

THERAPEUTIC COMPOUNDS

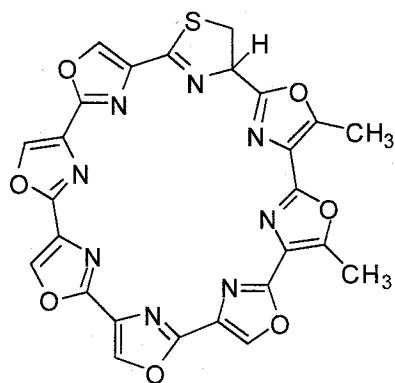
Priority of Invention

This application claims priority from U.S. Provisional Application Number 60/953648, filed 2 August 2007, which application is incorporated by reference.

Background of the Invention

10 A diverse array of compounds, including anthraquinones, acridines, cationic porphyrins, perylenes, thidium derivatives, fluorenones, pentacyclic acridinium salts, fluoroquinophenoxazines, and other specific miscellaneous polycyclic compounds, have been reported to stabilize G-quadruplex DNA. Most of these compounds have little or no selectivity for G-quadruplex vs. duplex DNA.

15 Telomestatin is a natural product isolated from *Streptomyces anulatus* 3533-SV4 (Shinya *et al.*, *J. Am. Chem. Soc.*, **2001**, *123*, 1262-1263). At the time of its discovery, telomestatin was viewed as the most potent inhibitor of telomerase. *In vitro*, telomestatin stabilizes G-quadruplex vs. duplex DNA in a 70:1 ratio (Kim *et al.*, *Cancer Res.*, **2003**, *63*, 3247-3256). It has been suggested that telomestatin also inhibits telomerase function *in vivo*, since cells treated 20 with the natural product exhibit a cellular senescence phenotype. Like telomere dysfunction, telomestatin activates the ATM signaling pathway. While the precise mechanism by which telomestatin interacts with a G-quadruplex has not been definitively elucidated, telomestatin does suppress the plating efficiency of K62 leukemia cells but has a much lesser effect on burst-forming units - erythrocyte (BFU-E) and colony-forming units – granulocyte/macrophage (CFU-GM) from natural bone marrow CD34-positive cells (Tauchi *et al.*, *Oncogene*, **2003**, *22*, 5338-5347).

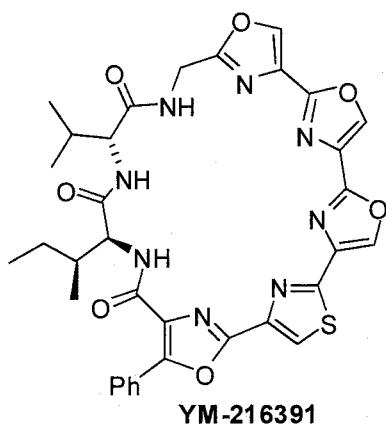


Telomestatin

30 The anticancer potential of telomestatin resides in its telomerase inhibitory activity (IC_{50} 5 nM) and in its ability to enhance apoptosis. Telomestatin has been evaluated for cytotoxicity in the human neuroblastoma cell lines SK-N-AS, LAN5, WAC2, and LAN1 with IC_{50} values of 0.8, 2.5, 3.2, and 4.0 μ M respectively (Binz *et al.*, *Eur. J. Cancer*, **2005**, *41*, 2873-2881) and in

5 the human pancreatic carcinoma MiaPaCa with an IC₅₀ value of 0.5 μ M (Liu *et al.*, *Nucleosides, Nucleotides, and Nucleic Acids*, **2005**, 24, 1801-1815).

10 Another macrocyclic polyoxazole, YM-216391 isolated from *Streptomyces nobilis* is active against the human breast cancer cell lines HBC-4, BSY-1, HBC-5, MCF-7, and MDA-MB-231 with GI₅₀ values ranging from 15-33 nM (Sohda, K-y., *et al.*, *J. Antibiotics*, **2005**, 58, 27-31 and Sohda, K-y., *et al.*, Hiramoto, M., Suzumura, K-i., Takebayashi, Y., Suzuki, K-i., Tanaka, A. *J. Antibiotics*, **2005**, 58, 32-36).

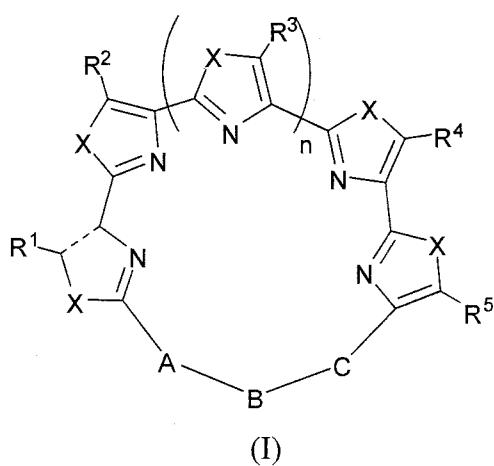


The mechanism of action of YM-216391 has not yet been elucidated.

15 Currently, there is a need for novel therapeutic agents and therapeutic methods that are useful for treating diseases such as cancer. Such agents may have improved binding affinity for G-quadruplex DNA and/or they may have advantageous drug-like properties.

Summary of the Invention

The present invention provides compounds that exhibit anti-cancer properties. Accordingly, in one embodiment of the invention there is provided a compound of the invention 20 which is compound of formula (I):

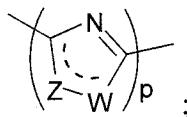


wherein:

5 the bond represented by ---- is a single or double bond;

A is $(-\text{C}(=\text{O})\text{NH}-\text{CH}(\text{R})-\text{x})$ or $(-\text{CH}(\text{R})-\text{NH}-\text{C}(=\text{O})-\text{x})$;

B is a group of formula:



C is $(-\text{C}(=\text{O})\text{NH}-\text{CH}(\text{R})-\text{y})$ or $(-\text{CH}(\text{R})-\text{NH}-\text{C}(=\text{O})-\text{y})$;

10 n is 0, 1 or 2;

p is 0, 1, or 2;

x is 1 or 2;

y is 0, 1 or 2;

provided that the sum of n, p, x and y is 4;

15 X is O, S or NH;

one of W and Z is O, S or NH and the other of W and Z is CR^6 ;

each of R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently hydrogen, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$, aryl or heteroaryl, wherein each $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$ and $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$ is optionally substituted with OH, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkylthio}$, aryl, NR^7R^8 , or $-\text{C}(=\text{O})\text{NR}^9\text{R}^{10}$; and 20 wherein each aryl or heteroaryl is optionally substituted with one or two substituents selected independently from a halo, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$, NR^7R^8 , and $\text{NR}^7\text{R}^8(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$;

each R is independently hydrogen, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_2\text{-}\text{C}_6)\text{alkenyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$, aryl or heteroaryl, wherein each $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_2\text{-}\text{C}_6)\text{alkenyl}$ and $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$ is optionally substituted with OH, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkylthio}$, aryl, $\text{NR}^{11}\text{R}^{12}$, or $-\text{C}(=\text{O})\text{NR}^{13}\text{R}^{14}$; and 25 wherein each aryl or heteroaryl is optionally substituted with one or two substituents selected independently from halo, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $\text{NR}^{11}\text{R}^{12}$, and $\text{NR}^{13}\text{R}^{14}(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$;

each of R^7 and R^8 is independently hydrogen, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkanoyl}$, arylcarbonyl, heteroarylcarbonyl, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxycarbonyl}$, carbamoyl, $\text{N}-(\text{C}_1\text{-}\text{C}_6)\text{alkylaminocarbonyl}$, aryl or heteroaryl, wherein each $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkanoyl}$, or $(\text{C}_1\text{-}\text{C}_6)\text{alkoxycarbonyl}$ is optionally substituted with one or more $\text{NR}^{15}\text{R}^{16}$; or R^7 and R^8 together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

each of R^9 and R^{10} is independently hydrogen, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkanoyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxycarbonyl}$, carbamoyl, $\text{N}-(\text{C}_1\text{-}\text{C}_6)\text{alkylaminocarbonyl}$, aryl or heteroaryl, wherein each $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkanoyl}$, or $(\text{C}_1\text{-}\text{C}_6)\text{alkoxycarbonyl}$ is optionally substituted with one or

5 more NR¹⁵R¹⁶; or R⁹ and R¹⁰ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

each of R¹¹ and R¹² is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or

10 more NR¹⁵R¹⁶; or R¹¹ and R¹² together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

each of R¹³ and R¹⁴ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or

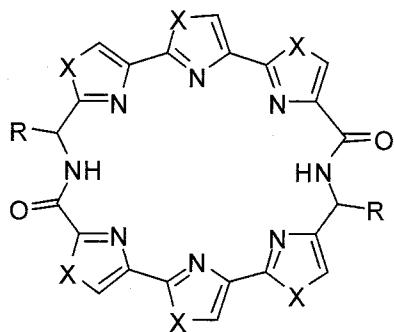
15 more NR¹⁵R¹⁶; or R¹³ and R¹⁴ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

each of R¹⁵ and R¹⁶ is independently hydrogen, (C₁-C₆)alkyl, or (C₁-C₆)alkanoyl; or R¹⁵ and R¹⁶ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

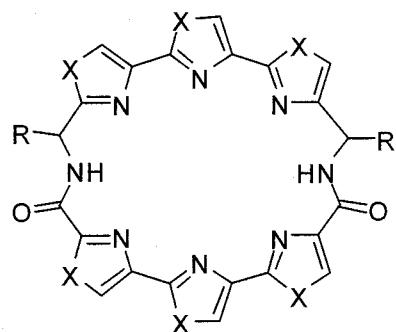
20 or a salt thereof.

In one embodiment of the invention the compound of formula (I) is not YM-216391.

In one embodiment the invention also provides a compound of formula (II) or (III):



or



(III)

25 wherein:
each X is independently O, S or NH;
each R is independently hydrogen, (C₁-C₆)alkyl, (C₂-C₆)alkenyl, (C₁-C₆)alkoxy, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₂-C₆)alkenyl or (C₁-C₆)alkoxy is optionally substituted with OH, (C₁-C₆)alkoxy, (C₁-C₆)alkylthio, aryl, NR¹¹R¹², or -C(=O)NR¹³R¹⁴; and wherein

5 each aryl or heteroaryl is optionally substituted with one or two substituents selected independently from halo, (C₁-C₆)alkyl, NR¹¹R¹², and NR¹³R¹⁴(C₁-C₆)alkyl-;

10 each of R¹¹ and R¹² is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or more NR¹⁵R¹⁶; or R¹¹ and R¹² together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

15 each of R¹³ and R¹⁴ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or more NR¹⁵R¹⁶; or R¹³ and R¹⁴ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

20 each of R¹⁵ and R¹⁶ is independently hydrogen, (C₁-C₆)alkyl or (C₁-C₆)alkanoyl; or R¹⁵ and R¹⁶ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

or a salt thereof.

The invention also provides a pharmaceutical composition comprising a compound of formula (I), (II), or (III) or a pharmaceutically acceptable salt thereof, in combination with a pharmaceutically acceptable diluent or carrier.

Additionally, the invention provides a therapeutic method for treating cancer comprising administering to a mammal (*e.g.*, a human male or female) in need of such therapy, an effective amount of a compound of formula (I), (II), or (III), or a pharmaceutically acceptable salt thereof.

The invention also provides a compound of formula (I), (II), or (III) or a pharmaceutically acceptable salt thereof for use in medical therapy (*e.g.*, for use in treating cancer), as well as the use of a compound of formula (I), (II), or (III) or a pharmaceutically acceptable salt thereof for the manufacture of a medicament useful for the treatment of cancer in a mammal, such as a human.

The invention also provides a compound of formula (I), (II), or (III), or a pharmaceutically acceptable salt thereof for use in the prophylactic or therapeutic treatment of cancer.

35 The invention also provides processes and intermediates disclosed herein that are useful for preparing compounds of formula (I), (II), or (III) or salts thereof.

Detailed Description

The following definitions are used, unless otherwise described: halo is fluoro, chloro, bromo, or iodo. Alkyl, alkoxy, *etc.* denote both straight and branched groups; but reference to an individual radical such as propyl embraces only the straight chain radical, a branched chain isomer such as isopropyl being specifically referred to. Aryl denotes a phenyl radical or an 10 ortho-fused bicyclic carbocyclic radical having about nine to ten ring atoms in which at least one ring is aromatic. Heteroaryl denotes an aromatic heterocyclic ring containing 5 or 6-ring members including from one to four ring hetero atoms selected from oxygen, sulfur and nitrogen, the remainder being carbon, which ring is optionally ortho-fused to a benzene ring or another 5- or 6-membered heteroaromatic ring.

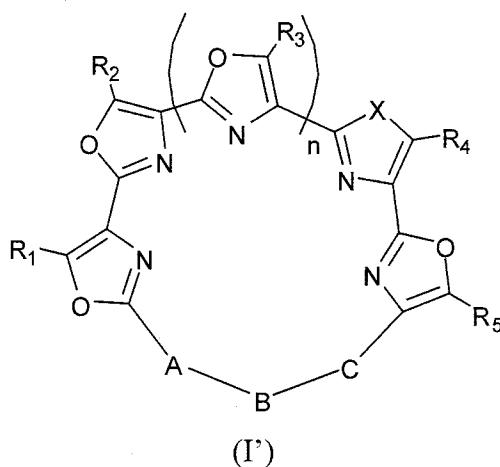
15 It will be appreciated by those skilled in the art that compounds of the invention having a chiral center may exist in and be isolated in optically active and racemic forms. Some compounds may exhibit polymorphism. It is to be understood that the present invention encompasses any racemic, optically-active, polymorphic, or stereoisomeric form, or mixtures thereof, of a compound of the invention, which possess the useful properties described herein, it 20 being well known in the art how to prepare optically active forms (for example, by resolution of the racemic form by recrystallization techniques, by synthesis from optically-active starting materials, by chiral synthesis, or by chromatographic separation using a chiral stationary phase).

25 Specific values listed below for radicals, substituents, and ranges, are for illustration only; they do not exclude other defined values or other values within defined ranges for the radicals and substituents.

Specifically, (C₁-C₆)alkyl can be methyl, ethyl, propyl, isopropyl, butyl, iso-butyl, sec-butyl, pentyl, 3-pentyl, or hexyl; (C₂-C₆)alkenyl can be vinyl, allyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 1-pentenyl, 2-pentenyl, 3-pentenyl, 4-pentenyl, 1-hexenyl, 2-hexenyl, 3-hexenyl, 4-hexenyl, or 5-hexenyl; (C₁-C₆)alkanoyl can be acetyl, propanoyl or 30 butanoyl; (C₁-C₆)alkoxy can be methoxy, ethoxy, propoxy, isopropoxy, butoxy, iso-butoxy, sec-butoxy, pentoxy, 3-pentoxy, or hexyloxy; and aryl can be phenyl, indenyl, or naphthyl. Aryl can be phenyl. Heteroaryl can be pyridyl.

An example of the bond represented by ---- is a double bond.

In one embodiment, the compound of formula (I) is a compound of formula (I')



An example of a particular value for each X in the compounds of formulae (I) and (I') is O.

10 Examples for each group of formula $-C(=O)NH-CH(R)-$ are residues of D- or L- amino acids, such as D- or L- glycine, alanine, valine, leucine, isoleucine and phenylalanine, more particularly alanine, valine, leucine, isoleucine, and phenylalanine.

Examples of particular values for R are independently hydrogen, methyl, isopropyl, 1-methylpropyl, 2-methylpropyl and benzyl, more particularly methyl, isopropyl, 1-methylpropyl, 2-methylpropyl and benzyl.

15 Examples of particular values for R are independently $(C_1-C_6)alkyl$ or $(C_2-C_6)alkenyl$ wherein each $(C_1-C_6)alkyl$, and $(C_2-C_6)alkenyl$, is optionally substituted with $NR^{11}R^{12}$.

Examples of particular values for R are independently aminomethyl, 2-aminoethyl, 3-aminopropyl or 4-aminobutyl.

A particular value for R^1 is hydrogen.

20 A particular value for R^2 is hydrogen.

A particular value for R^3 is hydrogen or $-(CH_2)_q-NR^aR^b$ in which q is 1, 2, 3 or 4, R^a is hydrogen and R^b is acetyl, benzoyl, pyridylcarbonyl, methoxycarbonyl, N-methylaminocarbonyl or phenyl.

A particular value for R^4 is hydrogen.

25 A particular value for R^5 is hydrogen, methyl, phenyl, N-methylaminophenyl, N-acetylaminooethylphenyl, pyridyl, or methoxypyridyl.

A particular value for R^6 is hydrogen.

A particular value for A is $-C(=O)NH-CH(R)-$.

A particular value for A is $-C(=O)NH-CH(R)-C(=O)NH-CH(R)-$.

30 A particular value for A is $-C(=O)NH-CH_2-$.

A particular value for A is $-C(=O)NH-CH_2-C(=O)NH-CH_2-$.

5

A particular value for A is $-\text{CH}(\text{R})\text{-NH-C(=O)}$.

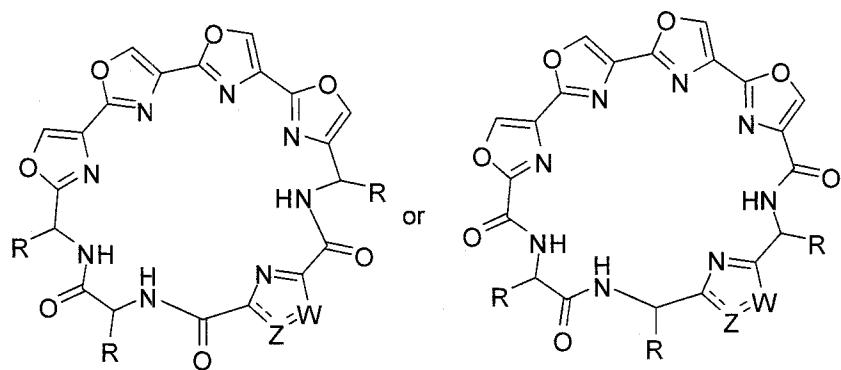
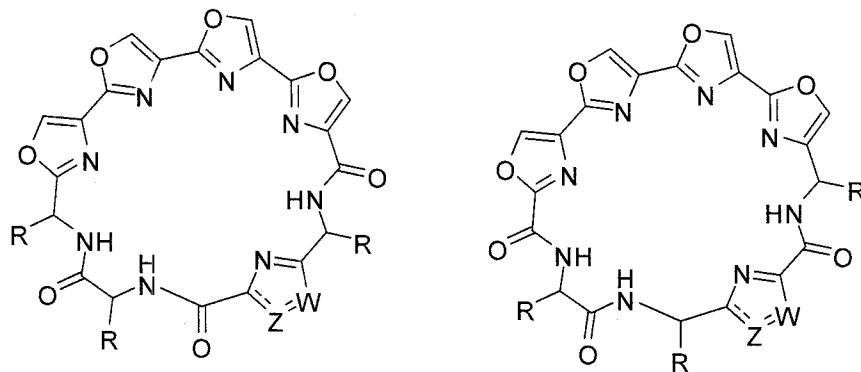
A particular value for A is $-\text{CH}(\text{R})\text{-NH-C(=O)-CH}(\text{R})\text{-NH-C(=O)}$.

A particular value for A is $-\text{CH}_2\text{-NH-C(=O)}$.

A particular value for A is $-\text{CH}_2\text{NH-C(=O)-CH}_2\text{-NH-C(=O)}$.

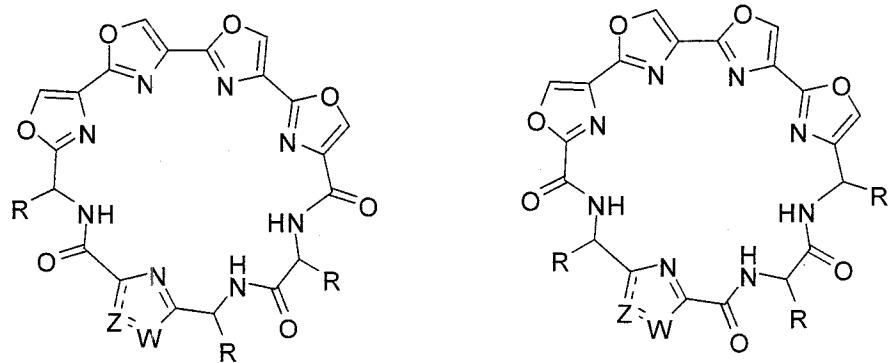
A specific compound of formula (I) is:

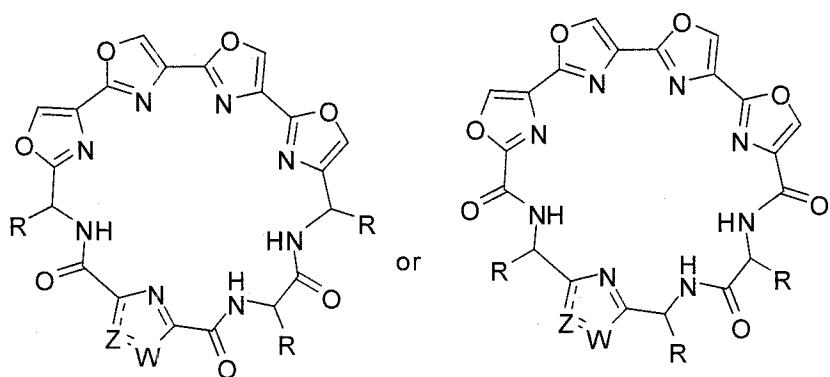
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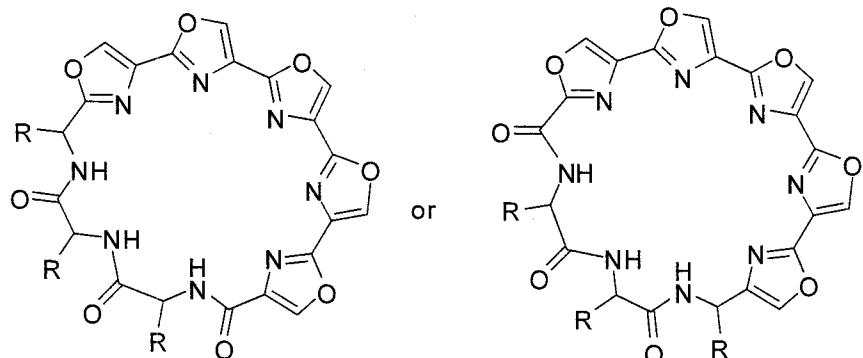
A specific compound of formula (I) is:





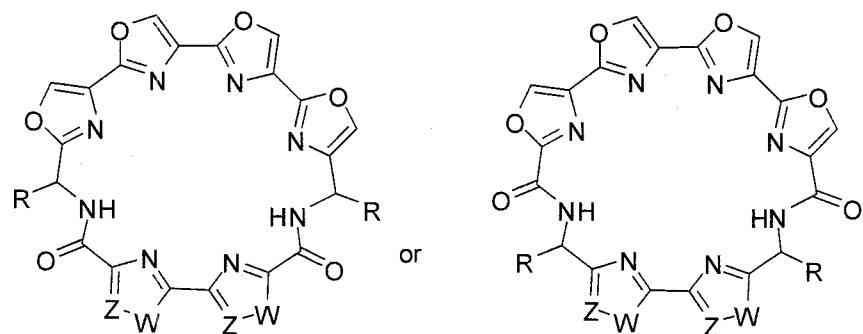
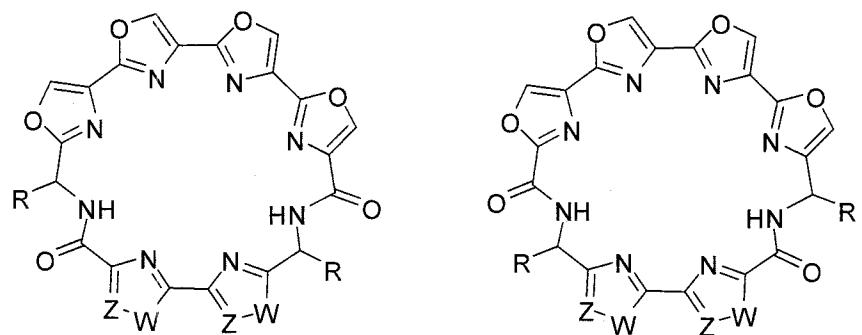
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A specific compound of formula (I) is:



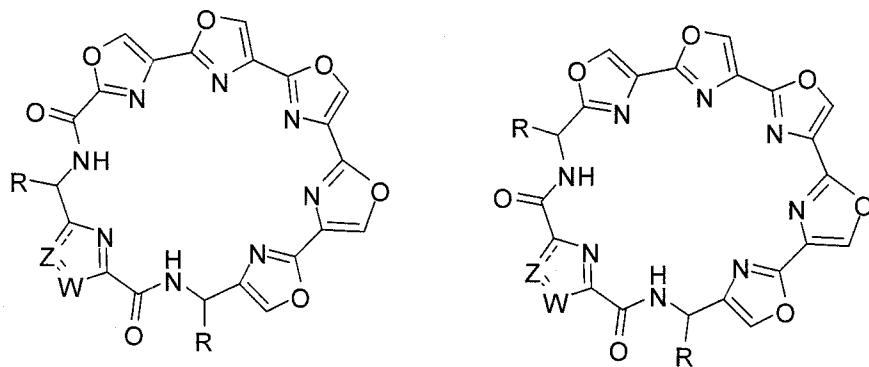
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A specific compound of formula (I) is:

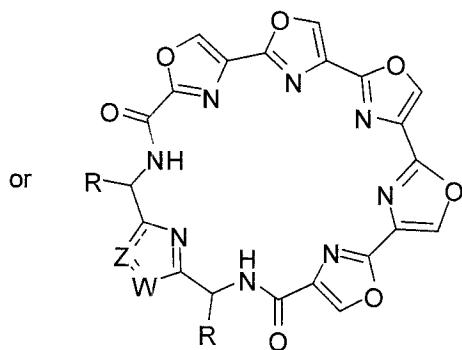


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A specific compound of formula (I) is:

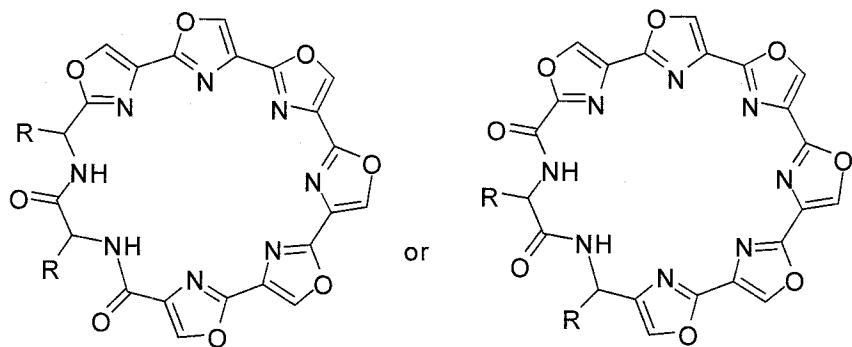


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A specific compound of formula (I) is:

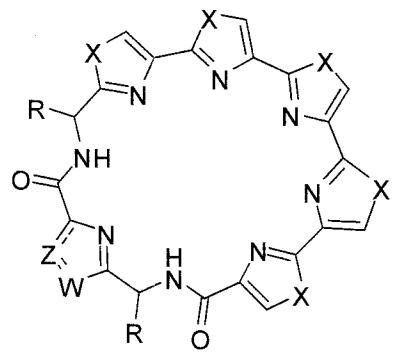
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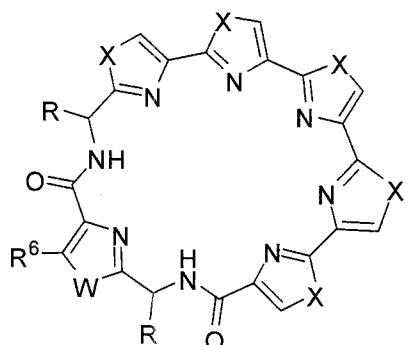
A specific group of compounds are compounds wherein W is O or S and Z is CR⁶.

A specific group of compounds are compounds wherein Z is O or S and W is CR⁶.

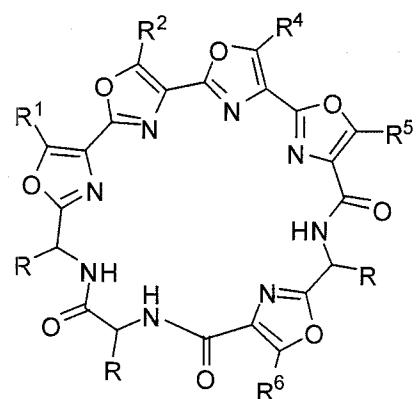
15 In one embodiment of the invention the compound of formula (I) is not a compound of the following formula:



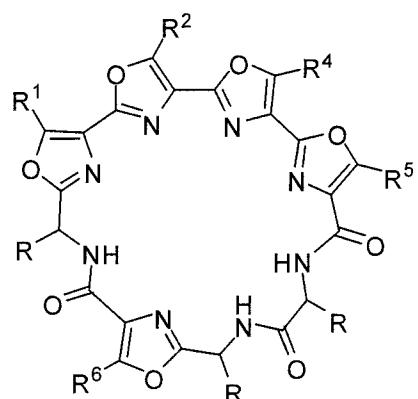
In one embodiment of the invention the compound of formula (I) is not a compound of the following formula:



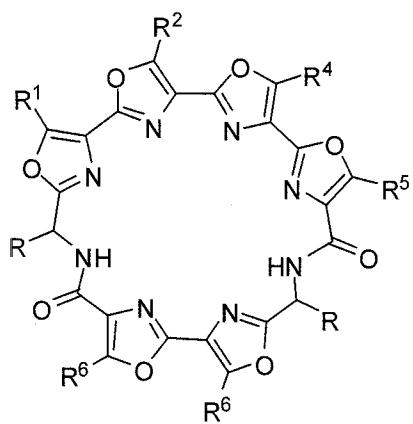
Representative examples of compounds of formula (I) are compounds of formula:



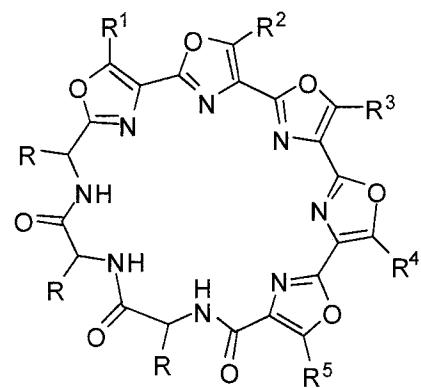
(Ia)



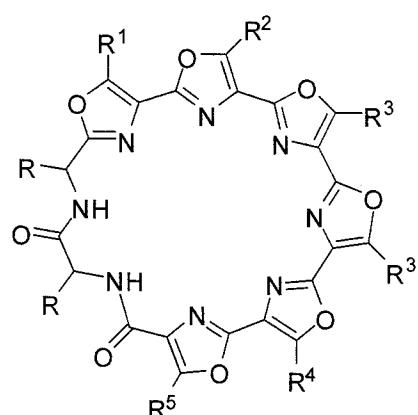
(Ib)



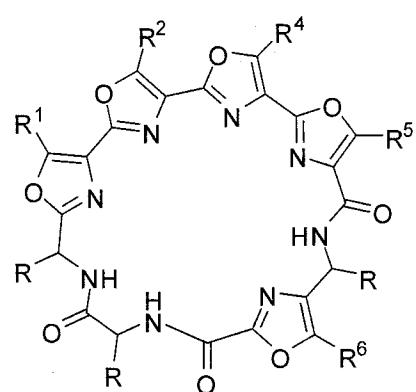
(Ic)



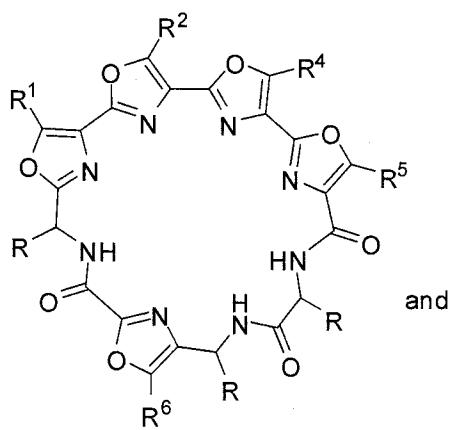
(Id)



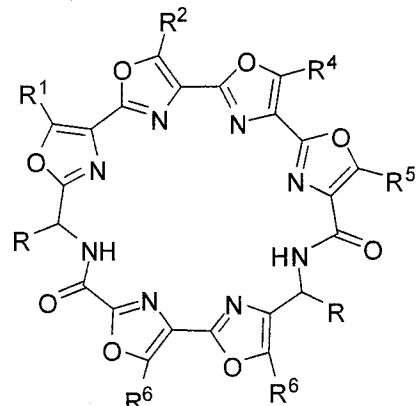
(Ie)



(If)



(Ig)



(Ih)

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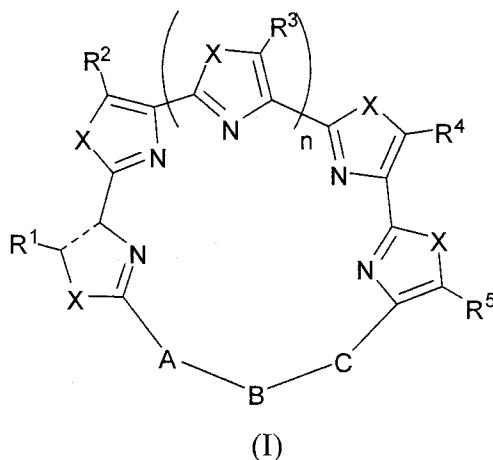
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In one embodiment the invention provides a compound of formula (I) wherein x is 1, y is 0 and n+p is 1, 2 or 4 and wherein x is 1, y is 1, p is 1 and n is 0 or 2.

5 In one embodiment the invention provides a compound of formula (I) wherein x is 1, y is 0 and n+p is 1, 2 or 4.

In one embodiment the invention provides a compound of formula (I) wherein x is 1, y is 1, p is 1 and n is 0 or 2.

10 In one embodiment of the invention there is provided a compound of the invention which is compound of formula (I):

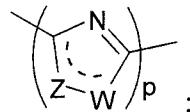


wherein:

15 the bond represented by ---- is a single or double bond;

A is $(-C(=O)NH-CH(R)-)_x$ or $(-CH(R)-NH-C(=O)-)_x$;

B is a group of formula:



C is $(-C(=O)NH-CH(R)-)_y$ or $(-CH(R)-NH-C(=O)-)_y$;

20 n is 0, 1 or 2;

p is 0, 1, or 2;

x is 1 or 2;

y is 0, 1 or 2;

provided that the sum of n, p, x and y is 4;

25 X is O, S or NH;

one of W and Z is O, S or NH and the other of W and Z is CR⁶;

each of R¹, R², R³, R⁴, R⁵ and R⁶ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkoxy, aryl, or heteroaryl, wherein each (C₁-C₆)alkyl and (C₁-C₆)alkoxy is optionally substituted with OH, (C₁-C₆)alkoxy, (C₁-C₆)alkylthio, aryl, NR⁷R⁸, or -C(=O)NR⁹R¹⁰; and

5 wherein each aryl or heteroaryl is optionally substituted with one or two substituents selected independently from a halo, (C₁-C₆)alkyl, NR⁷R⁸, and NR⁷R⁸(C₁-C₆)alkyl-;

each R is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkoxy, aryl, or heteroaryl, wherein each (C₁-C₆)alkyl and (C₁-C₆)alkoxy is optionally substituted with OH, (C₁-C₆)alkoxy, (C₁-C₆)alkylthio, aryl, NR¹¹R¹², or -C(=O)NR¹³R¹⁴; and wherein each aryl or heteroaryl is 10 optionally substituted with one or two substituents selected independently from halo, (C₁-C₆)alkyl, NR¹¹R¹², and NR¹³R¹⁴(C₁-C₆)alkyl-;

each of R⁷ and R⁸ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or 15 more NR¹⁵R¹⁶; or R⁷ and R⁸ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

each of R⁹ and R¹⁰ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or 20 more NR¹⁵R¹⁶; or R⁹ and R¹⁰ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

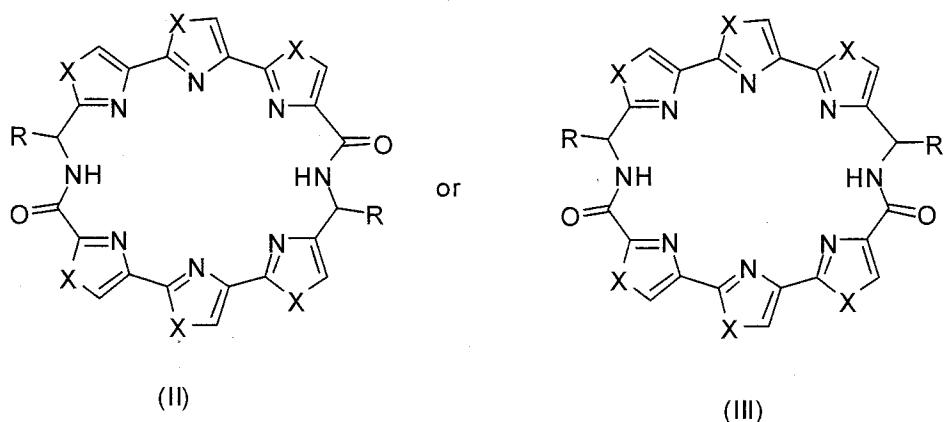
each of R¹¹ and R¹² is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or 25 more NR¹⁵R¹⁶; or R¹¹ and R¹² together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

each of R¹³ and R¹⁴ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or 30 more NR¹⁵R¹⁶; or R¹³ and R¹⁴ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

each of R¹⁵ and R¹⁶ is independently hydrogen, (C₁-C₆)alkyl, or (C₁-C₆)alkanoyl; or R¹⁵ and R¹⁶ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

35 or a salt thereof.

In one embodiment the invention also provides a compound of formula (II) or (III):



5

wherein:

each X is independently O, S or NH;

each R is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkoxy, aryl or heteroaryl,

10 wherein each (C₁-C₆)alkyl and (C₁-C₆)alkoxy is optionally substituted with OH, (C₁-C₆)alkoxy, (C₁-C₆)alkylthio, aryl, NR¹¹R¹² or -C(=O)NR¹³R¹⁴; and wherein each aryl or heteroaryl is optionally substituted with one or two substituents selected independently from halo, (C₁-C₆)alkyl, NR¹¹R¹², and NR¹³R¹⁴(C₁-C₆)alkyl-;

each of R¹¹ and R¹² is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-

15 C_6)alkoxycarbonyl, carbamoyl, N -(C_1 - C_6)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C_1 - C_6)alkyl, (C_1 - C_6)alkanoyl, or (C_1 - C_6)alkoxycarbonyl is optionally substituted with one or more $NR^{15}R^{16}$; or R^{11} and R^{12} together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

each of R¹³ and R¹⁴ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-

20 C_6)alkoxycarbonyl, carbamoyl, N -(C_1 - C_6)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C_1 - C_6)alkyl, (C_1 - C_6)alkanoyl, or (C_1 - C_6)alkoxycarbonyl is optionally substituted with one or more $NR^{15}R^{16}$; or R^{13} and R^{14} together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

each of R¹⁵ and R¹⁶ is independently hydrogen, (C₁-C₆)alkyl, or (C₁-C₆)alkanoyl; or

25 R¹⁵ and R¹⁶ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

or a salt thereof.

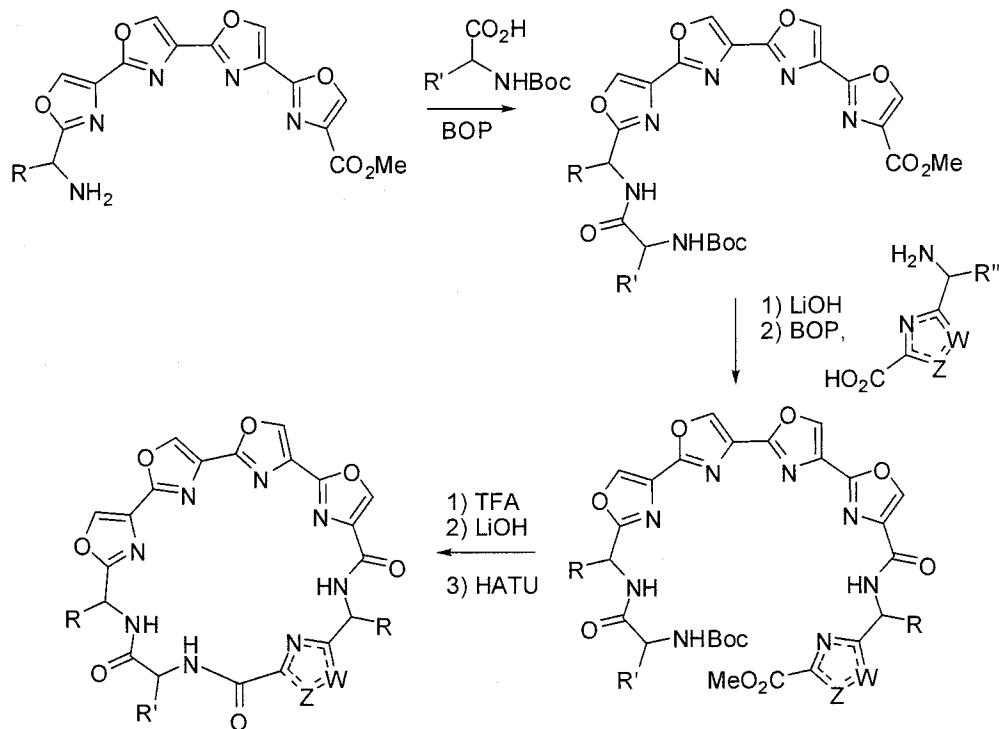
The compounds of formula (I) can be prepared by forming an intermediate comprising a linear chain of the requisite polyazoles and aminoacids, or a protective derivative thereof, then

5 cyclizing this by forming an amide bond and optionally removing any protecting groups and/or forming a salt.

Examples of synthetic routes to compounds of formula (I) are provided in Schemes 1 to 15 below.

Scheme 1

10



Where W = O, When Z = CH and W = CH, When Z = O

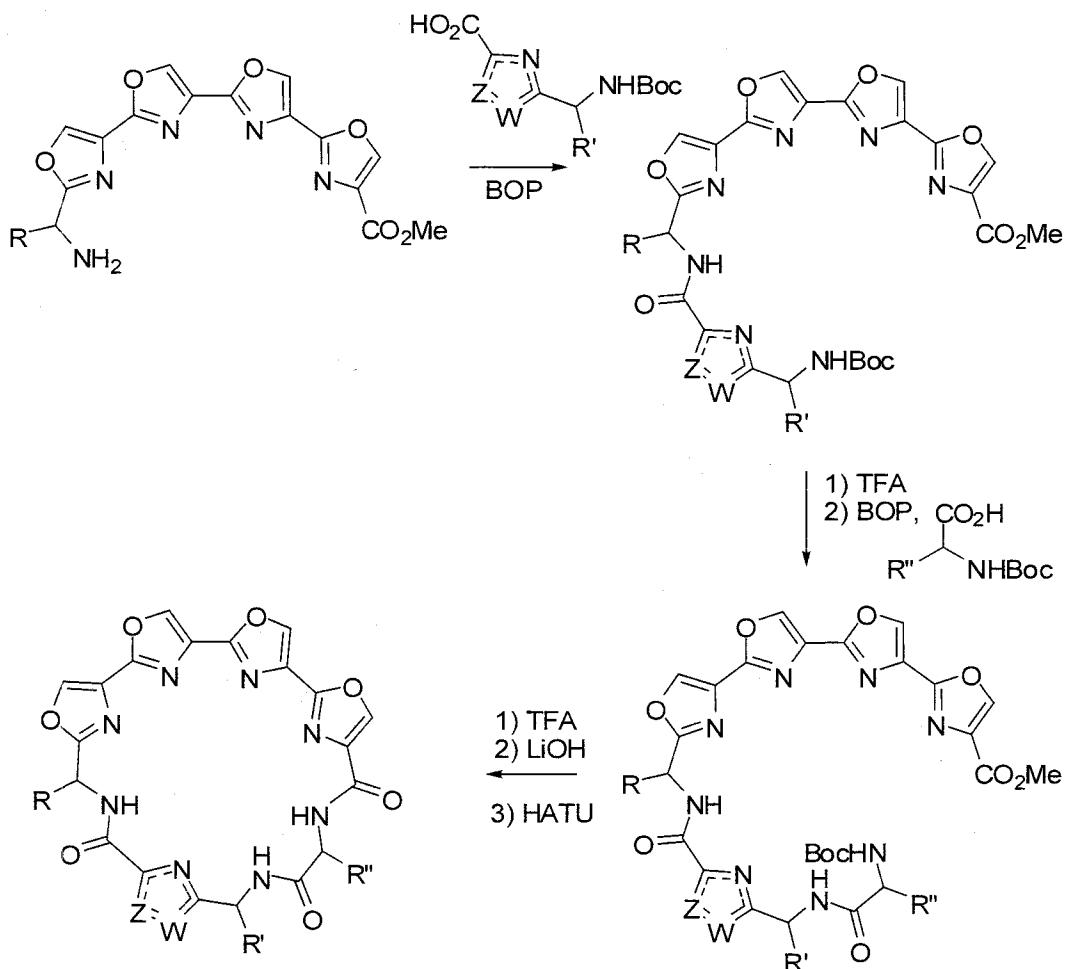
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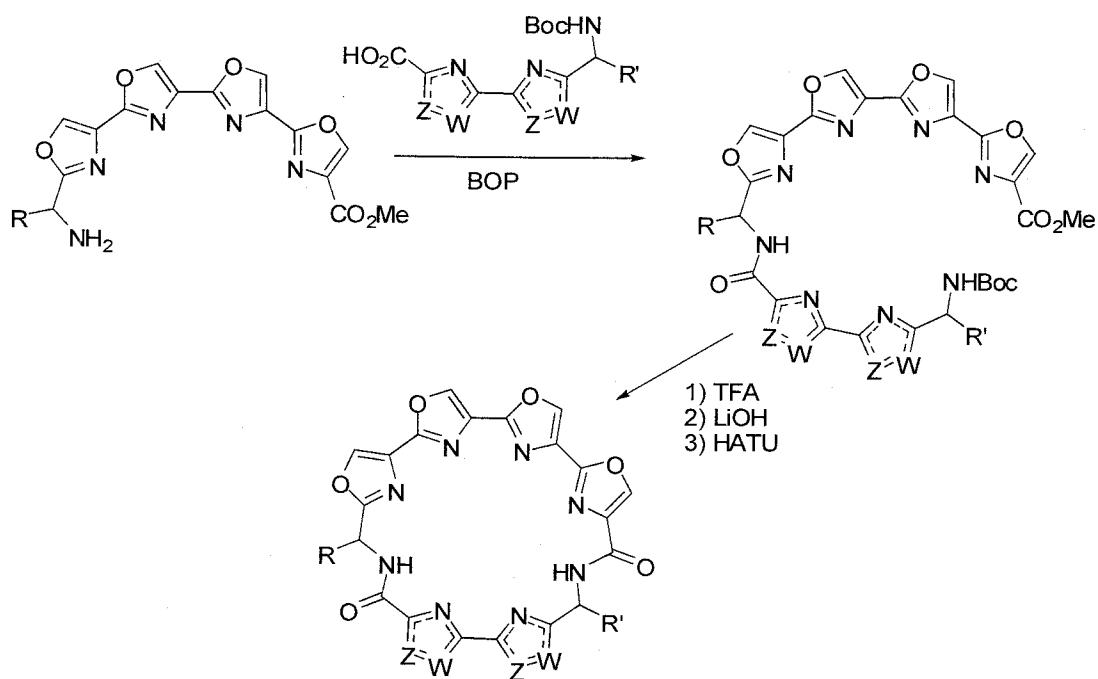
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Scheme 2



5

Scheme 3



Where $W = O$, When $Z = CH$ and $W = CH$, When $Z = O$

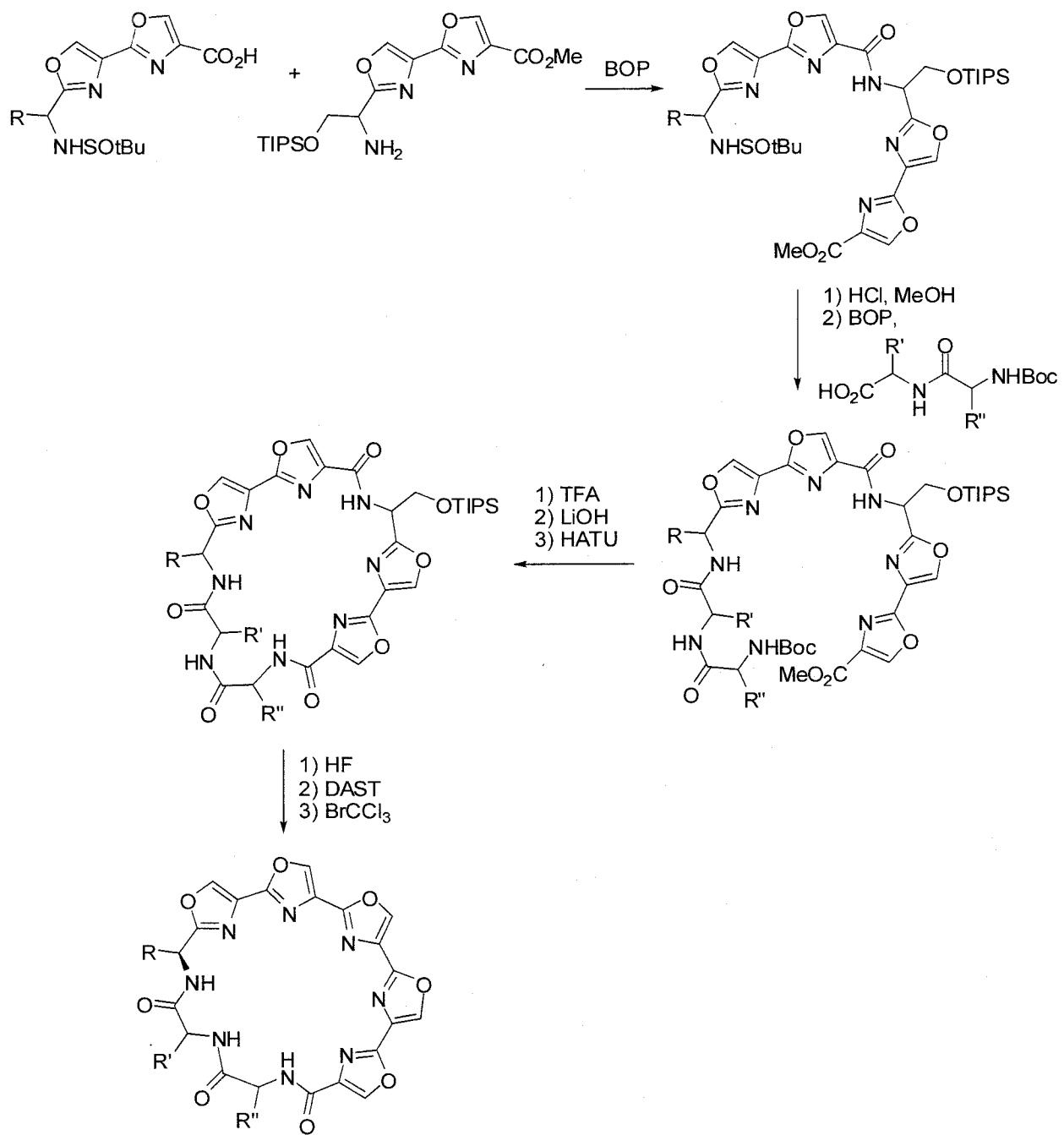
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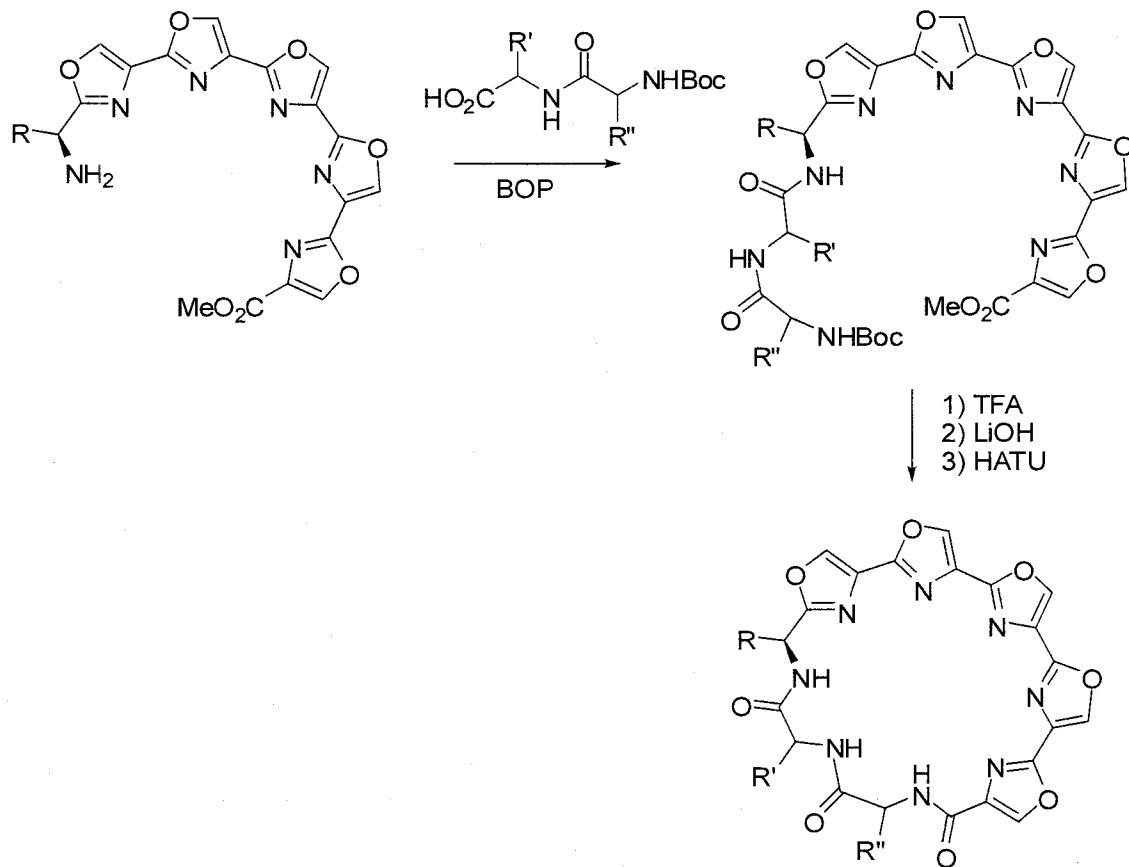
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Scheme 4



Scheme 5

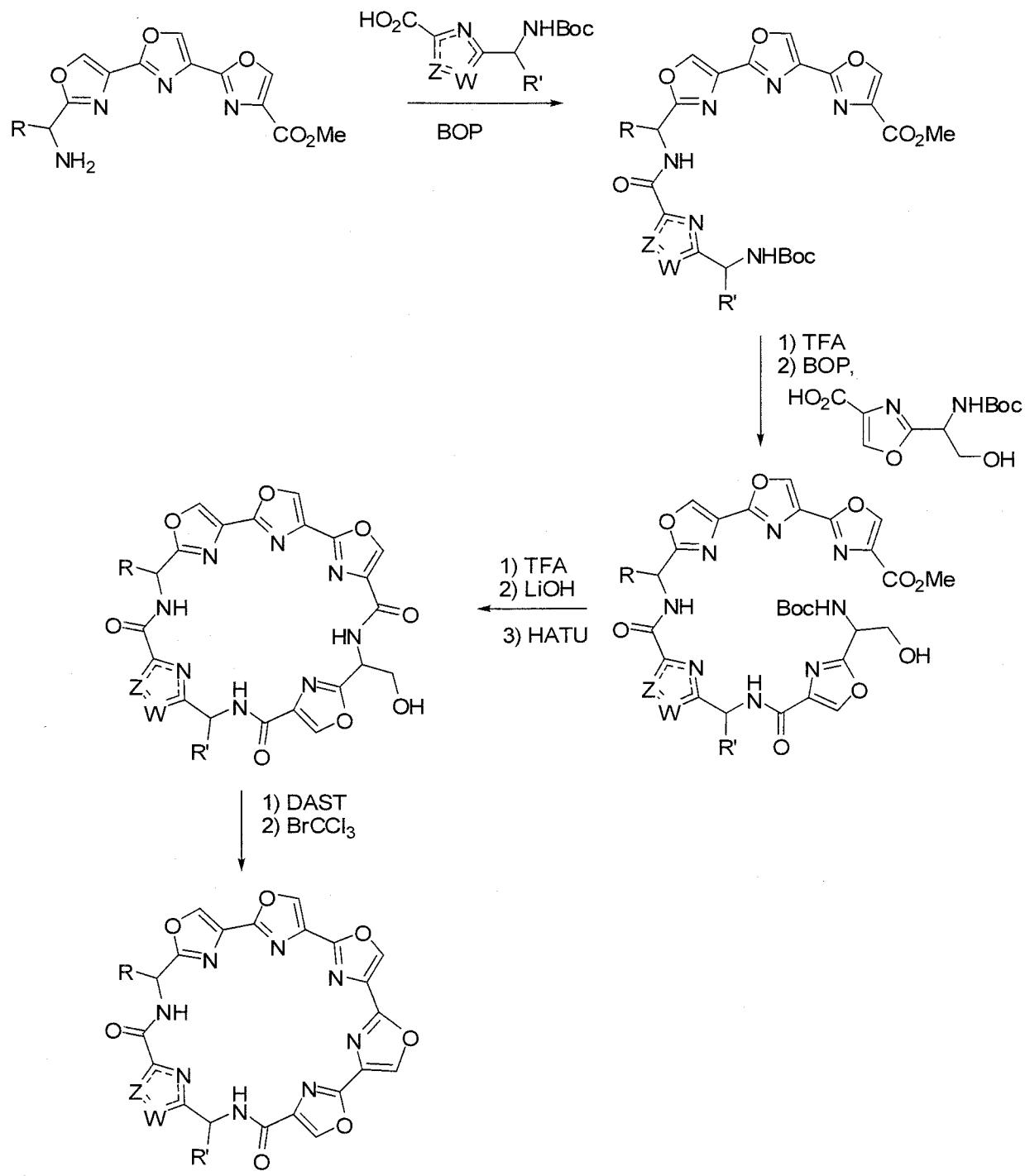


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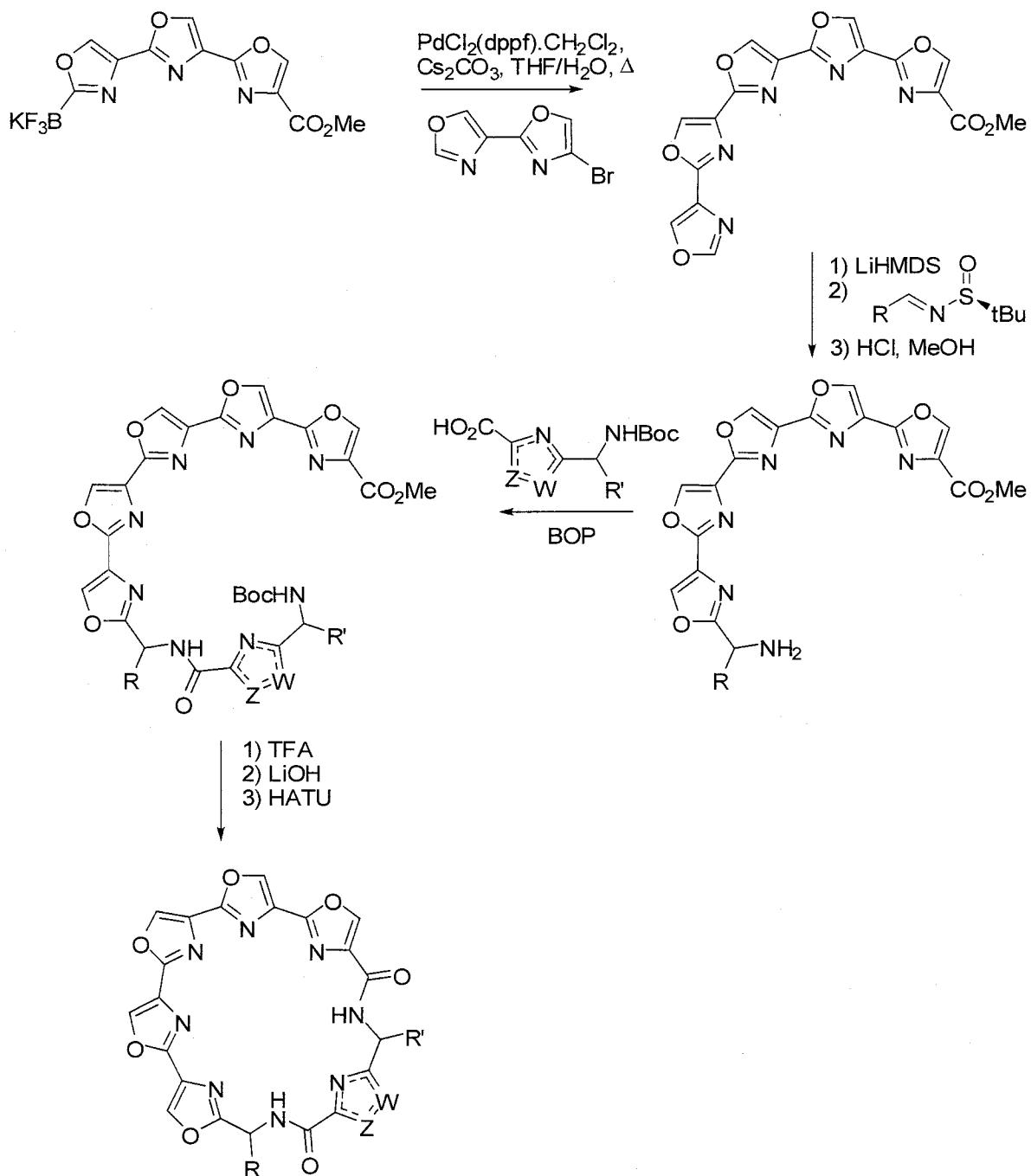
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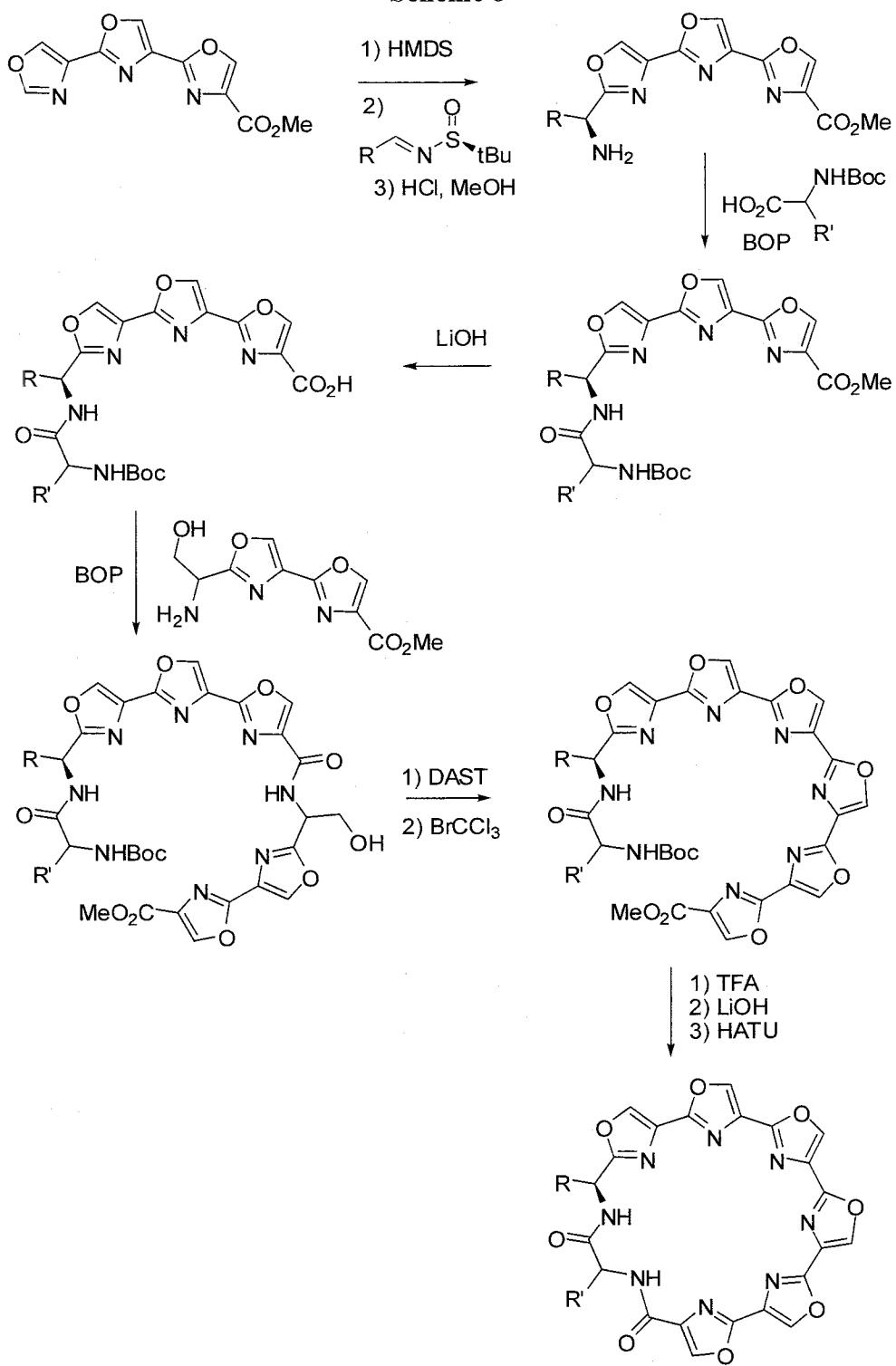
Scheme 6



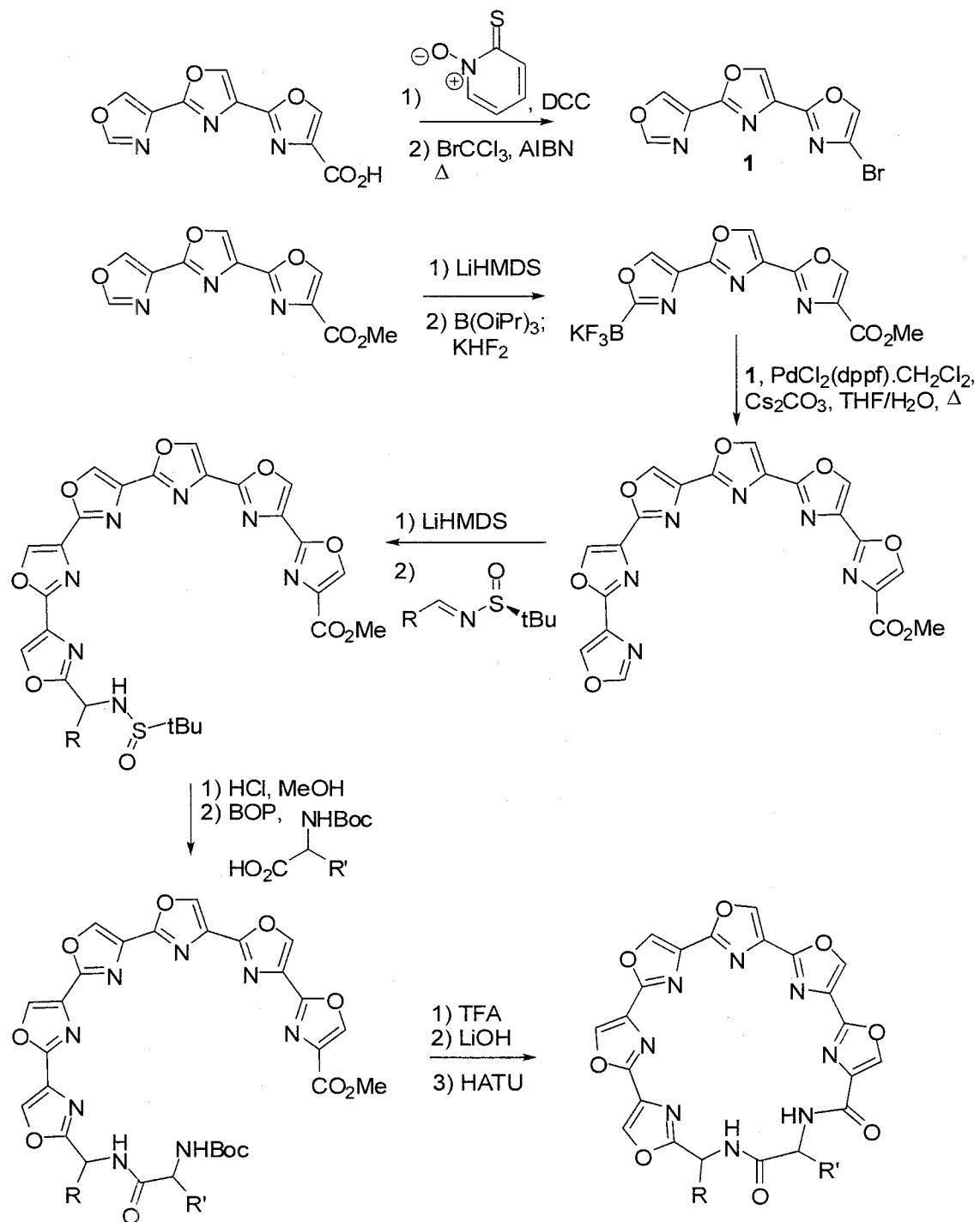
Scheme 7



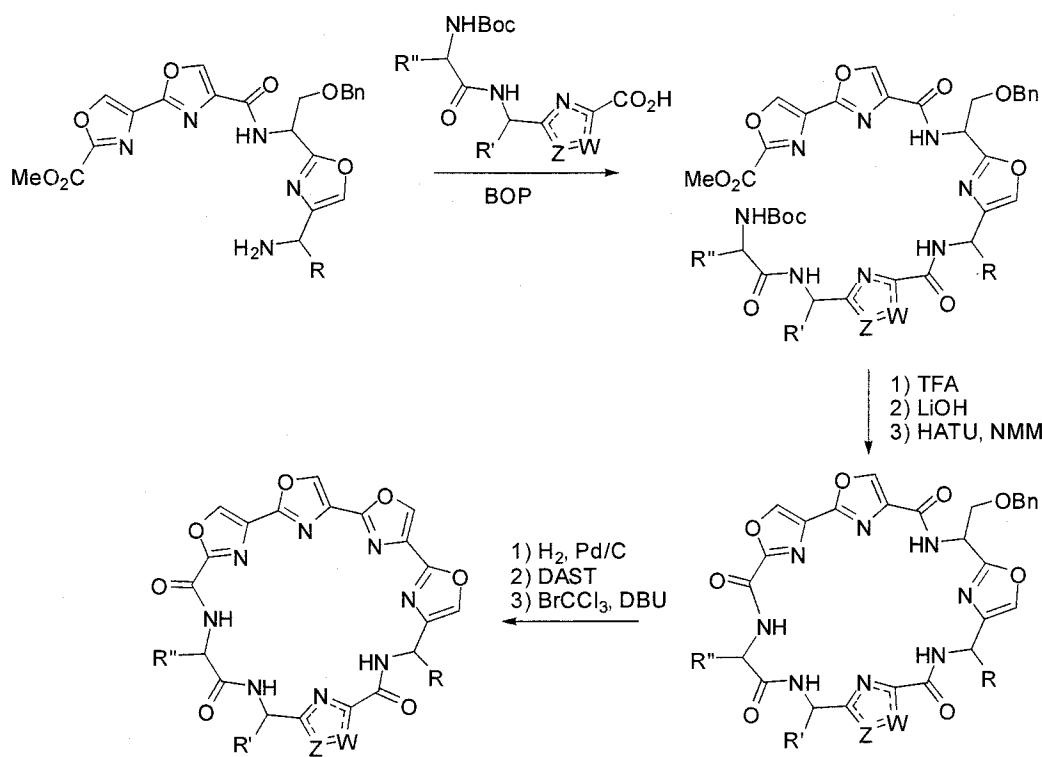
Scheme 8



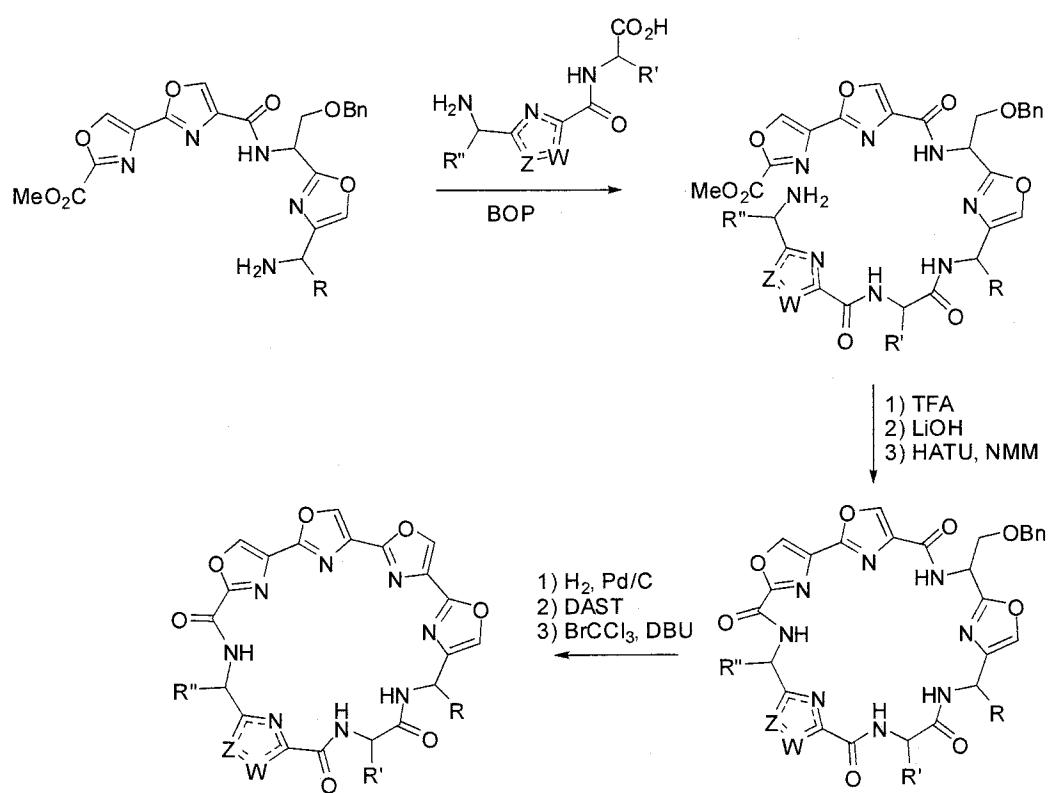
Scheme 9



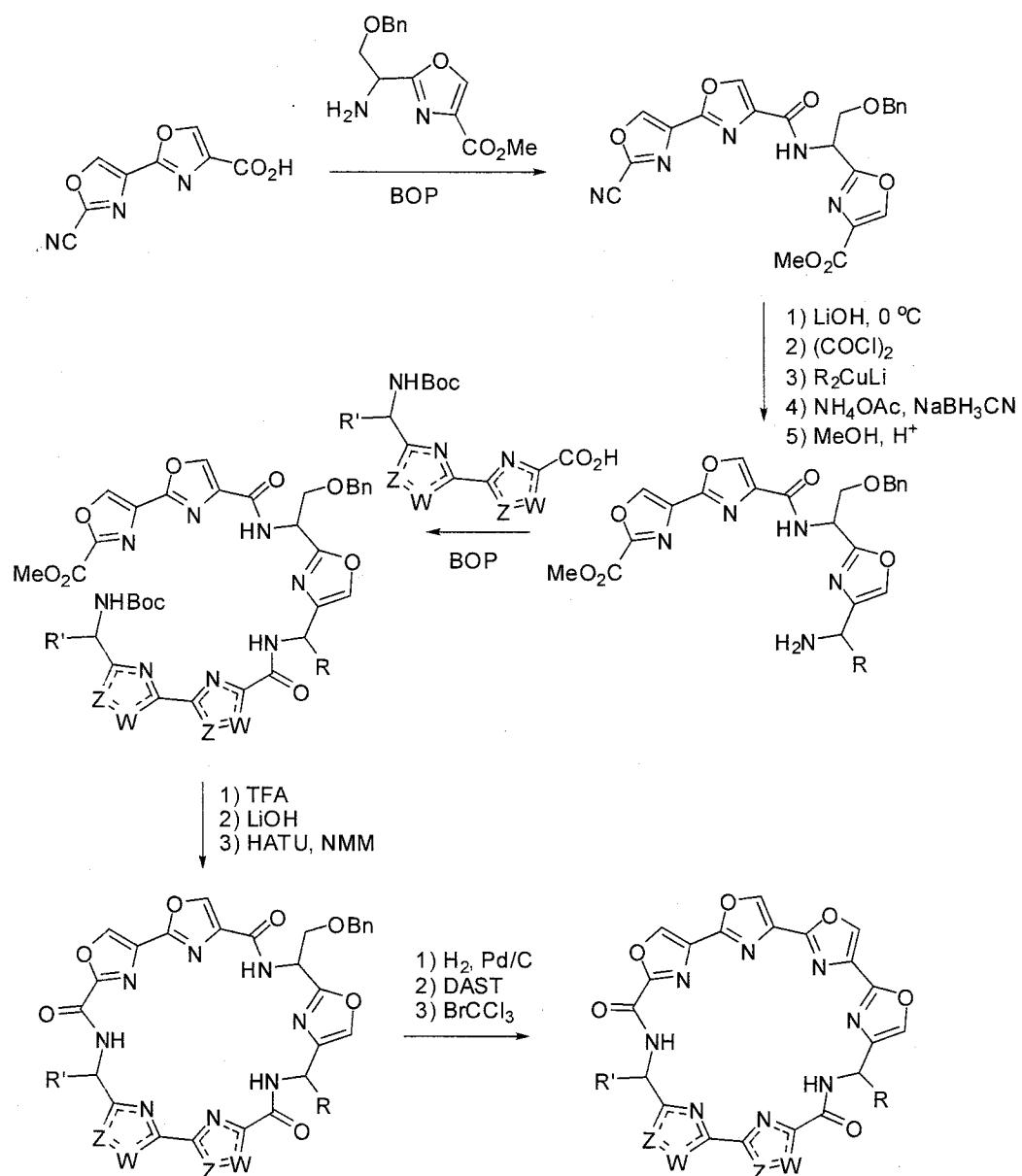
Scheme 10



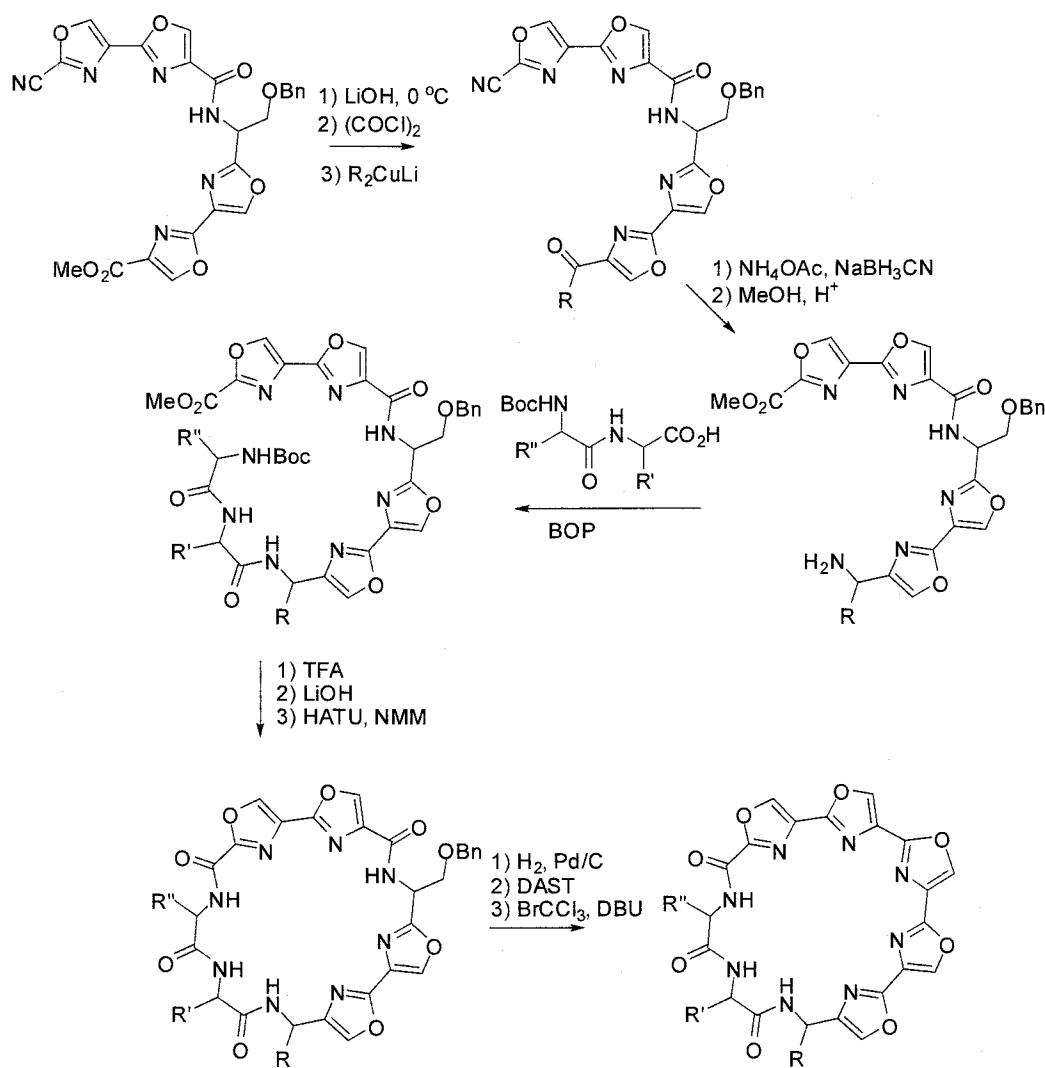
Scheme 11



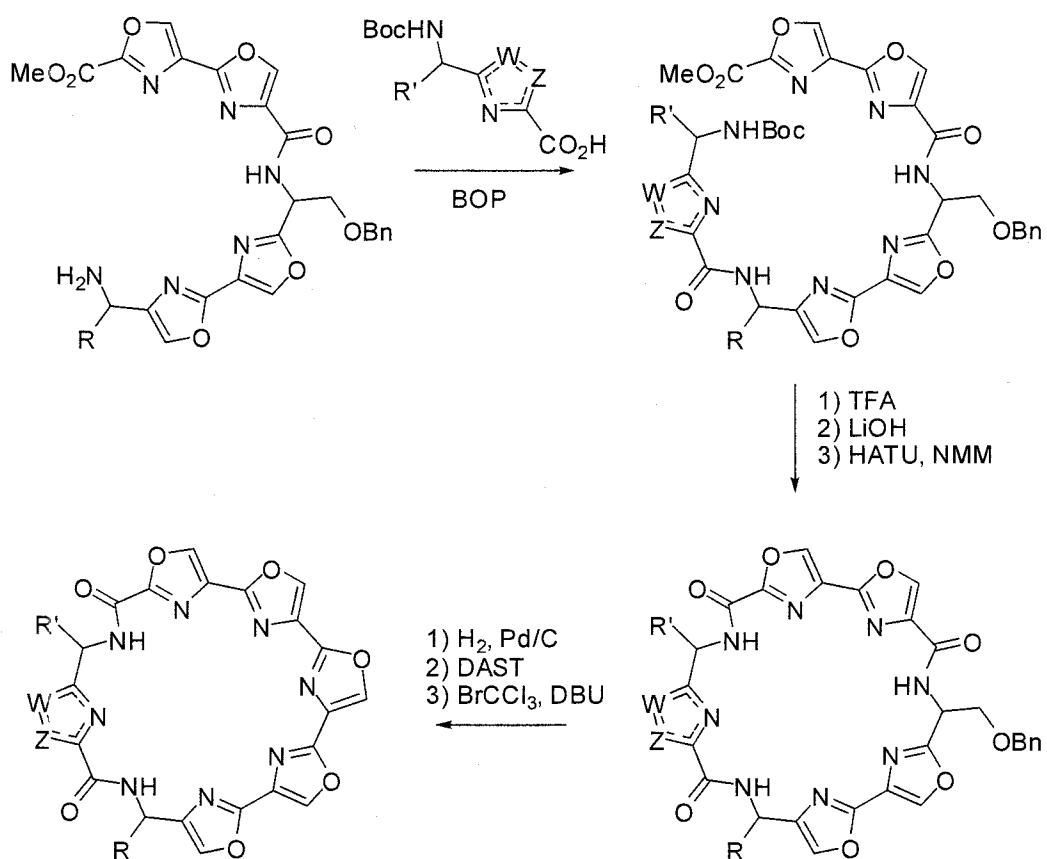
Scheme 12



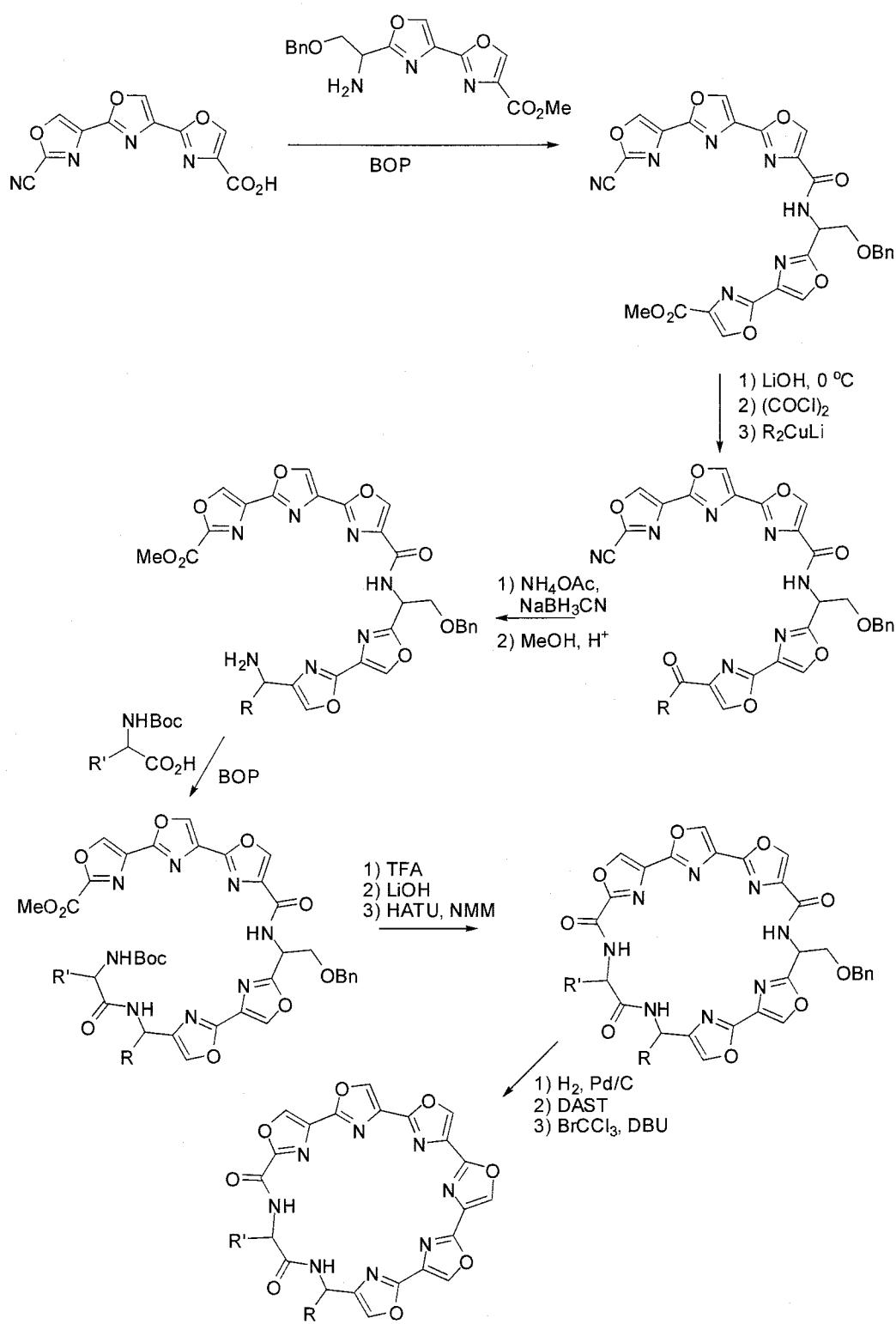
Scheme 13



Scheme 14



Scheme 15



5 In cases where compounds are sufficiently basic or acidic, a salt of a compound of the invention can be useful as an intermediate for isolating or purifying a compound of the invention. Additionally, administration of a compound of the invention as a pharmaceutically acceptable acid or base salt may be appropriate. Examples of pharmaceutically acceptable salts are organic acid addition salts formed with acids which form a physiological acceptable anion, 10 for example, tosylate, methanesulfonate, acetate, citrate, malonate, tartrate, succinate, benzoate, ascorbate, α -ketoglutarate, and α -glycerophosphate. Suitable inorganic salts may also be formed, including hydrochloride, sulfate, nitrate, bicarbonate, and carbonate salts.

15 Pharmaceutically acceptable salts may be obtained using standard procedures well known in the art, for example by reacting a sufficiently basic compound such as an amine with a suitable acid affording a physiologically acceptable anion. Alkali metal (for example, sodium, potassium or lithium) or alkaline earth metal (for example calcium) salts of carboxylic acids can also be made.

20 The compounds of the invention can be formulated as pharmaceutical compositions and administered to a mammalian host, such as a human patient in a variety of forms adapted to the chosen route of administration, *e.g.*, orally or parenterally, by intravenous, intramuscular, topical or subcutaneous routes.

25 Thus, the present compounds may be systemically administered, *e.g.*, orally, in combination with a pharmaceutically acceptable vehicle such as an inert diluent or an assimilable edible carrier. They may be enclosed in hard or soft shell gelatin capsules, may be compressed into tablets, or may be incorporated directly with the food of the patient's diet. For oral therapeutic administration, the active compound may be combined with one or more excipients and used in the form of ingestible tablets, buccal tablets, troches, capsules, elixirs, suspensions, syrups, wafers, and the like. Such compositions and preparations should contain at least 0.1% of active compound. The percentage of the compositions and preparations may, of course, be varied and may conveniently be between about 2 to about 60% of the weight of a given unit dosage form. The amount of active compound in such therapeutically useful compositions is such that an effective dosage level will be obtained.

5 The tablets, troches, pills, capsules, and the like may also contain the following: binders such as gum tragacanth, acacia, corn starch or gelatin; excipients such as dicalcium phosphate; a disintegrating agent such as corn starch, potato starch, alginic acid and the like; a lubricant such as magnesium stearate; and a sweetening agent such as sucrose, fructose, lactose or aspartame or a flavoring agent such as peppermint, oil of wintergreen, or cherry flavoring may be added.

10 When the unit dosage form is a capsule, it may contain, in addition to materials of the above type, a liquid carrier, such as a vegetable oil or a polyethylene glycol. Various other materials may be present as coatings or to otherwise modify the physical form of the solid unit dosage form. For instance, tablets, pills, or capsules may be coated with gelatin, wax, shellac or sugar and the like. A syrup or elixir may contain the active compound, sucrose or fructose as a

15 sweetening agent, methyl and propylparabens as preservatives, a dye and flavoring such as cherry or orange flavor. Of course, any material used in preparing any unit dosage form should be pharmaceutically acceptable and substantially non-toxic in the amounts employed. In addition, the active compound may be incorporated into sustained-release preparations and devices.

20 The active compound may also be administered intravenously or intraperitoneally by infusion or injection. Solutions of the active compound or its salts can be prepared in water, optionally mixed with a nontoxic surfactant. Dispersions can also be prepared in glycerol, liquid polyethylene glycols, triacetin, and mixtures thereof and in oils. Under ordinary conditions of storage and use, these preparations contain a preservative to prevent the growth of

25 microorganisms.

The pharmaceutical dosage forms suitable for injection or infusion can include sterile aqueous solutions or dispersions or sterile powders comprising the active ingredient which are adapted for the extemporaneous preparation of sterile injectable or infusible solutions or dispersions, optionally encapsulated in liposomes. In all cases, the ultimate dosage form should

30 be sterile, fluid and stable under the conditions of manufacture and storage. The liquid carrier or vehicle can be a solvent or liquid dispersion medium comprising, for example, water, ethanol, a polyol (for example, glycerol, propylene glycol, liquid polyethylene glycols, and the like), a vegetable oil, a nontoxic glyceryl ester, and suitable mixtures thereof. The proper fluidity can be maintained, for example, by the formation of liposomes, by the maintenance of the required

35 particle size in the case of dispersions or by the use of surfactants. The prevention of the action of microorganisms can be brought about by various antibacterial and antifungal agents, for example, parabens, chlorobutanol, phenol, sorbic acid, thimerosal, and the like. In many cases,

5 it will be preferable to include isotonic agents, for example, sugars, buffers or sodium chloride. Prolonged absorption of the injectable compositions can be brought about by the use in the compositions of agents delaying absorption, for example, aluminum monostearate and gelatin.

10 Sterile injectable solutions can be prepared by incorporating the active compound in the required amount in the appropriate solvent with various of the other ingredients enumerated above, as required, followed by filter sterilization. In the case of sterile powders for the preparation of sterile injectable solutions, the preferred methods of preparation are vacuum drying and the freeze drying techniques, which yield a powder of the active ingredient plus any additional desired ingredient present in the previously sterile-filtered solutions.

15 For topical administration, the present compounds may be applied in pure form, *e.g.*, when they are liquids. However, it will generally be desirable to administer them to the skin as compositions or formulations, in combination with a dermatologically acceptable carrier, which may be a solid or a liquid.

20 Useful solid carriers include finely divided solids such as talc, clay, microcrystalline cellulose, silica, alumina and the like. Useful liquid carriers include water, alcohols or glycols or water-alcohol/glycol blends, in which the present compounds can be dissolved or dispersed at effective levels, optionally with the aid of non-toxic surfactants. Adjuvants such as fragrances and additional antimicrobial agents can be added to optimize the properties for a given use. The resultant liquid compositions can be applied from absorbent pads, used to impregnate bandages and other dressings, or sprayed onto the affected area using pump-type or aerosol sprayers.

25 Thickeners such as synthetic polymers, fatty acids, fatty acid salts and esters, fatty alcohols, modified celluloses or modified mineral materials can also be employed with liquid carriers to form spreadable pastes, gels, ointments, soaps, and the like, for application directly to the skin of the user.

30 Examples of useful dermatological compositions which can be used to deliver the compounds of formula (I) to the skin are known to the art; for example, see Jacquet *et al.* (U.S. Pat. No. 4,608,392), Geria (U.S. Pat. No. 4,992,478), Smith *et al.* (U.S. Pat. No. 4,559,157) and Wortzman (U.S. Pat. No. 4,820,508).

35 Useful dosages of the compounds of formula (I) can be determined by comparing their *in vitro* activity, and *in vivo* activity in animal models. Methods for the extrapolation of effective dosages in mice, and other animals, to humans are known to the art; for example, see U.S. Pat. No. 4,938,949.

5 Generally, the concentration of the compound(s) of formula (I) in a liquid composition, such as a lotion, will be from about 0.1-25 wt-%, preferably from about 0.5-10 wt-%. The concentration in a semi-solid or solid composition such as a gel or a powder will be about 0.1-5 wt-%, preferably about 0.5-2.5 wt-%.

10 The amount of the compound, or an active salt or derivative thereof, required for use in treatment will vary not only with the particular salt selected but also with the route of administration, the nature of the condition being treated and the age and condition of the patient and will be ultimately at the discretion of the attendant physician or clinician.

15 In general, however, a suitable dose will be in the range of from about 0.5 to about 100 mg/kg, *e.g.*, from about 10 to about 75 mg/kg of body weight per day, such as 3 to about 50 mg per kilogram body weight of the recipient per day, preferably in the range of 6 to 90 mg/kg/day, most preferably in the range of 15 to 60 mg/kg/day.

20 The compound is conveniently administered in unit dosage form; for example, containing 5 to 1000 mg, conveniently 10 to 750 mg, most conveniently, 50 to 500 mg of active ingredient per unit dosage form.

25 Ideally, the active ingredient should be administered to achieve peak plasma concentrations of the active compound of from about 0.5 to about 75 μ M, preferably, about 1 to 50 μ M, most preferably, about 2 to about 30 μ M. This may be achieved, for example, by the intravenous injection of a 0.05 to 5% solution of the active ingredient, optionally in saline, or orally administered as a bolus containing about 1-100 mg of the active ingredient. Desirable blood levels may be maintained by continuous infusion to provide about 0.01-5.0 mg/kg/hr or by intermittent infusions containing about 0.4-15 mg/kg of the active ingredient(s).

30 The desired dose may conveniently be presented in a single dose or as divided doses administered at appropriate intervals, for example, as two, three, four or more sub-doses per day. The sub-dose itself may be further divided, *e.g.*, into a number of discrete loosely spaced administrations; such as multiple inhalations from an insufflator or by application of a plurality of drops into the eye.

35 Compounds of the invention can also be administered in combination with other therapeutic agents, for example, other agents that are useful for the treatment of cancer. Accordingly, in one embodiment the invention also provides a composition comprising a compound of formula (I), or a pharmaceutically acceptable salt thereof, at least one other therapeutic agent, and a pharmaceutically acceptable diluent or carrier. The invention also provides a kit comprising a compound of formula (I), or a pharmaceutically acceptable salt

5 thereof, at least one other therapeutic agent, packaging material, and instructions for administering the compound of the invention or the pharmaceutically acceptable salt thereof and the other therapeutic agent or agents to an animal to treat cancer.

10 The ability of a compound of the invention to stabilize G-quadruplex DNA may be determined using pharmacological models which are well known to the art, or using Test A described below.

Test A. Stabilization of G-quadruplex DNA

15 Analyses can be performed to determine the ability of the agents to bind and thermally stabilize the duplex, triplex, and quadruplex forms of nucleic acids. Toward this end, the UV absorbances of the nucleic acids as a function of temperature in the absence and presence of HXDV is monitored. The melting of duplex and triplex nucleic acids is generally associated with a hyperchromic shift at 260 nm while the melting of quadruplex nucleic acids is associated with a hypochromic shift at 295 nm. Thus, the temperature-dependent absorbances of duplexes and triplexes is monitored at 260 nm, with corresponding quadruplex absorbances being 20 monitored at 295 nm. ST DNA, p(rA)•p(rU), p(rA)•p(dT), p(dA)•2p(dT), p(rA)•2p(rU), d(T₂AG₃)₄, and r(UG₄U) is used as representative models of a DNA duplex, an RNA duplex, a hybrid DNA•RNA duplex, a DNA triplex, an RNA triplex, a DNA quadruplex, and an RNA quadruplex, respectively. All the UV melting studies are conducted at pH 7.5 in the presence of potassium ions.

25 The ability of compounds to stabilize G-quadruplex DNA may also be determined using Test B described below.

Test B. Temperature-dependent spectrophotometry

30 Temperature-dependent absorption experiments are conducted on an AVIV Model 14DS Spectrophotometer (Aviv Biomedical, Lakewood, NJ) equipped with a thermoelectrically controlled cell holder. Quartz cells with a pathlength of 1.0 cm are used for all the absorbance studies. Temperature-dependent absorption profiles are acquired at either 260 (for duplex and triplex) or 295 (for quadruplex) nm with a 5 sec averaging time. The temperature is raised in 0.5 °C increments, and the samples are allowed to equilibrate for 1.5 min at each temperature 35 setting. In the quadruplex melting studies, the concentrations of d(T₂AG₃)₄, 9AP, 15AP, and 21AP are 5 μM in strand (120 μM in nucleotide), while the concentration of r(UG₄U) is 20 μM

5 in strand (120 μ M in nucleotide). In the duplex and triplex melting studies, the nucleic acid concentration is 15 μ M in base pair (30 μ M in nucleotide) or 15 μ M in base triple (45 μ M in nucleotide) and the HXDV concentration, when present, is 15 μ M. The buffer for all the UV melting experiments contains 10 mM EPPS (pH 7.5). In addition, sufficient KCl is added to each solution to bring the total K^+ concentration to either 150 mM for $d(T_2AG_3)_4$ and

10 $p(rA)\bullet p(dT)$, 2 mM for $r(UG_4U)$, 50 mM for ST DNA, 250 mM for $p(dA)\bullet 2p(dT)$, or 20 mM for $p(rA)\bullet 2p(rU)$. Prior to their use in UV melting experiments, all nucleic acid solutions are preheated at 90 °C for 5 min and slowly cooled to room temperature over a period of 4 hr.

The anti-proliferative activity of a compound of the invention may be determined using pharmacological models which are well known to the art, or using Test C described below.

15

Test C. Evaluation of G-quadruplex stabilizers using the MTT assay.

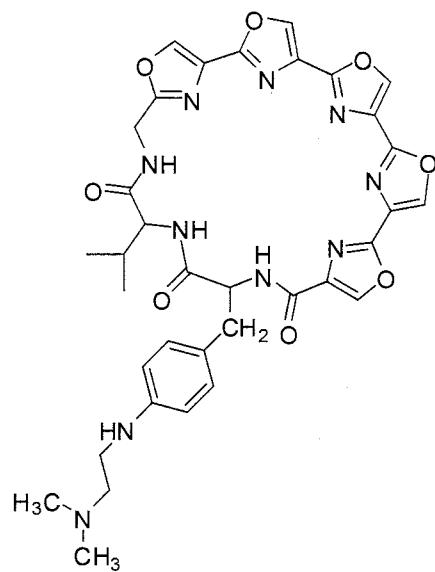
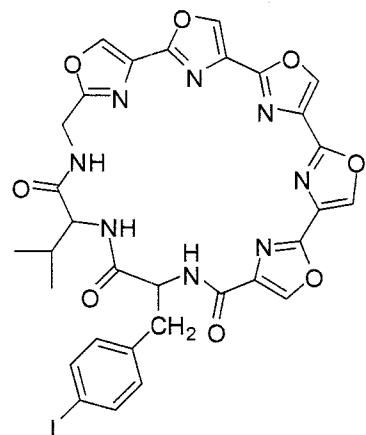
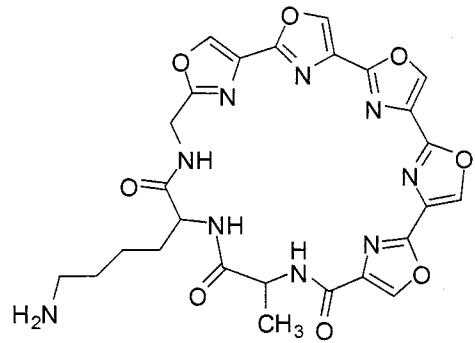
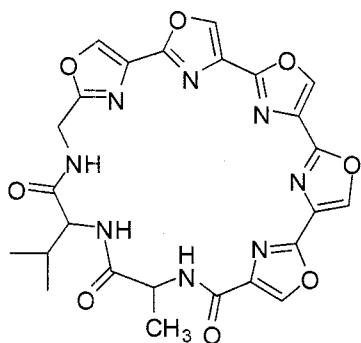
Cell lines are selected based upon one or more factors including data on their relative telomerase activity, varied organ sites, available comparative data, and their ability to form solid tumors in athymic nude mice. The advantage of an MTT assay is that the cytotoxic/cytostatic activities can be readily determined. Cells are cultured for 4 days at 37 °C followed by addition of MTT (3-[4,5-dimethylthiozol-2-yl]-2,5-diphenyltetrazolium bromide (Sigma) (0.1 mg/ml). Cells are treated with MTT for 3 hrs and then dissolved in 100 μ l 100% DMSO. Absorbance is measured at OD₅₇₀ using a microplate reader (Model 3550 UV from BIO-RAD). The MTT value is normalized to OD₅₇₀ of cells treated with Cellfectin alone. Stock solutions of each compound are prepared. MTT assays are performed using spectrometric analysis and 96 well plates.

The invention will now be illustrated by the following non-limiting Examples.

30

5 **Example 1.** Preparation of Representative Compounds of the Invention

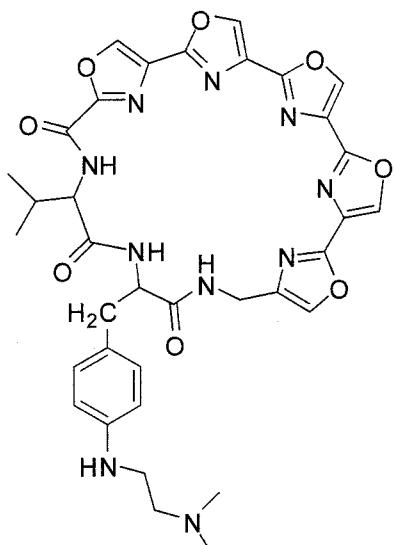
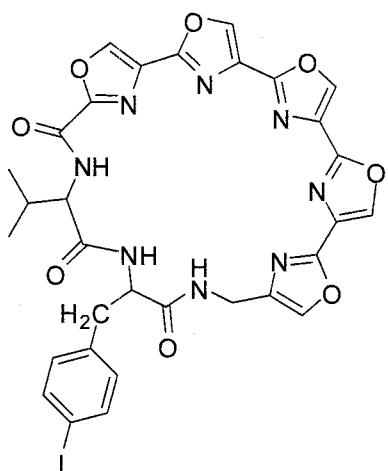
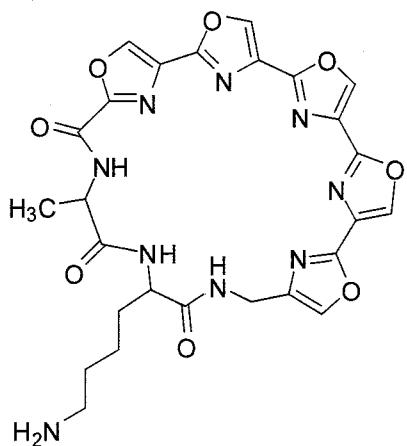
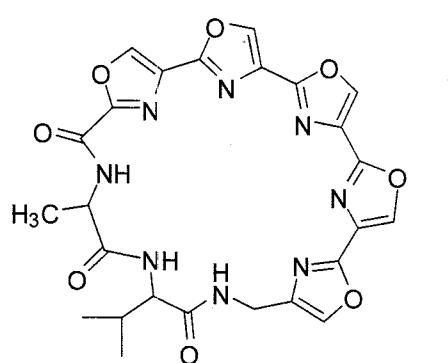
Using procedures similar to those described herein, the following representative compounds of the invention can be prepared.



10

Example 2. Preparation of Representative Compounds of the Invention

Using procedures similar to those described herein, the following representative compounds of the invention can be prepared.



5

Example 3. The following illustrate representative pharmaceutical dosage forms, containing a compound of formula I ('Compound X'), for therapeutic or prophylactic use in humans.

10	<u>(i) Tablet 1</u>	<u>mg/tablet</u>
	Compound X=	100.0
	Lactose	77.5
	Povidone	15.0
	Croscarmellose sodium	12.0
15	Microcrystalline cellulose	92.5
	Magnesium stearate	3.0
		300.0

5	<u>(ii) Tablet 2</u>	<u>mg/tablet</u>
	Compound X=	20.0
	Microcrystalline cellulose	410.0
	Starch	50.0
10	Sodium starch glycolate	15.0
	Magnesium stearate	<u>5.0</u>
		500.0

15	<u>(iii) Capsule</u>	<u>mg/capsule</u>
	Compound X=	10.0
15	Colloidal silicon dioxide	1.5
	Lactose	465.5
	Pregelatinized starch	120.0
	Magnesium stearate	<u>3.0</u>
		600.0

20	<u>(iv) Injection 1 (1 mg/ml)</u>	<u>mg/ml</u>
	Compound X= (free acid form)	1.0
	Dibasic sodium phosphate	12.0
	Monobasic sodium phosphate	0.7
25	Sodium chloride	4.5
	1.0 N Sodium hydroxide solution (pH adjustment to 7.0-7.5)	q.s.
	Water for injection	q.s. ad 1 mL

30	<u>(v) Injection 2 (10 mg/ml)</u>	<u>mg/ml</u>
	Compound X= (free acid form)	10.0
	Monobasic sodium phosphate	0.3
	Dibasic sodium phosphate	1.1
	Polyethylene glycol 400	200.0
35	01 N Sodium hydroxide solution (pH adjustment to 7.0-7.5)	q.s.
	Water for injection	q.s. ad 1 mL

40	<u>(vi) Aerosol</u>	<u>mg/can</u>
	Compound X=	20.0
	Oleic acid	10.0
	Trichloromonofluoromethane	5,000.0
	Dichlorodifluoromethane	10,000.0
	Dichlorotetrafluoroethane	5,000.0

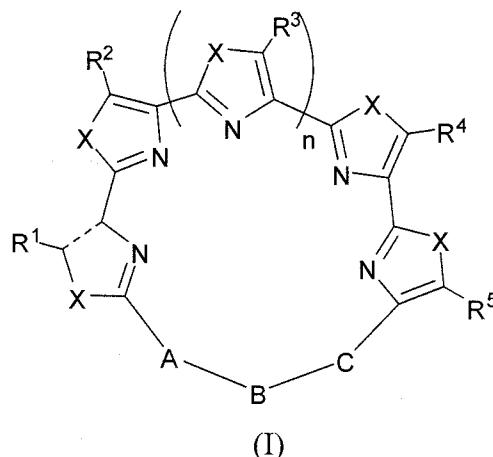
45 The above formulations may be obtained by conventional procedures well known in the pharmaceutical art.

5 All publications, patents, and patent documents are incorporated by reference herein, as though individually incorporated by reference. The invention has been described with reference to various specific and preferred embodiments and techniques. However, it should be understood that many variations and modifications may be made while remaining within the spirit and scope of the invention.

CLAIMS

What is claimed is:

1. A compound of formula (I):

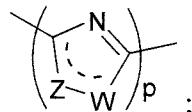


wherein:

the bond represented by ---- is a single or double bond;

A is $(-C(=O)NH-CH(R)-)_X$ or $(-CH(R)-NH-C(=O)-)_X$;

15 B is a group of formula:



C is $(-C(=O)NH-CH(R)-)_Y$ or $(-CH(R)-NH-C(=O)-)_Y$;

n is 0, 1 or 2;

p is 0, 1, or 2;

20 x is 1 or 2;

y is 0, 1 or 2;

provided that the sum of n, p, x and y is 4;

X is O, S or NH;

one of W and Z is O, S or NH and the other of W and Z is CR⁶;

25 each of R¹, R², R³, R⁴, R⁵ and R⁶ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkoxy, aryl or heteroaryl, wherein each (C₁-C₆)alkyl and (C₁-C₆)alkoxy is optionally substituted with OH, (C₁-C₆)alkoxy, (C₁-C₆)alkylthio, aryl, NR⁷R⁸, or -C(=O)NR⁹R¹⁰; and wherein each aryl or heteroaryl is optionally substituted with one or two substituents selected independently from a halo, (C₁-C₆)alkyl, (C₁-C₆)alkoxy, NR⁷R⁸, and NR⁷R⁸(C₁-C₆)alkyl-;

5 each R is independently hydrogen, (C₁-C₆)alkyl, (C₂-C₆)alkenyl, (C₁-C₆)alkoxy, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₂-C₆)alkenyl and (C₁-C₆)alkoxy is optionally substituted with OH, (C₁-C₆)alkoxy, (C₁-C₆)alkylthio, aryl, NR¹¹R¹², or -C(=O)NR¹³R¹⁴; and wherein each aryl or heteroaryl is optionally substituted with one or two substituents selected independently from halo, (C₁-C₆)alkyl, NR¹¹R¹², and NR¹³R¹⁴(C₁-C₆)alkyl-;

10 each of R⁷ and R⁸ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, arylcarbonyl, heteroarylcarbonyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or more NR¹⁵R¹⁶; or R⁷ and R⁸ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

15 each of R⁹ and R¹⁰ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or more NR¹⁵R¹⁶; or R⁹ and R¹⁰ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

20 each of R¹¹ and R¹² is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or more NR¹⁵R¹⁶; or R¹¹ and R¹² together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

25 each of R¹³ and R¹⁴ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or more NR¹⁵R¹⁶; or R¹³ and R¹⁴ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

30 each of R¹⁵ and R¹⁶ is independently hydrogen, (C₁-C₆)alkyl, or (C₁-C₆)alkanoyl; or R¹⁵ and R¹⁶ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

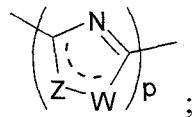
35 or a salt thereof; provided that the compound of formula (I) is not YM-216391.

2. The compound of formula (I) as claimed in claim 1,
wherein:

5 the bond represented by ---- is a single or double bond;

A is $(-\text{C}(=\text{O})\text{NH}-\text{CH}(\text{R})-\text{)}_x$ or $(-\text{CH}(\text{R})-\text{NH}-\text{C}(=\text{O})-\text{)}_x$;

B is a group of formula:



C is $(-\text{C}(=\text{O})\text{NH}-\text{CH}(\text{R})-\text{)}_y$ or $(-\text{CH}(\text{R})-\text{NH}-\text{C}(=\text{O})-\text{)}_y$;

10 n is 0, 1 or 2;

p is 0, 1, or 2;

x is 1 or 2;

y is 0, 1 or 2;

provided that the sum of n, p, x and y is 4;

15 X is O, S or NH;

one of W and Z is O, S or NH and the other of W and Z is CR^6 ;

each of R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently hydrogen, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$, aryl or heteroaryl, wherein each $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$ and $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$ is optionally substituted with OH, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkylthio}$, aryl, NR^7R^8 , or $-\text{C}(=\text{O})\text{NR}^9\text{R}^{10}$; and wherein each aryl or heteroaryl is optionally substituted with one or two substituents selected independently from a halo, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, NR^7R^8 , and $\text{NR}^7\text{R}^8(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$;

20 each R is independently hydrogen, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$, aryl or heteroaryl, wherein each $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$ and $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$ is optionally substituted with OH, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxy}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkylthio}$, aryl, $\text{NR}^{11}\text{R}^{12}$, or $-\text{C}(=\text{O})\text{NR}^{13}\text{R}^{14}$; and wherein each aryl or heteroaryl is 25 optionally substituted with one or two substituents selected independently from halo, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $\text{NR}^{11}\text{R}^{12}$, and $\text{NR}^{13}\text{R}^{14}(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$;

each of R^7 and R^8 is independently hydrogen, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkanoyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxycarbonyl}$, carbamoyl, $\text{N}-(\text{C}_1\text{-}\text{C}_6)\text{alkylaminocarbonyl}$ aryl or heteroaryl, wherein each $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkanoyl}$, or $(\text{C}_1\text{-}\text{C}_6)\text{alkoxycarbonyl}$ is optionally substituted with one or 30 more $\text{NR}^{15}\text{R}^{16}$; or R^7 and R^8 together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

each of R^9 and R^{10} is independently hydrogen, $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkanoyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkoxycarbonyl}$, carbamoyl, $\text{N}-(\text{C}_1\text{-}\text{C}_6)\text{alkylaminocarbonyl}$, aryl or heteroaryl, wherein each $(\text{C}_1\text{-}\text{C}_6)\text{alkyl}$, $(\text{C}_1\text{-}\text{C}_6)\text{alkanoyl}$, or $(\text{C}_1\text{-}\text{C}_6)\text{alkoxycarbonyl}$ is optionally substituted with one or 35 more $\text{NR}^{15}\text{R}^{16}$; or R^9 and R^{10} together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

5 each of R¹¹ and R¹² is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or more NR¹⁵R¹⁶; or R¹¹ and R¹² together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

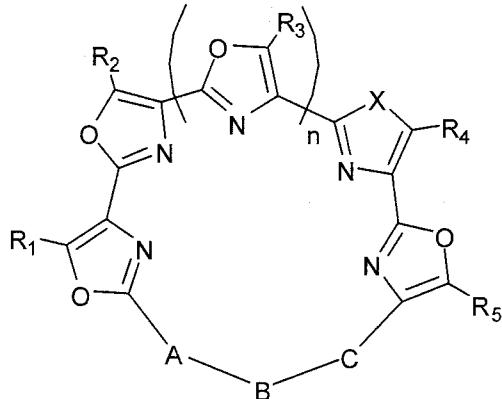
10 each of R¹³ and R¹⁴ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-C₆)alkoxycarbonyl, carbamoyl, N-(C₁-C₆)alkylaminocarbonyl, aryl or heteroaryl, wherein each (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, or (C₁-C₆)alkoxycarbonyl is optionally substituted with one or more NR¹⁵R¹⁶; or R¹³ and R¹⁴ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

15 each of R¹⁵ and R¹⁶ is independently hydrogen, (C₁-C₆)alkyl, or (C₁-C₆)alkanoyl; or R¹⁵ and R¹⁶ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

 or a salt thereof; provided that the compound of formula (I) is not YM-216391.

20 3. The compound as claimed in claim 1 or claim 2, in which the bond represented by ----- is a double bond.

 4. The compound as claimed in any one of claims 1 to 3, which is of the formula (I')



25 (I')

 5. The compound as claimed in any one of claims 1 to 4, in which each X is O.

 6. The compound as claimed in any one of claims 1 to 5, in which each R is selected independently from hydrogen, methyl, isopropyl, 1-methylpropyl, 2-methylpropyl and benzyl.

5 7. A compound as claimed in any one of claims 1 to 5 in which each R is selected independently from (C₁-C₆)alkyl or (C₂-C₆)alkenyl wherein each (C₁-C₆)alkyl and (C₂-C₆)alkenyl, is optionally substituted with NR¹¹R¹².

10 8. A compound as claimed in any one of claims 1 to 5 in which each R is selected independently from aminomethyl, 2-aminoethyl, 3-aminopropyl or 4-aminobutyl.

9. The compound as claimed in any one of claims 1 to 8, in which R¹ is H.

15 10. The compound as claimed in any one of claims 1 to 9, in which R² is H.

11. The compound as claimed in any one of claims 1 to 10, in which R³ is H.

12. The compound as claimed in any one of claims 1 to 11, in which R⁴ is H.

20 13. The compound as claimed in any one of claims 1 to 12, in which R⁵ is H.

14. The compound as claimed in any one of claims 1 to 13, in which each R⁶ is H.

15. The compound as claimed in any one of claims 1 to 14, in which A is

25 -C(=O)NH-CH(R)-.

16. The compound as claimed in any one of claims 1 to 14, in which A is

-C(=O)NH-CH(R)-C(=O)NH-CH(R)-.

30 17. The compound as claimed in any one of claims 1 to 14, in which A is

-C(=O)NH-CH₂-.

18. The compound as claimed in any one of claims 1 to 14, in which A is

-C(=O)NH-CH₂-C(=O)NH-CH₂-.

35

19. The compound as claimed in any one of claims 1 to 14, in which A is

-CH(R)-NH-C(=O)-.

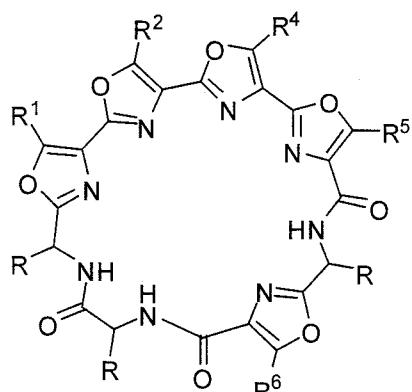
5 20. The compound as claimed in any one of claims 1 to 14, in which A is
-CH(R)-NH-C(=O)-CH(R)-NH-C(=O)-.

21. The compound as claimed in any one of claims 1 to 14, in which A is
-CH₂-NH-C(=O)-.

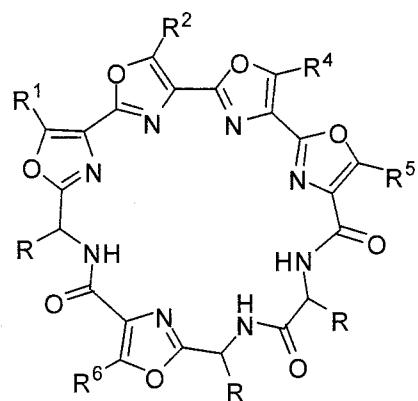
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22. The compound as claimed in any one of claims 1 to 14, in which A is
-CH₂NH-C(=O)-CH₂-NH-C(=O)-.

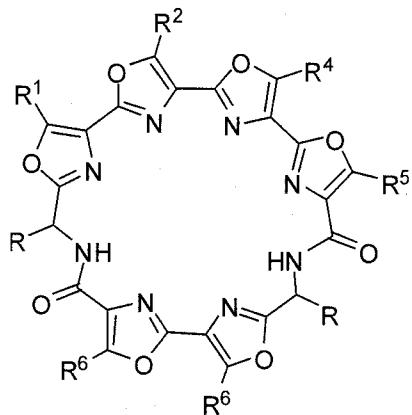
23. The compound as claimed in any one of claims 1 to 13, which is of the formula:



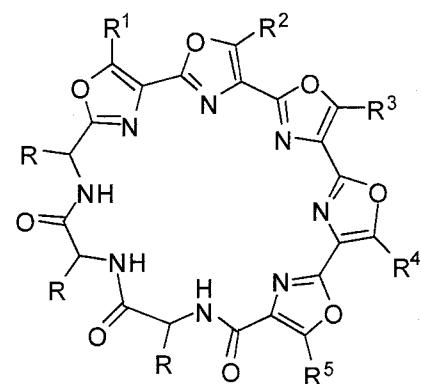
(Ia)



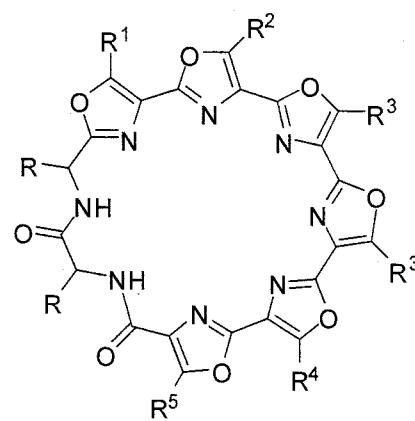
(Ib)



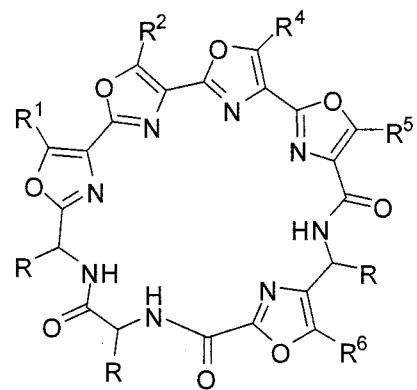
(Ic)



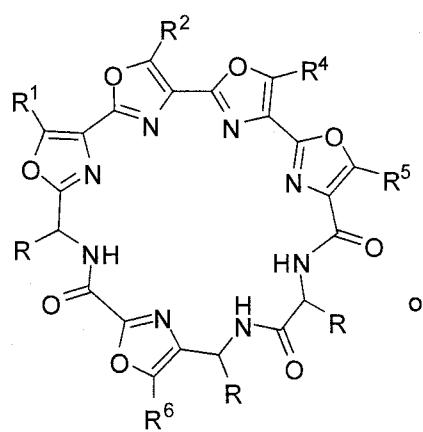
(Id)



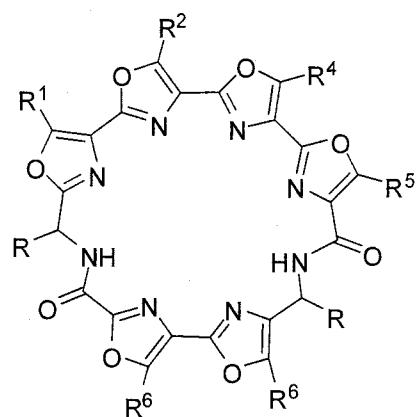
(Ie)



(If)

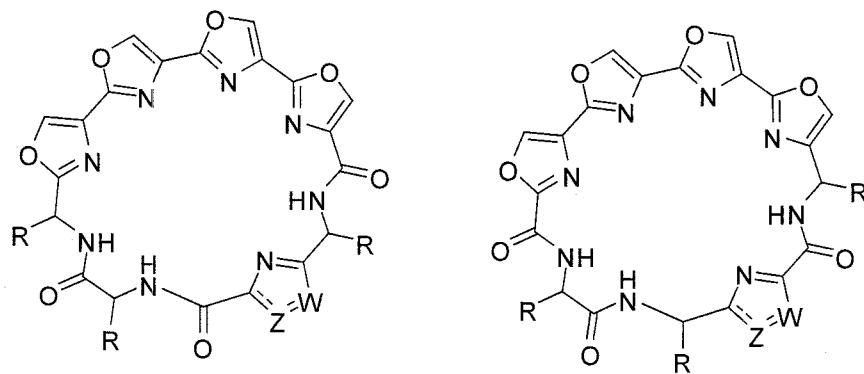


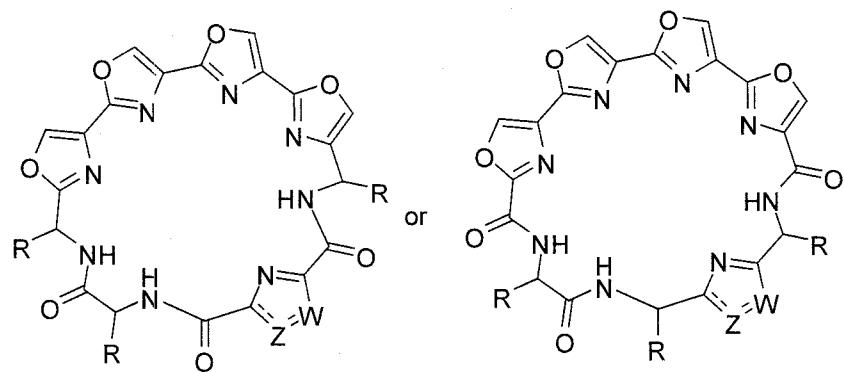
(Ig)



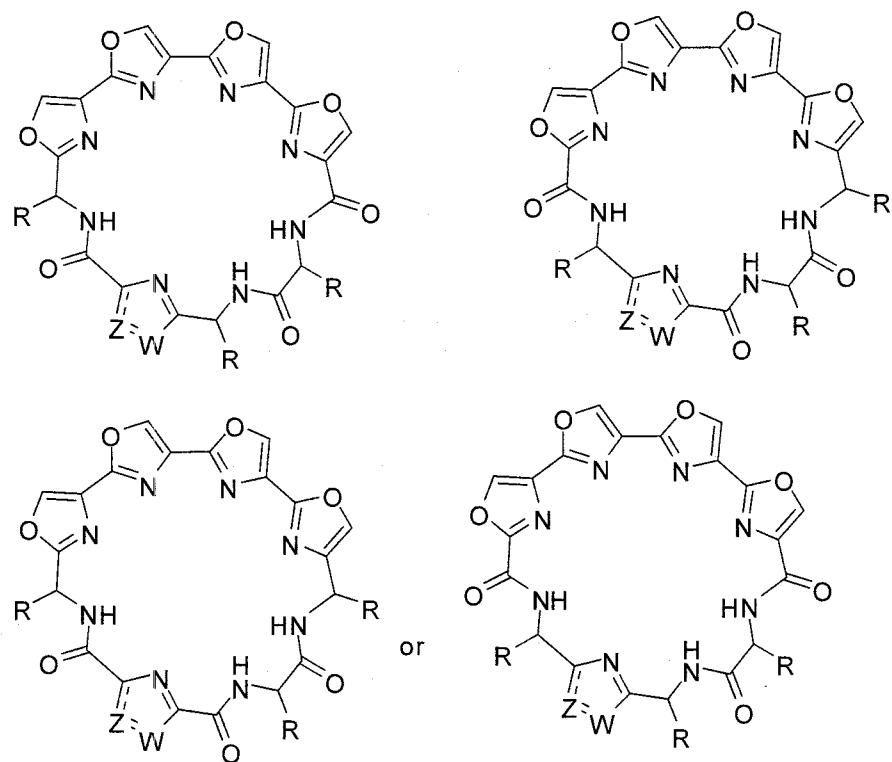
(Ih)

10 24. The compound as claimed in any one of claims 1 to 13, which is of the formula:



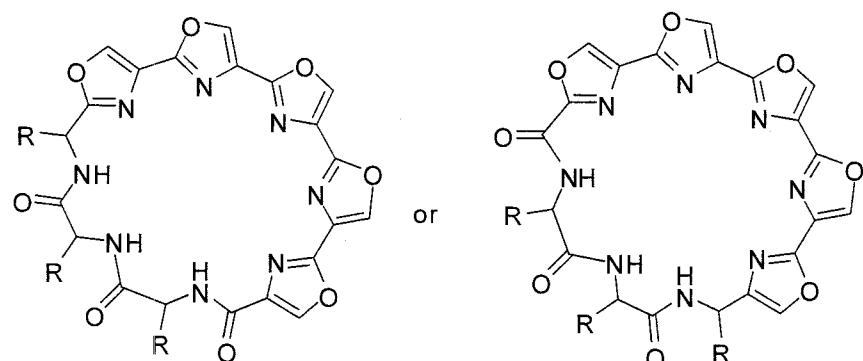


25. The compound as claimed in any one of claims 1 to 13, which is of the formula:

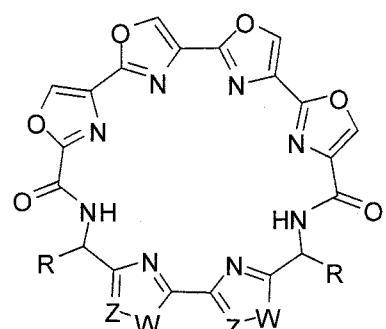
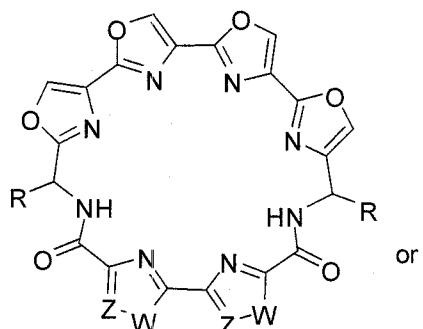
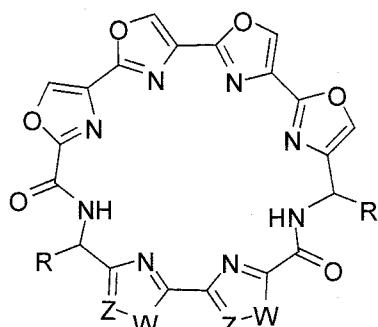
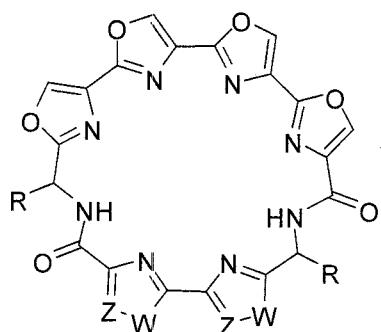


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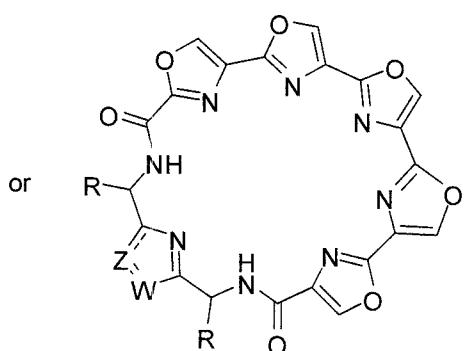
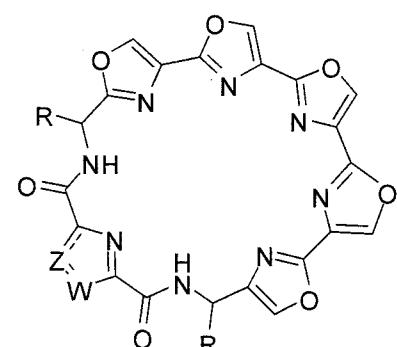
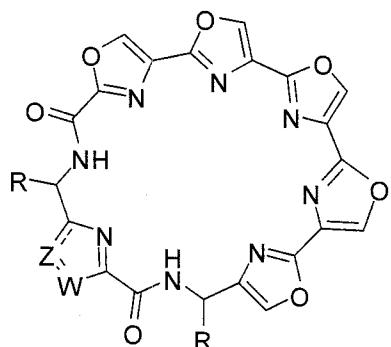
26. The compound as claimed in any one of claims 1 to 13, which is of the formula:



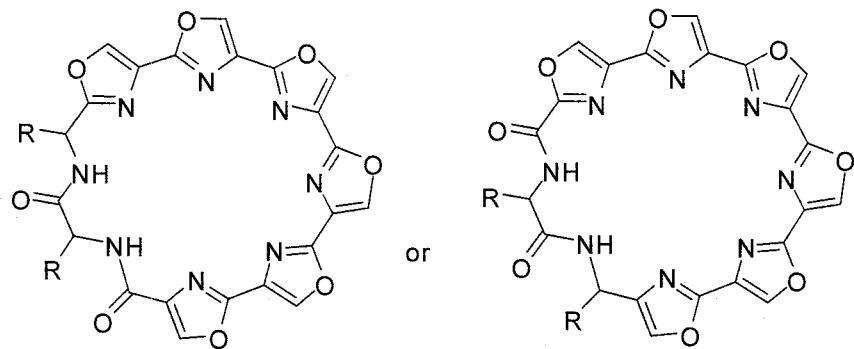
27. The compound as claimed in any one of claims 1 to 13, which is of the formula:



28. The compound as claimed in any one of claims 1 to 13, which is of the formula:



29. The compound as claimed in any one of claims 1 to 13, which is of the formula:



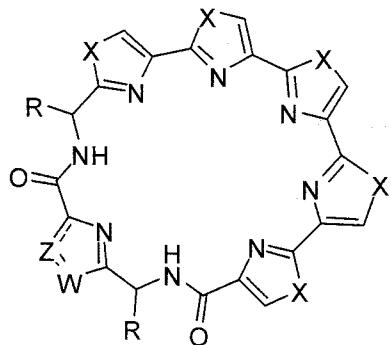
5

30. The compound of any one of claims 24-28 wherein W is O or S and Z is CR⁶.

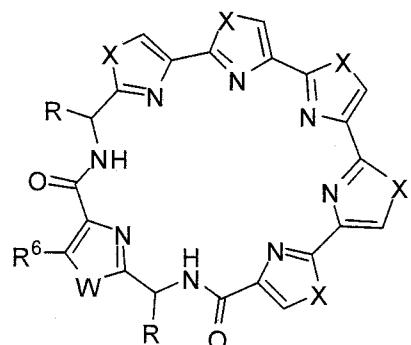
31. The compound of any one of claims 24-28 wherein Z is O or S and W is CR⁶.

10

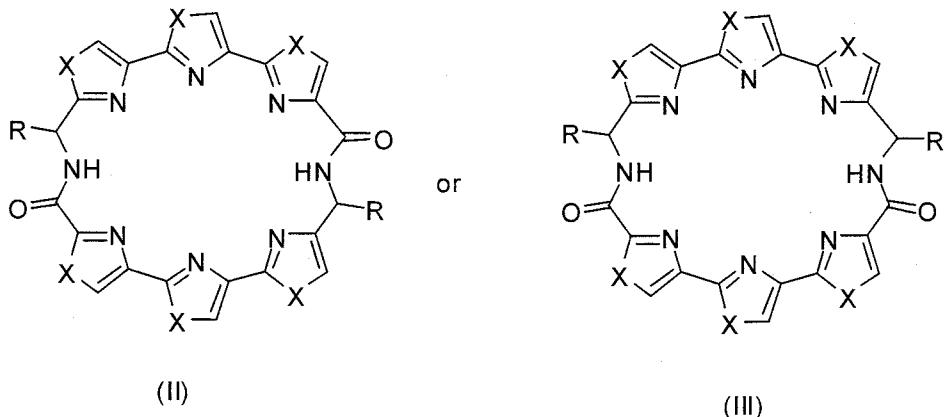
32. The compound of any one of claims 1-14 wherein the compound of formula (I) is not a compound of the following formula:



15 33. The compound of any one of claims 1-14 wherein the compound of formula (I) is not a compound of the following formula:



34. A compound of formula (II) or (III):



wherein:

each X is independently O, S or NH;

each R is independently hydrogen, (C₁-C₆)alkyl, (C₂-C₆)alkenyl, (C₁-C₆)alkoxy, aryl or

10 heteroaryl, wherein each (C₁-C₆)alkyl, (C₂-C₆)alkenyl and (C₁-C₆)alkoxy is optionally substituted with OH, (C₁-C₆)alkoxy, (C₁-C₆)alkylthio, aryl, NR¹¹R¹², or -C(=O)NR¹³R¹⁴; and wherein each aryl or heteroaryl is optionally substituted with one or two substituents selected independently from halo, (C₁-C₆)alkyl, NR¹¹R¹², and NR¹³R¹⁴(C₁-C₆)alkyl-;

each of R¹¹ and R¹² is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-

15 C_6)alkoxycarbonyl, carbamoyl, $N-(C_1-C_6)$ alkylaminocarbonyl, aryl or heteroaryl, wherein each (C_1-C_6) alkyl, (C_1-C_6) alkanoyl, or (C_1-C_6) alkoxycarbonyl is optionally substituted with one or more $NR^{15}R^{16}$; or R^{11} and R^{12} together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring; and

each of R¹³ and R¹⁴ is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkanoyl, (C₁-

20 C_6)alkoxycarbonyl, carbamoyl, $N-(C_1-C_6)$ alkylaminocarbonyl, aryl or heteroaryl, wherein each (C_1-C_6) alkyl, (C_1-C_6) alkanoyl, or (C_1-C_6) alkoxycarbonyl is optionally substituted with one or more $NR^{15}R^{16}$; or R^{13} and R^{14} together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

each of R¹⁵ and R¹⁶ is independently hydrogen, (C₁-C₆)alkyl or (C₁-C₆)alkanoyl; or

25 R¹⁵ and R¹⁶ together with the nitrogen to which they are attached form a pyrrolidino, piperidino, piperazino, morpholino, thiomorpholino, or azepino ring;

or a salt thereof.

35. The compound of claim 34 wherein each R is independently hydrogen, (C₁-C₆)alkyl, (C₁-C₆)alkoxy, aryl or heteroaryl, wherein each (C₁-C₆)alkyl and (C₁-C₆)alkoxy is optionally

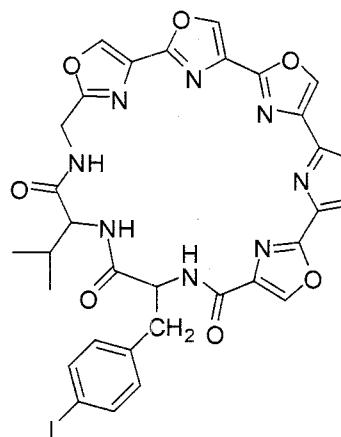
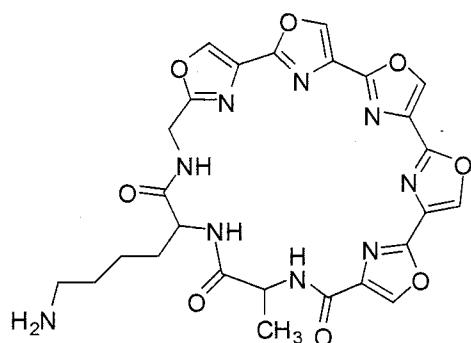
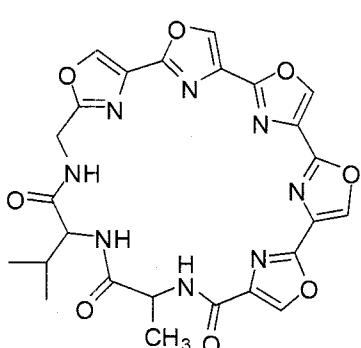
5 substituted with OH, (C₁-C₆)alkoxy, (C₁-C₆)alkylthio, aryl, NR¹¹R¹², or -C(=O)NR¹³R¹⁴; and
wherein each aryl or heteroaryl is optionally substituted with one or two substituents selected
independently from halo, (C₁-C₆)alkyl, NR¹¹R¹², and NR¹³R¹⁴(C₁-C₆)alkyl-;

36. The compound of claim 34 or claim 35 wherein each X is O.

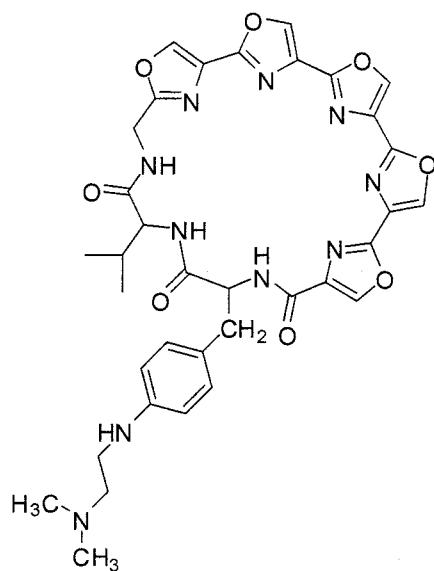
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37. The compound of any one of claims 34-36 wherein each R is H.

38. The compound of claim 1 which is,



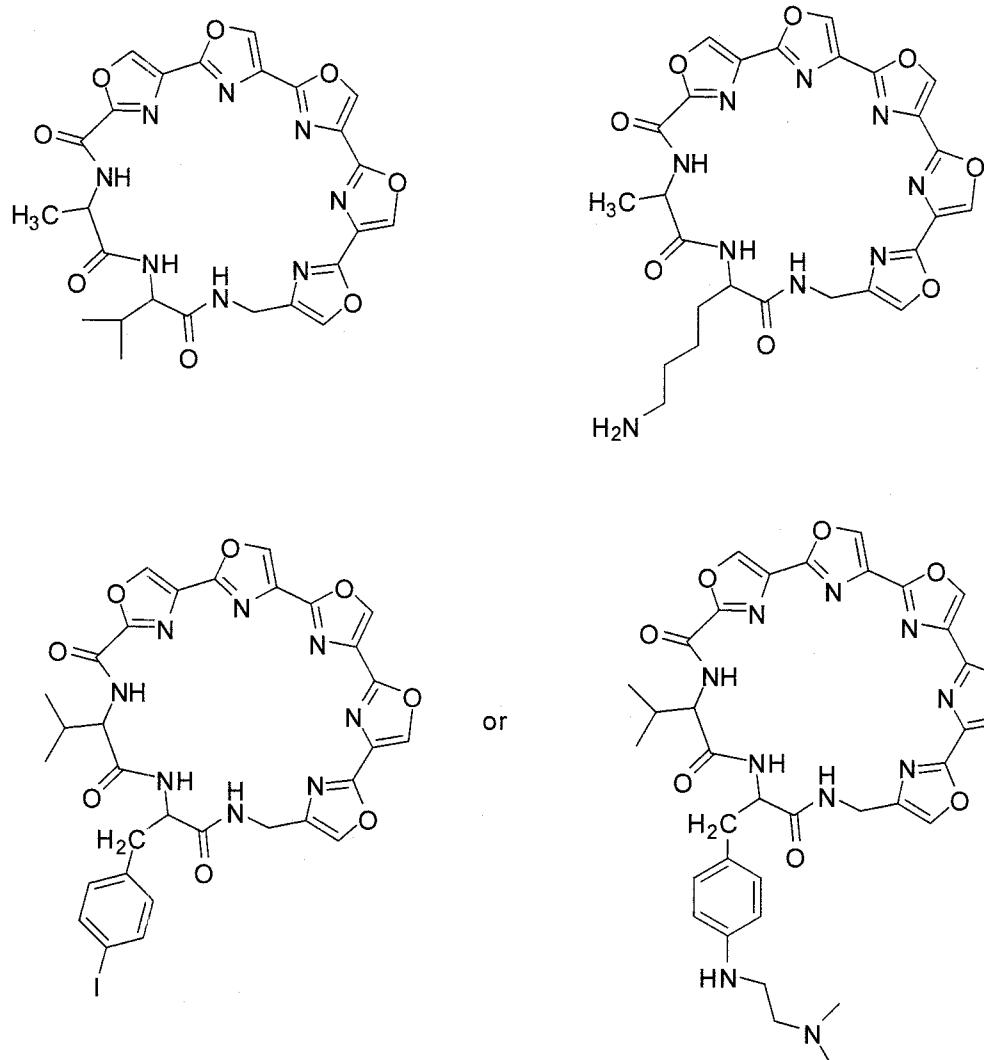
or



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or a salt thereof.

39. The compound of claim 1 which is,



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or a salt thereof.

40. A pharmaceutical composition comprising a compound of formula (I), (II), or (III) as defined in any one of claims 1-39; or a pharmaceutically acceptable salt thereof; and a pharmaceutically acceptable carrier.

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41. A therapeutic method for treating cancer comprising administering to a mammal in need of such therapy, an effective amount of a compound of formula (I), (II), or (III) as defined in any one of claims 1-39, or a pharmaceutically acceptable salt thereof.

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42. A method to stabilize G-quadruplex DNA comprising contacting the G-quadruplex DNA with a compound of formula (I), (II), or (III) as defined in any one of claims 1-39, or a salt thereof.

5 43. A compound as defined in any one of claims 1-39, or a pharmaceutically acceptable salt thereof for use in medical therapy.

10 44. The use of a compound as defined in any one of claims 1-39, or a pharmaceutically acceptable salt thereof for the manufacture of a medicament useful for the treatment of cancer in a mammal.

15 45. A compound as defined in any one of claims 1-39 or a pharmaceutically acceptable salt thereof for use in the prophylactic or therapeutic treatment of cancer.

20 46. The use of claim 44 wherein the cancer is nasopharynx cancer, breast cancer, pancreatic cancer, leukemia, acute leukemia, ovarian cancer, colon cancer, head cancer and neck cancer.

47. The compound of claim 45 wherein the cancer is nasopharynx cancer, breast cancer, pancreatic cancer, leukemia, acute leukemia, ovarian cancer, colon cancer, head cancer and neck cancer.