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(71) Applicants (for all designated States except US): **ASTRAZENECA AB** [SE/SE]; S-151 85 Sodertälje (SE). **ARGENTA DISCOVERY LIMITED** [GB/GB]; 8/9 Spire Green Centre, Flex Meadow, Harlow, Essex CM19 5TR (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **FORD, Rhonan, Lee** [GB/GB]; AstraZeneca, Bakewell Road, Loughborough, Leicestershire LE11 5RH (GB). **MATHER, Andrew, Nigel** [GB/GB]; AstraZeneca, Bakewell Road, Loughborough, Leicestershire LE11 5RH (GB). **METE, Antonio** [IT/GB]; AstraZeneca, Bakewell Road, Loughborough, Leicestershire LE11 5RH (GB). **BULL, Richard, James** [GB/GB]; Argenta Discovery Limited, 8/9 Spire Green Centre, Flex Meadow, Harlow, Essex CM19 5TR (GB). **SKIDMORE, Elizabeth, Anne**

[GB/GB]; Argenta Discovery Limited, 8/9 Spire Green Centre, Flex Meadow, Harlow, Essex CM19 5TR (GB).

(74) Agent: **STANSFIELD, Kevin**; AstraZeneca AB, Global Intellectual Property, SE-151 85 Södertälje (SE).

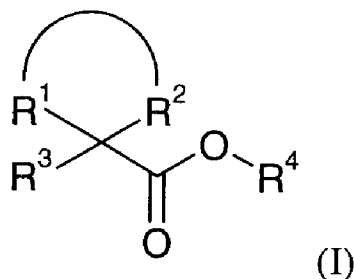
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(54) Title: QUINUCLIDINE DERIVATIVES AS MUSCARINIC M3 RECEPTOR ANTAGONISTS



(57) Abstract: The invention provides named compounds of formula (I), wherein R4 is a N- substituted quinuclidine (I) pharmaceutical compositions containing them and a process for preparing the pharmaceutical compositions. Their use in therapy for the treatment of conditions mediated by M3 muscarinic receptors, such as chronic obstructive pulmonary disease is also disclosed.

QUINUCLIDINE DERIVATIVES AS MUSCARINIC M3 RECEPTOR ANTAGONISTS

NEW COMPOUNDS 273

The present invention relates to cycloalkyl-substituted alkyl esters of polycyclic aminic
5 alcohols, a process for their preparation, pharmaceutical compositions containing them
process for preparing pharmaceutical compositions, their use in therapy and intermedi-
of use in their preparation.

Background to the Invention

10 Muscarinic receptors are a G-protein coupled receptor (GPCR) family having five fam-
members M₁, M₂, M₃, M₄ and M₅. Of the five muscarinic subtypes, three (M₁, M₂ and
are known to exert physiological effects on human lung tissue.

15 Parasympathetic nerves are the main pathway for reflex bronchoconstriction in human
airways and mediate airway tone by releasing acetylcholine onto muscarinic receptors
Airway tone is increased in patients with respiratory disorders such as asthma and chro-
obstructive pulmonary disease (COPD), and for this reason muscarinic receptor antago-
have been developed for use in treating airway diseases. Muscarinic receptor antagoni-
20 often called anticholinergics in clinical practice, have gained widespread acceptance as
first-line therapy for individuals with COPD, and their use has been extensively review-
in the literature (e.g. Lee et al, Current Opinion in Pharmacology 2001,1, 223-229).

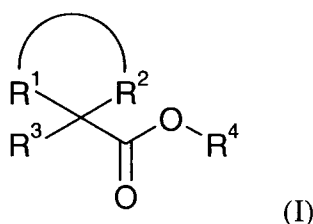
When used to treat respiratory disorders, muscarinic receptor antagonists are typically
25 administered by inhalation. However, when administered by inhalation a significant
proportion of the muscarinic receptor antagonist is often absorbed into the systemic
circulation resulting in reported side effects such as dry mouth. Additionally, the major-
of muscarinic antagonists have a relatively short duration of action requiring that they
administered several times a day. Such a multiple-daily dosing regime is not only
30 inconvenient to the patient but also creates a significant risk of inadequate treatment due
patient non-compliance associated with the frequent repeat dosing schedule.

There therefore remains a need for novel compounds that are capable of blocking muscarinic receptors. In particular, a need exists for new muscarinic antagonists that have high potency and reduced systemic side effects when administered by inhalation.

Moreover, a need exists for new muscarinic antagonists that exhibit a long duration of action when dosed by inhalation, and which are amenable to either once or twice daily dosing.

WO 98/04517 describes arylcyclopropane, arylcyclobutane, arylcyclopentane and arylcyclohexane carboxylic esters having antimuscarinic activity on the urinary bladder smooth muscle.

Our co-pending application PCT/GB2007/004350 relates to compounds of formula (I)

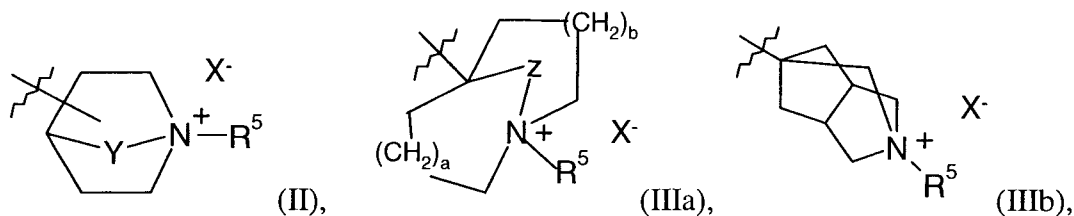


wherein

R^1 and R^2 together with the carbon atom to which they are both directly attached form a membered aliphatic carbocyclic ring which may be optionally substituted by one or more substituents independently selected from halogen, hydroxyl, C_{1-6} alkoxy, NH_2 , $NH(C_{1-6} \text{ alkyl})$, $N(C_{1-6} \text{ alkyl})_2$ and C_{1-6} alkyl which C_{1-6} alkyl may be optionally substituted by one or more substituents independently selected from halogen and hydroxyl;

R^3 represents phenyl or a 5 to 6 membered heteroaryl ring, each of which may be optionally substituted by one or more substituents independently selected from halogen, cyano, nitro, SH , $S(O)_{0-2}R^9$, $NR^{10}R^{11}$, $S(O)_2NR^{12}R^{13}$, $C(O)NR^{14}R^{15}$, $C(O)_2R^{16}$, $NR^{17}S(O)_2R^{18}$, $NR^{19}C(O)R^{20}$, $NR^{21}C(O)_2R^{22}$, $NR^{23}C(O)NR^{24}R^{25}$, OR^{26} and C_{1-6} alkyl which C_{1-6} alkyl may be optionally substituted by one or more substituents independently selected from halogen, hydroxyl, C_{1-6} alkoxy, NH_2 , $NH(C_{1-6} \text{ alkyl})$ and $N(C_{1-6} \text{ alkyl})_2$; R^4 represents a group of formula (II) or (IIIa) or (IIIb);

3



wherein

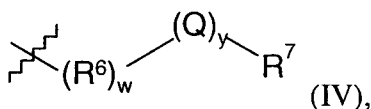
Y is $-\text{CH}_2-$, $-\text{CH}_2\text{CH}_2-$ or $-\text{CH}_2\text{CH}_2\text{CH}_2-$ and the substitution on the ring in group (II) may be in the 3 or 4 positions;

a is 1 or 2;

b is 1 or 2;

Z is $-\text{CH}_2-$;

R^5 represents a group of formula (IV)



wherein

w is 0 or 1;

R^6 represents C_{1-4} alkylene optionally substituted by one or more substituents independently selected from halogen, hydroxyl, C_{1-6} alkoxy, NH_2 , $\text{NH}(\text{C}_{1-6} \text{ alkyl})$ and $\text{N}(\text{C}_{1-6} \text{ alkyl})_2$;

when w is 0, y is 0; when w is 1, y is 0 or 1;

Q represents O, $\text{S}(\text{O})_{0-2}$, NR^8 , $-\text{CONR}^8-$, $-\text{SO}_2\text{NR}^8-$, $-\text{NR}^8\text{CO}-$, $-\text{NR}^8\text{SO}_2-$, $-\text{OC}(\text{O})-$, $-\text{C}(\text{O})\text{O}-$, $-\text{HC}=\text{CH}-$ or ethynylene;

R^7 represents a cyclic group Cyc^1 or a C_{1-4} alkyl group which C_{1-4} alkyl group may be optionally substituted by one or more substituents independently selected from halogen, hydroxyl, C_{1-4} alkoxy, NH_2 , $\text{NH}(\text{C}_{1-4} \text{ alkyl})$, $\text{N}(\text{C}_{1-4} \text{ alkyl})_2$, a cyclic group Cyc^2 and $-\text{OCyc}^2$; and R^7 may additionally represent hydrogen when Q represents O, NR^8 , $-\text{CONR}^8-$, $-\text{SO}_2\text{NR}^8-$, $-\text{C}(\text{O})\text{O}-$, $-\text{HC}=\text{CH}-$ or ethynylene;

Cyc^1 and Cyc^2 each independently represent aryl, heteroaryl, a 3 to 8 membered aliphatic carbocyclic ring or a 4 to 8 membered aliphatic heterocyclic ring, each of which may be optionally substituted by one or more substituents independently selected from halogen, hydroxyl, C_{1-6} alkoxy, NH_2 , $\text{NH}(\text{C}_{1-6} \text{ alkyl})$, $\text{N}(\text{C}_{1-6} \text{ alkyl})_2$, a cyclic group Cyc^3 and $-\text{OCyc}^3$;

wherein R^8 represents halogen, hydroxyl, C_{1-6} alkoxy, NH_2 , $\text{NH}(\text{C}_{1-6} \text{ alkyl})$, $\text{N}(\text{C}_{1-6} \text{ alkyl})_2$, a cyclic group Cyc^4 and $-\text{OCyc}^4$;

alkyl which phenyl or C₁₋₆ alkyl may be optionally substituted by one or more substituents independently selected from halogen, hydroxyl, C₁₋₆ alkoxy, NH₂, NH(C₁₋₆ alkyl) and N(C₁₋₆ alkyl)₂;

R⁸ represents hydrogen or C₁₋₆ alkyl;

5 R⁹ and R¹⁸ each independently represent C₁₋₆ alkyl, which C₁₋₆ alkyl may be optionally substituted by one or more substituents independently selected from halogen, hydroxyl, C₁₋₆ alkoxy, NH₂, NH(C₁₋₆ alkyl) and N(C₁₋₆ alkyl)₂; and

R¹⁰, R¹¹, R¹², R¹³, R¹⁴, R¹⁵, R¹⁶, R¹⁷, R¹⁹, R²⁰, R²¹, R²², R²³, R²⁴, R²⁵ and R²⁶ each independently represent hydrogen or C₁₋₆ alkyl, which C₁₋₆ alkyl may be optionally substituted by one or more substituents independently selected from halogen, hydroxyl, C₁₋₆ alkoxy, NH₂, NH(C₁₋₆ alkyl) and N(C₁₋₆ alkyl)₂; or any of R¹⁰ and R¹¹, R¹² and R¹³, R¹⁵ or R²⁴ and R²⁵, together with the nitrogen atom to which they are both attached, may form a 4 to 8 membered aliphatic heterocyclic ring, which heterocyclic ring may be optionally substituted by one or more substituents independently selected from halogen, hydroxyl and C₁₋₆ alkyl, which C₁₋₆ alkyl may be optionally substituted by one or more substituents independently selected from halogen and hydroxyl; and X represents a pharmaceutically acceptable anion of a mono or polyvalent acid.

Summary of the Invention

20 The present invention provides compounds falling within the scope of, but not specifically disclosed in, our co-pending application PCT/GB2007/004350 referred to above.

Thus, the present invention provides a compound which has a quaternary ammonium species selected from the group consisting of:

(*R*)-1-[(6-Methyl-pyridin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(6-Methyl-pyrazin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-[(6-trifluoromethyl-pyridazin-3-

(*R*)-1-(Benzo[*d*]isoxazol-3-ylcarbamoymethyl)-3-(1-phenyl-cycloheptanecarbonylox
azonia-bicyclo[2.2.2]octane X;

(*R*)-1-(Pyridazin-3-ylcarbamoymethyl)-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy
azonia-bicyclo[2.2.2]octane X;

5 (*R*)-1-[(5-Methyl-isoxazol-3-ylcarbamoymethyl)-methyl]-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(3-Methyl-isoxazol-5-ylcarbamoymethyl)-methyl]-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

10 (*R*)-1-[(3-Fluoro-phenylcarbamoymethyl)-methyl]-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(5-Methyl-pyrazin-2-ylcarbamoymethyl)-methyl]-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-(Benzo[*d*]isoxazol-3-ylcarbamoymethyl)-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

15 (*R*)-1-(Pyrazin-2-ylcarbamoymethyl)-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy)-1
azonia-bicyclo[2.2.2]octane X;

(*R*)-3-[1-(3-Fluoro-phenyl)-cycloheptanecarbonyloxy]-1-(pyrazin-2-ylcarbamoymeth
1-azonia-bicyclo[2.2.2]octane X;

20 (*R*)-3-[1-(3-Fluoro-phenyl)-cycloheptanecarbonyloxy]-1-(isoxazol-3-ylcarbamoymeth
1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoymethyl)-1-azoni
bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-4-ylcarbamoymethyl)-1-azoni
bicyclo[2.2.2]octane X;

25 (*R*)-1-[(5-Fluoro-pyridin-2-ylcarbamoymethyl)-methyl]-3-(1-phenyl-cycloheptanecarbonylo
1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(5-Methyl-pyridin-2-ylcarbamoymethyl)-methyl]-3-(1-phenyl-cycloheptanecarbonylc
1-azonia-bicyclo[2.2.2]octane X;

30 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-3-ylcarbamoymethyl)-1-azoni
bicyclo[2.2.2]octane X;

(*R*)-1-[(2-Methyl-pyridin-4-ylcarbamoymethyl)-methyl]-3-(1-phenyl-cycloheptanecarbonylc

(*R*)-1-Phenylcarbamoylmethyl-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-4-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane X;

5 (*R*)-1-[(2-Fluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(2,3-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

10 (*R*)-1-[2-(2,3-Dihydro-benzofuran-5-yl)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[2-(4-Fluoro-phenoxy)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-(pyridazin-4-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane X;

15 (*R*)-1-[(5-Fluoro-pyridin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-[2-(pyridin-3-yloxy)-ethyl]-1-azonia-bicyclo[2.2.2]octane X;

20 (*R*)-1-[(6-Methyl-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*o*-tolylcarbamoyl-methyl)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(2-pyrazin-2-yl-ethyl)-1-azonia-bicyclo[2.2.2]octane X;

25 (*S*)-1-(3-Phenoxy-propyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-{[2-(3-Fluoro-phenoxy)-ethylcarbamoyl]-methyl}-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

30 (*R*)-1-[(3,5-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[2-(4-methoxy-benzyloxy)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-(2-Phenethyloxy-ethyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(2,6-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

5 (*R*)-1-[(Methyl-phenyl-carbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[3-(4-Cyano-phenoxy)-propyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

10 (*R*)-1-[(2,5-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[2-(4-Cyano-benzyloxy)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-[(6-trifluoromethyl-pyridin-2-ylcarbamoymethyl)-1-azonia-bicyclo[2.2.2]octane X;

15 (*R*)-1-[(4-Methyl-pyridin-2-ylcarbamoymethyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(5-Chloro-pyridin-2-ylcarbamoymethyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

20 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*p*-tolylcarbamoymethyl)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*m*-tolylcarbamoymethyl)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-(Oxazol-2-ylcarbamoymethyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

25 (*R*)-1-[(6-Methyl-pyridazin-3-ylcarbamoymethyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-2-ylcarbamoymethyl)-1-azonia-bicyclo[2.2.2]octane X;

30 (*R*)-1-[(5-Cyano-pyridin-2-ylcarbamoymethyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-5-ylcarbamoymethyl)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(3-Fluoro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonylo
1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(3-Fluoro-pyridin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonylo
1-azonia-bicyclo[2.2.2]octane X;

5 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{2-[(pyrazine-2-carbonyl)-amino]-ethyl
azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-([1,2,4]thiadiazol-5-ylcarbamoylmethyl
azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{3-[(pyridine-2-carbonyl)-amino]-propy
10 azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(2-Methyl-pyrimidin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(6-Methyl-pyrimidin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

15 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{2-[(pyridine-2-carbonyl)-amino]-ethyl
azonia-bicyclo[2.2.2]octane X; and

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(3-pyridin-4-yl-propyl)-1-azonia-
bicyclo[2.2.2]octane X;

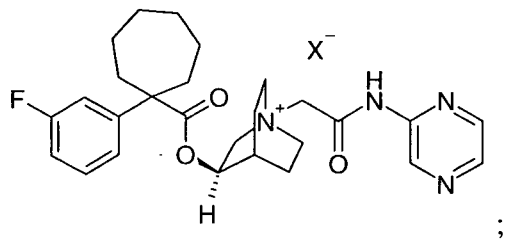
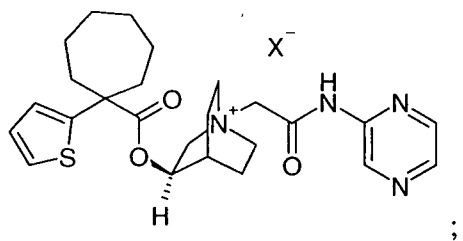
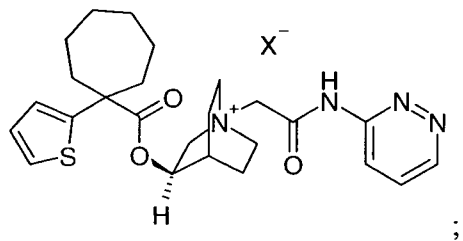
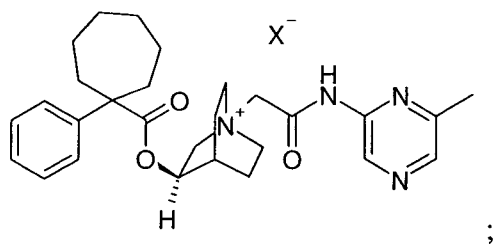
wherein X represents a pharmaceutically acceptable anion of a mono or polyvalent aci

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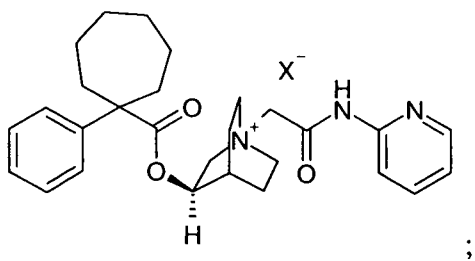
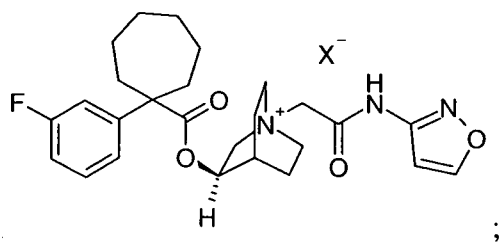
The compounds of formula (I), referred to above, and those of the present invention
comprise an anion X associated with the positive charge on the quaternary nitrogen at
The anion X may be any pharmaceutically acceptable anion of a mono or polyvalent (o
bivalent) acid. In an embodiment of the invention X may be an anion of a mineral acid
25 example chloride, bromide, iodide, sulfate, nitrate or phosphate; or an anion of a suitat
organic acid, for example acetate, maleate, fumarate, citrate, oxalate, succinate, tartrate
methanesulphonate, p-toluenesulphonate, benzenesulphonate, napadisylate (naphthalene
1,5-disulfonate) (e.g. a heminapadisylate), 2,5-dichlorobenzenesulphonate, 1-
hydroxynaphthalene-2-sulphonate or xinafoate (1-hydroxy-2-naphthoate).

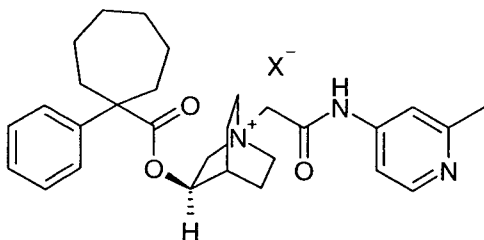
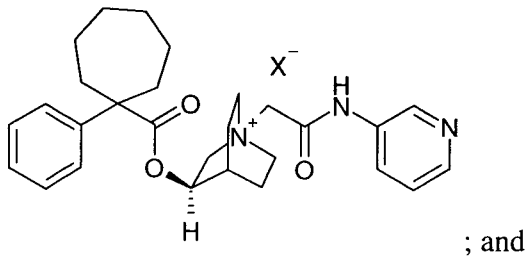
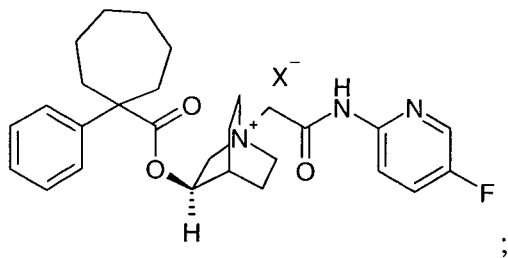
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According to the invention, there is also provided a compound selected from the group



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wherein X represents a pharmaceutically acceptable anion of a mono or polyvalent acid.

5

It will be understood that certain compounds of the present invention may exist in solvated forms, for example hydrated, as well as unsolvated forms. It is to be understood that the present invention encompasses all such solvated forms. Certain compounds of the present invention may exist as tautomers. Tautomers and mixtures thereof also form an aspect of the present invention.

10

The compounds of the present invention display beneficial pharmaceutical properties. For example, the compounds of the invention display activity as antagonists of muscarinic receptors, particularly muscarinic M₃ receptors. Moreover, the compounds also display desirable plasma protein binding properties. Plasma protein binding may be an advantageous property for compounds administered via inhalation as it can lessen the impact of any systemic effect the compound may have.

15

The compounds of the invention have activity as pharmaceuticals, in particular as

particular M3 antagonists. Diseases and conditions which may be treated with the compounds include:

1. *respiratory tract*: obstructive diseases of the airways including: asthma, including bronchial, allergic, intrinsic, extrinsic, exercise-induced, drug-induced (including aspirin and NSAID-induced) and dust-induced asthma, both intermittent and persistent and of severities, and other causes of airway hyper-responsiveness; chronic obstructive pulmonary disease (COPD); bronchitis, including infectious and eosinophilic bronchitis; emphysema; bronchiectasis; cystic fibrosis; sarcoidosis; farmer's lung and related diseases;

hypersensitivity pneumonitis; lung fibrosis, including cryptogenic fibrosing alveolitis, idiopathic interstitial pneumonias, fibrosis complicating anti-neoplastic therapy and chronic infection, including tuberculosis and aspergillosis and other fungal infections; complications of lung transplantation; vasculitic and thrombotic disorders of the lung vasculature, and pulmonary hypertension; antitussive activity including treatment of chronic cough associated with inflammatory and secretory conditions of the airways, and iatrogenic cough; acute and chronic rhinitis including rhinitis medicamentosa, and vasomotor rhinitis; perennial and seasonal allergic rhinitis including rhinitis nervosa (hay fever); nasal polyposis; acute viral infection including the common cold, and infection to respiratory syncytial virus, influenza, coronavirus (including SARS) and adenovirus;

2. *bone and joints*: arthritides associated with or including osteoarthritis/osteoarthrosis both primary and secondary to, for example, congenital hip dysplasia; cervical and lumbar spondylitis, and low back and neck pain; rheumatoid arthritis and Still's disease; seronegative spondyloarthropathies including ankylosing spondylitis, psoriatic arthritis, reactive arthritis and undifferentiated spondyloarthropathy; septic arthritis and other infection related arthropathies and bone disorders such as tuberculosis, including Potts' disease; Poncet's syndrome; acute and chronic crystal-induced synovitis including urate gout, calcium pyrophosphate deposition disease, and calcium apatite related tendon, bursal and synovial inflammation; Behcet's disease; primary and secondary Sjogren's syndrome; systemic sclerosis and limited scleroderma; systemic lupus erythematosus, mixed connective tissue disease, and undifferentiated connective tissue disease; inflammatory myopathies including dermatomyositis and polymyositis; polymyalgia rheumatica; juvenile arthritis including idiopathic inflammatory arthritides of whatever joint distribution and

including giant cell arteritis, Takayasu's arteritis, Churg-Strauss syndrome, polyarteritis nodosa, microscopic polyarteritis, and vasculitides associated with viral infection, hypersensitivity reactions, cryoglobulins, and paraproteins; low back pain; Familial Mediterranean fever, Muckle-Wells syndrome, and Familial Hibernian Fever, Kikuchi disease; drug-induced arthralgias, tendonitides, and myopathies;

3. *pain and connective tissue remodelling of musculoskeletal disorders due to injury example sports injury] or disease:* arthritides (for example rheumatoid arthritis, osteoarthritis, gout or crystal arthropathy), other joint disease (such as intervertebral disc degeneration or temporomandibular joint degeneration), bone remodelling disease (such as osteoporosis, Paget's disease or osteonecrosis), polychondritits, scleroderma, mixed connective tissue disorder, spondyloarthropathies or periodontal disease (such as periodontitis);

4. *skin:* psoriasis, atopic dermatitis, contact dermatitis or other eczematous dermatoses and delayed-type hypersensitivity reactions; phyto- and photodermatitis; seborrhoeic dermatitis, dermatitis herpetiformis, lichen planus, lichen sclerosus et atrophica, pyoderma gangrenosum, skin sarcoid, discoid lupus erythematosus, pemphigus, pemphigoid, epidermolysis bullosa, urticaria, angioedema, vasculitides, toxic erythemas, cutaneous eosinophilias, alopecia areata, male-pattern baldness, Sweet's syndrome, Weber-Christ syndrome, erythema multiforme; cellulitis, both infective and non-infective; panniculitis; cutaneous lymphomas, non-melanoma skin cancer and other dysplastic lesions; drug-induced disorders including fixed drug eruptions;

5. *eyes:* blepharitis; conjunctivitis, including perennial and vernal allergic conjunctivitis; anterior and posterior uveitis; choroiditis; autoimmune; degenerative or inflammatory disorders affecting the retina; ophthalmitis including sympathetic ophthalmitis; sarcoidosis; infections including viral, fungal, and bacterial;

6. *gastrointestinal tract:* glossitis, gingivitis, periodontitis; oesophagitis, including eosinophilic gastro-enteritis, mastocytosis, Crohn's disease, colitis including ulcerative colitis, proctitis, pruritis ani; coeliac disease, irritable bowel syndrome, and food-related allergies which may have effects remote from the gut (for example migraine, rhinitis and eczema);

7. *abdominal:* hepatitis, including autoimmune, alcoholic and viral; fibrosis and cirrhosis

8. *genitourinary*: nephritis including interstitial and glomerulonephritis; nephrotic syndrome; cystitis including acute and chronic (interstitial) cystitis and Hunner's ulcer; acute and chronic urethritis, prostatitis, epididymitis, oophoritis and salpingitis; vulvovaginitis; Peyronie's disease; erectile dysfunction (both male and female);
- 5 9. *allograft rejection*: acute and chronic following, for example, transplantation of kidney, heart, liver, lung, bone marrow, skin or cornea or following blood transfusion; chronic graft versus host disease;
- 10 10. *CNS*: Alzheimer's disease and other dementing disorders including CJD and nvCJ; amyloidosis; multiple sclerosis and other demyelinating syndromes; cerebral atherosclerosis and vasculitis; temporal arteritis; myasthenia gravis; acute and chronic (acute, intermittent or persistent, whether of central or peripheral origin) including vis-
pain, headache, migraine, trigeminal neuralgia, atypical facial pain, joint and bone pain
pain arising from cancer and tumor invasion, neuropathic pain syndromes including
diabetic, post-herpetic, and HIV-associated neuropathies; neurosarcoidosis; central and
15 peripheral nervous system complications of malignant, infectious or autoimmune processes;
11. other auto-immune and allergic disorders including Hashimoto's thyroiditis, Graves disease, Addison's disease, diabetes mellitus, idiopathic thrombocytopenic purpura, eosinophilic fasciitis, hyper-IgE syndrome, antiphospholipid syndrome;
- 20 12. other disorders with an inflammatory or immunological component; including acquired immune deficiency syndrome (AIDS), leprosy, Sezary syndrome, and paraneoplastic syndromes;
13. *cardiovascular*: atherosclerosis, affecting the coronary and peripheral circulation; pericarditis; myocarditis, inflammatory and auto-immune cardiomyopathies including
25 myocardial sarcoid; ischaemic reperfusion injuries; endocarditis, valvulitis, and aortitis including infective (for example syphilitic); vasculitides; disorders of the proximal and peripheral veins including phlebitis and thrombosis, including deep vein thrombosis and complications of varicose veins;
14. *oncology*: treatment of common cancers including prostate, breast, lung, ovarian,
30 pancreatic, bowel and colon, stomach, skin and brain tumors and malignancies affecting the bone marrow (including the leukaemias) and lymphoproliferative systems, such as

Hodgkin's and non-Hodgkin's lymphoma; including the prevention and treatment of metastatic disease and tumour recurrences, and paraneoplastic syndromes; and,
15. *gastrointestinal tract*: Coeliac disease, proctitis, eosinophilic gastro-enteritis, mastocytosis, Crohn's disease, ulcerative colitis, microscopic colitis, indeterminate
5 irritable bowel disorder, irritable bowel syndrome, non-inflammatory diarrhea, food-related allergies which have effects remote from the gut, e.g., migraine, rhinitis and eczema.

Accordingly, the present invention further provides a compound of the present invention
10 as hereinbefore defined, for use in therapy.

In another aspect, the invention provides the use of a compound of the present invention as hereinbefore defined, in the manufacture of a medicament for use in therapy.

15 In the context of the present specification, the term "therapy" also includes "prophylaxis" unless there are specific indications to the contrary. The terms "therapeutic" and "therapeutically" should be construed accordingly.

A further aspect of the invention provides a method of treating a disease state in a mammal
20 suffering from, or at risk of, said disease, which comprises administering to a mammal in need of such treatment a therapeutically effective amount of a compound of the present invention, as hereinbefore defined.

The present invention also provides a compound of the present invention, as hereinbefore
25 defined, for treating chronic obstructive pulmonary disease (COPD) (such as irreversible COPD).

The present invention also provides a compound of the present invention, as hereinbefore defined, for treating asthma.

The present invention also provides the use of a compound of the present invention, a hereinbefore defined, in the treatment of chronic obstructive pulmonary disease (COPD) (such as irreversible COPD).

5 The present invention also provides the use of a compound of the present invention, a hereinbefore defined, in the treatment of asthma.

The present invention also provides the use of a compound of the present invention, a hereinbefore defined, in the manufacture of a medicament for use in the treatment of
10 chronic obstructive pulmonary disease (COPD) (such as irreversible COPD).

The present invention also provides the use of a compound of the present invention, a hereinbefore defined, in the manufacture of a medicament for use in the treatment of asthma.

15 The present invention further provides a method of treating chronic obstructive pulmonary disease (COPD) (such as irreversible COPD), in a warm-blooded animal, such as man which comprises administering to a mammal in need of such treatment an effective amount of a compound of the present invention, as hereinbefore defined.

20 The present invention further provides a method of treating asthma in a warm-blooded animal, such as man, which comprises administering to a mammal in need of such treatment an effective amount of a compound of the present invention, as hereinbefore defined.

25 In order to use a compound of the invention for the therapeutic treatment of a warm-blooded animal, such as man, said ingredient is normally formulated in accordance with standard pharmaceutical practice as a pharmaceutical composition.

30 Therefore in another aspect the present invention provides a pharmaceutical composition that comprises a compound of the invention as hereinbefore defined and a

invention provides a process for the preparation of said composition, which comprises mixing active ingredient with a pharmaceutically acceptable adjuvant, diluent or carrier. Depending on the mode of administration, the pharmaceutical composition will, for example, comprise from 0.05 to 99%w (per cent by weight), such as from 0.05 to 80%
5 for example from 0.10 to 70%w, such as from 0.10 to 50%w, of active ingredient, all percentages by weight being based on total composition.

The pharmaceutical compositions of this invention may be administered in standard manner for the disease condition that it is desired to treat, for example by topical (such
10 to the lung and/or airways or to the skin), oral, rectal or parenteral administration. For these purposes the compounds of this invention may be formulated by means known in the art into the form of, for example, aerosols, dry powder formulations, tablets, capsules, syrups, powders, granules, aqueous or oily solutions or suspensions, (lipid) emulsions, dispersible powders, suppositories, ointments, creams, drops and sterile injectable aqueous
15 or oily solutions or suspensions.

A suitable pharmaceutical composition of this invention is one suitable for oral administration in unit dosage form, for example a tablet or capsule, which contains between 0.1mg and 1g of active ingredient.

20

In another aspect a pharmaceutical composition of the invention is one suitable for intravenous, subcutaneous or intramuscular injection. Each patient may receive, for example, an intravenous, subcutaneous or intramuscular dose of 0.01mgkg^{-1} to 100mg of the compound, for example in the range of 0.1mgkg^{-1} to 20mgkg^{-1} of this invention
25 composition being administered 1 to 4 times per day. The intravenous, subcutaneous or intramuscular dose may be given by means of a bolus injection. Alternatively the intravenous dose may be given by continuous infusion over a period of time. Alternatively each patient will receive a daily oral dose, which is approximately equivalent to the daily parenteral dose, the composition being administered 1 to 4 times per day

30

Another suitable pharmaceutical composition of this invention is one suitable for inha

compounds of the invention when treating respiratory diseases such as chronic obstructive pulmonary disease (COPD) or asthma. When administered by inhalation the compound of the present invention may be used effectively at doses in the μg range, for example 0.1 to 500 μg , 0.1 to 50 μg , 0.1 to 40 μg , 0.1 to 30 μg , 0.1 to 20 μg , 0.1 to 10 μg , 5 to 10 μg , 5 to 40 μg , 5 to 30 μg , 5 to 20 μg , 5 to 10 μg , 10 to 50 μg , 10 to 40 μg , 10 to 30 μg or 10 to 20 μg of active ingredient.

In an embodiment of the invention, there is provided a pharmaceutical composition comprising a compound of the invention as hereinbefore defined, in association with a pharmaceutically acceptable adjuvant, diluent or carrier, which is formulated for inhalation administration.

When administered by inhalation, metered dose inhaler devices may be used to administer the active ingredient, dispersed in a suitable propellant and with or without additional excipients such as ethanol, surfactants, lubricants or stabilising agents. Suitable propellants include hydrocarbon, chlorofluorocarbon and hydrofluoroalkane (e.g. heptafluoroalkane) propellants, or mixtures of any such propellants. Preferred propellants are P134a and F-gases, each of which may be used alone or in combination with other propellants and/or surfactant and/or other excipients. Nebulised aqueous suspensions or, preferably, solutions may also be employed, with or without a suitable pH and/or tonicity adjustment, either as unit-dose or multi-dose formulations.

Dry powder inhalers may be used to administer the active ingredient, alone or in combination with a pharmaceutically acceptable carrier, in the latter case either as a fine divided powder or as an ordered mixture. The dry powder inhaler may be single dose or multi-dose and may utilise a dry powder or a powder-containing capsule.

Metered dose inhaler, nebuliser and dry powder inhaler devices are well known and a variety of such devices are available.

The invention further relates to combination therapies wherein a compound of the

invention, is administered concurrently or sequentially or as a combined preparation with another therapeutic agent or agents, for the treatment of one or more of the conditions listed.

5 In particular, for the treatment of the inflammatory diseases such as (but not restricted to) rheumatoid arthritis, osteoarthritis, asthma, allergic rhinitis, chronic obstructive pulmonary disease (COPD), psoriasis, and inflammatory bowel disease, the compounds of the invention may be combined with agents listed below.

10 Non-steroidal anti-inflammatory agents (hereinafter NSAIDs) including non-selective cyclo-oxygenase COX-1 / COX-2 inhibitors whether applied topically or systemically (such as piroxicam, diclofenac, propionic acids such as naproxen, flurbiprofen, fenopiracetam, ketoprofen and ibuprofen, fenamates such as mefenamic acid, indomethacin, sulindac, azapropazone, pyrazolones such as phenylbutazone, salicylates such as aspirin); selective
15 COX-2 inhibitors (such as meloxicam, celecoxib, rofecoxib, valdecoxib, lumiracoxib, parecoxib and etoricoxib); cyclo-oxygenase inhibiting nitric oxide donors (CINODs); glucocorticosteroids (whether administered by topical, oral, intramuscular, intravenous or intra-articular routes); methotrexate; leflunomide; hydroxychloroquine; d-penicillamine; auranofin or other parenteral or oral gold preparations; analgesics; diacerein; intra-articular
20 therapies such as hyaluronic acid derivatives; and nutritional supplements such as glucosamine.

The present invention still further relates to the combination of a compound of the invention together with a cytokine or agonist or antagonist of cytokine function, (including
25 agents which act on cytokine signalling pathways such as modulators of the SOCS system including alpha-, beta-, and gamma-interferons; insulin-like growth factor type I (IGF) and interleukins (IL) including IL1 to 17, and interleukin antagonists or inhibitors such as anakinra; tumour necrosis factor alpha (TNF- α) inhibitors such as anti-TNF monoclonal antibodies (for example infliximab; adalimumab, and CDP-870) and TNF receptor
30 antagonists including immunoglobulin molecules (such as etanercept) and low-molecular weight agents such as pentoxifylline.

In addition the invention relates to a combination of a compound of the invention with monoclonal antibody targeting B-Lymphocytes (such as CD20 (rituximab), MRA-aIL and T-Lymphocytes, CTLA4-Ig, HuMax IL-15).

5 The present invention still further relates to the combination of a compound of the invention with a modulator of chemokine receptor function such as an antagonist of CCR1, CCR2, CCR2A, CCR2B, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10 and CCR11 (for the C-C family); CXCR1, CXCR2, CXCR3, CXCR4 and CXCR5 (for the C-X-C family) and CX3CR1 for the C-X₃-C family.

10

The present invention further relates to the combination of a compound of the invention with an inhibitor of matrix metalloprotease (MMPs), i.e., the stromelysins, the collagenases, and the gelatinases, as well as aggrecanase; especially collagenase-1 (MMP-1), collagenase-2 (MMP-8), collagenase-3 (MMP-13), stromelysin-1 (MMP-3),
15 stromelysin-2 (MMP-10), and stromelysin-3 (MMP-11) and MMP-9 and MMP-12, including agents such as doxycycline.

The present invention still further relates to the combination of a compound of the invention and a leukotriene biosynthesis inhibitor, 5-lipoxygenase (5-LO) inhibitor or
20 lipoxygenase activating protein (FLAP) antagonist such as; zileuton; ABT-761; fenleupoxalin; Abbott-79175; Abbott-85761; a N-(5-substituted)-thiophene-2-alkylsulfonamide; 2,6-di-tert-butylphenolhydrazones; a methoxytetrahydropyrans such as Zeneca ZD-2138; the compound SB-210661; a pyridinyl-substituted 2-cyanonaphthalene compound such as L-739,010; a 2-cyanoquinoline compound such as L-746,530; or an
25 indole or quinoline compound such as MK-591, MK-886, and BAY x 1005.

The present invention further relates to the combination of a compound of the invention and a receptor antagonist for leukotrienes (LT) B₄, LTC₄, LTD₄, and LTE₄ selected from the group consisting of the phenothiazin-3-ols such as L-651,392; amidino compounds
30 as CGS-25019c; benzoxalamines such as ontazolast; benzenecarboximidamides such as BIIL 284/260; and compounds such as zafirlukast, ablukast, montelukast, pranlukast,

The present invention still further relates to the combination of a compound of the invention and a phosphodiesterase (PDE) inhibitor such as a methylxanthanine including theophylline and aminophylline; a selective PDE isoenzyme inhibitor including a PDE inhibitor an inhibitor of the isoform PDE4D, or an inhibitor of PDE5.

The present invention further relates to the combination of a compound of the invention and a histamine type 1 receptor antagonist such as cetirizine, loratadine, desloratadine, fexofenadine, acrivastine, terfenadine, astemizole, azelastine, levocabastine, chlorpheniramine, promethazine, cyclizine, or mizolastine; applied orally, topically or parenterally.

The present invention still further relates to the combination of a compound of the invention and a proton pump inhibitor (such as omeprazole) or a gastroprotective histamine type 2 receptor antagonist.

The present invention further relates to the combination of a compound of the invention and an antagonist of the histamine type 4 receptor.

The present invention still further relates to the combination of a compound of the invention and an alpha-1/alpha-2 adrenoceptor agonist vasoconstrictor sympathomimetic agent, such as propylhexedrine, phenylephrine, phenylpropanolamine, ephedrine, pseudoephedrine, naphazoline hydrochloride, oxymetazoline hydrochloride, tetrahydrozoline hydrochloride, xylometazoline hydrochloride, tramazoline hydrochloride, or ethylnorepinephrine hydrochloride.

The present invention still further relates to the combination of a compound of the invention and a beta-adrenoceptor agonist (including beta receptor subtypes 1-4) such as isoprenaline, salbutamol, formoterol, salmeterol, terbutaline, orciprenaline, bitolterol mesylate, pirbuterol, or indacaterol or a chiral enantiomer thereof.

The present invention further relates to the combination of a compound of the invention and a chromone, such as sodium cromoglycate or nedocromil sodium.

5 The present invention still further relates to the combination of a compound of the invention with a glucocorticoid, such as flunisolide, triamcinolone acetonide, beclomethasone dipropionate, budesonide, fluticasone propionate, ciclesonide or mometasone furoate.

10 The present invention further relates to the combination of a compound of the invention with an agent that modulates a nuclear hormone receptor such as PPARs.

15 The present invention still further relates to the combination of a compound of the invention together with an immunoglobulin (Ig) or Ig preparation or an antagonist or antibody modulating Ig function such as anti-IgE (for example omalizumab).

The present invention further relates to the combination of a compound of the invention and another systemic or topically-applied anti-inflammatory agent, such as thalidomid a derivative thereof, a retinoid, dithranol or calcipotriol.

20 The present invention still further relates to the combination of a compound of the invention and combinations of aminosaliclates and sulfapyridine such as sulfasalazin mesalazine, balsalazide, and olsalazine; and immunomodulatory agents such as the thiopurines, and corticosteroids such as budesonide.

25 The present invention further relates to the combination of a compound of the invention together with an antibacterial agent such as a penicillin derivative, a tetracycline, a macrolide, a beta-lactam, a fluoroquinolone, metronidazole, an inhaled aminoglycosid antiviral agent including acyclovir, famciclovir, valaciclovir, ganciclovir, cidofovir, amantadine, rimantadine, ribavirin, zanamavir and oseltamavir; a protease inhibitor su
30 indinavir, nelfinavir, ritonavir, and saquinavir; a nucleoside reverse transcriptase inhib such as didanosine, lamivudine, stavudine, zalcitabine or zidovudine; or a non-nucleos

The present invention still further relates to the combination of a compound of the invention and a cardiovascular agent such as a calcium channel blocker, a beta-adrenoceptor blocker, an angiotensin-converting enzyme (ACE) inhibitor, an angioten
5 receptor antagonist; a lipid lowering agent such as a statin or a fibrate; a modulator of blood cell morphology such as pentoxifylline; thrombolytic, or an anticoagulant such platelet aggregation inhibitor.

The present invention further relates to the combination of a compound of the invention
10 and a CNS agent such as an antidepressant (such as sertraline), an anti-Parkinsonian drug (such as deprenyl, L-dopa, ropinirole, pramipexole, a MAOB inhibitor such as selegiline, a COMT inhibitor such as tasmar, an A-2 inhibitor, a dopamine reuptake inhibitor, an NMDA antagonist, a nicotine agonist, a dopamine agonist or an inhibitor neuronal nitric oxide synthase), or an anti-Alzheimer's drug such as donepezil,
15 rivastigmine, tacrine, a COX-2 inhibitor, propentofylline or metrifonate.

The present invention still further relates to the combination of a compound of the invention and an agent for the treatment of acute or chronic pain, such as a centrally or peripherally-acting analgesic (for example an opioid or derivative thereof), carbamazepine,
20 phenytoin, sodium valproate, amitriptyline or other anti-depressant agent-s, paracetamol or a non-steroidal anti-inflammatory agent.

The present invention further relates to the combination of a compound of the invention together with a parenterally or topically-applied (including inhaled) local anaesthetic agent
25 such as lignocaine or a derivative thereof.

A compound of the present invention can also be used in combination with an anti-osteoporosis agent including a hormonal agent such as raloxifene, or a bisphosphonate as alendronate.

30

The present invention still further relates to the combination of a compound of the

antagonist; (iii) interleukin converting enzyme (ICE) inhibitor; (iv) IMPDH inhibitor; adhesion molecule inhibitors including VLA-4 antagonist; (vi) cathepsin; (vii) kinase inhibitor such as an inhibitor of tyrosine kinase (such as Btk, Itk, Jak3 or MAP, for example Gefitinib or Imatinib mesylate), a serine / threonine kinase (such as an inhibitor of a MAP kinase such as p38, JNK, protein kinase A, B or C, or IKK), or a kinase involved in cell cycle regulation (such as a cyclin dependent kinase); (viii) glucose-6 phosphate dehydrogenase inhibitor; (ix) kinin-B1. - or B2. -receptor antagonist; (x) anti-gout agent for example colchicine; (xi) xanthine oxidase inhibitor, for example allopurinol; (xii) uricosuric agent, for example probenecid, sulfinpyrazone or benzbromarone; (xiii) growth hormone secretagogue; (xiv) transforming growth factor (TGF β); (xv) platelet-derived growth factor (PDGF); (xvi) fibroblast growth factor for example basic fibroblast growth factor (bFGF); (xvii) granulocyte macrophage colony stimulating factor (GM-CSF); (xviii) capsaicin cream; (xix) tachykinin NK1 or NK3 receptor antagonist such as NKP-608C SB-233412 (talnetant) or D-4418; (xx) elastase inhibitor such as UT-77 or ZD-0892; (xxi) TNF-alpha converting enzyme inhibitor (TACE); (xxii) induced nitric oxide synthase (iNOS) inhibitor; (xxiii) chemoattractant receptor-homologous molecule expressed on cells, (such as a CCR2 antagonist); (xxiv) inhibitor of P38; (xxv) agent modulating the function of Toll-like receptors (TLR), (xxvi) agent modulating the activity of purinergic receptors such as P2X7; or (xxvii) inhibitor of transcription factor activation such as NF κ B, API, or STATS.

A compound of the invention can also be used in combination with an existing therapeutic agent for the treatment of cancer, for example suitable agents include:

(i) an antiproliferative/antineoplastic drug or a combination thereof, as used in medical oncology, such as an alkylating agent (for example cis-platin, carboplatin, cyclophosphamide, nitrogen mustard, melphalan, chlorambucil, busulphan or a nitrosourea); an antimetabolite (for example an antifolate such as a fluoropyrimidine or 5-fluorouracil or tegafur, raltitrexed, methotrexate, cytosine arabinoside, hydroxyurea, gemcitabine or paclitaxel); an antitumour antibiotic (for example an anthracycline such as doxorubicin, bleomycin, doxorubicin, daunomycin, epirubicin, idarubicin, mitomycin or dactinomycin or mithramycin); an antimitotic agent (for example a vinca alkaloid such as

topoisomerase inhibitor (for example an epipodophyllotoxin such as etoposide, teniposide, irinotecan, topotecan or a camptothecin);

(ii) a cytostatic agent such as an antioestrogen (for example tamoxifen, toremifene, raloxifene, droloxifene or idoxifene), an oestrogen receptor down regulator (for example fulvestrant), an antiandrogen (for example bicalutamide, flutamide, nilutamide or cyproterone acetate), a LHRH antagonist or LHRH agonist (for example goserelin, leuporelin or buserelin), a progestogen (for example megestrol acetate), an aromatase inhibitor (for example as anastrozole, letrozole, vorazole or exemestane) or an inhibitor of 5 α -reductase such as finasteride;

(iii) an agent which inhibits cancer cell invasion (for example a metalloproteinase inhibitor like marimastat or an inhibitor of urokinase plasminogen activator receptor function);

(iv) an inhibitor of growth factor function, for example: a growth factor antibody (for example the anti-erbB2 antibody trastuzumab, or the anti-erbB1 antibody cetuximab [C225]), a farnesyl transferase inhibitor, a tyrosine kinase inhibitor or a serine/threonine

kinase inhibitor, an inhibitor of the epidermal growth factor family (for example an EGFR family tyrosine kinase inhibitor such as N-(3-chloro-4-fluorophenyl)-7-methoxy-6-(3-morpholinopropoxy)quinazolin-4-amine (gefitinib, AZD1839), N-(3-ethynylphenyl)-6-bis(2-methoxyethoxy)quinazolin-4-amine (erlotinib, OSI-774) or 6-acrylamido-N-(3-chloro-4-fluorophenyl)-7-(3-morpholinopropoxy)quinazolin-4-amine (CI 1033)), an inhibitor of the platelet-derived growth factor family, or an inhibitor of the hepatocyte growth factor family;

(v) an antiangiogenic agent such as one which inhibits the effects of vascular endothelial growth factor (for example the anti-vascular endothelial cell growth factor antibody bevacizumab, a compound disclosed in WO 97/22596, WO 97/30035, WO 97/32856 or WO 98/13354), or a compound that works by another mechanism (for example linomide or an inhibitor of integrin $\alpha v \beta 3$ function or an angiostatin);

(vi) a vascular damaging agent such as combretastatin A4, or a compound disclosed in WO 99/02166, WO 00/40529, WO 00/41669, WO 01/92224, WO 02/04434 or WO 02/082

(vii) an agent used in antisense therapy, for example one directed to one of the targets listed above, such as ISIS 2503, an anti-ras antisense;

(viii) an agent used in a gene therapy approach, for example approaches to replace abe

pro-drug therapy) approaches such as those using cytosine deaminase, thymidine kinase, a bacterial nitroreductase enzyme and approaches to increase patient tolerance to chemotherapy or radiotherapy such as multi-drug resistance gene therapy; or (ix) an agent used in an immunotherapeutic approach, for example ex-vivo and in-vivo approaches to increase the immunogenicity of patient tumour cells, such as transfection with cytokines such as interleukin 2, interleukin 4 or granulocyte-macrophage colony stimulating factor, approaches to decrease T-cell anergy, approaches using transfected immune cells such as cytokine-transfected dendritic cells, approaches using cytokine-transfected tumour cell lines and approaches using anti-idiotypic antibodies.

In a further embodiment the present invention provides a pharmaceutical product comprising, in combination, a first active ingredient which is a compound of the present invention, as hereinbefore described, and at least one further active ingredient selected from:-

- a phosphodiesterase inhibitor,
- a β_2 adrenoceptor agonist,
- a modulator of chemokine receptor function,
- an inhibitor of kinase function,
- a protease inhibitor,
- a steroidal glucocorticoid receptor agonist, and a
- a non-steroidal glucocorticoid receptor agonist.

The pharmaceutical product according to this embodiment may, for example, be a pharmaceutical composition comprising the first and further active ingredients in admixture. Alternatively, the pharmaceutical product may, for example, comprise the first and further active ingredients in separate pharmaceutical preparations suitable for simultaneous, sequential or separate administration to a patient in need thereof.

The pharmaceutical product of this embodiment is of particular use in treating respiratory diseases such as asthma, COPD or rhinitis.

Examples of a phosphodiesterase inhibitor that may be used in the pharmaceutical pro
according to this embodiment include a PDE4 inhibitor such as an inhibitor of the isoform
PDE4D, a PDE3 inhibitor and a PDE5 inhibitor. Examples include the compounds
(Z)-3-(3,5-dichloro-4-pyridyl)-2-[4-(2-indanyloxy-5-methoxy-2-pyridyl)]propenenitrile

5 N-[9-amino-4-oxo-1-phenyl-3,4,6,7-tetrahydropyrrolo[3,2,1-jk][1,4]benzodiazepin-3(yl)]pyridine-3-carboxamide (CI-1044)

3-(benzyloxy)-1-(4-fluorobenzyl)-N-[3-(methylsulphonyl)phenyl]-1H-indole-2-carboxamide,

(1S-exo)-5-[3-(bicyclo[2.2.1]hept-2-yloxy)-4-methoxyphenyl]tetrahydro-2(1H)-pyrimidinone (Atizoram),

10 N-(3,5-dichloro-4-pyridinyl)-2-[1-(4-fluorobenzyl)-5-hydroxy-1H-indol-3-yl]-2-oxoacetamide (AWD-12-281),

β -[3-(cyclopentyloxy)-4-methoxyphenyl]-1,3-dihydro-1,3-dioxo-2H-isoindole-2-propanamide (CDC-801),

15 N-[9-methyl-4-oxo-1-phenyl-3,4,6,7-tetrahydropyrrolo[3,2,1-jk][1,4]benzodiazepin-3(yl)]pyridine-4-carboxamide (CI-1018),

cis-[4-cyano-4-(3-cyclopentyloxy-4-methoxyphenyl)cyclohexane-1-carboxylic acid (Cilomilast)

8-amino-1,3-bis(cyclopropylmethyl)xanthine (Cipamfylline)

20 N-(2,5-dichloro-3-pyridinyl)-8-methoxy-5-quinolinecarboxamide (D-4418),

5-(3,5-di-tert-butyl-4-hydroxybenzylidene)-2-iminothiazolidin-4-one (Darbufelone),

2-methyl-1-[2-(1-methylethyl)pyrazolo[1,5-a]pyridin-3-yl]-1-propanone (Ibudilast),

2-(2,4-dichlorophenylcarbonyl)-3-ureidobenzofuran-6-yl methanesulphonate (Lirimila)

(-)-(R)-5-(4-methoxy-3-propoxyphenyl)-5-methyloxazolidin-2-one (Mesopram),

25 (-)-cis-9-ethoxy-8-methoxy-2-methyl-1,2,3,4,4a,10b-hexahydro-6-(4-diisopropylaminocarbonylphenyl)-benzo[c][1,6]naphthyridine (Pumafentrine),

3-(cyclopropylmethoxy)-N-(3,5-dichloro-4-pyridyl)-4-(difluoromethoxy)benzamide

(Roflumilast),
the N-oxide of Roflumilast,

30 5,6-diethoxybenzo[b]thiophene-2-carboxylic acid (Tibenelast)

2,3,6,7-tetrahydro-2-(mesitylimino)-9,10-dimethoxy-3-methyl-4H-pyrimido[6,1-

3-[[3-(cyclopentyloxy)-4-methoxyphenyl]-methyl]-N-ethyl-8-(1-methylethyl)-3H-pur
6-amine (V-11294A).

Examples of a β_2 -adrenoceptor agonist that may be used in the pharmaceutical product
according to this embodiment include metaproterenol, isoproterenol, isoprenaline,
5 albuterol, salbutamol (e.g. as sulphate), formoterol (e.g. as fumarate), salmeterol (e.g.
xinafoate), terbutaline, orciprenaline, bitolterol (e.g. as mesylate), pirbuterol or indaca
The β_2 -adrenoceptor agonist of this embodiment may be a long-acting β_2 -agonists, for
example salmeterol (e.g. as xinafoate), formoterol (e.g. as fumarate), bambuterol (e.g.
10 hydrochloride), carmoterol (TA 2005, chemically identified as 2(1H)-Quinolone, 8-
hydroxy-5-[1-hydroxy-2-[[2-(4-methoxy-phenyl)-1-methylethyl]-amino]ethyl]-
monohydrochloride, [R-(R*,R*)] also identified by Chemical Abstract Service Registr
Number 137888-11-0 and disclosed in U.S. Patent No 4,579,854), indacaterol (CAS n
312753-06-3; QAB-149), formanilide derivatives e.g. 3-(4-{[6-((2R)-2-[3-
15 (formylamino)-4-hydroxyphenyl]-2-hydroxyethyl)amino)hexyl]oxy}-butyl)-
benzenesulfonamide as disclosed in WO 2002/76933, benzenesulfonamide derivatives
3-(4-{[6-((2R)-2-hydroxy-2-[4-hydroxy-3-(hydroxy-methyl)phenyl]ethyl)amino]-
hexyl]oxy}butyl)benzenesulfonamide as disclosed in WO 2002/88167, aryl aniline
receptor agonists as disclosed in WO 2003/042164 and WO 2005/025555, indole
20 derivatives as disclosed in WO 2004/032921 and US 2005/222144, and compounds G
159797, GSK 159802, GSK 597901, GSK 642444 and GSK 678007.

Examples of a modulator of chemokine receptor function that may be used in the
pharmaceutical product according to this embodiment include a CCR1 receptor antagc
25

Examples of an inhibitor of kinase function that may be used in the pharmaceutical pro
according to this embodiment include a p38 kinase inhibitor and an IKK inhibitor.

Examples of a protease inhibitor that may be used in the pharmaceutical product accor
30 to this embodiment include an inhibitor of neutrophil elastase or an inhibitor of MMP1

Examples of a steroidal glucocorticoid receptor agonist that may be used in the pharmaceutical product according to this embodiment include budesonide, fluticasone (as propionate ester), mometasone (e.g. as furoate ester), beclomethasone (e.g. as 17-propionate or 17,21-dipropionate esters), ciclesonide, loteprednol (as e.g. etabonate), etiprednol (as e.g. dicloacetate), triamcinolone (e.g. as acetonide), flunisolide, zoticasone, flumoxonide, rofleponide, butixocort (e.g. as propionate ester), prednisolone, prednisolone tipredane, steroid esters e.g. 6 α ,9 α -difluoro-17 α -[(2-furanylcarbonyl)oxy]-11 β -hydroxy-16 α -methyl-3-oxo-androsta-1,4-diene-17 β -carbothioic acid S-fluoromethyl ester, 6 α ,9 α -difluoro-11 β -hydroxy-16 α -methyl-3-oxo-17 α -propionyloxy-androsta-1,4-diene-17 β -carbothioic acid S-(2-oxo-tetrahydro-furan-3S-yl) ester and 6 α ,9 α -difluoro-11 β -hydroxy-16 α -methyl-17 α -[(4-methyl-1,3-thiazole-5-carbonyl)oxy]-3-oxo-androsta-1,4-diene-17 β -carbothioic acid S-fluoromethyl ester, steroid esters according to DE 4129535, steroid esters according to WO 2002/00679, WO 2005/041980, or steroids GSK 870086, GSK 6856 and GSK 799943.

Examples of a modulator of a non-steroidal glucocorticoid receptor agonist that may be used in the pharmaceutical product according to this embodiment include those described in WO2006/046916.

The invention is illustrated by the following Examples. In the Examples the following Figures are presented:

Figure 1: X-ray powder diffraction pattern of Form A of Example 14.

Figure 2: X-ray powder diffraction pattern of Form A of Example 15.

In the examples the NMR spectra were measured on a Varian Unity Inova spectrometer with a proton frequency of either 300 or 400 or 500 MHz, or on a Bruker DRX spectrometer with a proton frequency of 400 or 500 MHz, or on a Bruker Avance spectrometer with a proton frequency of 600 MHz or on a Bruker Avance DPX 300 spectrometer with a proton frequency of 300 MHz. The MS spectra were measured on either an Agilent 1100 MSD G1946D spectrometer or a Hewlett Packard HP1100 MSD G1946A spectrometer or a

Waters Micromass ZQ2000 spectrometer. Names were generated using the Autonom (version 4.01.305) software supplied by MDL.

5 XRPD data were collected using either a PANalytical CubiX PRO machine or a PANalytical X-Pert machine.

XRPD – PANalytical CubiX PRO

Data was collected with a PANalytical CubiX PRO machine in θ - θ configuration over a scan range 2° to 40° 2θ with 100-second exposure per 0.02° increment. The X-rays were generated by a copper long-fine focus tube operated at 45kV and 40mA. The wavelength of the copper X-rays was 1.5418 \AA . The Data was collected on zero background holder on which ~ 2 mg of the compound was placed. The holder was made from a single crystal of silicon, which had been cut along a non-diffracting plane and then polished on an optically flat finish. The X-rays incident upon this surface were negated by Bragg extinction.

PANalytical X-Pert

Data was collected using a PANalytical X-Pert machine in 2θ - θ configuration over a scan range 2° to 40° 2θ with 100-second exposure per 0.02° increment. The X-rays were generated by a copper long-fine focus tube operated at 45kV and 40mA. The wavelength of the copper X-rays was 1.5418 \AA . The Data was collected on zero background holder on which ~ 2 mg of the compound was placed. The holder was made from a single crystal of silicon, which had been cut along a non-diffracting plane and then polished on an optically flat finish. The X-rays incident upon this surface were negated by Bragg extinction.

DSC thermograms were measured using a TA Q1000 Differential Scanning Calorimeter with aluminium pans and pierced lids. The sample weights varied between 0.5 to 5 mg. The procedure was carried out under a flow of nitrogen gas (50 mL/min) and the temperature studied from 25 to 300°C at a constant rate of temperature increase of 10°C per minute.

TGA thermograms were measured using a TA Q500 Thermogravimetric Analyser, with platinum pans. The sample weights varied between 1 and 5 mg. The procedure was carried out under a flow of nitrogen gas (60 mL/min) and the temperature studied from 100 to 300°C at a constant rate of temperature increase of 10°C per minute.

5

GVS profiles were measured using a Dynamic Vapour Sorption DVS-1 instrument. The solid sample ca. 1-5 mg was placed into a glass vessel and the weight of the sample was recorded during a dual cycle step method (40 to 90 to 0 to 90 to 0% relative humidity (RH), in steps of 10% RH).

10

Abbreviations used in the experimental section:

Aq = aqueous

DCE = 1,2-dichloroethane

DCM = dichloromethane

15

DMF = dimethylformamide

DMSO = Dimethylsulfoxide

EtOAc = ethyl acetate

EtOH = ethanol

GVS = Gravimetric vapour sorption

20

HATU = *O*-(7-Azabenzotriazol-1-yl)-*N,N,N',N'*-tetramethyluronium hexafluorophosphate

MeCN - Acetonitrile

MeOH = methanol

RT = RT

Rt = retention time

25

THF = tetrahydrofuran

Satd = saturated

DSC = Differential Scanning Calorimetry

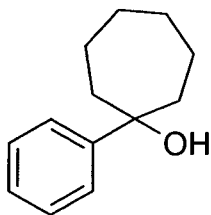
TGA = Thermogravimetric analysis

XRPD = X-Ray Powder Diffraction

30

Example 1: (*R*)-1-[(6-Methyl-pyridin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

a) 1-Phenyl-cycloheptanol

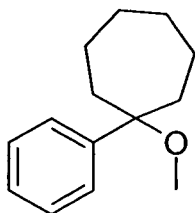


- 5 To magnesium (1.2 g) in anhydrous tetrahydrofuran (60 mL) under an environment of nitrogen was added a crystal of iodine followed by bromobenzene (7.85 g) at such a rate that the reaction maintained a steady reflux. The reaction mixture was stirred for 20 minutes then cycloheptanone (4.48 g) was added with care. After stirring for 10 minutes saturated aqueous ammonium chloride (10 mL) was added and the reaction was partitioned
- 10 between water (100 mL) and isohexane (100 mL). The organic layer was dried (MgSO₄) and evaporated to afford the sub-titled compound (7.6 g) as an oil.

¹H NMR (300 MHz, CDCl₃) δ 7.53 - 7.47 (m, 2H), 7.36 - 7.29 (m, 2H), 7.26 - 7.19 (m, 1H), 2.07 (ddd, 2H), 1.97 - 1.50 (m, 11H).

15

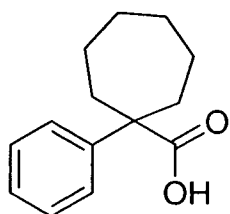
b) 1-Methoxy-1-phenyl-cycloheptane



- 1-Phenyl-cycloheptanol (Example 1a) (7.6 g) was dissolved in tetrahydrofuran (100 mL) and sodium hydride (60% in oil, 2.0 g) added. The reaction was stirred at 60°C for 5 minutes and iodomethane (7.1 g) added. The mixture was maintained at 60°C overnight and then further quantities of sodium hydride (60% in oil, 2.0 g) and iodomethane (7.1 g) were added and the reaction was refluxed for 70 hours. The reaction mixture was partitioned between water (100 mL) and isohexane (100 mL) and the organic layer
- 20

^1H NMR (300 MHz, CDCl_3) δ 7.43 - 7.37 (m, 2H), 7.37 - 7.30 (m, 2H), 7.24 - 7.19 (1H), 2.98 (s, 3H), 2.12 - 1.88 (m, 4H), 1.88 - 1.45 (m, 8H).

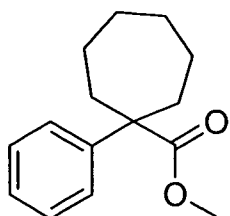
5 c) 1-Phenyl-cycloheptanecarboxylic acid



Potassium (2.62 g) and sodium (0.52 g) were heated together at 120°C in mineral oil under an environment of nitrogen for 30 minutes and then cooled to room temperature. The oil was removed and replaced with ether (100 mL) and 1-methoxy-1-phenyl-cycloheptane (Example 1b) (4.9 g) was added and the reaction was stirred under nitrogen overnight at room temperature. The reaction was cooled to -78°C and solid carbon dioxide (~20 g) was added with stirring. The reaction was allowed to warm to room temperature and water (150 mL) was added carefully under an environment of nitrogen. The aqueous layer was separated, neutralised with concentrated hydrochloric acid and extracted with diethyl ether (150 mL). The organic layer was dried (MgSO_4) and evaporated to afford the sub-title compound (4.15 g) as an oil.

^1H NMR (300 MHz, CDCl_3) δ 7.40 - 7.20 (m, 5H), 2.49 - 2.35 (m, 2H), 2.16 - 2.03 (m, 2H), 1.76 - 1.47 (m, 8H).

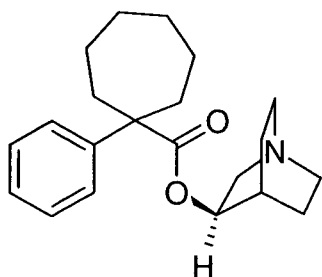
d) 1-Phenyl-cycloheptanecarboxylic acid methyl ester



1-Phenyl-cycloheptanecarboxylic acid (Example 1c) (4.15 g) was refluxed in methanol (150 mL) and concentrated hydrochloric acid (5 mL) for 24 hours. The solvent was evaporated and the residue was dissolved in ether (100 mL) which was washed with water (100 mL), saturated sodium bicarbonate (50 mL) and water (100 mL), dried (MgSO₄) and evaporated to afford the sub-titled compound (3.5 g) as an oil.

¹H NMR (300 MHz, CDCl₃) δ 7.37 - 7.18 (m, 5H), 3.63 (s, 3H), 2.47 - 2.35 (m, 2H), 2.08 - 1.97 (m, 2H), 1.70 - 1.48 (m, 8H).

e) 1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester

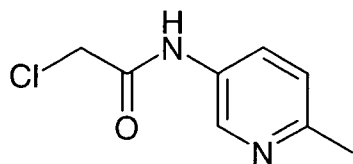


1-Phenyl-cycloheptanecarboxylic acid methyl ester (Example 1d) (1.0 g) and (*R*)-quinuclidin-3-ol (0.39 g) were refluxed in heptane (50 mL) containing sodium (~5 mg) and Dean and Stark apparatus for 24 hours. Heptane (20 mL) was replaced with toluene (20 mL) and the reflux was continued for 3 days. The reaction was partitioned between water (50 mL) and ether (50 mL) and the ether layer was separated, dried (MgSO₄) and evaporated. The crude product was purified by column chromatography on silica eluted with ethyl acetate / triethylamine (99/1) to afford the titled compound as an oil (0.83 g).

m/e 328 [M+H]⁺

¹H NMR (300 MHz, CDCl₃) δ 7.35 - 7.27 (m, 4H), 7.23 - 7.16 (m, 1H), 4.78 - 4.71 (m, 1H), 3.12 (ddd, 1H), 2.79 - 2.32 (m, 7H), 2.16 - 1.98 (m, 2H), 1.91 - 1.80 (m, 1H), 1.34 (m, 12H).

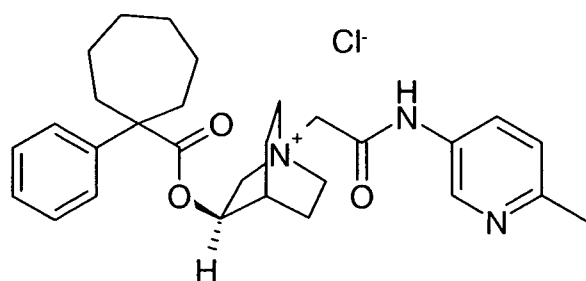
f) 2-Chloro-*N*-(6-methyl-pyridin-3-yl)-acetamide



A mixture of 6-methylpyridin-3-amine (1g) and triethylamine (2.2 mL) in dry THF (2 mL) was stirred and cooled to -60°C. 2-Chloroacetyl chloride (1.567 g) was added *via*
 5 syringe to the stirred mixture forming a yellow suspension. The mixture was stirred at 60°C until analysis showed complete disappearance of starting material. The reaction slurry was poured into water and the products extracted with ethyl acetate (2 x 150 mL). The combined organic extracts were dried over magnesium sulphate and concentrated dryness. The crude brown solid was recrystallised from ether to afford the subtitled
 10 compound (700 mg).

¹H NMR (400 MHz, DMSO-D₆) δ 10.40 (1H, s), 8.60 (1H, d), 7.91 (1H, dd), 7.22 (1H, d), 4.27 (2H, s), 2.42 (3H, s).

15 **Example 1: (R)-1-[(6-Methyl-pyridin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride**



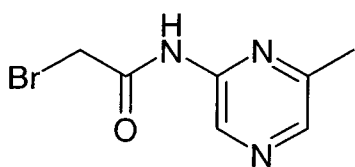
20 1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 1e) (52 mg) was dissolved in acetonitrile (2 mL) and 2-chloro-*N*-(6-methylpyridin-3-yl)acetamide (Example 1f) (29 mg) was added. The reaction mixture was stirred for 14 days and diluted with ethyl acetate (4 mL) and *iso*hexane (14 mL). The mixture was left standing for 5 days, whereupon the resulting crystals were separated and washed with

m/e 476 $[M]^+$

1H NMR (400 MHz, DMSO- D_6) δ 11.33 (s, 1H), 8.70 (d, 1H), 7.91 (dd, 1H), 7.38 - 7.31 (m, 4H), 7.27 (d, 1H), 7.28 - 7.20 (m, 1H), 5.16 - 5.07 (m, 1H), 4.36 (d, 1H), 4.31 (d, 1H), 4.16 - 4.07 (m, 1H), 3.72 - 3.54 (m, 4H), 3.44 - 3.34 (m, 2H), 2.44 (s, 3H), 2.42 - 2.28 (m, 2H), 2.22 - 2.10 (m, 2H), 2.01 - 1.86 (m, 3H), 1.83 - 1.71 (m, 1H), 1.69 - 1.61 (m, 8H).

Example 2: (R)-1-[(6-Methyl-pyrazin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

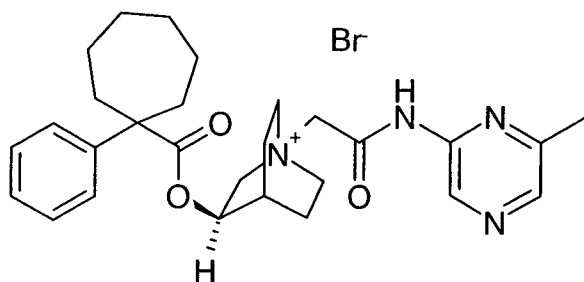
a) 2-Bromo-*N*-(6-methyl-pyrazin-2-yl)-acetamide



6-Methyl-pyrazin-2-ylamine (150 mg) and potassium carbonate (571 mg) were added to dichloromethane (25 mL). 2-Bromoacetyl bromide (0.120 mL) was added to the suspension with stirring. The reaction was stirred overnight then water (0.1 mL) was added with further stirring. Further quantities of potassium carbonate (571 mg), 2-bromoacetyl bromide (0.120 mL) and water (0.1 mL) were added over 2 hours until the reaction had proceeded to completion. The reaction was diluted with water (100 mL), carefully acidified with hydrochloric acid and extracted with dichloromethane (2 x 50 mL) which was dried and evaporated to afford the sub-titled compound which was used crude (365 mg).

1H NMR (400 MHz, $CDCl_3$) δ 9.45 (s, 1H), 9.37 (s, 1H), 8.33 (s, 1H), 4.05 (s, 2H), 2.44 (s, 3H).

Example 2: (R)-1-[(6-Methyl-pyrazin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



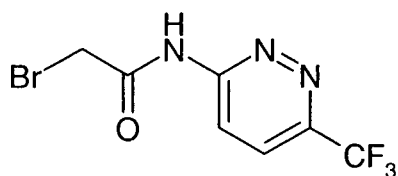
1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 1e) (70 mg) and 2-bromo-*N*-(6-methylpyrazin-2-yl)acetamide (Example 2a) (49.2 mg) were dissolved in acetonitrile (1 mL) and left to stand overnight. Crystals separated on standing and were filtered and washed with acetonitrile (2 x 1 mL), ethyl acetate (2 x 1 mL) and diethyl ether (2 x 3 mL) and dried to yield the titled compound (24 mg).

m/e 477 $[M]^+$

1H NMR (400 MHz, DMSO- D_6) δ 11.33 (s, 1H), 9.09 (s, 1H), 8.37 (s, 1H), 7.38 - 7.27 (m, 4H), 7.27 - 7.22 (m, 1H), 5.15 - 5.09 (m, 1H), 4.36 - 4.25 (m, 2H), 4.16 - 4.07 (m, 1H), 3.68 - 3.56 (m, 4H), 3.46 - 3.33 (m, 1H), 2.47 (s, 3H), 2.42 - 2.29 (m, 2H), 2.24 - 2.11 (m, 2H), 2.04 - 1.87 (m, 3H), 1.83 - 1.73 (m, 1H), 1.68 - 1.45 (m, 9H).

Example 3: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-[(6-trifluoromethyl-pyridazin-3-ylcarbamoyl)-methyl]-1-azonia-bicyclo[2.2.2]octane bromide

a) 2-Bromo-*N*-(6-trifluoromethyl-pyridazin-3-yl)-acetamide



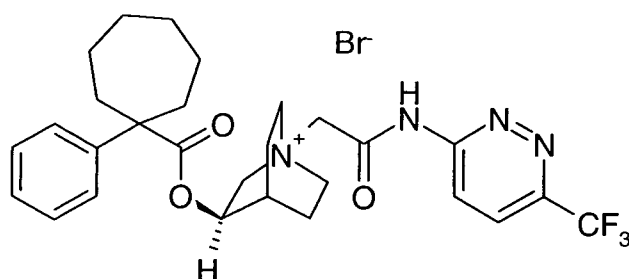
6-Trifluoromethyl-pyridazin-3-ylamine (0.042 g) (prepared by a procedure similar to that described in WO2007048779) was dissolved in dichloromethane (40 mL) and stirred with potassium carbonate (0.214 g). 2-Bromoacetyl bromide (0.12 mL) was added and stirring continued for 1.5 hours. Water (0.24 mL) was added and the reaction mixture was stirred for 1.5 hours after which water (40 mL) was added and the reaction mixture stirred for

further 1.5 hours. The dichloromethane was separated, dried (MgSO₄) and evaporated to afford the sub-titled compound as a white solid (0.053 g).

m/e 284/286 [M+H]⁺

¹H NMR (400 MHz, DMSO-D₆) δ 11.04 (s, 1H), 8.79 (d, 1H), 7.91 (d, 1H), 4.31 (s,

Example 3: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-[(6-trifluoromethyl-pyridazin-3-ylcarbamoyl)-methyl]-1-azonia-bicyclo[2.2.2]octane bromide

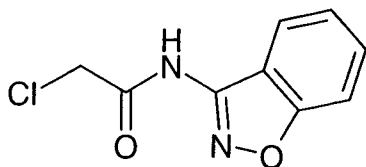


1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 1e) (61.1 mg) and 2-bromo-*N*-(6-trifluoromethyl-pyridazin-3-yl)-acetamide (Example 53.0 mg) were dissolved in acetonitrile (2 mL) and left overnight. The solvent was evaporated and the product was purified by column chromatography on silica eluting with 10% methanol in dichloromethane to afford the titled compound (107 mg).

m/e 531 [M]⁺

¹H NMR (400 MHz, DMSO-D₆) δ 12.17 (s, 1H), 8.50 (d, 1H), 8.36 (d, 1H), 7.40 - 7.33 (m, 4H), 7.28 - 7.23 (m, 1H), 5.17 - 5.10 (m, 1H), 4.57 - 4.42 (m, 2H), 4.22 - 4.14 (m, 1H), 3.76 - 3.61 (m, 4H), 3.47 (dd, 1H), 2.43 - 2.30 (m, 2H), 2.25 - 2.12 (m, 2H), 2.00 - 1.88 (m, 3H), 1.86 - 1.73 (m, 1H), 1.72 - 1.44 (m, 9H).

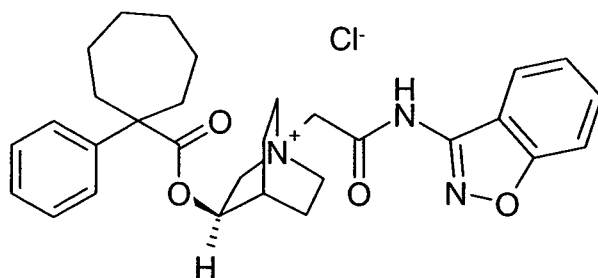
Example 4: (R)-1-(Benzo[*d*]isoxazol-3-ylcarbamoylmethyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



To a mixture of benzo[*d*]isoxazol-3-ylamine (1 g) and cesium carbonate (2.42 g) in dry DMF (20 mL), stirred at rt, was added bromoacetyl chloride (0.62 mL) by dropwise addition. After stirring the mixture for 8 hours, the reaction was poured into water (100 mL) and the products extracted into ether (2 x 200 mL). The combined extracts were dried over magnesium sulfate and concentrated to dryness. The crude product was purified on silica gel using ether / *iso*hexane (4 / 6) to afford the sub-titled compound as a colourless solid (0.5 g).

m/e 210 $[M+H]^+$

Example 4: (*R*)-1-(Benzo[*d*]isoxazol-3-ylcarbamoylmethyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 1e) (114 mg) and *N*-benzo[*d*]isoxazol-3-yl-2-chloro-acetamide (Example 4a) (89 mg) dissolved in acetonitrile (10 mL) and left for one week. The resulting crystals were filtered off and washed with diethyl ether (3 x 10 mL) to afford the titled compound as a solid (120 mg).

m/e 502 $[M]^+$

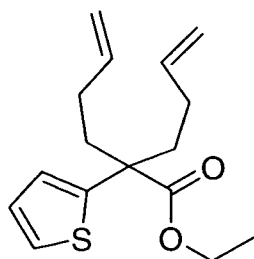
1H NMR (400 MHz, DMSO- d_6) δ 12.15 (s, 1H), 8.16 (d, 1H), 7.74 (d, 1H), 7.72 - 7.6

4.63 - 4.46 (m, 2H), 4.17 (ddd, 1H), 3.76 - 3.61 (m, 4H), 3.49 (dd, 1H), 2.43 - 2.29 (m, 2H), 2.24 - 2.12 (m, 2H), 2.03 - 1.89 (m, 3H), 1.86 - 1.74 (m, 1H), 1.70 - 1.44 (m, 9H)

Example 5: (R)-1-(Pyridazin-3-ylcarbamoymethyl)-3-(1-thiophen-2-yl-

5 **cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide**

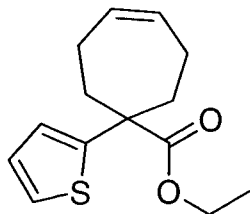
a) 2-But-3-enyl-2-thiophen-2-yl-hex-5-enoic acid ethyl ester



Ethyl 2-(thiophen-2-yl)acetate (2.35 g) was dissolved in tetrahydrofuran (30 mL) and
 10 cooled to -78°C. Lithium *bis*(trimethylsilyl)amide (2.31 g) in THF (1M solution, 13.8
 was added and the solution was stirred for 30 minutes. 4-Bromo-but-1-ene (1.4 mL) w
 added and the reaction mixture was allowed to warm to room temperature and stirred f
 hour. The reaction mixture was re-cooled to -78°C and lithium *bis*(trimethylsilyl)amic
 (2.31 g) in THF (1M solution, 13.8 mL) was added and the solution was stirred for 30
 15 minutes. 4-Bromo-but-1-ene (1.4 mL) was added and the reaction mixture was allowe
 warm to room temperature and stand overnight. HPLC-MS analysis indicated that the
 reaction was incomplete so the reaction was again cooled to -78°C and further aliquots
 lithium *bis*(trimethylsilyl)amide (1M solution, 10 mL) and 4-bromo-but-1-ene (1.0 mL
 were added following the procedure outlined above. After stirring for a further 2 hours
 20 water (30 mL) was added and the reaction was extracted with diethyl ether (2 x 60 mL
 The combined organic extracts were dried (MgSO₄) and evaporated. The resulting oil
 purified by column chromatography on silica eluting with ethyl acetate / *iso*hexane (1/
 to afford the sub-titled compound (3.18 g).

25 ¹H NMR (400 MHz, DMSO-D₆) δ 7.21 (dd, 1H), 6.97 - 6.94 (m, 2H), 5.79 (ddt, 2H),
 (dq, 2H), 4.95 (dq, 2H), 4.17 (q, 2H), 2.22 - 2.08 (m, 4H), 2.00 - 1.85 (m, 4H), 1.24 (t
 3H)

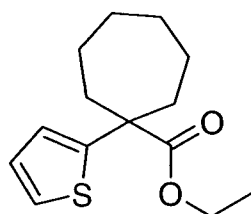
b) 1-Thiophen-2-yl-cyclohept-4-enecarboxylic acid ethyl ester



To 2-but-3-enyl-2-thiophen-2-yl-hex-5-enoic acid ethyl ester (Example 5a) (3.18 g) in
5 dichloromethane (100 mL) was added Grubbs Catalyst (2nd Generation, Sigma-Aldrich
Company Ltd) (0.100 g). The mixture was warmed to reflux under nitrogen. After 20
the mixture was allowed to cool to room temperature and evaporated to an oil. Purified
by column chromatography on silica eluting with ethyl acetate / *isohexane* (10:90) to
the sub-titled compound (2.60 g) as a coloured oil.

¹H NMR (400 MHz, DMSO-D₆) δ 7.19 (dd, 1H), 6.98 - 6.92 (m, 2H), 5.72 (t, 2H), 4.1
10 2H), 2.66 - 2.59 (m, 2H), 2.25 - 2.14 (m, 6H), 1.21 (t, 3H).

c) 1-Thiophen-2-yl-cycloheptanecarboxylic acid ethyl ester



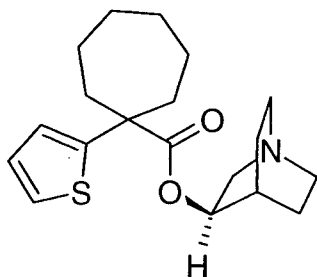
1-Thiophen-2-yl-cyclohept-4-enecarboxylic acid ethyl ester (Example 5b) (2.86 g) was
dissolved in ethanol (30 mL) and tris(triphenylphosphine)rhodium(I) chloride (0.100 g)
was added. The reaction mixture was stirred rapidly under 5 atmospheres of hydrogen
overnight. Further tris(triphenylphosphine)rhodium(I) chloride (0.050 g) was added and
20 the reaction mixture was stirred under 5 atmospheres of hydrogen for 3 days. A third
addition of tris(triphenylphosphine)rhodium(I) chloride (0.050 g) was made and the
reaction mixture was stirred under 3 atmospheres of hydrogen overnight. The contents
were evaporated to dryness and purified on silica eluting with ethyl acetate / *isohexane*

m/e 253 [M+H⁺]

¹H NMR (400 MHz, DMSO-D₆) δ 7.17 (dd, 1H), 6.95 - 6.91 (m, 2H), 4.13 (q, 2H), 2.14 - 2.03 (dd, 2H), 2.14 - 2.03 (m, 2H), 1.70 - 1.50 (m, 8H), 1.20 (t, 3H).

5

d) 1-Thiophen-2-yl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester

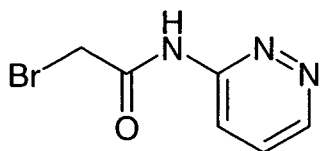


1-Thiophen-2-yl-cycloheptanecarboxylic acid ethyl ester (Example 5c) (2.5 g) and (*R*)
 10 quinuclidin-3-ol (2.08 g) were dissolved in toluene (350 mL) and sodium hydride (0.1 g) was added under nitrogen. The mixture was heated to reflux for 20 hours after which the toluene was carefully distilled off to leave ~100 mL which was cooled and washed with water (100 mL), dried (MgSO₄) and evaporated. The crude product was purified by column chromatography on silica eluting with ethyl acetate / triethylamine (99/1) to afford the sub-titled compound (2.84 g).
 15

m/e 334 [M+H⁺]

¹H NMR (400 MHz, CDCl₃) δ 7.18 (t, 1H), 6.95 - 6.92 (m, 2H), 4.77 - 4.72 (m, 1H), 2.83 - 2.64 (ddd, 1H), 2.83 - 2.64 (m, 4H), 2.59 - 2.50 (m, 3H), 2.18 - 2.08 (m, 2H), 1.95 - 1.90 (m, 1H), 1.71 - 1.44 (m, 11H), 1.34 - 1.23 (m, 1H).
 20

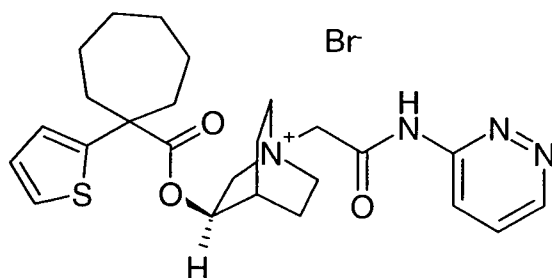
e) 2-Bromo-*N*-pyridazin-3-yl-acetamide



To a suspension of pyridazin-3-ylamine (2.7 g) and diisopropylethylamine (6.3 mL) in dichloromethane (100 mL) at 0°C was added bromoacetic anhydride (9.0 g) in dichloromethane (10 mL) by dropwise addition. The mixture was stirred at 0°C for 0.5 hours and then allowed to warm to rt. The resulting suspension was filtered, washed with dichloromethane and dried to afford the sub-titled compound as a solid (2.0 g).

¹H NMR (400 MHz, DMSO-D₆) δ 11.51 (s, 1H), 9.00 (dd, 1H), 8.28 (dd, 1H), 7.74 - 7.64 (m, 1H), 4.15 (s, 2H).

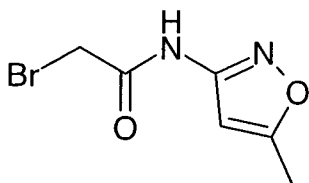
Example 5: (R)-1-(Pyridazin-3-ylcarbamoylmethyl)-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



1-Thiophen-2-yl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 5d) (80 mg) and 2-bromo-*N*-pyridazin-3-yl-acetamide (Example 5e) (52 mg) were dissolved in acetonitrile (3 mL) and stirred overnight. Ethyl acetate (9 mL) and *isohexane* (4 mL) were added and stirred overnight. The resulting crystals were filtered and then triturated with ethyl acetate to afford the titled compound (14 mg).

m/e 469 [M⁺]

¹H NMR (400 MHz, DMSO-D₆) δ 11.68 (s, 1H), 9.05 (dd, 1H), 8.25 (d, 1H), 7.79 (dd, 1H), 7.44 (dd, 1H), 7.03 (dd, 1H), 6.99 (dd, 1H), 5.14 - 5.09 (m, 1H), 4.37 (s, 2H), 4.14 - 4.08 (m, 1H), 3.76 - 3.57 (m, 4H), 3.57 - 3.46 (m, 1H), 2.48 - 2.42 (m, 1H), 2.29 - 2.22 (m, 1H), 2.21 - 2.11 (m, 1H), 2.07 - 1.90 (m, 4H), 1.90 - 1.80 (m, 1H), 1.78 - 1.68 (m, 1H), 1.66 - 1.46 (m, 8H).

a) 2-Bromo-*N*-(5-methyl-isoxazol-3-yl)-acetamide

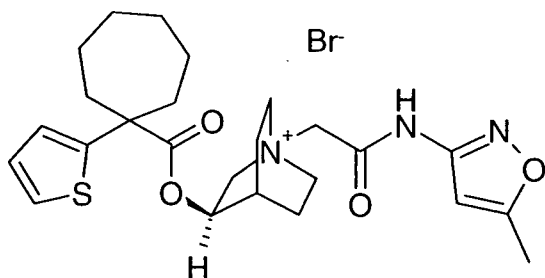
5 To a stirred suspension of sodium bicarbonate (1.242 g) and 5-methyl-isoxazol-3-ylan (1.45 g) in dichloromethane (50 mL) was added 2-bromoacetyl bromide (1.28 mL) by dropwise addition. The reaction mixture was stirred overnight and then washed with water (2 x 50 mL). The organic fraction was separated, dried with magnesium sulfate and evaporated to yield the sub-titled compound (279 mg).

10

^1H NMR (400 MHz, DMSO- D_6) δ 11.32 (s, 1H), 6.62 (s, 1H), 4.06 (s, 2H), 2.38 (s,

Example 6: (*R*)-1-[(5-Methyl-isoxazol-3-ylcarbamoyl)-methyl]-3-(1-thiophen-2-yl cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

15



1-Thiophen-2-yl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 5d) (68 mg) and 2-bromo-*N*-(5-methyl-isoxazol-3-yl)-acetamide (Example 4) (45 mg) were dissolved in acetonitrile (2 mL) and stirred overnight. Ethyl acetate (10 mL) and isohexane (9 mL) were added and stirred overnight. The resulting crystals were filtered off and washed with ethyl acetate to afford the titled compound (82 mg).

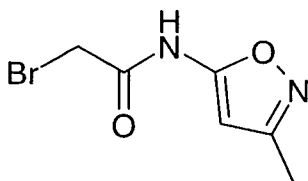
20

m/e 472 [M^+]

- 3.55 (m, 4H), 3.53 - 3.43 (m, 1H), 2.54 - 2.42 (m, 1H), 2.41 (d, 3H), 2.27 - 2.22 (m, 2.19 - 2.13 (m, 1H), 2.07 - 1.90 (m, 4H), 1.89 - 1.77 (m, 1H), 1.77 - 1.65 (m, 1H), 1.61 - 1.48 (m, 8H).

5 **Example 7: (R)-1-[(3-Methyl-isoxazol-5-ylcarbamoyl)-methyl]-3-(1-thiophen-2-ylcycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide**

a) 2-Bromo-*N*-(3-methyl-isoxazol-5-yl)-acetamide



10

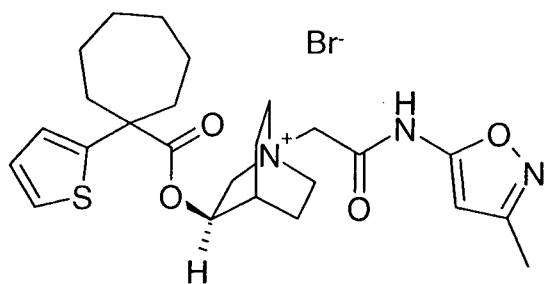
3-Methyl-isoxazol-5-ylamine (2.9 g) and potassium carbonate (9.8 g) were suspended in dichloromethane (100 mL) at room temperature and 2-bromoacetyl bromide (6 g) was added dropwise. The mixture was allowed to stir overnight. Water (0.3 mL) was added together with a further quantity of potassium carbonate (3 g) and the reaction mixture stirred for a further 30 minutes. The reaction mixture was poured into water (100 mL) extracted with dichloromethane (2 x 50 mL). The combined organic extracts were dried over magnesium sulfate and then evaporated *in vacuo*. The crude product was purified by column chromatography on silica eluting with ethyl acetate / *iso*hexane (50:50) to give sub-titled compound (4.8 g).

15

20

¹H NMR (300 MHz, CDCl₃) δ 11.97 (s, 1H), 6.16 (s, 1H), 4.09 (s, 2H), 2.19 (s, 3H)

25 **Example 7: (R)-1-[(3-Methyl-isoxazol-5-ylcarbamoyl)-methyl]-3-(1-thiophen-2-ylcycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide**



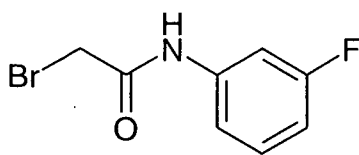
1-Thiophen-2-yl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester
(Example 5d) (50 mg) and 2-bromo-*N*-(3-methylisoxazol-5-yl)acetamide (Example 7a)
5 mg) were dissolved in acetonitrile (2 mL) and left overnight. Ethyl acetate (10 mL) and
*iso*hexane (10 mL) were added and the crystals filtered off, washed with ethyl acetate
dried to afford the titled compound (37 mg).

m/e 472 [M^+]

10 1H NMR (400 MHz, DMSO- D_6) δ 12.21 (s, 1H), 7.44 (dd, 1H), 7.03 (dd, 1H), 6.99 (c
1H), 6.18 (s, 1H), 5.15 - 5.07 (m, 1H), 4.35 (d, 1H), 4.30 (d, 1H), 4.14 - 4.05 (m, 1H),
- 3.54 (m, 4H), 3.54 - 3.43 (m, 1H), 3.17 (d, 1H), 2.47 - 2.42 (m, 1H), 2.27 - 2.20 (m,
2.21 (s, 3H), 2.19 - 2.12 (m, 1H), 2.08 - 1.77 (m, 4H), 1.77 - 1.65 (m, 1H), 1.65 - 1.46
8H).

15 **Example 8: (*R*)-1-[(3-Fluoro-phenylcarbamoyl)-methyl]-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide**

a) 2-Bromo-*N*-(3-fluoro-phenyl)-acetamide



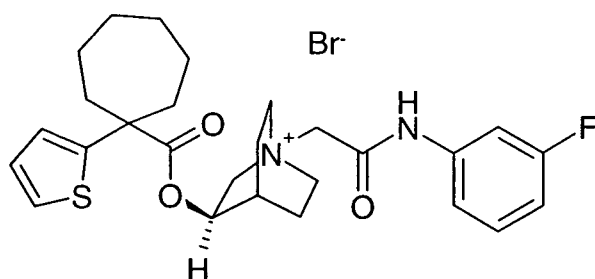
20 To a suspension of sodium bicarbonate (1 g) and 3-fluoroaniline (0.46 g) in
dichloromethane (100 mL) was added 2-bromoacetyl bromide (0.36 mL) by dropwise

addition. After stirring overnight the reaction mixture was washed with water, dried with magnesium sulfate and evaporated to yield the sub-titled compound (1.07 g).

m/e 232 $[M+H^+]$

¹H NMR (300 MHz, CDCl₃) δ 8.14 (s, 1H), 7.50 (dt, 1H), 7.31 (td, 1H), 7.18 (ddd, 1H), 6.87 (tdd, 1H), 4.03 (s, 2H).

Example 8: (*R*)-1-[(3-Fluoro-phenylcarbamoyl)-methyl]-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

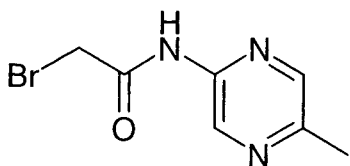


1-Thiophen-2-yl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 5d) (96 mg) and 2-bromo-*N*-(3-fluoro-phenyl)-acetamide (Example 8a) (67 mg) were dissolved in acetonitrile (2 mL) and left overnight. Diethyl ether (10 mL) and isohexane (8 mL) were added and the mixture was left overnight. The resulting crystals were filtered off and washed with diethyl ether to afford the titled compound (90 mg).

m/e 485 $[M^+]$

¹H NMR (400 MHz, DMSO-*D*₆) δ 10.84 (s, 1H), 7.58 (dt, 1H), 7.46 - 7.39 (m, 2H), 7.29 (m, 1H), 7.04 (dd, 1H), 7.02 - 6.96 (m, 2H), 5.15 - 5.10 (m, 1H), 4.33 - 4.24 (m, 1H), 4.17 - 4.07 (m, 1H), 3.77 - 3.58 (m, 4H), 3.51 (dd, 1H), 2.56 - 2.44 (m, 1H), 2.28 - 2.21 (m, 1H), 2.21 - 2.12 (m, 1H), 2.08 - 1.70 (m, 6H), 1.66 - 1.47 (m, 8H).

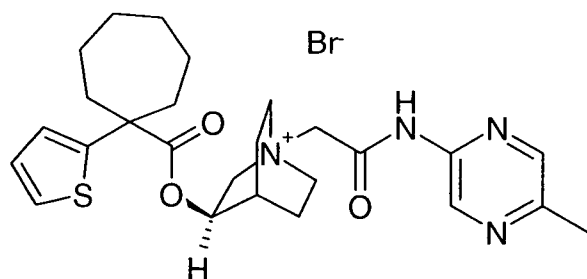
Example 9: (*R*)-1-[(5-Methyl-pyrazin-2-ylcarbamoyl)-methyl]-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



To a mixture of 5-methyl-pyrazin-2-ylamine and cesium carbonate (11.2 g) dissolved dry DMF (30 mL) was added by dropwise addition bromoacetyl bromide (2.89 g) and mixture stirred at rt for 2 hours. Water (200 mL) was added and the mixture extracted ethyl acetate (2 x 100 mL) and dried over magnesium sulfate. Concentration of the extract to ~50 mL and addition of *isohexane* (100 mL) gave the sub-titled compound as a solid (1.64 g).

¹H NMR (400 MHz, DMSO-D₆) δ 11.06 (1H, s), 9.17 (1H, s), 8.31 (1H, d), 4.16 (2H, s), 2.46 (3H, s).

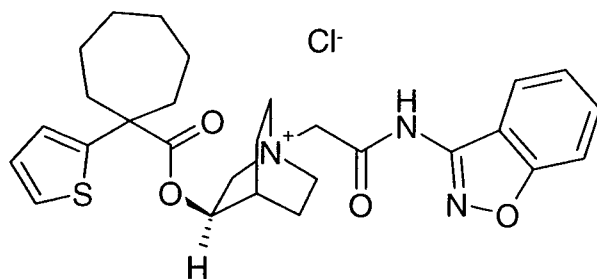
Example 9: (*R*)-1-[(5-Methyl-pyrazin-2-ylcarbamoyl)-methyl]-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



1-Thiophen-2-yl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 5d) (48 mg) was dissolved in acetonitrile (2 mL) and 2-bromo-*N*-(5-methyl-pyrazin-2-yl)-acetamide (Example 9a) (33 mg) was added. After stirring for 1 week diethyl ether (8 mL) and *isohexane* (5 mL) were added. The crystals were collected by filtration, washed with ethyl acetate (2 x 4 mL) and dried to afford the titled compound (mg).

¹H NMR (400 MHz, DMSO-D₆) δ 11.26 (s, 1H), 9.15 (s, 1H), 8.36 (s, 1H), 7.44 (dd, 1H), 7.04 (dd, 1H), 6.99 (dd, 1H), 5.15 - 5.08 (m, 1H), 4.33 (s, 2H), 4.13 (ddd, 1H), 3.75 - 3.65 (m, 4H), 3.56 - 3.46 (m, 1H), 2.48 (s, 3H), 2.50 - 2.44 (m, 1H), 2.28 - 2.22 (m, 1H), 2.11 (m, 1H), 2.08 - 1.90 (m, 4H), 1.90 - 1.80 (m, 1H), 1.79 - 1.69 (m, 1H), 1.64 - 1.48 (m, 8H).

Example 10: (*R*)-1-(Benzo[*d*]isoxazol-3-ylcarbamoylmethyl)-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

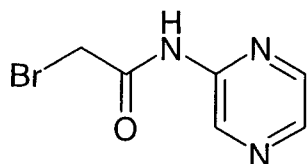


1-Thiophen-2-yl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 5d) (71 mg) and *N*-benzo[*d*]isoxazol-3-yl-2-chloro-acetamide (Example 4a) (82 mg) were dissolved in acetonitrile (10 mL) and left to stand for 6 days. The resulting crystals were filtered off and washed with diethyl ether (3 x 10 mL) to afford the titled compound (82 mg).

m/e 509 [M⁺]

¹H NMR (400 MHz, DMSO-D₆) δ 12.16 (s, 1H), 8.17 (d, 1H), 7.74 (d, 1H), 7.72 - 7.61 (m, 1H), 7.44 - 7.39 (m, 2H), 7.04 (dd, 1H), 6.98 (dd, 1H), 5.16 - 5.11 (m, 1H), 4.64 - 4.50 (m, 2H), 4.21 - 4.13 (m, 1H), 3.82 - 3.64 (m, 4H), 3.59 (dd, 1H), 2.56 - 2.44 (m, 2H), 2.29 - 2.22 (m, 1H), 2.22 - 2.13 (m, 1H), 2.08 - 1.89 (m, 3H), 1.89 - 1.81 (m, 1H), 1.80 - 1.69 (m, 1H), 1.64 - 1.47 (m, 8H).

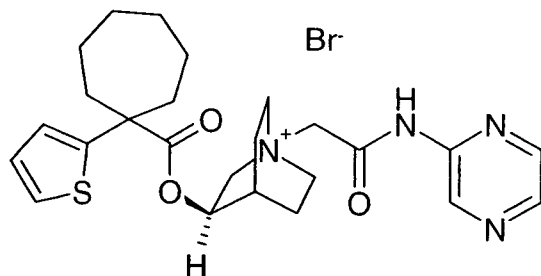
Example 11: (*R*)-1-(Pyrazin-2-ylcarbamoylmethyl)-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



To a stirred suspension of pyrazin-2-ylamine (1.87 g) and potassium carbonate (8.19 g) in dichloromethane (25 mL) was added by dropwise addition 2-bromoacetyl bromide (1.0 mL). The reaction mixture was stirred overnight and then washed with water (2 x 50 mL). The organic phase was separated, dried with magnesium sulfate and evaporated to yield the sub-titled compound (0.70 g).

¹H NMR (400 MHz, CDCl₃) δ 9.51 (d, 1H), 8.63 (s, 1H), 8.42 (d, 1H), 8.30 (dd, 1H), 8.15 (s, 2H).

Example 11: (R)-1-(Pyrazin-2-ylcarbamoylmethyl)-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



1-Thiophen-2-yl-cycloheptanecarboxylic acid (R)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 5d) (116 mg) and 2-bromo-N-pyrazin-2-yl-acetamide (Example 11a) (75 mg) were dissolved in acetonitrile (2 mL) and left overnight. Diethyl ether (10 mL) and isohexane (8 mL) were added and the mixture was left to stand overnight. The resulting crystals were filtered off and washed with diethyl ether to afford the titled compound (100 mg).

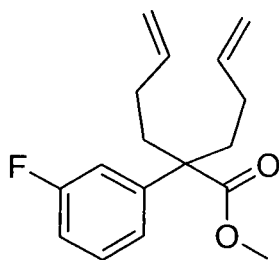
m/e 469 [M⁺]

¹H NMR (400 MHz, DMSO-D₆) δ 11.38 (s, 1H), 9.28 (s, 1H), 8.50 - 8.45 (m, 2H), 7.45 (dd, 1H), 7.04 (dd, 1H), 6.99 (dd, 1H), 5.15 - 5.09 (m, 1H), 4.36 (s, 2H), 4.18 - 4.08 (m, 2H).

2.29 - 2.22 (m, 1H), 2.21 - 2.12 (m, 1H), 2.08 - 1.88 (m, 3H), 1.88 - 1.79 (m, 1H), 1.72 (m, 1H), 1.64 - 1.48 (m, 8H).

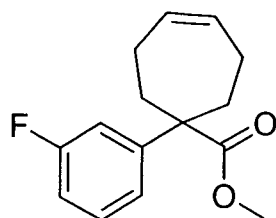
Example 12: (R)-3-[1-(3-Fluoro-phenyl)-cycloheptanecarbonyloxy]-1-(pyrazin-2-ylcarbamoymethyl)-1-azonia-bicyclo[2.2.2]octane bromide

a) 2-But-3-enyl-2-(3-fluoro-phenyl)-hex-5-enoic acid methyl ester



(3-Fluoro-phenyl)-acetic acid methyl ester (4.30 g) was dissolved in tetrahydrofuran (20 mL) and cooled to -78°C . Lithium *bis*(trimethylsilyl)amide (25.6 mL, 1M THF solution) was added and the solution was stirred for 30 minutes. 4-Bromo-but-1-ene (2.60 mL) was added and the reaction contents were allowed to warm to room temperature and stir for 1 hour. The reaction mixture was again cooled to -78°C . Lithium *bis*(trimethylsilyl)amide (25.6 mL, 1M THF solution) was added and the solution was stirred for 30 minutes. 4-Bromo-1-butene (2.60 mL) was added and the reaction mixture was allowed to warm to room temperature and stir for an hour. The contents were again cooled to -78°C and five aliquots of Lithium *bis*(trimethylsilyl)amide (25.6 mL, 1M THF solution) and 4-bromo-1-butene (2.60 mL) were added following the procedure outlined above. After stirring overnight, water (20 mL) was added and the reaction mixture extracted with diethyl ether (2 x 60 mL). The combined organic extracts were dried with magnesium sulfate and evaporated. The resulting liquid was purified by column chromatography on silica eluted with ethyl acetate / *iso*hexane (1 / 99) to afford the sub-titled compound (5.0 g).

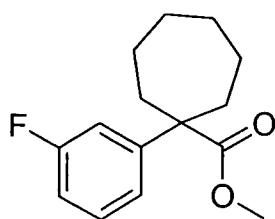
m/e 277 $[\text{M}+\text{H}]^{+}$



To 2-but-3-enyl-2-(3-fluoro-phenyl)-hex-5-enoic acid methyl ester (Example 12a) (5.0 g) in dichloromethane (100 mL) was added Grubbs Catalyst (2nd Generation, Sigma-Aldrich Company Ltd) (0.05 g). The mixture was warmed to reflux under nitrogen. After 20 h the reaction was cooled to room temperature, evaporated to an oil and purified by column chromatography on silica eluting with ethyl acetate / *iso*hexane (5 / 95) to yield an oil. Analysis of the product showed that significant amounts of starting material was present in the mixture so the mixture was subjected to a repetition of the reaction conditions and purification as above to afford the subtitled compound as a coloured oil (3.60 g).

m/e 249 $[M+H]^+$

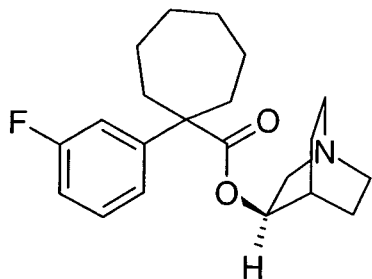
c) 1-(3-Fluoro-phenyl)-cycloheptanecarboxylic acid methyl ester



1-(3-Fluoro-phenyl)-cyclohept-4-enecarboxylic acid methyl ester (Example 12b) (1.09 g) was dissolved in methanol (20 mL), palladium on carbon (50 mg) added and mixture stirred under 4 atm of hydrogen overnight. The solution was filtered and evaporated to afford sub-titled compound (1.09 g).

m/e 251 $[M+H]^+$

d) 1-(3-Fluoro-phenyl)-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester

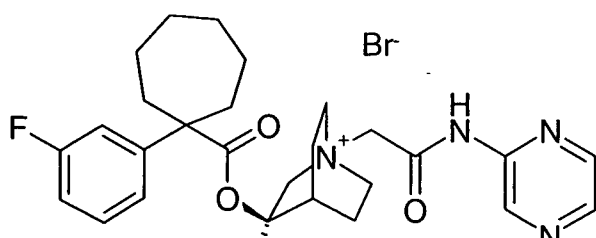


1-(3-Fluoro-phenyl)-cycloheptanecarboxylic acid methyl ester (Example 12c) (0.280 g) was dissolved in toluene (100 mL) and (*R*)-quinuclidin-3-ol (0.320 g) was added. Toluene (10 mL) was distilled off in a Dean and Stark apparatus and after cooling sodium hydride (10 mg) was added. The reaction was refluxed in a Dean and Stark apparatus for 4 hours after which time an extra amount of sodium hydride (10 mg) was added and the reaction was heated to reflux for a further 4 hours. After allowing to cool to room temperature, toluene was washed with water, dried (MgSO_4) and evaporated. The residue was purified by column chromatography eluting with ethyl acetate / *isohexane* / triethylamine (50 / 1) then ethyl acetate / triethylamine (99 / 1) to afford the sub-titled compound (0.200 g).

m/e 346 $[\text{M}+\text{H}]^+$

^1H NMR (399.824 MHz, CDCl_3) δ 7.26 (td, 1H), 7.10 - 7.07 (m, 1H), 7.04 (dd, 1H), 6.98 (ddd, 1H), 4.78 - 4.73 (m, 1H), 3.14 (ddd, 1H), 2.79 - 2.66 (m, 3H), 2.66 - 2.56 (m, 1H), 2.53 - 2.46 (m, 1H), 2.46 - 2.36 (m, 2H), 2.13 - 1.99 (m, 2H), 1.90 - 1.85 (m, 1H), 1.71 - 1.40 (m, 11H), 1.29 - 1.18 (m, 1H).

Example 12: (*R*)-3-[1-(3-Fluoro-phenyl)-cycloheptanecarbonyloxy]-1-(pyrazin-2-yl)carbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane bromide



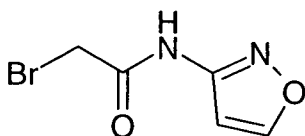
1-(3-Fluoro-phenyl)-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) e
 (Example 12d) (0.100 g) was dissolved in acetonitrile (8 mL) and 2-bromo-*N*-pyrazin
 acetamide (Example 11a) (0.05 g) was added. The reaction mixture was stirred for 3 c
 5 diluted with diethyl ether (8 mL), stirred for a futher 10 minutes, the resulting solid w
 filtered and washed with diethyl ether (3 x 8 mL) to afford a solid which was recrystal
 from hot butanone (8 mL) to afford the titled compound as a solid (0.081 g).

m/e 481 [M^+]

10 1H NMR (399.826 MHz, DMSO- D_6) δ 11.42 (s, 1H), 9.28 (s, 1H), 8.49 - 8.45 (m, 2H)
 7.40 (td, 1H), 7.19 - 7.12 (m, 2H), 7.09 (td, 1H), 5.17 - 5.10 (m, 1H), 4.40 - 4.30 (m, 2
 4.16 - 4.07 (m, 1H), 3.71 - 3.57 (m, 4H), 3.52 - 3.41 (m, 1H), 2.43 - 2.27 (m, 2H), 2.20
 2.19 (m, 1H), 2.19 - 2.09 (m, 1H), 2.05 - 1.87 (m, 3H), 1.86 - 1.76 (m, 1H), 1.71 - 1.40
 9H).

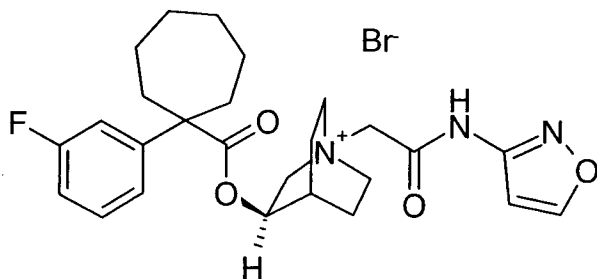
Example 13: (*R*)-3-[1-(3-Fluoro-phenyl)-cycloheptanecarbonyloxy]-1-(isoxazol-3-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane bromide

20 a) 2-Bromo-*N*-isoxazol-3-yl-acetamide



Isioxazol-3-ylamine (1.14 g) was dissolved in dichloromethane (50 mL) and potassium
 25 carbonate (3.74 g) was added. Bromoacetyl chloride (1.12 mL) was added slowly with
 stirring and the suspension was stirred overnight. The reaction mixture was washed with
 water (2 x 50 mL), dried and evaporated. The product was recrystallised from
 dichloromethane / isohexane to afford the sub-titled compound (2.3 g).

Example 13: (*R*)-3-[1-(3-Fluoro-phenyl)-cycloheptanecarbonyloxy]-1-(isoxazol-3-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane bromide



5

1-(3-Fluoro-phenyl)-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 12d) (50 mg) and 2-bromo-*N*-isoxazol-3-yl-acetamide (Example 13a) (30 mg) were dissolved in acetonitrile (4 mL) and stirred overnight. The solution was diluted with diethyl ether (12 mL) and stirred overnight. The resulting crystals were filtered off,
 10 washed with ether (3 x 10 mL) and dried to afford the titled compound as a solid (48 mg).

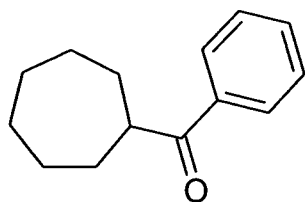
m/e 470 [M^+]

1H NMR (399.826 MHz, DMSO- D_6) δ 11.69 (s, 1H), 8.90 (d, 1H), 7.40 (td, 1H), 7.18
 15 7.07 (m, 3H), 6.91 (d, 1H), 5.16 - 5.10 (m, 1H), 4.31 (d, 1H), 4.25 (d, 1H), 4.09 (ddd,
 3.68 - 3.53 (m, 4H), 3.43 (dd, 1H), 2.42 - 2.27 (m, 2H), 2.25 - 2.19 (m, 1H), 2.18 - 2.0
 1H), 2.04 - 1.88 (m, 3H), 1.85 - 1.75 (m, 1H), 1.69 - 1.51 (m, 9H).

Example 14: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride

20

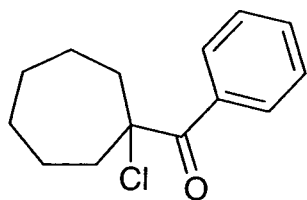
a) Cycloheptyl-phenyl-methanone



Phenylmagnesium bromide (3.0M solution in diethyl ether) (271 mL), was added dropwise to a stirred (overhead stirrer) solution of cycloheptanecarbonitrile (50 g) in 229 mL diethyl ether under nitrogen at such a rate as to maintain gentle reflux. The reaction mixture was then heated at reflux for 3 hours. TLC indicated no starting material present in the reaction mixture. The reaction mixture was allowed to cool to room temperature and stood under nitrogen overnight. The reaction mixture was cooled to 0°C and treated dropwise with 10 mL 4N HCl(aq) keeping the temperature below 20°C. 4N sulfuric acid (203 mL) was added dropwise rapidly to start with and then more slowly towards the end. The ice bath was removed and the diethyl ether was distilled off. The reaction mixture was heated 10 80-90°C for 3.5 hours then allowed to cool to room temperature and stood overnight. The mixture was diluted with ether (approx 450 mL) and water (100 mL). The layers were separated and the aqueous layer was extracted with ether (2 x 400 mL). The organic layers were combined and washed with saturated aqueous sodium hydrogen carbonate (600 mL) and brine (600 mL), dried over magnesium sulphate, filtered and evaporated to give the 15 sub-titled compound as an orange liquid (86.5 g).

¹H NMR (300 MHz, CDCl₃) δ 7.96-7.91 (d, 2H), 7.54-7.49 (m, 1H), 7.48-7.40 (t, 2H), 3.48-3.37 (m, 1H), 1.98-1.88 (m, 2H), 1.85-1.44 (m, 10H).

b) (1-Chloro-cycloheptyl)-phenyl-methanone

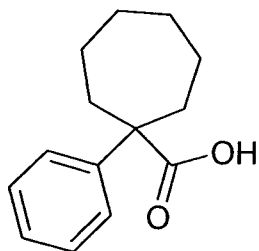


Sulfonyl chloride (210 mL) was added dropwise to neat cycloheptyl-phenyl-methanone (Example 14a) (86.5 g) at 0°C over approximately 1 hour. Gas evolution and an exotherm were observed. The internal temperature was kept below 15°C during the addition and evolved gas was scrubbed by passing through a 10.2M aqueous solution of NaOH. The 25 reaction mixture was heated to reflux overnight. The reaction mixture was cooled to 0°C and poured slowly onto ice (1 L) with stirring. The layers were separated and the aqueous layer was extracted with ether (2 x 400 mL). The combined organic layers were washed with water (600 mL), saturated aqueous sodium hydrogen carbonate (600 mL), and brine

(600 mL), dried over magnesium sulphate, filtered and evaporate to give the sub-titled compound as a brown oil (100 g).

¹H NMR (400 MHz, CDCl₃) δ 8.10-8.06 (d, 2H), 7.52-7.46 (t, 1H), 7.44-7.36 (t, 2H),
5 (ddd, 2H), 2.29 (ddd, 2H), 1.84-1.73 (m, 2H), 1.68-1.58 (m, 2H), 1.58-1.43 (m, 4H)

c) 1-Phenyl-cycloheptanecarboxylic acid

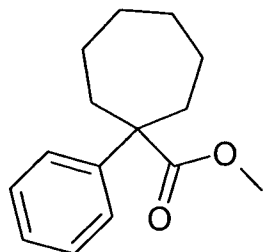


A solution of (1-chloro-cycloheptyl)-phenyl-methanone (Example 14b) (100 g) in 750
10 dioxane was treated dropwise rapidly with a cloudy solution of silver nitrate (137 g) in
water (85 mL) causing a precipitate to form. The reaction mixture was heated to 75°C
4.5 hours. The reaction mixture was cooled to room temperature then filtered and
concentrated to approximately 200 mL. Water (200 mL) and ether (300 mL) were added
and the layers separated. The aqueous layer was extracted with ether (2 x 250 mL). The
15 combined organic layers were extracted with 10% aqueous sodium carbonate (3 x 250
mL). The combined basic extracts were heated to 90°C over 40 minutes and then cooled to
room temperature and acidified with concentrated HCl (aq). The resulting brown solid
filtered off, washed with water (x2) and dried under vacuum at 50°C. Crystallisation from
hot ethanol (40 mL) gave the sub-titled compound as pale brown crystals (9.83 g).

20

¹H NMR (400 MHz, CD₃OD) δ 7.36-7.26 (m, 4H), 7.21-7.15 (m, 1H), 2.43-2.35 (m, 2
2.07-1.98 (m, 2H), 1.70-1.53 (m, 8H).

d) 1-Phenyl-cycloheptanecarboxylic acid methyl ester

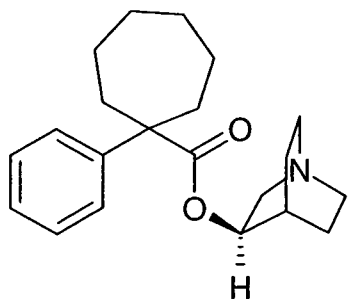


A 2.0 M solution of trimethylsilyl diazomethane (29.2 mL) was added dropwise to a solution of 1-phenyl-cycloheptanecarboxylic acid (Example 14c) (9.8 g) in methanol (mL) and toluene (300 mL) under an atmosphere of nitrogen.

- 5 After 45 minutes the reaction mixture was concentrated under vacuum and the crude product was purified by column chromatography eluting with 0-10% ethyl acetate / cyclohexane to give the product as a pale yellow oil (9.25 g).

¹H NMR (300 MHz, CD₃OD) δ 7.32-7.24 (m, 4H), 7.21-7.12 (m, 1H), 3.60 (s, 3H), 2.32 (m, 2H), 2.07-1.96 (m, 2H), 1.65-1.58 (m, 8H).

e) 1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester

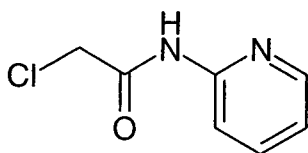


- 15 A solution of (*R*)-(3)-quinuclidinol (10.13 g) and 1-phenyl-cycloheptanecarboxylic acid methyl ester (Example 14d) (9.25 g) in toluene (90 mL) was heated to reflux with a Dean-Stark trap for 30 min. The reaction mixture was allowed to cool to room temperature and the trap was removed. Sodium hydride (60% dispersion in mineral oil) (3.19 g) was added portionwise under nitrogen and the reaction mixture was heated to reflux overnight under nitrogen. The reaction mixture was cooled in an ice bath and diluted with ethyl acetate (200 mL) and water (200 mL). The mixture was filtered and the layers separated. The aqueous layer was extracted with ethyl acetate (2 x 250 mL) and the combined organic layers were washed with brine, dried over magnesium sulfate and evaporated to give the

crude product which was purified by silica gel chromatography eluting with EtOAc containing 1% triethylamine to give the sub-titled compound as a colourless oil (7.63

¹H NMR (400 MHz, CD₃OD) δ 7.34-7.28 (m, 4H), 7.23-7.17 (m, 1H), 4.80-4.75 (m, 3.12 (ddd, 1H), 2.75-2.65 (m, 3H), 2.53-2.37 (m, 4H), 2.14-2.06 (m, 2H), 1.88-1.85 (1H), 1.69-1.54 (m, 10H), 1.54-1.42 (m, 1H), 1.35-1.24 (m, 1H).

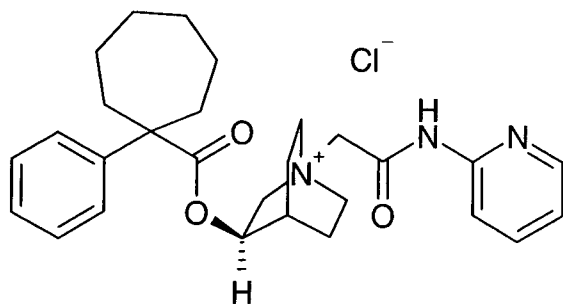
f) 2-Chloro-*N*-pyridin-2-yl-acetamide



A solution of 2-amino-pyridine (1.0 g) in dry dichloromethane (10.6 mL) under nitrogen at 0°C was treated with triethylamine (1.63 mL) followed by slow addition of chloroacetyl chloride (0.93 mL). The reaction mixture was allowed to warm up to room temperature. After 2 hours, the mixture was partitioned between dichloromethane and water. The phases were separated and the aqueous layer was extracted with dichloromethane (x2). The combined organic layers were washed with brine, dried over magnesium sulphate, filtered and concentrated to give the crude product which was purified by silica gel chromatography eluting with 0-30% ethyl acetate / cyclohexane to give the title compound (1.43 g) as a pink solid. Further purification was achieved by trituration with 40-60 petroleum ether to give 1.15 g of the desired product. Crystallisation of a 0.94 g portion of the material from refluxing acetonitrile (2.4 mL) gave the sub-titled compound as a pink solid (0.73g).

¹H NMR (400 MHz, CDCl₃): δ 8.96 (s, 1H), 8.32 (ddd, 1H), 8.21 (d, 1H), 7.76 (ddd, 1H), 7.12 (ddd, 1H), 4.20 (s, 2H).

Example 14: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride



A solution of 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (254 mg) in acetonitrile (5 mL) was treated with 2-chloro-*N*-pyridin-2-yl-acetamide (Example 14f) (146 mg) and the resulting yellow solution was stirred at room temperature overnight during which time a solid precipitated. The reaction mixture was treated with ~2 mL of ether and the solid was filtered off, washed with ether and dried under vacuum to give the title compound as an off-white solid (217 mg). Crystallisation from refluxing acetonitrile (20 mL) gave 98 mg of the titled compound as a white crystalline solid.

m/e 462 [M]⁺

¹H NMR (400 MHz, DMSO-*D*₆): δ 11.09 (s, 1H), 8.34-8.32 (d, 1H), 7.97 (d, 1H), 7.79 (t, 1H), 7.33-7.25 (m, 4H), 7.21-7.13 (m, 2H), 5.07 (m, 1H), 4.29 (s, 2H), 4.07 (ddd, 1H), 3.65-3.51 (m, 4H), 3.41-3.29 (m, 1H), 2.36-2.23 (m, 2H), 2.17-2.04 (m, 2H), 1.99-1.81 (m, 3H), 1.78-1.66 (m, 1H), 1.77-1.19 (m, 9H).

Preparation of Example 14: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride Crystalline Form A

A solution of 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (254 mg, 0.78mmol) in acetonitrile (5 mL) was treated with 2-chloro-*N*-pyridin-2-yl-acetamide (Example 14f) (146 mg) and the resulting yellow solution was stirred at room temperature overnight during which a solid precipitated. The reaction mixture was treated with a couple of mLs of ether and the solid was filtered off, washed with ether and dried under vacuum to give the title compound (217 mg) as an off-white solid. Crystallisation from refluxing acetonitrile (20 mL) gave 98 mg of the title compound.

m/e 462 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 11.09 (s, 1H), 8.34-8.32 (d, 1H), 7.97 (d, 1H), 7.79 (t, 1H), 7.33-7.25 (m, 4H), 7.21-7.13 (m, 2H), 5.07 (m, 1H), 4.29 (s, 2H), 4.07 (ddd, 1H), 3.65-3.51 (m, 4H), 3.41-3.29 (m, 1H), 2.36-2.23 (m, 2H), 2.17-2.04 (m, 1.99-1.81 (m, 3H), 1.78-1.66 (m, 1H), 1.77-1.19 (m, 9H).

Analysis of Example 14: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoymethyl)-1-azonia-bicyclo[2.2.2]octane chloride Crystalline Form A

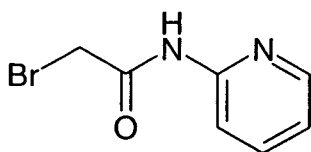
A sample of crystalline Example 14 Crystalline Form A obtained by the procedure described above was analysed by XRPD (PANalytical X'Pert system), DSC and TGA.

The melting temperature of Example 14 chloride Form A as determined by DSC was found to be 239°C (onset) (±2°C). Weight loss observed prior to melting by TGA was negligible. GVS determination gave a negligible weight increase (%w/w) at 80% RH (±0.2%).

An XRPD spectrum of Example 14 chloride Form A is presented in Figure 1.

Example 15: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoymethyl)-1-azonia-bicyclo[2.2.2]octane bromide

a) 2-Bromo-N-pyridin-2-yl-acetamide

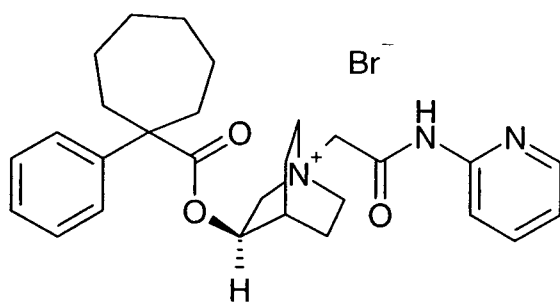


To a solution of 2-aminopyridine (48.8 mmol) in anhydrous THF (98 mL) at room temperature was added Et₃N (58.6 mmol) and bromoacetyl bromide (58.6 mmol) dropwise. The mixture was stirred overnight and quenched with sat. NaHCO₃ (aq). EtOAc was added to the mixture and the layers separated. The aqueous phase was extracted with EtOAc

Purification by flash silica gel chromatography eluting with 1-2% MeOH / dichloromethane gave the sub-titled compound as a yellow solid (1.14 g).

¹H NMR (400 MHz, CDCl₃): δ 8.75 (s, 1H), 8.26 (ddd, 1H), 8.10 (d, 1H), 7.67 (ddd, 1H), 7.03 (ddd, 1H), 3.94 (s, 2H).

Example 15: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane bromide



1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.79 mmol) and 2-bromo-*N*-pyridin-2-yl-acetamide (Example 15a) (0.87 mmol) stirred together in anhydrous MeCN at room temperature for 2.5 days. The reaction mixture was concentrated *in vacuo* and the yellow solid purified by flash silica gel chromatography eluting with 2-8% MeOH / dichloromethane to give a tan solid which crystallised from boiling MeCN to give the titled compound as a white solid (211 mg).

m/e 462 [M]⁺

¹H NMR (400 MHz, DMSO-*D*₆) δ 11.02 (s, 1H), 8.33 (ddd, 1H), 7.97 (d, 1H), 7.86-7.84 (m, 1H), 7.32-7.25 (m, 4H), 7.23-7.12 (m, 2H), 5.09-5.04 (m, 1H), 4.23 (s, 2H), 4.0 (ddd, 1H), 3.63-3.49 (m, 4H), 3.41-3.29 (m, 1H), 2.37-2.22 (m, 2H), 2.17-2.04 (m, 2H), 1.98-1.83 (m, 3H), 1.78-1.66 (m, 1H), 1.65-1.39 (m, 9H).

Preparation of Example 15: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane bromide Crystalline Form A

1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.79 mmol) and 2-bromo-*N*-pyridin-2-yl-acetamide (Example 15a) (0.87 mmol) stirred together in anhydrous MeCN at room temperature for 2.5 days. The reaction mixture was concentrated *in vacuo* and the yellow solid purified by flash silica gel column chromatography eluting with 2-8% MeOH/dichloromethane to give a tan solid. The solid was dissolved up in refluxing MeCN and the solution was allowed to cool down to room temperature. The resulting crystals were filtered off and washed with a small quantity of cold MeCN to give the title compound (211 mg) as a white crystalline solid.

m/e 462 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 11.02 (s, 1H), 8.33 (ddd, 1H), 7.97 (d, 1H), 7.86-7.84 (m, 1H), 7.32-7.25 (m, 4H), 7.23-7.12 (m, 2H), 5.09-5.04 (m, 1H), 4.23 (s, 2H), 4.00 (ddd, 1H), 3.63-3.49 (m, 4H), 3.41-3.29 (m, 1H), 2.37-2.22 (m, 2H), 2.17-2.04 (m, 2H), 1.98-1.83 (m, 3H), 1.78-1.66 (m, 1H), 1.65-1.39 (m, 9H).

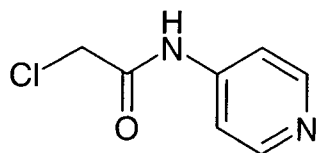
Analysis of Example 15: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane bromide Crystalline Form A

A sample of crystalline Example 15 Crystalline Form A obtained by the procedure described above was analysed by XRPD (PANalytical X'Pert system), DSC and TGA.

The melting temperature of Example 15 bromide Form A as determined by DSC was found to be 230°C (onset) (±2°C). Weight loss observed prior to melting by TGA was negligible. GVS determination gave a negligible weight increase (%w/w) at 80% RH (±0.2%).

An XRPD spectrum of Example 15 bromide Form A is presented in Figure 2.

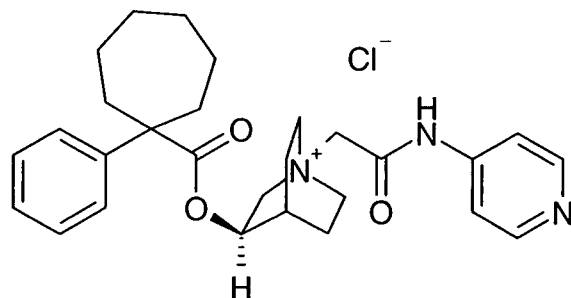
Example 16: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-4-

a) 2-Chloro-*N*-pyridin-4-yl-acetamide

A suspension of 4-aminopyridine (0.96 g) in dry dichloromethane (10 mL) under nitro
 5 was cooled to 0°C in an ice bath. Triethylamine (1.56 mL) was added, followed by the
 slow addition of chloroacetyl chloride (0.89 mL). The ice bath was removed and the
 reaction mixture allowed to reach room temperature. The reaction mixture was diluted
 with water (20 mL) and dichloromethane (25 mL). The solid was filtered off, washed with
 pentane and dried to give the title compound as a brown solid (0.87 g). The layers of the
 10 filtrate were separated and the organic layer was washed with water, dried and the solvent
 was evaporated to give a dark brown glass. Trituration with pentane gave another batch of
 the title compound (0.91 g).

¹H NMR (400 MHz, DMSO-D₆) δ 10.79 (s, 1H), 8.47 (d, 2H), 7.59 (d, 2H), 4.33 (s, 2H)

Example 16: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-4-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride



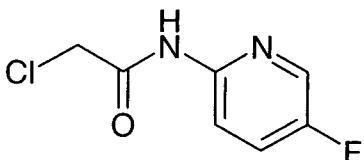
2-Chloro-*N*-pyridin-4-yl-acetamide (Example 16a) (30 mg) was added to a solution of
 20 phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example
 15 (53 mg) in acetonitrile (1 mL). The reaction mixture was stirred at room temperature for
 1 h. Diethyl ether (2 mL) was added and the reaction mixture was filtered to give a light
 brown solid. The solid was washed several times with diethyl ether and dried under
 vacuum at 40°C. Purification by column chromatography eluting with 0-10% MeOH /

m/e 462 $[M]^+$

1H NMR (400 MHz, DMSO- D_6) δ 11.34 (s, 1H), 8.46 (d, 2H), 7.55 (d, 2H), 7.34-7.31 (m, 4H), 7.22-7.17 (m, 1H), 5.08 (m, 1H), 4.30 (s, 2H), 4.11-4.02 (m, 1H), 3.65-3.61 (m, 4H), 3.42-3.30 (m, 1H), 2.38-2.24 (m, 2H), 2.17-2.06 (m, 2H), 1.99-1.84 (m, 3H), 1.79-1.67 (m, 1H), 1.69-1.26 (m, 9H).

Example 17: (*R*)-1-[(5-Fluoro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

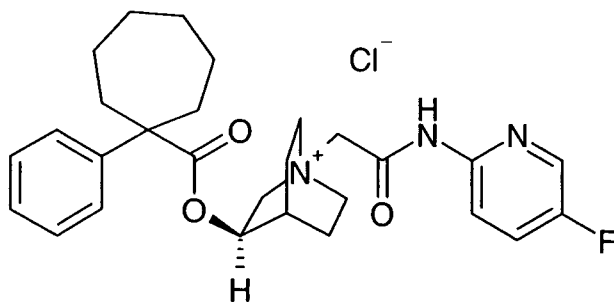
a) 2-Chloro-*N*-(5-fluoro-pyridin-2-yl)-acetamide



The title compound (0.99 g, 73%, white solid) was prepared according to the method in Example 14f but using 2-amino-5-fluoro-pyridine.

1H NMR (400 MHz, DMSO- D_6) δ 10.91 (s, 1H), 8.35 (d, 1H), 8.10 (dd, 1H), 7.80-7.77 (m, 1H), 4.34 (s, 2H).

Example 17: (*R*)-1-[(5-Fluoro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



2-Chloro-*N*-(5-fluoro-pyridin-2-yl)-acetamide (Example 17a) (31 mg) was added to a solution of 1-phenyl-cycloheptanecarboxylic acid (*R*)-1-aza-bicyclo[2.2.2]oct-3-yl ester

temperature overnight. Diethyl ether (2 mL) was added to the reaction mixture and the white solid was filtered off, washed several times with diethyl ether and dried under vacuum at 40°C to give the title compound (49 mg).

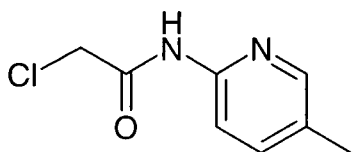
5 m/e 480 [M]⁺

¹H NMR (400 MHz, DMSO-D₆) δ 11.19 (s, 1H), 8.36 (d, 1H), 8.02 (m, 1H), 7.81 (d, 1H), 7.33-7.26 (m, 4H), 7.22-7.17 (m, 1H), 5.07 (m, 1H), 4.26 (s, 2H), 4.11-4.03 (t, 1H), 3.64-3.50 (m, 4H), 3.41-3.29 (m, 1H), 2.36-2.23 (m, 2H), 2.17-2.05 (m, 2H), 1.82 (m, 3H), 1.78-1.65 (m, 1H), 1.70-1.41 (m, 9H).

10

Example 18: (R)-1-[(5-Methyl-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

a) 2-Chloro-*N*-(5-methyl-pyridin-2-yl)-acetamide



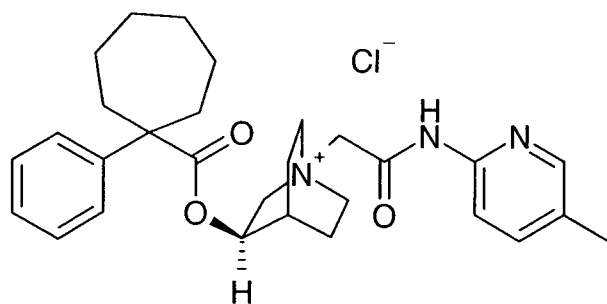
15

The title compound (0.50 g) was prepared according to the method used in Example 1 but using 2-amino-5-picoline.

20 ¹H NMR (400 MHz, DMSO-D₆) δ 10.69 (s, 1H), 8.17 (dt, 1H), 7.95 (d, 1H), 7.63 (d, 1H), 4.32 (s, 2H), 2.25 (s, 3H).

Example 18: (R)-1-[(5-Methyl-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

25



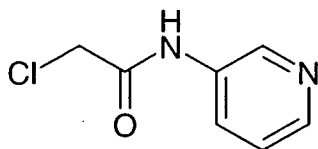
The title compound (36 mg) was prepared according to the method used to prepare Example 17 using 2-chloro-*N*-(5-methyl-pyridin-2-yl)-acetamide (Example 18a) in place of 2-chloro-*N*-(5-fluoro-pyridin-2-yl)-acetamide.

m/e 476 $[M]^+$

1H NMR (400 MHz, DMSO- D_6) δ 10.98 (s, 1H), 8.17 (d, 1H), 7.88 (d, 1H), 7.65 (dd, 1H), 7.33-7.25 (m, 4H), 7.23-7.17 (m, 1H), 5.07 (m, 1H), 4.24 (s, 2H), 4.10-4.02 (t, 1H), 3.64-3.50 (m, 4H), 3.40-3.27 (m, 1H), 2.37-2.22 (m, 2H), 2.23 (s, 3H), 2.17-2.10 (m, 2H), 1.97-1.84 (m, 3H), 1.78-1.66 (m, 1H), 1.66-1.35 (m, 9H).

Example 19: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-3-yl)carbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride

a) 2-Chloro-*N*-pyridin-3-yl-acetamide

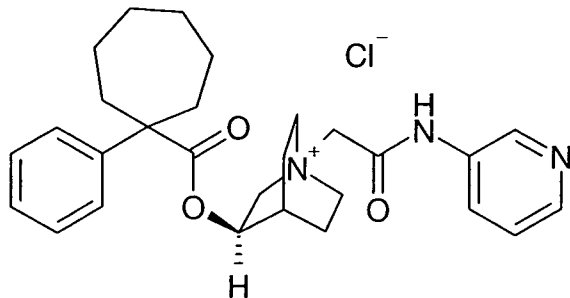


A mixture of 3-aminopyridine (350 mg) and sodium hydroxide (0.6 g) were dissolved in water (8 mL) and the reaction mixture was cooled in an ice bath. Chloroacetyl chloride (1.19 mL) was added dropwise and the reaction mixture was allowed to stir at room temperature overnight. The reaction mixture was extracted with dichloromethane and the organic layer was concentrated and purified by column chromatography, eluting with 60% ethyl acetate / cyclohexane to give the title compound (0.10g) as a white solid.

^1H NMR (400 MHz, DMSO- D_6) δ 10.51 (s, 1H), 8.73 (d, 1H), 8.30 (dd, 1H), 8.03 (d, 1H), 7.40-7.35 (m, 1H), 4.30 (s, 2H).

Example 19: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-3-

ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride



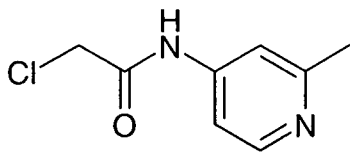
The title compound (78 mg) was prepared by an analogous method to that used in Example 15 using 2-chloro-*N*-pyridin-3-yl-acetamide in place of 2-bromo-*N*-pyridin-2-yl-acetamide.

m/e 462 $[\text{M}]^+$

^1H NMR (400 MHz, DMSO- D_6) δ 11.27 (s, 1H), 8.76 (d, 1H), 8.30 (dd, 1H), 7.98 (d, 1H), 7.37 (ddd, 1H), 7.33-7.25 (m, 4H), 7.22-7.15 (m, 1H), 5.07 (d, 1H), 4.28 (dd, 1H), 4.11-4.03 (m, 1H), 3.65-3.50 (m, 4H), 3.41-3.29 (m, 1H), 2.37-2.21 (m, 2H), 2.19-2.11 (m, 2H), 1.97-1.83 (m, 3H), 1.78-1.66 (m, 1H), 1.71-1.27 (m, 9H).

Example 20: (*R*)-1-[(2-Methyl-pyridin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

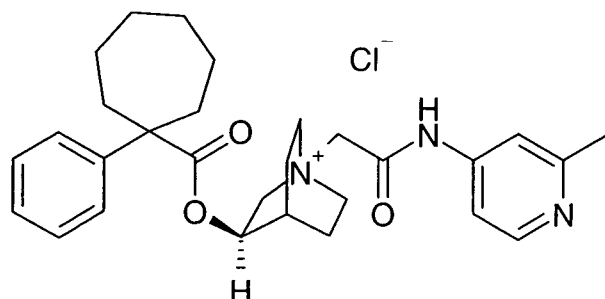
a) 2-Chloro-*N*-(2-methyl-pyridin-4-yl)-acetamide



The title compound (1.0 g) was prepared according to the method used in Example 14 using 4-amino-2-methylpyridine.

^1H NMR (400 MHz, DMSO- D_6) δ 10.64 (s, 1H), 8.32 (d, 1H), 7.44 (d, 1H), 7.38-7.3

Example 20: (R)-1-[(2-Methyl-pyridin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



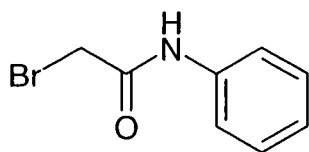
- 5 The title compound was prepared using an analogous procedure to that used to prepare Example 17. Further purification was achieved by silica gel chromatography eluting with 0-20% MeOH / dichloromethane to give the title compound as a white solid (57 mg).

m/e 476 [M]⁺

- 10 ¹H NMR (400 MHz, DMSO-D₆) δ 11.32 (s, 1H), 8.31 (d, 1H), 7.43 (d, 1H), 7.35-7.22 (m, 5H), 7.22-7.16 (m, 1H), 5.09-5.04 (m, 1H), 4.30 (dd, 2H), 4.09-4.01 (m, 1H), 3.49 (m, 4H), 3.41-3.29 (m, 1H), 2.38 (s, 3H), 2.39-2.23 (m, 2H), 2.17-2.05 (m, 2H), 1.97-1.82 (m, 3H), 1.78-1.65 (m, 1H), 1.65-1.41 (m, 9H).

- 15 **Example 21: (R)-1-Phenylcarbamoylmethyl-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide**

a) 2-Bromo-N-phenyl-acetamide

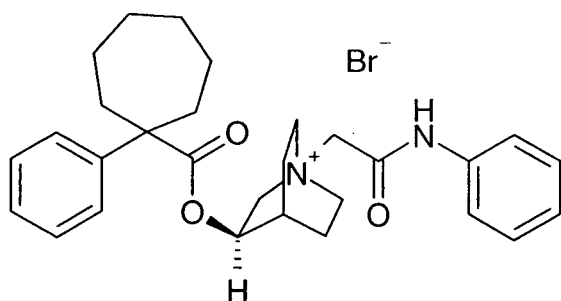


- 20 To a solution of bromoacetyl bromide (9.6 mL) and potassium carbonate (11.4 g) in dichloromethane (100 mL) was added aniline (5 mL) dropwise over 15-20 mins causing the reaction mixture to get warm and a white precipitate to form. After 4.5h the reaction mixture was poured into water, shaken for several minutes and then the phases were separated. The organic layer was washed with water and concentrated to a smaller volume.

resulting in precipitation of a solid that was filtered off to give the sub-titled compound (970 mg) as a white solid.

¹H NMR (400 MHz, CDCl₃): δ 8.10 (s, 1H), 7.53 (d, 2H), 7.40-7.33 (m, 2H), 7.17 (t, 4.03 (s, 2H).

Example 21: (*R*)-1-Phenylcarbamoymethyl-3-(1-phenyl-cycloheptanecarbonyloxy azonia-bicyclo[2.2.2]octane bromide



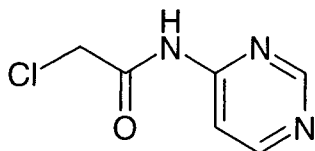
To 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (50 mg) in acetonitrile (1 mL) was added 2-bromo-*N*-phenylacetamide (Example 21a) (36 mg). The reaction mixture was stirred at room temperature for 3 days. Ether was added to the reaction mixture and the resultant solid was collected by filtration and dried to afford the title compound as a colourless solid (39 mg).

m/e 461 [M]⁺

¹H NMR (DMSO-*d*₆): δ 10.49 (s, 1H), 7.53-7.50 (m, 2H), 7.35-7.24 (m, 6H), 7.21-7.11 (m, 1H), 7.12-7.07 (m, 1H), 5.08 (m, 1H), 4.21-4.11 (m, 2H), 4.06 (dd, 1H), 3.64-3.41 (4H), 3.27 (s, 1H), 2.37-2.21 (m, 2H), 2.18-2.04 (m, 2H), 1.98-1.88 (m, 3H), 1.77-1.66 (1H), 1.70-1.30 (m, 9H).

Example 22: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-4-ylcarbamoymethyl)-1-azonia-bicyclo[2.2.2]octane chloride

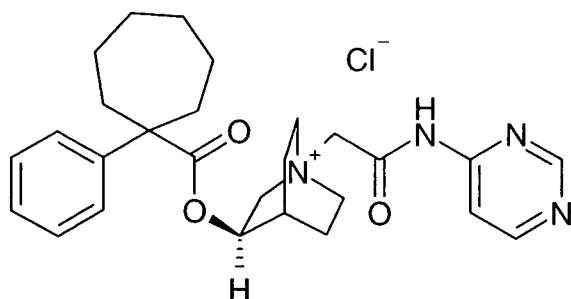
a) 2-Chloro-*N*-pyrimidin-4-yl-acetamide



A solution of chloroacetyl chloride (1.22 mmol) in anhydrous CHCl_3 (2.4 mL) was added slowly to a mixture of 4-aminopyrimidine (1.11 mmol) and Et_3N (1.66 mmol) in anhydrous CHCl_3 (22 mL) at room temperature. The bright yellow mixture gradually
 5 turned orange and after 4 hr the reaction was quenched with H_2O (1 mL). After stirring 15 min the mixture was concentrated to dryness under reduced pressure and the residue purified by flash silica gel chromatography (1-2% MeOH / dichloromethane) to give a yellow solid (122 mg).

10 ^1H NMR (400 MHz, $\text{DMSO}-d_6$): δ 11.21 (s, 1H), 8.93-8.90 (m, 1H), 8.70 (d, 1H), 8.41 (dd, 1H), 4.40 (s, 2H).

Example 22: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-4-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride



15 1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.44 mmol) and 2-chloro-*N*-pyrimidin-4-yl-acetamide (Example 22a) (0.48 mmol) in anhydrous MeCN (2 mL) were stirred together at room temperature for 2.5 days. The reaction mixture was concentrated *in vacuo* and the residue purified by flash silica gel
 20 chromatography (2-10% MeOH/dichloromethane) to give the title compound as a light yellow solid (134 mg).

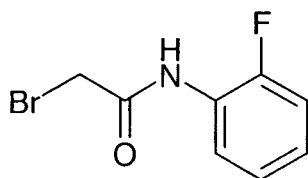
m/e 463 $[\text{M}]^+$

^1H NMR (400 MHz, $\text{DMSO}-d_6$): δ 11.44 (s, 1H), 8.91 (s, 1H), 8.72 (d, 1H), 7.94 (d,

(m, 1H), 3.61-3.49 (m, 4H), 3.40-3.28 (m, 1H), 2.36-2.21 (m, 2H), 2.18-2.04 (m, 2H), 2.00-1.84 (m, 3H), 1.75-1.66 (m, 1H), 1.66-1.39 (m, 9H).

Example 23: (R)-1-[(2-Fluorophenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

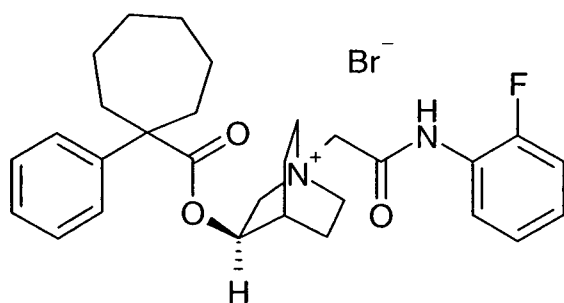
a) 2-Bromo-*N*-(2-fluoro-phenyl)-acetamide



To a mixture of 2-fluoroaniline (2 mL) and potassium carbonate (4.3 g) in dichloromethane (50 mL) was added bromoacetyl bromide (3.6 mL). The reaction mixture was stirred for 10 then water was added and the phases separated. The organic layer was concentrated, the residue treated with ether and evaporated again to give the sub-titled compound (4.98 g) as a cream solid that was used without further purification.

¹H NMR (400 MHz, CDCl₃): δ 8.38 (s, 1H), 8.26 (t, 1H), 7.18-7.09 (m, 3H), 4.05 (s,

Example 23: (R)-1-[(2-Fluorophenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



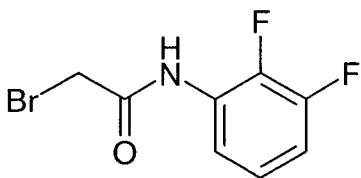
A mixture of 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (56 mg) and 2-bromo-*N*-(2-fluoro-phenyl)-acetamide (Example 2) (44 mg) in acetonitrile (1 mL) was stirred at room temperature for 30 h. The resulting precipitate was collected by filtration, washed with ether and dried under vacuum at 50 °C to give the title compound (52 mg) as a colourless solid.

¹H NMR (400 MHz, DMSO-D₆): δ 10.34 (s, 1H), 7.83-7.77 (m, 1H), 7.32-7.16 (m, 8H), 5.12-5.03 (m, 1H), 4.25 (s, 2H), 4.10-4.02 (m, 1H), 3.63-3.51 (m, 4H), 3.41-3.29 (m, 1H), 2.37-2.23 (m, 2H), 2.17-2.06 (m, 2H), 1.98-1.88 (m, 3H), 1.79-1.67 (m, 1H), 1.39 (s, 9H).

5

Example 24: (R)-1-[(2,3-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

a) 2-Bromo-N-(2,3-difluoro-phenyl)-acetamide



10

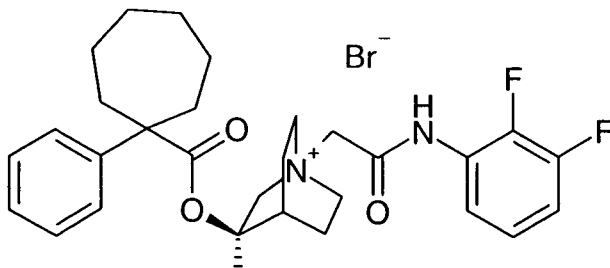
To a mixture of 2,3-difluoroaniline (630 mg) and potassium carbonate (1.01 g) in dichloromethane (30 mL) was added bromoacetyl bromide (0.86 mL). The reaction mixture was stirred for 5h then water was added and the phases separated. The organic layer was concentrated to give a 2:1 mixture of the sub-titled compound and bromoacetyl bromide. The residue was dissolved up in dichloromethane and washed with water. The volatiles were evaporated to give the sub-titled compound (1.15 g) as an off-white solid that was used without further purification.

15

¹H NMR (400 MHz, CDCl₃): δ 8.38 (s, 1H), 8.03 (t, 1H), 7.12-7.05 (m, 1H), 7.00-6.94 (m, 1H), 4.05 (d, 2H).

20

Example 24: (R)-1-[(2,3-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



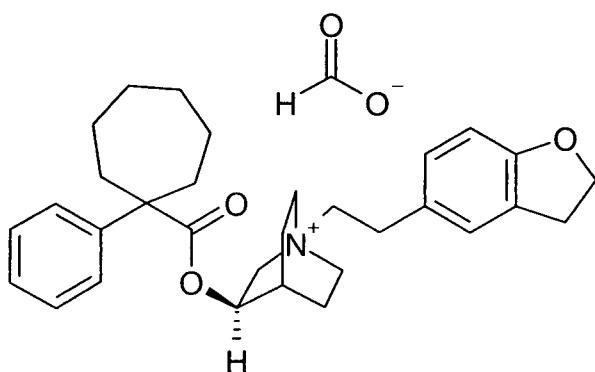
The title compound (colourless solid, 28 mg, 31%) was prepared by a similar procedure that used for Example 23 using 2-bromo-*N*-(2,3-difluoro-phenyl)-acetamide (Example 23) in place of 2-bromo-*N*-(2-fluoro-phenyl)-acetamide.

5 m/e 497 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 10.54 (s, 1H), 7.58 (t, 1H), 7.32-7.16 (m, 7H), 5.04 (m, 1H), 4.26 (s, 2H), 4.10-4.02 (m, 1H), 3.62-3.49 (m, 4H), 3.42-3.29 (m, 1H), 2.37-2.23 (m, 2H), 2.17-2.06 (m, 2H), 1.98-1.85 (m, 3H), 1.79-1.67 (m, 1H), 1.66-1.54 (m, 9H).

10

Example 25: (*R*)-1-[2-(2,3-Dihydro-benzofuran-5-yl)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane formate



15 A mixture of 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (126 mg) and 5-(2-bromo-ethyl)-2,3-dihydro-benzofuran (105 mg, 0.46mmol) in acetonitrile (1.5 mL) was stirred at room temperature for 22h. The volatiles were evaporated and the residue purified by silica gel chromatography eluting with dichloromethane then 5% then 10% MeOH/dichloromethane. The relevant fractions were combined and evaporated and the residue triturated with dichloromethane to give a white foam. Further purification was achieved by reverse-phase HPLC (5-98% MeCN containing 0.1% formic acid) to give the title compound (70 mg) as a white gummy solid.

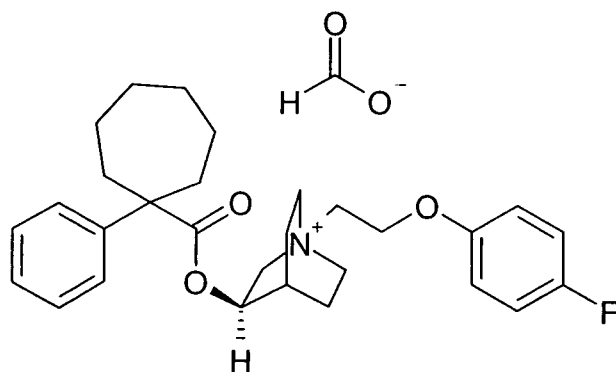
m/e 474 [M]⁺

25 ¹H NMR (400 MHz, DMSO-D₆): δ 8.35 (s, 1H), 7.35-7.26 (m, 4H), 7.24-7.18 (m, 1H), 7.16-7.08 (m, 1H), 7.06-6.98 (m, 1H), 6.96-6.88 (m, 1H), 6.86-6.78 (m, 1H), 6.76-6.68 (m, 1H), 6.66-6.58 (m, 1H), 6.56-6.48 (m, 1H), 6.46-6.38 (m, 1H), 6.36-6.28 (m, 1H), 6.26-6.18 (m, 1H), 6.16-6.08 (m, 1H), 6.06-5.98 (m, 1H), 5.96-5.88 (m, 1H), 5.86-5.78 (m, 1H), 5.76-5.68 (m, 1H), 5.66-5.58 (m, 1H), 5.56-5.48 (m, 1H), 5.46-5.38 (m, 1H), 5.36-5.28 (m, 1H), 5.26-5.18 (m, 1H), 5.16-5.08 (m, 1H), 5.06-4.98 (m, 1H), 4.96-4.88 (m, 1H), 4.86-4.78 (m, 1H), 4.76-4.68 (m, 1H), 4.66-4.58 (m, 1H), 4.56-4.48 (m, 1H), 4.46-4.38 (m, 1H), 4.36-4.28 (m, 1H), 4.26-4.18 (m, 1H), 4.16-4.08 (m, 1H), 4.06-3.98 (m, 1H), 3.96-3.88 (m, 1H), 3.86-3.78 (m, 1H), 3.76-3.68 (m, 1H), 3.66-3.58 (m, 1H), 3.56-3.48 (m, 1H), 3.46-3.38 (m, 1H), 3.36-3.28 (m, 1H), 3.26-3.18 (m, 1H), 3.16-3.08 (m, 1H), 3.06-2.98 (m, 1H), 2.96-2.88 (m, 1H), 2.86-2.78 (m, 1H), 2.76-2.68 (m, 1H), 2.66-2.58 (m, 1H), 2.56-2.48 (m, 1H), 2.46-2.38 (m, 1H), 2.36-2.28 (m, 1H), 2.26-2.18 (m, 1H), 2.16-2.08 (m, 1H), 2.06-1.98 (m, 1H), 1.96-1.88 (m, 1H), 1.86-1.78 (m, 1H), 1.76-1.68 (m, 1H), 1.66-1.58 (m, 1H), 1.56-1.48 (m, 1H), 1.46-1.38 (m, 1H), 1.36-1.28 (m, 1H), 1.26-1.18 (m, 1H), 1.16-1.08 (m, 1H), 1.06-0.98 (m, 1H), 0.96-0.88 (m, 1H), 0.86-0.78 (m, 1H), 0.76-0.68 (m, 1H), 0.66-0.58 (m, 1H), 0.56-0.48 (m, 1H), 0.46-0.38 (m, 1H), 0.36-0.28 (m, 1H), 0.26-0.18 (m, 1H), 0.16-0.08 (m, 1H), 0.06-0.08 (m, 1H).

1H), 3.47-3.25 (m, 5H), 3.20-3.06 (m, 3H), 3.04-2.97 (m, 1H), 2.86-2.75 (m, 2H), 2.23 (m, 2H), 2.18-2.10 (m, 2H), 2.01-1.78 (m, 3H), 1.69-1.44 (m, 10H).

Example 26: (R)-1-[2-(4-Fluoro-phenoxy)-ethyl]-3-(1-phenyl-

cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane formate



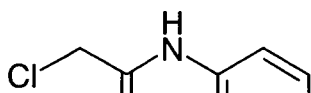
A mixture of 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (50 mg) and 1-(2-bromoethoxy)-4-fluorobenzene (50 mg) in acetonitrile (1 mL) was stirred at room temperature for 22h. Purification by prep. HPL using 5-98% MeCN/H₂O containing 0.1% formic acid gave the title compound (19 mg) a colourless oil.

m/e 466 [M]⁺

¹H NMR (400 MHz, DMSO-*d*₆): δ 8.39 (s, 1H), 7.28-7.23 (m, 4H), 7.20-7.11 (m, 3H), 6.97-6.92 (m, 2H), 5.06-4.99 (m, 1H), 4.39-4.28 (m, 2H), 3.93 (ddd, 1H), 3.70-3.56 (m, 2H), 3.56-3.46 (m, 4H), 3.15-3.03 (m, 1H), 2.35-2.20 (m, 2H), 2.15-2.03 (m, 2H), 1.78 (m, 3H), 1.73-1.61 (m, 1H), 1.61-1.39 (m, 9H).

Example 27: (R)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-(pyridazin-4-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane formate

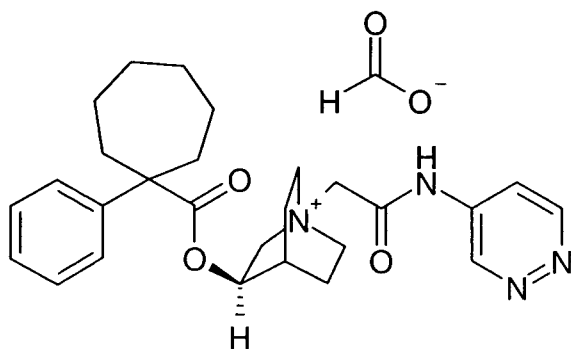
a) 2-Chloro-*N*-pyridazin-4-yl-acetamide



A solution of pyridazin-4-ylamine (1.0 g) in dry dichloromethane (10 mL) under nitro
 was cooled to 0°C in an ice bath. Triethylamine (1.6 mL) was added, followed by slo
 addition of chloroacetyl chloride (0.92 mL). On completion of the addition the ice bat
 removed and the reaction mixture was allowed to reach room temperature and stirred
 5 hours. The reaction mixture was diluted with water (25 mL) and dichloromethane (30
 A solid was filtered off and washed with pentane, water and more pentane to give the
 titled compound (0.87g, 48%) as a brown solid.

¹H NMR (400 MHz, DMSO-D₆): δ 11.17 (s, 1H), 9.33 (dd, 1H), 9.07 (dd, 1H), 7.94
 10 1H), 4.39 (s, 2H).

Example 27: (R)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-(pyridazin-4-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane formate



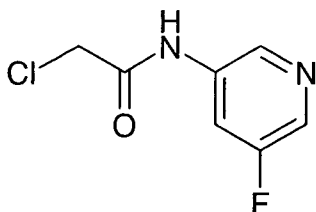
15 2-Chloro-*N*-pyridazin-4-yl-acetamide (Example 27a) (58 mg) was added to a solution
 phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example
 (100 mg) in acetonitrile (2 mL). The reaction mixture was allowed to stir at room
 temperature for 24h. Diethyl ether (2 mL) was added to the reaction mixture and stirre
 15 minutes. The solid was filtered off, washed with diethyl ether, and dried under vac
 at 40°C overnight. The filtrate was evaporated, combined with the solid and purified b
 20 column chromatography, eluting with 0-15% MeOH/dichloromethane. Further purific
 by reverse-phase prep HPLC with gradient elution from 15% MeCN/H₂O containing
 formic acid increasing by 1% per minute gave the title compound (19 mg) as a colour
 gum.

¹H NMR (400 MHz, DMSO-D₆): δ 9.17 (s, 1H), 8.89 (d, 1H), 8.41 (s, 1H), 7.80 (dd, 1H), 7.32-7.25 (m, 4H), 7.21-7.15 (m, 1H), 5.08-5.02 (m, 1H), 4.28-4.14 (m, 2H), (dd, 1H), 3.66 (d, 2H), 3.62-3.48 (m, 2H), 3.45-3.33 (m, 1H), 2.37-2.23 (m, 2H), 2.05 (m, 2H), 1.96-1.83 (m, 3H), 1.75-1.62 (m, 1H), 1.56-1.42 (m, 9H).

5

Example 28: (R)-1-[(5-Fluoro-pyridin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

a) 2-Chloro-*N*-(5-fluoro-pyridin-3-yl)-acetamide



10

A solution of 3-amino-5-fluoropyridine (1 g) in dry dichloromethane (10 mL) under nitrogen was cooled to 0°C in an ice bath. Triethylamine (1.36 mL) was added followed by slow addition of chloroacetyl chloride (0.78 mL). On completion of the addition, the ice bath was removed and the reaction mixture was allowed to reach room temperature and was stirred for 2 hours. The reaction mixture was diluted with water (25 mL) and dichloromethane (30 mL). The organic layer was washed with water (2 x 20 mL), dried (MgSO₄) and evaporated to give the crude product. Purification was achieved by silica chromatography eluting with 0-30% ethyl acetate/cyclohexane to give the sub-titled compound (1.0 g) as a tan coloured solid.

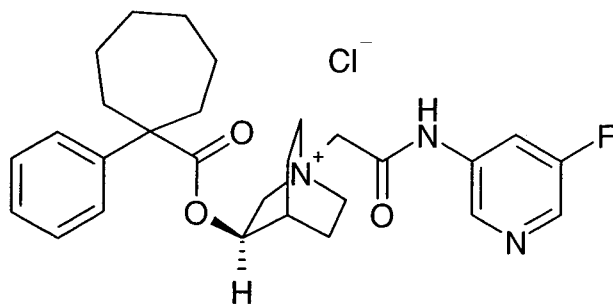
15

¹H NMR (400 MHz, DMSO-D₆): δ 10.77 (s, 1H), 8.56 (t, 1H), 8.33 (d, 1H), 8.04 (dt, 1H), 4.33 (s, 2H).

Example 28: (R)-1-[(5-Fluoro-pyridin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

20

25



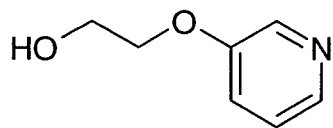
2-Chloro-*N*-(5-fluoro-pyridin-3-yl)-acetamide (Example 28a) (53 mg) was added to a solution of 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) e (Example 14e) (84 mg) in acetonitrile (2 mL). The reaction mixture was allowed to sit at room temperature for 24h. The solid was filtered off and dried under vacuum at 40°C to give the title compound (47 mg, 35%) as a white solid.

m/e 480 $[M]^+$

1H NMR (400 MHz, DMSO- D_6): δ 11.53 (s, 1H), 8.58 (s, 1H), 8.34 (d, 1H), 7.99 (d, 1H), 7.32-7.25 (m, 4H), 7.21-7.15 (m, 1H), 5.09-5.04 (m, 1H), 4.29 (s, 2H), 4.10-4.05 (m, 1H), 3.63-3.51 (m, 4H), 3.41-3.29 (m, 1H), 2.37-2.23 (m, 2H), 2.16-2.05 (m, 2H), 1.96-1.83 (m, 3H), 1.78-1.65 (m, 1H), 1.65-1.39 (m, 9H).

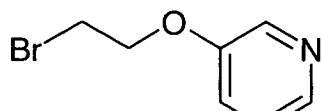
Example 29: (*R*)-3-(1-phenyl-cycloheptanecarboxyloxy)-1-[2-(pyridin-3-yloxy)-ethyl]-1-azonia-bicyclo[2.2.2]octane formate

a) 2-(Pyridin-3-yloxy)-ethanol



The sub-titled compound (0.99g, 63%) was prepared according to the procedure described in WO2004/000829.

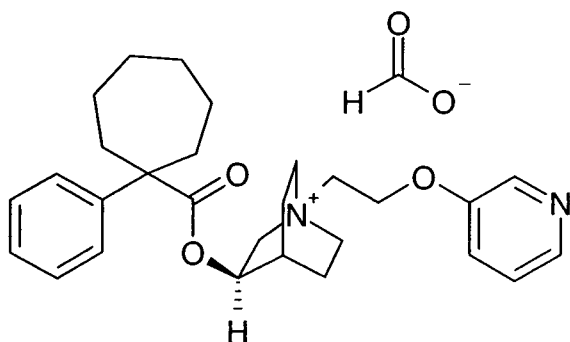
b) 3-(2-Bromo-ethoxy)-pyridine



A solution of 2-(pyridin-3-yloxy)-ethanol (200 mg) in 5 mL dichloromethane was cooled to 0°C and treated with carbon tetrabromide (524 mg) followed by triphenylphosphine (mg) portionwise. The reaction mixture was stirred at 0°C for 30 mins then at room temperature for 45 mins. The volatiles were evaporated and the residue purified by silica gel chromatography eluting with 0-100% EtOAc/pentane to give the title compound (mg) as a colourless liquid which was used without further purification.

¹H NMR (400 MHz, CDCl₃): δ 8.34 (dd, 1H), 8.28-8.22 (m, 1H), 7.25-7.20 (m, 2H), (t, 2H), 3.66 (t, 2H).

Example 29: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-[2-(pyridin-3-yloxy)-ethyl-azonia-bicyclo[2.2.2]octane formate

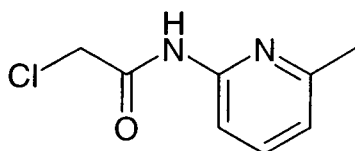


The title compound (10 mg, 13%, colourless gum) was prepared using a procedure analogous to that used for the preparation of Example 25 using 3-(2-Bromo-ethoxy)-pyridine (Example 29b) in place of 5-(2-bromo-ethyl)-2,3-dihydro-benzofuran.

m/e 449 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 8.51 (s, 1H), 8.29 (d, 1H), 8.21 (dd, 1H), 7.38-7.28 (m, 2H), 7.28-7.24 (m, 4H), 7.19-7.14 (m, 1H), 5.06-4.99 (m, 1H), 4.51-4.39 (m, 2H), 3.99-3.90 (m, 1H), 3.74-3.59 (m, 2H), 3.57-3.37 (m, 3H), 3.14-3.05 (m, 1H), 2.36-2.14 (m, 2H), 2.14-2.05 (m, 2H), 1.98-1.82 (m, 3H), 1.74-1.62 (m, 1H), 1.62-1.38 (m, 9H).

Example 30: (R)-1-[(6-Methyl-pyridin-2-ylcarbonyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



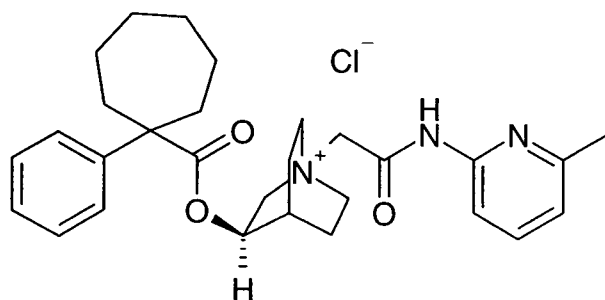
The sub-titled compound (0.95g, 58%, white solid) was prepared by a similar procedure that used for the preparation of Example 28a using 2-amino-6-picoline in place of 3-amino-5-fluoropyridine.

5

^1H NMR (400 MHz, DMSO- D_6): δ 10.73 (s, 1H), 7.86 (d, 1H), 7.69 (t, 1H), 7.03-6.91 (m, 1H), 4.32 (s, 2H), 2.41 (s, 3H).

Example 30: (R)-1-[(6-Methyl-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

10



The title compound (34 mg, 43%, white solid) was prepared using a similar method to used to prepare Example 17 using 2-chloro-*N*-(6-methyl-pyridin-2-yl)-acetamide (Example 30a) in place of 2-chloro-*N*-(5-fluoro-pyridin-2-yl)-acetamide.

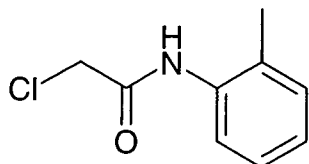
15

m/e 476 $[\text{M}]^+$

^1H NMR (400 MHz, DMSO- D_6): δ 11.01 (s, 1H), 7.79 (d, 1H), 7.71 (t, 1H), 7.32-7.27 (m, 4H), 7.23-7.16 (m, 1H), 7.02 (d, 1H), 5.09-5.04 (m, 1H), 4.24 (s, 2H), 4.06 (dd, 1H), 3.63-3.50 (m, 4H), 3.38-3.29 (m, 1H), 2.38 (s, 3H), 2.38-2.23 (m, 2H), 2.17-2.00 (m, 2H), 2.00-1.82 (m, 3H), 1.78-1.66 (m, 1H), 1.65-1.40 (m, 9H).

20

Example 31: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*o*-tolylcarbamoyl)-met 1-azonia-bicyclo[2.2.2]octane bromide



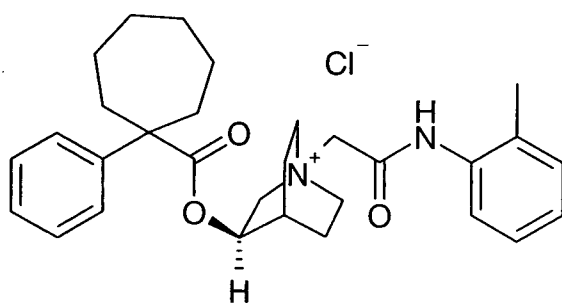
The sub-titled compound (0.83g, 49%, off-white solid) was prepared using a procedure similar to that used to prepare Example 28a using *o*-toluidine in place of 3-amino-5-fluoropyridine.

5

¹H NMR (400 MHz, DMSO-D₆): δ 9.62 (s, 1H), 7.39 (d, 1H), 7.23-7.08 (m, 3H), 4.22 (s, 2H), 2.23 (s, 3H).

Example 31: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*o*-tolylcarbamoyl-met
1-azonia-bicyclo[2.2.2]octane bromide

10



The title compound (25 mg, 35%, white solid) was prepared using a similar method to that used to prepare Example 17 using 2-chloro-*N*-*o*-tolyl-acetamide (Example 31a) in place of 2-chloro-*N*-(5-fluoro-pyridin-2-yl)-acetamide.

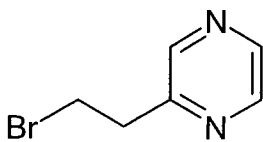
15

m/e 475 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 10.26 (s, 1H), 7.34 (dd, 1H), 7.31-7.25 (m, 4H), 7.09 (m, 4H), 5.11-5.05 (m, 1H), 4.31 (dd, 2H), 4.07 (ddd, 1H), 3.68-3.52 (m, 4H), 3.40-3.31 (m, 1H), 2.38-2.22 (m, 2H), 2.19 (s, 3H), 2.17-2.06 (m, 2H), 1.97-1.84 (m, 3H), 1.79-1.67 (m, 1H), 1.65-1.39 (m, 9H).

20

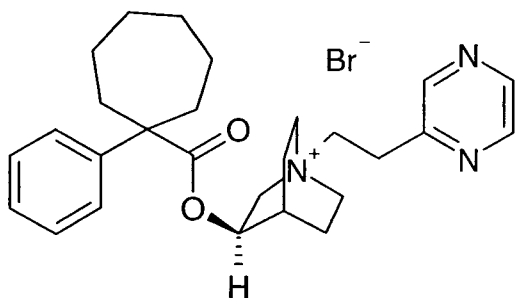
Example 32: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(2-pyrazin-2-yl-ethyl)-1-azonia-bicyclo[2.2.2]octane bromide



To a solution of 2-(2'-hydroxyethyl)pyrazine (0.91 g) in 30 mL dichloromethane at 0°C was added carbon tetrabromide (2.65 g) followed by triphenylphosphine (2.1 g) portionwise. The solution became very dark. After stirring for 1h the reaction mixture
 5 adsorbed onto HMN diatomaceous earth and purified by silica gel chromatography eluting with 0-5% MeOH/dichloromethane to give a cream solid (3.07g) that was purified further by silica gel chromatography eluting with 0-50% EtOAc/pentane to give the sub-titled compound (0.47g, 34%) as a yellow oil.

10 ¹H NMR (400 MHz, CDCl₃): δ 8.56-8.48 (m, 3H), 3.78 (t, 2H), 3.37 (t, 2H).

Example 32: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(2-pyrazin-2-yl-ethyl)-azonia-bicyclo[2.2.2]octane bromide



15 2-(2-Bromo-ethyl)-pyrazine (Example 32a) (43 mg) was added to a solution of 1-phenyl-cycloheptanecarboxylic acid (R)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (5 mg) in acetonitrile (1 mL). The reaction mixture was allowed to stir at room temperature for 68h. The volatiles were evaporated and the product was purified by silica gel chromatography eluting with 0-20% MeOH/dichloromethane. The relevant fractions were
 20 combined and concentrated, dissolved up in dichloromethane, filtered and evaporated to give the title compound (30 mg) as a yellow gummy glass.

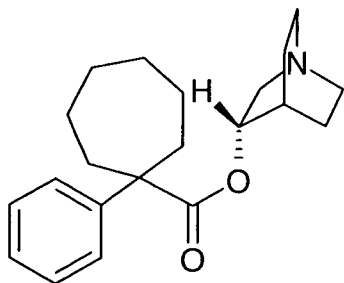
m/e 434 [M]⁺

¹H NMR (400 MHz, CD₃OD): δ 8.60 (d, 1H), 8.54 (dd, 1H), 8.51 (d, 1H), 7.31-7.24

3H), 3.24-3.12 (m, 3H), 3.08-2.97 (m, 1H), 2.36-2.19 (m, 2H), 2.15-2.06 (m, 2H), 1.78 (m, 3H), 1.71-1.59 (m, 1H), 1.57-1.37 (m, 9H).

Example 33: (S)-1-(3-Phenoxy-propyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane formate

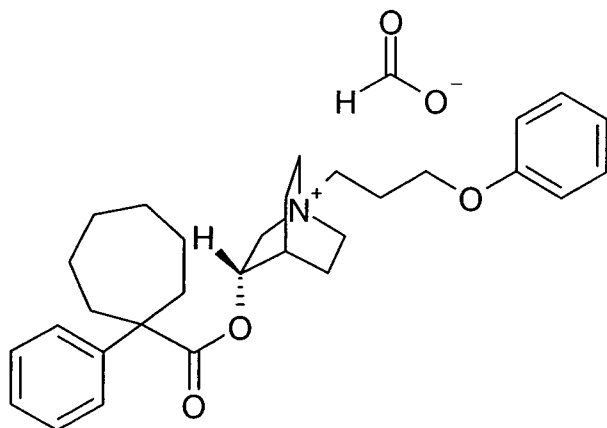
a) 1-Phenyl-cycloheptanecarboxylic acid (S)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester



A solution of (S)-(+)-3-quinuclidinol (299 mg) and 1-phenyl-cycloheptanecarboxylic acid methyl ester (Example 14d) (455 mg) in 6.5 mL dry toluene under nitrogen was treated with a 60% dispersion of sodium hydride (94 mg) and the mixture was heated to reflux for 24h then cooled to room temperature and allowed to stand over the weekend. EtOAc and sat. NaHCO_3 (aq) were added and the phases separated. The aqueous phase was extracted with EtOAc (x3) and the combined organic layer was washed with brine, dried (MgSO_4) and evaporated to afford the crude product. Purification was achieved by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the sub-titled compound (384 mg) as a yellow oil.

^1H NMR (300 MHz, CD_3OD): δ 7.39-7.27 (m, 4H), 7.25-7.14 (m, 1H), 4.80 (dt, 1H), 3.16 (ddd, 1H), 2.83-2.64 (m, 3H), 2.56-2.34 (m, 4H), 2.15-2.04 (m, 2H), 1.91-1.86 (m, 1H), 1.72-1.44 (m, 11H), 1.38-1.25 (m, 1H).

Example 33: (S)-1-(3-Phenoxy-propyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane formate



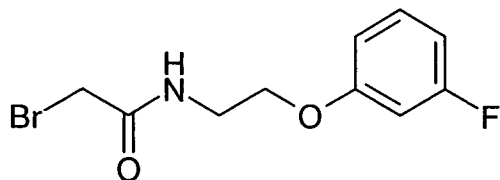
A mixture of 3-phenoxypropyl bromide (0.026 mL) was added to a solution of 1-phenylcycloheptanecarboxylic acid (*S*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 33a) (4 mg) in acetonitrile (1 mL). The reaction mixture was allowed to stir at room temperature for 72hrs then heated to 50°C for 3 days. The volatiles were evaporated and the residue purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give 57 mg of a hygroscopic foam. Further purification was achieved by reverse phase HPLC using a C18 column eluting with 5-95% MeCN/H₂O containing 0.1% formic acid over 30mins gave the title compound (43 mg) as an oil.

m/e 462 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 8.38 (s, 1H), 7.34-7.24 (m, 6H), 7.23-7.17 (m, 1H), 6.94-6.87 (m, 3H), 5.07-4.97 (m, 1H), 3.98 (t, 2H), 3.87-3.77 (m, 1H), 3.44-3.26 (m, 5H), 3.16-3.09 (m, 1H), 3.01-2.90 (m, 1H), 2.38-2.23 (m, 2H), 2.16-1.77 (m, 7H), 1.43 (m, 10H).

Example 34: (*R*)-1-[[2-(3-Fluoro-phenoxy)-ethylcarbamoyl]-methyl]-3-(1-phenylcycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

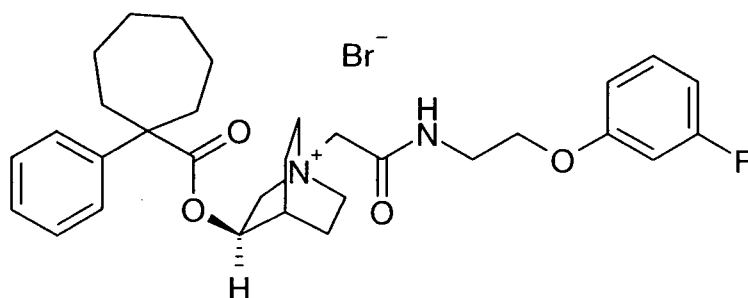
a) 2-Bromo-*N*-[2-(3-fluoro-phenoxy)-ethyl]-acetamide



A mixture of 2-(3-fluorophenoxy)ethylamine (0.93 g) and potassium carbonate (1.24 g) in dichloromethane (20 mL) at 0°C was treated with bromoacetyl bromide (1.04 mL). The reaction mixture was stirred at 0°C for 30mins then at room temperature for 6h. Water was added and the mixture was stirred until effervescence ceased. The organic layer was separated and the organic layer was evaporated to afford the crude product which was purified by silica gel chromatography eluting with 0-50% EtOAc/pentane to give the titled compound (1.17 g) as a brown oil.

¹H NMR (400 MHz, CDCl₃): δ 7.24 (dt, 1H), 6.90 (s, 1H), 6.71-6.66 (m, 2H), 6.63 (d, 1H), 4.06 (t, 2H), 3.90 (s, 2H), 3.71 (q, 2H).

Example 34: (R)-1-[[2-(3-Fluoro-phenoxy)-ethylcarbamoyl]-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

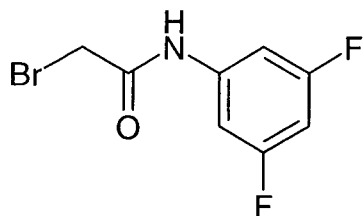


The title compound (70 mg, 76%, yellow foam) was prepared by a similar procedure to that used to prepare Example 32 using 2-bromo-*N*-[2-(3-fluoro-phenoxy)-ethyl]-acetamide (Example 34a) in place of 2-(2-bromo-ethyl)-pyrazine.

m/e 523 [M]⁺

¹H NMR (400 MHz, DMSO-*d*₆): δ 8.74 (t, 1H), 7.33-7.23 (m, 5H), 7.23-7.16 (m, 1H), 6.79-6.71 (m, 3H), 5.09-5.02 (m, 1H), 4.03-3.94 (m, 5H), 3.57-3.40 (m, 6H), 3.33-3.25 (m, 1H), 2.35-2.20 (m, 2H), 2.10 (d, 2H), 1.96-1.82 (m, 3H), 1.74-1.62 (m, 1H), 1.61-1.40 (m, 9H).

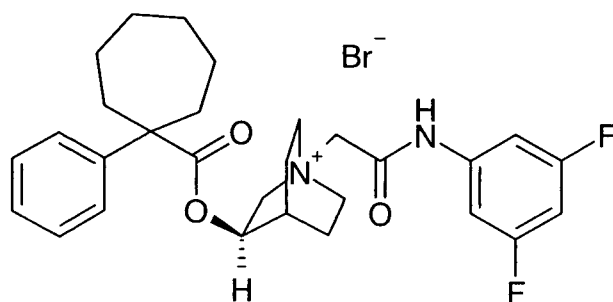
Example 35: (R)-1-[(3,5-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

a) 2-Bromo-*N*-(3,5-difluoro-phenyl)-acetamide

The sub-titled compound (2.02 g, colourless waxy solid) was prepared using a similar procedure to that used for the preparation of Example 38a but using 3,5-difluoroaniline
 5 place of 2,6-difluoroaniline.

¹H NMR (400 MHz, CDCl₃): δ 8.17 (s, 1H), 7.16 (d, 2H), 6.63 (td, 1H), 4.02 (s, 2H).

Example 35: (*R*)-1-[(3,5-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

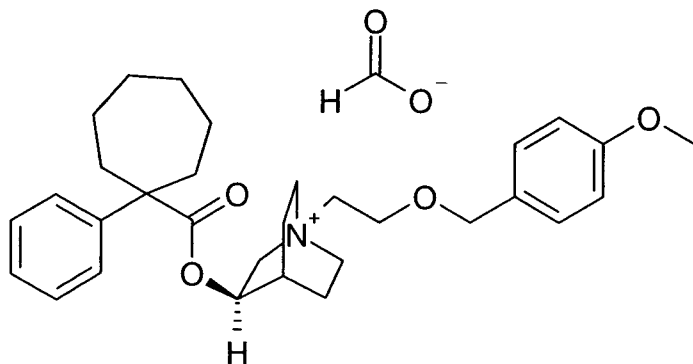


A mixture of 2-bromo-*N*-(3,5-difluoro-phenyl)-acetamide (42 mg) (Example 35a) and phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 35b) (50 mg) in MeCN (1 mL) was stirred at room temperature for 72h. The solid precipitate
 15 was filtered off, washed with ether and dried at 50°C under vacuum overnight. The mother liquors were evaporated, treated with ether and the resulting solid was filtered off. The solids were combined and crystallised from hot isopropyl alcohol to give the title compound (15 mg) as a colourless solid.

^{m/e} 497 [M]⁺

¹H NMR (400 MHz, DMSO-*d*₆): δ 10.89 (s, 1H), 7.33-7.17 (m, 7H), 7.01 (tt, 1H), 5.06 (m, 1H), 4.26-4.14 (m, 2H), 4.10-4.01 (m, 1H), 3.63-3.49 (m, 4H), 3.43-3.32 (m, 1H), 3.28-3.22 (m, 2H), 3.18-3.06 (m, 2H), 1.98-1.86 (m, 2H), 1.70-1.67 (m, 1H), 1.48-1.45 (m, 1H).

Example 36: (*R*)-1-[2-(4-methoxy-benzyloxy)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane formate



5

A mixture of 1-(2-bromo-ethoxymethyl)-4-methoxy-benzene (42 mg) and 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (5 mg) in MeCN (1 mL) was stirred at room temperature for 16h then heated to 80°C under nitrogen overnight. A further 1.1 equivalents of 1-(2-bromo-ethoxymethyl)-4-methoxy-benzene were added and the mixture was heated at 80°C for a further 48h. The volatiles were evaporated and the crude product was purified by silica gel chromatography eluted with 0-10% of a 10% conc. NH₃/MeOH solution in dichloromethane to give 61 mg of a product that was purified further by reverse phase HPLC (Gemini 5μM C6 phenyl column) eluted with 5-95% MeOH/H₂O containing 0.1% formic acid over 30min with UV detection at 220nm. The relevant fractions were combined and evaporated to afford the title compound (34 mg) as an oil.

15

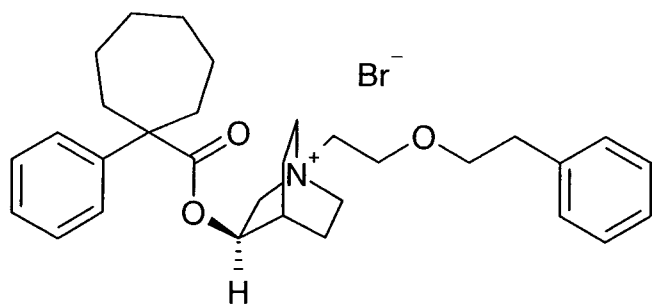
m/e 492 [M]⁺

¹H NMR (400 MHz, CD₃OD): δ 8.48 (s, 1H), 7.31-7.16 (m, 7H), 6.91-6.86 (m, 2H), 5.09-5.03 (m, 1H), 4.44-4.39 (m, 2H), 3.92-3.63 (m, 6H), 3.46-3.29 (m, 5H), 2.99-2.91 (m, 1H), 2.43-2.28 (m, 2H), 2.24-2.20 (m, 1H), 2.15-1.86 (m, 4H), 1.75-1.51 (m, 10H).

20

Example 37: (*R*)-1-(2-Phenethyloxy-ethyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

25



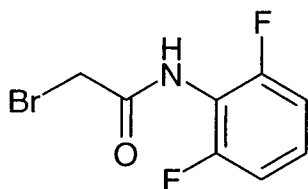
The title compound (68 mg, 77%, gummy solid) was prepared according to a similar procedure to that used for Example 36 using [2-(2-bromo-ethoxy)-ethyl]-benzene in place of 1-(2-bromo-ethoxymethyl)-4-methoxy-benzene.

m/e 476 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 7.32-7.11 (m, 10H), 5.00-4.92 (m, 1H), 3.80-3.65 (m, 3H), 3.60 (t, 2H), 3.41-3.11 (m, 6H), 2.99-2.88 (m, 1H), 2.77 (t, 2H), 2.38-2.21 (m, 2H), 2.17-2.04 (m, 2H), 1.99-1.89 (m, 1H), 1.84-1.67 (m, 2H), 1.67-1.32 (m, 10H).

Example 38: (R)-1-[(2,6-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

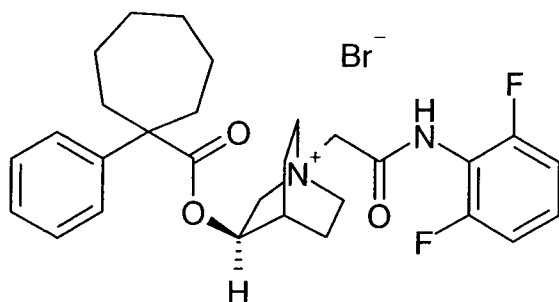
a) 2-Bromo-N-(2,6-difluoro-phenyl)-acetamide



To a mixture of 2,6-difluoroaniline (1.12 g) and potassium carbonate (1.8 g) in 50 mL dichloromethane was added bromoacetyl bromide (1.5 mL) and the mixture was stirred at room temperature for 17h. Water was added and the mixture stirred for several hours then the phases were separated on a hydrophobic frit and the organic layer was evaporated. The crude product was purified by silica gel chromatography eluting with 0-100% EtOAc/cyclohexane to give the sub-titled compound (0.92 g) as a white solid.

¹H NMR (400 MHz, CDCl₃): δ 7.74 (s, 1H), 7.31-7.21 (m, 1H), 6.98 (t, 2H), 4.08 (s, 2

Example 38: (*R*)-1-[(2,6-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



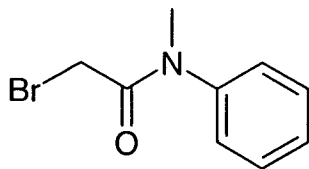
A mixture of 2-bromo-*N*-(2,6-difluoro-phenyl)-acetamide (Example 38a) (42 mg) and phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 5 (50 mg) in MeCN (1 mL) was stirred at room temperature for 19h. A further 20 mg 2-bromo-*N*-(2,6-difluoro-phenyl)-acetamide was added and stirring continued for another 22h. The volatiles were evaporated and the residue was purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the title compound (41 mg) as a colourless foam.

m/e 497 $[M]^+$

1H NMR (400 MHz, DMSO- D_6): δ 10.40 (s, 1H), 7.42-7.35 (m, 1H), 7.31-7.25 (m, 4H), 7.22-7.16 (m, 3H), 5.12-5.05 (m, 1H), 4.32-4.27 (m, 2H), 4.10-4.02 (m, 1H), 3.66-3.58 (m, 4H), 3.43-3.31 (m, 1H), 2.36-2.21 (m, 2H), 2.17-2.06 (m, 2H), 1.99-1.85 (m, 3H), 1.77-1.66 (m, 1H), 1.68-1.25 (m, 9H).

Example 39: (*R*)-1-[(Methyl-phenyl-carbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane formate

a) 2-Bromo-*N*-methyl-*N*-phenyl-acetamide

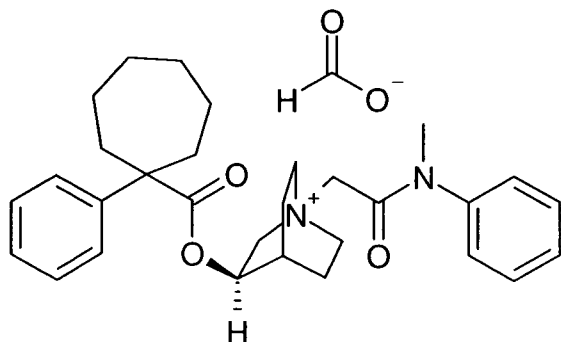


To a mixture of *N*-methyl aniline (5 mL) and potassium carbonate (9.6 g) in 100 mL

concentrated. The crude product was purified by silica gel chromatography eluting with 100% EtOAc/cyclohexane. The relevant fractions were combined and evaporated and residue was taken up in dichloromethane and washed with water. The organic layer was stirred with another portion of water for a few minutes and then the layers were separated. Evaporation of the organic layer gave the sub-titled compound (10.2 g) as a straw colored solid.

^1H NMR (400 MHz, CDCl_3): δ 7.50-7.36 (m, 3H), 7.31-7.26 (m, 2H), 3.67 (s, 2H), 3.41 (s, 3H).

Example 39: (*R*)-1-[(Methyl-phenyl-carbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane formate

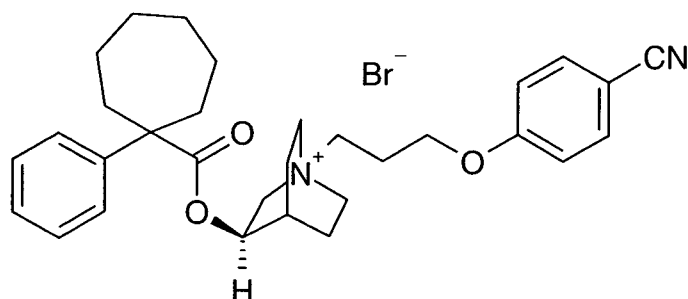


A mixture of 2-bromo-*N*-methyl-*N*-phenyl-acetamide ((Example 39a) (38 mg) and 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 39b) (50 mg) in 1 mL MeCN was stirred at room temperature for 48h. The volatiles were evaporated and the residue purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane. Further purification by reverse phase HPLC eluting with 20% MeCN/ H_2O containing 0.1% formic acid gave the title compound (17 mg) as a colourless gum.

m/e 475 $[\text{M}]^+$

^1H NMR (400 MHz, $\text{DMSO}-d_6$ with a drop of TFA- d_4): δ 8.08 (s, 1H), 7.47 (t, 2H), 7.32-7.23 (dd, 3H), 7.32-7.23 (m, 4H), 7.20-7.15 (m, 1H), 5.09-4.98 (m, 1H), 4.01-3.83 (m, 3H), 3.61-3.34 (m, 5H), 3.16-3.09 (s, 3H), 2.37-2.21 (m, 2H), 2.16-2.05 (m, 2H), 1.96-1.7

Example 40: (*R*)-1-[3-(4-Cyano-phenoxy)-propyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



- 5 A mixture of 4-(3-bromo-propoxy)-benzonitrile (41 mg) and 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (5 mg) in MeCN (1 mL) was stirred at room temperature for 16h then heated to 80°C under nitrogen for a further 16h. The volatiles were evaporated and the residue was triturated with ether to give an off-white solid that was triturated with EtOAc and dried under vacuum to give the title compound (61 mg) as a white solid.

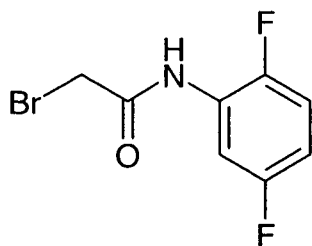
m/e 487 $[M]^+$

- 1H NMR (400 MHz, DMSO- D_6): δ 7.78-7.73 (m, 2H), 7.33-7.26 (m, 4H), 7.22-7.17 (m, 1H), 7.09-7.04 (m, 2H), 5.05-4.99 (m, 1H), 4.08 (t, 2H), 3.82 (ddd, 1H), 3.43-3.26 (m, 5H), 3.21-3.08 (m, 1H), 3.02-2.90 (m, 1H), 2.39-2.22 (m, 2H), 2.17-2.00 (m, 4H), 1.78 (m, 3H), 1.68-1.43 (m, 10H).

Example 41: (*R*)-1-[(2,5-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

20

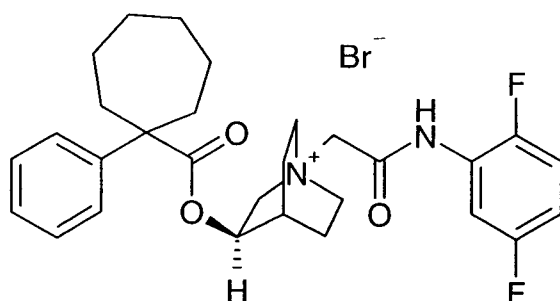
a) 2-Bromo-*N*-(2,5-difluoro-phenyl)-acetamide



The sub-titled compound (3.6g, 90%, orange solid) was prepared by a similar procedure that used to prepare Example 38a using 2,5-difluoroaniline in place of 2,6-difluoroaniline.

¹H NMR (400 MHz, CDCl₃): δ 8.42 (s, 1H), 8.13 (ddd, 1H), 7.08 (ddd, 1H), 6.82-6.77 (m, 1H), 4.04 (s, 2H).

Example 41: (*R*)-1-[(2,5-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

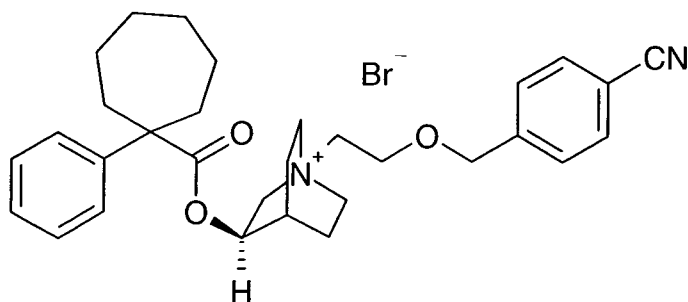


A mixture of 2-bromo-*N*-(2,5-difluoro-phenyl)-acetamide (Example 41a) (47 mg) and phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 38a) (56 mg) in MeCN (1 mL) was stirred at room temperature for 30h. The resulting precipitate was filtered off, washed with ether and dried at 50°C under vacuum overnight to afford the title compound (65 mg) as a colourless solid.

m/e 497 [M]⁺

¹H NMR (400 MHz, DMSO-*d*₆): δ 10.51 (s, 1H), 7.82-7.75 (m, 1H), 7.38-7.26 (m, 1H), 7.21-7.16 (m, 1H), 7.09-7.01 (m, 1H), 5.12-5.06 (m, 1H), 4.25 (s, 2H), 4.05 (ddd, 1H), 3.61-3.48 (m, 4H), 3.42-3.29 (m, 1H), 2.36-2.23 (m, 2H), 2.17-2.06 (m, 2H), 1.98-1.87 (m, 3H), 1.76-1.67 (m, 1H), 1.66-1.41 (m, 9H).

Example 42: (*R*)-1-[2-(4-Cyano-benzyloxy)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



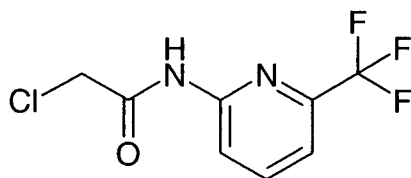
A mixture of 4-(2-bromo-ethoxymethyl)-benzonitrile (41 mg, 0.17mmol) and 1-phenyl
cycloheptanecarboxylic acid (R)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (41
mg) in MeCN (1 mL) was stirred at room temperature for 16h then heated to 80°C under
5 nitrogen overnight. The resulting solid was filtered off, washed with ether and dried under
vacuum to give the title compound (70 mg) as a white solid.

m/e 487 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 7.80 (dd, 2H), 7.48 (d, 2H), 7.31-7.22 (m, 4H), 7.16 (m, 1H), 5.06-4.96 (m, 1H), 4.57 (s, 2H), 3.94-3.78 (m, 3H), 3.56-3.35 (m, 5H),
10 3.27-3.18 (m, 1H), 3.11-3.00 (m, 1H), 2.36-2.18 (m, 2H), 2.08 (d, 2H), 1.98-1.77 (m, 3H), 1.72-1.60 (m, 1H), 1.60-1.38 (m, 9H).

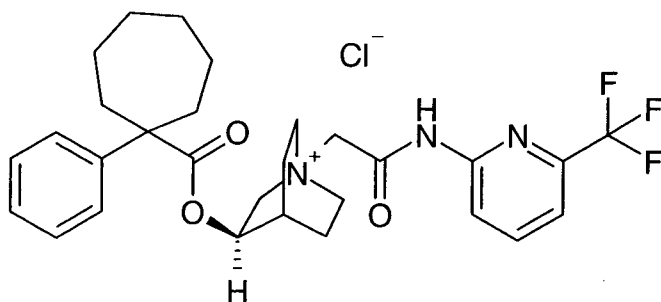
**Example 43: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-[(6-trifluoromethyl-
15 pyridin-2-ylcarbamoyl)-methyl]-1-azonia-bicyclo[2.2.2]octane chloride**

a) 2-Chloro-N-(3-trifluoromethyl-phenyl)-acetamide



The sub-titled compound (1.1g, quant., white solid) was prepared by a similar procedure
20 that used to prepare Example 14f using 2-amino-6-(trifluoromethyl)pyridine in place of
2-amino-pyridine and adding the chloroacetyl chloride at room temperature rather than at
0°C.

Example 43: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-[(6-trifluoromethyl-pyridin-2-ylcarbamoyl)-methyl]-1-azonia-bicyclo[2.2.2]octane chloride



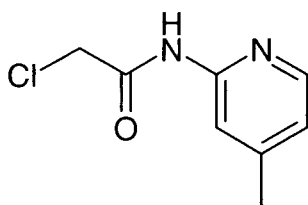
- 5 The title compound (66 mg, 76%, white solid) was prepared by a similar procedure to used to prepare Example 14 using 2-chloro-*N*-(3-trifluoromethyl-phenyl)-acetamide (Example 43a) in place of 2-chloro-*N*-pyridin-2-yl-acetamide.

m/e 530 [M]⁺

- 10 ¹H NMR (400 MHz, DMSO-D₆): δ 11.48 (s, 1H), 8.25 (d, 1H), 8.14 (t, 1H), 7.67 (d, 7.33-7.26 (m, 4H), 7.22-7.17 (m, 1H), 5.12-5.05 (m, 1H), 4.28 (s, 2H), 4.11-4.03 (m, 1H), 3.66-3.49 (m, 4H), 3.41-3.29 (m, 1H), 2.36-2.23 (m, 2H), 2.18-2.06 (m, 2H), 1.82 (m, 3H), 1.79-1.66 (m, 1H), 1.66-1.40 (m, 9H).

- 15 **Example 44: (R)-1-[(4-Methyl-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride**

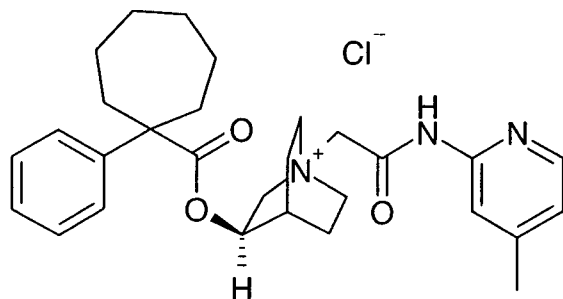
a) 2-Chloro-*N*-(4-methyl-pyridin-2-yl)-acetamide



- 20 The sub-titled compound (1.3g, 74%, solid) was prepared by a similar procedure to that used to prepare Example 14f using 2-amino-4-methylpyridine in place of 2-amino-pyridine and adding the chloroacetyl chloride at room temperature rather than at 0°C.

¹H NMR (400 MHz, CDCl₃): δ 8.77 (s, 1H), 8.17 (d, 1H), 8.03 (s, 1H), 6.93 (d, 1H), (s, 2H), 2.39 (s, 3H).

Example 44: (*R*)-1-[(4-Methyl-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



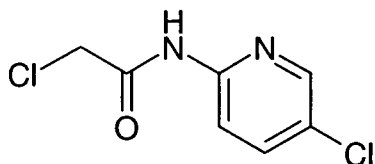
To a solution of 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-ester (Example 14e) (100 mg) in 1 mL MeCN was added 2-chloro-*N*-(4-methyl-pyridinyl)-acetamide (Example 44a) (62 mg) and the mixture was stirred at room temperature 21h. The precipitate was filtered off and dried under vacuum at 50°C to give the title compound (80 mg) as a white solid.

m/e 476 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 10.98 (s, 1H), 8.18 (d, 1H), 7.85 (s, 1H), 7.33-7. (m, 4H), 7.22-7.17 (m, 1H), 7.02-7.00 (m, 1H), 5.11-5.04 (m, 1H), 4.24 (s, 2H), 4. 4.02 (m, 1H), 3.64-3.50 (m, 4H), 3.40-3.29 (m, 1H), 2.42-2.20 (m, 5H), 2.17-2.06 (2H), 1.98-1.84 (m, 3H), 1.79-1.67 (m, 1H), 1.73-1.31 (m, 9H).

Example 45: (*R*)-1-[(5-Chloro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

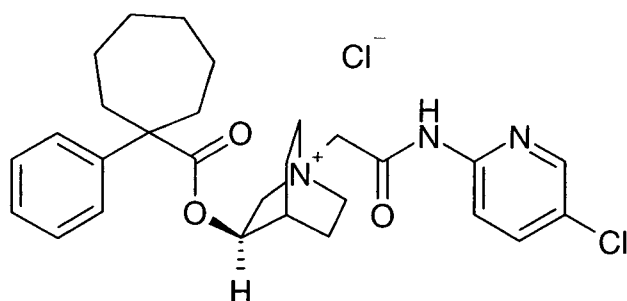
a) 2-Chloro-*N*-(5-chloro-pyridin-2-yl)-acetamide



The sub-titled compound (0.33g, 20%) was prepared by a similar procedure to that used to prepare Example 14f using 2-amino-5-chloropyridine in place of 2-amino-pyridine and adding the chloroacetyl chloride at room temperature rather than at 0°C.

¹H NMR (400 MHz, CDCl₃): δ 8.80 (s, 1H), 8.28 (d, 1H), 8.19 (d, 1H), 7.70 (dd, 1H), 4.20 (d, 2H).

Example 45: (*R*)-1-[(5-Chloro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



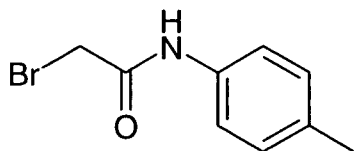
The title compound (103 mg, 63%, white solid) was prepared by a similar procedure to that used to prepare Example 44 using 2-chloro-*N*-(5-chloro-pyridin-2-yl)-acetamide (Example 45a) in place of 2-chloro-*N*-(4-methyl-pyridin-2-yl)-acetamide.

m/e 496 [M]⁺

¹H NMR (400 MHz, DMSO-*d*₆): δ 11.26 (s, 1H), 8.41-8.39 (m, 1H), 8.02-7.94 (m, 2H), 7.32-7.25 (m, 4H), 7.22-7.17 (m, 1H), 5.12-5.03 (m, 1H), 4.27 (s, 2H), 4.09-4.02 (m, 1H), 3.63-3.50 (m, 4H), 3.42-3.32 (m, 1H), 2.37-2.23 (m, 2H), 2.17-2.05 (m, 2H), 1.84 (m, 3H), 1.78-1.65 (m, 1H), 1.65-1.39 (m, 9H).

Example 46: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*p*-tolylcarbamoyl-methyl)-1-azonia-bicyclo[2.2.2]octane bromide

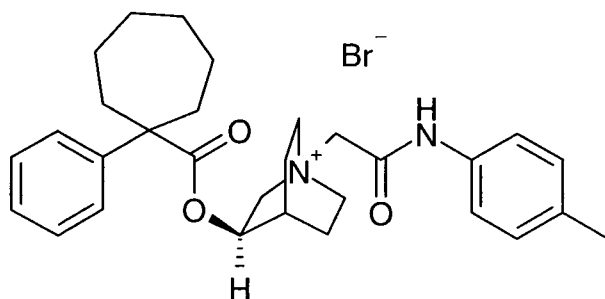
a) 2-Bromo-*N*-*p*-tolyl-acetamide



To a solution of *p*-toluidine (2.35 g) in 100 mL dichloromethane was added potassium carbonate (6.21 g). The reaction mixture was flushed with argon then bromoacetyl bromide (1.6 mL) was added dropwise and then the reaction mixture was stirred for 17h. Water was added and the layers were separated. The organic layer was treated with cyclohexane and the volume was reduced *in vacuo* causing a solid to precipitate which was filtered off to afford the sub-titled compound (2.67 g) as an off-white solid.

¹H NMR (400 MHz, CDCl₃): δ 8.06 (s, 1H), 7.40 (d, 2H), 7.16 (d, 2H), 4.01 (s, 2H), 3.64-3.42 (m, 4H).

Example 46: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*p*-tolylcarbamoyl)-met
1-azonia-bicyclo[2.2.2]octane bromide

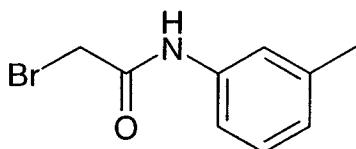


To 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (51 mg) in acetonitrile (1 mL) was added 2-bromo-*N*-*p*-tolyl-acetamide (Example 46a) (39 mg). The reaction was stirred at room temperature overnight and the acetonitrile was removed under reduced pressure. The material was recrystallised from acetonitrile/ethyl acetate to afford the title compound as a colourless solid (16 mg).

m/e 475 [M]⁺

¹H NMR (400MHz, DMSO-D₆): δ 10.40 (s, 1H), 7.40 (d, 2H), 7.33-7.25 (m, 4H), 7.21-7.16 (m, 1H), 7.13 (d, 2H), 5.11-5.04 (m, 1H), 4.13 (q, 2H), 4.09-4.00 (m, 1H), 3.64-3.42 (m, 4H), 3.42-3.36 (m, 1H), 2.37-2.23 (m, 2H), 2.23 (s, 3H), 2.17-2.04 (m, 2H), 1.95-1.78 (m, 3H), 1.78-1.66 (m, 1H), 1.65-1.40 (m, 9H).

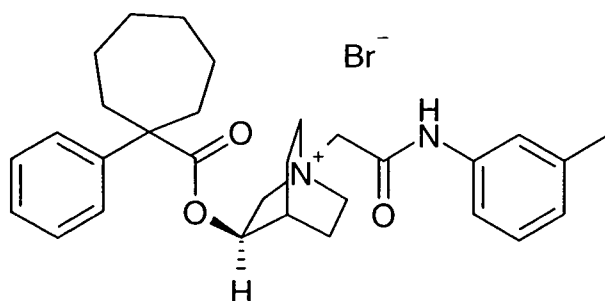
Example 47: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*m*-tolylcarbamoyl)-

a) 2-Bromo-*N-m*-tolyl-acetamide

To a solution of *m*-toluidine (5.35 g) in 150 mL dichloromethane was added potassium carbonate (17.3 g). The reaction mixture was flushed with argon then bromoacetyl bromide (3.6 mL) was added dropwise over ~ 15 mins and the reaction mixture was stirred for 5 Water was added and the layers were separated. The organic layer was evaporated and the residue was treated with EtOAc/cyclohexane. The precipitate was filtered off and discarded. The mother liquors were evaporated and purified by silica gel chromatography eluting with 0-100% EtOAc/cyclohexane to give the sub-titled compound (6.13 g) as 10 off-white solid.

¹H NMR (400 MHz, CDCl₃): δ 8.06 (s, 1H), 7.38-7.28 (m, 2H), 7.27-7.21 (t, 1H), 6.91 (t, 1H), 4.02 (s, 2H), 2.36 (s, 3H).

Example 47: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*m*-tolylcarbamoyl-methyl)-1-azonia-bicyclo[2.2.2]octane bromide



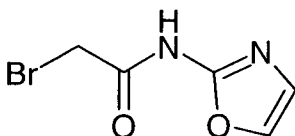
To 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (50 mg) in acetonitrile (1 mL) was added 2-bromo-*N-m*-tolyl-acetamide (Example 47a) (38 mg). The reaction was stirred at room temperature for 26 hours and 20 acetonitrile was removed under reduced pressure. The material was purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to afford the title compound (37 mg) as a colourless foam.

m/e 475 [M]⁺

¹H NMR (400MHz, DMSO-D₆): δ 10.40 (s, 1H), 7.39 (s, 1H), 7.32-7.25 (m, 5H), 7.21-7.15 (m, 2H), 6.92 (d, 1H), 5.11-5.05 (m, 1H), 4.14 (q, 2H), 4.11-4.01 (m, 1H), 3.64-3.57 (m, 4H), 3.42-3.30 (m, 1H), 2.39-2.21 (m, 5H), 2.18-2.05 (m, 2H), 1.97-1.84 (m, 3H), 1.77-1.66 (m, 1H), 1.65-1.39 (m, 9H).

Example 48: (*R*)-1-(Oxazol-2-ylcarbamoylmethyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

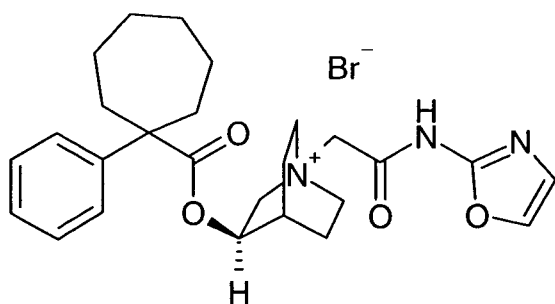
a) 2-Bromo-*N*-oxazol-2-yl-acetamide



A solution of bromoacetyl bromide (0.44 mL) in dry CHCl₃ (5 mL) was added dropwise to a suspension of 2-amino-1,3-oxazole (0.39 g) and triethylamine (0.96 mL) in dry CHCl₃ (92 mL) at room temperature. The brown mixture was allowed to stir for 16h, then quenched with H₂O (2 mL) and stirred for 20mins before concentrating under reduced pressure to a light brown solid. The crude product was purified by silica gel chromatography eluting with 1-3% MeOH/dichloromethane to give the title compound (0.56g) as an off-white solid.

¹H NMR (400 MHz, DMSO-D₆): δ 11.61 (s, 1H), 7.89 (s, 1H), 7.12 (s, 1H), 4.11 (s,

Example 48: (*R*)-1-(Oxazol-2-ylcarbamoylmethyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



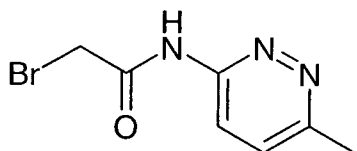
1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.31 mmol) and 2-bromo-*N*-oxazol-2-yl-acetamide (Example 48a) (0.31 mmol) stirred in anhydrous MeCN at room temperature for 18 hours. The reaction mixture was concentrated *in vacuo* and the yellow solid purified by flash silica gel column chromatography eluting with 0-15% MeOH/dichloromethane to give the title compound (100 mg) as a white solid.

m/e 452 $[M]^+$

1H NMR (400 MHz, DMSO- D_6 , 353K): δ 7.67 (s, 1H), 7.35-7.29 (m, 4H), 7.26-7.18 (1H), 7.02 (s, 1H), 5.14-5.05 (m, 1H), 4.17-4.04 (m, 3H), 3.66-3.56 (m, 4H), 3.52-3 (m, 1H), 2.42-2.29 (m, 2H), 2.24-2.12 (m, 2H), 2.10-1.86 (m, 3H), 1.82-1.70 (m, 1H), 1.70-1.47 (m, 9H).

Example 49: (*R*)-1-[(6-Methyl-pyridazin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide

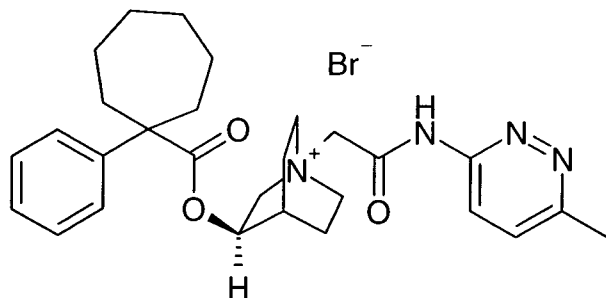
a) 2-Bromo-*N*-(6-methyl-pyridazin-3-yl)-acetamide



A solution of bromoacetyl bromide (0.22 mL) in dry $CHCl_3$ (4 mL) was added slowly to a suspension of 3-amino-6-methylpyridazine (0.24 g) and triethylamine (0.47 mL) in dry $CHCl_3$ (45 mL) at room temperature. The brown mixture was allowed to stir for 3.5 hr then quenched with H_2O (1.5 mL) and stirred for 20 mins before concentrating under reduced pressure to a brown solid. The crude product was purified by silica gel chromatography eluting with 1-2% MeOH/dichloromethane. The relevant fractions were combined and evaporated to give the title compound (0.20 g) as a pinkish/beige solid.

1H NMR (400 MHz, DMSO- D_6): δ 11.41 (s, 1H), 8.18 (d, 1H), 7.59 (d, 1H), 4.17 (s, 2H), 2.57 (s, 3H).

Example 49: (*R*)-1-[(6-Methyl-pyridazin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane bromide



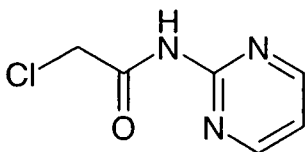
1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.20 mmol) and 2-bromo-*N*-(6-methyl-pyridazin-3-yl)-acetamide (Example 49a) (0.20 mmol) were stirred together in anhydrous MeCN at room temperature for 18 hours. The reaction mixture was concentrated *in vacuo* and the yellow solid purified by flash silica gel column chromatography eluting with 0-15% MeOH/dichloromethane to give the title compound (65 mg) as a tan solid.

m/e 477 [M]⁺

¹H NMR (400 MHz, CDCl₃): δ 8.19 (d, 1H), 7.38 (d, 1H), 7.27 (d, 4H), 7.20-7.12 (m, 1H), 5.18-4.96 (m, 3H), 4.41 (dd, 1H), 4.11-3.95 (m, 3H), 3.81 (d, 1H), 3.47-3.37 (m, 1H), 2.66 (s, 3H), 2.45-2.27 (m, 2H), 2.26-2.13 (m, 2H), 2.08-1.96 (m, 3H), 1.81-1.69 (m, 1H), 1.69-1.30 (m, 9H).

Example 50: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-2-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride

a) 2-Chloro-*N*-pyrimidin-2-yl-acetamide

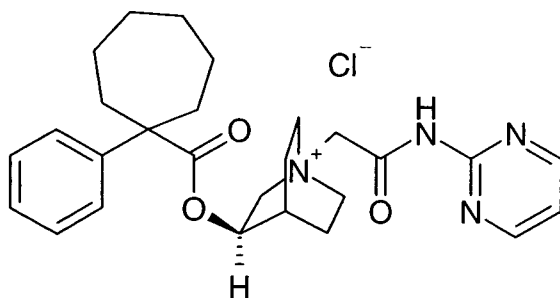


A solution of 2-amino-pyrimidine (2.0 g) in dry dichloromethane (17 mL) under nitrogen at 0°C was treated with triethylamine (2.6 mL) followed by slow addition of chloroacetyl chloride (1.5 mL, 18.4 mmol). The reaction mixture was allowed to warm up to room

The phases were separated and the aqueous layer was extracted with dichloromethane. The combined organic layers were washed with brine, dried over sodium sulphate, filtered and concentrated to give the crude product which was purified by silica gel chromatography eluting with 10% MeOH/dichloromethane. The relevant fractions were combined and evaporated to give the title compound (1.20 g) as a green solid.

^1H NMR (400 MHz, CDCl_3): δ 8.84 (s, 1H), 8.65 (d, 2H), 7.09 (t, 1H), 4.46 (s, 2H).

Example 50: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-2-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride

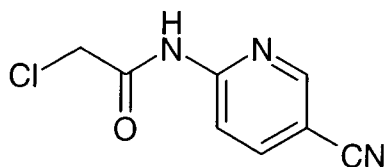


1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e, 0.30 mmol) and 2-chloro-*N*-pyrimidin-2-yl-acetamide (Example 50a) (0.36 mmol) in MeCN (1.5 mL) were stirred together at room temperature overnight. The reaction mixture was concentrated *in vacuo* and the residue purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the title compound as a white solid (1.20 mg).

m/e 463 $[\text{M}]^+$

^1H NMR (400 MHz, $\text{DMSO}-d_6$): δ 11.19 (s, 1H), 8.66 (d, 2H), 7.32-7.24 (m, 4H), 7.14 (m, 2H), 5.09-5.03 (m, 1H), 4.48 (s, 2H), 4.06 (ddd, 1H), 3.65-3.51 (m, 4H), 3.34 (m, 1H), 2.37-2.21 (m, 2H), 2.15-2.07 (m, 2H), 1.96-1.80 (m, 3H), 1.75-1.64 (m, 1H), 1.63-1.38 (m, 9H).

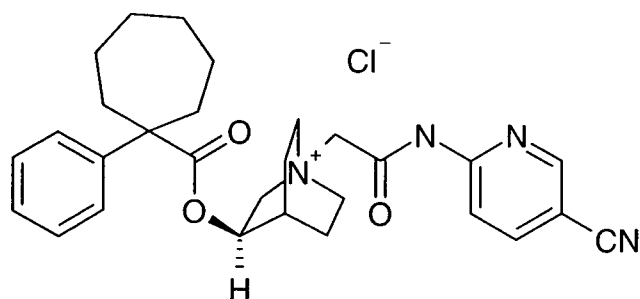
Example 51: (*R*)-1-[(5-Cyano-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

a) 2-Chloro-*N*-(5-cyano-pyridin-2-yl)-acetamide

A solution of 2-amino-5-cyano pyridine (2.0 g) in dry dichloromethane (17 mL) under nitrogen at 0°C was treated with triethylamine (2.6 mL) followed by slow addition of chloroacetyl chloride (1.5 mL). The reaction mixture was allowed to warm up to room temperature. After 2h, the mixture was partitioned between dichloromethane and water. The phases were separated and the aqueous layer was extracted with dichloromethane. The combined organic layer was washed with brine, dried over sodium sulphate, filtered and concentrated to give the crude product which was purified by silica gel chromatography eluting with 50% EtOAc/cyclohexane. The relevant fractions were combined and evaporated to give the title compound (2.17g) as a light brown solid.

¹H NMR (400 MHz, CDCl₃): δ 8.99 (s, 1H), 8.61 (dd, 1H), 8.36 (dd, 1H), 8.00-7.97 (m, 1H), 4.23 (s, 2H).

Example 51: (*R*)-1-[(5-Cyano-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.30 mmol) and 2-chloro-*N*-(5-cyano-pyridin-2-yl)-acetamide (Example 51a) (0.30 mmol) in MeCN (1.5 mL) were stirred together at room temperature overnight. The reaction mixture was concentrated *in vacuo* and the residue purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the title compound.

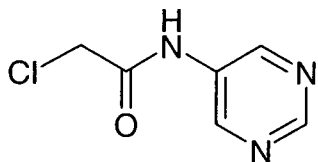
m/e 487 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 11.56 (s, 1H), 8.81 (dd, 1H), 8.31 (dd, 1H), 8.09 (s, 1H), 7.32-7.25 (m, 4H), 7.23-7.17 (m, 1H), 5.11-5.04 (m, 1H), 4.32 (s, 2H), 4.10-4.05 (m, 1H), 3.63-3.50 (m, 4H), 3.42-3.29 (m, 1H), 2.37-2.23 (m, 2H), 2.17-2.05 (m, 2H), 2.00-1.82 (m, 3H), 1.78-1.65 (m, 1H), 1.65-1.40 (m, 9H).

Example 52: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-5-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride

10

a) 2-Chloro-N-pyrimidin-5-yl-acetamide

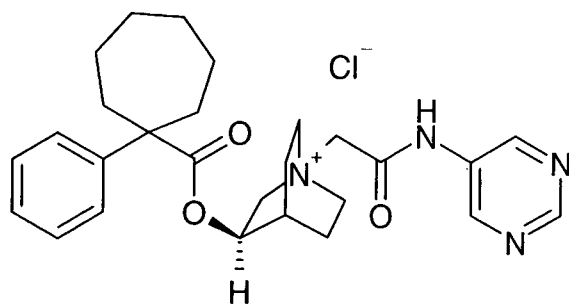


5-Aminopyrimidine (450 mg) was suspended in DCE (2 mL) and acetonitrile (2 mL) in a microwave vial. Chloroacetyl chloride (0.377 mL) was added with stirring. The vial was sealed and the reaction mixture was heated in the microwave at 80°C for 5 minutes. The solid was filtered off, washed with acetonitrile (2 x 5 mL), DCE (2 x 5 mL) and pentane (2 x 30 mL) and then partitioned between saturated sodium bicarbonate and DCE (50 mL/50 mL) ensuring the aqueous layer was still basic. The organic layer was separated and the aqueous layer was extracted with DCE (2 x 75 mL). The combined organic layer was dried over magnesium sulfate and evaporated to give the sub-titled compound (200 mg) as a yellow solid.

¹H NMR (400 MHz, DMSO-D₆): δ 10.71 (s, 1H), 9.00 (s, 2H), 8.93 (s, 1H), 4.35 (s, 2H)

Example 52: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-5-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride

25



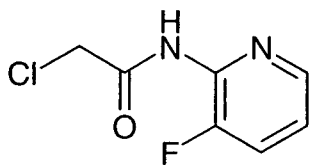
1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (115 mg) in acetonitrile (2 mL) was treated with 2-chloro-*N*-pyrimidin-5-yl-acetamide (Example 52a) (66 mg) to give a dark brown solution that was stirred at room temperature overnight. The resulting solid was filtered off, washed with cold acetonitrile (2 mL) and pentane (3 mL) and dried under vacuum at 45°C to give the title compound as a tan solid (151 mg).

m/e 463 [M]⁺

¹H NMR (400 MHz, DMSO-*D*₆): δ 11.70 (s, 1H), 9.01 (s, 2H), 8.93 (s, 1H), 7.33-7.22 (m, 4H), 7.22-7.16 (m, 1H), 5.11-5.05 (m, 1H), 4.34 (s, 2H), 4.12-4.04 (m, 1H), 3.63-3.52 (m, 4H), 3.43-3.31 (m, 1H), 2.37-2.22 (m, 2H), 2.17-2.06 (m, 2H), 1.99-1.83 (m, 3H), 1.79-1.67 (m, 1H), 1.65-1.40 (m, 9H).

Example 53: (*R*)-1-[(3-Fluoro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

a) 2-Chloro-*N*-(3-fluoro-pyridin-2-yl)-acetamide

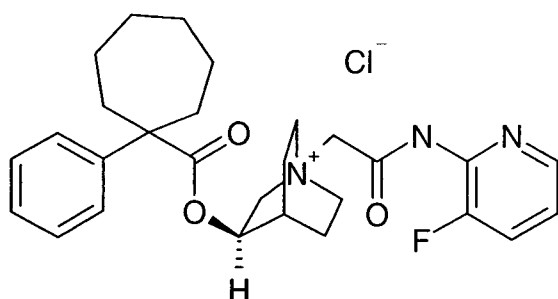


2-Amino-3-fluoropyridine (1.5 g) was dissolved in DCE (15 mL) and chloroacetylchloride (1.1 mL) was added dropwise. The reaction was heated in a microwave at 80°C for 5 min. The reaction mixture was cooled and the resulting solid was filtered off, washed with MeCN and pentane then suspended in dichloromethane and aqueous NaHCO₃ (sat) was added. The organic phase was separated and the aqueous layer was extracted with

concentrated. The crude product was purified by silica gel chromatography eluting with 100% EtOAc/cyclohexane to give the title compound as a white solid (800 mg).

¹H NMR (400 MHz, DMSO-D₆): δ 10.61 (s, 1H), 8.27 (dt, 1H), 7.83-7.77 (m, 1H), 7.35 (m, 1H), 4.37 (s, 2H).

Example 53: (R)-1-[(3-Fluoro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



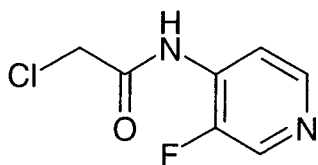
1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.30 mmol) and 2-chloro-*N*-(3-fluoro-pyridin-2-yl)-acetamide (Example 53a) (0 mmol) in MeCN (1.5 mL) were stirred at room temperature overnight. The reaction mixture was concentrated *in vacuo* and the residue purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the title compound as a white solid (mg).

m/e 480 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 11.07 (s, 1H), 8.25 (dt, 1H), 7.81 (ddd, 1H), 7.35 (ddd, 1H), 7.31-7.24 (m, 4H), 7.22-7.15 (m, 1H), 5.11-5.04 (m, 1H), 4.36 (s, 2H), 4.04 (m, 1H), 3.66-3.52 (m, 4H), 3.44-3.32 (m, 1H), 2.37-2.21 (m, 2H), 2.19-2.06 (m, 2H), 1.99-1.82 (m, 3H), 1.77-1.65 (m, 1H), 1.65-1.38 (m, 9H).

Example 54: (R)-1-[(3-Fluoro-pyridin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

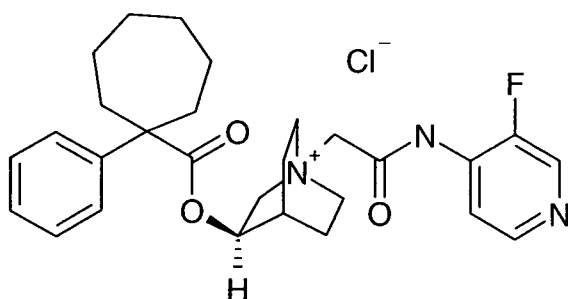
a) 2-Chloro-*N*-(3-fluoro-pyridin-4-yl)-acetamide



A solution of 3-fluoro-pyridin-4-ylamine (0.2 g) in dry dichloromethane (2 mL) under nitrogen at 0°C was treated with triethylamine (0.28 mL) followed by slow addition of chloroacetyl chloride (0.16 mL). The reaction mixture was allowed to warm up to room temperature. After 2h, the mixture was partitioned between dichloromethane and water. The phases were separated and the aqueous layer was extracted with dichloromethane. The combined organic layer was washed with brine, dried over sodium sulphate, filtered and concentrated to give the crude product which was purified by silica gel chromatography eluting with 0-100% EtOAc/cyclohexane. The relevant fractions were combined and evaporated to give the title compound (0.11 g) as a pink solid.

¹H NMR (400 MHz, DMSO-D₆): δ 10.55 (s, 1H), 8.56 (d, 1H), 8.35 (d, 1H), 8.16 (d, 1H), 4.44 (s, 2H).

Example 54: (R)-1-[(3-Fluoro-pyridin-4-ylcarbonyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



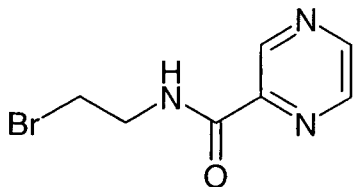
1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.30 mmol) and 2-chloro-*N*-(3-fluoro-pyridin-4-yl)-acetamide (Example 54a) (0.30 mmol) in MeCN (1.5 mL) were stirred together at room temperature overnight. The reaction mixture was concentrated *in vacuo* and the residue purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the title compound as a white solid (110 mg).

¹H NMR (400 MHz, DMSO-D₆): δ 10.92 (s, 1H), 8.56 (d, 1H), 8.35 (d, 1H), 8.03 (c 1H), 7.32-7.26 (m, 4H), 7.21-7.16 (m, 1H), 5.11-5.05 (m, 1H), 4.41-4.29 (m, 2H), 4.02 (m, 1H), 3.63-3.50 (m, 4H), 3.42-3.30 (m, 1H), 2.36-2.23 (m, 2H), 2.17-2.06 (2H), 1.98-1.82 (m, 3H), 1.78-1.65 (m, 1H), 1.66-1.40 (m, 9H).

5

Example 55: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{2-[(pyrazine-2-carboxamino]-ethyl}-1-azonia-bicyclo[2.2.2]octane bromide

a) Pyrazine-2-carboxylic acid (2-bromo-ethyl)-amide



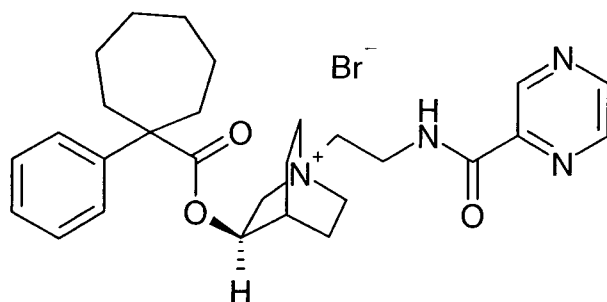
10

2-Pyrazine carboxylic acid (1 g) in dichloromethane (30 mL) was treated with triethylamine (1.27 mL) and HATU (3.6 g) and the mixture was stirred for 10 minutes. A solution of 2-bromoethylamine hydrobromide (1.5 g) and triethylamine (1.27 mL) in dichloromethane (20 mL) was added and the reaction mixture was stirred for 3 hours.

15 Water (50 mL) was added and the organic layer was separated and washed with water (50 mL). The organic layer was dried over magnesium sulphate and evaporated to give a crude product which was purified by silica gel chromatography eluting with 0-100% EtOAc/dichloromethane. The relevant fractions were combined and evaporated to give a residue which was dissolved in EtOAc (40 mL) and washed with saturated sodium
20 hydrogen carbonate ensuring the aqueous layer was basic. The organic layer was dried over magnesium sulfate and evaporated to give the sub-titled compound (1.0 g) as a white solid.

¹H NMR (400 MHz, DMSO-D₆): δ 9.21 (d, 1H), 9.14 (t, 1H), 8.90 (d, 1H), 8.75 (dd, 25 3.75-3.69 (m, 2H), 3.66-3.60 (m, 2H).

Example 55: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{2-[(pyrazine-2-carboxamino]-ethyl}-1-azonia-bicyclo[2.2.2]octane bromide



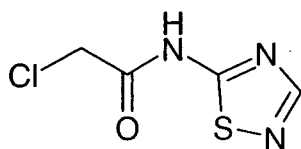
Pyrazine-2-carboxylic acid (2-bromo-ethyl)-amide (Example 55a) (87 mg) was added to a solution of 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (113 mg) in acetonitrile (2 mL). The reaction mixture was allowed to warm to room temperature for 16h. A solid precipitated out and was filtered off, washed with acetonitrile and dried under vacuum at 40°C to give the title compound (96 mg) as a white solid.

m/e 477 $[M]^+$

¹H NMR (400 MHz, DMSO- D_6): δ 9.22 (t, 1H), 9.17 (d, 1H), 8.88 (d, 1H), 8.72 (dd, 1H), 7.33-7.25 (m, 4H), 7.22-7.16 (m, 1H), 5.01-4.96 (m, 1H), 3.89 (ddd, 1H), 3.72-3.57 (m, 2H), 3.51-3.28 (m, 5H), 3.22 (dt, 1H), 3.13-3.02 (m, 1H), 2.38-2.30 (m, 1H), 2.30-2.20 (m, 1H), 2.17-2.06 (m, 2H), 1.97-1.76 (m, 3H), 1.69-1.37 (m, 10H).

Example 56: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-([1,2,4]thiadiazol-5-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride

a) 2-Chloro-*N*-[1,2,4]thiadiazol-5-yl-acetamide

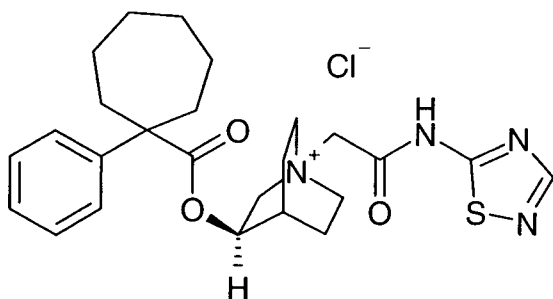


A solution of [1,2,4]-thiadiazol-5-ylamine (3.0 g) in dry dichloromethane (30 mL) under nitrogen at 0°C was treated with triethylamine (4.6 mL) followed by slow addition of chloroacetyl chloride (2.6 mL). The reaction mixture was allowed to warm up to room temperature. After 2h, the mixture was partitioned between dichloromethane and water. The phases were separated and the aqueous layer was extracted with dichloromethane.

and concentrated to give the crude product which was purified by silica gel chromatography eluting with 50-75% EtOAc/cyclohexane to give the title compound g) as a yellow solid.

¹H NMR (400 MHz, DMSO-D₆): δ 13.32 (s, 1H), 8.51 (s, 1H), 4.52 (s, 2H).

Example 56: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-([1,2,4]thiadiazol-5-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane chloride



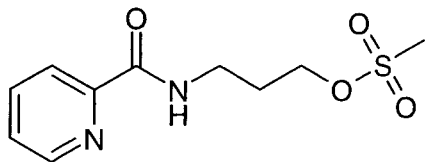
1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.30 mmol) and 2-chloro-*N*-[1,2,4]thiadiazol-5-yl-acetamide (Example 56a) in MeCN (1.5 mL) were stirred at room temperature overnight. The reaction mixture was filtered and the solid obtained was washed with cold MeCN to give the title compound (30 mg) as a solid.

m/e 469 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 13.70 (s, 1H), 8.51 (s, 1H), 7.34-7.27 (m, 4H), 7.17 (m, 1H), 5.11-5.05 (m, 1H), 4.54-4.43 (m, 2H), 4.12-4.05 (m, 1H), 3.67-3.53 (t, 4H), 3.45-3.33 (m, 1H), 2.38-2.24 (m, 2H), 2.18-2.05 (m, 2H), 1.99-1.83 (m, 3H), 1.67 (m, 1H), 1.67-1.40 (m, 9H).

Example 57: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{3-[(pyridine-2-carboxamido]-propyl}-1-azonia-bicyclo[2.2.2]octane bromide

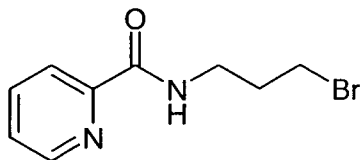
a) Methanesulfonic acid 3-[(pyridine-2-carboxamido)-amino]-propyl ester



Isobutyl chloroformate (3.35 mL) was added to a solution of 2-pyridine carboxylic acid (2.10 g) and *N*-methyl morpholine (2.82 mL) in dry THF (85 mL) at 0 °C. After 15 min amino-1-propanol (1.31 mL) was added and the mixture stirred overnight. The reaction mixture was concentrated to a pink solid *in vacuo* and was passed through a pad of silica (1-5% MeOH/dichloromethane). The resultant brown oil was taken up in dichloromethane (85 mL) and cooled to 0°C. To this solution was added Et₃N (4.75 mL) and methanesulfonylchloride (2.0 mL). After 30 mins the reaction was warmed to room temperature and stirred for 2.5 h before quenching with H₂O (50 mL). The layers were separated and the organic phase washed with sat. NaHCO₃ (aq) and dried (MgSO₄). Concentration under reduced pressure gave an orange oil which was purified by silica gel chromatography eluting with 90% EtOAc/cyclohexane to give the sub-titled compound (2.06 g) as an orange oil.

¹H NMR (400 MHz, CDCl₃): δ 8.55 (ddd, 1H), 8.29 (s, 1H), 8.17 (dt, 1H), 7.88-7.83 (m, 1H), 7.45 (ddd, 1H), 4.35 (t, 2H), 3.63 (q, 2H), 3.07 (s, 3H), 2.11 (p, 2H).

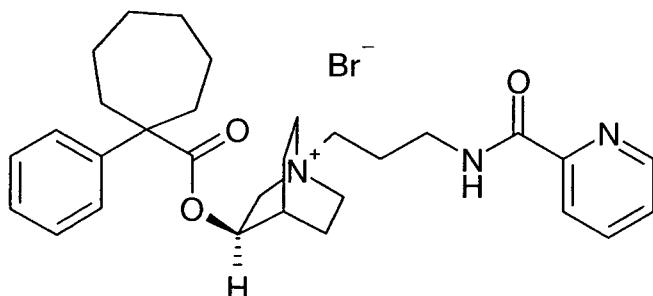
b) Pyridine-2-carboxylic acid (3-bromo-propyl)-amide



A mixture of methanesulfonic acid 3-[(pyridine-2-carbonyl)-amino]-propyl ester (Example 57a) (1.96 g) and lithium bromide (3.29 g) in acetone (19 mL) was heated to reflux for 2 h. The reaction mixture was cooled to room temperature, concentrated *in vacuo* and the residue partitioned between EtOAc/H₂O (60 mL, 1:1). The phases were separated and the aqueous phase further extracted with EtOAc (2 x 25 mL). The combined organics were dried (MgSO₄) and concentrated *in vacuo* to a brown oil which solidified on standing. Purification by silica gel chromatography eluting with 0-100% EtOAc/cyclohexane gave

¹H NMR (400 MHz, CDCl₃): δ 8.55 (ddd, 1H), 8.25-8.12 (s, 1H), 8.19 (dt, 1H), 7.85 (1H), 7.43 (ddd, 1H), 3.64 (q, 2H), 3.50 (t, 2H), 2.22 (p, 2H).

5 **Example 57: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{3-[(pyridine-2-carboxamino]-propyl}-1-azonia-bicyclo[2.2.2]octane bromide**



1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.31 mmol) and pyridine-2-carboxylic acid (3-bromo-propyl)-amide (Example 5
10 (0.31 mmol) were stirred together in anhydrous MeCN (3 mL) at room temperature for 3 days. The reaction mixture was concentrated *in vacuo* and the solid purified by silica chromatography eluting with 0-15% MeOH/dichloromethane to give the title compound (145 mg) as a white solid.

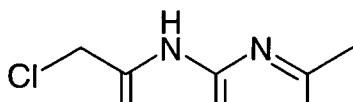
15 m/e 490 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 8.94 (t, 1H), 8.62 (ddd, 1H), 8.03-7.95 (m, 2H), 7.75-7.65 (ddd, 1H), 7.31-7.24 (m, 4H), 7.19-7.13 (m, 1H), 5.01-4.95 (m, 1H), 3.76 (ddd, 1H), 3.51-3.09 (m, 7H), 3.09-3.01 (m, 1H), 2.93-2.82 (m, 1H), 2.36-2.22 (m, 2H), 2.14-2.06 (m, 2H), 1.99-1.90 (m, 1H), 1.92-1.71 (m, 4H), 1.68-1.39 (m, 10H).

20

Example 58: (*R*)-1-[(2-Methyl-pyrimidin-4-ylcarbonyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

a) 2-Chloro-*N*-(2-methyl-pyrimidin-4-yl)-acetamide

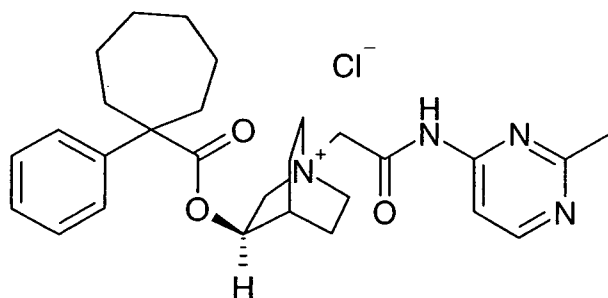


2-Methyl-pyrimidin-4-yl amine (545 mg) was suspended in DCE (5 mL) and chloroacetylchloride (0.4 mL) was added dropwise. The reaction was heated in a microwave at 80°C for 5mins. The reaction mixture was cooled to give a solid that was filtered, washed with dichloromethane then suspended in dichloromethane and sat.

5 NaHCO₃ (aq) was added. The organic phase was collected and the aqueous layer extracted with dichloromethane (x2). The combined organic layer was dried over sodium sulphate and concentrated. The crude product was purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the sub-titled compound as a yellow solid (55 mg, 7.5 %).

¹H NMR (400 MHz, DMSO-D₆): δ 11.16 (s, 1H), 8.58 (d, 1H), 7.84 (d, 1H), 4.37 (s, 2H), 2.53 (s, 3H).

Example 58: (R)-1-[(2-Methyl-pyrimidin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



1-Phenyl-cycloheptanecarboxylic acid (R)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e, 0.29 mmol) and 2-chloro-N-(2-methyl-pyrimidin-4-yl)-acetamide (Example 58a) (0.35 mmol) in MeCN (2.0 mL) were stirred together at room temperature for 16h. The reaction mixture was concentrated *in vacuo* and the residue purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the title compound as a white solid (55 mg).

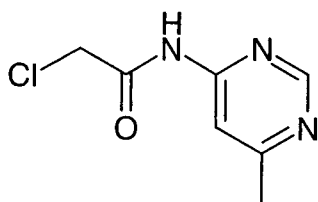
m/e 477 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 11.40 (s, 1H), 8.61 (d, 1H), 7.75 (d, 1H), 7.32-7.34 (m, 4H), 7.23-7.17 (m, 1H), 5.10-5.03 (m, 1H), 4.28 (s, 2H), 4.09-4.01 (m, 1H), 3.6

3.48 (m, 4H), 3.40-3.30 (m, 1H), 2.50 (s, 3H), 2.36-2.24 (m, 2H), 2.17-2.05 (m, 2H), 1.98-1.84 (m, 3H), 1.78-1.65 (m, 1H), 1.64-1.41 (m, 9H).

Example 59: (R)-1-[(6-Methyl-pyrimidin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride

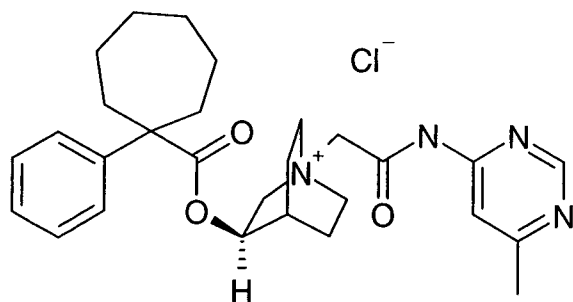
a) 2-Chloro-N-(6-methyl-pyrimidin-4-yl)-acetamide



6-Methyl-pyrimidin-4-yl amine (545 mg) was suspended in DCE (5 mL) and chloroacetylchloride (0.4 mL) was added dropwise. The reaction was heated in a microwave at 80°C for 5mins. The reaction mixture was cooled, filtered and a solid obtained. The reaction was repeated a second time and both batches of solid were combined, washed with dichloromethane then suspended in dichloromethane and sat. NaHCO₃ (aq.) was added. The organic phase was collected and the aqueous layer extracted with dichloromethane (x2). The combined organic layer was dried over sodium sulphate and concentrated. The crude product was purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the sub-titled compound as a yellow solid (mg).

¹H NMR (400 MHz, DMSO-D₆): δ 11.11 (s, 1H), 8.76 (d, 1H), 7.91 (s, 1H), 4.38 (s, 2H), 2.44 (s, 3H).

Example 59: (R)-1-[(6-Methyl-pyrimidin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane chloride



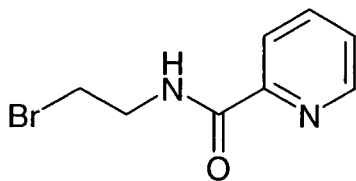
1-Phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (0.30 mmol) and 2-chloro-*N*-(6-methyl-pyrimidin-4-yl)-acetamide (Example 59a) (0.36 mmol) in MeCN (2. mL) were stirred together at room temperature for 16h. The reaction mixture was concentrated *in vacuo* and the residue purified by silica gel chromatography eluting with 0-10% MeOH/dichloromethane to give the title compound as a white solid (125 mg).

m/e 477 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 11.39 (s, 1H), 8.76 (d, 1H), 7.83 (s, 1H), 7.34-7.32 (m, 4H), 7.22-7.17 (m, 1H), 5.10-5.04 (m, 1H), 4.32 (s, 2H), 4.10-4.01 (m, 1H), 3.63-3.50 (m, 4H), 3.43-3.31 (m, 1H), 2.42 (s, 3H), 2.37-2.23 (m, 2H), 2.18-2.06 (m, 2H), 1.98-1.81 (m, 3H), 1.78-1.66 (m, 1H), 1.65-1.39 (m, 9H).

Example 60: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{2-[(pyridine-2-carboxamino]-ethyl)-1-azonia-bicyclo[2.2.2]octane bromide

a) Pyridine-2-carboxylic acid (2-bromo-ethyl)-amide

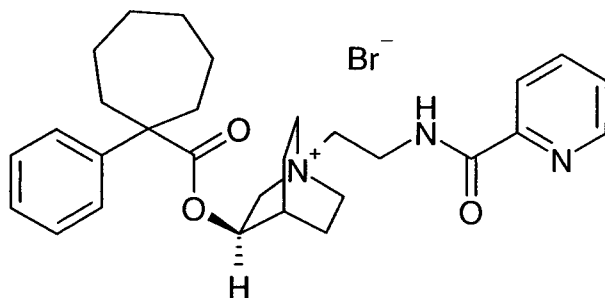


Picolinic acid (0.99 g) in dichloromethane (30 mL) was treated with triethylamine (1.2 mL) and HATU (3.6 g). The mixture was stirred for 10 minutes then a solution of 2-bromoethylamine hydrobromide (1.5 g) and triethylamine (1.27 mL) in dichloromethane

over magnesium sulphate and evaporated to afford the crude product which was purified by silica gel chromatography eluting with 0-100% EtOAc/dichloromethane. The relevant fractions were combined and evaporated, dissolved up in EtOAc (40 mL) and washed with saturated sodium hydrogen carbonate solution, ensuring the aqueous layer remained below the organic layer. The organic layer was dried over magnesium sulphate and evaporated to give the sub-
 5 compound (0.88 g) as a white solid.

¹H NMR (400 MHz, DMSO-D₆): δ 9.01 (t, 1H), 8.66 (ddd, 1H), 8.07-7.98 (m, 2H), 7.61 (ddd, 1H), 3.70 (q, 2H), 3.62 (t, 2H).

Example 60: (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{2-[(pyridine-2-carboxamino]-ethyl}-1-azonia-bicyclo[2.2.2]octane bromide



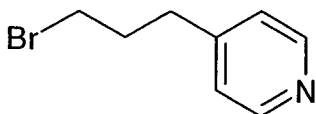
Pyridine-2-carboxylic acid (2-bromo-ethyl)-amide (Example 60a) (75 mg) was added to a solution of 1-phenyl-cycloheptanecarboxylic acid (*R*)-(1-aza-bicyclo[2.2.2]oct-3-yl) ester (Example 14e) (98 mg) in acetonitrile (2 mL). The reaction mixture was allowed to stir at room temperature for 16h. A further 10 mg of pyridine-2-carboxylic acid (2-bromo-ethyl) amide was added and the reaction mixture was stirred for 8h. The volatiles were evaporated and the residue was purified by silica gel chromatography eluting with 0-1
 20 MeOH/dichloromethane to give the title compound (55 mg) as a white solid.

m/e 476 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 9.12 (t, 1H), 8.64-8.62 (m, 1H), 8.05-7.97 (m, 2H), 7.61 (ddd, 1H), 7.32-7.25 (m, 4H), 7.22-7.15 (m, 1H), 5.02-4.96 (m, 1H), 3.88 (ddd, 1H), 3.71-3.55 (m, 2H), 3.49-3.27 (m, 5H), 3.22 (dt, 1H), 3.12-3.02 (m, 1H), 2.38-2.32 (m, 2H), 2.17-2.07 (m, 2H), 1.96-1.75 (m, 3H), 1.69-1.38 (m, 10H).

Example 61: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(3-pyridin-4-yl-propyl) azonia-bicyclo[2.2.2]octane bromide

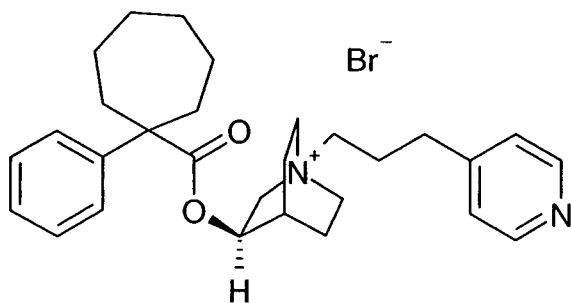
a) 4-(3-Bromo-propyl)-pyridine hydrobromide



A solution of 3-pyridin-4-yl-propan-1-ol (2.88 mL) in hydrobromic acid (16 mL, 141.4 mmol) was heated at reflux at 135°C for 18h. The cooled solution was concentrated under vacuum and the residue was re-dissolved in *isopropanol* and re-concentrated (this process was repeated three more times). The residue was dissolved in *isopropanol*, decolourised by boiling with activated charcoal, filtered, and the clear solution left to crystallise in a refrigerator over 48h. The resulting crystals were removed by filtration, washed with *isopropanol* / diethyl ether (1:1) followed by diethyl ether and then dried under vacuum at 40°C and room temperature to afford the sub-titled compound as a pale brown solid (3.55 g).

¹H NMR (400 MHz, D₂O): δ 8.64 (d, 2H), 7.96 (d, 2H), 3.52 (t, 2H), 3.12 (t, 2H), 2.30 (quint., 2H).

Example 61: (R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(3-pyridin-4-yl-propyl) azonia-bicyclo[2.2.2]octane bromide



4-(3-Bromo-propyl)-pyridine hydrobromide (Example 61a) (0.210 g) was added to diethyl ether (10 mL) and sodium hydroxide solution (4 mL) (10%) in a separating funnel and the mixture shaken and separated. The ethereal layer was washed with water (2 x 10 mL), dried (MgSO₄) and evaporated to afford the free base as an oil. To the residue was added

(20 mL) gave an oil, the supernatant was removed by decantation and the residue was with ethyl acetate (2 x 20 mL). The oil was crystallised by stirring with diethyl ether mL) and the solid washed twice with diethyl ether (2 x 20 mL) to afford the titled compound as a solid (0.094 g).

5

m/e 447 [M]⁺

¹H NMR (400 MHz, DMSO-D₆): δ 8.51 (d, 2H), 7.35 - 7.30 (m, 4H), 7.30 - 7.27 (m, 1H), 7.24 - 7.18 (m, 1H), 5.07 - 5.01 (m, 1H), 3.81 (ddd, 1H), 3.43 - 3.27 (m, 2H), 3.21 - 3.15 (m, 1H), 3.10 (d, 1H), 2.97 - 2.88 (m, 2H), 2.59 (t, 2H), 2.40 - 2.27 (m, 3H), 2.18 - 2.11 (m, 2H), 2.04 - 1.76 (m, 5H), 1.72 - 1.43 (m, 10H).

10

Pharmacological Analysis

M3 Receptor Activity Assay

15 The affinity (pIC₅₀) of compounds to the M₃ receptor was determined by competition binding of [³H]N-methyl scopolamine (NMS) to CHO-K1 (Chinese Hamster Ovary) c membranes expressing the human muscarinic acetylcholine M₃ receptor (M₃-ACh) in scintillation proximity assay (SPA) format.

20 SPA beads were precoated with membranes and then incubated at 2 mg of beads per v with with serial dilutions of the compounds of the invention, [³H]NMS at 0.2nM, half (experimentally determined dissociation constant) and assay buffer (20 mM HEPES p containing 5 mM MgCl₂). The assay was conducted in a final volume of 200 μL, in the presence of 1% (v/v) dimethyl sulphoxide (DMSO). Total binding of [³H]NMS was
25 determined in the absence of competing compound and non-specific binding of [³H]N was determined in the presence of 1 μM atropine. The plates were incubated for 16 h at room temperature and then read on Wallac Microbeta[™] using a normalised ³H protocol. The pIC₅₀, defined as the negative logarithm of the concentration of compound required 50% reduction in specific [³H]-NMS binding, was determined. Table 1 shows the pIC
30 figures for some representative Examples.

Table 1

Compound of Example No.	pIC ₅₀
1	9.1
5	9.4
13	10.1

Table 2 gives IC₅₀ strengths for the compounds of the examples.

Table 2

Example No.	M3 binding IC ₅₀	Example No.	M3 binding IC ₅₀	Example No.	M3 binding IC ₅₀
1	+++	21	+++	41	++
2	+++	22	+++	42	++
3	++	23	+++	43	++
4	+++	24	+++	44	++
5	+++	25	+++	45	+++
6	+++	26	+++	46	++
7	++	27	++	47	++
8	+++	28	++	48	++
9	+++	29	++	49	+++
10	+++	30	+++	50	+++
11	+++	31	++	51	++
12	+++	32	++	52	+++
13	+++	33	++	53	++
14	+++	34	++	54	+++
15	+++	35	++	55	++
16	+++	36	++	56	++
17	+++	37	+++	57	++
18	+++	38	+++	58	+++

61	+++				
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M3 Binding IC₅₀ <2nM “+++”; IC₅₀ 2-10nM “++”; IC₅₀ > 10nM “+”; NT – Not Tested

Measurement of Plasma Protein Binding

- 5 The extent of plasma protein binding was determined via equilibrium dialysis of a compound between human plasma and aqueous buffer at 37°C and determination of the concentration of compound in the plasma and buffer by HPLC-MS/MS.

Method

- 10 Dialysis cells (molecular weight cut-off 5000) were prepared by rinsing with water followed by soaking in the dialysis buffer for a minimum of 1 hour. The dialysis buffer was isotonic buffered saline pH 7.4. Stock solutions of compound in dimethylsulphoxide were prepared at a concentration of 0.5mM. Frozen pooled Human plasma was obtained from volunteers.

15

The stock DMSO solution of a compound was added to the plasma at a ratio of 10 µl of DMSO to each ml of plasma. This gave a 1% DMSO in plasma solution with each compound at a concentration of 5 µM.

- 20 Dialysis cells were then prepared and one half of the cell filled with 750 µl of dialysis buffer and the other half of the cell with 750 µl of plasma solution of compound. Once prepared the cells were sealed and placed in an incubator box at 37°C. These cells were then rotated for a minimum of 4 hours to equilibrate.

- 25 After equilibration 500 µl of the buffer samples were removed and added to HPLC vials along with 100 µl of plasma (sample in 6-fold diluted plasma), and 100 µl of the plasma samples were removed and added to HPLC vials along with 500 µl of dialysis buffer (sample in 6-fold diluted plasma).

0.013 μM , 0.05 μM , 0.25 μM and 1.25 μM which were injected in this order followed the buffer sample and then the plasma sample.

Calculation

- 5 The concentration of compound in the samples were determined using MassLynx version 4.1 software (produced by Waters/Micromass) that automatically calculated a calibration curve and the concentration of compound in the cells. Plasma protein binding was determined from the calibration curve as the percentage of compound bound in human plasma (% bound) using the following equation;

$$\% \text{ bound} = 100 - 100 \left(\frac{\text{buffer peak area} / \text{buffer injection volume}}{5 \left(\text{plasma peak area} / \text{plasma injection volume} \right)} \right)$$

Table 3 shows the measured human plasma protein binding figure using the procedure described above for some representative Examples.

15 Table 3

Compound of Example No.	% bound
11	95.2
13	93.2
15	96.1
17	97.6
20	98.2
21	99.4

Methacholine Induced Bronchoconstriction in vivo

- 20 Dunkin-Hartley guinea-pigs (300 – 600g) were supplied by a designated breeding establishment. Animals were dosed with test compound or vehicle either by inhalation

anaesthesia (5% halothane). Animals were allowed to recover from the anaesthesia prior to the measurement of bronchoconstriction. Up to 48 hours post-dosing guinea-pigs were terminally anaesthetized with sodium pentobarbitone (60 mg/kg), the trachea cannula for artificial ventilation and the jugular vein was cannulated for intravenous administration of methacholine. The guinea-pigs were ventilated using a constant volume respiratory pump (Harvard Rodent Ventilator model 683) at a rate of 60 breath/min and a tidal volume of 5 ml/kg during surgical preparation. Lung function (lung resistance and compliance) was measured in anaesthetized and ventilated guinea-pigs using a pulmonary measurement Flexivent system (SCIREQ, Montreal, Canada) connected to the tracheal cannulae. The animals were ventilated (quasi-sinusoidal ventilation pattern) at 60 breaths/min at a tidal volume of 5 ml/kg. A positive end expiratory pressure of 2-3 cmH₂O was applied. Respiratory resistance was measured using the Flexivent "snapshot" facility (1 second duration, 1 Hz frequency). Lung resistance and compliance was measured before and intravenous administration of methacholine (3, 10 and 30 ug/kg). The peak increase in resistance following methacholine challenge was calculated and the effect of the test compound on methacholine-induced lung function changes was calculated. Percentage inhibition of bronchoconstriction was calculated at each dose of methacholine as follows:

$$\frac{[\text{Change in resistance in vehicle treated group} - \text{Change in resistance in compound treated group}]}{[\text{Change in resistance in vehicle treated group}]} \times 100$$

Inhibition of pilocarpine induced salivation by i.n. administered compounds.

Guinea pigs (450-550g) supplied by Harlan UK or David Hall, Staffs UK and acclimated to the in-house facilities for a minimum of three days before use. Guinea pigs were randomly assigned into treatment groups and weighed. Each animal was lightly anaesthetized (4% Halothane) and administered compound or vehicle intranasally (0.5ml/kg) at up to 24 hours before challenge with pilocarpine. At the test time point, guinea pigs were terminally anaesthetized with urethane (25% solution in H₂O, 1.5g/kg). Once sufficient anaesthesia had developed (absence of toe pinch reflex) each animal had an absorbent pad placed in the mouth for 5 minutes to dry residual saliva, this pad was removed and replaced with a new pre-weighed pad for 5 minutes to establish a reading baseline saliva production. At the end of this 5 minute period the pad was removed and

s.c. pilocarpine administered under the skin at the back of the neck (0.6mg/kg @ 2ml/ The pad was removed, weighed and replaced with a new pre-weighed pad every 5 min up to 15 minutes.

- 5 Saliva production was calculated by subtracting the pre-weighed weight of the pad from each 5 minute period post weighed pad and these numbers added together to produce an accumulation of saliva over 15 minutes. Each 5 minute period could be analysed in addition to the whole 15 minute recording period. Baseline production of saliva was assumed to be constant and multiplied by three to produce a reading for baseline saliva
10 production over 15 minutes.

Inhibition of saliva produced by the compound could be calculated by using the following equation: $(1 - (\text{Test-baseline}) / (\text{Veh-baseline})) * 100$.

CLAIMS

1. A compound selected from the group consisting of:

- 5 (R)-1-[(6-Methyl-pyridin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyl-
1-azonia-bicyclo[2.2.2]octane X;
(R)-1-[(6-Methyl-pyrazin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyl-
1-azonia-bicyclo[2.2.2]octane X;
(R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-[(6-trifluoromethyl-pyridazin-3-
10 ylcarmoyl)-methyl]-1-azonia-bicyclo[2.2.2]octane X;
(R)-1-(Benzo[d]isoxazol-3-ylcarbamoymethyl)-3-(1-phenyl-cycloheptanecarbonylox-
azonia-bicyclo[2.2.2]octane X;
(R)-1-(Pyridazin-3-ylcarbamoymethyl)-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy-
azonia-bicyclo[2.2.2]octane X;
15 (R)-1-[(5-Methyl-isoxazol-3-ylcarbamoymethyl)-methyl]-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;
(R)-1-[(3-Methyl-isoxazol-5-ylcarbamoymethyl)-methyl]-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;
(R)-1-[(3-Fluoro-phenylcarbamoymethyl)-methyl]-3-(1-thiophen-2-yl-
20 cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;
(R)-1-[(5-Methyl-pyrazin-2-ylcarbamoymethyl)-methyl]-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;
(R)-1-(Benzo[d]isoxazol-3-ylcarbamoymethyl)-3-(1-thiophen-2-yl-
cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;
25 (R)-1-(Pyrazin-2-ylcarbamoymethyl)-3-(1-thiophen-2-yl-cycloheptanecarbonyloxy)-1-
azonia-bicyclo[2.2.2]octane X;
(R)-3-[1-(3-Fluoro-phenyl)-cycloheptanecarbonyloxy]-1-(pyrazin-2-ylcarbamoymeth-
1-azonia-bicyclo[2.2.2]octane X;
(R)-3-[1-(3-Fluoro-phenyl)-cycloheptanecarbonyloxy]-1-(isoxazol-3-ylcarbamoymeth-
30 1-azonia-bicyclo[2.2.2]octane X;
(R)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-2-ylcarbamoymethyl)-1-azonia-

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-4-ylcarbamoylmethyl)-1-azoniabicyclo[2.2.2]octane X;

(*R*)-1-[(5-Fluoro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

5 (*R*)-1-[(5-Methyl-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyridin-3-ylcarbamoylmethyl)-1-azoniabicyclo[2.2.2]octane X;

10 (*R*)-1-[(2-Methyl-pyridin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-Phenylcarbamoylmethyl-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azoniabicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-4-ylcarbamoylmethyl)-1-azoniabicyclo[2.2.2]octane X;

15 (*R*)-1-[(2-Fluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(2,3-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

20 (*R*)-1-[2-(2,3-Dihydro-benzofuran-5-yl)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[2-(4-Fluoro-phenoxy)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azoniabicyclo[2.2.2]octane X;

(*R*)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-(pyridazin-4-ylcarbamoylmethyl)-1-azoniabicyclo[2.2.2]octane X;

25 (*R*)-1-[(5-Fluoro-pyridin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-[2-(pyridin-3-yloxy)-ethyl]-1-azoniabicyclo[2.2.2]octane X;

30 (*R*)-1-[(6-Methyl-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*o*-tolylcarbamoyl-methyl)-1-azonia-

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(2-pyrazin-2-yl-ethyl)-1-azonia-bicyclo[2.2.2]octane X;

(*S*)-1-(3-Phenoxy-propyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

5 (*R*)-1-{[2-(3-Fluoro-phenoxy)-ethylcarbamoyl]-methyl}-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(3,5-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

10 (*R*)-1-[2-(4-methoxy-benzyloxy)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-(2-Phenethyloxy-ethyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(2,6-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

15 (*R*)-1-[(Methyl-phenyl-carbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[3-(4-Cyano-phenoxy)-propyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

20 (*R*)-1-[(2,5-Difluoro-phenylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[2-(4-Cyano-benzyloxy)-ethyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-[(6-trifluoromethyl-pyridin-2-ylcarbamoyl)-methyl]-1-azonia-bicyclo[2.2.2]octane X;

25 (*R*)-1-[(4-Methyl-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(5-Chloro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

30 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*p*-tolylcarbamoyl-methyl)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(*m*-tolylcarbamoyl-methyl)-1-azonia-

(*R*)-1-(Oxazol-2-ylcarbamoylmethyl)-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(6-Methyl-pyridazin-3-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

5 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-2-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(5-Cyano-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

10 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(pyrimidin-5-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(3-Fluoro-pyridin-2-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(3-Fluoro-pyridin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

15 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{2-[(pyrazine-2-carbonyl)-amino]-ethyl}-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-([1,2,4]thiadiazol-5-ylcarbamoylmethyl)-1-azonia-bicyclo[2.2.2]octane X;

20 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{3-[(pyridine-2-carbonyl)-amino]-propyl}-1-azonia-bicyclo[2.2.2]octane X;

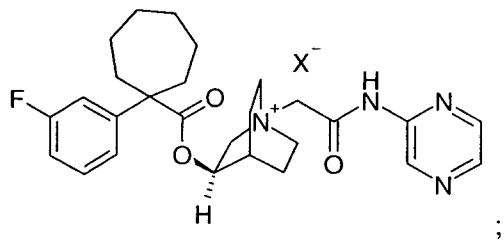
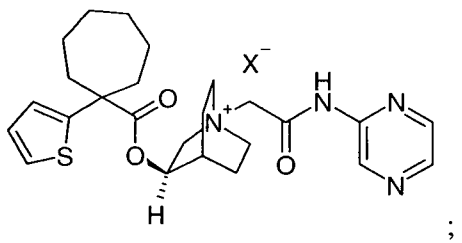
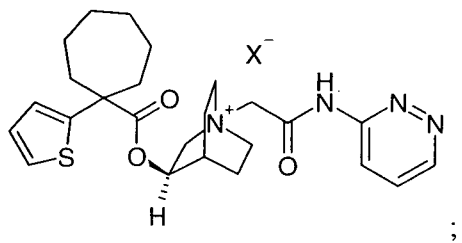
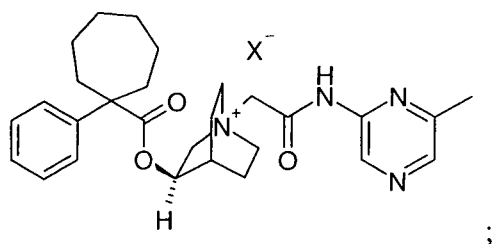
(*R*)-1-[(2-Methyl-pyrimidin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

(*R*)-1-[(6-Methyl-pyrimidin-4-ylcarbamoyl)-methyl]-3-(1-phenyl-cycloheptanecarbonyloxy)-1-azonia-bicyclo[2.2.2]octane X;

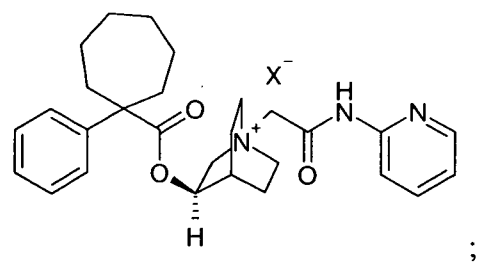
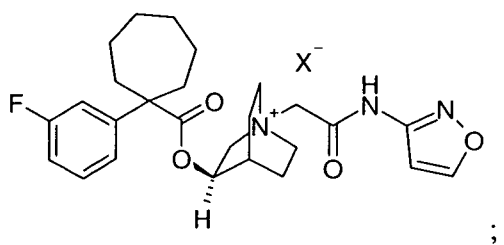
25 (*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-{2-[(pyridine-2-carbonyl)-amino]-ethyl}-1-azonia-bicyclo[2.2.2]octane X; and

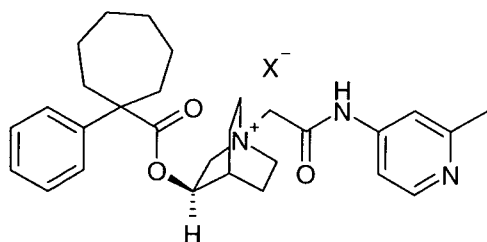
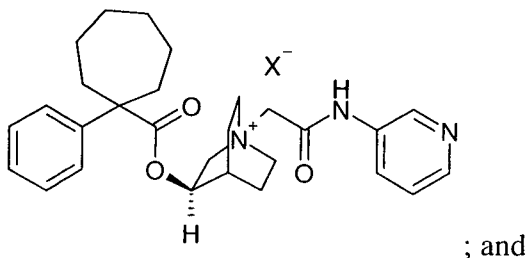
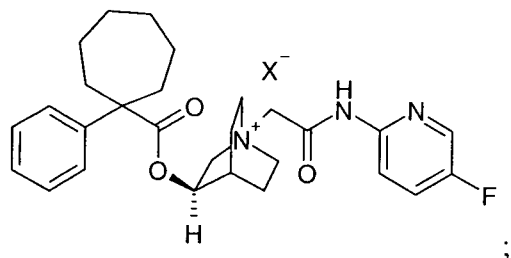
(*R*)-3-(1-Phenyl-cycloheptanecarbonyloxy)-1-(3-pyridin-4-yl-propyl)-1-azonia-bicyclo[2.2.2]octane X;

30 wherein X represents a pharmaceutically acceptable anion of a mono or polyvalent acid



5





wherein X represents a pharmaceutically acceptable anion of a mono or polyvalent acid

5

3. A pharmaceutical composition comprising a compound according to claim 1 or claim 2, in association with a pharmaceutically acceptable adjuvant, diluent or carrier.

4. A process for the preparation of a pharmaceutical composition as claimed in claim 3, which comprises mixing a compound according to claim 1 or claim 2 with a pharmaceutically acceptable adjuvant, diluent or carrier.

10

5. A compound according to claim 1 or claim 2 for use in therapy.

15

6. Use of compound according to claim 1 or claim 2, in the manufacture of a medicament for use in the treatment of chronic obstructive pulmonary disease.

7. A method of treating chronic obstructive pulmonary disease in a warm-blooded animal, such as man, which comprises administering to a mammal in need of such

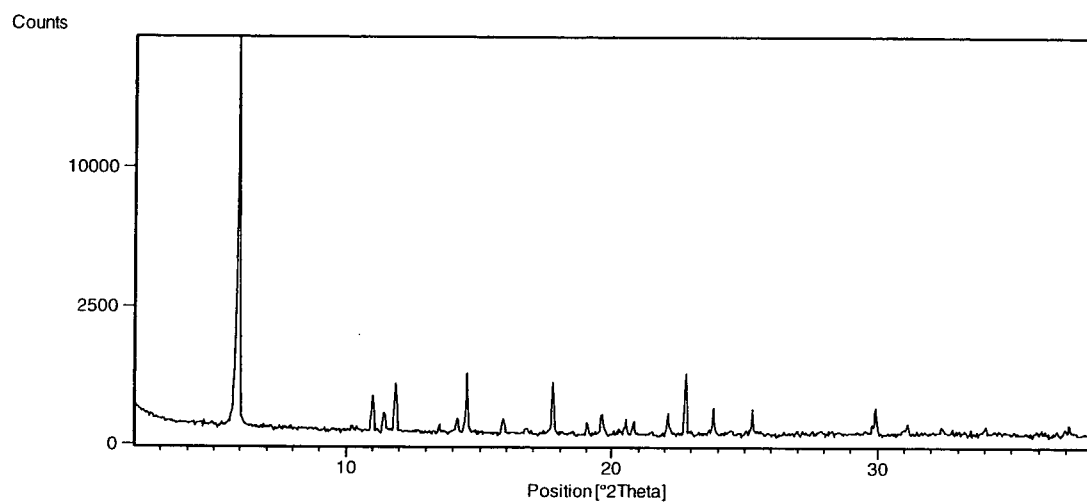
8. A pharmaceutical product comprising, in combination, a first active ingredient which is a compound according to claim 1 or claim 2, and at least one further active ingredient selected from:-

- 5 • a phosphodiesterase inhibitor,
- a β_2 adrenoceptor agonist,
- a modulator of chemokine receptor function,
- an inhibitor of kinase function,
- a protease inhibitor,
- 10 • a steroidal glucocorticoid receptor agonist, and a
- a non-steroidal glucocorticoid receptor agonist.

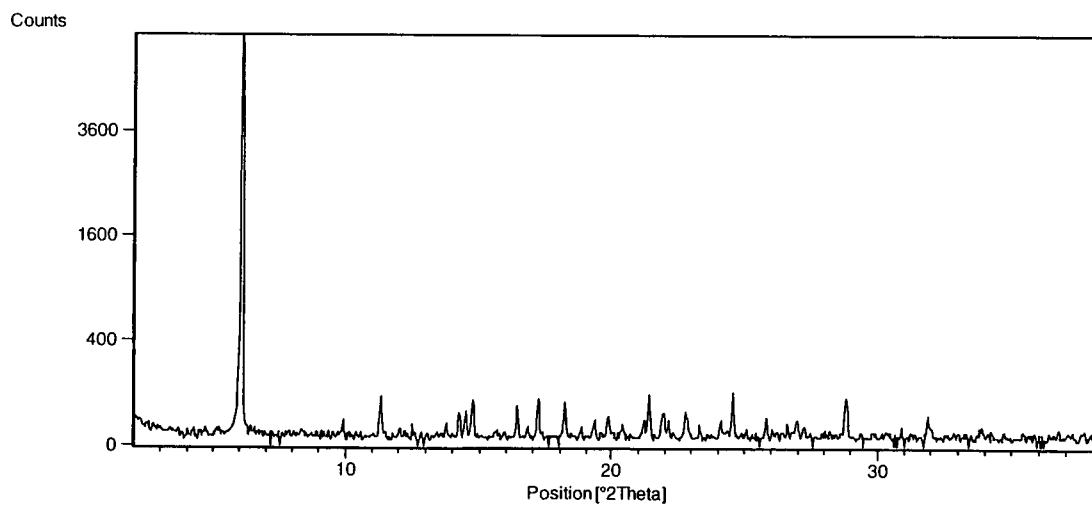
1/1

Figure 1

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Figure 2

10



INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2008/001647

A. CLASSIFICATION OF SUBJECT MATTER

INV. C07D453/02 A61K31/439 A61P11/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C07D

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

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

EPO-Internal, WPI Data, BEILSTEIN Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	WO 2008/059245 A (ASTRAZENECA AB [SE]; ASTRAZENECA UK LTD [GB]; FORD RHONAN [GB]; MATHER) 22 May 2008 (2008-05-22) the whole document	1-8
A	WO 2006/048225 A (NOVARTIS AG [CH]; NOVARTIS PHARMA GMBH [AT]; PRESS NEIL JOHN [GB]; COL) 11 May 2006 (2006-05-11) claims 1, 8-12	1-8
A	WO 2004/096800 A (NOVARTIS AG [CH]; NOVARTIS PHARMA GMBH [AT]; COLLINGWOOD STEPHEN PAUL) 11 November 2004 (2004-11-11) Claims 1, 16 and 17, last compound in page 106	1-8
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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

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

Date of the actual completion of the international search

26 February 2009

Date of mailing of the international search report

09/03/2009

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Sahagún Krause, H

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2008/001647

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 2002/169208 A1 (DRUZGALA PASCAL [US]) 14 November 2002 (2002-11-14) claims 1, 45 and example 7 -----</p>	1-8

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Information on patent family members

International application No

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