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(54) Benævnelse: **Pyridin- og pyrazinderivat til behandling af kronisk obstruktiv lungesygdom (KOL)**

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DESCRIPTION

[0001] This invention relates to pyridine compounds, their preparation and use as pharmaceuticals.

[0002] Cystic fibrosis (CF) is a fatal genetic disease caused by mutations in the gene encoding the CF transmembrane conductance regulator (CFTR), a protein kinase A (PKA)-activated epithelial anion channel involved in salt and fluid transport in multiple organs, including the lung. Most CF mutations either reduce the number of CFTR channels at the cell surface (e.g., synthesis or processing mutations) or impair channel function (e.g., gating or conductance mutations) or both. There are currently no approved therapies that target CFTR directly. The present invention discloses compounds which restore or enhance the function of mutant and/or wild type CFTR to treat chronic obstructive pulmonary disease.

[0003] In one aspect, the invention provides compounds
or pharmaceutically acceptable salts thereof, as defined in claim 1, for use in the treatment of chronic obstructive pulmonary disease.

[0004] Various embodiments of the invention are described herein. It will be recognized that features specified in each embodiment may be combined with other specified features to provide further embodiments.

[0005] Another embodiment of the invention as defined above provides compounds for use with substantially pure enantiomers with the R configuration.

[0006] Another embodiment of the invention as defined above provides compounds for use with substantially pure enantiomers with the S configuration.

[0007] Another embodiment of the invention as defined above provides compounds for use, represented by
3-Amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid ((S)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide; or
3-Amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid ((R)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide;
It is understood that any and all embodiments of the present invention may be taken in conjunction with any other embodiment to describe additional embodiments of the present invention. Furthermore, any elements of an embodiment are meant to be combined with any and all other elements from any of the embodiments to describe additional embodiments. It is understood by those skilled in the art that combinations of substituents where not possible are not an aspect of the present invention.

[0008] A second aspect of the invention provides a compound as defined herein for use in a pharmaceutical composition for use in the treatment of chronic obstructive pulmonary disease.

[0009] A further aspect of the invention provides a compound as defined herein for use in the treatment of chronic obstructive pulmonary disease.

[0010] An embodiment of the present invention provides for the use of a compound as defined herein, in free or pharmaceutically acceptable salt form, for the manufacture of a medicament for the treatment of chronic obstructive pulmonary disease.

[0011] Throughout this specification and in the claims that follow, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", should 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.

[0012] As used herein, the term "pharmaceutically acceptable salts" refers to salts that retain the biological effectiveness and properties of the compounds of this invention and, which typically are not biologically or otherwise undesirable. In many cases, the compounds for use in the present invention are capable of forming acid and/or base salts by virtue of the presence of amino and/or carboxyl groups or groups similar thereto.

[0013] Pharmaceutically acceptable acid addition salts can be formed with inorganic acids and organic acids, e.g., acetate, aspartate, benzoate, besylate, bromide/hydrobromide, bicarbonate/carbonate, bisulfate/sulfate, camphorsulfornate, chloride/hydrochloride, chlortheophyllonate, citrate, ethandisulfonate, fumarate, gluceptate, gluconate, glucuronate, hippurate, hydroiodide/iodide, isethionate, lactate, lactobionate, laurylsulfate, malate, maleate, malonate, mandelate, mesylate, methylsulphate, naphthoate, napsylate, nicotinate, nitrate, octadecanoate, oleate, oxalate, palmitate, pamoate, phosphate/hydrogen phosphate/dihydrogen phosphate, polygalacturonate, propionate, stearate, succinate, sulfosalicylate,

tartrate, tosylate and trifluoroacetate salts.

[0014] Inorganic acids from which salts can be derived include, for example, hydrochloric acid, hydrobromic acid, sulfuric acid, nitric acid, phosphoric acid, and the like.

[0015] Organic acids from which salts can be derived include, for example, acetic acid, propionic acid, glycolic acid, oxalic acid, maleic acid, malonic acid, succinic acid, fumaric acid, tartaric acid, citric acid, benzoic acid, mandelic acid, methanesulfonic acid, ethanesulfonic acid, toluenesulfonic acid, and sulfosalicylic acid.

[0016] Pharmaceutically acceptable base addition salts can be formed with inorganic and organic bases.

[0017] Inorganic bases from which salts can be derived include, for example, ammonium salts and metals from columns I to XII of the periodic table. In certain embodiments, the salts are derived from sodium, potassium, ammonium, calcium, magnesium, iron, silver, zinc, and copper; particularly suitable salts include ammonium, potassium, sodium, calcium and magnesium salts.

[0018] Organic bases from which salts can be derived include, for example, primary, secondary, and tertiary amines, substituted amines including naturally occurring substituted amines, cyclic amines, basic ion exchange resins, and the like. Certain organic amines include isopropylamine, benzathine, cholinate, diethanolamine, diethylamine, lysine, meglumine, piperazine and tromethamine.

[0019] The pharmaceutically acceptable salts can be synthesized from a parent compound, a basic or acidic moiety, by conventional chemical methods. Generally, such salts can be prepared by reacting free acid forms of these compounds with a stoichiometric amount of the appropriate base (such as Na, Ca, Mg, or K hydroxide, carbonate, bicarbonate or the like), or by reacting free base forms of these compounds with a stoichiometric amount of the appropriate acid. Such reactions are typically carried out in water or in an organic solvent, or in a mixture of the two. Generally, use of non-aqueous media like ether, ethyl acetate, ethanol, isopropanol, or acetonitrile is desirable, where practicable. Lists of additional suitable salts can be found, e.g., in "Remington's Pharmaceutical Sciences", 20th ed., Mack Publishing Company, Easton, Pa., (1985); and in "Handbook of Pharmaceutical Salts: Properties, Selection, and Use" by Stahl and Wermuth (Wiley-VCH, Weinheim, Germany, 2002).

[0020] Furthermore, the compounds for use in the present invention, including their salts, can also be obtained in the form of their hydrates, or include other solvents used for their crystallization.

[0021] Compounds for use in the invention that contain groups capable of acting as donors and/or acceptors for hydrogen bonds may be capable of forming co-crystals with suitable co-crystal formers. These co-crystals may be prepared from said compounds by known co-crystal forming procedures. Such procedures include grinding, heating, co-subliming, co-melting, or contacting in solution said compounds with the co-crystal former under crystallization conditions and isolating co-crystals thereby formed. Suitable co-crystal formers include those described in WO 2004/078163.

[0022] As used herein, the term "isomers" refers to different compounds that have the same molecular formula but differ in arrangement and configuration of the atoms. Also as used herein, the term "an optical isomer" or "a stereoisomer" refers to any of the various stereo isomeric configurations which may exist for a given compound for use in the present invention and includes geometric isomers. It is understood that a substituent may be attached at a chiral center of a carbon atom. Therefore, the invention includes enantiomers, diastereomers or racemates of the compound. "Enantiomers" are a pair of stereoisomers that are non- superimposable mirror images of each other. A 1:1 mixture of a pair of enantiomers is a "racemic" mixture. The term is used to designate a racemic mixture where appropriate. "Diastereoisomers" are stereoisomers that have at least two asymmetric atoms, but which are not mirror-images of each other. The absolute stereochemistry is specified according to the Cahn- Ingold- Prelog R-S system. When a compound is a pure enantiomer the stereochemistry at each chiral carbon may be specified by either R or S. Resolved compounds whose absolute configuration is unknown can be designated (+) or (-) depending on the direction (dextro- or levorotatory) which they rotate plane polarized light at the wavelength of the sodium D line. Certain of the compounds described herein contain one or more asymmetric centers or axes and may thus give rise to enantiomers, diastereomers, and other stereoisomeric forms that may be defined, in terms of absolute stereochemistry, as (*R*)- or (*S*)-. The present invention is meant to include all such possible isomers, including racemic mixtures, optically pure forms and intermediate mixtures. Optically active (*R*)- and (*S*)- isomers may be prepared using chiral synthons or chiral reagents, or resolved using conventional techniques. If the compound contains a double bond, the substituent may be E or Z configuration. If the compound contains a disubstituted cycloalkyl, the cycloalkyl substituent may have a cis- or trans-configuration. All tautomeric forms are also intended to be included.

[0023] Any asymmetric atom (e.g., carbon or the like) of the compound(s) for use in the present invention can be present in

racemic or enantiomerically enriched, for example the (R)-, (*S*)- or (*R,S*)- configuration. In certain embodiments, each asymmetric atom has at least 50 % enantiomeric excess, at least 60 % enantiomeric excess, at least 70 % enantiomeric excess, at least 80 % enantiomeric excess, at least 90 % enantiomeric excess, at least 95 % enantiomeric excess, or at least 99 % enantiomeric excess in the (*R*)- or (S)- configuration. Substituents at atoms with unsaturated bonds may, if possible, be present in *cis*- (*Z*)- or *trans*- (*E*)- form.

[0024] Accordingly, as used herein a compound for use in the present invention can be in the form of one of the possible isomers, rotamers, atropisomers, tautomers or mixtures thereof, for example, as substantially pure geometric (*cis* or *trans*) isomers, diastereomers, optical isomers (antipodes), racemates or mixtures thereof.

[0025] Any resulting mixtures of isomers can be separated on the basis of the physicochemical differences of the constituents, into the pure or substantially pure geometric or optical isomers, diastereomers, racemates, for example, by chromatography and/or fractional crystallization.

[0026] Any resulting racemates of final products or intermediates can be resolved into the optical antipodes by known methods, e.g., by separation of the diastereomeric salts thereof, obtained with an optically active acid or base, and liberating the optically active acidic or basic compound. In particular, a basic moiety may thus be employed to resolve the compounds of the present invention into their optical antipodes, e.g., by fractional crystallization of a salt formed with an optically active acid, e.g., tartaric acid, dibenzoyl tartaric acid, diacetyl tartaric acid, di-*O*,*O*'-*p*-toluoyl tartaric acid, mandelic acid, malic acid or camphor-10-sulfonic acid. Racemic products can also be resolved by chiral chromatography, e.g., high pressure liquid chromatography (HPLC) using a chiral adsorbent.

[0027] Since the compounds for use in the invention are intended for use in pharmaceutical compositions it will readily be understood that they are each preferably provided in substantially pure form, for example at least 60% pure, more suitably at least 75% pure and preferably at least 85%, especially at least 98% pure (% are on a weight for weight basis). Impure preparations of the compounds may be used for preparing the more pure forms used in the pharmaceutical compositions; these less pure preparations of the compounds should contain at least 1 %, more suitably at least 5% and preferably from 10 to 59% of a compound.

[0028] Compounds for use in the present invention are either obtained in the free form, as a salt thereof, or as prodrug derivatives thereof.

[0029] When both a basic group and an acid group are present in the same molecule, the compounds for use in the present invention may also form internal salts, e.g., zwitterionic molecules.

[0030] Any formula given herein is also intended to represent unlabeled forms as well as isotopically labeled forms of the compounds. Isotopically labeled compounds have structures depicted by the formulas given herein except that one or more atoms are replaced by an atom having a selected atomic mass or mass number. Examples of isotopes that can be incorporated into compounds include isotopes of hydrogen, carbon, nitrogen, oxygen, phosphorous, fluorine, and chlorine, such as ^{2}H, ^{3}H, ^{11}C, ^{13}C, ^{14}C, ^{15}N, ^{18}F ^{31}P, ^{32}P, ^{35}S, ^{36}Cl, ^{125}I respectively. Included are various isotopically labeled compounds as defined herein, for example those into which radioactive isotopes, such as ^{3}H, ^{13}C, and ^{14}C are present. Such Isotopically labeled compounds are useful in metabolic studies (with ^{14}C), reaction kinetic studies (with, for example ^{2}H or ^{3}H), detection or imaging techniques, such as positron emission tomography (PET) or single-photon emission computed tomography (SPECT) including drug or substrate tissue distribution assays, or in radioactive treatment of patients. In particular, an ^{18}F or labeled compound may be particularly desirable for PET or SPECT studies. Isotopically labeled compounds of this invention can generally be prepared by carrying out the procedures disclosed in the schemes or in the examples and preparations described below by substituting a readily available isotopically labeled reagent for a non-isotopically labeled reagent.

[0031] Further, substitution with heavier isotopes, particularly deuterium (i.e., ^{2}H or D) may afford certain therapeutic advantages resulting from greater metabolic stability, for example increased in vivo half-life or reduced dosage requirements or an improvement in therapeutic index. It is understood that deuterium in this context is regarded as a substituent of a compound. The concentration of such a heavier isotope, specifically deuterium, may be defined by the isotopic enrichment factor. The term "isotopic enrichment factor" as used herein means the ratio between the isotopic abundance and the natural abundance of a specified isotope. If a substituent in a compound of this invention is denoted deuterium, such compound has an isotopic enrichment factor for each designated deuterium atom of at least 3500 (52.5% deuterium incorporation at each designated deuterium atom), at least 4000 (60% deuterium incorporation), at least 4500 (67.5% deuterium incorporation), at least 5000 (75%

deuterium incorporation), at least 5500 (82.5% deuterium incorporation), at least 6000 (90% deuterium incorporation), at least 6333.3 (95% deuterium incorporation), at least 6466.7 (97% deuterium incorporation), at least 6600 (99% deuterium incorporation), or at least 6633.3 (99.5% deuterium incorporation).

[0032] Isotopically-labeled compounds can generally be prepared by conventional techniques known to those skilled in the art or by processes analogous to those described in the accompanying Examples and Preparations using an appropriate isotopically-labeled reagents in place of the non-labeled reagent previously employed.

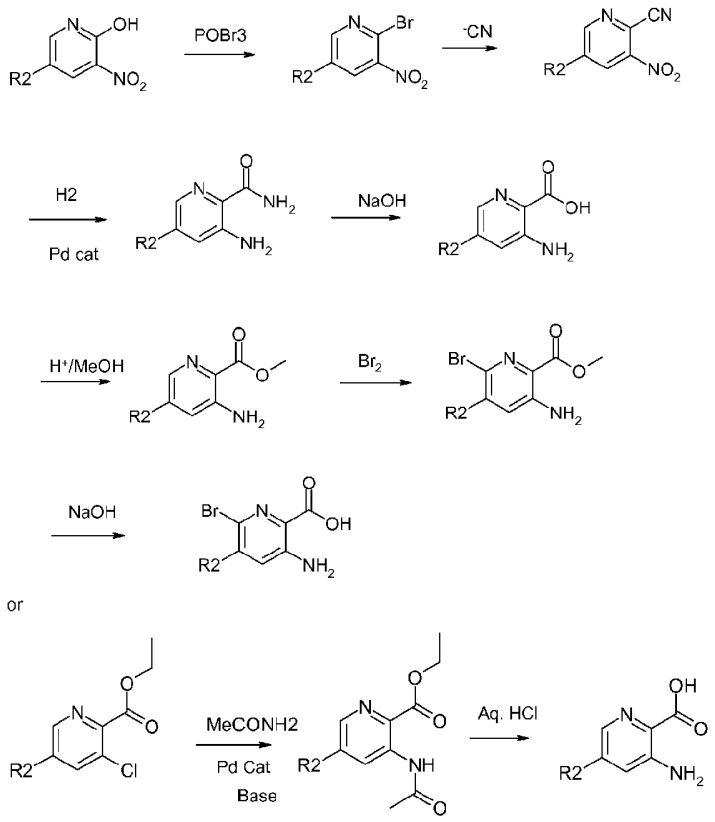
[0033] Pharmaceutically acceptable solvates in accordance with the invention include those wherein the solvent of crystallization may be isotopically substituted, e.g. D_2O, d_6-acetone, d_6-DMSO.

Synthesis

[0034] Generally, the compounds can be synthesized by the routes described in Scheme 1, 2 and 3 and the Examples. Schemes 2 and 5 are provided for reference purposes and the groups A, R^1, R^2, R^3, R^4, R^5 and R^6, are defined as corresponding with the compounds for use in the invention herein.

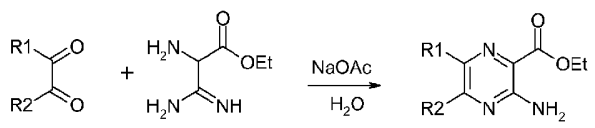
[0035] The pyridinyl moiety may be synthesized according to the general scheme 1 shown below.

Scheme 1

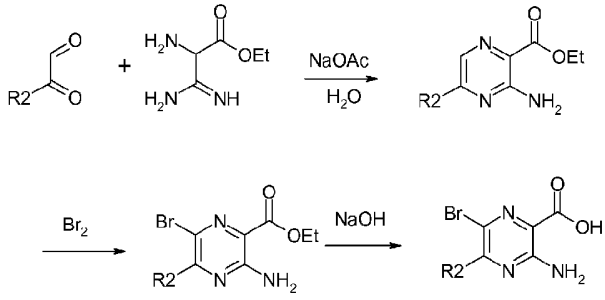


[0036] A pyrazine moiety may be synthesized according to the general scheme 2 shown below.

Scheme 2

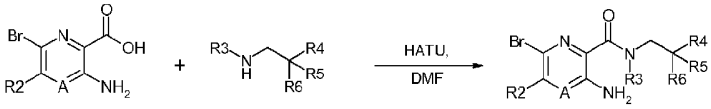


or



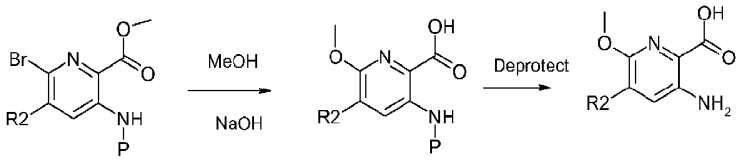
[0037] The right hand side of the moiety is typically added via an amide formation reaction as shown below in general scheme 3.

Scheme 3

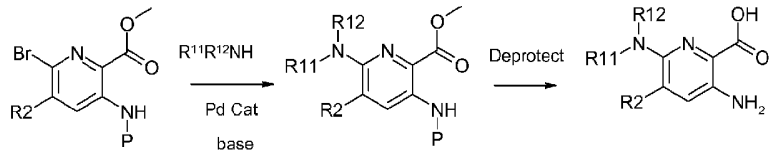


[0038] HATU (2-(1H-7-Azabenzotriazol-1-yl)--1,1,3,3-tetramethyl uronium hexafluorophosphate Methanaminium) is a peptide coupling agent. A skilled artisan would understand that other coupling agents cold possibly work. The halogen group in the above schemes can be replaced with other groups by choosing the appropriate nucleophile and catalyst. Protection of the Aryl NH2 group may be required and is represented by P. The schemes 4 -7 below are some representative examples.

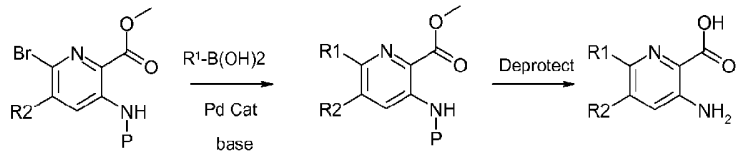
Scheme 4



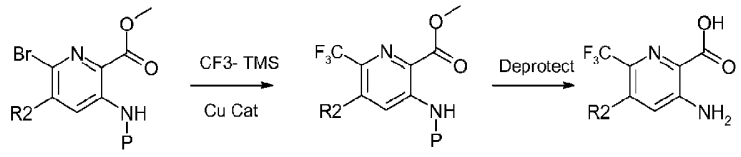
Scheme 5



Scheme 6



Scheme 7



[0039] The skilled person will appreciate that the general synthetic routes detailed above show common reactions to transform the starting materials as required. The specific reaction conditions are not provided, but these are well known to those skilled in the art and appropriate conditions considered to be within the skilled person's common general knowledge.

[0040] The starting materials are either commercially available compounds or are known compounds and can be prepared from procedures described in the organic chemistry art.

[0041] Compounds in free form, may be converted into salt form, and vice versa, in a conventional manner understood by those skilled in the art. The compounds in free or salt form can be obtained in the form of hydrates or solvates containing a solvent used for crystallisation. Compounds 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 crystallisation or asymmetric synthesis from correspondingly asymmetrically substituted, e.g., optically active, starting materials.

[0042] The compounds can be prepared, e.g., using the reactions and techniques described below and in the Examples. 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 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.

[0043] 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 for use hereininto another compound for use herein. 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 Greene and Wuts, Protective Groups in Organic Synthesis, Wiley and Sons (1999).

Pharmacological activity

[0044] Having regard to their modulation of CFTR activity, the compounds described herein, 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 modulation of CFTR activity, particularly conditions benefiting from mucosal hydration such as cystic fibrosis.

[0045] Diseases mediated by modulation of CFTR activity, include diseases associated with the regulation of fluid volumes across epithelial membranes. For example, the volume of airway surface liquid is a key regulator of mucociliary clearance and the maintenance of lung health. The modulation of CFTR activity will promote fluid accumulation on the mucosal side of the airway epithelium thereby promoting mucus clearance and preventing the accumulation of mucus and sputum in respiratory tissues (including lung airways). Such diseases include respiratory diseases, such as cystic fibrosis, primary ciliary dyskinesia, chronic bronchitis, chronic obstructive pulmonary disease (COPD), asthma, respiratory tract infections (acute and chronic; viral and bacterial) and lung carcinoma. Diseases mediated by modulation of CFTR activity also include diseases other than respiratory diseases that are associated with abnormal fluid regulation across an epithelium, perhaps involving abnormal physiology of the protective surface liquids on their surface, e.g., Sjögren's Syndrome, xerostomia (dry mouth) or keratoconjunctivitis sire (dry eye). Furthermore, modulation of CFTR activity in the kidney could be used to promote diuresis and thereby induce a hypotensive effect.

[0046] Treatment in accordance with the invention may be symptomatic or prophylactic.

[0047] Asthma includes 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".)

[0048] 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, improvements 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 4-6 am, i.e., at a time normally substantially distant from any previously administered symptomatic asthma therapy.

[0049] Chronic obstructive pulmonary disease includes 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 phthinoid bronchitis.

[0050] Dry eye disease is characterized by a decrease in tear aqueous production and abnormal tear film lipid, protein and mucin profiles. There are many causes of dry eye, some of which include age, laser eye surgery, arthritis, medications, chemical/thermal burns, allergies and diseases, such as cystic fibrosis and Sjögren's Syndrome. Increasing anion secretion via CFTR would enhance fluid transport from the corneal endothelial cells and secretory glands surrounding the eye to increase corneal hydration. This would help to alleviate the symptoms associated with dry eye disease.

[0051] Sjögren's Syndrome is an autoimmune disease in which the immune system attacks moisture-producing glands throughout the body, including eye, mouth, skin, respiratory tissue, liver, vagina and gut. Symptoms include dry eye, dry mouth and dry vagina, as well as lung disease. The disease is also associated rheumatoid arthritis, systemic lupus, systemic sclerosis and polymypositis/dermatomyositis. Defective protein trafficking is believed to cause the disease, for which treatment options are limited. Modulators of CFTR activity may hydrate the various organs affected by the disease and help to alleviate the associated symptoms.

[0052] The suitability of CFTR activity modulators as a treatment of a disease benefiting from mucosal hydration may be tested by determining the movement of chloride ions in a suitable cell-based assay. For example single cells or confluent epithelia, endogenously expressing or engineered to overexpress CFTR can be used to assess channel function using electrophysiological techniques or ion flux studies. See methods described in: Hirsh et al., J Pharm Exp Ther (2004); Moody et al., Am J Physiol Cell Physiol (2005).

[0053] CFTR activity modulators, including the compounds described herein, 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 cystic fibrosis or obstructive or inflammatory airways diseases such as those mentioned hereinbefore, e.g., as potentiators of therapeutic activity of such drugs or as a means of reducing required dosaging or potential side effects of such drugs.

[0054] The compounds described herein 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.

[0055] Accordingly, the invention relates to a combination of a CFTR activity modulator compound described herein with osmotic agents (hypertonic saline, dextran, mannitol, Xylitol), ENaC blockers, an anti-inflammatory, bronchodilatory, antihistamine, anti-tussive, antibiotic and/or DNase drug substance, wherein the CFTR activity modulator and the further drug substance may be in the same or different pharmaceutical composition.

[0056] Suitable antibiotics include macrolide antibiotics, e.g., tobramycin (TOBI™).

[0057] Suitable DNase drug substances include dornase alfa (Pulmozyme™), a highly-purified solution of recombinant human

deoxyribonuclease I (rhDNase), which selectively cleaves DNA. Dornase alfa is used to treat cystic fibrosis.

[0058] Other useful combinations of CFTR activity modulators 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-methyl-phenyl)-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 USP 6,166,037 (particularly claims 18 and 19), WO 00/66558 (particularly claim 8), WO 00/66559 (particularly claim 9), WO 04/018425 and WO 04/026873.

[0059] 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; LTD4 antagonists, such as montelukast and zafirlukast; PDE4 inhibitors, such as cilomilast (Ariflo® GlaxoSmithKline), Roflumilast (Byk Gulden),V-11294A (Napp), BAY19-8004 (Bayer), SCH-351591 (Schering-Plough), Arofylline (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 A2B 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, preferably compounds of the Examples thereof, especially indacaterol 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, USP 2002/0055651, 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, WO 04/108765 and WO 04/108676.

[0060] 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, USP 3,714,357, USP 5,171,744, 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 and WO 04/05285.

[0061] Suitable dual anti-inflammatory and bronchodilatory drugs include dual beta-2 adrenoceptor agonist/muscarinic antagonists such as those disclosed in USP 2004/0167167, WO 04/74246 and WO 04/74812.

[0062] 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.

[0063] In another aspect the invention provides a compound described herein, in free form or in the form of a pharmaceutically acceptable salt, for use in the manufacture of a medicament for the treatment of COPD.

[0064] 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 an obstructive airways disease; intranasally, e.g., in the treatment of allergic rhinitis; topically to the skin; or rectally. The compounds described herein can be provided as a pharmaceutical composition comprising the compound, 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.

[0065] 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 compound 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 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.

[0066] The compounds for use in the invention may include:

1. (a) a compound in inhalable form, e.g., in an aerosol or other atomisable composition or in inhalable particulate, e.g., micronised form;
2. (b) an inhalable medicament comprising a compound in inhalable form;
3. (c) a pharmaceutical product comprising a compound in inhalable form in association with an inhalation device; and
4. (d) an inhalation device containing a compound in inhalable form.

[0067] Dosages of compounds 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.

Pharmaceutical Use and Assay

[0068] Compounds for use described herein and their pharmaceutically acceptable salts, hereinafter referred to alternatively as "agents of the invention", are useful as pharmaceuticals. In particular, the compounds are suitable CFTR activity modulators and may be tested in the following assays.

Membrane potential assay

[0069] CFTR activity can be quantified by measuring the transmembrane potential. The means for measuring the transmembrane potential in a biological system can employ a number of methods including electrophysiological and optical fluorescence-based membrane potential assays.

[0070] The optical membrane potential assay utilises a negatively charged potentiometric dye, such as the FLIPR membrane potential dye (FMP) (see Baxter DF, Kirk M, Garcia AF, Raimondi A, Holmqvist MH, Flint KK, Bojanic D, Distefano PS, Curtis R, Xie Y. 'A novel membrane potential-sensitive fluorescent dye improves cell-based assays for ion channels.' J Biomol Screen. 2002 Feb;7(1):79-85) which when extracellular is bound to a quenching agent. Upon cellular depolarisation the negatively charged dye redistributes to the intracellular compartment, unbinding from the membrane impermeant quench agent, yielding an increase in fluorescence. This change in fluorescence is proportional to the change in transmembrane potential which can result from the activity of CFTR. The changes in fluorescence can be monitored in real time by an appropriately equipped fluorescence detector such as the FLIPR (fluorometric imaging plate reader) in 96 or 384-well microtitre plates.

Cell culture:

[0071] Chinese hamster ovary (CHO) cells stably expressing the ΔF508-CFTR channel were used for membrane potential experiments. Cells were maintained at 37 °C in 5% v/v CO_2 at 100% humidity in Modified Eagles medium (MEM) supplemenetd with 8% v/v foetal calf serum, 100µg/ml methotrexate and 100U/ml penicillin/streptomycin. Cells were grown in 225 cm^2 tissue culture flasks. For membrane potential assays cells were seeded into 96 well plates at 40,000 cells per well, allowed to adhere

and then maintained at 26 °C for 48h to facilitate channel insertion.

Potentiator assay:

[0072] The membrane potential screening assay utilised a low chloride ion containing extracellular solution (~5mM) combined with a double addition protocol. The first addition was of buffer with or without test compound followed 5 minutes later by an addition of forskolin (1-20 µM) - this protocol favours maximum chloride efflux in response to ΔF508-CFTR activation. The ΔF508-CFTR mediated chloride ion efflux leads to a membrane depolarisation which is optically monitored by the FMP dye.

Solutions:

[0073]

Low chloride extracellular (mM): 120 Na-gluconate, 1.2 $CaCl_2$, 3.3 KH_2PO_4, 0.8 K_2HPO_4, 1.2 $MgCl_2$, 10.0 D-glucose, 20.0 HEPES, pH 7.4 with NaOH

FMP dye: made up as per manufacturers' instructions in low chloride extracellular solution detailed above, at 10x final concentration, and stored as 1 mL aliquots at -20°C.

IonWorks Quattro assay:

[0074] CFTR activity can also be quantified electrophysiologically using the whole-cell configuration of the patch clamp technique (Hamill et al Pflugers Acrhive 1981). This assay directly measures the currents associated with chloride flow through CFTR channels whilst either maintaining or adjusting the transmembrane voltage. This assay can use either single glass micropipettes or parallel planar arrays to measure CFTR activity from native or recombinant cell systems. Currents measured using parallel planar arrays can be quantified using an appropriately equipped instrument such as the IonWorks Quattro (Molecular Devices) or the Qpatch (Sophion). The Quattro system can measure CFTR currents from either a single cell per recording well (HT configuration) or alternatively from a population of 64 cells per well (Population Patch Clamp PPC) (Finkel A, Wittel A, Yang N, Handran S, Hughes J, Costantin J. 'Population patch clamp improves data consistency and success rates in the measurement of ionic currents.' J Biomol Screen. 2006 Aug;11(5):488-96).

Cell culture:

[0075] Chinese hamster ovary (CHO) cells stably expressing the ΔF508-CFTR channel were used for IonWorks Quattro experiments. Cells were maintained at 37 °C in 5% v/v CO_2 at 100% humidity in D-MEM supplemented with 10 % (v/v) FCS, 100 U/mL Penicillin/Streptomycin, 1 % (v/v) NEAA, 1 mg/ml Zeocin and 500 ug/ml Hygromycin B. For experiments cells were grown in 225 cm^2 tissue culture flasks until near confluence and then cultured at 26 °C for 48-72h to facilitate channel insertion. Cells were removed from the flask and resuspended in either extracellular recording solution for immediate experimentation or alternatively in growth medium supplemented with 10% v/v DMSO and frozen to -80°C as 1-2 mL aliquots for use at a later date.

Potentiator assay:

[0076] Cells, at a density of 1.5-3 million per mL, were placed on the Quattro system, added to the planar patch array and seals allowed to establish for 5-10 mins. After assessing seal resistances (commonly >50 MΩ), whole-cell access was obtained by perforation with 100 µg/mL amphotericin B. Baseline currents were measured by a pre-compound scan obtained by application of a voltage ramp from -100 to +100 mV. This was followed by addition of either buffer or test compound diluted in the extracellular solution supplemented with 20 µM forskolin, to each of the 384 wells of the planar parch array. After incubation step (5-20 minutes) the post-compound currents were measured again by application of a voltage ramp from -100 to +100 mV. The difference in currents between the pre- and post-compound scans defined the efficacy of CFTR potentiation.

Solutions:

[0077]

Extracellular solution (ECS) : 145 mM NaCl, 4 mM CsCl, 5 mM D-glucose, 10 mM TES, 1 mM $CaCl_2$, 1 mM $MgCl_2$, pH 7.4 NaOH

Intracellular buffer (ICS): 113 mM L-Aspartic acid, 113 mM CsOH, 27 mM CsCl, 1 mM NaCl, 1 mM $MgCl_2$, 1 mM EGTA, 10 mM TES. pH 7.2 with CsOH. Filter sterilized before use.

Ion transport assay:

[0078] Another method to measure CFTR function is Ussings chamber short circuit current measurement. Engineered or native epithelial cells are grown to confluent monolayer on a semi-permeable filter and sandwiched between two perspex blocks. The flow of chloride ions via CFTR from one side of the epithelia to the other can be quantified by measuring the flow of current whilst maintaining the transepithelial potential at 0mV. This is achieved using KCl filled agar-based electrodes to both clamp the cellular monolayer and measure the flow of currents.

Cell culture:

[0079] FRT cells stably expressing ΔF508-CFTR were cultured on plastic in Coon's modified F-12 medium supplemented with 32mM $NaHCO_3$, 10% v/v fetal bovine serum, 2 mM L-glutamine, 100 U/mL penicillin, 100 µg/mL streptomycin and 30 µg/mL hygromycin B as the growth medium. For Ussing chamber experiments, the cells were grown as polarized epithelia on Snapwell permeable support inserts (500000 cells/insert in growth medium) and cultured for 7 to 9 days. The inserts were fed with fresh Coon's modified F-12 growth medium every 48 hours, and 24 hours prior to Ussing chamber experiment. To increase the ΔF508 CFTR protein expression at the cell surface, plates were incubated at 27°C for 48h before performing an Ussing chamber experiment.

Potentiator assay:

[0080] Fischer Rat Thyroid (FRT) epithelial cells, stably expressing human ΔF508-CFTR were used as monolayer cultures on permeable supports. Cl^- current was measured using the short circuit current technique, under an imposed basolateral to apical Cl^- gradient in Ussing chambers. To measure stable Cl^- currents, FRT cells were cultured for 48h at 27°C to facilitate the insertion of ΔF508 CFTR into the plasma membrane. Ussing chamber studies were likewise conducted at 27°C. Under these conditions, the effects of cumulative additions of test compounds on ΔF508 CFTR currents could be quantitated with both potency and efficacy endpoints. Compounds were added to both the apical and basloalteral sides subsequent to addition of 10µM forskolin. Efficacy of compounds was compared to a known potentiator such as gensitein.

Solutions:

[0081]

Basolateral Ringer solution (mM): 126 NaCl, 24 $NaHCO_3$, 0.38 KH_2PO_4, 2.13 K_2HPO_4, 1 $MgSO_4$, 1 $CaCl_2$ and 10 glucose.

Apical Ringer solution (mM): 140 Na-gluconate, 1 $MgSO_4$, 2 $CaCl_2$, 1 HCl, 10 glucose and 24 $NaHCO_3$.

[0082] Compounds can also be tested for their ability to stimulate insertion of ΔF508 CFTR into the cell membrane using the above assays. For these assays the protocols were identical other than cells were not cultured at low temperature (26 or 27°C)

but instead incubated with test compounds for 12-24 h prior to assay.

[0083] Compounds of the Examples, herein below, generally have EC_{50} values in the data measurements described above below 10 μM. Table 1 provides a list of representative compounds with their EC_{50} value.

Table 1.

Example No	EC_{50} μM
2 (reference)	0.015
3 (reference)	0.055
4	0.076
5	0.05
6	0.426
7	0.040
8	0.060
16	0.008
17	0.010

[0084] The invention is illustrated by the following Examples.

Examples

General Conditions:

[0085] Mass spectra were run on LC-MS systems using electrospray ionization. These were either Agilent 1100 HPLC/Micromass Platform Mass Spectrometer combinations or Waters Acquity UPLC with SQD Mass Spectrometer. $[M+H]^+$ refers to mono-isotopic molecular weights.

[0086] NMR spectra were run on open access Bruker AVANCE 400 NMR spectrometers using ICON-NMR. Spectra were measured at 298K and were referenced using the solvent peak.

[0087] Optical rotations were measured at 589nm and 546nm using an Optical activity AA-1000 polarimeter at 21°C.

[0088] The following examples are intended to illustrate the invention and are not to be construed as being limitations thereon. Temperatures are given in degrees centigrade. If not mentioned otherwise, all evaporations are performed under reduced pressure, preferably between about 15 mm Hg and 100 mm Hg (= 20-133 mbar). The structure of final products, intermediates and starting materials is confirmed by standard analytical methods, *e.g.*, microanalysis and spectroscopic characteristics, *e.g.*, MS, IR, and NMR. Abbreviations used are those conventional in the art. If not defined, the terms have their generally accepted meanings.

Abbreviations:

[0089]

app
: apparent

ATP
: adenosine 5'-triphosphate

BINAP
: racemic 2,2'-bis(diphenylphosphino)-1,1'-binaphthyl

BOC

tertiary butyl carboxy

br

broad

d

doublet

dd

doublet of doublets

DCM

dichloromethane

DIEA

diethylisopropylamine

DIPEA

diisopropylethylamine

DMF

N,N-dimethylformamide

DMSO

dimethylsulfoxide

DTT

dithiothreitol

ESI

electrospray ionization

EtOAc

ethyl acetate

eq

equivalent

h

hour(s)

HATU

2-(7-Aza-1 H-benzotriazole-1-yl)-1,1,3,3-tetramethyluronium hexafluorophosphate

HPLC

high pressure liquid chromatography

IR

infrared spectroscopy

LCMS

liquid chromatography and mass spectrometry

MeOH

methanol

MS

mass spectrometry

MW

microwave

m

multiplet

min

minutes

ml

milliliter(s)

m/z

mass to charge ratio

NMR

nuclear magnetic resonance

ppm

parts per million

PS

polymer supported

rac

racemic

RT

room temperature

Rt

retention time

s

singlet

SCX-2

strong cation exchange (e.g. Isolute® SCX-2 columns from Biotage)

t

triplet

TEA

triethylamine

TFA

trifluoroacetic acid

THF

tetrahydrofuran

[0090] Referring to the examples that follow, compounds of the preferred embodiments were synthesized using the methods described herein, or other methods, which are known in the art.

[0091] The various starting materials, intermediates, and compounds of the preferred embodiments may be isolated and purified, where appropriate, using conventional techniques such as precipitation, filtration, crystallization, evaporation, distillation, and chromatography. Unless otherwise stated, all starting materials are obtained from commercial suppliers and used without further purification. Salts may be prepared from compounds by known salt-forming procedures.

[0092] It should be understood that the organic compounds according to the preferred embodiments may exhibit the phenomenon of tautomerism. As the chemical structures within this specification can only represent one of the possible tautomeric forms, it should be understood that the preferred embodiments encompasses any tautomeric form of the drawn structure.

[0093] If not indicated otherwise, the analytical HPLC conditions are as follows:

Method 10minLC_v002

Column	Waters BEH C18 50x2.1 mm, 1.7 µm
Column Temperature	50 °C
Eluents	A: H_2O, B: methanol, both containing 0.1 % TFA
Flow Rate	0.8 ml/min
Gradient	0.20 min 5% B; 5% to 95% B in 7.80 min, 1.00 min 95% B

Method 10minLC_v003

Column	Waters BEH C18 50x2.1 mm, 1.7 µm
Column Temperature	50 °C
Eluents	A: H_2O, B: acetonitrile, both containing 0.1 % TFA
Flow Rate	0.8 ml/min
Gradient	0.20 min 5% B; 5% to 95% B in 7.80 min, 1.00 min 95% B

Method 2minLC_v002

Column	Waters BEH C18 50x2.1 mm, 1.7 µm
Column Temperature	50 °C
Eluents	A: H_2O, B: methanol, both containing 0.1 % TFA
Flow Rate	0.8 ml/min
Gradient	0.20 min 5% B; 5% to 95% B in 1.30 min, 0.25 min 95% B

Method 2minLC_v003

Column	Waters BEH C18 50x2.1 mm, 1.7 µm

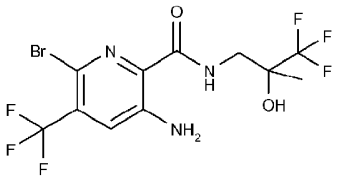
Column Temperature	50 °C
Eluents	A: H_2O, B: acetonitrile, both containing 0.1 % TFA
Flow Rate	0.8 ml/min
Gradient	0.20 min 5% B; 5% to 95% B in 1.30 min, 0.25 min 95% B

Preparation of Final Compounds

Reference Example 1.0

3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid (3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide

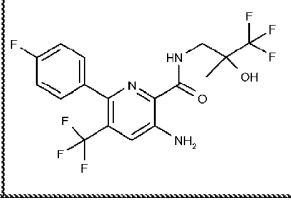
[0094]



[0095] 3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid (Intermediate A) (397 mg, 1.392 mmol), 3-amino-1,1,1-trifluoro-2-methyl-propan-2-ol hydrochloride (250 mg, 1.392 mmol) and HATU (529 mg, 1.392 mmol) were dissolved in DMF (10 ml) and stirred at RT for 2 min. 4-Methylmorpholine (0.413 ml, 4.18 mmol) was added and stirring continued at RT for 3 h. The reaction mixture was poured onto ice/water (100 ml) and extracted with EtOAc (250 ml). The organic extract was washed with sat NH_4Cl solution (~50 ml), dried over $MgSO_4$ and concentrated *in vacuo* to give a pale brown oil. The oil was dissolved in $CHCl_3$ (~3 ml) and loaded onto a 24g ISCO (silica) column eluting with iso-hexane:EtOAc to afford the title product; LC-MS Rt = 1.46 mins; $[M+H]^+$ 410.1, Method 2minLC_v002. ^1H NMR (400 MHz, DMSO-d6) δ 8.30 (NH, t), 7.72 (1H, s), 7.29 (NH2, b s), 6.28 (OH, s), 3.68 (1 H, dd), 3.47 (1 H, dd), 1.24 (3H, s). ^{19}F NMR (400 MHz, DMSO-d6) δ -62.71 (CF3, s),-80.48 (CF3, s).

[0096] The compound of the following Table 2 was prepared by a similar method to that of Example 1 from the appropriate starting compound and amine. Herein single enantiomers were prepared by using chiral amines or by separation of the product by Supercritical Fluid Chromatography. The preparations of the starting compounds and amines are described in the Intermediates section, unless they are commercially available. DIPEA or TEA may have been used in place of 4-methylmorpholine in some reactions.

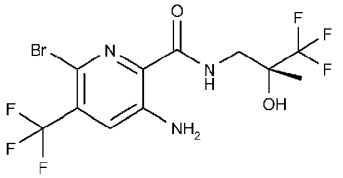
Table 2

Ex.	Structure	Name	Retention Time, $[M+H]^+$, 1H NMR
1.25		3-Amino-6-(4-fluorophenyl)-5-trifluoromethyl-pyridine-2-carboxylic acid (3,3,3-trifluoro-2-hydroxy-2-methylpropyl)-amide	Rt 5.41 mins; $[M+H]^+$ 426 ; Method 10minLC_v002. 1H NMR δ 8.42 (1H, m), 7.72 (1 H, s), 7.5 (2H, m), 7.3 (2H, t), 7.22 (2H, br s), 6.24 (1 H, s), 3.68 (1 H, m), 3.46 (1 H, m), 1.24 (3H, s)

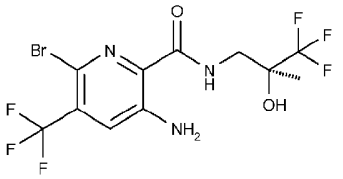
Reference Example 2 and 3

[0097] These compounds namely,

3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid ((R)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide. (Ex. 2)



and 3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid ((S)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide. (Ex.3)



are prepared by chiral separation of 3-amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid (3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide. (Example 1) using Supercritical Fluid Chromatography under the following conditions:

Mobile Phase : 12% isopropanol + 0.1 % DEA / 88% CO_2

Column: Chiralpak OJ-H, 250 x 10 mm id, 5 µm

Detection: UV @ 220nm

Flow rate: 10 ml/min

Sample concentration: 347mg in 5 ml EtOH.

Injection volume: 50µl

Example 2: First eluted peak: 3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid ((R)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide.
LC-MS: Rt = 4.97min [M+H]+ 410.1/412.2 (Method 10minLC_v002).

^{1}H NMR (400 MHz, DMSO-d6) δ 8.30 (NH, t), 7.72 (1 H, s), 7.29 (NH2, b s), 6.28 (OH, s), 3.68 (1 H, dd), 3.47 (1 H, dd), 1.24 (3H, s)

^{19}F NMR (400 MHz, DMSO-d6) d -62.70 (CF3, s), -80.47 (CF3, s)

Optical rotation $[\alpha]^{21}_D$ at 589 nm +14.4°(c= 0.522, MeOH).

Example 3: Second eluted peak: 3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid ((S)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide.
LC-MS Rt = 4.94 min [M+H]+ 412.1 (Method 10minLC_v002).

^{1}H NMR (400 MHz, DMSO-d6) δ 8.30 (NH, t), 7.72 (1 H, s), 7.29 (NH2, b s), 6.28 (OH, s), 3.68 (1 H, dd), 3.47 (1 H, dd), 1.24 (3H, s)

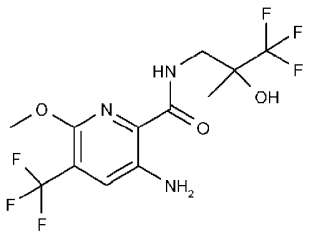
^{19}F NMR (400 MHz, DMSO-d6) d -62.70 (CF3, s), -80.48 (CF3, s).

[0098] The stereochemistry of this compound was confirmed by X-ray crystallography.

Example 4, 5 and 6

[0099] This compound namely,

3-Amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid (3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide. (Ex. 4),



was prepared according to the following procedure:

A solution comprising 3-amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid (Intermediate D)(4 g, 16.94 mmol) and 3-amino-1,1,1-trifluoro-2-methylpropan-2-ol hydrochloride (Intermediate R) (3.04 g, 16.94 mmol) in NMP (188 ml) was treated with HATU (7.73 g, 20.33 mmol) followed by dropwise addition (2 ml portions) of DIPEA (8.88 ml, 50.8 mmol) over 1 hour. After stirring for a further hour, the reaction mixture was poured into water (450 ml) and EtOAc (450 ml). The aqueous phase was acidified with 5M HCl (50 ml) and the layers were separated. The organic portion was washed with 2M NaOH (200 ml), water (4 x 200 ml), brine (2 x 100 ml), dried over $MgSO_4$, filtered and concentrated *in vacuo* to afford a brown solid. Purification of the solid by chromatography on silica (220 g pre-packed silica cartridge) eluting with 0 - 50 % EtOAc in iso-hexane afforded the racemate, 3-amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid (3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide (Ex. 4)as a yellow solid;
1 H NMR (400 MHz, DMSO-d6) δ 8.3 (1 H, t), 7.7 (1 H, s), 6.7 (2H, s), 6.2 (1 H, s), 3.9 (3H, s),3.7 (1 H, m), 3.5 (1 H, m), 1.2 (3H, s).
LC-MS: Rt 1.24 min; MS m/z 362.4 [M+H]+; Method 2minLC_v003.

[0100] Chiral separation of the racemate by Supercritical Fluid Chromatography was carried out using the following conditions to afford the compounds listed hereinafter:

Mobile Phase: 12% 2-propanol + 0.1 % DEA / 50% CO_2

Column: Chiralcel OD-H, 250 x 10 mm id, 5 µm (2 columns linked in series)

Detection: UV @ 220nm

Flow rate: 10 ml/min

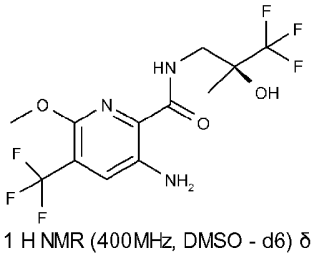
Sample concentration: 3.5 g in 30 ml EtOH

Injection volume: 100µl

Examples 5 and 6 are enantiomers.

<u>Example 5:</u> First eluted peak Rt = 7.30 minutes. 3-Amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid ((S)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide:

[0101]



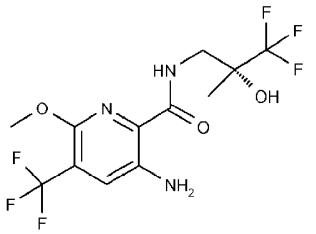
1 H NMR (400MHz, DMSO - d6) δ 8.3 (1 H, t), 7.6 (1 H, s), 6.6 (2H, broad), 6.2 (1 H, s), 3.9 (3H, s), 3.6 (1 H, m), 3.5 (1 H, m), 1.3 (3H, s);
LC-MS Rt = 1.15 mins, [M+H]+ 362.4 (Method 2minLC_v003).

Optical rotation $[\alpha]^{21}_D$ at 589 nm -20.83°(c= 0.513, MeOH).

[0102] The stereochemistry of this compound was confirmed by X-ray crystallography.

Example 6: Second eluted peak Rt = 8.29 minutes. 3-Amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid ((R)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide

[0103]



1 H NMR (400MHz, DMSO - d6) δ 8.3 (1 H, t), 7.6 (1 H, s), 6.6 (2H, broad), 6.2 (1 H, s), 3.9 (3H, s), 3.6 (1 H, m), 3.5 (1 H, m), 1.3 (3H, s);
LC-MS Rt = 1.15 mins [M+H]+ 362.4 (Method 2minLC_v003).

[0104] Alternatively, Example 5 may be prepared according to the following method:

To a solution of 3-amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid (Intermediate D) (10 g, 42.3 mmol) and (S)-3-amino-1,1,1-trifluoro-2-methylpropan-2-ol hydrochloride (Intermediate RA)(7.60 g, 42.3 mmol) in NMP (400 ml) was added HATU (19.3 g, 50.8 mmol) followed by dropwise addition of DIPEA (22.19 ml, 127 mmol) over ~1 hr. After stirring at room temperature for 30 min, the mixture was added to EtOAc (2 L), washed with 1 M NaOH (2 x 1 L), water (1 L), brine (1 L), dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product as a dark brown oil. Purification by chromatography on silica eluting with a gradient of 1 to-25% of EtOAc in iso-hexane afforded a yellow oil. Recrystallisation of the oil from iso-hexane/DCM afforded 3-amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid ((S)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide as a crystalline solid;

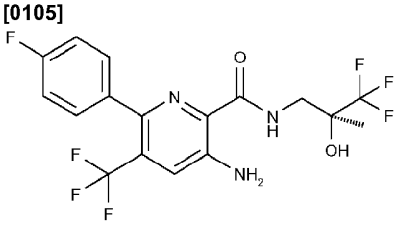
^{1}H NMR (400MHz, DMSO - d6) δ 8.28 (1 H, t), 7.66 (1 H, s), 6.67 (2H, s), 6.27 (1 H, s), 3.91 (3H, s), 3.65 (1 H, m), 3.45 (1 H, m), 1.24 (3H, s).

^{19}F NMR (376MHz, DMSO - d6) -62.58 ppm (s), -80.43 ppm (s)

Example 7

3-Amino-6-(4-fluoro-phenyl)-5-trifluoromethyl-pyridine-2-carboxylic acid ((S)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide.

[0105]



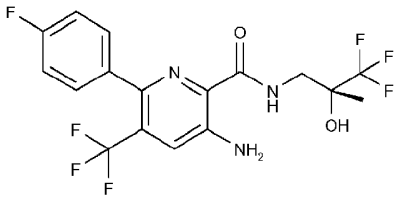
[0106] A mixture comprising 3-amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid ((S)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide (Ex. 3)(100 mg, 0.244 mmol), 4-fluorophenylboronic acid (37.5 mg, 0.268 mmol) and 1,1'bis(diphenylphosphoshio) ferrocenepalladium dichloride (19.90 mg, 0.024 mmol) was suspended in THF (2 ml) and 1 M Cs_2CO_3 (0.667 ml). The vial was flushed with N_2, sealed and heated at 160°C using microwave radiation for 15 minutes. The mixture was partitioned between

EtOAc (50ml) and water (50ml). The organic portion was separated and washed with brine (30ml), dried ($MgSO_4$), filtered through Celite® (filter material) and concentrated *in vacuo*. The crude residue was dissolved in DMSO (2ml) and purified by mass directed LCMS using MeCN/Water/0.1% TFA eluent to afford clean product. The product fraction obtained as MeCN/Water/0.1% TFA solution was poured into EtOAc (50 ml) and washed with saturated $NaHCO_3$ (50 ml) to free base the product. The organic portion were combined, dried ($MgSO_4$) and concentrated *in vacuo* to afford the title compound as a pale orange crystalline solid; 1 H NMR (400MHz, DMSO - d6) δ 8.4 (1 H, m), 7.7 (1 H, s), 7.49 (2H, m), 7.29 (2H, t), 7.2 (2H, br s), 6.22 (1 H, s), 3.68 (1 H, m), 3.44 (1 H, m), 1.22 (3H, s); LC-MS Rt 4.41 mins [M+H]+ 426 (Method 10minLC_v003).

Example 8

3-Amino-6-(4-fluoro-phenyl)-5-trifluoromethyl-pyridine-2-carboxylic acid ((R)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide.

[0107]

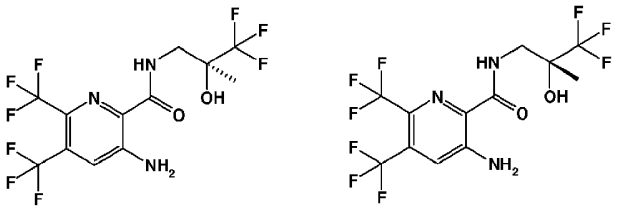


[0108] This compound was prepared from 3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid ((R)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide (Ex. 2) analogously to Example 8. 1 H NMR (400MHz, DMSO - d6) δ 8.42 (1 H, m), 7.7 (1 H, s), 7.5 (2H, m), 7.3 (2H, t), 7.21 (2H, br s), 6.24 (1 H, s), 3.68 (1 H, m), 3.44 (1 H, m), 1.22 (3H, s); LC-MS Rt = 4.39 mins [M+H]+ 426 (Method 10minLC_v003).

Example 16 and 17

3-Amino-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid ((S)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide and 3-Amino-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid ((R)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide

[0109]



<u>Step 1:</u> 3-(2,5-Dimethyl-pyrrol-1-yl)-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid (3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide

[0110] To a stirred solution of 3-(2,5-dimethyl-pyrrol-1-yl)-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid (Intermediate M) (1.16 g, 3.29 mmol) in NMP (32 ml) was added 3-Amino-1,1,1-trifluoro-2-methyl-propan-2-ol hydrochloride (commercially available) (591 mg, 3.29 mmol) followed by HATU (1.25 g, 3.29 mmol) and NEt_3 (918 ul, 6.59 mmol) and the reaction mixture was left to stir at RT. After 1h a further 0.2 equiv. NEt_3 was added. After 15 min a further 0.4 equiv. NEt_3 and 0.2 equiv. amine were added. After 30 min a further 0.1 equiv HATU was added. After 30 min most of the starting material had been consumed. The reaction mixture was

added to EtOAc (50 ml), washed with 0.1 M NaOH and the aqueous layer was back extracted with EtOAc (2 x 50 ml). The combined organic extracts were washed with water (2 x 150 ml), brine (100 ml), dried ($MgSO_4$) and concentrated *in vacuo* to give the crude product as an orange oil.

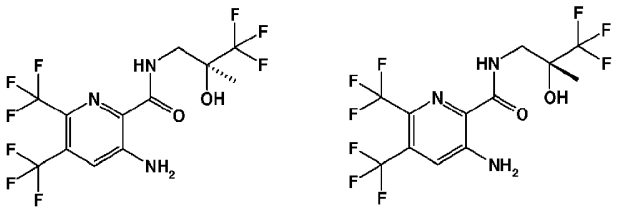
[0111] The crude material was purified by chromatography on silica eluting with 0-15% EtOAc in iso-hexane to afford the title product as a yellow solid; LC-MS Rt 1.32 min; MS m/z 478.2 [M+H]+; Method 2minLC_v003.

Step 2: 3-Amino-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid (3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide

[0112] To a stirred solution of 3-(2,5-dimethyl-pyrrol-1-yl)-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid (3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide (985 mg, 2.064 mmol) in 2:1 EtOH/H_2O (7.5 ml) was added hydroxylamine hydrochloride (1.43 g, 20.64 mmol) followed by NEt_3 (575 ml, 4.13 mmol). The reaction mixture was heated to reflux (~98 °C) for 11.5 hours and then allowed to cool to RT. The solvent was removed *in vacuo* and the resulting residue was partitioned between EtOAc (25 ml) and water (25 ml). The aqueous layer was separated and extracted with EtOAc (2 x 25 ml) and the combined organic extracts were washed with brine (50 ml), dried ($MgSO_4$) and concentrated *in vacuo*. The crude material was purified by chromatography on silica eluting with 0-25% EtOAc in iso-hexane to afford the title product as a pale yellow solid; LC-MS: Rt 1.24 min; MS m/z 400.0 [M+H]+; Method 2minLC_v003.

Step 3: 3-Amino-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid ((S)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide and 3-Amino-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid ((R)-3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide

[0113]



[0114] These compounds were prepared by chiral separation of 3-amino-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid (3,3,3-trifluoro-2-hydroxy-2-methyl-propyl)-amide;

Enantiomer 1: LC-MS Rt 1.23 min; MS m/z 400.0 [M+H]+; Method 2minLC_v003. SFC Retention Time 5.07 min.

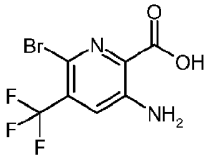
Enantiomer 2: LC-MS Rt 1.23 min; MS m/z 400.0 [M+H]+; Method 2minLC_v003. SFC Retention Time 5.13 min.

Preparation of Intermediates

Intermediate A

3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid

[0115]



Intermediate A1: 2-Bromo-3-nitro-5-trifluoromethyl-pyridine

[0116] 3-Nitro-5-(trifluoromethyl)pyridin-2-ol (31.00 g, 149 mmol) was dissolved in acetonitrile (250 ml) to give a dark brown solution. Phosphorus(V) oxybromide (85 g, 298 mmol) was added and the mixture was heated at reflux for 4.5 hours and then stirred at RT overnight. The reaction mixture was quenched by pouring into vigorously stirring water (600 ml) containing sodium hydrogencarbonate (110g). The dark brown mixture was extracted with DCM (3 x 200 ml) and the organic phase was washed with water (200ml) and brine (100ml), dried ($MgSO_4$) and concentrated *in vacuo* to afford the title product as a brown oil. ^{1}H-NMR: [400MHz, $CDCl_3$, δ_H 8.87 (1H, d, J = 1.4Hz, ArH), 8.39 (1H, d, J = 1.9Hz, ArH).

Intermediate A2: 3-Nitro-5-trifluoromethyl-pyridine-2-carbonitrile

[0117] 2-Bromo-3-nitro-5-trifluoromethyl-pyridine (10.00 g, 36.87 mmol) was dissolved in toluene (250 ml) with stirring to give a pale yellow solution. Tetrabutylammonium bromide (11.90 g, 36.9 mmol) was added followed by copper(I) cyanide (9.92 g, 111 mmol) and the mixture was heated at reflux for 10 h. After cooling to RT, the reaction mixture was partitioned between water (750 ml) and EtOAc (750ml). The organic fractions were combined, washed with water (2 x 250ml) and brine (100ml), dried ($MgSO_4$) and concentrated *in vacuo* to afford the title product. ^{1}H-NMR: [400MHz, DMSO-d_6 δ_H 9.55 (1 H, m, ArH), 9.24 (1 H, m, ArH)

Intermediate A3: 3-Amino-5-trifluoromethyl-pyridine-2-carboxylic acid methyl ester

[0118] 3-Nitro-5-trifluoromethyl-pyridine-2-carbonitrile (6.5 g, 29.9 mmol) was dissolved in EtOAc (150 ml) to give a pale yellow solution and placed under an atmosphere of nitrogen. 10 % Palladium on activated carbon (3.19 g, 2.99 mmol) was added and the reaction mixture stirred under an atmosphere of hydrogen for 18 hours. The reaction mixture was filtered and concentrated *in vacuo*. The crude residue was dissolved in HCl conc. (45 ml) and heated to reflux for 24 hours. The reaction mixture was allowed to cool to RT and concentrated *in vacuo*. The solid was dissolved in MeOH (300 ml) and sulfuric acid (14.4 ml) was added. The resulting solution was heated at reflux for 48 hours. The reaction was allowed to cool to RT, then neutralised by addition of 10% $NaHCO_{3(aq)}$ (600 ml). The product was extracted into DCM (3 x 200 ml) and the combined organic phases were washed with water (200ml), brine (50 ml), ($MgSO_4$) and concentrated *in vacuo*. The resulting solid was purified by chromatography on silica : Eluant gradient: isohexane (500 ml), 10% EtOAc in isohexane (1000 ml), 20% EtOAc in isohexane (1500 ml) to afford the titled compound as a pale yellow solid ^{1}H-NMR: [400MHz, DMSO-d_6, δ_H 8.13 (1 H, d, J = 1.7Hz, ArH), 7.60 (1 H, d, J = 1.3Hz, ArH), 7.01 (2H, br, NH_2), 3.85 (3H, s, $ArOCH_3$), m/z 221.1 $[M+H]^+$

Intermediate A4: 3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid methyl ester

[0119] 3-Amino-5-trifluoromethyl-pyridine-2-carboxylic acid methyl ester (9.49 g, 43.16 mmol) was suspended in water (300 ml). Sulfuric acid (4.60 ml, 86 mmol) was added followed by dropwise addition over 30 minutes of a solution of bromine (2.222 ml, 43.1 mmol) in acetic acid (29.6 ml, 517 mmol). The reaction mixture was stirred at RT for 18 hours. A further 100ml of water was added, followed by a further 0.25 equivalents of the bromine/AcOH mixture (550 µL bromine in 7.4ml AcOH) and the reaction mixture stirred at RT for an additional 90 minutes. The reaction mixture was diluted with 500ml water and neutralised by addition of solid $NaHCO_3$ (~85 g). The suspension was extracted with DCM (3 x 300 ml) and the combined organic phases washed with sat.$NaHCO_{3(aq)}$ (250 ml), water (250 ml) and brine (100 ml), dried ($MgSO_4$) and concentrated *in vacuo*. The crude material was recrystallised from boiling MeOH (~300 ml) to give the title product as a pale orange solid m/z 301.0 $[M+H]^+$ ^{1}H-NMR: [400MHz, DMSO-d_6 δ_H 7.77 (1 H, s, ArH), 7.17 (2H, s, NH_2), 3.86 (3H, s, $ArCO_2CH_3$).

Intermediate A: 3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid

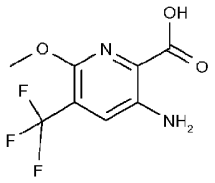
[0120] 3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid methyl ester (1.40 g, 4.68 mmol) was suspended in MeOH

(15 ml); Sodium hydroxide (2.0 M aqueous solution) (14.04 ml, 28.1 mmol) was added and the suspension was stirred at RT overnight. The mixture was concentrated *in vacuo* and the resulting residue was dissolved in water (100 ml) and then acidifed by the addition of 5.0M HCl(aq). The product was extracted into ethyl acetate (2 x 75 ml) and the combined organic extracts were washed with water (50 ml), brine (25 ml), dried ($MgSO_4$) and concentrated *in vacuo* to afford the title product as a yellow solid. ^{1}H-NMR: [400MHz, DMSO-d_6, δ_H 13.24 (1 H, br s, CO_2H), 7.74 (1 H, s, ArH), 7.17 92H, br s $ArNH_2$). m/z 285.1, 287.1 $[M+H]^+$

Intermediate D

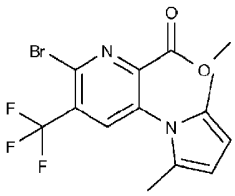
3-Amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid

[0121]



Intermediate D1: 6-Bromo-3-(2,5-dimethyl-pyrrol-1-yl)-5-trifluoromethyl-pyridine-2-carboxylic acid methyl ester

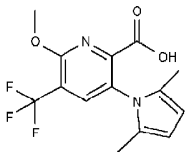
[0122]



3-Amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid methyl ester (Intermediate A4) (2 g, 6.69 mmol) was suspended in toluene (8 ml), and treated with p-toluenesulfonic acid (TsOH) (0.115 g, 0.669 mmol) and acetonylacetone (0.941 ml, 8.03 mmol). The reaction mixture was heated at reflux for 2 hours (using Dean-Stark apparatus) and allowed to cool to RT overnight. The resulting dark red/ black solution was concentrated *in vacuo* to remove toluene and the crude residue diluted with EtOAc(200 ml), washed with $NaHCO_3$ (50 ml), dried ($MgSO_4$) and concentrated *in vacuo* to give a brown solid. Purification of the solid by chromatography on silica eluting with EtOAc/iso-hexane afforded the title compound; LC-MS Rt = 5.58 min $[M+H]+$ 377/379 (Method 10minLC_v002).
1 H NMR (400 MHz, DMSO-d6) δ 8.50 (1 H, s), 7.77 (2H, s), 5.83 (3H, s), 1.90 (6H, s); 19F NMR (400 MHz, DMSO-d6) δ -62.26 (CF3, s).

Intermediate D2: 3-(2,5-Dimethyl-pyrrol-1-yl)-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid

[0123]



[0124] 6-Bromo-3-(2,5-dimethyl-pyrrol-1-yl)-5-trifluoromethyl-pyridine-2-carboxylic acid methyl ester (2 g, 5.30 mmol) was dissolved in MeOH (40 ml) and treated with 2M NaOH (20 ml) to give a suspension which was stirred at RT for 1h to afford a clear solution. The solvent was removed *in vacuo* and the resulting residue was acidified to pH1 with 5M HCl. The mixture was extracted with EtOAc (200 ml) and the organic extract was dried ($MgSO_4$) and concentrated *in vacuo* to afford the title compound as a dark

brown solid which was used in the next step without further purification; LC-MS Rt=1.50 min [M+H]+ 315.2.1/316.2 (Method 2minLC_v002);1H NMR (400 MHz, DMSO-d6) δ14.42-12.61 (COOH, b), 8.25 (1H, s), 5.84 (2H, s), 4.13 (3H, s), 1.97 (6H, s); 19F NMR (400 MHz, DMSO-d6) δ -62.43 (CF3, s).

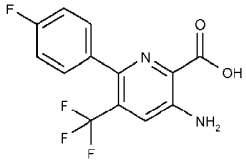
Intermediate D: 3-Amino-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid

[0125] 3-(2,5-Dimethyl-pyrrol-1-yl)-6-methoxy-5-trifluoromethyl-pyridine-2-carboxylic acid (2.1g , 6.68 mmol) was dissolved in EtOH (40 ml) and water (20 ml). To this mixture was added TEA (2.79 ml, 20.05 mmol) followed by hydroxylamine hydrochloride (4.64g, 66.8 mmol). The resulting mixture was heated at reflux for 5 hours. After cooling to RT, the mixture was diluted with EtOAc (100ml) and washed with aqueous HCl (1M, 100ml). The aqueous phase was back extracted with EtOAc (100ml) and the combined organic phases washed with brine (100ml), dried (MgSO4) and concentrated in vacuo to afford the product as an orange solid. The material can be used crude or recrystallised from isohexane-EtOAc (10:1) LC-MS Rt =1.0 min [M+H]+ 237 (Method 2minLC_v003)
1 H NMR (400 MHz, DMSO-d6) δ 8.5 (NH2, b), 7.70 (1 H, s), 3.89 (3H, s).

Reference Intermediate G

3-Amino-6-(4-fluoro-phenyl)-5-trifluoromethyl-pyridine-2-carboxylic acid

[0126]

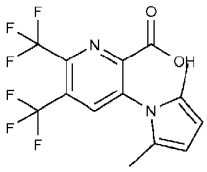


[0127] A mixture comprising 3-amino-6-bromo-5-trifluoromethyl-pyridine-2-carboxylic acid (Intermediate A) (1 g, 3.51 mmol), 4-fluorophenylboronic acid (0.736 g, 5.26 mmol) and 1,1'Bis(diphenylphosphoshio)ferrocene palladium dichloride (0.286 g, 0.351 mmol) and 1.0M Cs_2CO_3 (3.3ml) in THF (10 ml) was heated to reflux for 10 hours. After cooling to RT, the mixture was partitioned between DCM (100ml) and 1 M NaOH (2 x 100ml). The aqueous phase was acidified with 5M HCl and the resulting milky solution was extracted into DCM (2 x 100ml). The organic portion was separated, dried ($MgSO_4$) and concentrated *in vacuo* to afford the product as a crude oil. The crude material was purified by flash chromatography on silica cartridge eluting with a gradient of DCM: MeOH from 0% to 10% MeOH to afford the title product as a pale yellow solid;
^{1}H NMR (DMSO-d6, 400MHz) δ 12.9 (1 H, br s, COOH), 7.7 (1H, s, CH, Ar-H), 7.4 (2H, m, Ar-H), 7.25 (2H, m, Ar-H), 7.1 (2H, br s, NH2).

Intermediate M

3-(2,5-Dimethyl-pyrrol-1-yl)-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid

[0128]



Intermediate M1: 3-(2,5-Dimethyl-pyrrol-1-yl)-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid methyl ester

[0129] A stirred mixture of KF (2.12 g, 5.62 mmol) and CuI (0.490 g, 8.43 mmol) was heated in a sealed 10.0 - 20.0 ml microwave vial under vacuum until a slight greenish colour began to appear. The vial was then placed under nitrogen to cool. A solution 6-bromo-3-(2,5-dimethyl-pyrrol-1-yl)-5-trifluoromethyl-pyridine-2-carboxylic acid methyl ester (Intermediate D) (2.64 ml, 16.86 mmol) in 1:1 dry DMF/dry NMP (14 ml) was then added, followed by TMS-CF_3 (2.64 ml, 16.86 mmol). A new septum was then used to seal the vial and the reaction mixture was heated using microwave radiation with stirring at 100 °C for 3 h and allowed to cool. The mixture was added to 5M NH3 solution (50 ml) and then extracted with diethyl ether (4 x 50 ml). The combined organic extracts were washed with 5M NH_3 solution (3 x 20 ml), 1 M HCl (50 ml), sat. sodium bicarbonate solution (2 x 50 ml), brine (50 ml), dried ($MgSO_4$) and concentrated *in vacuo* to give a brown oil. The crude material was purified by chromatography on silica eluting with Iso-hexane / EtOAc, 0-10 % to afford the title compound as an orange solid; LC-MS Rt 1.37 min; MS m/z 367.1 [M+H]+; Method 2minLC_v003.

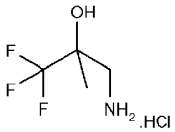
Intermediate M: 3-(2,5-Dimethyl-pyrrol-1-yl)-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid

[0130] To a stirred solution 3-(2,5-dimethyl-pyrrol-1-yl)-5,6-bis-trifluoromethyl-pyridine-2-carboxylic acid methyl ester (1.28 g, 3.49 mmol) in methanol (25 ml) was added 1 M NaOH (7 ml, 6.99 mmol) and the reaction mixture was left to stir at RT for 30 min. The solvent was removed *in vacuo* and water (20 ml) was added to the remaining residue. The pH was adjusted to pH 4/5 by the addition of 1 M HCl. The mixture was extracted with EtOAc (3 x 20 ml) and the combined organic extracts were washed with brine (30 ml), dried ($MgSO_4$) and concentrated *in vacuo* and dried in a vacuum oven (50 °C) overnight to give the crude title product as an orange solid which was used without further purification; LC-MS: Rt 1.23 min; MS m/z 353.1 [M+H]+; Method 2minLC_v003.

Intermediate R

3-Amino-1,1,1-trifluoro-2-methylpropan-2-ol hydrochloride

[0131]



Step 1: 1,1,1-trifluoro-2-methyl-3-nitropropan-2-ol

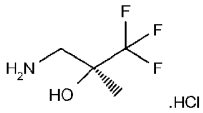
[0132] To LiOH (0.193 g, 8.06 mmol) in a 3-neck roundbottom flask was added water (25 ml), nitromethane (3.76 ml, 81 mmol) and trifluoroacetone (7.95 ml, 89 mmol). Cetyltrimethylammonium chloride (3.8 g, 10.88 mmol) and $MgSO_4$ (1.9 g, 16.12 mmol) were added and the resulting yellow solution stirred at 20-25 °C for 2 days. The reaction mixture was poured into diethyl ether (120 ml) and washed with water (3x 200 ml) and brine (1x 100 ml). The organic portion was dried over $MgSO_4$ and concentrated *in vacuo* to afford the title compound as a yellow liquid. 1 H NMR ($CDCl_3$, 400 MHz): δ 4.7 (1 H d), δ 4.5 (1H, d), δ 3.7 (1H, broad), δ 1.6 (3H, s). Step 2: 3-Amino-1,1,1-trifluoro-2-methylpropan-2-ol hydrochloride

[0133] Pd/C was added (1 g) to a 200 ml glass vessel. Ethanol (50 ml, dry) was added cautiously under an atmosphere of CO_2. 1,1,1-Trifluoro-2-methyl-3-nitropropan-2-ol (10 g, 57.8 mmol) was dissolved in ethanol (50 ml, dry) and added to the glass vessel. The reaction mixture was put under a positive pressure of hydrogen (5 bar) at room temperature and hydrogenated for 2 days. The reaction mixture was filtered through Celite®(filter material) and washed with excess ethanol. The solvent was removed *in vacuo* to yield a colourless oil. The oil was dissolved in MeOH (50 ml) and treated dropwise with HCl (1 M) in MeOH (30 ml). The solution was left to stir for 30 minutes and concentrated *in vacuo* azeotroping with MeCN to afford the title compound as a waxy white solid; 1 H NMR (DMSO-d6, 400MHz) δ 8.3 (3H, broad s), 6.9 (1 H, broad), 3.0 (2H, q), 1.4 (3H, s).

Intermediate RA

(S)-3-Amino-1,1,1-trifluoro-2-methylpropan-2-ol hydrochloride

[0134]



Step 1: Benzyl 3,3,3-trifluoro-2-hydroxy-2-methylpropylcarbamate

[0135] To a stirring suspension of amino-1,1,1-trifluoro-2-methylpropan-2-ol hydrochloride (Intermediate R) (1.5 g, 8.35 mmol) in DCM (50 ml) was added TEA 93.54 g, 35.0 mmol) followed by benzyl 2,5-dioxopyrrolidin-1-yl carbonate (1.983 g, 7.96 mmol). The mixture was stirred at RT for 6 hours and then diluted with water. The organic portion was separated using a phase separator and concentrated *in vacuo*. Purification by chromatography on silica eluting with 0-70% EtOAc in iso-hexane afforded the title product; 1 H NMR (400 MHz, DMSO-d6) δ 7.34 (6H, m), 5.98 (1 H, s), 5.05 (2H, s), 3.31 (1 H, m), 3.18 (1H, m), 1.21 (3H. s)LC-MS: Rt 1.05 min; MS m/z 278.1 [M+H]+; Method 2minLC_v003.

Step 2: Separation of Enantiomers of benzyl 3,3,3-trifluoro-2-hydroxy-2-methyl propylcarbamate

[0136] Benzyl 3,3,3-trifluoro-2-hydroxy-2-methylpropylcarbamate (1.7 g) was dissolved in 2-propanol (10 ml) and purified using the following chromatographic conditions:

Mobile Phase: 10% 2-propanol / 90% CO_2

Column: 2 x Chiralcel OJ-H, 250 x 10 mm id, 5 µm (columns coupled in series)

Detection: UV @ 220nm

Flow rate: 10 ml/min

Sample concentration: 1.7 g in 10 ml 2-propanol

Injection volume: 75µl

First eluted peak: Rt = 6.94 minutes (R)-benzyl 3,3,3-trifluoro-2-hydroxy-2-methyl propylcarbamate

Second eluted peak: Rt = 8.04 minutes (S)-benzyl 3,3,3-trifluoro-2-hydroxy-2-methyl propylcarbamate (Stereochemistry confirmed by analysis of final compound prepared by subsequent steps)

Step 3: (S)-3-Amino-1,1,1-trifluoro-2-methylpropan-2-ol hydrochloride

[0137] A mixture comprising (S)-benzyl 3,3,3-trifluoro-2-hydroxy-2-methyl propylcarbamate in EtOH(165 ml) was pumped through a H-Cube (hydrogenation reactor, 1-2 ml/min, 1 bar pressure, RT) for 8 hours using a 10% palladium on carbon catalyst cartridge. 1.25 M HCl in methanol (130 ml) was added to the mixture was stirred for 30mins. The solvent was removed *in vacuo* azeotroping with MeCN to afford the title product as a white powder; 1 H NMR (400 MHz, DMSO-d6) δ 8.3 (3H, broad), 6.8 (1 H, s), 3.0 (2H, s), 1.5 (3H, s).

[0138] Alternatively, racemic 3-Amino-1,1,1-trifluoro-2-methylpropan-2-ol can be resolved into separate enantiomers by recrystallistion with either (S)-Mandelic acid or L-tartaric acid in isopropanol or ethanol.

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This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

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PATENTKRAV

1. Forbindelse til anvendelse ved behandling af kronisk obstruktiv lungesygdom valgt blandt:

3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;

3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;

3-amino-6-(4-fluor-phenyl)-5-trifluormethyl-pyridin-2-carboxylsyre (3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;

3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid; og

3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;

eller et farmaceutisk acceptabelt salt deraf.

2. Forbindelsen 3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, til anvendelse ved behandling af kronisk obstruktiv lungesygdom.

3. Forbindelsen 3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, til anvendelse ved behandling af kronisk obstruktiv lungesygdom.

4. Forbindelsen 3-amino-6-(4-fluor-phenyl)-5-trifluormethyl-pyridin-2-carboxylsyre (3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, til anvendelse ved behandling af kronisk obstruktiv lungesygdom.

5. Forbindelsen 3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, til anvendelse ved behandling af kronisk obstruktiv lungesygdom.

6. Forbindelsen 3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, til anvendelse ved behandling af kronisk obstruktiv lungesygdom.

7. Farmaceutisk sammensætning til anvendelse ved behandling af kronisk obstruktiv lungesygdom, omfattende:
en forbindelse valgt blandt:
3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
3-amino-6-(4-fluor-phenyl)-5-trifluormethyl-pyridin-2-carboxylsyre (3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid; og
3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
eller et farmaceutisk acceptabelt salt deraf og
ét eller flere farmaceutisk acceptable excipienser.

8. Farmaceutisk sammensætning til anvendelse ifølge krav 7, hvor sammensætningen omfatter forbindelsen 3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, og ét eller flere farmaceutisk acceptable excipienser.

9. Farmaceutisk sammensætning til anvendelse ifølge krav 7, hvor sammensætningen omfatter forbindelsen 3-Amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, og ét eller flere farmaceutisk acceptable excipienser.

10. Farmaceutisk sammensætning til anvendelse ifølge krav 7, hvor sammensætningen omfatter forbindelsen 3-Amino-6-(4-fluor-phenyl)-5-trifluormethyl-pyridin-2-carboxylsyre (3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, og ét eller flere farmaceutisk acceptable excipienser.

11. Farmaceutisk sammensætning til anvendelse ifølge krav 7, hvor sammensætningen omfatter forbindelsen 3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, og ét eller flere farmaceutisk acceptable excipienser.

12. Farmaceutisk sammensætning til anvendelse ifølge krav 7, hvor sammensætningen omfatter forbindelsen 3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf, og ét eller flere farmaceutisk acceptable excipienser.

13. Anvendelse af en forbindelse eller et farmaceutisk acceptabelt salt deraf, valgt blandt:
3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
3-amino-6-(4-fluor-phenyl)-5-trifluormethyl-pyridin-2-carboxylsyre (3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid; og
3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid,
til fremstillingen af et medikament til anvendelse ved behandling af kronisk obstruktiv lungesygdom.

14. Anvendelse af en forbindelse eller et farmaceutisk acceptabelt salt deraf, ifølge krav 13, hvor forbindelsen er 3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid.

15. Anvendelse af en forbindelse eller et farmaceutisk acceptabelt salt deraf, ifølge krav 13, hvor forbindelsen er 3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid.

16. Anvendelse af en forbindelse eller et farmaceutisk acceptabelt salt deraf, ifølge krav 13, hvor forbindelsen er 3-amino-6-(4-fluor-phenyl)-5-trifluormethyl-pyridin-2-carboxylsyre (3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid.

17. Anvendelse af en forbindelse eller et farmaceutisk acceptabelt salt deraf, ifølge krav 13, hvor forbindelsen er 3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid.

18. Anvendelse af en forbindelse eller et farmaceutisk acceptabelt salt deraf, ifølge krav 13, hvor forbindelsen er 3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid.

19. Farmaceutisk kombination til anvendelse ved behandlingen af kronisk obstruktiv lungesygdom, omfattende:
et første aktivt stof omfattende en forbindelse valgt blandt:
3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
3-amino-6-(4-fluor-phenyl)-5-trifluormethyl-pyridin-2-carboxylsyre (3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid;
3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid; og
3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid, eller et farmaceutisk acceptabelt salt deraf og
et andet aktivt stof valgt blandt osmotiske midler, ENaC blokkere, anti-inflammatoriske midler, bronchodilatoriske midler, antihistamin-midler, anti-tussive midler, antibiotiske midler og DNase medikamentstoffer, hvor det første og andet aktive stof kan foreligge i den samme eller forskellige farmaceutiske sammensætninger.

20. Farmaceutisk kombination til anvendelse ifølge krav 19, hvor det første aktive stof er 3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid eller et farmaceutisk acceptabelt salt deraf.

21. Farmaceutisk kombination til anvendelse ifølge krav 19, hvor det første aktive stof er 3-amino-6-methoxy-5-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid eller et farmaceutisk acceptabelt salt deraf.

22. Farmaceutisk kombination til anvendelse ifølge krav 19, hvor det første aktive stof er 3-amino-6-(4-fluor-phenyl)-5-trifluormethyl-pyridin-2-carboxylsyre (3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid eller et farmaceutisk acceptabelt salt deraf.

23. Farmaceutisk kombination til anvendelse ifølge krav 19, hvor det første aktive stof er 3-Amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((S)-3,3,3-trifluor-2-hydroxy-2-

methyl-propyl)-amid eller et farmaceutisk acceptabelt salt deraf.

24. Farmaceutisk kombination til anvendelse ifølge krav 19, hvor det første aktive stof er 3-amino-5,6-bis-trifluormethyl-pyridin-2-carboxylsyre ((R)-3,3,3-trifluor-2-hydroxy-2-methyl-propyl)-amid eller et farmaceutisk acceptabelt salt deraf.