

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
13 April 2006 (13.04.2006)

PCT

(10) International Publication Number
WO 2006/037185 A1

(51) International Patent Classification:

C07H 15/14 (2006.01) **A61P 31/04** (2006.01)
A61K 31/70 (2006.01)

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(21) International Application Number:

PCT/AU2005/001548

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(22) International Filing Date: 7 October 2005 (07.10.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

2004905781 7 October 2004 (07.10.2004) AU

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: NOVEL SULFENAMIDES AND SULFENAMIDE OXIDES

(57) Abstract: A compound of the general formula (I): wherein R₁, R₂, X₁, X₁', X₂, X₂', X₃, X₃', X₄, X₄' and X₅ define various substituents and p is 0, 1 or 2. The invention also relates to use of the compounds as anti-microbial agents.



WO 2006/037185 A1

NOVEL SULFENAMIDES AND SULFENAMIDE OXIDESTechnical Field

5 The present invention relates to novel
sulfenamides and their oxides that have physiological
activity, particularly an antimicrobial action, methods
for their synthesis, pharmaceutical compositions
containing them and method of treatment of patients, in
particular, those suffering a microbial infection.

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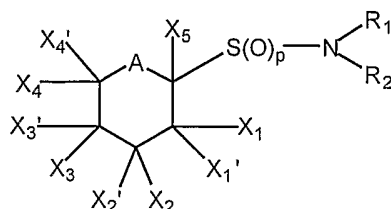
Background Art

Many bacterial diseases once thought to be on the
decline are beginning to re-emerge and annually devastate
populations in many countries. This problem is amplified
15 by the emergence of many new drug resistant strains of the
microorganisms that cause these diseases. Our interest in
the development of carbohydrate-based antimicrobial agents
(see, for example, von Itzstein, Wu, et al., 1993; Kok,
Campbell, Mackey, & von Itzstein, 1996; Fazli, Bradley et
20 al., 2001) has led to the discovery of a new class of
antimicrobial agents described below. A large amount of
work has been published (see, for example Ernst, Hart &
Sinay, 2000) in the area of carbohydrate chemistry and
biology. In addition, carbohydrate mimics based on
25 isosteres of the ring structure are well known in the
literature and often present interesting biological
activities (see, for example, Chapleur, 1998; Lillelund,
Jensen, Liang, & Bols, 2002; Kok, Campbell, Mackey, & von
Itzstein, 1996). Despite this large body of work little
30 to date has provided compounds that are clinically useful
antimicrobial medicines. There remains a need for the
identification of new antimicrobial agents.

Disclosure of the Invention

35 The present invention is concerned generally with
novel sulfenamides and their oxides that have physiologic
activity, in particular, an antimicrobial action.

In a first aspect of the present invention there is provided a compound of the following general formula (I):



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

or R_1 and R_2 together with the nitrogen atom from which they depend form a saturated or unsaturated, optionally substituted heterocyclic group which may include additional heteroatoms selected from the group consisting of O, N and S;

A is selected from the group consisting of O, S, SO, SO_2 , Se, Te, NR_8 , $CR_9R'_9$, $N \rightarrow O$, and $C(O)$;

X_1 is selected from the group consisting of OR_3 , SR_3 , $NR_3R'_3$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_3$, $-N(C=(Z)(T)_nR_3)_2$, N_3 , CN, OCN, SCN, OSO_3R_3 , OSO_2R_3 , $OPO_3R_3R'_3$, $OPO_2R_3R'_3$, $S(O)R_3$, $S(O)_2R_3$, $S(O)_2OR_3$, $PO_3R_3R'_3$, $NR_3NR'_3R''_3$, $SNR_3R'_3$, $NR_3SR'_3$, SSR_3 and R_3 , or is an oxo group, $=S$, $=NOR_3$ or $=CR_3R'_3$ and $X_{1'}$ is absent, or X_1 is $C=(Z)$ and R_2 is a bond thereto so as to form a cyclic moiety $-C=(Z)NR_1S(O)_p-$;

X_2 is selected from the group consisting of OR_4 , SR_4 , $NR_4R'_4$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_4$, $-N(C=(Z)(T)_nR_4)_2$, N_3 , CN , OCN , SCN , OSO_3R_4 , OSO_2R_4 , $OPO_3R_4R'_4$, $OPO_2R_4R'_4$, $S(O)R_4$, $S(O)_2R_4$, $S(O)_2OR_4$, $PO_3R_4R'_4$, $NR_4NR'_4R''_4$, $SNR_4R'_4$, $NR_4SR'_4$, SSR_4 and R_4 , or is an oxo group, $=S$, $=NOR_4$ or $=CR_4R'_4$ and X_2' is absent;

X_3 is selected from the group consisting of OR_5 , SR_5 , $NR_5R'_5$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_5$, $-N(C=(Z)(T)_nR_5)_2$, N_3 , CN , OCN , SCN , OSO_3R_5 , OSO_2R_5 , $OPO_3R_5R'_5$, $OPO_2R_5R'_5$, $S(O)R_5$, $S(O)_2R_5$, $S(O)_2OR_5$, $PO_3R_5R'_5$, $NR_5NR'_5R''_5$, $SNR_5R'_5$, $NR_5SR'_5$, SSR_5 and R_5 , or is an oxo group, $=S$, $=NOR_5$ or $=CR_5R'_5$ and X_3' is absent;

X_4 is selected from the group consisting of OR_6 , SR_6 , $NR_6R'_6$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_6$, $-N(C=(Z)(T)_nR_6)_2$, N_3 , CN , OCN , SCN , OSO_3R_6 , OSO_2R_6 , $OPO_3R_6R'_6$, $OPO_2R_6R'_6$, $S(O)R_6$, $S(O)_2R_6$, $S(O)_2OR_6$, $PO_3R_6R'_6$, $NR_6NR'_6R''_6$, $SNR_6R'_6$, $NR_6SR'_6$, SSR_6 , R_6 , or is an oxo group, $=S$, $=NOR_6$ or $=CR_6R'_6$ and X_4' is absent, and $-(CX_6X_6')_vCX_7X_7'X_7''$ wherein v is an integer in the range of 0 to 6 inclusive and, when v is in the range of 1 to 6, may include a double bond or epoxide group, each of X_6 , X_7 and X_7' is independently selected from the group consisting of OR_{12} , SR_{12} , $NR_{12}R'_{12}$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_{12}$, $-N(C=(Z)(T)_nR_{12})_2$, N_3 , CN , OCN , SCN , OSO_3R_{12} , OSO_2R_{12} , $OPO_3R_{12}R'_{12}$, $OPO_2R_{12}R'_{12}$, $S(O)R_{12}$, $S(O)_2R_{12}$, $S(O)_2OR_{12}$, $PO_3R_{12}R'_{12}$, $NR_{12}NR'_{12}R''_{12}$, $SNR_{12}R'_{12}$, $NR_{12}SR'_{12}$, SSR_{12} and R_{12} , or is an oxo group, $=S$, $=NOR_{12}$ or $=CR_{12}R'_{12}$ and X_6' or X_7'' , respectively, is absent; and each of X_6' and X_7'' is independently selected from the group hydrogen, CN , optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

X_5 is selected from the group consisting of hydrogen, CN , $-C=(Z)(T)_nR_{11}$, $S(O)R_{11}$, $S(O)_2R_{11}$, $S(O)_2OR_{11}$, $PO_3R_{11}R'_{11}$, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

X_1' , X_2' , X_3' and X_4' are the same or different and are selected from the group consisting of hydrogen, CN, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and A when A contains a carbon or nitrogen atom, X_5 and A when A contains a carbon or nitrogen atom, and X_5 and X_1 together constitute a double bond, or R_1 and X_1 , R_2 and X_1 , R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4' together form part of a ring structure which optionally includes at least one heteroatom selected from O, S and N and is optionally substituted;

m and n are independently zero or one and Y, Z and T are independently selected from the group consisting of O, S, and NR_{10}

p is zero, one or two;

R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 , R''_6 , R_7 , R_8 , R_9 , R'_9 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} are the same or different and are selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aryl, optionally substituted heterocyclic, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted acyl and a carbohydrate moiety;

with the proviso that at least two of X_1 , X_2 , X_3 , X_4 , X_6 and X_7 are other than hydrogen or a group linked to the ring through a carbon-carbon bond and the further

proviso that the compound is not *N,N*-diethyl-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-galactopyranosyl)sulfenamide, *N,N*-diethyl-*S*-(2-acetamido-3,4,6-tri-*O*-acetyl-2-deoxy- β -D-glucopyranosyl)sulfenamide, methyl *N*-acetyl-4,7,8,9-tetra-*O*-acetyl-2-*S*-(diethylamino)-2-thio- α -neuraminate, *N,N*-di(isopropyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, 1-[(2,3,4,6-tetra-*O*-acetyl- β -D-galactopyranosyl)thio]piperidine, 1-[(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)thio]piperidine, 4-[(2,3,4,6-tetra-*O*-acetyl- β -D-galactopyranosyl)thio]morpholine, *N*-(1-adamantyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, *N*-benzyl-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, *N*-phenyl-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, *N*-phenyl-*S*-(D-glucopyranosyl)sulfenamide, *N*-(4-methylphenyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, *N*-(2-chlorophenyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, *N*-(4-hydroxyphenyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, 2-[(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)thio]-1(2H)-isoquinoline, methyl 1-deoxy-1-[(4-thioxo-1(4H)-pyrimidinyl)thio]- β -D-glucopyranuronate, 1-(galactopyranosylthio)-1H-tetrazole, 1-(glucopyranosylthio)-1H-tetrazole, or 1,1'-[sulfonylbis(4,1-phenyleneiminosulfonyl)]bis[1-deoxy- β -D-glucopyranuronic acid] tetrasodium salt; or a pharmaceutically acceptable salt thereof.

It will be appreciated that the manner of representing substituents in the foregoing general formula does not imply any particular stereochemistry or orientation for the substituents.

The term "alkyl" used either alone or in a compound word such as "optionally substituted alkyl" or "optionally substituted cycloalkyl" denotes straight chain, branched or mono- or poly- cyclic alkyl. Examples of straight chain and branched C alkyl include methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, amyl, isoamyl, sec-amyl, 1,2-dimethylpropyl,

1,1-dimethylpropyl, hexyl, 4-methylpentyl, 1-methylpentyl, 2-methylpentyl, 3-methylpentyl, 1,1-dimethylbutyl, 2,2-dimethylbutyl, 3,3-dimethylbutyl, 1,2-dimethylbutyl, 1,3-dimethylbutyl, 1,2,2-trimethylpropyl, 1,1,2-trimethylpropyl, heptyl, 5-methylhexyl, 1-methylhexyl, 2,2-dimethylpentyl, 3,3-dimethylpentyl, 4,4-dimethylpentyl, 1,2-dimethylpentyl, 1,3-dimethylpentyl, 1,4-dimethylpentyl, 1,2,3-trimethylbutyl, 1,1,2-trimethylbutyl, nonyl, 1-, 2-, 3-, 4-, 5-, 6- or 7-methyloctyl, 1-, 2-, 3-, 4- or 5-ethylheptyl, 1-2- or 3-propylhexyl, decyl, 1-, 2-, 3-, 4-, 5-, 6-, 7- and 8-methylnonyl, 1-, 2-, 3-, 4-, 5- or 6-ethyloctyl, 1-, 2-, 3- or 4-propylheptyl, undecyl 1-, 2-, 3-, 4-, 5-, 6-, 7-, 8- or 9-methyldecyl, 1-, 2-, 3-, 4-, 5-, 6- or 7-ethylnonyl, 1-, 2-, 3-, 4- or 5-propyloctyl, 1-, 2- or 3-butylheptyl, 1-pentylhexyl, dodecyl, 1-, 2-, 3-, 4-, 5-, 6-, 7-, 8-, 9- or 10-methylundecyl, 1-, 2-, 3-, 4-, 5-, 6-, 7- or 8-ethyldecyl, 1-, 2-, 3-, 4-, 5- or 6-propylnonyl, 1-, 2-, 3- or 4-butyloctyl, 1-2-pentylheptyl and the like.

Examples of cycloalkyl include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl and cyclodecyl and the like.

The term "alkenyl" used either alone or in compound words such as "alkenyloxy" denotes groups formed from straight chain, branched or cyclic alkenes including ethylenically mono-, di- or poly-unsaturated alkyl or cycloalkyl groups as defined above. Examples of C₄₋₃₀ alkenyl include butenyl, iso-butenyl, 3-methyl-2-butenyl, 1-pentenyl, cyclopentenyl, 1-methyl-cyclopentenyl, 1-hexenyl, 3-hexenyl, cyclohexenyl, 1-heptenyl, 3-heptenyl, 1-octenyl, cyclooctenyl, 1-nonenyl, 2-nonenyl, 3-nonenyl, 1-decenyl, 3-decenyl, 1,3-butadienyl, 1,4-pentadienyl, 1,3-cyclopentadienyl, 1,3-hexadienyl, 1,4-hexadienyl, 1,3-cyclohexadienyl, 1,4-cyclohexadienyl, 1,3-cycloheptadienyl, 1,3,5-cycloheptatrienyl and 1,3,5,7-cyclooctatetraenyl.

The term "acyl" used either alone or in compound words such as "optionally substituted acyl" or "optionally

substituted acyloxy" denotes an aliphatic acyl group or an acyl group containing an aromatic ring, which is referred to as aromatic acyl, or a heterocyclic ring, which is referred to as heterocyclic acyl, preferably C₁₋₃₀ acyl.

5 Examples of acyl include straight chain or branched alkanoyl such as formyl, acetyl, propanoyl, butanoyl, 2-methylpropanoyl, pentanoyl, 2,2-dimethylpropanoyl, hexanoyl, heptanoyl, octanoyl, nonanoyl, decanoyl, undecanoyl, dodecanoyl, tridecanoyl, pentadecanoyl, 10 hexadecanoyl, heptadecanoyl, octadecanoyl, nonadecanoyl and icosanoyl; cycloalkylcarbonyl such as cyclopropylcarbonyl, cyclobutylcarbonyl, cyclopentylcarbonyl and cyclohexylcarbonyl; aroyl such as benzoyl, toluoyl and naphthoyl; aralkanoyl such as 15 phenylalkanoyl (e.g. phenylacetyl, phenylpropanoyl, phenylbutanoyl, phenylisobutyl, phenylpentanoyl and phenylhexanoyl) and naphthylalkanoyl (e.g. naphthylacetyl, naphthylpropanoyl and naphthylbutanoyl); aralkenoyl such as 20 phenylalkenoyl (e.g. phenylpropenoyl, phenylbutenoyl, phenylmethacrylyl, phenylpentenoyl and phenylhexenoyl and naphthylalkenoyl (e.g. naphthylpropenoyl, naphthylbutenoyl and naphthylpentenoyl); heterocycliccarbonyl; heterocyclicalkanoyl such as thienylacetyl, thienylpropanoyl, thienylbutanoyl, thienylpentanoyl, 25 thienylhexanoyl, thiazolylacetyl, thiadiazolylacetyl and tetrazolylacetyl; and heterocyclicalkenoyl such as heterocyclicpropenoyl, heterocyclicbutenoyl, heterocyclicpentenoyl and heterocyclichexenoyl.

The term "aryl" used either alone or in compound 30 words such as "optionally substituted aryl", "optionally substituted aryloxy" or "optionally substituted heteroaryl" denotes single, polynuclear, conjugated and fused residues of aromatic hydrocarbons ("carbocyclic aryl" or "carboaryl") or aromatic heterocyclic 35 ("heteroaryl") ring systems. Examples of carbocyclic aryl include phenyl, biphenyl, terphenyl, quaterphenyl, phenoxyphenyl, naphthyl, tetrahydronaphthyl, anthracenyl, dihydroanthracenyl, benzanthracenyl, dibenzanthracenyl,

phenanthrenyl, fluorenyl, pyrenyl, indenyl, azulenyl, chrysenyl. Examples of heteroaryl include pyridyl, 4-phenylpyridyl, 3-phenylpyridyl, thienyl, furyl, pyrrol, pyrrolyl, furanyl, imadazolyl, pyrrolydiny, pyridinyl, 5 piperidinyl, indolyl, pyridazinyl, pyrazolyl, pyrazinyl, thiazolyl, pyrimidinyl, quinolinyl, isoquinolinyl, benzofuranyl, benzothienyl, purinyl, quinazolinyl, phenazinyl, acridinyl, benzoxazolyl, benzothiazolyl and the like. Preferably, a carbocyclic aromatic ring system 10 contains 6-10 carbon atoms and an aromatic heterocyclic ring system contains 1 to 4 heteratoms independently selected from N, O and S and up to 9 carbon atoms in the ring.

The term "heterocyclyl" or equivalent terms such 15 as "heterocyclic" used either alone or in compound words such as "optionally substituted saturated or unsaturated heterocyclyl" denotes monocyclic or polycyclic heterocyclyl groups containing at least one heteroatom atom selected from nitrogen, sulphur and oxygen. Suitable 20 heterocyclyl groups include N-containing heterocyclic groups, such as, unsaturated 3 to 6 membered heteromonocyclic groups containing 1 to 4 nitrogen atoms, for example, pyrrolyl, pyrrolinyl, imidazolyl, pyrazolyl, pyridyl, pyrimidinyl, pyrazinyl, pyridazinyl, triazolyl or 25 tetrazolyl;

saturated 3 to 6-membered heteromonocyclic groups containing 1 to 4 nitrogen atoms, such as, pyrrolidinyl, imidazolidinyl, piperidino or piperazinyl;

unsaturated condensed heterocyclic groups 30 containing 1 to 5 nitrogen atoms, such as indolyl, isoindolyl, indoliziny, benzimidazolyl, quinolyl, isoquinolyl, indazolyl, benzotriazolyl or tetrazolopyridazinyl;

unsaturated 3 to 6-membered heteromonocyclic 35 group containing an oxygen atom, such as, oxiranyl, pyranyl or furyl;

unsaturated 3 to 6-membered heteromonocyclic group containing 1 to 2 sulfur atoms, such as, thienyl;

unsaturated 3 to 6-membered heteromonocyclic group containing 1 to 2 oxygen atoms and 1 to 3 nitrogen atoms, such as, oxazolyl, isoxazolyl or oxadiazolyl;

5 saturated 3 to 6-membered heteromonocyclic group containing 1 to 2 oxygen atoms and 1 to 3 nitrogen atoms, such as, morpholinyl;

unsaturated condensed heterocyclic group containing 1 to 2 oxygen atoms and 1 to 3 nitrogen atoms, such as, benzoxazolyl or benzoxadiazolyl;

10 unsaturated 3 to 6-membered heteromonocyclic group containing 1 to 2 sulphur atoms and 1 to 3 nitrogen atoms, such as, thiazolyl or thiadiazolyl;

saturated 3 to 6-membered heteromonocyclic group containing 1 to 2 sulphur atoms and 1 to 3 nitrogen atoms, such as, thiazolidinyl; and

unsaturated condensed heterocyclic group containing 1 to 2 sulphur atoms and 1 to 3 nitrogen atoms, such as, benzothiazolyl or benzothiadiazolyl.

The term "carbohydrate" denotes a carbohydrate residue or a functionalised or deoxygenated carbohydrate residue, and includes monosaccharides and oligosaccharides. A carbohydrate residue is an acyclic polyhydroxy-aldehyde or ketone, or one of their cyclic tautomers, and includes a compound resulting from reduction of the aldehyde or keto group such as alditols. Oxygen atoms may be replaced by hydrogen or bonds to a halogen, nitrogen, sulfur or carbon atoms, or carbon-oxygen bonds such as in ethers or esters may be introduced. Examples of carbohydrates include but are not limited to D-galactose, D-galactofuranose, N-acetyl-D-galactofuranose, D-galactopyranose, N-acetyl-D-galactopyranose, D-glucose, D-glucofuranose, N-acetyl-D-glucofuranose, D-glucopyranose and N-acetyl-D-glucopyranose, D-mannose, D-mannofuranose, D-mannopyranose, N-acetyl-D-mannopyranose, D-arabinofuranose, D-arabinopyranose, L-rhamnopyranose, D-ribose, D-fucose, N-acetylneuraminic acid, 2-keto-3-deoxy-nonulosonic acid, 2-keto-3-deoxy-octulosonic acid, D-galacturonic acid, D-

glucuronic acid, D-muramic acid, D-fructose, D-galactitol, D-glucitol, D-mannitol, D-lactitol, and their equivalents where oxygen atoms have been replaced in selected positions with hydrogen or bonds to halogen, nitrogen, sulfur or carbon, as well as oligosaccharides containing these moieties.

In this specification "optionally substituted" means that a group may or may not be further substituted with one or more functional groups such as alkyl, alkenyl, alkynyl, aryl, halo, haloalkyl, haloalkenyl, haloalkynyl, haloaryl, hydroxy, alkoxy, alkenyloxy, aryloxy, benzyloxy, haloalkoxy, haloalkenyloxy, haloaryloxy, nitro, nitroalkyl, nitroalkenyl, nitroalkynyl, nitroaryl, nitroheterocyclyl, amino, alkylamino, dialkylamino, alkenylamino, alkynylamino, arylamino, diarylamino, benzylamino, dibenzylamino, acyl, alkenylacyl, alkynylacyl, arylacyl, acylamino, diacylamino, acyloxy, alkylsulphonyloxy, arylsulphenyloxy, heterocyclyl, heterocycloxy, heterocyclamino, haloheterocyclyl, alkylsulphenyl, arylsulphenyl, carboalkoxy, carboaryloxy, mercapto, alkylthio, benzylthio, acylthio, phosphorus-containing groups and the like, and including groups such as oxo, =S, =N-, where appropriate, particularly as substituents in ring structures such as lactones, lactams and cyclic imides, provided that none of the substituents outlined above interferes with the formation or activity of the subject compound.

Any of the moieties whose length is defined in terms of the number of carbon atoms present may possess any number of carbon atoms within the specified range. Nevertheless, within this range certain species will be preferred due to factors such as availability and cost of precursors and ease of synthesis, as well as efficacy. In particular, such moieties may contain 1 to 24 carbon atoms, advantageously 1 to 12 carbon atoms, and typically 1 to 10 carbon atoms

In an embodiment one or both of R_1 and R_2 is alkyl. In a further embodiment one or both of R_1 and R_2 is

C₄₋₃₀ alkyl, and may be C₆₋₁₂ alkyl or C₈₋₁₀ alkyl, advantageously C₈ alkyl. Furthermore one or both of R₁ and R₂ may be aralkyl, alkyl interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇, and -(Y)_mC=(Z)(T)_n, alkenyl or R₁ and R₂ together with a nitrogen atom from which they depend may form an optionally substituted saturated or unsaturated heterocyclic group, for example, a cyclic imide or a lactam. If one or both R₁ and R₂ is alkenyl it may be C₄₋₃₀ alkenyl, in a further embodiment, C₆₋₁₂ alkenyl and in a still further embodiment C₈₋₁₀ alkenyl. In the case of one or both R₁ and R₂ being alkyl interrupted by one or more heteroatoms or functional groups, the heteroatom may be oxygen, and, in an embodiment, R₁ and/or R₂ may have the formula CH₃(CH₂)_xO(CH₂)_yO(CH₂)_z or CH₃(CH₂)_yO(CH₂)_z wherein x is an integer in the range 0 to 12 inclusive and y and z are independently integers in the range 1 to 12 inclusive. Advantageously R₁ and/or R₂ may have the formula CH₃(CH₂)_yO(CH₂)_z where y is in the range 3 to 9, typically 7, and x is in the range 2 to 6, typically 2. Equally, if one of R₃, R'₃, R''₃, R₄, R'₄, R''₄, R₅, R'₅, R''₅, R₆, R'₆, R''₆, R₇, R₈, R₉, R'₉, R₁₀, R₁₁, R'₁₁, R₁₂, R'₁₂ or R''₁₂ is alkyl, alkenyl, aralkyl or alkyl or alkenyl interrupted by one or more heteroatoms or functional groups, embodiments are as set out for R₁ and R₂.

In an embodiment the amine portion of the sulfenamide or its oxide is tethered to the carbohydrate moiety through an additional linkage. While the amine moiety may be tethered by linkage to any position in the carbohydrate moiety, linkage to the position bearing X₁ through either R₁ or R₂ forming a ring together with X₁ is preferred. By way of example only, the linkage may take the form of an optionally substituted alkyl chain being linked to the end of a functional group located in the position bearing X₁ of the carbohydrate ring and linked to a functional group located within R₁ or R₂.

In an embodiment X₁ is OR₃. Advantageously R₃ is hydrogen or optionally substituted acyl.

In an embodiment X_2 is OR_4 . Advantageously, R_4 is hydrogen or optionally substituted acyl.

In an embodiment X_3 is OR_5 . Advantageously, R_5 is hydrogen or optionally substituted acyl.

5 In an embodiment X_4 is $-(CX_6X_6')_vCX_7X_7'X_7''$ wherein v is an integer in the range of 0 to 6 inclusive, preferably 0, 1 or 2, and each of X_6 , X_7 and X_7' is independently selected from the group consisting of OR_{12} , SR_{12} , $NR_{12}R'_{12}$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_{12}$, $-$
 10 $N(C=(Z)(T)_nR_{12})_2$, N_3 , CN , OCN , SCN , OSO_3R_{12} , OSO_2R_{12} , $OPO_3R_{12}R'_{12}$, $OPO_2R_{12}R'_{12}$, $S(O)R_{12}$, $S(O)_2R_{12}$, $S(O)_2OR_{12}$, $PO_3R_{12}R'_{12}$, $NR_{12}NR'_{12}R''_{12}$, $SNR_{12}R'_{12}$, $NR_{12}SR'_{12}$, SSR_{12} and R_{12} , or is an oxo group, $=S$, $=NOR_{12}$ or $=CR_{12}R'_{12}$ and X_6' or X_7'' , respectively, is absent; and each of X_6' and X_7'' is
 15 independently selected from the group hydrogen, CN , optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl; and R_{12} , R'_{12} and R''_{12} are the same or different and are
 20 selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O , S , $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by
 25 one or more heteroatoms or functional groups selected from the group consisting of O , S , $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aryl, optionally substituted heterocyclic, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more
 30 heteroatoms or functional groups selected from the group consisting of O , S , $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted acyl and a carbohydrate moiety.

In an embodiment, X_4 is CH_2OR_{12} , $CHOR_{12}CH_2OR_{12}$ or $CHOR_{12}CHOR_{12}CH_2OR_{12}$ where each R_{12} may be any of the groups
 35 recited above. Typically X_4 is CH_2OR_{12} .

In an embodiment any one of the substituents R_3 , R_4 , R_5 , R_6 and R_{12} is optionally substituted acyl, in particular, optionally substituted acyl where the

substituent on the acyl group effects the lipophilicity or water solubility of the compound. By way of example, preferred compounds include amino acid esters where the amino acid side chain is selected to provide a predetermined lipophilicity for the compound. The amino acid side chains envisaged include all of the natural occurring amino acid side chains as well as common synthetic amino acids. Alternatively, the compounds maybe succinyl esters terminating in amides that improve water solubility.

In an embodiment p is 2 and the compounds are sulfonamides. Alternatively, p is 1 and the compounds are sulfinamides.

In an embodiment the compounds of the invention are galactopyranosyl compounds.

In an embodiment the compounds of the invention are glucopyranosyl compounds.

Advantageously the compounds of general formula (I) are selected from the group consisting of:

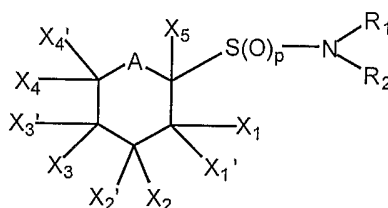
N,N -dioctyl- S -(2,3,5,6-tetra- O -acetyl- β -D-galactopyranosyl) sulfenamide,
 N,N -di(2-octyloxyethyl)- S -(2,3,5,6-tetra- O -acetyl- β -D-galactopyranosyl) sulfenamide,
 N,N -dioctyl- S -(2,3,5,6-tetra- O -acetyl- β -D-glucopyranosyl) sulfenamide,
 N,N -di(2-octyloxyethyl)- S -(2,3,5,6-tetra- O -acetyl- β -D-glucopyranosyl) sulfenamide,
 N,N -dioctyl- S -(β -D-galactopyranosyl) sulfenamide,
 N,N -di(2-octyloxyethyl)- S -(β -D-galactopyranosyl) sulfenamide,
 N,N -dioctyl- S -(β -D-glucopyranosyl) sulfenamide, and
 N,N -di(2-octyloxyethyl)- S -(β -D-glucopyranosyl) sulfenamide, and their oxides.

In an embodiment the compound of general formula (I) is selected from the group consisting of N,N -dioctyl- S -(β -D-galactopyranosyl) sulfenamide, N,N -di(2-octyloxyethyl)- S -(β -D-galactopyranosyl) sulfenamide, N,N -dioctyl- S -(β -D-glucopyranosyl) sulfenamide and N,N -di(2-

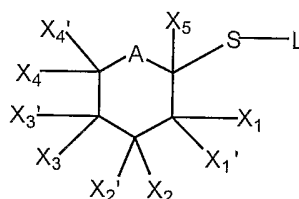
octyloxyethyl)-S-(β -D-glucopyranosyl)sulfenamide, and their oxides.

In an embodiment the compound is a thio- (A = S) or aza- (A = NR₈) analogue of N,N-dioctyl-S-(β -D-galactopyranosyl)sulfenamide and its oxides.

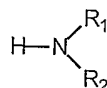
According to a second aspect of the present invention there is provided a method of preparation of a compound of general formula (I):



comprising reacting a compound of general formula (II):



wherein L is an acyl group, preferably acetyl and X₁, X₂, X₃, X₄, X₁', X₂', X₃' X₄' and X₅ are as defined above; with a compound of general formula (III):



wherein R₁ and R₂ are as defined above;

in the presence of a bis-activated alkyl halide;

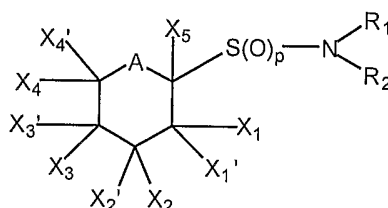
and, optionally,

reacting the product with an oxidising agent.

Typically the bis-activated alkyl halide is diethyl bromomalonate, trimethyl bromophosphonoacetate or N-bromosuccinimide. In general terms the reaction is performed in the presence of an excess of the secondary

amine of general formula (III) in an inert solvent such as DMF or THF, in an alcoholic solvent such as methanol or ethanol, or in mixtures of such solvents, at a temperature from 20°C to 60°C, preferably 25°C to 40°C, under an atmosphere of nitrogen or argon. The reaction mixture may be left to stir typically for 2 to 160 hours, preferably greater than 12 hours, prior to isolation and purification, or deprotection. In an embodiment R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 , R''_6 , R_7 , R_8 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} may be a protecting group, and the process may include the further step of removing the protecting groups. Protecting groups may not always be required. Suitable protecting groups for hydroxyl groups are well known to the person skilled in the art, and in this case the acetyl and benzoyl groups are preferred. Acetyl and benzoyl protecting groups are typically removed through hydrolysis with sodium methoxide in methanol. Suitable protecting groups for nitrogen atoms are well known to the person skilled in the art. The sulfenamides of the present invention may also be synthesised through the condensation of sulfenyl halides with a secondary amine of general formula (III), the reaction of the relevant thiols and amines in the presence of oxidising reagents or via the reaction of disulfides or thiosulfonates and amines in the presence of silver or mercuric salts, such as are disclosed in Craine & Raban, 1989; Koval', 1996; Illyés, 2004; the contents of which are incorporated herein by reference. A number of methods have been developed to oxidise sulfenamides as disclosed, for example, in Craine and Raban, 1989; Glass & Swedo, 1977; Haake, Gebbing, & Benack, 1979; the contents of which are incorporated herein by reference. Typically the oxidising agent is 3-chloroperbenzoic acid. An extensive array of methodologies has been developed to manipulate different positions on carbohydrate templates as disclosed, for example, Ernst, Hart & Sinay, 2000; Chapleur, 1998; Stick, 2001; the contents of which are incorporated herein by reference.

According to a third aspect of the present invention there is provided a method for the treatment of a microbial infection, comprising administering to a patient in need of such treatment a therapeutically effective amount of a compound of general formula (I):



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

or R_1 and R_2 together with the nitrogen atom from which they depend form a saturated or unsaturated, optionally substituted heterocyclic group which may include additional heteroatoms selected from the group consisting of O, N and S;

A is selected from the group consisting of O, S, SO, SO_2 , Se, Te, NR_8 , $CR_9R'_9$, $N \rightarrow O$, and $C(O)$;

X_1 is selected from the group consisting of OR_3 , SR_3 , $NR_3R'_3$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_3$, $-N(C=(Z)(T)_nR_3)_2$, N_3 , CN, OCN, SCN, OSO_3R_3 , OSO_2R_3 , $OPO_3R_3R'_3$, $OPO_2R_3R'_3$, $S(O)R_3$, $S(O)_2R_3$, $S(O)_2OR_3$, $PO_3R_3R'_3$, $NR_3NR'_3R''_3$, $SNR_3R'_3$, $NR_3SR'_3$, SSR_3 and R_3 , or is an oxo group, $=S$, $=NOR_3$

or $=\text{CR}_3\text{R}'_3$ and X_1' is absent, or X_1 is $\text{C}=\text{(Z)}$ and R_2 is a bond thereto so as to form a cyclic moiety $-\text{C}=\text{(Z)}\text{NR}_1\text{S}(\text{O})_{\text{p}}^-$;

X_2 is selected from the group consisting of OR_4 , SR_4 , $\text{NR}_4\text{R}'_4$, hydrogen, halogen, $-(\text{Y})_{\text{m}}\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_4$, -
 5 $\text{N}(\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_4)_2$, N_3 , CN , OCN , SCN , OSO_3R_4 , OSO_2R_4 , $\text{OPO}_3\text{R}_4\text{R}'_4$, $\text{OPO}_2\text{R}_4\text{R}'_4$, $\text{S}(\text{O})\text{R}_4$, $\text{S}(\text{O})_2\text{R}_4$, $\text{S}(\text{O})_2\text{OR}_4$, $\text{PO}_3\text{R}_4\text{R}'_4$, $\text{NR}_4\text{NR}'_4\text{R}''_4$, $\text{SNR}_4\text{R}'_4$, $\text{NR}_4\text{SR}'_4$, SSR_4 and R_4 , or is an oxo group, $=\text{S}$, $=\text{NOR}_4$ or $=\text{CR}_4\text{R}'_4$ and X_2' is absent;

X_3 is selected from the group consisting of OR_5 ,
 10 SR_5 , $\text{NR}_5\text{R}'_5$, hydrogen, halogen, $-(\text{Y})_{\text{m}}\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_5$, -
 $\text{N}(\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_5)_2$, N_3 , CN , OCN , SCN , OSO_3R_5 , OSO_2R_5 , $\text{OPO}_3\text{R}_5\text{R}'_5$, $\text{OPO}_2\text{R}_5\text{R}'_5$, $\text{S}(\text{O})\text{R}_5$, $\text{S}(\text{O})_2\text{R}_5$, $\text{S}(\text{O})_2\text{OR}_5$, $\text{PO}_3\text{R}_5\text{R}'_5$, $\text{NR}_5\text{NR}'_5\text{R}''_5$, $\text{SNR}_5\text{R}'_5$, $\text{NR}_5\text{SR}'_5$, SSR_5 and R_5 , or is an oxo group, $=\text{S}$, $=\text{NOR}_5$ or $=\text{CR}_5\text{R}'_5$ and X_3' is absent;

15 X_4 is selected from the group consisting of OR_6 , SR_6 , $\text{NR}_6\text{R}'_6$, hydrogen, halogen, $-(\text{Y})_{\text{m}}\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_6$, -
 $\text{N}(\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_6)_2$, N_3 , CN , OCN , SCN , OSO_3R_6 , OSO_2R_6 , $\text{OPO}_3\text{R}_6\text{R}'_6$, $\text{OPO}_2\text{R}_6\text{R}'_6$, $\text{S}(\text{O})\text{R}_6$, $\text{S}(\text{O})_2\text{R}_6$, $\text{S}(\text{O})_2\text{OR}_6$, $\text{PO}_3\text{R}_6\text{R}'_6$, $\text{NR}_6\text{NR}'_6\text{R}''_6$, $\text{SNR}_6\text{R}'_6$, $\text{NR}_6\text{SR}'_6$, SSR_6 , R_6 , or is an oxo group, $=\text{S}$, $=\text{NOR}_6$ or
 20 $=\text{CR}_6\text{R}'_6$ and X_4' is absent, and $-(\text{CX}_6\text{X}_6')_{\text{v}}\text{CX}_7\text{X}_7'\text{X}_7''$ wherein v is an integer in the range of 0 to 6 inclusive and, when v is in the range of 1 to 6, may include a double bond or epoxide group, each of X_6 , X_7 and X_7' is independently selected from the group consisting of OR_{12} , SR_{12} , $\text{NR}_{12}\text{R}'_{12}$,
 25 hydrogen, halogen, $-(\text{Y})_{\text{m}}\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_{12}$, $-\text{N}(\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_{12})_2$, N_3 , CN , OCN , SCN , $\text{OSO}_3\text{R}_{12}$, $\text{OSO}_2\text{R}_{12}$, $\text{OPO}_3\text{R}_{12}\text{R}'_{12}$, $\text{OPO}_2\text{R}_{12}\text{R}'_{12}$, $\text{S}(\text{O})\text{R}_{12}$, $\text{S}(\text{O})_2\text{R}_{12}$, $\text{S}(\text{O})_2\text{OR}_{12}$, $\text{PO}_3\text{R}_{12}\text{R}'_{12}$, $\text{NR}_{12}\text{NR}'_{12}\text{R}''_{12}$, $\text{SNR}_{12}\text{R}'_{12}$, $\text{NR}_{12}\text{SR}'_{12}$, SSR_{12} and R_{12} , or is an oxo group, $=\text{S}$, $=\text{NOR}_{12}$ or $=\text{CR}_{12}\text{R}'_{12}$ and X_6' or X_7'' , respectively, is absent;
 30 and each of X_6' and X_7'' is independently selected from the group hydrogen, CN , optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

35 X_5 is selected from the group consisting of hydrogen, CN , $-\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_{11}$, $\text{S}(\text{O})\text{R}_{11}$, $\text{S}(\text{O})_2\text{R}_{11}$, $\text{S}(\text{O})_2\text{OR}_{11}$, $\text{PO}_3\text{R}_{11}\text{R}'_{11}$, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl,

optionally substituted aralkyl, and optionally substituted acyl;

X_1' , X_2' , X_3' and X_4' are the same or different and are selected from the group consisting of hydrogen, CN, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and A when A contains a carbon or nitrogen atom, X_5 and A when A contains a carbon or nitrogen atom, and X_5 and X_1 together constitute a double bond, or R_1 and X_1 , R_2 and X_1 , R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4' together form part of a ring structure which optionally includes at least one heteroatom selected from O, S and N and is optionally substituted;

m and n are independently zero or one and Y, Z and T are independently selected from the group consisting of O, S, and NR_{10}

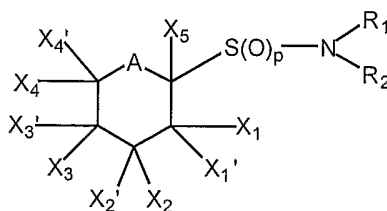
p is zero, one or two;

R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 , R''_6 , R_7 , R_8 , R_9 , R'_9 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} are the same or different and are selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aryl, optionally substituted heterocyclic, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted acyl and a carbohydrate moiety;

with the proviso that at least two of X_1 , X_2 , X_3 ,

X_4 , X_6 and X_7 are other than hydrogen or a group linked to the ring through a carbon-carbon bond;
or a pharmaceutically acceptable salt thereof.

According to a fourth aspect of the present
5 invention there is provided the use of a compound of general formula (I):



10 wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted
15 alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or
20 functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

or R_1 and R_2 together with the nitrogen atom from
25 which they depend form a saturated or unsaturated, optionally substituted heterocyclic group which may include additional heteroatoms selected from the group consisting of O, N and S;

A is selected from the group consisting of O, S, SO, SO₂, Se, Te, NR_8 , $CR_9R'_9$, $N->O$, and C(O);

30 X_1 is selected from the group consisting of OR_3 , SR_3 , $NR_3R'_3$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_3$, $-N(C=(Z)(T)_nR_3)_2$, N_3 , CN, OCN, SCN, OSO_3R_3 , OSO_2R_3 , $OPO_3R_3R'_3$, $OPO_2R_3R'_3$, $S(O)R_3$, $S(O)_2R_3$, $S(O)_2OR_3$, $PO_3R_3R'_3$, $NR_3NR'_3R'_3$,

$\text{SNR}_3\text{R}'_3$, $\text{NR}_3\text{SR}'_3$, SSR_3 and R_3 , or is an oxo group, $=\text{S}$, $=\text{NOR}_3$ or $=\text{CR}_3\text{R}'_3$ and X_1' is absent, or X_1 is $\text{C}=\text{(Z)}$ and R_2 is a bond thereto so as to form a cyclic moiety $-\text{C}=\text{(Z)}\text{NR}_1\text{S}(\text{O})_p-$;

X_2 is selected from the group consisting of OR_4 , SR_4 , $\text{NR}_4\text{R}'_4$, hydrogen, halogen, $-(\text{Y})_m\text{C}=\text{(Z)}(\text{T})_n\text{R}_4$, $-\text{N}(\text{C}=\text{(Z)}(\text{T})_n\text{R}_4)_2$, N_3 , CN , OCN , SCN , OSO_3R_4 , OSO_2R_4 , $\text{OPO}_3\text{R}_4\text{R}'_4$, $\text{OPO}_2\text{R}_4\text{R}'_4$, $\text{S}(\text{O})\text{R}_4$, $\text{S}(\text{O})_2\text{R}_4$, $\text{S}(\text{O})_2\text{OR}_4$, $\text{PO}_3\text{R}_4\text{R}'_4$, $\text{NR}_4\text{NR}'_4\text{R}''_4$, $\text{SNR}_4\text{R}'_4$, $\text{NR}_4\text{SR}'_4$, SSR_4 and R_4 , or is an oxo group, $=\text{S}$, $=\text{NOR}_4$ or $=\text{CR}_4\text{R}'_4$ and X_2' is absent;

X_3 is selected from the group consisting of OR_5 , SR_5 , $\text{NR}_5\text{R}'_5$, hydrogen, halogen, $-(\text{Y})_m\text{C}=\text{(Z)}(\text{T})_n\text{R}_5$, $-\text{N}(\text{C}=\text{(Z)}(\text{T})_n\text{R}_5)_2$, N_3 , CN , OCN , SCN , OSO_3R_5 , OSO_2R_5 , $\text{OPO}_3\text{R}_5\text{R}'_5$, $\text{OPO}_2\text{R}_5\text{R}'_5$, $\text{S}(\text{O})\text{R}_5$, $\text{S}(\text{O})_2\text{R}_5$, $\text{S}(\text{O})_2\text{OR}_5$, $\text{PO}_3\text{R}_5\text{R}'_5$, $\text{NR}_5\text{NR}'_5\text{R}''_5$, $\text{SNR}_5\text{R}'_5$, $\text{NR}_5\text{SR}'_5$, SSR_5 and R_5 , or is an oxo group, $=\text{S}$, $=\text{NOR}_5$ or $=\text{CR}_5\text{R}'_5$ and X_3' is absent;

X_4 is selected from the group consisting of OR_6 , SR_6 , $\text{NR}_6\text{R}'_6$, hydrogen, halogen, $-(\text{Y})_m\text{C}=\text{(Z)}(\text{T})_n\text{R}_6$, $-\text{N}(\text{C}=\text{(Z)}(\text{T})_n\text{R}_6)_2$, N_3 , CN , OCN , SCN , OSO_3R_6 , OSO_2R_6 , $\text{OPO}_3\text{R}_6\text{R}'_6$, $\text{OPO}_2\text{R}_6\text{R}'_6$, $\text{S}(\text{O})\text{R}_6$, $\text{S}(\text{O})_2\text{R}_6$, $\text{S}(\text{O})_2\text{OR}_6$, $\text{PO}_3\text{R}_6\text{R}'_6$, $\text{NR}_6\text{NR}'_6\text{R}''_6$, $\text{SNR}_6\text{R}'_6$, $\text{NR}_6\text{SR}'_6$, SSR_6 , R_6 , or is an oxo group, $=\text{S}$, $=\text{NOR}_6$ or $=\text{CR}_6\text{R}'_6$ and X_4' is absent, and $-(\text{CX}_6\text{X}_6')_v\text{CX}_7\text{X}_7'\text{X}_7''$ wherein v is an integer in the range of 0 to 6 inclusive, and when v is in the range of 1 to 6, may include a double bond or epoxide group, and each of X_6 , X_7 and X_7' is independently selected from the group consisting of OR_{12} , SR_{12} , $\text{NR}_{12}\text{R}'_{12}$, hydrogen, halogen, $-(\text{Y})_m\text{C}=\text{(Z)}(\text{T})_n\text{R}_{12}$, $-\text{N}(\text{C}=\text{(Z)}(\text{T})_n\text{R}_{12})_2$, N_3 , CN , OCN , SCN , $\text{OSO}_3\text{R}_{12}$, $\text{OSO}_2\text{R}_{12}$, $\text{OPO}_3\text{R}_{12}\text{R}'_{12}$, $\text{OPO}_2\text{R}_{12}\text{R}'_{12}$, $\text{S}(\text{O})\text{R}_{12}$, $\text{S}(\text{O})_2\text{R}_{12}$, $\text{S}(\text{O})_2\text{OR}_{12}$, $\text{PO}_3\text{R}_{12}\text{R}'_{12}$, $\text{NR}_{12}\text{NR}'_{12}\text{R}''_{12}$, $\text{SNR}_{12}\text{R}'_{12}$, $\text{NR}_{12}\text{SR}'_{12}$, SSR_{12} and R_{12} , or is an oxo group, $=\text{S}$, $=\text{NOR}_{12}$ or $=\text{CR}_{12}\text{R}'_{12}$ and X_6' or X_7'' , respectively, is absent; and each of X_6' and X_7'' is independently selected from the group hydrogen, CN , optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

X_5 is selected from the group consisting of hydrogen, CN , $-\text{C}=\text{(Z)}(\text{T})_n\text{R}_{11}$, $\text{S}(\text{O})\text{R}_{11}$, $\text{S}(\text{O})_2\text{R}_{11}$, $\text{S}(\text{O})_2\text{OR}_{11}$, $\text{PO}_3\text{R}_{11}\text{R}'_{11}$, optionally substituted alkyl, optionally

substituted alkaryl, optionally substituted aryl,
optionally substituted aralkyl, and optionally substituted
acyl;

5 X_1' , X_2' , X_3' and X_4' are the same or different
and are selected from the group consisting of hydrogen,
CN, optionally substituted alkyl, optionally substituted
alkaryl, optionally substituted aryl, optionally
substituted aralkyl, and optionally substituted acyl;

or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and
10 A when A contains a carbon or nitrogen atom, X_5 and A when
A contains a carbon or nitrogen atom, and X_5 and X_1
together constitute a double bond, or R_1 and X_1 , R_2 and X_1 ,
 R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and
 X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3
15 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4'
together form part of a ring structure which optionally
includes at least one heteroatom selected from O, S and N
and is optionally substituted;

m and n are independently zero or one and Y, Z
20 and T are independently selected from the group consisting
of O, S, and NR_{10}

p is zero, one or two;

R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 ,
 R''_6 , R_7 , R_8 , R_9 , R'_9 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} are
25 the same or different and are selected from the group
consisting of hydrogen, optionally substituted alkyl which
may be interrupted by one or more heteroatoms or
functional groups selected from the group consisting of O,
S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted
30 alkenyl which may be interrupted by one or more
heteroatoms or functional groups selected from the group
consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$,
optionally substituted aryl, optionally substituted
heterocyclic, optionally substituted aralkyl which may be
35 interrupted within the alkyl moiety by one or more
heteroatoms or functional groups selected from the group
consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$,
optionally substituted acyl and a carbohydrate moiety;

with the proviso that at least two of X_1 , X_2 , X_3 , X_4 , X_6 and X_7 are other than hydrogen or a group linked to the ring through a carbon-carbon bond;
or a pharmaceutically acceptable salt thereof;
5 in the manufacture of a medicament for use in the treatment of a microbial infection.

As used herein, the term "therapeutically effective amount" means an amount of a compound of the present invention effective to yield a desired therapeutic
10 response, for example to prevent or treat a disease which by administration of a pharmaceutically-active agent.

The specific "therapeutically effective amount" will, obviously, vary with such factors as the particular condition being treated, the physical condition and
15 clinical history of the subject, the type of animal being treated, the duration of the treatment, the nature of concurrent therapy (if any), and the specific formulations employed and the structure of the compound or its derivatives.

As used herein, a "pharmaceutical carrier" is a pharmaceutically acceptable solvent, suspending agent, excipient or vehicle for delivering the compound of general formula (I) to the subject. The carrier may be liquid or solid, and is selected with the planned manner
20 of administration in mind.

The compound of general formula (I) may be administered orally, topically, or parenterally in dosage unit formulations containing conventional non-toxic pharmaceutically acceptable carriers, adjuvants, and
30 vehicles. The term parenteral as used herein includes subcutaneous, intravenous, intramuscular, intrathecal, intracranial, injection or infusion techniques.

The invention also provides suitable topical, oral, aerosol, and parenteral pharmaceutical formulations
35 for use in the novel methods of treatment of the present invention. The compounds of the invention may be administered orally as tablets, aqueous or oily suspensions, lozenges, troches, powders, granules,

emulsions, capsules, syrups or elixirs. The composition for oral use may contain one or more agents selected from the group of sweetening agents, flavouring agents, colouring agents and preserving agents in order to produce pharmaceutically elegant and palatable preparations. The tablets contain the active ingredient in admixture with non-toxic pharmaceutically acceptable excipients which are suitable for the manufacture of tablets.

These excipients may be, for example, inert diluents, such as calcium carbonate, lactose, calcium phosphate or sodium phosphate; granulating and disintegrating agents, such as corn starch or alginic acid; binding agents, such as starch, gelatin or acacia; or lubricating agents, such as magnesium stearate, stearic acid or talc. The tablets may be uncoated, or may be coated by known techniques to delay disintegration and absorption in the gastrointestinal tract and thereby provide a sustained action over a longer period. For example, a time-delay material such as glyceryl monostearate or glyceryl distearate may be employed. Coating may also be performed using techniques described in the U. S. Pat. Nos. 4,256,108; 4,160,452; and 4,265,874 to form osmotic therapeutic tablets for control release.

The compound of general formula (I) of the invention can be administered, for *in vivo* application, parenterally by injection or by gradual perfusion over time independently or together. Administration may be intravenously, intra-arterial, intraperitoneally, intramuscularly, subcutaneously, intracavity, or transdermally. For *in vitro* studies the agents may be added or dissolved in an appropriate biologically acceptable buffer and added to a cell or tissue.

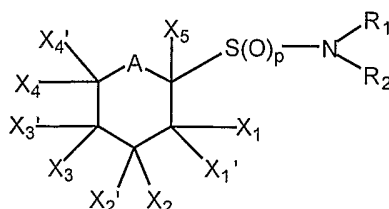
Preparations for parenteral administration include sterile aqueous or non-aqueous solutions, suspensions, and emulsions. Examples of non-aqueous solvents are propylene glycol, polyethylene glycol, vegetable oils such as olive oil, and injectable organic esters such as ethyl oleate. Aqueous carriers include

water, alcoholic/aqueous solutions, emulsions or suspensions, including saline and buffered media. Parenteral vehicles include sodium chloride solution, Ringer's dextrose, dextrose and sodium chloride, lactated
5 Ringer's intravenous vehicles include fluid and nutrient replenishers, electrolyte replenishers such as those based on Ringer's dextrose, and the like. Preservatives and other additives may also be present such as, for example, anti-microbials, anti-oxidants, chelating agents, growth
10 factors and inert gases and the like.

The compounds of general formula (I) are antimicrobial agents which are active, in particular but not limited to, against *Staphylococcus* including *Staphylococcus aureus* and *S. aureus* (Coagulas-negative),
15 *Streptococcus* species, *Enterococci* species, *Mycobacterium* including *Mycobacterium tuberculosis*, *M. avium intracellulare*, *M. fortuitum*, *M. abscessus* and rapid growing atypical Mycobacterial strains and *Nocardia*, particularly *Nocardia asteroides* and *N. nova*. The
20 compounds of general formula (I) are particularly useful in treating infections involving these organisms.

Generally, the terms "treating", "treatment" and the like are used herein to mean affecting a subject, tissue or cell to obtain a desired pharmacological and/or
25 physiological effect. The effect may be prophylactic in terms of completely or partially preventing infection, and/or may be therapeutic in terms of a partial or complete cure of an infection. "Treating" as used herein covers any treatment of, or prevention of infection in a
30 vertebrate, a mammal, particularly a human, and includes: preventing the infection from occurring in a subject that may have been exposed to the infectious agent, but has not yet been diagnosed as affected; inhibiting the infection, ie., arresting its development; or relieving or
35 ameliorating the effects of the infection, ie., cause regression of the effects of the infection.

According to a fifth aspect of the present invention there is provided a pharmaceutical composition comprising a compound of general formula (I):



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

or R_1 and R_2 together with the nitrogen atom from which they depend form a saturated or unsaturated, optionally substituted heterocyclic group which may include additional heteroatoms selected from the group consisting of O, N and S;

A is selected from the group consisting of O, S, SO, SO_2 , Se, Te, NR_8 , $CR_9R'_9$, $N \rightarrow O$, and $C(O)$;

X_1 is selected from the group consisting of OR_3 , SR_3 , $NR_3R'_3$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_3$, $-N(C=(Z)(T)_nR_3)_2$, N_3 , CN, OCN, SCN, OSO_3R_3 , OSO_2R_3 , $OPO_3R_3R'_3$, $OPO_2R_3R'_3$, $S(O)R_3$, $S(O)_2R_3$, $S(O)_2OR_3$, $PO_3R_3R'_3$, $NR_3NR'_3R''_3$, $SNR_3R'_3$, $NR_3SR'_3$, SSR_3 and R_3 , or is an oxo group, $=S$, $=NOR_3$ or $=CR_3R'_3$ and X_1' is absent, or X_1 is $C=(Z)$ and R_2 is a bond thereto so as to form a cyclic moiety $-C=(Z)NR_1S(O)_p-$;

X_2 is selected from the group consisting of OR_4 , SR_4 , $NR_4R'_4$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_{nR_4}$, $-N(C=(Z)(T)_{nR_4})_2$, N_3 , CN , OCN , SCN , OSO_3R_4 , OSO_2R_4 , $OPO_3R_4R'_4$, $OPO_2R_4R'_4$, $S(O)R_4$, $S(O)_2R_4$, $S(O)_2OR_4$, $PO_3R_4R'_4$, $NR_4NR'_4R''_4$,
 5 $SNR_4R'_4$, $NR_4SR'_4$, SSR_4 and R_4 , or is an oxo group, $=S$, $=NOR_4$ or $=CR_4R'_4$ and X_2' is absent;

X_3 is selected from the group consisting of OR_5 , SR_5 , $NR_5R'_5$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_{nR_5}$, $-N(C=(Z)(T)_{nR_5})_2$, N_3 , CN , OCN , SCN , OSO_3R_5 , OSO_2R_5 , $OPO_3R_5R'_5$,
 10 $OPO_2R_5R'_5$, $S(O)R_5$, $S(O)_2R_5$, $S(O)_2OR_5$, $PO_3R_5R'_5$, $NR_5NR'_5R''_5$, $SNR_5R'_5$, $NR_5SR'_5$, SSR_5 and R_5 , or is an oxo group, $=S$, $=NOR_5$ or $=CR_5R'_5$ and X_3' is absent;

X_4 is selected from the group consisting of OR_6 , SR_6 , $NR_6R'_6$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_{nR_6}$, $-N(C=(Z)(T)_{nR_6})_2$, N_3 , CN , OCN , SCN , OSO_3R_6 , OSO_2R_6 , $OPO_3R_6R'_6$,
 15 $OPO_2R_6R'_6$, $S(O)R_6$, $S(O)_2R_6$, $S(O)_2OR_6$, $PO_3R_6R'_6$, $NR_6NR'_6R''_6$, $SNR_6R'_6$, $NR_6SR'_6$, SSR_6 , R_6 , or is an oxo group, $=S$, $=NOR_6$ or $=CR_6R'_6$ and X_4' is absent, and $-(CX_6X_6')_vCX_7X_7'X_7''$ wherein v is an integer in the range of 0 to 6 inclusive and, when v is in the range of 1 to 6, may include a double bond or
 20 epoxide group, and each of X_6 , X_7 and X_7' is independently selected from the group consisting of OR_{12} , SR_{12} , $NR_{12}R'_{12}$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_{nR_{12}}$, $-N(C=(Z)(T)_{nR_{12}})_2$, N_3 , CN , OCN , SCN , OSO_3R_{12} , OSO_2R_{12} , $OPO_3R_{12}R'_{12}$, $OPO_2R_{12}R'_{12}$,
 25 $S(O)R_{12}$, $S(O)_2R_{12}$, $S(O)_2OR_{12}$, $PO_3R_{12}R'_{12}$, $NR_{12}NR'_{12}R''_{12}$, $SNR_{12}R'_{12}$, $NR_{12}SR'_{12}$, SSR_{12} and R_{12} , or is an oxo group, $=S$, $=NOR_{12}$ or $=CR_{12}R'_{12}$ and X_6' or X_7'' , respectively, is absent; and each of X_6' and X_7'' is independently selected from the group hydrogen, CN , optionally substituted alkyl,
 30 optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

X_5 is selected from the group consisting of hydrogen, CN , $-C=(Z)(T)_{nR_{11}}$, $S(O)R_{11}$, $S(O)_2R_{11}$, $S(O)_2OR_{11}$,
 35 $PO_3R_{11}R'_{11}$, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

- X_1' , X_2' , X_3' and X_4' are the same or different and are selected from the group consisting of hydrogen, CN, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;
- or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and A when A contains a carbon or nitrogen atom, X_5 and A when A contains a carbon or nitrogen atom, and X_5 and X_1 together constitute a double bond, or R_1 and X_1 , R_2 and X_1 , R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4' together form part of a ring structure which optionally includes at least one heteroatom selected from O, S and N and is optionally substituted;
- m and n are independently zero or one and Y, Z and T are independently selected from the group consisting of O, S, and NR_{10}
- p is zero, one or two;
- R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 , R''_6 , R_7 , R_8 , R_9 , R'_9 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} are the same or different and are selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aryl, optionally substituted heterocyclic, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted acyl and a carbohydrate moiety;
- with the proviso that at least two of X_1 , X_2 , X_3 , X_4 , X_6 and X_7 are other than hydrogen or a group linked to the ring through a carbon-carbon bond;

or a pharmaceutically acceptable salt thereof;
and a pharmaceutically acceptable carrier.

The pharmaceutical compositions according to one
embodiment of the invention are prepared by bringing a
5 compound of general formula (I) into a form suitable for
administration to a subject using carriers, excipients and
additives or auxiliaries.

Frequently used carriers or auxiliaries include
magnesium carbonate, titanium dioxide, lactose, mannitol
10 and other sugars, talc, milk protein, gelatin, starch,
vitamins, cellulose and its derivatives, animal and
vegetable oils, polyethylene glycols and solvents, such as
sterile water, alcohols, glycerol and polyhydric alcohols.
Intravenous vehicles include fluid and nutrient
15 replenishers. Preservatives include antimicrobial, anti-
oxidants, chelating agents and inert gases. Other
pharmaceutically acceptable carriers include aqueous
solutions, non-toxic excipients, including salts,
preservatives, buffers and the like, as described, for
20 instance, in Remington's Pharmaceutical Sciences, 15th ed.
Easton: Mack Publishing Co., 1405-1412, 1461-1487 (1975)
and The National Formulary XIV., 14th ed. Washington:
American Pharmaceutical Association (1975), the contents
of which are hereby incorporated by reference. The pH and
25 exact concentration of the various components of the
pharmaceutical composition are adjusted according to
routine skills in the art. See Goodman and Gilman's The
Pharmacological Basis for Therapeutics (7th ed.).

The pharmaceutical compositions are preferably
30 prepared and administered in dosage units. Solid dosage
units include tablets, capsules and suppositories. For
treatment of a subject, depending on activity of the
compound, manner of administration, nature and severity of
the disorder, age and body weight of the subject,
35 different daily doses can be used. Under certain
circumstances, however, higher or lower daily doses may be
appropriate. The administration of the daily dose can be
carried out both by single administration in the form of

an individual dose unit or else several smaller dose units and also by multiple administration of subdivided doses at specific intervals.

5 The pharmaceutical compositions according to the invention may be administered locally or systemically in a therapeutically effective dose. Amounts effective for this use will, of course, depend on the severity of the microbial infection and the weight and general state of the subject. Typically, dosages used *in vitro* may provide
10 useful guidance in the amounts useful for *in situ* administration of the pharmaceutical composition, and animal models may be used to determine effective dosages for treatment of the cytotoxic side effects. Various considerations are described, eg., in Langer, Science,
15 249: 1527, (1990). Formulations for oral use may be in the form of hard gelatin capsules wherein the active ingredient is mixed with an inert solid diluent, for example, calcium carbonate, calcium phosphate or kaolin. They may also be in the form of soft gelatin capsules
20 wherein the active ingredient is mixed with water or an oil medium, such as peanut oil, liquid paraffin or olive oil.

Aqueous suspensions normally contain the active materials in admixture with excipients suitable for the
25 manufacture of aqueous suspension. Such excipients may be suspending agents such as sodium carboxymethyl cellulose, methyl cellulose, hydroxypropylmethylcellulose, sodium alginate, polyvinylpyrrolidone, gum tragacanth and gum acacia; dispersing or wetting agents, which may be (a)
30 naturally occurring phosphatide such as lecithin; (b) a condensation product of an alkylene oxide with a fatty acid, for example, polyoxyethylene stearate; (c) a condensation product of ethylene oxide with a long chain aliphatic alcohol, for example,
35 heptadecaethylenoxycetanol; (d) a condensation product of ethylene oxide with a partial ester derived from a fatty acid and hexitol such as polyoxyethylene sorbitol monooleate, or (e) a condensation product of ethylene

oxide with a partial ester derived from fatty acids and hexitol anhydrides, for example polyoxyethylene sorbitan monooleate.

5 The pharmaceutical compositions may be in the form of a sterile injectable aqueous or oleaginous suspension. This suspension may be formulated according to known methods using suitable dispersing or wetting agents and suspending agents such as those mentioned above. The sterile injectable preparation may also a
10 sterile injectable solution or suspension in a non-toxic parenterally-acceptable diluent or solvent, for example, as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents which may be employed are water, Ringer's solution, and isotonic sodium chloride solution.
15 In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose, any bland fixed oil may be employed, including synthetic mono-or diglycerides. In addition, fatty acids such as oleic acid find use in the preparation of
20 injectables.

Compounds of general formula (I) may also be administered in the form of liposome delivery systems, such as small unilamellar vesicles, large unilamellar vesicles, and multilamellar vesicles. Liposomes can be
25 formed from a variety of phospholipids, such as cholesterol, stearylamine, or phosphatidylcholines. Compounds of general formula (I) may also be administered in combination with cyclodextrins for enhanced aqueous solubility.

30 Dosage levels of the compound of general formula (I) of the present invention will usually be of the order of about 0.05mg to about 20mg per kilogram body weight, with a preferred dosage range between about 0.05mg to about 10mg per kilogram body weight per day (from about
35 0.1g to about 3g per patient per day). The amount of active ingredient which may be combined with the carrier materials to produce a single dosage will vary, depending upon the host to be treated and the particular mode of

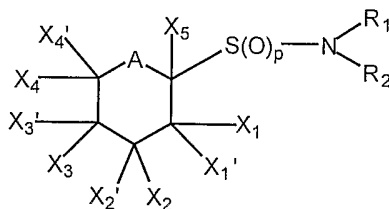
administration. For example, a formulation intended for oral administration to humans may contain about 1mg to 1g of an active compound with an appropriate and convenient amount of carrier material, which may vary from about 5 to 95 percent of the total composition. Dosage unit forms will generally contain between from about 5mg to 500mg of active ingredient.

It will be understood, however, that the specific dose level for any particular patient will depend upon a variety of factors including the activity of the specific compound employed, the age, body weight, general health, sex, diet, time of administration, route of administration, rate of excretion, drug combination and the severity of the particular disease undergoing therapy.

In addition, some of the compounds of the invention may form solvates with water or common organic solvents. Such solvates are encompassed within the scope of the invention.

The compounds of the invention may additionally be combined with other compounds to provide an operative combination. It is intended to include any chemically compatible combination of pharmaceutically-active agents, as long as the combination does not eliminate the activity of the compound of general formula (I) of this invention.

According to a sixth aspect of the present invention there is provided a method of killing a microorganism, comprising exposing said microorganism to a compound of general formula (I):



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms

or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

or R₁ and R₂ together with the nitrogen atom from which they depend form a saturated or unsaturated, optionally substituted heterocyclic group which may include additional heteroatoms selected from the group consisting of O, N and S;

A is selected from the group consisting of O, S, SO, SO₂, Se, Te, NR₈, CR₉R'₉, N->O, and C(O);

X₁ is selected from the group consisting of OR₃, SR₃, NR₃R'₃, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₃, -N(C=(Z)(T)_nR₃)₂, N₃, CN, OCN, SCN, OSO₃R₃, OSO₂R₃, OPO₃R₃R'₃, OPO₂R₃R'₃, S(O)R₃, S(O)₂R₃, S(O)₂OR₃, PO₃R₃R'₃, NR₃NR'₃R'₃, SNR₃R'₃, NR₃SR'₃, SSR₃ and R₃, or is an oxo group, =S, =NOR₃ or =CR₃R'₃ and X₁' is absent, or X₁ is C=(Z) and R₂ is a bond thereto so as to form a cyclic moiety -C=(Z)NR₁S(O)_p-;

X₂ is selected from the group consisting of OR₄, SR₄, NR₄R'₄, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₄, -N(C=(Z)(T)_nR₄)₂, N₃, CN, OCN, SCN, OSO₃R₄, OSO₂R₄, OPO₃R₄R'₄, OPO₂R₄R'₄, S(O)R₄, S(O)₂R₄, S(O)₂OR₄, PO₃R₄R'₄, NR₄NR'₄R'₄, SNR₄R'₄, NR₄SR'₄, SSR₄ and R₄, or is an oxo group, =S, =NOR₄ or =CR₄R'₄ and X₂' is absent;

X₃ is selected from the group consisting of OR₅, SR₅, NR₅R'₅, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₅, -N(C=(Z)(T)_nR₅)₂, N₃, CN, OCN, SCN, OSO₃R₅, OSO₂R₅, OPO₃R₅R'₅, OPO₂R₅R'₅, S(O)R₅, S(O)₂R₅, S(O)₂OR₅, PO₃R₅R'₅, NR₅NR'₅R'₅, SNR₅R'₅, NR₅SR'₅, SSR₅ and R₅, or is an oxo group, =S, =NOR₅ or =CR₅R'₅ and X₃' is absent;

X₄ is selected from the group consisting of OR₆,

SR_6 , $NR_6R'_6$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_6$, $-N(C=(Z)(T)_nR_6)_2$, N_3 , CN, OCN, SCN, OSO_3R_6 , OSO_2R_6 , $OPO_3R_6R'_6$, $OPO_2R_6R'_6$, $S(O)R_6$, $S(O)_2R_6$, $S(O)_2OR_6$, $PO_3R_6R'_6$, $NR_6NR'_6R''_6$, $SNR_6R'_6$, $NR_6SR'_6$, SSR_6 , R_6 , or is an oxo group, $=S$, $=NOR_6$ or $=CR_6R'_6$ and X_4' is absent, and $-(CX_6X_6')_vCX_7X_7'X_7''$ wherein v is an integer in the range of 0 to 6 inclusive and, when v is in the range of 1 to 6, may include a double bond or epoxide group, each of X_6 , X_7 and X_7' is independently selected from the group consisting of OR_{12} , SR_{12} , $NR_{12}R'_{12}$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_{12}$, $-N(C=(Z)(T)_nR_{12})_2$, N_3 , CN, OCN, SCN, OSO_3R_{12} , OSO_2R_{12} , $OPO_3R_{12}R'_{12}$, $OPO_2R_{12}R'_{12}$, $S(O)R_{12}$, $S(O)_2R_{12}$, $S(O)_2OR_{12}$, $PO_3R_{12}R'_{12}$, $NR_{12}NR'_{12}R''_{12}$, $SNR_{12}R'_{12}$, $NR_{12}SR'_{12}$, SSR_{12} and R_{12} , or is an oxo group, $=S$, $=NOR_{12}$ or $=CR_{12}R'_{12}$ and X_6' or X_7'' , respectively, is absent; and each of X_6' and X_7'' is independently selected from the group hydrogen, CN, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

X_5 is selected from the group consisting of hydrogen, CN, $-C=(Z)(T)_nR_{11}$, $S(O)R_{11}$, $S(O)_2R_{11}$, $S(O)_2OR_{11}$, $PO_3R_{11}R'_{11}$, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

X_1' , X_2' , X_3' and X_4' are the same or different and are selected from the group consisting of hydrogen, CN, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and A when A contains a carbon or nitrogen atom, X_5 and A when A contains a carbon or nitrogen atom, and X_5 and X_1 together constitute a double bond, or R_1 and X_1 , R_2 and X_1 , R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4' together form part of a ring structure which optionally

includes at least one heteroatom selected from O, S and N and is optionally substituted;

m and n are independently zero or one and Y, Z and T are independently selected from the group consisting of O, S, and NR₁₀

p is zero, one or two;

R₃, R'₃, R''₃, R₄, R'₄, R''₄, R₅, R'₅, R''₅, R₆, R'₆, R''₆, R₇, R₈, R₉, R'₉, R₁₀, R₁₁, R'₁₁, R₁₂, R'₁₂ and R''₁₂ are the same or different and are selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted aryl, optionally substituted heterocyclic, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted acyl and a carbohydrate moiety;

with the proviso that at least two of X₁, X₂, X₃, X₄, X₆ and X₇ are other than hydrogen or a group linked to the ring through a carbon-carbon bond; or a pharmaceutically acceptable salt thereof.

Advantageously, although not limited to, the microorganism is selected from the group consisting of *Staphylococcus* including *Staphylococcus aureus* and *S. aureus* (Coagulase-negative), *Streptococcus* species, *Enterococci* species, *Mycobacterium* including *Mycobacterium tuberculosis*, *M. avium intracellulare*, *M. fortuitum*, *M. abscessus* and rapid growing atypical *Mycobacterium* strains and *Nocardia*, particularly *Nocardia asteroides* and *N. nova*.

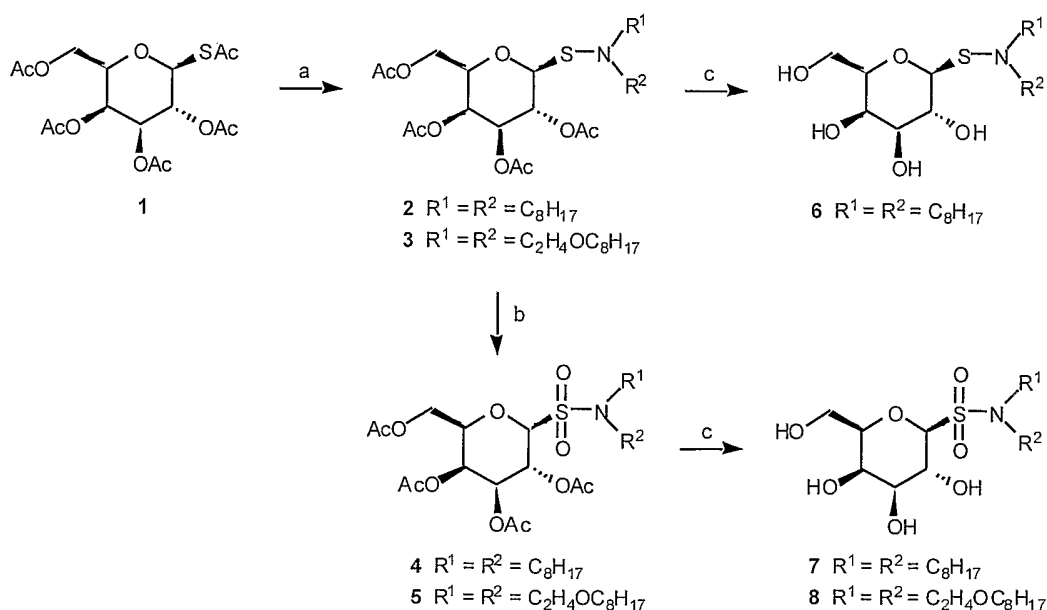
Throughout this specification and the claims, the words "comprise", "comprises" and "comprising" are used in a non-exclusive sense, except where the context requires

otherwise.

It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents forms part of the common general knowledge in the art, in Australia or in any other country.

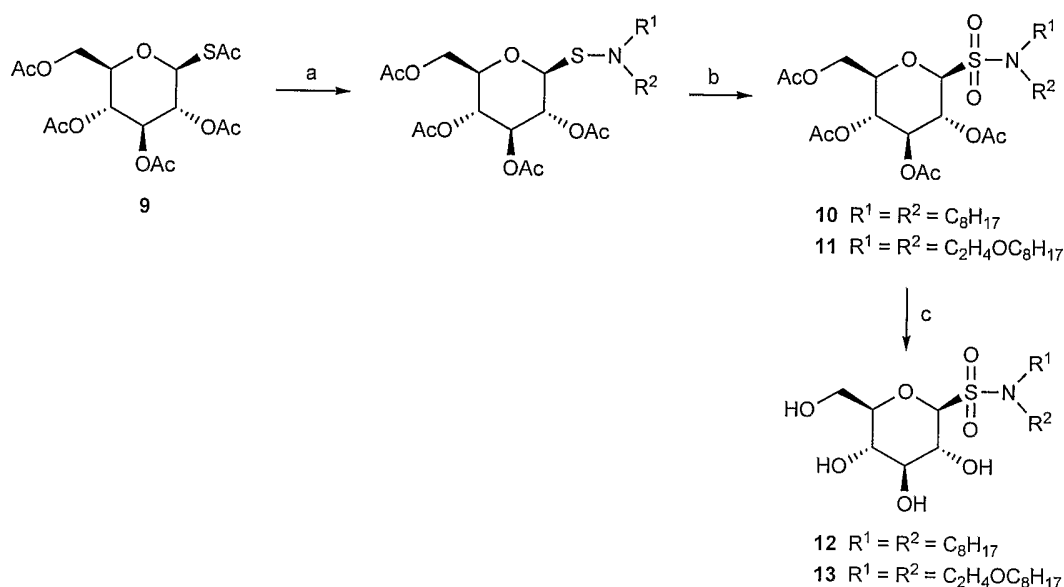
Modes for Performing the Invention

The synthetic scheme employed to prepare compounds in accordance with preferred embodiments of the invention is now described in more detail. The synthesis of protected (compounds 2-5; Examples 1-4) and deprotected (compounds 6-8; Examples 5-7) galactopyranosyl derivatives is shown in Scheme 1. For the preparation of these examples, 1-S-acetyl-2,3,4,6-tetra-O-acetyl-1-thio-β-D-galactopyranose (compound 1; Holland et al., 1967) was prepared according to known literature methods and is shown in Scheme 1 without modification. Similarly prepared, from 1-S-acetyl-2,3,4,6-tetra-O-acetyl-1-thio-β-D-glucopyranose (compound 9; Holland et al., 1967) as shown in Scheme 2, were the protected (compounds 10 and 11; Examples 8 and 9) and deprotected (compounds 12 and 13; Examples 10 and 11) glucopyranosyl derivatives. All new compounds gave the expected spectroscopic data.



Scheme 1

Reagents and Conditions: a) $\text{BrCH}(\text{COOEt})_2$, HNR^1R^2 , DMF, THF, or MeOH, rt, 24 h to 7 d; b) MCPBA, CH_2Cl_2 , reflux, 20 h; c) NaOMe, MeOH, rt, 2 h, N_2 .



Scheme 2

Reagents and Conditions: a) $\text{BrCH}(\text{COOEt})_2$, HNR^1R^2 , DMF, THF, or MeOH, rt, 24 h to 7 d; b) MCPBA, CH_2Cl_2 , reflux, 20 h; c) NaOMe, MeOH, rt, 2 h, N_2 .

General procedure for the oxidation of sulfenamides to the corresponding sulfonamides:

To a solution of the protected sulfenamide (0.5 mmol) in dichloromethane (20 mL) is added *meta*-chloroperoxybenzoic acid (3 equiv.) and the mixture is heated under reflux. Upon completion of the reaction, the reaction mixture is diluted to 60 mL with EtOAc and quenched with saturated aqueous sodium hydrogen carbonate. The organic phase is separated, dried, filtered, and concentrated under reduced pressure, and the residue is chromatographed on silica.

25

General procedure for the deprotection of acetate protecting groups:

To a solution of the acetylated derivative (0.5 mmol) in dry MeOH (10 mL) under an atmosphere of N₂ is added one equivalent of sodium methoxide (1M solution in dry MeOH). The reaction is left to stir at room temperature for 2 h. After this time the reaction is neutralized with Amberlite (H⁺) resin. The resin is removed by filtration, the solvent removed under reduced pressure, and the residue purified by column chromatography on silica.

Example 1

N,N-Dioctyl-*S*-(2,3,5,6-tetra-*O*-acetyl-β-*D*-galactopyranosyl)sulfenamide (2; R₁ = R₂ = C₈H₁₇):

1-*S*-Acetyl-2,3,5,6-tetra-*O*-acetyl-1-thio-β-*D*-galactopyranose (1) (1.0 g, 2.5 mmol) was dissolved in dry THF (25 mL) under an inert atmosphere.

Diethylbromomalonate (1.3 mL, 7.5 mmol) and *N,N*-dioctylamine (6 mL, 20 mmol) were added and the solution stirred at room temperature for 7 days. The reaction mixture was concentrated and the residue purified by flash chromatography on silica (1:9 → 1:2 EtOAc/hexanes) to give the desired product (0.63 g, 42%). R_f 0.56 (1:2 EtOAc/hexanes). ¹H NMR (300 MHz, CDCl₃): δ 0.87 (6H, m, CH₃), 1.10–1.30 (20H, m, CH₂), 1.52 (4H, m, CH₂), 1.94, 2.00, 2.03, 2.11 (4 x 3H, 4 x s, 4 x OAc), 2.81 (4H, m, CH₂), 3.93 (1H, dt, J_{4,5} 0.9, J_{5,6} 7.2 Hz, H-5), 4.17 (2H, m, H-6, H-6'), 4.67 (1H, m, H-2), 5.00 (2H, m, H-3 and H-1), 5.42 (1H, d, J_{4,3} 1.5 Hz, H-4).

Example 2

N,N-Di(2-octyloxyethyl)-*N*-trityl amine:

To a solution of *N*-trityl-diethanolamine (3.0 g, 8.6 mmole) in dry THF (40 mL) under an atmosphere of nitrogen was added tosyl-*n*-octanol (9.8 g, 34.4 mmol) and finely ground potassium hydroxide (5.8 g, 103 mmole). The solution was refluxed for 20 h then cooled to room temperature. The reaction mixture was diluted with EtOAc, washed twice with saturated NaCl, water and the organic

phase dried and concentrated. The residue was purified by column chromatography on silica (10% EtOAc/hexanes) to give *N,N*-di(2-octyloxyethyl)-*N*-trityl amine (4.92 g, 83%). R_f 0.65 (10% EtOAc/hexanes). ^1H NMR (300 MHz, CDCl_3): δ 0.87 (6H, t, J 6.0 Hz, CH_3), 1.28 (20H, m, CH_2), 1.55 (4H, m, CH_2), 2.54 (4H, t, J 6.0 Hz, EtO), 3.38 (4H, t, J 6.0 Hz, O-octyl), 3.57 (4H, t, J 6.0 Hz, EtO), 7.10-7.60 (15H, m, trityl ArH).

10 *N,N*-Di(2-octyloxyethyl)amine:

To a solution of *N,N*-di(2-octyloxyethyl)-*N*-trityl amine (3.70 g, 6.5 mmole) in a mixture of CH_2Cl_2 (10 mL) and MeOH (25 mL), was added 5% HCl (aq.) (15 mL) and the solution stirred for 5 min. The reaction mixture was diluted with CH_2Cl_2 and washed twice with saturated aqueous sodium bicarbonate, water and the organic phase dried (sodium sulphate) and concentrated. The residue was purified by column chromatography on silica (1:1 EtOAc/hexanes $\rightarrow$ 15% MeOH/EtOAc) to give *N,N*-di(2-octyloxyethyl)amine (1.76 g, 83%). R_f 0.35 (10% MeOH/EtOAc). ^1H NMR (300 MHz, CDCl_3): δ 0.87 (6H, t, J 6.0 Hz, CH_3), 1.26 (20H, m, CH_2), 1.53 (4H, m, CH_2), 2.00 (1H, bs, NH) 2.79 (4H, t, J 6.0 Hz, EtO), 3.41 (4H, t, J 6.0 Hz, O-octyl), 3.53 (4H, t, J 6.0 Hz, EtO).

25 *N,N*-Di(2-octyloxyethyl)-*S*-(2,3,5,6-tetra-*O*-acetyl- β -D-galactopyranosyl)sulfenamide (3; $R_1 = R_2 = \text{C}_2\text{H}_4\text{OC}_8\text{H}_{17}$):
1-*S*-acetyl-2,3,5,6-tetra-*O*-acetyl-1-thio- β -D-galactopyranose (1) (399 mg, 0.98 mmol) was dissolved in methanol (10 mL). Diethylbromomalonate (280 μL , 1.5 mmol) and *N,N*-di(2-octyloxyethyl)amine (824 mg, 2.5 mmol) were added and the reaction stirred at room temperature for 16 days. The reaction was concentrated and the residue purified by column chromatography on silica (1:3 EtOAc/hexanes) to give the desired product (428 mg, 63%). R_f 0.18 (3:1 hexanes/EtOAc). ^1H NMR (300 MHz, CDCl_3): δ 0.87 (6H, t, CH_3), 1.30 (20H, m, octyl), 1.55 (4H, m, octyl), 1.97, 2.04, 2.06, 2.14 (4 x 3H, 4 x s, 4 x OAc),

3.15 (4H, m, EtO), 3.40 (4H, t, J 6.0 Hz, O-octyl), 3.56 (4H, t, J 6.0 Hz, EtO), 3.89 (1H, dt, $J_{4,5}$ 0.9, $J_{5,6}$ 7.2 Hz, H-5), 4.10 (2H, m, H-6, H-6'), 4.69 (1H, m, H-2), 5.05 (2H, m, H-3 and H-1), 5.40 (1H, d, $J_{4,3}$ 1.5, H-4).

5

Example 3

N,N-Dioctyl-*S*-(2,3,5,6-tetra-*O*-acetyl- β -D-galactopyranosyl)sulfonamide (4; $R_1 = R_2 = C_8H_{17}$):

N,N-Dioctyl-*S*-(2,3,5,6-tetra-*O*-acetyl- β -D-galactopyranosyl)sulfenamide (2) was oxidised according to the general procedure and the residue purified by column chromatography on silica (EtOAc) to give the desired product. Yield: 26%. R_f 0.19 (3:1 hexanes/EtOAc). ^1H NMR (300 MHz, $CDCl_3$): δ 0.80 (6H, m, CH_3), 1.10-1.30 (20H, m, CH_2), 1.50 (4H, m, CH_2), 1.94, 1.98, 2.02, 2.13 (4 x 3H, 4 x s, 4 x OAc), 3.1 and 3.3 (each 2H, m, CH_2), 3.95 (1H, dd, $J_{4,5}$ 0.9, $J_{5,6}$ 6.9 Hz, H-5), 4.09 (2H, m, H-6, H-6'), 4.38 (1H, d, $J_{1,2}$ 9.9 Hz, H-1), 5.05 (1H, dd, $J_{3,4}$ 3.3, $J_{2,3}$ 9.9 Hz, H-3), 5.39 (1H, d, $J_{3,4}$ 3.3 Hz, H-4), 5.52 (1H, app. t, $J_{2,3}$ 9.9, $J_{1,2}$ 9.9 Hz, H-2).

20

Example 4

N,N-Di(2-octyloxyethyl)-*S*-(2,3,5,6-tetra-*O*-acetyl- β -D-galactopyranosyl)sulfonamide (5; $R_1 = R_2 = C_2H_4OC_8H_{17}$):

N,N-Di(2-octyloxyethyl)-*S*-(2,3,5,6-tetra-*O*-acetyl- β -D-galactopyranosyl)sulfonamide (3) was oxidised according to the general procedure and the residue purified by column chromatography on silica (2:1 hexanes/EtOAc) to give the desired product. Yield: 95%. R_f 0.45 (3:1 hexanes/EtOAc). ^1H NMR (300 MHz, $CDCl_3$): δ 0.87 (6H, t, CH_3), 1.30 (20H, m, octyl), 1.55 (4H, m, octyl), 1.97, 2.04, 2.06, 2.14 (4 x 3H, 4 x s, 4 x OAc), 3.30-3.80 (12H, m, 2 x EtO and O-octyl), 3.97 (1H, dt, $J_{4,5}$ 0.9, $J_{5,6}$ 6.0 Hz, H-5), 4.13 (2H, m, H-6, H-6'), 4.75 (1H, d, $J_{1,2}$ 9.6 Hz, H-1), 4.70 (1H, dd, $J_{2,3}$ 9.9, $J_{3,4}$ 3.3 Hz, H-3), 5.46 (1H, dd, $J_{3,4}$ 3.3, $J_{4,5}$ 0.9 Hz, H-4), 5.61 (1H, app. t, $J_{1,2}$ 9.6, $J_{2,3}$ 9.9 Hz, H-2).

35

Example 5

N,N-Dioctyl-*S*-(β -D-galactopyranosyl)sulfenamide (6; $R_1 = R_2 = C_8H_{17}$):

N,N-Dioctyl-*S*-(2,3,5,6-tetra-*O*-acetyl- β -D-galactopyranosyl)sulfenamide (2) was de-*O*-acetylated according to the general procedure to give the desired product. Yield: 74%. R_f 0.38 (EtOAc). ^1H NMR (300 MHz, CD_3OD): δ 0.91 (6H, m, CH_3), 1.20-1.40 (20H, m, CH_2), 1.59 (4H, m, CH_2), 2.85 (4H, m, CH_2), 3.48 (1H, dd, $J_{3,4}$ 3.3, $J_{2,3}$ 9.3 Hz, H-3), 3.51 (1H, m, H-5), 3.68 (1H, app. t $J_{2,3}$ 9.3, $J_{1,2}$ 9.3 Hz, H-2), 3.72 (2H, m, H-6, H-6'), 3.91 (1H, d, $J_{3,4}$ 2.7, H-4), 4.39 (1H, d, $J_{1,2}$ 9.3, H-1).

Example 6

N,N-Dioctyl-*S*-(β -D-galactopyranosyl)sulfonamide (7; $R_1 = R_2 = C_8H_{17}$):

N,N-Dioctyl-*S*-(2,3,5,6-tetra-*O*-acetyl- β -D-galactopyranosyl)sulfonamide (4) was de-*O*-acetylated according to the general procedure to give the desired product. Yield: 80%. R_f 0.26 (EtOAc). ^1H NMR (300 MHz, CD_3OD): δ 0.90 (6H, m, CH_3), 1.20-1.40 (20H, m, CH_2), 1.59 (4H, m, CH_2), 3.20 and 3.35 (each 2H, m, CH_2), 3.55 (1H, dd, $J_{3,4}$ 3.3, $J_{2,3}$ 9.3 Hz, H-3), 3.51 (1H, m, H-5), 3.72 (2H, m, H-6, H-6'), 3.91 (1H, d, $J_{3,4}$ 3.3, H-4), 3.99 (1H, app. t, $J_{2,3}$ 9.3, $J_{1,2}$ 9.3, H-2), 4.31 (1H, d, $J_{1,2}$ 9.3, H-1).

Example 7

N,N-Di(2-octyloxyethyl)-*S*-(β -D-galactopyranosyl)sulfonamide (8; $R_1 = R_2 = C_2H_4OC_8H_{17}$):

N,N-Di(2-octyloxyethyl)-*S*-(2,3,5,6-tetra-*O*-acetyl- β -D-galactopyranosyl)sulfonamide (5) was de-*O*-acetylated according to the general procedure to give the desired product. Yield: 82%. R_f 0.34 (EtOAc). ^1H NMR (300 MHz, CD_3OD): δ 0.87 (6H, t, CH_3), 1.30 (20H, m, octyl), 1.55 (4H, m, octyl), 3.40-3.80 (16H, m, 2 x EtO, *O*-octyl, H-3, H-5, H-6 and H-6'), 3.88 (1H, d, $J_{3,4}$ 3.0 Hz,

H-4), 3.99 (1H, app. t, $J_{2,3}$ 9.3, $J_{1,2}$ 9.3 Hz, H-2), 4.43 (1H, d, $J_{1,2}$ 9.3 Hz, H-1).

Example 8

5 *N,N*-Dioctyl-*S*-(2,3,5,6-tetra-*O*-acetyl- β -*D*-glucopyranosyl)sulfenamide:

1-S-Acetyl-2,3,5,6-tetra-*O*-acetyl-1-thio- β -*D*-glucopyranose (9) (2.31 g, 5.69 mmol) was dissolved in MeOH (100 mL). Diethylbromomalonate (1.46 mL, 8.54 mmol) and *N,N*-dioctylamine (5.10 mL, 17.10 mmol) were added and the reaction stirred at room temperature for 4 hours. The reaction was concentrated and the residue purified by column chromatography on silica (4:1 hexanes/EtOAc) to give the desired product (2.75 g, 80%). R_f 0.18 (4:1 hexanes/EtOAc). ^1H NMR (300 MHz, CDCl_3): δ 0.87 (6H, t, 2 x CH_3), 1.20-1.32 (20H, m, 10 x CH_2), 1.48-1.60 (4H, m, 2 x CH_2), 2.00, 2.02, 2.05, 2.08 (4 x 3H, 4 x s, 4 x COCH_3), 2.85-2.90 (4H, m, 2 x CH_2), 3.64-3.71 (1H, m, H-5), 4.09-4.29 (2H, obscured m, H-6, H-6'), 4.63 (1H, d, $J_{1,2}$ 10.2 Hz, H-1), 4.82-4.92 (1H, m, H-2), 5.03 (1H, t, $J_{4,3} \sim J_{4,5}$ 9.6 Hz, H-4), 5.23 (1H, t, $J_{3,2} \sim J_{3,4}$ 9.3 Hz, H-3).

N,N-Dioctyl-*S*-(2,3,5,6-tetra-*O*-acetyl- β -*D*-glucopyranosyl)sulfonamide (10; $\text{R}_1 = \text{R}_2 = \text{C}_8\text{H}_{17}$):

25 *N,N*-Dioctyl-*S*-(2,3,4,6-tetra-*O*-acetyl- β -*D*-glucopyranosyl)sulfenamide was oxidized according to the general procedure to give the desired product. Yield: 42%. R_f 0.21 (3:1 hexanes/EtOAc). ^1H NMR (300 MHz, CDCl_3): δ 0.87 (6H, t, CH_3), 1.21-1.34 (20H, m, 10 x CH_2), 1.44-1.63 (4H, m, 2 x CH_2), 2.01, 2.03, 2.06, 2.08 (4 x 3H, 4 x s, 4 x COCH_3), 3.09-3.16 (2H, m, CH_2), 3.30-3.40 (2H, m, CH_2), 3.70-3.76 (1H, m, H-5), 4.18-4.22 (2H, m, H-6, H-6'), 4.44 (1H, d, $J_{1,2}$ 9.6 Hz, H-1), 5.08 (1H, t, $J_{4,3} \sim J_{4,5}$ 9.6 Hz, H-4), 5.27 (1H, t, $J_{3,2} \sim J_{3,4}$ 9.3 Hz, H-3), 5.39 (1H, t, $J_{2,1} \sim J_{2,3}$ 9.6, H-2).

Example 9

N,N-Di(2-octyloxyethyl)-*S*-(2,3,5,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide:

1-S-Acetyl-2,3,5,6-tetra-*O*-acetyl-1-thio- β -D-glucopyranose (9) (446 mg, 1.1 mmol) was dissolved in methanol (20 mL). Diethyl bromomalonate (280 μ L) and di(2-octyloxyethyl)amine (904 mg) were added and the reaction stirred at room temperature for 16 h. The reaction was concentrated and the residue purified by column chromatography on silica (3:1 hexanes/EtOAc) to give the desired product (557 mg, 73%). R_f 0.18 (3:1 hexanes/EtOAc). ^1H NMR (300 MHz, CDCl_3): δ 0.87 (6H, t, CH_3), 1.20–1.35 (20H, m, 10 x CH_2), 1.50–1.60 (4H, m, 2 x CH_2), 1.99, 2.02, 2.04, 2.07 (4 x 3H, 4 x s, 4 x COCH_3), 3.11–3.21 (4H, m, 2 x NCH_2 (ethyl)), 3.40 (4H, t, 2 x OCH_2 (octyl)), 3.56 (4H, t, 2 x CH_2O (ethyl)), 3.64–3.71 (1H, m, H-5), 4.11 (1H, dd (obscured), H-6), 4.23 (1H, dd, $J_{6',5}$ 5.1, $J_{6',6}$ 12.3 Hz, H-6'), 4.63 (1H, d, $J_{1,2}$ 10.5 Hz, H-1), 4.91 (1H, dd, $J_{2,3}$ 9.0, $J_{2,1}$ 10.5, H-2), 5.04 (1H, t, $J_{4,3} \sim J_{4,5}$ 9.6 Hz, H-4), 5.23 (1H, t, $J_{3,2} \sim J_{3,4}$ 9.3 Hz, H-3).

N,N-Di(2-octyloxyethyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfonamide (11; $R_1 = R_2 = \text{C}_2\text{H}_4\text{OC}_8\text{H}_{17}$):

N,N-Di(2-octyloxyethyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide was oxidised according to the general procedure to give the desired product. Yield: 95%. R_f 0.27 (2:1 hexanes/EtOAc). ^1H NMR (300 MHz, CDCl_3): δ 0.88 (6H, t, CH_3), 1.20–1.37 (20H, m, 10 x CH_2), 1.52–1.62 (4H, m, 2 x CH_2), 2.01, 2.03, 2.05, 2.09 (4 x 3H, 4 x s, 4 x COCH_3), 3.33–3.78 (13H, m, 2 x NCH_2 (ethyl), 2 x OCH_2 (octyl), 2 x CH_2O (ethyl), H-5), 4.13–4.23 (2H, m, H-6, H-6'), 4.77 (1H, d, $J_{1,2}$ 9.6 Hz, H-1), 5.07 (1H, t, $J_{4,3} \sim J_{4,5}$ 9.6 Hz, H-4), 5.24 (1H, t, $J_{3,2} \sim J_{3,4}$ 9.3 Hz, H-3), 5.43 (1H, t, $J_{2,3} \sim J_{2,1}$ 9.3, H-2).

Example 10

N,N-Dioctyl-*S*-(β -D-glucopyranosyl)sulfonamide (12; $R_1 = R_2 = \text{C}_8\text{H}_{17}$):

N,N-Dioctyl-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfonamide (10) was de-*O*-acetylated according to the general procedure to give the desired product. Yield: 75%. R_f 0.21 (EtOAc). ^1H NMR (300 MHz, CD_3OD): δ 0.91 (6H, t, CH_3), 1.25-1.38 (20H, br. s, 10 x CH_2), 1.51-1.67 (4H, m, 2 x CH_2), 3.15-3.28 (2H, m, CH_2), 3.32-3.44 (5H, obscured m, CH_2 , H-3, H-4, H-5), 3.63-3.69 (2H, m, H-2, H-6), 3.88 (1H, dd, $J_{6',5}$ 1.8, $J_{6',6}$ 12.3 Hz, H-6'), 4.32 (1H, d, $J_{1,2}$ 9.3 Hz, H-1).

Example 11

N,N-Di(2-octyloxyethyl)-*S*-(β -D-glucopyranosyl)sulfonamide (13; $R_1 = R_2 = \text{C}_2\text{H}_4\text{OC}_8\text{H}_{17}$):

N,N-Di(2-octyloxyethyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfonamide (11) was de-*O*-acetylated according to the general procedure to give the desired product after purification by chromatography on silica (EtOAc). Yield: 89%. ^1H NMR (300 MHz, CD_3OD): δ 0.91 (6H, t, CH_3), 1.23-1.42 (20H, m, 10 x CH_2), 1.52-1.63 (4H, m, 2 x CH_2), 3.32-3.71 (17H, m, 2 x NCH_2 (ethyl), 2 x OCH_2 (octyl), 2 x CH_2O (ethyl), H-2, H-3, H-4, H-5, H-6), 3.89 (1H, dd, $J_{6',5}$ 1.2, $J_{6',6}$ 12.0 Hz, H-6'), 4.51 (1H, d, $J_{1,2}$ 9.6, H-1).

Biological Data

Example 12

Inhibition of various bacteria by compound (6) where $R^1 = R^2 = \text{C}_8\text{H}_{17}$ is described in Table 1. The biological data were determined by a Zone Inhibition Assay method. The compound was tested by spotting 100 μg of compound as a solution in methanol onto a sterile filter disc placed on a lawn of bacteria on the surface of an LB agar plate. After incubation at 37 °C overnight (or for 3 days for *M. smegmatis*), the zone of inhibition was measured using an arbitrary scale: +++ = relatively large zone of inhibition, - = no zone of inhibition.

Table 1

Organism tested	Zone of inhibition for (6)
<i>Streptococcus pyogenes</i>	+
<i>Bacillus subtilis</i>	+
<i>Enterococcus faecalis</i>	++
<i>Mycobacterium smegmatis</i>	++

Example 13

Inhibition of *Bacillus subtilis* by compounds (7) and (12) is described in Table 2. The biological data were determined by Minimum Inhibitory Concentration (MIC) Serial Dilution Assay. Standard solutions of the compounds were prepared in MeOH. Assays were carried out in a final volume of 2 mL LB Broth with a maximum 2% MeOH concentration, in 10 mL Falcon tubes with 5 μ L of saturated culture. Tubes were incubated at 37 °C with shaking for 18 to 20 hours. The MIC₈₀ was then determined as the concentration in which there was 80% or greater reduction in growth as compared to the control.

Table 2

Organism tested	Compound MIC ₈₀ (μ g/mL)	
	(7)	(12)
<i>Bacillus subtilis</i>	8	8

Example 14

MIC data against *Enterococcus* and *Streptococcus* spp. for compounds (6), (7), (8), (12) and (13) is described in Table 3. The MIC assays were carried-out according to NCCLS (National Committee for Clinical Laboratory Standards) guidelines. Standard solutions of the compounds were prepared in DMSO. Assays were carried out in Mueller Hinton II Broth in 96-well microdilution plates with a final cell concentration of 5×10^5 colony-forming-units/ml. Plates incubated at 35°C for approximately 20

h. The MIC was recorded as the lowest concentration of drug that inhibited visible growth of the organism.

5

Table 3

Organism tested	Compound MIC ($\mu\text{g/mL}$)				
	(6)	(7)	(8)	(12)	(13)
<i>Enterococcus faecalis</i> spp	16	4	16	8	4
<i>Enterococcus faecium</i> spp	8	4	8	4	2
<i>Streptococcus pneumoniae</i> spp	4	ND	ND	ND	2

10 ND = not determined

Industrial Applicability

15 The compounds of general formula (I) are useful as pharmaceutical agents, particularly anti-microbial agents.

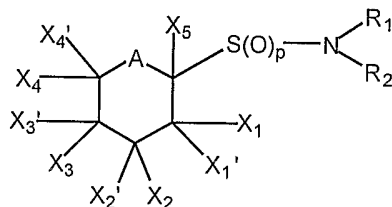
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The disclosure of the following documents is incorporated herein by reference:

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- 35

Claims:

1. A compound of the general formula (I):



5

wherein R₁ and R₂ are independently selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

or R₁ and R₂ together with the nitrogen atom from which they depend form a saturated or unsaturated, optionally substituted heterocyclic group which may include additional heteroatoms selected from the group consisting of O, N and S;

A is selected from the group consisting of O, S, SO, SO₂, Se, Te, NR₈, CR₉R'₉, N->O, and C(O);

X₁ is selected from the group consisting of OR₃, SR₃, NR₃R'₃, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₃, -N(C=(Z)(T)_nR₃)₂, N₃, CN, OCN, SCN, OSO₃R₃, OSO₂R₃, OPO₃R₃R'₃, OPO₂R₃R'₃, S(O)R₃, S(O)₂R₃, S(O)₂OR₃, PO₃R₃R'₃, NR₃NR'₃R''₃, SNR₃R'₃, NR₃SR'₃, SSR₃ and R₃, or is an oxo group, =S, =NOR₃ or =CR₃R'₃ and X₁' is absent, or X₁ is C=(Z) and R₂ is a bond thereto so as to form a cyclic moiety -C=(Z)NR₁S(O)_p-;

X₂ is selected from the group consisting of OR₄,

SR₄, NR₄R'₄, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₄, -
 N(C=(Z)(T)_nR₄)₂, N₃, CN, OCN, SCN, OSO₃R₄, OSO₂R₄, OPO₃R₄R'₄,
 OPO₂R₄R'₄, S(O)R₄, S(O)₂R₄, S(O)₂OR₄, PO₃R₄R'₄, NR₄NR'₄R''₄,
 SNR₄R'₄, NR₄SR'₄, SSR₄ and R₄, or is an oxo group, =S, =NOR₄
 5 or =CR₄R'₄ and X₂' is absent;

X₃ is selected from the group consisting of OR₅,
 SR₅, NR₅R'₅, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₅, -
 N(C=(Z)(T)_nR₅)₂, N₃, CN, OCN, SCN, OSO₃R₅, OSO₂R₅, OPO₃R₅R'₅,
 OPO₂R₅R'₅, S(O)R₅, S(O)₂R₅, S(O)₂OR₅, PO₃R₅R'₅, NR₅NR'₅R''₅,
 10 SNR₅R'₅, NR₅SR'₅, SSR₅ and R₅, or is an oxo group, =S, =NOR₅
 or =CR₅R'₅ and X₃' is absent;

X₄ is selected from the group consisting of OR₆,
 SR₆, NR₆R'₆, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₆, -
 N(C=(Z)(T)_nR₆)₂, N₃, CN, OCN, SCN, OSO₃R₆, OSO₂R₆, OPO₃R₆R'₆,
 15 OPO₂R₆R'₆, S(O)R₆, S(O)₂R₆, S(O)₂OR₆, PO₃R₆R'₆, NR₆NR'₆R''₆,
 SNR₆R'₆, NR₆SR'₆, SSR₆, R₆, or is an oxo group, =S, =NOR₆ or
 =CR₆R'₆ and X₄' is absent, and -(CX₆X₆')_vCX₇X₇'X₇'' wherein v
 is an integer in the range of 0 to 6 inclusive and, when v
 is in the range of 1 to 6, may include a double bond or
 20 epoxide group, each of X₆, X₇ and X₇' is independently
 selected from the group consisting of OR₁₂, SR₁₂, NR₁₂R'₁₂,
 hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₁₂, -N(C=(Z)(T)_nR₁₂)₂, N₃,
 CN, OCN, SCN, OSO₃R₁₂, OSO₂R₁₂, OPO₃R₁₂R'₁₂, OPO₂R₁₂R'₁₂,
 S(O)R₁₂, S(O)₂R₁₂, S(O)₂OR₁₂, PO₃R₁₂R'₁₂, NR₁₂NR'₁₂R''₁₂,
 25 SNR₁₂R'₁₂, NR₁₂SR'₁₂, SSR₁₂ and R₁₂, or is an oxo group, =S,
 =NOR₁₂ or =CR₁₂R'₁₂ and X₆' or X₇'', respectively, is absent;
 and each of X₆' and X₇'' is independently selected from the
 group hydrogen, CN, optionally substituted alkyl,
 optionally substituted alkaryl, optionally substituted
 30 aryl, optionally substituted aralkyl, and optionally
 substituted acyl;

X₅ is selected from the group consisting of
 hydrogen, CN, -C=(Z)(T)_nR₁₁, S(O)R₁₁, S(O)₂R₁₁, S(O)₂OR₁₁,
 PO₃R₁₁R'₁₁, optionally substituted alkyl, optionally
 35 substituted alkaryl, optionally substituted aryl,
 optionally substituted aralkyl, and optionally substituted
 acyl;

X₁', X₂', X₃' and X₄' are the same or different

and are selected from the group consisting of hydrogen, CN, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

5 or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and A when A contains a carbon or nitrogen atom, X_5 and A when A contains a carbon or nitrogen atom, and X_5 and X_1 together constitute a double bond, or R_1 and X_1 , R_2 and X_1 , R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4' together form part of a ring structure which optionally includes at least one heteroatom selected from O, S and N and is optionally substituted;

15 m and n are independently zero or one and Y, Z and T are independently selected from the group consisting of O, S, and NR_{10}

p is zero, one or two;

20 R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 , R''_6 , R_7 , R_8 , R_9 , R'_9 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} are the same or different and are selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aryl, optionally substituted heterocyclic, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted acyl and a carbohydrate moiety;

35 with the proviso that at least two of X_1 , X_2 , X_3 , X_4 , X_6 and X_7 are other than hydrogen or a group linked to the ring through a carbon-carbon bond and the further proviso that the compound is not N,N-diethyl-S-(2,3,4,6-

tetra-*O*-acetyl- β -D-galactopyranosyl)sulfenamide, *N,N*-
 diethyl-*S*-(2-acetamido-3,4,6-tri-*O*-acetyl-2-deoxy- β -D-
 glucopyranosyl)sulfenamide, methyl *N*-acetyl-4,7,8,9-tetra-
O-acetyl-2-*S*-(diethylamino)-2-thio- α -neuraminate, *N,N*-
 5 di(isopropyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-
 glucopyranosyl)sulfenamide, 1-[(2,3,4,6-tetra-*O*-acetyl- β -D-
 galactopyranosyl)thio]piperidine, 1-[(2,3,4,6-tetra-*O*-
 acetyl- β -D-glucopyranosyl)thio]piperidine, 4-[(2,3,4,6-
 tetra-*O*-acetyl- β -D-galactopyranosyl)thio]morpholine, *N*-(1-
 10 adamantyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-
 glucopyranosyl)sulfenamide, *N*-benzyl-*S*-(2,3,4,6-tetra-*O*-
 acetyl- β -D-glucopyranosyl)sulfenamide, *N*-phenyl-*S*-(2,3,4,6-
 tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, *N*-phenyl-*S*-
 (D-glucopyranosyl)sulfenamide, *N*-(4-methylphenyl)-*S*-
 15 (2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, *N*-
 (2-chlorophenyl)-*S*-(2,3,4,6-tetra-*O*-acetyl- β -D-
 glucopyranosyl)sulfenamide, *N*-(4-hydroxyphenyl)-*S*-
 (2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)sulfenamide, 2-
 [(2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranosyl)thio]-1(2H)-
 20 isoquinoline, methyl 1-deoxy-1-[(4-thioxo-1(4H)-
 pyrimidinyl)thio]- β -D-glucopyranuronate, 1-
 (galactopyranosylthio)-1H-tetrazole, 1-
 (glucopyranosylthio)-1H-tetrazole, or 1,1'-
 [sulfonylbis(4,1-phenyleneiminosulfonyl)]bis[1-deoxy- β -D-
 25 glucopyranuronic acid] tetrasodium salt;
 or a pharmaceutically acceptable salt thereof.

2. A compound as claimed in claim 1 wherein one or both
 of R_1 and R_2 is C_{4-30} alkyl.

30

3. A compound as claimed in claim 2 wherein one or both
 of R_1 and R_2 is C_{6-12} alkyl.

4. A compound as claimed in claim 3 wherein one or both
 35 of R_1 and R_2 is C_{8-10} alkyl.

5. A compound as claimed in claim 1 wherein one or both
 of R_1 and R_2 is alkyl interrupted by one or more

heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇, and -(Y)_mC=(Z)(T)_n, alkenyl or R₁ and R₂ together with the nitrogen atom from which they depend form an optionally substituted saturated or
5 unsaturated heterocyclic group.

6. A compound as claimed in claim 5 wherein one or both of R₁ and R₂ is alkyl interrupted by one or more oxygen atoms.

10

7. A compound as claimed in claim 6 wherein one or both of R₁ and R₂ has the formula CH₃(CH₂)_xO(CH₂)_yO(CH₂)_z or CH₃(CH₂)_yO(CH₂)_z wherein x is an integer in the range 0 to 12 inclusive and y and z are independently integers in the
15 range 1 to 12 inclusive.

8. A compound as claimed in any one of claims 1 to 7 wherein X₁ is OR₃.

20 9. A compound as claimed in claim 8 wherein R₃ is hydrogen or optionally substituted acyl.

10. A compound as claimed in any one of claims 1 to 9, wherein X₂ is OR₄.

25

11. A compound as claimed in claim 10 wherein R₄ is hydrogen or optionally substituted acyl.

12. A compound as claimed in any one of claims 1 to 11
30 wherein X₃ is OR₅.

13. A compound as claimed in claim 12 wherein R₅ is hydrogen or optionally substituted acyl.

35 14. A compound as claimed in any one of claims 1 to 13 wherein X₄ is -(CX₆X_{6'})_vCX₇X_{7'}X_{7''} wherein v is an integer in the range of 0 to 6 inclusive, and each of X₆, X₇ and X_{7'} is independently selected from the group consisting of

OR₁₂, SR₁₂, NR₁₂R'₁₂, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₁₂, -
 N(C=(Z)(T)_nR₁₂)₂, N₃, CN, OCN, SCN, OSO₃R₁₂, OSO₂R₁₂,
 OPO₃R₁₂R'₁₂, OPO₂R₁₂R'₁₂, S(O)R₁₂, S(O)₂R₁₂, S(O)₂OR₁₂,
 PO₃R₁₂R'₁₂, NR₁₂NR'₁₂R''₁₂, SNR₁₂R'₁₂, NR₁₂SR'₁₂, SSR₁₂ and R₁₂, or
 5 is an oxo group, =S, =NOR₁₂ or =CR₁₂R'₁₂ and X₆' or X₇'',
 respectively, is absent; and each of X₆' and X₇'' is
 independently selected from the group hydrogen, CN,
 optionally substituted alkyl, optionally substituted
 alkaryl, optionally substituted aryl, optionally
 10 substituted aralkyl, and optionally substituted acyl.

15. A compound as claimed in claim 14 wherein X₄ is
 CH₂OR₁₂, CHOR₁₂CH₂OR₁₂ or CHOR₁₂CHOR₁₂CH₂OR₁₂.

15 16. A compound as claimed in claim 15 wherein X₄ is
 CH₂OR₁₂.

17. A compound as claimed in any one of claims 1 to 16
 wherein p is zero.

20

18. A compound as claimed in any one of claims 1 to 16
 wherein p is one.

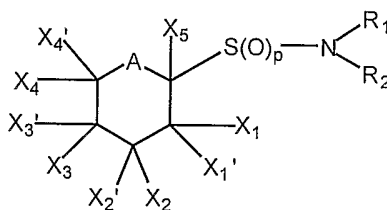
19. A compound as claimed in any one of claims 1 to 16
 25 wherein p is two.

20. A compound selected from the group consisting of:
 N,N-dioctyl-S-(2,3,5,6-tetra-O-acetyl-β-D-
 galactopyranosyl)sulfenamide,
 30 N,N-di(2-octyloxyethyl)-S-(2,3,5,6-tetra-O-acetyl-β-D-
 galactopyranosyl)sulfenamide,
 N,N-dioctyl-S-(2,3,5,6-tetra-O-acetyl-β-D-
 glucopyranosyl)sulfenamide,
 N,N-di(2-octyloxyethyl)-S-(2,3,5,6-tetra-O-acetyl-β-D-
 35 glucopyranosyl)sulfenamide,
 N,N-dioctyl-S-(β-D-galactopyranosyl)sulfenamide,
 N,N-di(2-octyloxyethyl)-S-(β-D-
 galactopyranosyl)sulfenamide,

N,N-dioctyl-*S*-(β -D-glucopyranosyl)sulfenamide, and
N,N-di(2-octyloxyethyl)-*S*-(β -D-
glucopyranosyl)sulfenamide, and their oxides,
and pharmaceutically acceptable salts thereof.

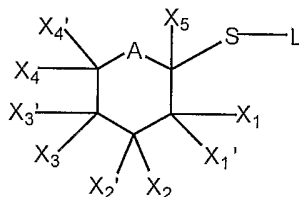
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21. A method of preparation of a compound of general
formula (I):



10

comprising reacting a compound of general formula
(II):

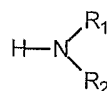


15

wherein L is an acyl group, preferably acetyl and
 X_1 , X_2 , X_3 , X_4 , X_1' , X_2' , X_3' , X_4' and X_5 are as defined in
claim 1;

20

with a compound of general formula (III):



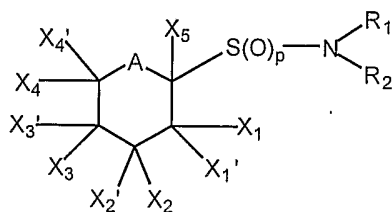
25

wherein R_1 and R_2 are as defined in claim 1;
in the presence of a bis-activated alkyl halide;
and, optionally,
reacting the product with an oxidising agent.

22. A method for the treatment of a microbial infection,
comprising administering to a patient in need of such

30

treatment a therapeutically effective amount of a compound of general formula (I):



5

wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

or R_1 and R_2 together with the nitrogen atom from which they depend form a saturated or unsaturated, optionally substituted heterocyclic group which may include additional heteroatoms selected from the group consisting of O, N and S;

A is selected from the group consisting of O, S, SO, SO_2 , Se, Te, NR_8 , $CR_9R'_9$, $N \rightarrow O$, and $C(O)$;

X_1 is selected from the group consisting of OR_3 , SR_3 , $NR_3R'_3$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_3$, $-N(C=(Z)(T)_nR_3)_2$, N_3 , CN, OCN, SCN, OSO_3R_3 , OSO_2R_3 , $OPO_3R_3R'_3$, $OPO_2R_3R'_3$, $S(O)R_3$, $S(O)_2R_3$, $S(O)_2OR_3$, $PO_3R_3R'_3$, $NR_3NR'_3R'_3$, $SNR_3R'_3$, $NR_3SR'_3$, SSR_3 and R_3 , or is an oxo group, $=S$, $=NOR_3$ or $=CR_3R'_3$ and X_1' is absent, or X_1 is $C=(Z)$ and R_2 is a bond thereto so as to form a cyclic moiety $-C=(Z)NR_1S(O)_p-$;

X_2 is selected from the group consisting of OR_4 ,

SR₄, NR₄R'₄, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₄, -
 N(C=(Z)(T)_nR₄)₂, N₃, CN, OCN, SCN, OSO₃R₄, OSO₂R₄, OPO₃R₄R'₄,
 OPO₂R₄R'₄, S(O)R₄, S(O)₂R₄, S(O)₂OR₄, PO₃R₄R'₄, NR₄NR'₄R''₄,
 SNR₄R'₄, NR₄SR'₄, SSR₄ and R₄, or is an oxo group, =S, =NOR₄
 5 or =CR₄R'₄ and X₂' is absent;

X₃ is selected from the group consisting of OR₅,
 SR₅, NR₅R'₅, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₅, -
 N(C=(Z)(T)_nR₅)₂, N₃, CN, OCN, SCN, OSO₃R₅, OSO₂R₅, OPO₃R₅R'₅,
 OPO₂R₅R'₅, S(O)R₅, S(O)₂R₅, S(O)₂OR₅, PO₃R₅R'₅, NR₅NR'₅R''₅,
 10 SNR₅R'₅, NR₅SR'₅, SSR₅ and R₅, or is an oxo group, =S, =NOR₅
 or =CR₅R'₅ and X₃' is absent;

X₄ is selected from the group consisting of OR₆,
 SR₆, NR₆R'₆, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₆, -
 N(C=(Z)(T)_nR₆)₂, N₃, CN, OCN, SCN, OSO₃R₆, OSO₂R₆, OPO₃R₆R'₆,
 15 OPO₂R₆R'₆, S(O)R₆, S(O)₂R₆, S(O)₂OR₆, PO₃R₆R'₆, NR₆NR'₆R''₆,
 SNR₆R'₆, NR₆SR'₆, SSR₆, R₆, or is an oxo group, =S, =NOR₆ or
 =CR₆R'₆ and X₄' is absent, and -(CX₆X₆')_vCX₇X₇'X₇'' wherein v
 is an integer in the range of 0 to 6 inclusive and, when v
 is in the range of 1 to 6, may include a double bond or
 20 epoxide group, each of X₆, X₇ and X₇' is independently
 selected from the group consisting of OR₁₂, SR₁₂, NR₁₂R'₁₂,
 hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₁₂, -N(C=(Z)(T)_nR₁₂)₂, N₃,
 CN, OCN, SCN, OSO₃R₁₂, OSO₂R₁₂, OPO₃R₁₂R'₁₂, OPO₂R₁₂R'₁₂,
 S(O)R₁₂, S(O)₂R₁₂, S(O)₂OR₁₂, PO₃R₁₂R'₁₂, NR₁₂NR'₁₂R''₁₂,
 25 SNR₁₂R'₁₂, NR₁₂SR'₁₂, SSR₁₂ and R₁₂, or is an oxo group, =S,
 =NOR₁₂ or =CR₁₂R'₁₂ and X₆' or X₇'', respectively, is absent;
 and each of X₆' and X₇' is independently selected from the
 group hydrogen, CN, optionally substituted alkyl,
 optionally substituted alkaryl, optionally substituted
 30 aryl, optionally substituted aralkyl, and optionally
 substituted acyl;

X₅ is selected from the group consisting of
 hydrogen, CN, -C=(Z)(T)_nR₁₁, S(O)R₁₁, S(O)₂R₁₁, S(O)₂OR₁₁,
 PO₃R₁₁R'₁₁, optionally substituted alkyl, optionally
 35 substituted alkaryl, optionally substituted aryl,
 optionally substituted aralkyl, and optionally substituted
 acyl;

X₁', X₂', X₃' and X₄' are the same or different

and are selected from the group consisting of hydrogen, CN, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

5 or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and A when A contains a carbon or nitrogen atom, X_5 and A when A contains a carbon or nitrogen atom, and X_5 and X_1 together constitute a double bond, or R_1 and X_1 , R_2 and X_1 , R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4' together form part of a ring structure which optionally includes at least one heteroatom selected from O, S and N and is optionally substituted;

15 m and n are independently zero or one and Y, Z and T are independently selected from the group consisting of O, S, and NR_{10}

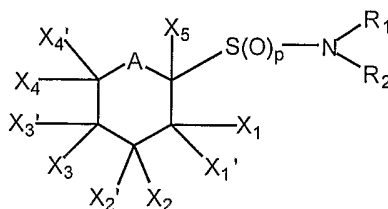
p is zero, one or two;

20 R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 , R''_6 , R_7 , R_8 , R_9 , R'_9 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} are the same or different and are selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aryl, optionally substituted heterocyclic, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted acyl and a carbohydrate moiety;

35 with the proviso that at least two of X_1 , X_2 , X_3 , X_4 , X_6 and X_7 are other than hydrogen or a group linked to the ring through a carbon-carbon bond; or a pharmaceutically acceptable salt thereof.

5

23. The use of a compound of general formula (I):



10

wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

or R_1 and R_2 together with the nitrogen atom from which they depend form a saturated or unsaturated, optionally substituted heterocyclic group which may include additional heteroatoms selected from the group consisting of O, N and S;

A is selected from the group consisting of O, S, SO, SO_2 , Se, Te, NR_8 , $CR_9R'_9$, $N \rightarrow O$, and $C(O)$;

X_1 is selected from the group consisting of OR_3 , SR_3 , $NR_3R'_3$, hydrogen, halogen, $-(Y)_mC=(Z)(T)_nR_3$, $-N(C=(Z)(T)_nR_3)_2$, N_3 , CN, OCN, SCN, OSO_3R_3 , OSO_2R_3 , $OPO_3R_3R'_3$, $OPO_2R_3R'_3$, $S(O)R_3$, $S(O)_2R_3$, $S(O)_2OR_3$, $PO_3R_3R'_3$, $NR_3NR'_3R''_3$,

$\text{SNR}_3\text{R}'_3$, $\text{NR}_3\text{SR}'_3$, SSR_3 and R_3 , or is an oxo group, $=\text{S}$, $=\text{NOR}_3$ or $=\text{CR}_3\text{R}'_3$ and X_1' is absent, or X_1 is $\text{C}=\text{(Z)}$ and R_2 is a bond thereto so as to form a cyclic moiety $-\text{C}=\text{(Z)}\text{NR}_1\text{S}(\text{O})_{\text{p}}-$;

X_2 is selected from the group consisting of OR_4 , SR_4 , $\text{NR}_4\text{R}'_4$, hydrogen, halogen, $-(\text{Y})_{\text{m}}\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_4$, $-\text{N}(\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_4)_2$, N_3 , CN , OCN , SCN , OSO_3R_4 , OSO_2R_4 , $\text{OPO}_3\text{R}_4\text{R}'_4$, $\text{OPO}_2\text{R}_4\text{R}'_4$, $\text{S}(\text{O})\text{R}_4$, $\text{S}(\text{O})_2\text{R}_4$, $\text{S}(\text{O})_2\text{OR}_4$, $\text{PO}_3\text{R}_4\text{R}'_4$, $\text{NR}_4\text{NR}'_4\text{R}''_4$, $\text{SNR}_4\text{R}'_4$, $\text{NR}_4\text{SR}'_4$, SSR_4 and R_4 , or is an oxo group, $=\text{S}$, $=\text{NOR}_4$ or $=\text{CR}_4\text{R}'_4$ and X_2' is absent;

X_3 is selected from the group consisting of OR_5 , SR_5 , $\text{NR}_5\text{R}'_5$, hydrogen, halogen, $-(\text{Y})_{\text{m}}\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_5$, $-\text{N}(\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_5)_2$, N_3 , CN , OCN , SCN , OSO_3R_5 , OSO_2R_5 , $\text{OPO}_3\text{R}_5\text{R}'_5$, $\text{OPO}_2\text{R}_5\text{R}'_5$, $\text{S}(\text{O})\text{R}_5$, $\text{S}(\text{O})_2\text{R}_5$, $\text{S}(\text{O})_2\text{OR}_5$, $\text{PO}_3\text{R}_5\text{R}'_5$, $\text{NR}_5\text{NR}'_5\text{R}''_5$, $\text{SNR}_5\text{R}'_5$, $\text{NR}_5\text{SR}'_5$, SSR_5 and R_5 , or is an oxo group, $=\text{S}$, $=\text{NOR}_5$ or $=\text{CR}_5\text{R}'_5$ and X_3' is absent;

X_4 is selected from the group consisting of OR_6 , SR_6 , $\text{NR}_6\text{R}'_6$, hydrogen, halogen, $-(\text{Y})_{\text{m}}\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_6$, $-\text{N}(\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_6)_2$, N_3 , CN , OCN , SCN , OSO_3R_6 , OSO_2R_6 , $\text{OPO}_3\text{R}_6\text{R}'_6$, $\text{OPO}_2\text{R}_6\text{R}'_6$, $\text{S}(\text{O})\text{R}_6$, $\text{S}(\text{O})_2\text{R}_6$, $\text{S}(\text{O})_2\text{OR}_6$, $\text{PO}_3\text{R}_6\text{R}'_6$, $\text{NR}_6\text{NR}'_6\text{R}''_6$, $\text{SNR}_6\text{R}'_6$, $\text{NR}_6\text{SR}'_6$, SSR_6 , R_6 , or is an oxo group, $=\text{S}$, $=\text{NOR}_6$ or $=\text{CR}_6\text{R}'_6$ and X_4' is absent, and $-(\text{CX}_6\text{X}_6')_{\text{v}}\text{CX}_7\text{X}_7'\text{X}_7''$ wherein v is an integer in the range of 0 to 6 inclusive and, when v is in the range of 1 to 6, may include a double bond or epoxide group, each of X_6 , X_7 and X_7' is independently selected from the group consisting of OR_{12} , SR_{12} , $\text{NR}_{12}\text{R}'_{12}$, hydrogen, halogen, $-(\text{Y})_{\text{m}}\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_{12}$, $-\text{N}(\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_{12})_2$, N_3 , CN , OCN , SCN , $\text{OSO}_3\text{R}_{12}$, $\text{OSO}_2\text{R}_{12}$, $\text{OPO}_3\text{R}_{12}\text{R}'_{12}$, $\text{OPO}_2\text{R}_{12}\text{R}'_{12}$, $\text{S}(\text{O})\text{R}_{12}$, $\text{S}(\text{O})_2\text{R}_{12}$, $\text{S}(\text{O})_2\text{OR}_{12}$, $\text{PO}_3\text{R}_{12}\text{R}'_{12}$, $\text{NR}_{12}\text{NR}'_{12}\text{R}''_{12}$, $\text{SNR}_{12}\text{R}'_{12}$, $\text{NR}_{12}\text{SR}'_{12}$, SSR_{12} and R_{12} , or is an oxo group, $=\text{S}$, $=\text{NOR}_{12}$ or $=\text{CR}_{12}\text{R}'_{12}$ and X_6' or X_7'' , respectively, is absent; and each of X_6' and X_7'' is independently selected from the group hydrogen, CN , optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aralkyl, and optionally substituted acyl;

X_5 is selected from the group consisting of hydrogen, CN , $-\text{C}=\text{(Z)}(\text{T})_{\text{n}}\text{R}_{11}$, $\text{S}(\text{O})\text{R}_{11}$, $\text{S}(\text{O})_2\text{R}_{11}$, $\text{S}(\text{O})_2\text{OR}_{11}$, $\text{PO}_3\text{R}_{11}\text{R}'_{11}$, optionally substituted alkyl, optionally

substituted alkaryl, optionally substituted aryl,
optionally substituted aralkyl, and optionally substituted
acyl;

5 X_1' , X_2' , X_3' and X_4' are the same or different
and are selected from the group consisting of hydrogen,
CN, optionally substituted alkyl, optionally substituted
alkaryl, optionally substituted aryl, optionally
substituted aralkyl, and optionally substituted acyl;

10 or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and
A when A contains a carbon or nitrogen atom, X_5 and A when
A contains a carbon or nitrogen atom, and X_5 and X_1
together constitute a double bond, or R_1 and X_1 , R_2 and X_1 ,
 R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and
 X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3
15 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4'
together form part of a ring structure which optionally
includes at least one heteroatom selected from O, S and N
and is optionally substituted;

20 m and n are independently zero or one and Y, Z
and T are independently selected from the group consisting
of O, S, and NR_{10}

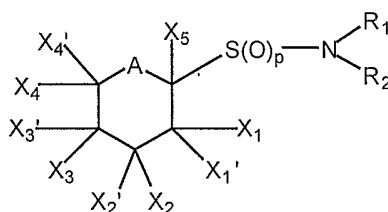
p is zero, one or two;

R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 ,
 R''_6 , R_7 , R_8 , R_9 , R'_9 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} are
25 the same or different and are selected from the group
consisting of hydrogen, optionally substituted alkyl which
may be interrupted by one or more heteroatoms or
functional groups selected from the group consisting of O,
S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted
30 alkenyl which may be interrupted by one or more
heteroatoms or functional groups selected from the group
consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$,
optionally substituted aryl, optionally substituted
heterocyclic, optionally substituted aralkyl which may be
35 interrupted within the alkyl moiety by one or more
heteroatoms or functional groups selected from the group
consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$,
optionally substituted acyl and a carbohydrate moiety;

with the proviso that at least two of X_1 , X_2 , X_3 , X_4 , X_6 and X_7 are other than hydrogen or a group linked to the ring through a carbon-carbon bond;
 or a pharmaceutically acceptable salt thereof;
 5 in the manufacture of a medicament for use in the treatment of a microbial infection.

24. A pharmaceutical composition comprising a compound of general formula (I):

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wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, optionally substituted
 15 alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O , S , $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more
 heteroatoms or functional groups selected from the group
 20 consisting of O , S , $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or
 functional groups selected from the group consisting of O , S , $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted
 25 heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

or R_1 and R_2 together with the nitrogen atom from which they depend form a saturated or unsaturated,
 optionally substituted heterocyclic group which may
 30 include additional heteroatoms selected from the group consisting of O , N and S ;

A is selected from the group consisting of O , S , SO , SO_2 , Se , Te , NR_8 , $CR_9R'_9$, $N \rightarrow O$, and $C(O)$;

X_1 is selected from the group consisting of OR_3 ,

SR₃, NR₃R'₃, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₃, -
 N(C=(Z)(T)_nR₃)₂, N₃, CN, OCN, SCN, OSO₃R₃, OSO₂R₃, OPO₃R₃R'₃,
 OPO₂R₃R'₃, S(O)R₃, S(O)₂R₃, S(O)₂OR₃, PO₃R₃R'₃, NR₃NR'₃R''₃,
 SNR₃R'₃, NR₃SR'₃, SSR₃ and R₃, or is an oxo group, =S, =NOR₃
 5 or =CR₃R'₃ and X₁' is absent, or X₁ is C=(Z) and R₂ is a
 bond thereto so as to form a cyclic moiety -C=(Z)NR₁S(O)_p-;

X₂ is selected from the group consisting of OR₄,
 SR₄, NR₄R'₄, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₄, -
 N(C=(Z)(T)_nR₄)₂, N₃, CN, OCN, SCN, OSO₃R₄, OSO₂R₄, OPO₃R₄R'₄,
 10 OPO₂R₄R'₄, S(O)R₄, S(O)₂R₄, S(O)₂OR₄, PO₃R₄R'₄, NR₄NR'₄R''₄,
 SNR₄R'₄, NR₄SR'₄, SSR₄ and R₄, or is an oxo group, =S, =NOR₄
 or =CR₄R'₄ and X₂' is absent;

X₃ is selected from the group consisting of OR₅,
 SR₅, NR₅R'₅, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₅, -
 15 N(C=(Z)(T)_nR₅)₂, N₃, CN, OCN, SCN, OSO₃R₅, OSO₂R₅, OPO₃R₅R'₅,
 OPO₂R₅R'₅, S(O)R₅, S(O)₂R₅, S(O)₂OR₅, PO₃R₅R'₅, NR₅NR'₅R''₅,
 SNR₅R'₅, NR₅SR'₅, SSR₅ and R₅, or is an oxo group, =S, =NOR₅
 or =CR₅R'₅ and X₃' is absent;

X₄ is selected from the group consisting of OR₆,
 20 SR₆, NR₆R'₆, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₆, -
 N(C=(Z)(T)_nR₆)₂, N₃, CN, OCN, SCN, OSO₃R₆, OSO₂R₆, OPO₃R₆R'₆,
 OPO₂R₆R'₆, S(O)R₆, S(O)₂R₆, S(O)₂OR₆, PO₃R₆R'₆, NR₆NR'₆R''₆,
 SNR₆R'₆, NR₆SR'₆, SSR₆, R₆, or is an oxo group, =S, =NOR₆ or
 =CR₆R'₆ and X₄' is absent, and -(CX₆X₆')_vCX₇X₇'X₇'' wherein v
 25 is an integer in the range of 0 to 6 inclusive and, when v
 is in the range of 1 to 6, may include a double bond or
 epoxide group, each of X₆, X₇ and X₇' is independently
 selected from the group consisting of OR₁₂, SR₁₂, NR₁₂R'₁₂,
 hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₁₂, -N(C=(Z)(T)_nR₁₂)₂, N₃,
 30 CN, OCN, SCN, OSO₃R₁₂, OSO₂R₁₂, OPO₃R₁₂R'₁₂, OPO₂R₁₂R'₁₂,
 S(O)R₁₂, S(O)₂R₁₂, S(O)₂OR₁₂, PO₃R₁₂R'₁₂, NR₁₂NR'₁₂R''₁₂,
 SNR₁₂R'₁₂, NR₁₂SR'₁₂, SSR₁₂ and R₁₂, or is an oxo group, =S,
 =NOR₁₂ or =CR₁₂R'₁₂ and X₆' or X₇'', respectively, is absent;
 and each of X₆' and X₇' is independently selected from the
 35 group hydrogen, CN, optionally substituted alkyl,
 optionally substituted alkaryl, optionally substituted
 aryl, optionally substituted aralkyl, and optionally
 substituted acyl;

X_5 is selected from the group consisting of hydrogen, CN, $-C=(Z)(T)_nR_{11}$, $S(O)R_{11}$, $S(O)_2R_{11}$, $S(O)_2OR_{11}$, $PO_3R_{11}R'_{11}$, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

X_1' , X_2' , X_3' and X_4' are the same or different and are selected from the group consisting of hydrogen, CN, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and A when A contains a carbon or nitrogen atom, X_5 and A when A contains a carbon or nitrogen atom, and X_5 and X_1 together constitute a double bond, or R_1 and X_1 , R_2 and X_1 , R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4' together form part of a ring structure which optionally includes at least one heteroatom selected from O, S and N and is optionally substituted;

m and n are independently zero or one and Y, Z and T are independently selected from the group consisting of O, S, and NR_{10}

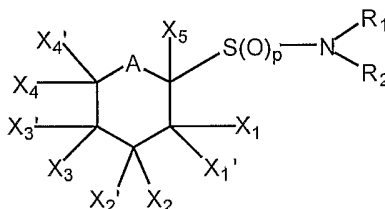
p is zero, one or two;

R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 , R''_6 , R_7 , R_8 , R_9 , R'_9 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} are the same or different and are selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted aryl, optionally substituted heterocyclic, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more

heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted acyl and a carbohydrate moiety;

- with the proviso that at least two of X₁, X₂, X₃,
 5 X₄, X₆ and X₇ are other than hydrogen or a group linked to the ring through a carbon-carbon bond;
 or a pharmaceutically acceptable salt thereof;
 and a pharmaceutically acceptable carrier.

- 10 25. A method of killing a microorganism, comprising exposing said microorganism to a compound of general formula (I):



15

- wherein R₁ and R₂ are independently selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of
 20 O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted aralkyl which may be interrupted
 25 within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted heterocyclic, optionally substituted aryl, optionally substituted acyl and a carbohydrate moiety;

- 30 or R₁ and R₂ together with the nitrogen atom from which they depend form a saturated or unsaturated, optionally substituted heterocyclic group which may include additional heteroatoms selected from the group consisting of O, N and S;

A is selected from the group consisting of O, S, SO, SO₂, Se, Te, NR₈, CR₉R'₉, N->O, and C(O);

X₁ is selected from the group consisting of OR₃, SR₃, NR₃R'₃, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₃, -
 5 N(C=(Z)(T)_nR₃)₂, N₃, CN, OCN, SCN, OSO₃R₃, OSO₂R₃, OPO₃R₃R'₃, OPO₂R₃R'₃, S(O)R₃, S(O)₂R₃, S(O)₂OR₃, PO₃R₃R'₃, NR₃NR'₃R'₃, SNR₃R'₃, NR₃SR'₃, SSR₃ and R₃, or is an oxo group, =S, =NOR₃ or =CR₃R'₃ and X₁' is absent, or X₁ is C=(Z) and R₂ is a bond thereto so as to form a cyclic moiety -C=(Z)NR₁S(O)_p-;

10 X₂ is selected from the group consisting of OR₄, SR₄, NR₄R'₄, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₄, - N(C=(Z)(T)_nR₄)₂, N₃, CN, OCN, SCN, OSO₃R₄, OSO₂R₄, OPO₃R₄R'₄, OPO₂R₄R'₄, S(O)R₄, S(O)₂R₄, S(O)₂OR₄, PO₃R₄R'₄, NR₄NR'₄R'₄, SNR₄R'₄, NR₄SR'₄, SSR₄ and R₄, or is an oxo group, =S, =NOR₄ or =CR₄R'₄ and X₂' is absent;

15 X₃ is selected from the group consisting of OR₅, SR₅, NR₅R'₅, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₅, - N(C=(Z)(T)_nR₅)₂, N₃, CN, OCN, SCN, OSO₃R₅, OSO₂R₅, OPO₃R₅R'₅, OPO₂R₅R'₅, S(O)R₅, S(O)₂R₅, S(O)₂OR₅, PO₃R₅R'₅, NR₅NR'₅R'₅, SNR₅R'₅, NR₅SR'₅, SSR₅ and R₅, or is an oxo group, =S, =NOR₅ or =CR₅R'₅ and X₃' is absent;

X₄ is selected from the group consisting of OR₆, SR₆, NR₆R'₆, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₆, -
 25 N(C=(Z)(T)_nR₆)₂, N₃, CN, OCN, SCN, OSO₃R₆, OSO₂R₆, OPO₃R₆R'₆, OPO₂R₆R'₆, S(O)R₆, S(O)₂R₆, S(O)₂OR₆, PO₃R₆R'₆, NR₆NR'₆R'₆, SNR₆R'₆, NR₆SR'₆, SSR₆, R₆, or is an oxo group, =S, =NOR₆ or =CR₆R'₆ and X₄' is absent, and -(CX₆X₆')_vCX₇X₇'X₇'' wherein v is an integer in the range of 0 to 6 inclusive and, when v is in the range of 1 to 6, may include a double bond or
 30 epoxide group, each of X₆, X₇ and X₇' is independently selected from the group consisting of OR₁₂, SR₁₂, NR₁₂R'₁₂, hydrogen, halogen, -(Y)_mC=(Z)(T)_nR₁₂, -N(C=(Z)(T)_nR₁₂)₂, N₃, CN, OCN, SCN, OSO₃R₁₂, OSO₂R₁₂, OPO₃R₁₂R'₁₂, OPO₂R₁₂R'₁₂, S(O)R₁₂, S(O)₂R₁₂, S(O)₂OR₁₂, PO₃R₁₂R'₁₂, NR₁₂NR'₁₂R'₁₂,
 35 SNR₁₂R'₁₂, NR₁₂SR'₁₂, SSR₁₂ and R₁₂, or is an oxo group, =S, =NOR₁₂ or =CR₁₂R'₁₂ and X₆' or X₇'', respectively, is absent; and each of X₆' and X₇' is independently selected from the group hydrogen, CN, optionally substituted alkyl,

optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

X_5 is selected from the group consisting of hydrogen, CN, $-C=(Z)(T)_nR_{11}$, $S(O)R_{11}$, $S(O)_2R_{11}$, $S(O)_2OR_{11}$, $PO_3R_{11}R'_{11}$, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

X_1' , X_2' , X_3' and X_4' are the same or different and are selected from the group consisting of hydrogen, CN, optionally substituted alkyl, optionally substituted alkaryl, optionally substituted aryl, optionally substituted aralkyl, and optionally substituted acyl;

or one of X_1 and X_2 , X_2 and X_3 , X_3 and X_4' , X_4' and A when A contains a carbon or nitrogen atom, X_5 and A when A contains a carbon or nitrogen atom, and X_5 and X_1 together constitute a double bond, or R_1 and X_1 , R_2 and X_1 , R_1 and X_2 , R_2 and X_2 , R_1 and X_3 , R_2 and X_3 , R_1 and X_4 , R_2 and X_4 , R_1 and X_4' , R_2 and X_4' , X_1 and X_2 , X_2 and X_3 , X_2 and X_4 , X_3 and X_4 , X_1 and X_1' , X_2 and X_2' , X_3 and X_3' or X_4 and X_4' together form part of a ring structure which optionally includes at least one heteroatom selected from O, S and N and is optionally substituted;

m and n are independently zero or one and Y, Z and T are independently selected from the group consisting of O, S, and NR_{10}

p is zero, one or two;

R_3 , R'_3 , R''_3 , R_4 , R'_4 , R''_4 , R_5 , R'_5 , R''_5 , R_6 , R'_6 , R''_6 , R_7 , R_8 , R_9 , R'_9 , R_{10} , R_{11} , R'_{11} , R_{12} , R'_{12} and R''_{12} are the same or different and are selected from the group consisting of hydrogen, optionally substituted alkyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$, optionally substituted alkenyl which may be interrupted by one or more heteroatoms or functional groups selected from the group consisting of O, S, $-N=$, NR_7 and $-(Y)_mC=(Z)(T)_n-$,

optionally substituted aryl, optionally substituted heterocyclic, optionally substituted aralkyl which may be interrupted within the alkyl moiety by one or more heteroatoms or functional groups selected from the group consisting of O, S, -N=, NR₇ and -(Y)_mC=(Z)(T)_n-, optionally substituted acyl and a carbohydrate moiety;

with the proviso that at least two of X₁, X₂, X₃, X₄, X₆ and X₇ are other than hydrogen or a group linked to the ring through a carbon-carbon bond;

or a pharmaceutically acceptable salt thereof.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2005/001548

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

C07H 15/14 (2006.01) *A61K 31/70* (2006.01) *A61P 31/04* (2006.01)

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)

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 practicable, search terms used)
STN Substructure search based on compounds of formula (I)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Chemical Abstracts Online Accession No. 130: 164488 & Maehrel et al, "Structural studies of the melibiose permease of Escherichia coli by fluorescence resonance energy transfer. I. Evidence for ion-induced conformational change" Journal of Biological Chemistry, Vol 273 (50), 1998, p 33192-33197 See Registry No. 220416-21-7	1, 8-17
X A	Illyes, Tunde-Zita et al, "Novel approaches to the syntheses of N-Substituted S-glycosyl-sulfenamides", Carbohydrate Research, Vol. 339 (8), 2004, p 1561-1564 See especially Table 1, p 1562	24 1-23, 25
A	Owen D. J et al, "A one-pot synthesis of novel N,N-dialkyl-S-glycosylsulfenamides", Carbohydrate Research, Vol. 328 (3), 2000, p 287-292	



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

"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

"E" earlier application or patent but published on or after the international filing date

"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

"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)

"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

"O" document referring to an oral disclosure, use, exhibition or other means

"&"

document member of the same patent family

"P" document published prior to the international filing date but later than the priority date claimed

Date of the actual completion of the international search

09 December 2005

Date of mailing of the international search report

14 DEC 2005

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2005/001548

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: **1-19, 21-25(in part)**
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 1-19 and 21-25 include a very large number of compounds wherein the ring containing variable A contains a double bond in a variety of positions. A search covering the full breadth of these compounds was not feasible. Consequently, the search was restricted to compounds wherein the ring containing the variable A does not contain such double bonds, as illustrated in the examples.
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.