-(4-hydroxy-phenyl)ethylamino]-2-chloro-purin-9-yl]-tetrahydro-furan-3,4-diol

The title compound is prepared in an analogous fashion to (2R,3S,4R,5R)-2-(2-benzyl-2H-tetrazol-5-yl)-5-[2-chloro-6-(2,2-diphenylethylamino)-purin-9-yl]-tetrahydro-furan-3,4-diol (WO 99/38877) by replacing 2,2-diphenylethylamine with 4,4'-(2-aminoethylidene)bis-phenol (Intermediate A).

Preparation of Examples

Example 1 1-((R)-1-[6-(2,2-Diphenyl-ethylamino)-9-[(2R,3R,4S,5R)-5-(2-ethyl-2H-tetrazol-5-yl)-3,4-dihydroxy-tetrahydro-furan-2-yl]-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea trifluoroacetate

Step 1: (2R,3R,4S,5R)-2-[6-(2,2-Diphenyl-ethylamino)-2-((R)-3-BOC-amino-pyrrolidin-1-yl)-purin-9-yl]-5-(2-ethyl-2H-tetrazol-5-yl)-tetrahydro-furan-3,4-diol

(2R,3R,4S,5R)-2-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(2-ethyl-2H-tetrazol-5-yl)-tetrahydro-furan-3,4-diol (Intermediate CF) (1 g, 1.82 mmol), (3R)-3-(BOC-amino)pyrrolidine (1.02 g, 5.47 mmol) and sodium iodide (273 mg, 1.82 mmol) are dissolved in acetonitrile (10 mL) and NMP (0.5 mL). The reaction mixture is heated using microwave radiation at 160 °C for 30 minutes in the Personal Chemistry Emrys™ Optimizer microwave reactor. The reaction mixture is concentrated *in vacuo* and purified by C-18 reverse phase column chromatography eluting with acetonitrile:water (0.1% TFA) (gradient 0-100% acetonitrile) to afford the titled compound.

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Step 2: (2*R*,3*R*,4*S*,5*R*)-2-[2-((*R*)-3-Amino-pyrrolidin-1-yl)-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3,4-diol trifluoroacetate

(2*R*,3*R*,4*S*,5*R*)-2-[6-(2,2-Diphenyl-ethylamino)-2-((*R*)-3-BOC-amino-pyrrolidin-1-yl)purin-9-yl]-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3,4-diol (Step AA1) is dissolved in DCM and TFA and stirred at RT overnight. The reaction mixture is concentrated *in vacuo* to afford the titled compound.

Step 3: 1-((*R*)-1-[6-(2,2-Diphenyl-ethylamino)-9-[(2*R*,3*R*,4*S*,5*R*)-5-(2-ethyl-2*H*-tetrazol-5-yl)-3,4-dihydroxy-tetrahydro-furan-2-yl]-9*H*-purin-2-yl]-pyrrolidin-3-yl]-3-(3-hydroxy-benzyl)-urea trifluoroacetate

(2*R*,3*R*,4*S*,5*R*)-2-[2-((*R*)-3-Amino-pyrrolidin-1-yl)-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(2-ethyl-2*H*-tetrazol-5-yl)-tetrahydro-furan-3,4-diol trifluoroacetate and (3-hydroxy-benzyl)-carbamic acid phenyl ester (Intermediate BA) are dissolved in methanol and TEA. The reaction mixture is heated using microwave radiation at 100°C for 30 minutes in the Personal Chemistry Emrys™ Optimizer microwave reactor. The reaction mixture is concentrated *in vacuo* and purified by C-18 reverse phase column chromatography eluting with acetonitrile:water (0.1% TFA) (gradient 0-100% acetonitrile) to afford the titled compound.

Examples 2-36

These are prepared analogously to Example 1 by combining the appropriate starting compound from Table 1a (Intermediates CA-CI) with the appropriate phenyl esters (Intermediates BA-BD).

Example 37 1-((*R*)-1-[9-[(2*R*,3*R*,4*S*,5*R*)-3,4-Dihydroxy-5-[2-(2-hydroxy-ethyl)-2*H*-tetrazol-5-yl]-tetrahydro-furan-2-yl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl]-3-(3-hydroxy-benzyl)-urea

Step 1: 1-((*R*)-1-[9-[(2*R*,3*R*,4*S*,5*R*)-5-(2-Benzyl-2*H*-tetrazol-5-yl)-3,4-dihydroxy-tetrahydro-furan-2-yl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl]-3-pyridin-3-yl-urea

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This compound is prepared from (2*R*,3*S*,4*R*,5*R*)-2-(2-benzyl-2*H*-tetrazol-5-yl)-5-[2-chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-tetrahydro-furan-3,4-diol (WO 99/38877) and pyridin-3-yl-carbamic acid phenyl ester (Intermediate **BB**) analogously to Example 1.

Step 2: 1-((*R*)-1-[9-[(2*R*,3*R*,4*S*,5*R*)-3,4-Dihydroxy-5-(2*H*-tetrazol-5-yl)-tetrahydro-furan-2-yl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea

A solution of 1-((*R*)-1-[9-[(2*R*,3*R*,4*S*,5*R*)-5-(2-Benzyl-2*H*-tetrazol-5-yl)-3,4-dihydroxy-tetrahydro-furan-2-yl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea in EtOH under an inert atmosphere of argon is treated with 10% palladium on carbon followed by ammonium formate. The reaction mixture is heated to 50°C for 4 hours and then filtered through celite®. The filtrate is concentrated *in vacuo* to afford the title compound.

Step 3: 1-((*R*)-1-[9-[(2*R*,3*R*,4*S*,5*R*)-3,4-Dihydroxy-5-[2-(2-hydroxy-ethyl)-2*H*-tetrazol-5-yl]-tetrahydro-furan-2-yl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea

A solution of 1-((*R*)-1-[9-[(2*R*,3*R*,4*S*,5*R*)-3,4-dihydroxy-5-(2*H*-tetrazol-5-yl)-tetrahydro-furan-2-yl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea in DMF is treated with potassium carbonate followed by 3-bromoethanol and stirred at RT for 18 hours. The mixture is then filtered and the filtrate is concentrated *in vacuo*. Purification of the crude product by C-18 reverse phase column chromatography eluting with acetonitrile:water (0.1% TFA) (gradient 0-100% acetonitrile) to affords the titled compound.

Examples 38-40

These compounds are prepared analogously to Example 37 by replacing pyridin-3-yl-carbamic acid phenyl ester (Intermediate **BB**) with Intermediates **BA**, **BD** and **BC**, respectively.

Examples 41-44

These examples are prepared analogously to Examples 37-40 by replacing (2*R*,3*S*,4*R*,5*R*)-2-(2-benzyl-2*H*-tetrazol-5-yl)-5-[2-chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-tetrahydro-furan-3,4-diol (WO 99/38877) with (2*R*,3*R*,4*S*,5*R*)-2-[6-((*S*)-1-Benzyl-2-

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hydroxy-ethylamino)-2-chloro-purin-9-yl]-5-(2-benzyl-2H-tetrazol-5-yl)-tetrahydro-furan-3,4-diol (Intermediate CJ).

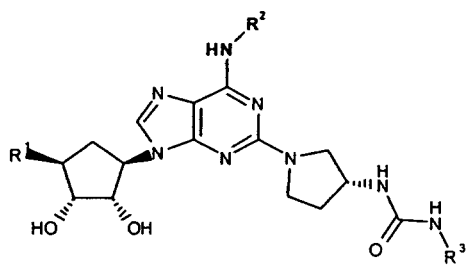
Examples 45-48

These examples are prepared analogously to Examples 37-40 by replacing (2R,3S,4R,5R)-2-(2-benzyl-2H-tetrazol-5-yl)-5-[2-chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-tetrahydro-furan-3,4-diol (WO 99/38877) with (2R,3S,4R,5R)-2-(2-Benzyl-2H-tetrazol-5-yl)-5-{6-[2,2-bis-(4-hydroxy-phenyl) ethylamino]-2-chloro-purin-9-yl]-tetrahydro-furan-3,4-diol (Intermediate CK)

Carbocyclic Examples

Examples C1-C84

Compounds of formula (I)



are shown in the following table. Methods for preparing such compounds are described hereinafter. The table also shows mass spectrometry, MH^+ (ESMS), data. The Examples are trifluoroacetate salts.

Ex.	Structure	R ¹	R ²	R ³	Name
C1					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-((S)-4-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea

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Ex.	Structure	R ¹	R ²	R ³	Name
C2					1-((R)-1-[9- [(1R,2S,3R,4S)-4- (2,5-Dioxo- imidazolidin-1-yl)-2,3- dihydroxy- cyclopentyl]-6-(2,2- diphenylethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)-3- pyridin-3-yl)-urea
C3					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-((S)-4- methyl-2,5-dioxo- imidazolidin-1-yl)- cyclopentyl]-6-(2,2- diphenylethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)-3-(3- hydroxy-benzyl)-urea
C4					4-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-((S)-4- methyl-2,5-dioxo- imidazolidin-1-yl)- cyclopentyl]-6-(2,2- diphenylethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C5					3-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-((S)-4- methyl-2,5-dioxo- imidazolidin-1-yl)- cyclopentyl]-6-(2,2- diphenylethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C6					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-((S)-4- methyl-2,5-dioxo- imidazolidin-1-yl)- cyclopentyl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)-3- pyridin-3-yl)-urea

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Ex.	Structure	R ¹	R ²	R ³	Name
C7					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(S)-4- methyl-2,5-dioxo- imidazolidin-1-yl]- cyclopentyl]-6-(S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)-3-(3- hydroxy-benzyl)-urea
C8					4-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(S)-4- methyl-2,5-dioxo- imidazolidin-1-yl]- cyclopentyl]-6-(S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C9					3-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(S)-4- methyl-2,5-dioxo- imidazolidin-1-yl]- cyclopentyl]-6-(S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C10					1-((R)-1-[6-[2,2-Bis- (4-hydroxy-phenyl)- ethylamino]-9- [(1R,2S,3R,4S)-2,3- dihydroxy-4-(S)-4- methyl-2,5-dioxo- imidazolidin-1-yl]- cyclopentyl]-9H- purin-2-yl]-pyrrolidin- 3-yl)-3-pyridin-3-yl- urea
C11					1-((R)-1-[6-[2,2-Bis- (4-hydroxy-phenyl)- ethylamino]-9- [(1R,2S,3R,4S)-2,3- dihydroxy-4-(S)-4- methyl-2,5-dioxo- imidazolidin-1-yl]- cyclopentyl]-9H- purin-2-yl]-pyrrolidin- 3-yl)-3-(3-hydroxy- benzyl)-urea

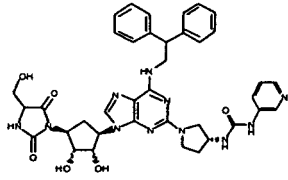
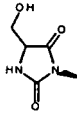
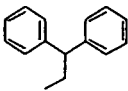
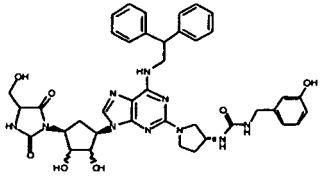
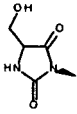
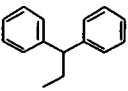
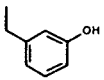
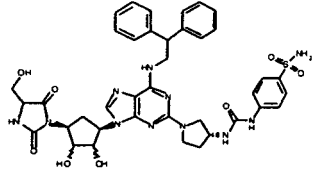
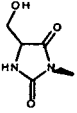
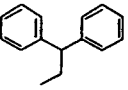
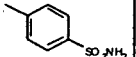
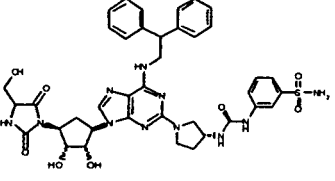
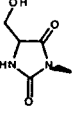
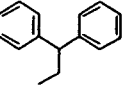
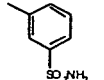
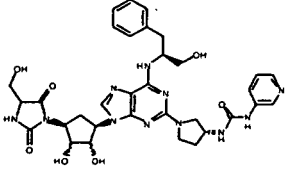
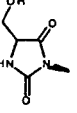
Ex.	Structure	R ¹	R ²	R ³	Name
C12					4-{3-[(R)-1-[6-[2,2-Bis-(4-hydroxyphenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-[(S)-4-methyl-2,5-dioxoimidazolidin-1-yl]-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido}-benzenesulfonamide
C13					3-[3-[(R)-1-[6-[2,2-Bis-(4-hydroxyphenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-[(S)-4-methyl-2,5-dioxoimidazolidin-1-yl]-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido]-benzenesulfonamide
C14					1-[(R)-1-[9-[(1R,2S,3R,4S)-4-(2,5-Dioxoimidazolidin-1-yl)-2,3-dihydroxy-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl]-3-(3-hydroxy-benzyl)-urea
C15					4-{3-[(R)-1-[9-[(1R,2S,3R,4S)-4-(2,5-Dioxoimidazolidin-1-yl)-2,3-dihydroxy-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido}-benzenesulfonamide
C16					3-[3-[(R)-1-[9-[(1R,2S,3R,4S)-4-(2,5-Dioxoimidazolidin-1-yl)-2,3-dihydroxy-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl]-ureido]-benzenesulfonamide

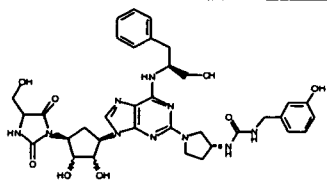
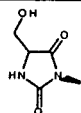
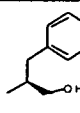
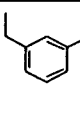
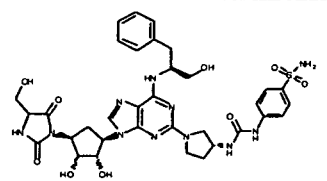
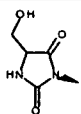
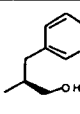
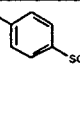
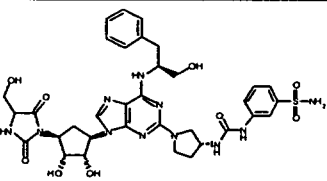
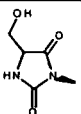
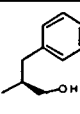
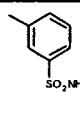
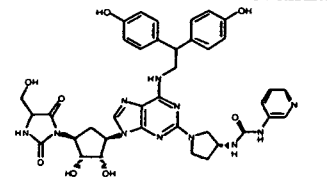
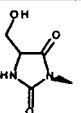
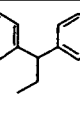
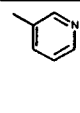
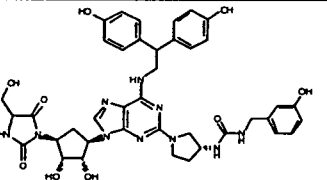
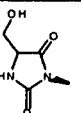
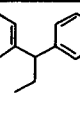
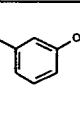
Ex.	Structure	R ¹	R ²	R ³	Name
C17					1-((R)-1-[9- [(1R,2S,3R,4S)-4- (2,5-Dioxo- imidazolidin-1-yl)-2,3- dihydroxy- cyclopentyl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl]-3- pyridin-3-yl)-urea
C18					1-((R)-1-[9- [(1R,2S,3R,4S)-4- (2,5-Dioxo- imidazolidin-1-yl)-2,3- dihydroxy- cyclopentyl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl]-3-(3- hydroxy-benzyl)-urea
C19					4-(3-((R)-1-[9- [(1R,2S,3R,4S)-4- (2,5-Dioxo- imidazolidin-1-yl)-2,3- dihydroxy- cyclopentyl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C20					3-(3-((R)-1-[9- [(1R,2S,3R,4S)-4- (2,5-Dioxo- imidazolidin-1-yl)-2,3- dihydroxy- cyclopentyl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C21					1-((R)-1-[6-[2,2-Bis- (4-hydroxy-phenyl)- ethylamino]-9- [(1R,2S,3R,4S)-4- (2,5-dioxo- imidazolidin-1-yl)-2,3- dihydroxy- cyclopentyl]-9H- purin-2-yl]-pyrrolidin- 3-yl]-3-pyridin-3-yl- urea

Ex.	Structure	R ¹	R ²	R ³	Name
C22					1-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[[1R,2S,3R,4S)-4-(2,5-dioxoimidazolidin-1-yl)-2,3-dihydroxy-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
C23					4-[3-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[[1R,2S,3R,4S)-4-(2,5-dioxoimidazolidin-1-yl)-2,3-dihydroxy-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C24					3-[3-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[[1R,2S,3R,4S)-4-(2,5-dioxoimidazolidin-1-yl)-2,3-dihydroxy-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C25					1-((R)-1-[9-[[1R,2S,3R,4S)-2,3-Dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
C26					1-((R)-1-[9-[[1R,2S,3R,4S)-2,3-Dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea

Ex.	Structure	R ¹	R ²	R ³	Name
C27					4-(3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide
C28					3-(3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide
C29					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
C30					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
C31					4-(3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide

Ex.	Structure	R ¹	R ²	R ³	Name
C32					3-[(3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide
C33					1-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl urea
C34					1-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxybenzyl)-urea
C35					4-[3-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C36					3-[3-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(3-methyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide

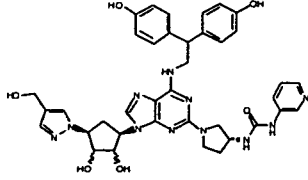
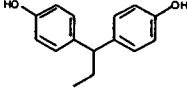
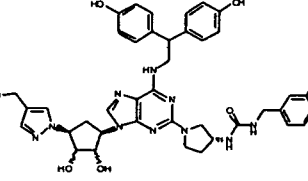
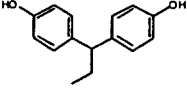
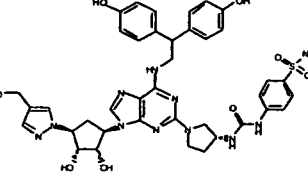
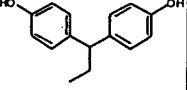
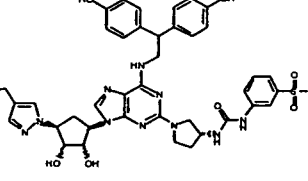
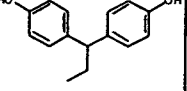
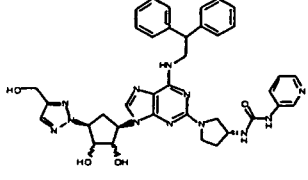
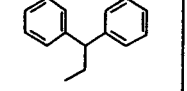
Ex.	Structure	R ¹	R ²	R ³	Name
C37					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-6- (2,2-diphenyl- ethylamino)-9H- purin-2-yl]-pyrrolidin- 3-yl)-3-pyridin-3-yl- urea
C38					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-6- (2,2-diphenyl- ethylamino)-9H- purin-2-yl]-pyrrolidin- 3-yl)-3-(3-hydroxy- benzyl)-urea
C39					4-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-6- (2,2-diphenyl- ethylamino)-9H- purin-2-yl]-pyrrolidin- 3-yl)-ureido)- benzenesulfonamide
C40					3-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-6- (2,2-diphenyl- ethylamino)-9H- purin-2-yl]-pyrrolidin- 3-yl)-ureido)- benzenesulfonamide
C41					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-6- (2,2-diphenyl- ethylamino)-9H- purin-2-yl]-pyrrolidin- 3-yl)-3-pyridin-3-yl- urea

Ex.	Structure	R ¹	R ²	R ³	Name
C42					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-6- ((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl]-3-(3- hydroxy-benzyl)-urea
C43					4-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-6- ((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C44					3-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-6- ((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C45					1-((R)-1-[6-[2,2-Bis- (4-hydroxy-phenyl)- ethylamino]-9- [(1R,2S,3R,4S)-2,3- dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-9H- purin-2-yl]-pyrrolidin- 3-yl]-3-pyridin-3-yl- urea
C46					1-((R)-1-[6-[2,2-Bis- (4-hydroxy-phenyl)- ethylamino]-9- [(1R,2S,3R,4S)-2,3- dihydroxy-4-(4- hydroxymethyl-2,5- dioxo-imidazolidin-1- yl)-cyclopentyl]-9H- purin-2-yl]-pyrrolidin- 3-yl]-3-(3-hydroxy- benzyl)-urea

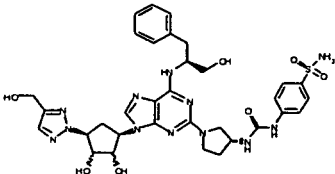
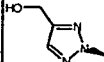
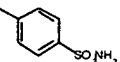
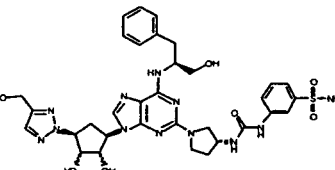
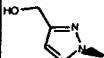
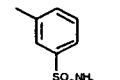
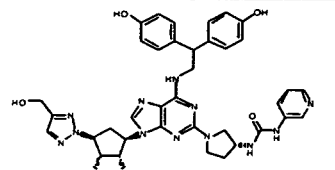
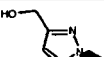
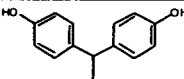
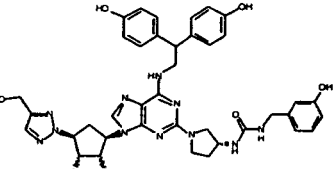
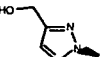
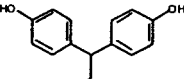
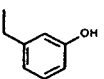
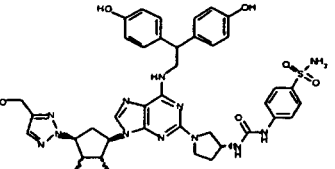
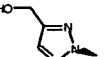
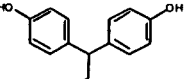
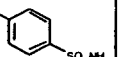
- 54 -

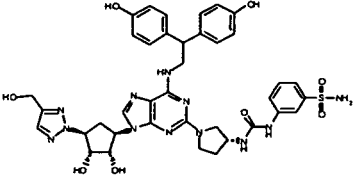
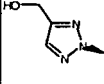
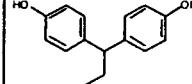
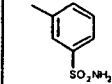
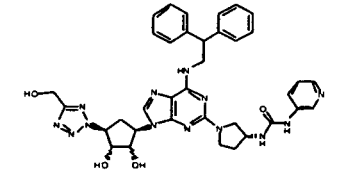
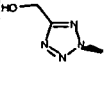
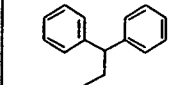
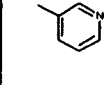
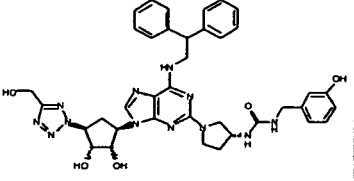
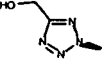
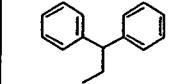
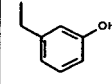
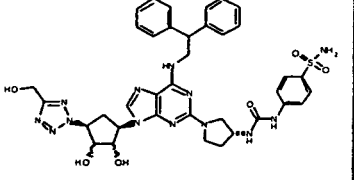
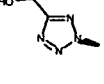
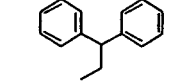
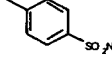
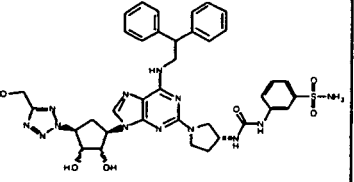
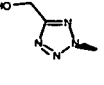
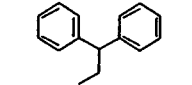
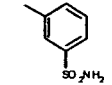
Ex.	Structure	R ¹	R ²	R ³	Name
C47					4-[3-((R)-1-[6-[2,2-Bis-(4-hydroxyphenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(4-hydroxymethyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C48					3-[3-((R)-1-[6-[2,2-Bis-(4-hydroxyphenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(4-hydroxymethyl-2,5-dioxoimidazolidin-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C49					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
C50					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
C51					4-(3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide

Ex.	Structure	R ¹	R ²	R ³	Name
C52					3-(3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(4-hydroxymethylpyrazol-1-yl)-cyclopentyl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide
C53					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(4-hydroxymethylpyrazol-1-yl)-cyclopentyl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
C54					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(4-hydroxymethylpyrazol-1-yl)-cyclopentyl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
C55					4-(3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(4-hydroxymethylpyrazol-1-yl)-cyclopentyl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide
C56					3-(3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(4-hydroxymethylpyrazol-1-yl)-cyclopentyl]-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido)-benzenesulfonamide

Ex.	Structure	R ¹	R ²	R ³	Name
C57					1-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
C58					1-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxybenzyl)-urea
C59					4-[3-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C60					3-[3-((R)-1-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C61					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(4-hydroxymethyl-[1,2,3]triazol-2-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea

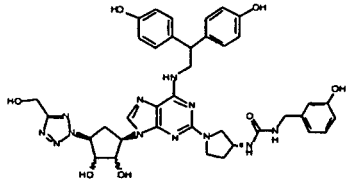
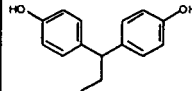
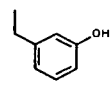
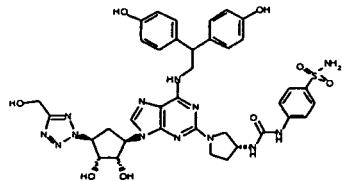
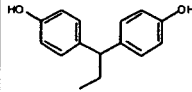
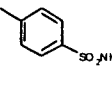
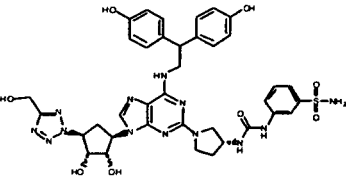
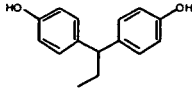
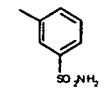
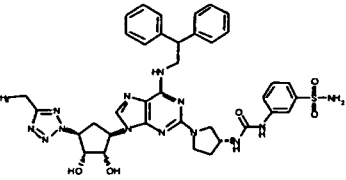
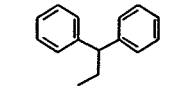
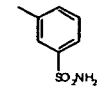
Ex.	Structure	R ¹	R ²	R ³	Name
C62					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-6-(2,2- diphenylethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl]-3-(3- hydroxy-benzyl)-urea
C63					4-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3-D ihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-6-(2,2- diphenylethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C64					3-(3-((R)-1-[9- [(1R,2S,3R,4S)-2,3-D ihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-6-(2,2- diphenylethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C65					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl]-3- pyridin-3-yl-urea
C66					1-((R)-1-[9- [(1R,2S,3R,4S)-2,3- Dihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl]-3-(3- hydroxy-benzyl)-urea

Ex.	Structure	R ¹	R ²	R ³	Name
C67					4-[3-((R)-1-[9- [(1R,2S,3R,4S)-2,3-D ihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C68					3-[3-((R)-1-[9- [(1R,2S,3R,4S)-2,3-D ihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-6-((S)-1- hydroxymethyl-2- phenyl-ethylamino)- 9H-purin-2-yl]- pyrrolidin-3-yl)- ureido)- benzenesulfonamide
C69					1-((R)-1-[6-[2,2-Bis- (4-hydroxy-phenyl)- ethylamino]-9- [(1R,2S,3R,4S)-2,3- dihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-9H- purin-2-yl]-pyrrolidin- 3-yl)-3-pyridin-3-yl- urea
C70					1-((R)-1-[6-[2,2-Bis- (4-hydroxy-phenyl)- ethylamino]-9- [(1R,2S,3R,4S)-2,3- dihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-9H- purin-2-yl]-pyrrolidin- 3-yl)-3-(3-hydroxy- benzyl)-urea
C71					4-[3-((R)-1-[6-[2,2-Bis- (4-hydroxy-phenyl)- ethylamino]-9- [(1R,2S,3R,4S)-2,3- dihydroxy-4-(4- hydroxymethyl- [1,2,3]triazol-2-yl)- cyclopentyl]-9H- purin-2-yl]-pyrrolidin- 3-yl)-ureido]- benzenesulfonamide

Ex.	Structure	R ¹	R ²	R ³	Name
C72					3-[3-((R)-1-[6-[2,2-Bis-(4-hydroxyphenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(4-hydroxymethyl-1,2,3-triazol-2-yl)-cyclopentyl]-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C73					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(5-hydroxymethyl-tetrazol-2-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea
C74					1-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(5-hydroxymethyl-tetrazol-2-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
C75					4-[3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(5-hydroxymethyl-tetrazol-2-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C76					3-[3-((R)-1-[9-[(1R,2S,3R,4S)-2,3-Dihydroxy-4-(5-hydroxymethyl-tetrazol-2-yl)-cyclopentyl]-6-(2,2-diphenylethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulfonamide

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Ex.	Structure	R ¹	R ²	R ³	Name
C77					1-((R)-1-[9- [[[(1R,2S,3R,4S)-2,3- Dihydroxy-4-(5- hydroxymethyl- tetrazol-2-yl)- cyclopentyl]-6-((S)-1- hydroxymethyl-2-phenyl- ethylamino)-9H-purin- 2-yl]-pyrrolidin-3-yl]- 3-pyridin-3-yl-urea
C78					1-((R)-1-[9- [[[(1R,2S,3R,4S)-2,3- Dihydroxy-4-(5- hydroxymethyl- tetrazol-2-yl)- cyclopentyl]-6-((S)-1- hydroxymethyl-2-phenyl- ethylamino)-9H-purin- 2-yl]-pyrrolidin-3-yl]- 3-(3-hydroxy-benzyl)-urea
C79					4-(3-((R)-1-[9- [[[(1R,2S,3R,4S)-2,3-D ihydroxy-4-(5- hydroxymethyl- tetrazol-2-yl)- cyclopentyl]-6-((S)-1- hydroxymethyl-2-phenyl- ethylamino)-9H-purin-2-yl]- pyrrolidin-3-yl]- ureido)- benzenesulfonamide
C80					3-(3-((R)-1-[9- [[[(1R,2S,3R,4S)-2,3-D ihydroxy-4-(5- hydroxymethyl- tetrazol-2-yl)- cyclopentyl]-6-((S)-1- hydroxymethyl-2-phenyl- ethylamino)-9H-purin-2-yl]- pyrrolidin-3-yl]- ureido)- benzenesulfonamide
C81					1-((R)-1-[6-[2,2-Bis- (4-hydroxy-phenyl)- ethylamino]-9- [[[(1R,2S,3R,4S)-2,3- dihydroxy-4-(5- hydroxymethyl- tetrazol-2-yl)- cyclopentyl]-9H- purin-2-yl]-pyrrolidin- 3-yl]-3-pyridin-3-yl- urea

Ex.	Structure	R ¹	R ²	R ³	Name
C82					1-((R)-1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(5-hydroxymethyl-tetrazol-2-yl)-cyclopentyl]-9H-purin-2-yl}-pyrrolidin-3-yl)-3-(3-hydroxy-benzyl)-urea
C83					4-[3-((R)-1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(5-hydroxymethyl-tetrazol-2-yl)-cyclopentyl]-9H-purin-2-yl}-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C84					3-[3-((R)-1-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(5-hydroxymethyl-tetrazol-2-yl)-cyclopentyl]-9H-purin-2-yl}-pyrrolidin-3-yl)-ureido]-benzenesulfonamide
C85					3-[3-((R)-1-{6-[2,2-Bis-phenyl-ethylamino]-9-[(1R,2S,3R,4S)-2,3-dihydroxy-4-(5-ethyl-tetrazol-2-yl)-cyclopentyl]-9H-purin-2-yl}-pyrrolidin-3-yl)-ureido]-benzenesulfonamide

Preparation of intermediate compounds

Intermediate 1 Carbonic acid (1*S*,4*R*)-4-(2,6-dichloro-purin-9-yl)-cyclopent-2-enyl ester ethyl ester

Step a: (1*S*,4*R*)-4-(2,6-Dichloro-purin-9-yl)-cyclopent-2-enol

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2,6-Dichloropurine (10 g, 52.90 mmol), (1*S*,4*R*)-*cis*-4-acetoxy-2-cyclopenten-1-ol (10 g, 70.40 mmol), *tris*(dibenzylideneacetone)dipalladium(0) (3.20 g, 3.50 mmol) and polymer supported triphenylphosphine (3 mmol/g, 11.60 g, 35.00 mmol) are placed in an oven-dried flask under an atmosphere of argon. Dry deoxygenated THF (80 mL) is added and the reaction mixture is stirred gently for 5 minutes. Triethylamine (20 mL) is added and the reaction mixture is stirred at 50°C. The reaction is shown to be complete by LCMS after 1 hour. The reaction mixture is allowed to cool, filtered and the solvent is removed *in vacuo*. The title compound is obtained after purification by flash column chromatography (silica, dichloromethane/methanol 25:1).

¹H NMR (CDCl₃, 400 MHz); 8.30 (s, 1H), 6.40 (m, 1H), 5.90 (m, 1H), 5.50 (m, 1H), 4.95 (m, 1H), 3.05 (m, 1H), 2.10 (m, 1H). (MH⁺) [MH⁺ 271]

Step b: Carbonic acid (1*S*,4*R*)-4-(2,6-dichloro-purin-9-yl)-cyclopent-2-enyl ester ethyl ester

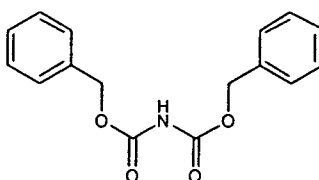
(1*S*,4*R*)-4-(2,6-Dichloro-purin-9-yl)-cyclopent-2-enol [step1] (9.5 g, 35.05 mmol) is placed in an oven-dried flask under an atmosphere of argon. Dry THF (200 mL) is added followed by dry pyridine (5.54 g, 70.1 mmol). Ethyl chloroformate (15.21 g, 140.2 mmol) is added slowly so that the temperature does not rise above 40 °C and the reaction mixture is stirred at RT. The reaction is shown to be complete by LCMS after 2 hours. The solvent is removed *in vacuo* and the residue is partitioned between dichloromethane (200 mL) and water (200 mL). The organic layer is washed with water (150 mL) and brine (150 mL), dried over MgSO₄, filtered and the solvent is removed *in vacuo*. The title compound is obtained after crystallization from methanol.

¹H NMR (CDCl₃, 400 MHz); 8.20 (s, 1H), 6.45 (m, 1H), 6.25 (m, 1H), 5.75 (m, 1H), 5.70 (m, 1H), 4.25 (q, 2H), 3.20 (m, 1H), 2.05 (m, 1H), 1.35 (t, 3H). [MH⁺ 343]

Intermediate 2 {[(1*S*,2*R*,3*S*,4*R*)-4-[2-((*R*)-3-Amino-pyrrolidin-1-yl)-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-2,3-dihydroxy-cyclopentyl]-carbamic acid benzyl ester

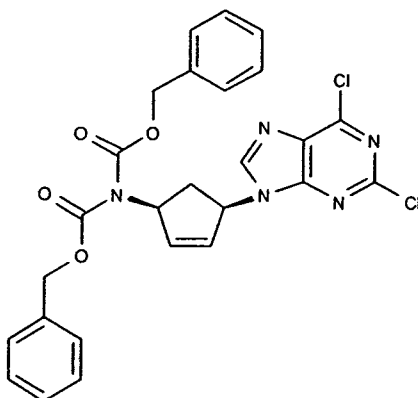
Step a: Preparation of Intermediate 2a Imidodicarbonic acid, bis(phenylmethyl) ester
(*Chemical Abstracts nomenclature*)

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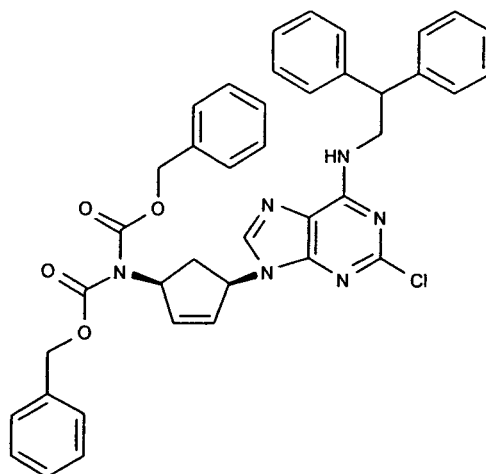
A cooled (0°C) solution of benzyl carbamate (4.0 g, 27 mmol) in THF (100 mL) under an inert atmosphere of argon is treated with potassium iodide (3.2 g of a 35% w/w dispersion in oil, 28 mmol) portionwise over 10 minutes. The reaction mixture is allowed to warm to RT over 30 minutes after which time benzyl chloroformate (5.0 g, 29 mmol) is added. After stirring at RT for 2 hours, the reaction is quenched with water (20 mL). The THF is removed *in vacuo* and the resulting mixture is partitioned between EtOAc and 2 M HCl. The organic portion is separated and washed with brine, dried (MgSO₄) and concentrated *in vacuo*. The resulting oil is purified by chromatography on silica eluting with 1:3 EtOAc/*iso*-hexane to yield a product which is recrystallized from DCM/*iso*-hexane to afford the title product.

Step b: Preparation of Intermediate 2b



A solution comprising carbonic acid (1*S*,4*R*)-4-(2,6-dichloro-purin-9-yl)-cyclopent-2-enyl ester ethyl ester (Intermediate 1) (2.0 g, 5.83 mmol), Intermediate 2a (2.2 g, 7.58 mmol) and triphenyl phosphine (229 mg, 0.9 mmol) in THF (20 mL) is stirred at RT for 30 minutes. *Tris*(dibenzylideneacetone)dipalladium (0) (238 mg, 0.3 mmol) is added and the resulting mixture is stirred at RT for 1.5 hours. The solvent is removed *in vacuo* and the crude product is purified by chromatography on silica eluting with MeOH/DCM (gradient of 0-1% MeOH) to yield the title compound.

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Step c: Preparation of Intermediate 2c

A solution comprising Intermediate **2b** (0.68 g, 1.26 mmol), 1-amino-2,2-diphenylethane (0.37 g, 1.90 mmol) and TEA (190 mg, 1.90 mmol) in THF (10 mL) is stirred at 50°C for 2 hours. The solvent is removed *in vacuo* the resulting oil/solid is partitioned between EtOAc and 0.2 M HCl. The organic portion is separated and washed with saturated sodium bicarbonate solution, water, brine, dried (MgSO₄) and concentrated *in vacuo* to afford the title compound. [MH⁺ 699.37]

Step d: Preparation of Intermediate 2d

A solution comprising Intermediate **2c** (2.0 g, 2.86 mmol) and NMO (0.67 g, 5.7 mmol) in THF (20 mL) is treated with osmium tetroxide (2 mL of a 4% solution in water) and stirred at RT overnight. The solvent is removed *in vacuo* and the crude residue is partitioned between DCM and water. The organic portion is separated, washed with water, brine, dried (MgSO₄) and concentrated *in vacuo*. The resulting solid is titrated with MeCN to afford the title product. [MH⁺ 733.40]

Step e: *{(R)-1-[9-((1 R,2S,3R,4S)-4-Benzylloxycarbonylamino-2,3-dihydroxy-cyclopentyl)-6-(2,2-diphenyl-ethylamino)-9H-purin-2-yl]-pyrrolidin-3-yl}-carbamic acid tert-butyl ester*

A suspension of Intermediate **2d** (1.03 g, 1.4 mmol) and (3*R*)-(+)-3-(Boc-amino)pyrrolidine (1.03 g, 5.5 mmol) in acetonitrile (2 mL) is treated with sodium iodide (ca. 2 mg) and then heated using microwave radiation at 160°C. After 1 hour, the solvent is

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removed *in vacuo* and the crude residue is partitioned between DCM and 0.2 M HCl. The organic layer is separated and the aqueous portion is extracted with DCM. The combined organic extracts are washed with saturated sodium bicarbonate solution, water, brine, dried (MgSO₄) and concentrated *in vacuo* to afford the title compound as a brown oil. [MH⁺ 745]

Step f: {(1*S*,2*R*,3*S*,4*R*)-4-[2-((*R*)-3-amino-pyrrolidin-1-yl)-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-2,3-dihydroxy-cyclopentyl}-carbamic acid benzyl ester

A solution of {(*R*)-1-[9-((1*R*,2*S*,3*R*,4*S*)-4-benzyloxycarbonylamino-2,3-dihydroxy-cyclopentyl)-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl}-carbamic acid tert-butyl ester (1.24 g, 1.7 mmol) in MeOH (3 mL) is treated with 4 M HCl in dioxane (5 mL) and stirred at RT for 2 hours. The solvent is removed *in vacuo* and purification is carried out by reverse phase column chromatography (Isolute™ C18, 0-100% acetonitrile in water – 0.1% HCl). The fractions are collected and the MeCN is removed *in vacuo*. The remaining aqueous portion is basified with saturated sodium bicarbonate solution and extracted with DCM. The combined organic extracts are dried (MgSO₄) and concentrated *in vacuo* to afford the title product. [MH⁺ =649]

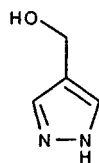
Intermediate 3 (1*R*,2*S*,3*R*,5*S*)-3-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentane-1,2-diol

Step a: {1-[(1*S*,4*R*)-4-(2,6-Dichloro-purin-9-yl)-cyclopent-2-enyl]-1*H*-pyrazol-4-yl}-methanol

A mixture comprising carbonic acid (1*S*,4*R*)-4-(2,6-dichloro-purin-9-yl)-cyclopent-2-enyl ester ethyl ester (Intermediate 1) (1.00 g, 2.92 mmol), (1*H*-pyrazol-4-yl)-methanol (preparation shown below) (0.34 g, 3.50 mmol) and triphenyl phosphine (0.115 g, 0.44 mmol) in deoxygenated THF (10 mL) under an inert atmosphere of argon is treated with *tris*(dibenzylideneacetone)dipalladium (0) (0.13 g, 0.15 mmol) and stirred at 50°C for 1 hour. The solvent is removed *in vacuo* and the crude product is purified by chromatography on silica eluting with MeOH/DCM (1:25) to yield the title compound.

Preparation of (1*H*-pyrazol-4-yl)-methanol

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4-Ethylpyrazole carboxylate (10 g, 71.40 mmol) is placed in an oven-dried flask under an atmosphere of argon. Dry THF (100 mL) is added followed by the dropwise addition of lithium aluminium hydride (1 M in THF, 100 mL, 100 mmol). Once the addition is complete the reaction mixture is stirred at 50°C. The reaction is shown to be complete by NMR after 4 hours. The reaction mixture is cooled on an ice-bath and the reaction mixture is quenched with water (3.8 mL) then 15% sodium hydroxide (3.8 mL) and finally water again (11.4 mL). The solvent is removed *in vacuo* and the solid is placed in a Soxhlet apparatus. THF is refluxed through the system for 24 hours. The solvent is removed *in vacuo* to give the title compound.

¹H NMR (MeOD, 400 MHz); 7.60 (s, 2H), 4.55 (s, 2H).

Step b: (1-[(1*S*,4*R*)-4-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-cyclopent-2-enyl]-1*H*-pyrazol-4-yl)-methanol

A mixture comprising {1-[(1*S*,4*R*)-4-(2,6-dichloro-purin-9-yl)-cyclopent-2-enyl]-1*H*-pyrazol-4-yl}-methanol (0.675 g, 1.92 mmol), diphenylethylamine (0.398 g, 2.02 mmol) and DIPEA (0.298 g, 2.31 mmol) in dry THF (20 mL) is stirred at 35°C for 3 days. The solvent is removed *in vacuo* and the resulting crude residue is partitioned between DCM and 0.1 M HCl. The organic portion is separated, washed with water, brine, dried (MgSO₄) and concentrated *in vacuo* to afford the title product.

Step d: (1*R*,2*S*,3*R*,5*S*)-3-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentane-1,2-diol

(1-[(1*S*,4*R*)-4-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-cyclopent-2-enyl]-1*H*-pyrazol-4-yl)-methanol (0.84 g, 1.64 mmol) and NMO (0.39 g, 3.28 mmol) in THF (20 mL) is treated with osmium tetroxide (2 mL of a 4% solution in water) and stirred at RT overnight. The solvent is removed *in vacuo* and the resulting crude residue is partitioned between DCM and 0.1 M HCl (a small amount of MeOH added to improve solubility). The organic portion is dried (MgSO₄) and concentrated *in vacuo*. The crude product is dissolved in hot DCM to form the title product as a precipitate on cooling.

Intermediates 4a-4h

Table 1

Intermediate	Structure	Name
4a		(1R,2S,3R,5S) - 3-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(4-hydroxymethyl-[1,2,3]triazol-2-yl)-cyclopentane-1,2-diol
4b		(1R,2S,3R,5S) - 3-[2-Chloro-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-5-(5-hydroxymethyl-tetrazol-2-yl)-cyclopentane-1,2-diol
4c		(1R,2S,3R,5S) - 3-[2-Chloro-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-purin-9-yl]-5-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentane-1,2-diol
4d		(1R,2S,3R,5S) - 3-[2-Chloro-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-purin-9-yl]-5-(4-hydroxymethyl-[1,2,3]triazol-2-yl)-cyclopentane-1,2-diol
4e		(1R,2S,3R,5S) - 3-[2-Chloro-6-((S)-1-hydroxymethyl-2-phenyl-ethylamino)-purin-9-yl]-5-(5-hydroxymethyl-tetrazol-2-yl)-cyclopentane-1,2-diol
4f		(1R,2S,3R,5S) - 3-[6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-2-chloro-purin-9-yl]-5-(4-hydroxymethyl-pyrazol-1-yl)-cyclopentane-1,2-diol

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Intermediate	Structure	Name
4g		(1R,2S,3R,5S) - 3-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-2-chloro-purin-9-yl}-5-(4-hydroxymethyl-[1,2,3]triazol-2-yl)-cyclopentane-1,2-diol
4h		(1R,2S,3R,5S) - 3-{6-[2,2-Bis-(4-hydroxy-phenyl)-ethylamino]-2-chloro-purin-9-yl}-5-(5-hydroxy methyl-tetrazol-2-yl)-cyclopentane-1,2-diol

The intermediates shown in the Table 1 are prepared analogously to Intermediate 3 by using the appropriate 5-membered heterocyclic alcohol in Step 3a and by using the appropriate amine in Step 3c.

Intermediate 5 3-Isocyanato-benzenesulfonamide

To a vigorously stirred solution of 3-aminobenzenesulphonamide (1 g, 5.8 mmol) in dry 1,4-dioxane (25 mL) is added trichloromethyl chloroformate (1.72 g, 8.7 mmol) and the reaction mixture is heated to reflux for 3 hours. The solvent is removed *in vacuo* to yield the title compound which is used without further purification.

Intermediate 6 4-Isocyanato-benzenesulfonamide

This compound is prepared from 4-aminobenzenesulphonamide using a procedure analogous to that of 3-isocyanato-benzenesulfonamide (Intermediate 5) by replacing 3-aminobenzenesulphonamide with 4-aminobenzenesulphonamide.

Intermediates 7 and 8

These compounds namely,

- ((1S,2R,3S,4R)-4-{2-((R)-3-Amino-pyrrolidin-1-yl)-6-[2,2-bis-(4-hydroxy-phenyl)-ethylamino]-purin-9-yl}-2,3-dihydroxy-cyclopentyl)-carbamic acid benzyl ester (Intermediate 7); and

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- ((1*S*,2*R*,3*S*,4*R*)-4-[2-((*R*)-3-Amino-pyrrolidin-1-yl)-6-((*S*)-1-hydroxymethyl-2-phenyl-ethylamino)-purin-9-yl]-2,3-dihydroxy-cyclopentyl)-carbamic acid benzyl ester (Intermediate 8),

are prepared analogously to Intermediate 2 by replacing 1-amino-2,2-diphenylethane (Step 2c) with the appropriate amine.

Preparation of Examples

Example C1 1-((*R*)-1-[9-((1*R*,2*S*,3*R*,4*S*)-4-(2,5-Dioxo-imidazolidin-1-yl)-2,3-dihydroxy-cyclopentyl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea

Step 1: ((1*S*,2*R*,3*S*,4*R*)-4-[6-(2,2-Diphenyl-ethylamino)-2-[(*R*)-3-(3-pyridin-3-yl-ureido)-pyrrolidin-1-yl]-purin-9-yl]-2,3-dihydroxy-cyclopentyl)-carbamic acid benzyl ester trifluoroacetate

A solution comprising ((1*S*,2*R*,3*S*,4*R*)-4-[2-((*R*)-3-amino-pyrrolidin-1-yl)-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-2,3-dihydroxy-cyclopentyl)-carbamic acid benzyl ester (Intermediate 2) (0.1 g, 0.15 mmol), pyridine-3-isocyanate (0.02 g, 0.17 mmol) and TEA (0.017 g, 0.17 mmol) in THF (2 mL) is stirred at RT overnight. The solvent is removed *in vacuo* and purification is carried out by reverse phase column chromatography (Isolute™ C18, 0-100% acetonitrile in water – 0.1% TFA). The fractions are collected and the MeCN is removed *in vacuo*. The remaining aqueous portion is basified with saturated sodium bicarbonate solution and extracted with DCM. The combined organic extracts are dried (MgSO₄) and concentrated *in vacuo* to afford the title product. [MH⁺ 769]

Step 2: 1-((*R*)-1-[9-((1*R*,2*S*,3*R*,4*S*)-4-Amino-2,3-dihydroxy-cyclopentyl)-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea

To a solution of ((1*S*,2*R*,3*S*,4*R*)-4-[6-(2,2-diphenyl-ethylamino)-2-[(*R*)-3-(3-pyridin-3-yl-ureido)-pyrrolidin-1-yl]-purin-9-yl]-2,3-dihydroxy-cyclopentyl)-carbamic acid benzyl ester trifluoroacetate (35 mg, 46 μmol) in ethanol (1 mL) under an inert atmosphere of argon is added 10% palladium on carbon (10 mg). The reaction mixture is purged with argon and placed under a positive atmosphere of hydrogen overnight after which time, the mixture is

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filtered through celite and the catalyst washed with ethanol. The organic portions are combined and concentrated *in vacuo* to yield the title compound. [MH+635]

Step 3: 1-((*R*)-1-[9-[(1*R*,2*S*,3*R*,4*S*)-4-(2,5-Dioxo-imidazolidin-1-yl)-2,3-dihydroxy-cyclopentyl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea hydrochloride

To a solution of 1-((*R*)-1-[9-[(1*R*,2*S*,3*R*,4*S*)-4-amino-2,3-dihydroxy-cyclopentyl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea (17 mg, 26 μ mol) in THF (1 mL) is added Z-L-alanine hydroxysuccinimidyl ester (9 mg, 29 μ mol) and the reaction mixture is stirred at RT overnight. The solvent is removed *in vacuo* and the crude residue is dissolved in EtOH (1 mL) and purged with argon. Palladium on carbon (approximately 5 mg) is added and the reaction mixture is placed under a constant pressure of hydrogen (0.35 bar) and stirred at room temperature overnight. The resulting mixture is filtered through celite and concentrated *in vacuo*. Purification of the crude residue by reverse phase column chromatography (Isolute™ C18, 0-100% acetonitrile in water – 0.1% HCl) affords the title compound. [MH+732.72].

Example C2 1-((*R*)-1-[9-[(1*R*,2*S*,3*R*,4*S*)-4-(2,5-Dioxo-imidazolidin-1-yl)-2,3-dihydroxy-cyclopentyl]-6-(2,2-diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl)-3-pyridin-3-yl-urea trifluoroacetate

This compound is prepared analogously to Example 1 by replacing Z-L-alanine hydroxysuccinimidyl ester (Step 3) with Z-glycine-*N*-succinimidyl ester. Purification is carried out by reverse phase column chromatography (Isolute™ C18, 0-100% acetonitrile in water – 0.1% TFA). [MH+718.68].

Examples C3-C48

These examples can be prepared analogously to Example 1 by using the appropriate starting compound (either Intermediate 2,7 or 8) and isocyanate in Step 1 and by using the appropriate succinimidyl ester in Step 3.

Those examples containing 3-hydroxybenzyl groups are prepared as follows: (3-hydroxy-benzyl)-carbamic acid phenyl ester (Intermediate BA) and (Intermediate 2, 7 or 8) are dissolved in MeOH and TEA. The reaction mixture is heated using microwave radiation at 100°C for 30 minutes and then the solvent is removed *in vacuo*. Purification of the crude

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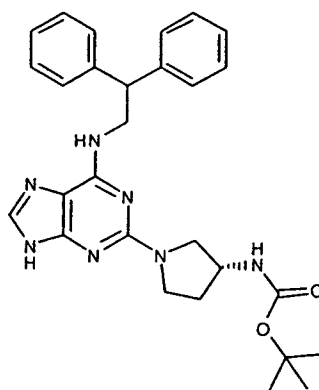
product by reverse phase column chromatography (Isolute™ C18, 0-100% acetonitrile in water – 0.1% TFA) affords the product which is taken through Steps 2 and 3 (using the appropriate succinimidyl ester) to afford the final compound.

Examples C49-C84

These compounds are prepared analogously to Example 1 by combining the appropriate starting compound (Intermediates **3** or **4a-4h**) with the appropriate phenyl esters (Intermediates **BA-BD**).

Example C85

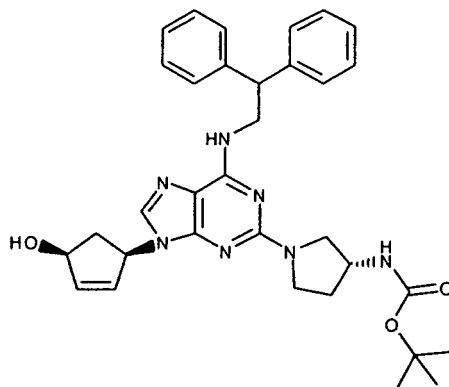
Step 1: {{(*R*)-1-[6-(2,2-Diphenyl-ethylamino)-9*H*-purin-2-yl]-pyrrolidin-3-yl}-carbamic acid tert-butyl ester



(2-Chloro-9*H*-purin-6-yl)-(2,2-diphenyl-ethyl)-amine (2.5 g) is added to Boc(*R*)-3-aminopyrrolidine (2.677 g). This is suspended in acetonitrile (10 mL) and put to microwave at 160 °C. Analysis by LCMS shows reaction to be complete after 30 minutes. The reaction mixture is then suspended in acetonitrile and filtered. The resulting precipitate is then dried to give the title compound. MS (ES+) *m/e* 498 (MH⁺)

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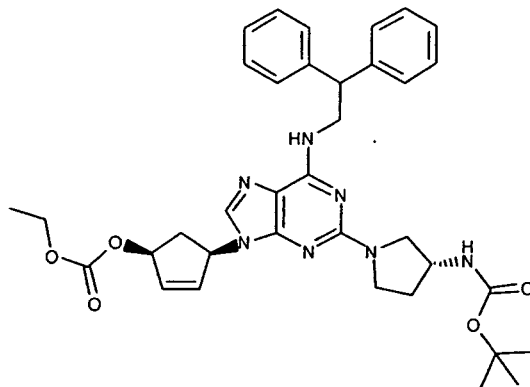
Step 2: $\{(R)-1-[6-(2,2\text{-Diphenyl-ethylamino})-9H\text{-purin-2-yl}]-pyrrolidin-3\text{-yl}\}$ -carbamic acid tert-butyl ester



$\{(R)-1-[6-(2,2\text{-Diphenyl-ethylamino})-9H\text{-purin-2-yl}]-pyrrolidin-3\text{-yl}\}$ -carbamic acid tert-butyl ester (2.5 g) is suspended in THF (15 mL) under an inert atmosphere and oven dried glassware. Sodium hydride (130 mg) is added to the stirring suspension. This is stirred until dissolution has occurred. (1*S*,4*R*)-*cis*-4-Acetoxy-2-cyclopentan-1-ol (865 mg) and triphenylphosphine (236 mg) are placed in an oven-dried flask under an inert atmosphere, this is dissolved in THF (15 mL). This solution is added to the solution of $\{(R)-1-[6-(2,2\text{-diphenyl-ethylamino})-9H\text{-purin-2-yl}]-pyrrolidin-3\text{-yl}\}$ -carbamic acid tert-butyl ester and sodium hydride via syringe. *tris*-(Dibenzylideneacetone)-dipalladium (275 mg) is then added and the reaction is stirred at 50 °C. The reaction is shown to be complete after 1 hour by LCMS. The reaction is allowed to cool and the solvent is removed *in vacuo*. The residue is purified by flash column chromatography (silica, dichloromethane/methanol 25:1), giving the title compound. MS (ES⁺) *m/e* 582.62 (MH⁺)

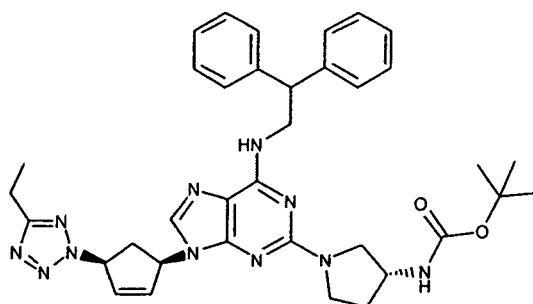
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Step 3: Carbonic acid (1*S*,4*R*)-4-[2-((*R*)-3-tert-butoxycarbonylamino-pyrrolidin-1-yl)-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-cyclopent-2-enyl ester ethyl ester



((*R*)-1-[6-(2,2-Diphenyl-ethylamino)-9-[(1*R*,4*S*)-4-hydroxy-cyclopent-2-enyl]-9*H*-purin-2-yl]-pyrrolidin-3-yl)-carbamic acid tert-butyl ester (500 mg) is dissolved in dry deoxygenated THF (10 mL). Pyridine (416 μ L) is added to the solution. Ethyl chloroformate (492 μ L) is pre-dissolved in THF (2.5 mL) and added dropwise to the solution at 0°C. The reaction is stirred at RT. Analysis by LCMS shows reaction completion after 2 hours. The solvent is removed *in vacuo*. The residue is dissolved in dichloromethane (10 mL) and portioned against 0.1 M HCl (10 mL). The organic layer is then washed with water (20 mL) and brine (10 mL), dried over MgSO₄, filtered and the solvent removed *in vacuo*. The title compound is obtained after purification by flash column chromatography (silica, dichloromethane/methanol 40:1). MS (ES⁺) *m/e* 655.46 (MH⁺).

Step 4: ((*R*)-1-[6-(2,2-Diphenyl-ethylamino)-9-[(1*R*,4*S*)-4-(5-ethyl-tetrazol-2-yl)-cyclopent-2-enyl]-9*H*-purin-2-yl]-pyrrolidin-3-yl)-carbamic acid tert-butyl ester

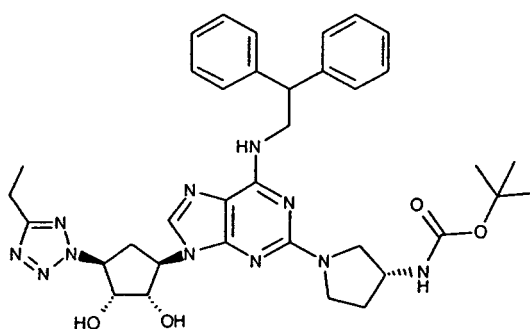


Carbonic acid (1*S*,4*R*)-4-[2-((*R*)-3-tert-butoxycarbonylamino-pyrrolidin-1-yl)-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-cyclopent-2-enyl ester ethyl ester (760 mg) is added to ethyl tetrazole (125 mg) and triphenylphosphine (46 mg) in an oven-dried flask under argon. This

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is dissolved in anhydrous THF (10 mL). *tris*-(Dibenzylideneacetone)-dipalladium (53 mg) is added to the stirring solution. The reaction is stirred at 50 °C. Analysis by LCMS shows reaction completion after 1 hour. The solvent is removed *in vacuo*. The title compound is obtained by flash column chromatography (silica, dichloromethane/methanol 50:1). MS (ES+) *m/e* 662.4 (MH⁺).

Step 5: ((*R*)-1-{6-(2,2-Diphenyl-ethylamino)-9-[(1*R*,4*S*)-4-(5-ethyl-tetrazol-2-yl)-2,3-dihydroxy-cyclopentyl]-9*H*-purin-2-yl]-pyrrolidin-3-yl}-carbamic acid tert-butyl ester



((*R*)-1-{6-(2,2-Diphenyl-ethylamino)-9-[(1*R*,4*S*)-4-(5-ethyl-tetrazol-2-yl)-cyclopent-2-enyl]-9*H*-purin-2-yl]-pyrrolidin-3-yl}-carbamic acid tert-butyl ester (500 mg) along with *N*-methylmorpholine-*N*-oxide (178 mg) is dissolved in THF (5 mL). Osmium tetroxide 4% in water (500 µL) is added to the stirring solution. The reaction is stirred at RT. Analysis by LCMS showed reaction completion after 72 hours. The solvent is removed *in vacuo* and the residue is portioned between dichloromethane and 0.1 M HCl. The organic layer is washed with water and brine, dried over MgSO₄, filtered and the solvent is removed *in vacuo*. The title compound is obtained by Flash column chromatography (silica, dichloromethane/methanol 100:1 - 50:1 - 25:1). MS (ES+) *m/e* 696.43 (MH⁺)

Step 6: 3-[3-((*R*)-1-{6-[bisphenyl-ethylamino]-9-[(1*R*,2*S*,3*R*,4*S*)-2,3-dihydroxy-4-(5-ethyl-tetrazol-2-yl)-cyclopentyl]-9*H*-purin-2-yl]-pyrrolidin-3-yl)-ureido]-benzenesulphonamide

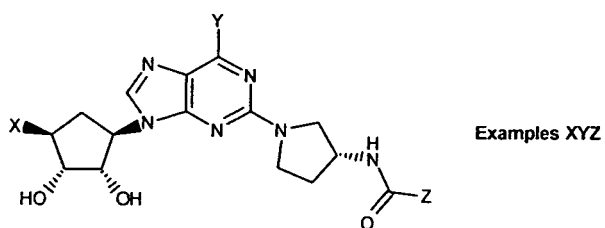
((*R*)-1-{6-(2,2-Diphenyl-ethylamino)-9-[(1*R*,4*S*)-4-(5-ethyl-tetrazol-2-yl)-2,3-dihydroxy-cyclopentyl]-9*H*-purin-2-yl]-pyrrolidin-3-yl}-carbamic acid tert-butyl ester is deprotected in methanolic HCl to give the corresponding amine hydrochloride salt. The free amine is obtained by neutralization with aqueous sodium hydrogencarbonate followed by elution from a C18 column with water/methanol gradient. The title compound is then prepared in an analogous manner to Example C1, Step 1 by replacing {(1*S*,2*R*,3*S*,4*R*)-4-[2-((*R*)-3-amino-

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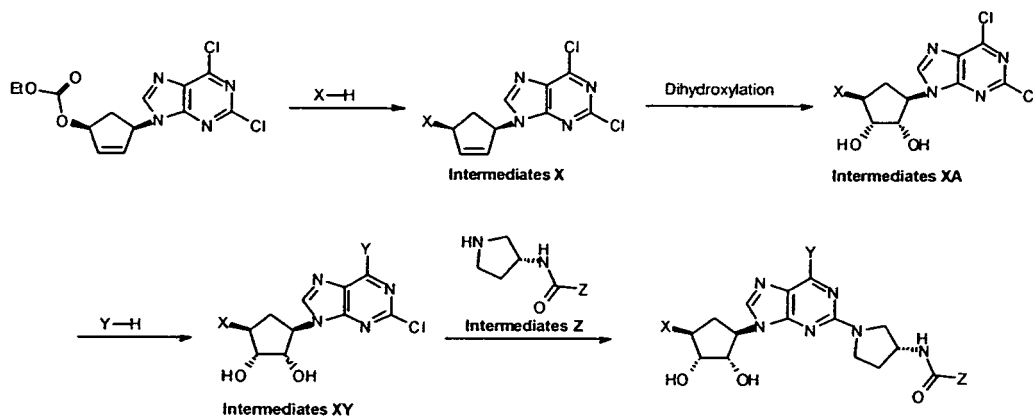
pyrrolidin-1-yl)-6-(2,2-diphenyl-ethylamino)-purin-9-yl]-2,3-dihydroxy-cyclopentyl}-carbamic acid benzyl ester with the above free amine and replacing pyridine-3-isocyanate with Intermediate 5.

Examples XYZ

Examples of the structure XYZ are prepared in a multiparallel sequence of reactions as described below.



Overall scheme:

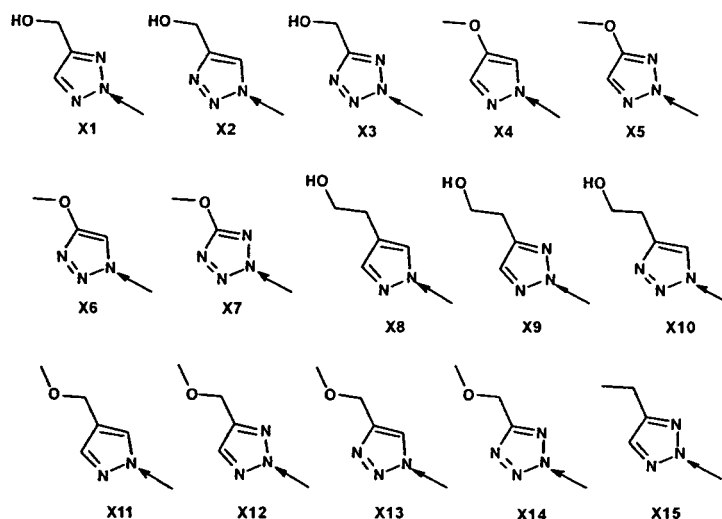


Parallel step 1

Reaction of Intermediate 1, in an analogous manner to that used in the preparation of Intermediate 3, Step a by replacing 4-hydroxymethylpyrazole with the appropriate heterocycle, individually, with the heterocycles X-H gives the Intermediates X.

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Heterocycles X-H



Heterocycles X-H are prepared as follows:

- X1-X8 and X15 are prepared following literature procedures.
- X11, X12 and X13 are prepared by O-methylation of the corresponding alcohols.
- X14 is prepared by reduction of the corresponding ester to the alcohol followed by O-methylation.
- X9 and X10 are prepared from the corresponding formyl derivatives following standard homologation procedures.

Parallel step 2

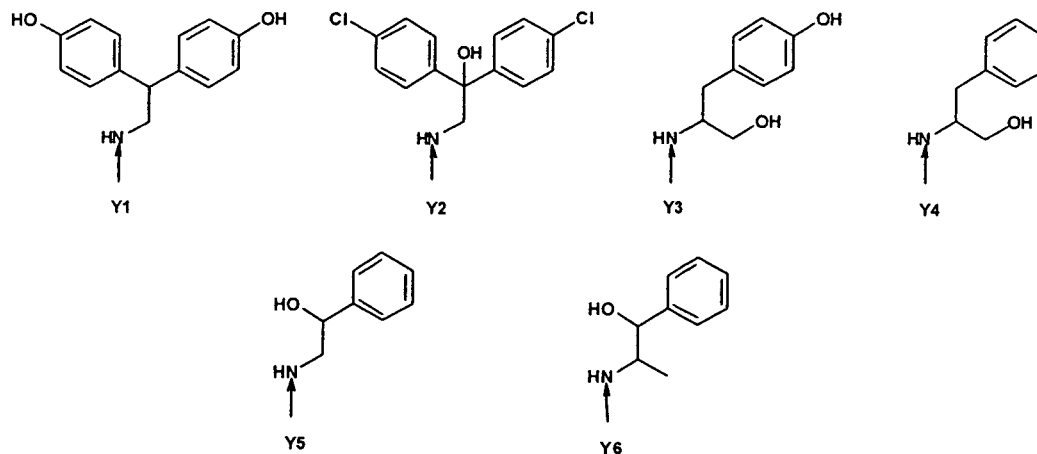
Reaction of Intermediates **X**, individually, with either the dihydroxylating agent osmium tetroxide or ruthenium tetroxide gives the Intermediates **XA**.

Parallel step 3

Reaction of Intermediates **XA**, in an analogous manner to that used in the preparation of Intermediate **3** Step *b* by replacing 2,2-diphenylethylamine with the appropriate amine, individually with the amines **Y-H** gives the Intermediates **XY**.

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Amines Y-H

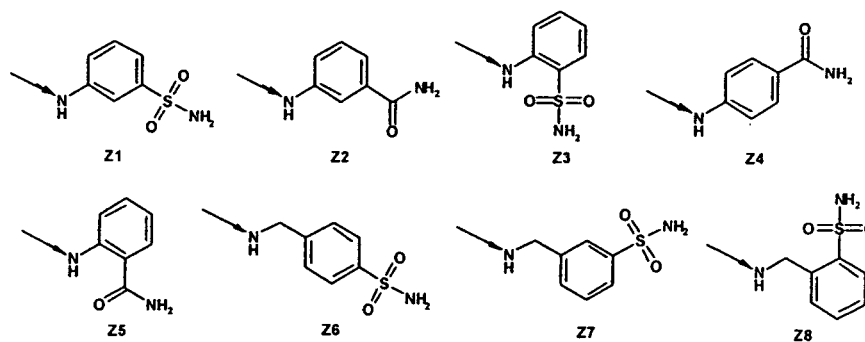


Parallel step 4

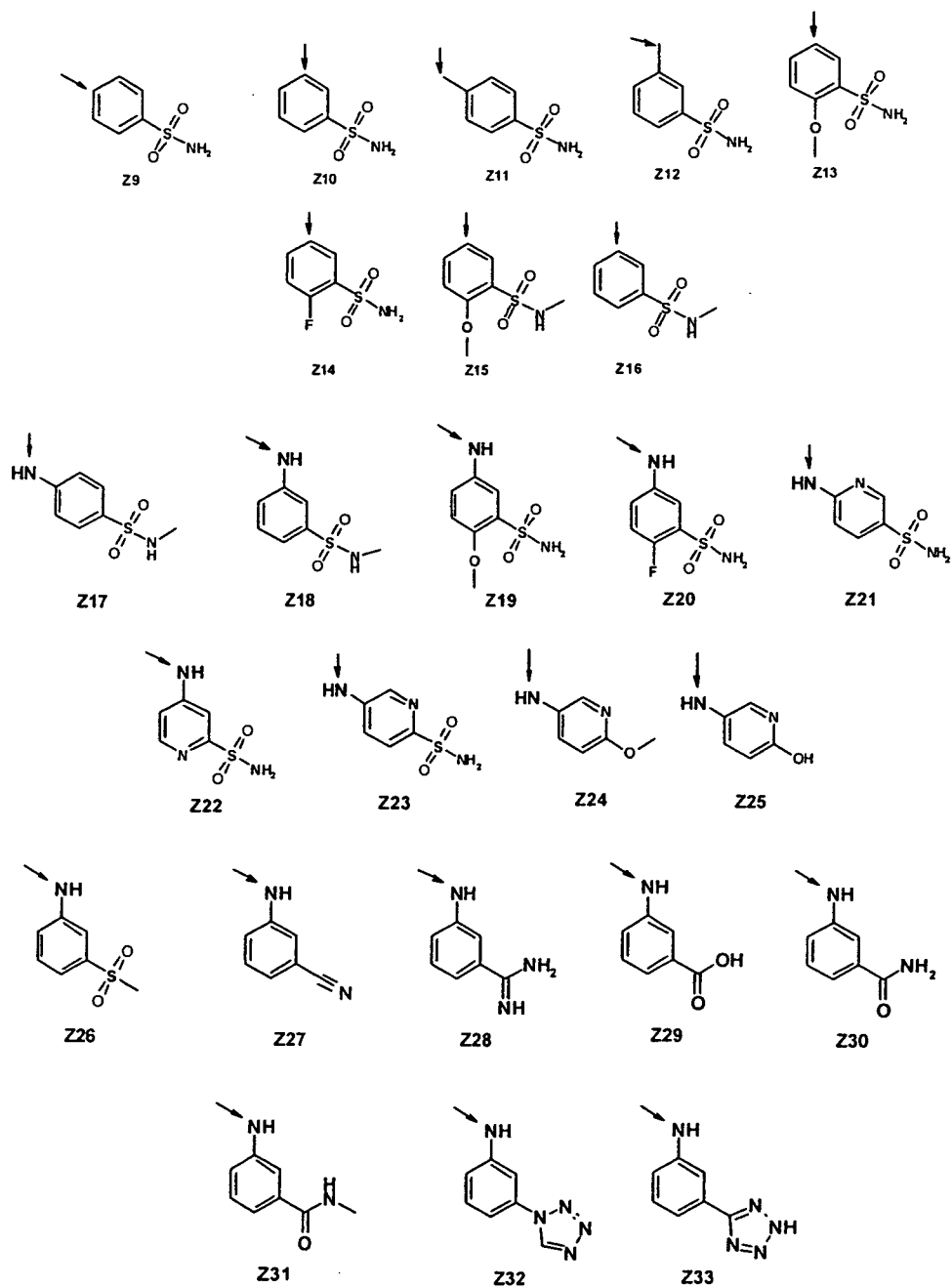
Intermediates XY are reacted in ethanol at reflux, or in DMSO at 90-110°C, for 18-24 hours, individually, with a 3-fold excess of the appropriate Intermediate Z. The Examples XYZ are isolated following purification by mass directed reversed phase chromatography.

Intermediates Z

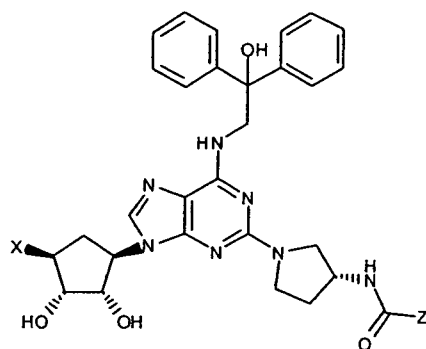
Where Z =



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Examples W



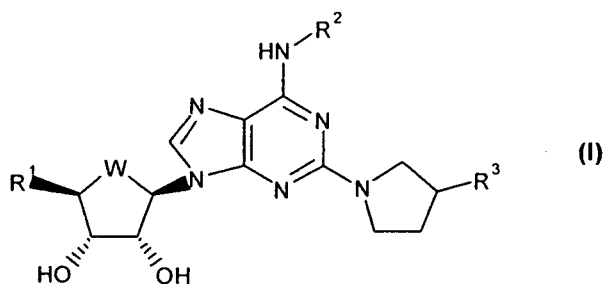
Examples W

For the Examples XYZ, where X = X2 a further hydrogenolysis of the aryl chlorides, individually, by transfer hydrogenation using ammonium formate with a palladium on carbon catalyst in ethanol gives a further series of Examples W.

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Claims

1. A compound of formula (I)



or stereoisomers or pharmaceutically acceptable salts thereof,
wherein

W is CH₂ or O, with the proviso that when W is O, then R¹ is not a N-bonded substituent;

R¹ is a 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, that group being optionally substituted by oxo, C₁-C₈-alkoxy, C₆-C₁₀-aryl, R^{1a} or by C₁-C₈-alkyl optionally substituted by hydroxyl;

R^{1a} is a 3- or 12-membered heterocyclic ring containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, said 3- or 12-membered heterocyclic ring being optionally substituted by halo, cyano, oxo, hydroxy, carboxy, amino, nitro, C₁-C₈-alkyl, C₁-C₈-alkylsulfonyl, aminocarbonyl, C₁-C₈-alkylcarbonyl or C₁-C₈-alkoxy optionally substituted by aminocarbonyl;

R² is C₁-C₈-alkyl substituted by OH, halogen C₆-C₁₀-aryl optionally substituted by OH, SO₂R⁵, SC₁-C₈-alkyl, CN, halogen, O-C₇-C₁₄-aralkyl, or O-C₁-C₈-alkyl, a C₃-C₁₅-carbocyclic group optionally substituted by O-C₇-C₁₄-aralkyl, C₃-C₁₅-carbocyclic group, O-C₁-C₈-alkyl, C₂-C₈-alkenyl, C₂-C₈-alkynyl or C₁-C₈-alkyl, O-C₁-C₈-alkyl, -SO₂-C₁-C₈-alkyl, a 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, that group being optionally substituted by 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, C₇-C₁₄-aralkyl, or C₆-C₁₄-aryl optionally substituted by O-C₇-C₁₄-aralkyl, or

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R^2 is a C_3 - C_{15} -carbocyclic group optionally substituted by O - C_7 - C_{14} -aralkyl, C_3 - C_{15} -carbocyclic group, O - C_1 - C_8 -alkyl, or C_1 - C_8 -alkyl, or

R^2 is a 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, that group being optionally substituted by 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, C_7 - C_{14} -aralkyl, or C_6 - C_{14} -aryl optionally substituted by O - C_7 - C_{14} -aralkyl;

R^3 is selected from $NR^{3a}R^{3b}$, $NR^3C(O)NR^{3g}R^{3h}$, $NHC(O)R^{3q}$, and $NHC(=NR^{3m})N(R^{3n})R^{3o}$; R^{3a} , R^{3f} and R^{3n} are, independently, H , C_1 - C_8 -alkyl or C_6 - C_{10} -aryl;

R^{3b} is H , C_1 - C_8 -alkyl a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by O - $3R^4$ or C_6 - C_{10} -aryl;

R^{3g} is C_1 - C_8 -alkyl optionally substituted by a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted with SO_2R^5 , CN , or O - $3R^4$, or

R^{3q} is a C_6 - C_{10} -aryl optionally substituted by OH , C_1 - C_8 -alkyl, O - C_1 - C_8 -alkyl, CN , $-C(=NH)NH_2$, SO_2R^5 , $-$ halogen, or a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by O - $3R^4$, or

R^{3h} is a C_7 - C_{14} -aralkyl optionally substituted by OH , O - C_1 - C_8 -alkyl, halogen, C_6 - C_{10} -aryl, SO_2R^5 , CN , $-C(=NH)NH_2$ or O - C_6 - C_{10} -aryl, or

R^{3o} is a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by O - $3R^4$;

R^{3m} is CN ;

R^{3n} is H or C_1 - C_8 -alkyl;

R^{3o} is H , C_1 - C_8 -alkyl optionally substituted by OH or by a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted with SO_2R^5 , CN , or O - $3R^4$, C_1 - C_8 -alkoxy, C_7 - C_{14} -aralkyl optionally substituted with OH , O - C_1 - C_8 -alkyl, halogen C_6 - C_{10} -aryl, or O - C_6 - C_{10} -aryl, C_1 - C_8 -alkoxy, C_6 - C_{10} -aryl optionally substituted by OH , C_1 - C_8 -alkyl, O - C_1 - C_8 -alkyl SO_2R^5 or $-$ halogen;

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R^{3p} is H, C_1-C_8 -alkyl or C_7-C_{14} -aralkyl;

R^{3q} is a C_6-C_{10} -aryl optionally substituted by OH, C_1-C_8 -alkyl, C_1-C_8 -alkoxy, SO_2R^5 or -halogen, or

R^{3q} is a C_7-C_{14} -aralkyl optionally substituted by OH, C_1-C_8 -alkyl, C_1-C_8 -alkoxy, SO_2R^5 or -halogen, or

R^{3q} is a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur optionally substituted by 0-3 R^4 or a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by 0-3 R^4 ;

R^4 is selected from OH, C_1-C_8 -alkyl optionally substituted by OH, CN, SO_2R^5 or halogen, $C(O)NHR^{3a}$, $O-C_1-C_8$ -alkyl optionally substituted by halogen, $NR^{4a}R^{4b}$, $NHC(O)R^{4c}$, a $C(O)-C_6-C_{10}$ -aryl optionally substituted by OH, C_1-C_8 -alkyl, $O-C_1-C_8$ -alkyl, -halogen, or SO_2R^5 ;

R^{4a} , R^{4b} and R^{4c} are, independently, H, C_1-C_8 -alkyl or C_6-C_{10} -aryl; and

R^5 is C_1-C_8 -alkyl optionally substituted by halogen, C_6-C_{10} -aryl optionally substituted by OH, C_1-C_8 -alkyl, $O-C_1-C_8$ -alkyl, or $NR^{3a}R^{3b}$.

2. A compound of formula (I) according to Claim 1 or stereoisomers or pharmaceutically acceptable salts thereof,

wherein

W is CH_2 or O, with the proviso that when W is O, then R^1 is not a N-bonded substituent;

R^1 is a 3- to 12-membered heterocyclic group containing from 1 to 4 ring nitrogen atoms and optionally containing from 1 to 4 other heteroatoms selected from the group consisting of oxygen and sulfur, that group being optionally substituted by oxo or by C_1-C_8 -alkyl optionally substituted by hydroxyl;

R^2 is selected from C_1-C_8 -alkyl optionally substituted by OH, halogen and C_6-C_{10} -aryl optionally substituted by OH, halogen, or $O-C_1-C_8$ -alkyl;

R^3 is selected from $NR^{3f}C(O)NR^{3g}R^{3h}$, $NR^{3a}NR^{3b}$, $NHC(O)R^{3i}$ and $NHC(=NR^{3m})N(R^{3n})R^{3o}$;

R^{3a} is selected from H and C_1-C_8 -alkyl;

R^{3b} is selected from H, C_1-C_8 -alkyl and 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by 0-3 R^4 ;

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R^{3f} and R^{3h} are H;

R^{3g} is C_1-C_8 -alkyl optionally substituted by a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted with SO_2R^5 , CN, or $O-3R^4$, or

R^{3g} is a C_6-C_{10} -aryl optionally substituted by OH, C_1-C_8 -alkyl, $O-C_1-C_8$ -alkyl, CN, $-C(=NH)NH_2$, SO_2R^5 , -halogen, or a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by $O-3R^4$, or

R^{3g} is a C_7-C_{14} -aralkyl optionally substituted by OH, $O-C_1-C_8$ -alkyl, halogen, C_6-C_{10} -aryl, SO_2R^5 , CN, $-C(=NH)NH_2$ or $O-C_6-C_{10}$ -aryl, or

R^{3g} is a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by $O-3R^4$;

R^{3m} is CN;

R^{3n} is H or C_1-C_8 alkyl;

R^{3o} is H, C_1-C_8 -alkyl optionally substituted by OH or by a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted with SO_2R^5 , CN, or $O-3R^4$, C_1-C_8 -alkoxy, C_7-C_{14} -aralkyl optionally substituted with OH, $O-C_1-C_8$ -alkyl, halogen C_6-C_{10} -aryl, or $O-C_6-C_{10}$ -aryl, C_1-C_8 -alkoxy, C_6-C_{10} -aryl optionally substituted by OH, C_1-C_8 -alkyl, $O-C_1-C_8$ -alkyl SO_2R^5 or -halogen;

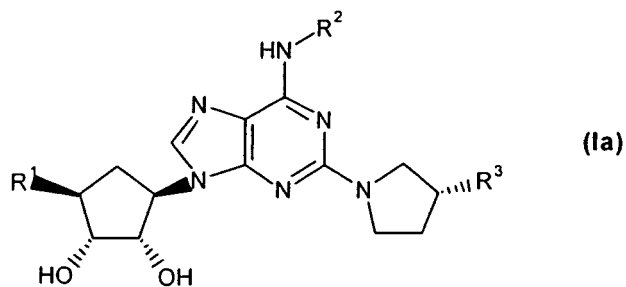
R^{3a} is a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur optionally substituted by a 3- to 12-membered heterocyclic group containing at least one ring heteroatom selected from the group consisting of nitrogen, oxygen and sulfur, optionally substituted by $O-3R^4$;

R^4 is selected from OH, C_1-C_8 -alkyl optionally substituted by OH, CN, SO_2R^5 or halogen, $C(O)NHR^{3a}$, $O-C_1-C_8$ -alkyl optionally substituted by halogen, $NR^{4a}R^{4b}$, $NHC(O)R^{4c}$, a $C(O)-C_6-C_{10}$ -aryl optionally substituted by OH, C_1-C_8 -alkyl, $O-C_1-C_8$ -alkyl, -halogen, or SO_2R^5 ;

R^{4a} , R^{4b} and R^{4c} are, independently, H, C_1-C_8 -alkyl or C_6-C_{10} -aryl; and

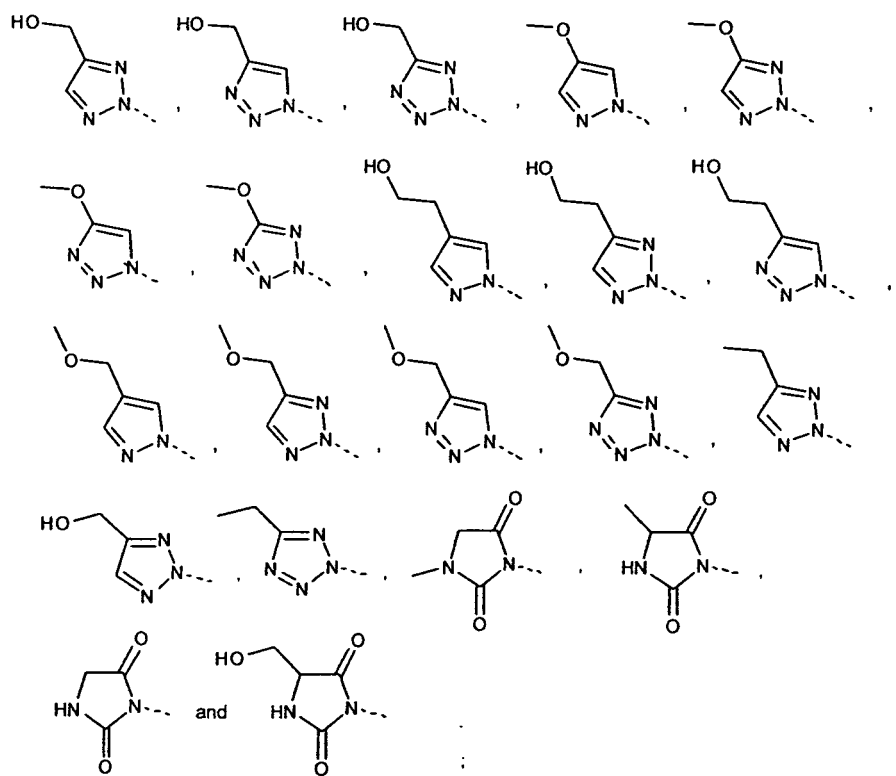
R^5 is C_1-C_8 -alkyl optionally substituted by halogen, C_6-C_{10} -aryl optionally substituted by OH, C_1-C_8 -alkyl, $O-C_1-C_8$ -alkyl or -halogen, or $NR^{3a}R^{3b}$.

3. A compound according to Claim 1, wherein the compound is of formula (Ia)

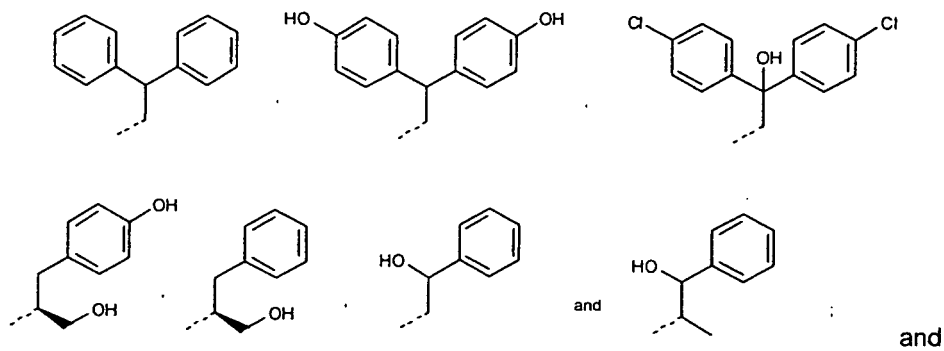
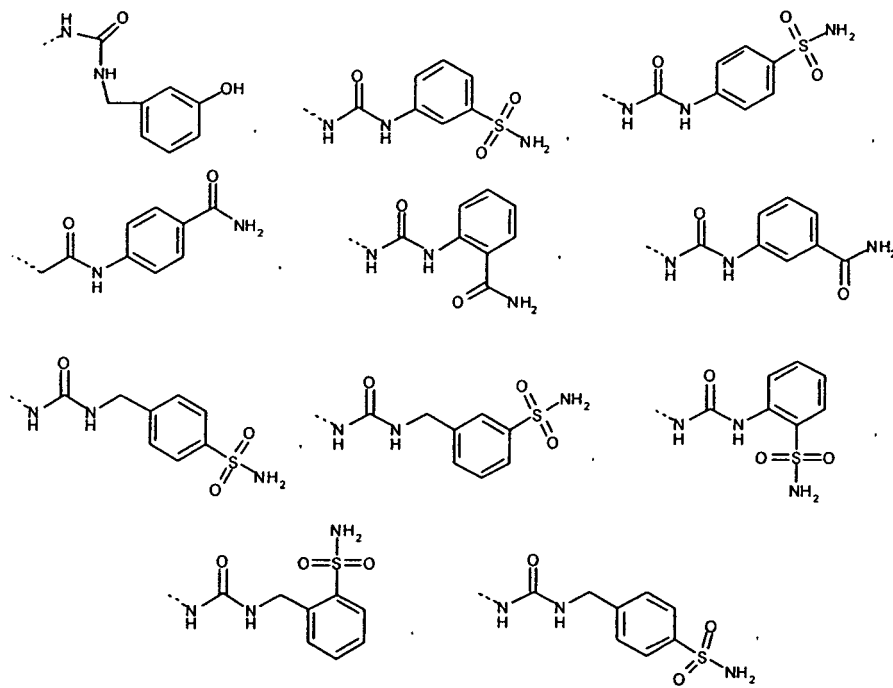


where

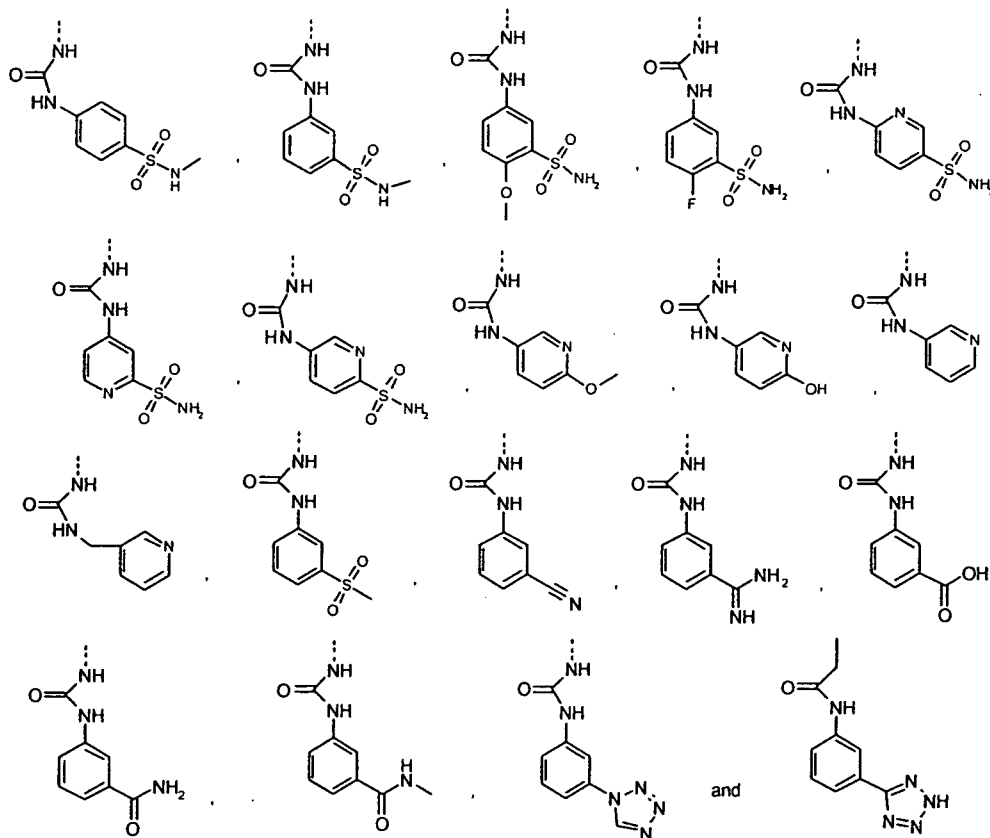
R^1 is selected from



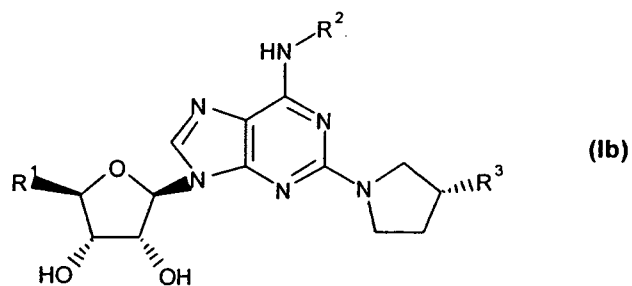
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 R^2 is selected from R^3 is selected from

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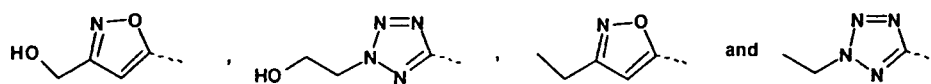


4. A compound according to Claim 1, wherein the compound is of formula (Ib)



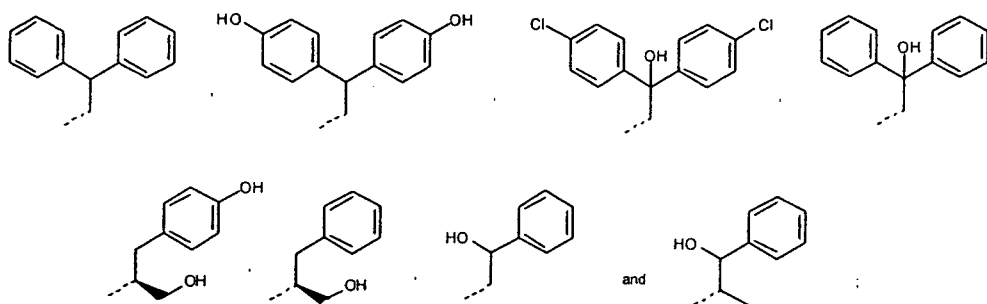
where

R¹ is selected from



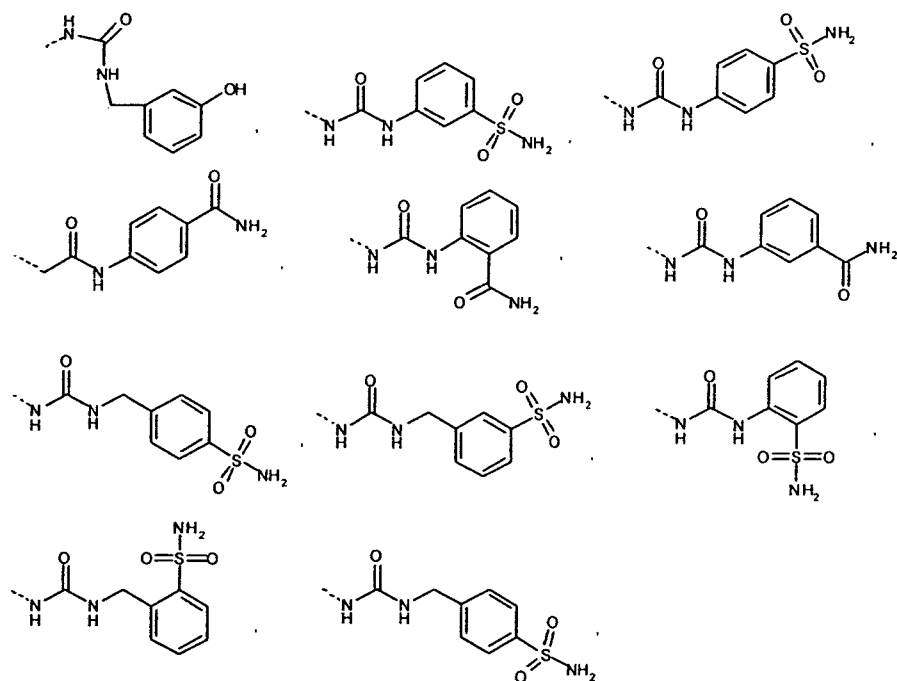
R² is selected from

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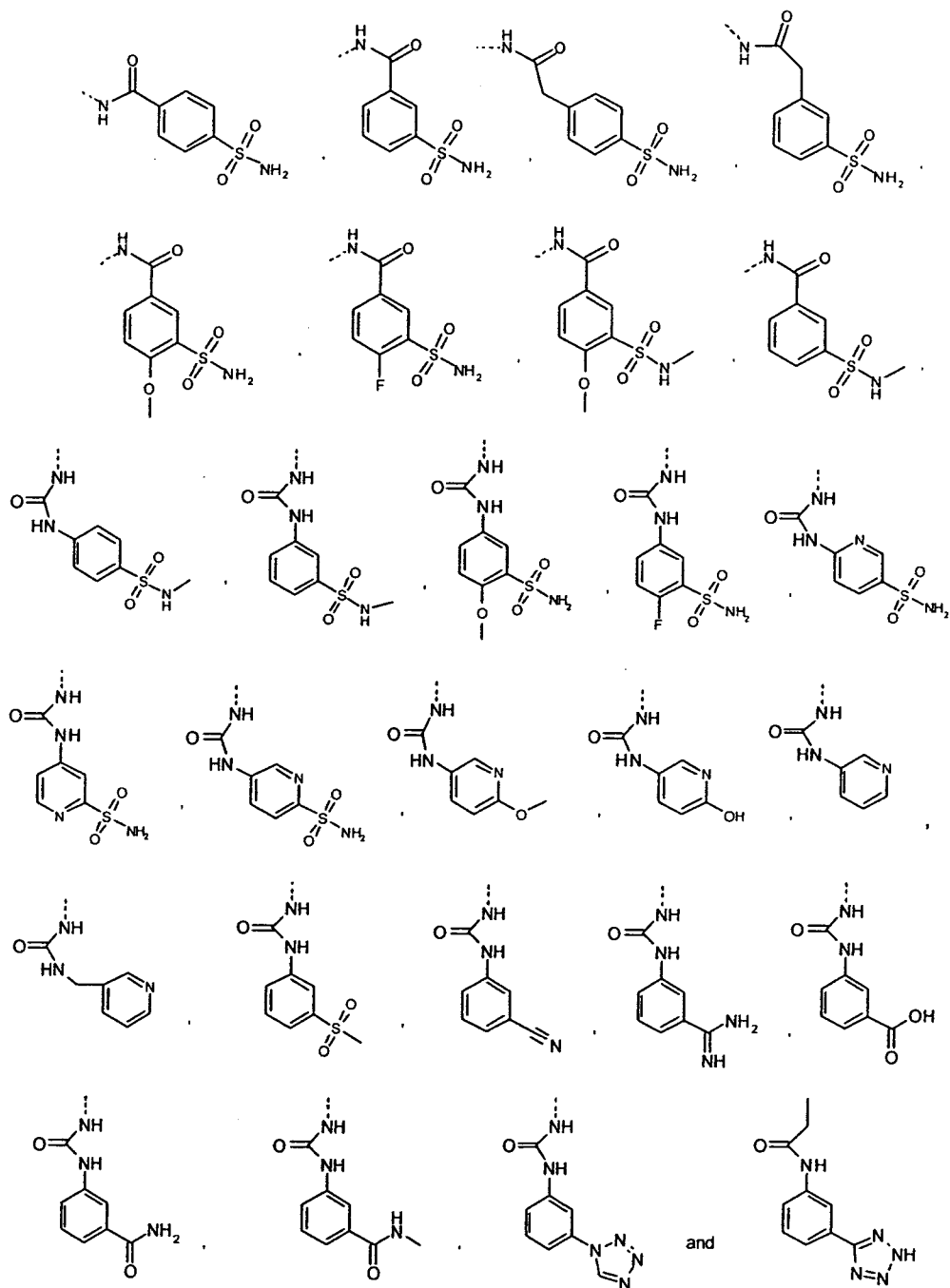


and

R^3 is selected from



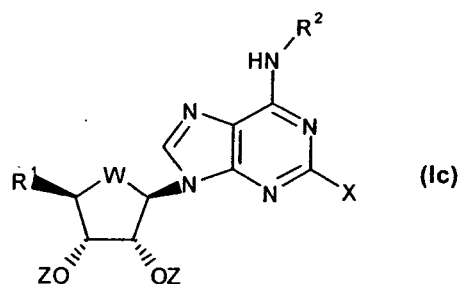
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5. A compound according to Claim 1, substantially as herein described with reference to any one of the Examples.

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6. A compound according to any one of the preceding claims for use as a pharmaceutical.
7. A compound according to any one of Claims 1-5, in combination with an anti-inflammatory, bronchodilatory, anti-histamine or anti-tussive drug substance, said compound and said drug substance being in the same or different pharmaceutical composition.
8. A pharmaceutical composition comprising as active ingredient a compound according to any one of Claims 1-5, optionally together with a pharmaceutically acceptable diluent or carrier.
9. Use of a compound according to any one of Claims 1-5, for the manufacture of a medicament for the treatment of a condition mediated by activation of the adenosine A2A receptor.
10. Use of a compound according to any one of Claims 1-5, for the manufacture of a medicament for the treatment of an inflammatory or obstructive airways disease.
11. A process for the preparation of compounds of formula (I) as defined in Claim 1, or stereoisomers or pharmaceutically acceptable salts thereof, which comprises the steps of:
 - (i) reacting a compound of formula (Ic)



wherein

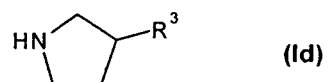
R^1 , W and R^2 are as defined in Claim 1;

Z is H or a protecting group; and

X is a leaving group,

with a compound of formula (Id)

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wherein

R³ is as defined in Claim 1; and

removing any protecting groups and recovering the resultant compound of formula (I), in free or pharmaceutically acceptable salt form.