wherein

C' is a C_2-C_{15} divalent linking group joining polymer chains P^b, wherein C' comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur,

each Z^c is an independent monovalent end group selected from the group consisting of hydrogen and C_1-C_{15} moieties,

each polymer chain P^b consists essentially of cationic carbonate repeat units, wherein i) the cationic polymer comprises a total of 5 to about 45 cationic carbonate repeat units, ii) each of the cationic carbonate repeat units comprises a backbone portion of the polymer chain and a cationic side chain linked to the backbone portion, and iii) the cationic side chain comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of all the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain comprising 6 to 9 carbons.

[0005a] In one aspect, there is provided an antimicrobial cationic polymer of formula (12):

$$Z^c\text{-}P^b\text{-}C'\text{-}P^b\text{-}Z^c \quad (12),$$

wherein

C' is a C_2-C_{15} divalent linking group joining polymer chains P^b, wherein C' comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur,

each Z^c is an independent monovalent end group selected from the group consisting of hydrogen and C_1-C_{15} moieties,

each polymer chain P^b consists essentially of cationic carbonate repeat units, wherein i) the cationic polymer comprises a total of 5 to about 45 cationic carbonate repeat units, ii) each of the cationic carbonate repeat units comprises a backbone portion of the polymer chain and a cationic side chain linked to the backbone portion, and iii) the cationic side chain comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of all the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain comprising 6 to 12 carbons.

[0006] Also disclosed is an antimicrobial cationic polymer of formula (14):

$$Z^c\text{-}P^b\text{-}C''\text{-}P^b\text{-}Z^c \quad (14),$$

wherein

C" is a divalent linking group joining polymer chains P^b, wherein C" comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and iii) a covalently bound form of a compound selected from the group consisting of steroids, non-steroid hormones, vitamins, and drugs,

each Z^c is an independent monovalent end group selected from the group consisting of hydrogen and C_1-C_{15} moieties,

each polymer chain P^b consists essentially of cationic carbonate repeat units, wherein i) the cationic polymer comprises a total of 5 to about 45 cationic carbonate repeat units, ii) each of the cationic carbonate repeat units comprises a backbone portion of the polymer chain and a C_6-C_{25} cationic side chain linked to the backbone portion, and iii) the cationic side chain comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain group comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain group comprising 6 to 9 carbons.

[0006a] In another aspect, there is provided an antimicrobial cationic polymer of formula (14):

Z^c-P^b-C''-P^b-Z^c (14),

wherein

C'' is a divalent linking group joining polymer chains P^b, wherein C'' comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and iii) a covalently bound form of a compound selected from the group consisting of steroids, non-steroid hormones, vitamins, and drugs,

each Z^c is an independent monovalent end group selected from the group consisting of hydrogen and C_1-C_{15} moieties,

each polymer chain P^b consists essentially of cationic carbonate repeat units, wherein i) the cationic polymer comprises a total of 5 to about 45 cationic carbonate repeat units, ii) each of the cationic carbonate repeat units comprises a backbone portion of the polymer chain and a C_6-C_{25} cationic side chain linked to the backbone portion, and iii) the cationic side chain comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain group comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain group comprising 6 to 9 carbons.

[0007] Further disclosed is an antimicrobial cationic random copolymer of formula (16):

Z^c-P^c-C'-P^c-Z^c (16),

wherein

C' is a C_2-C_{15} divalent linking group joining polymer chains P^c, wherein C' comprises i) a first heteroatom linked to a first polymer chain P^c, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and ii) a second heteroatom linked to a second polymer chain P^c, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur,

each Z^c is an independent monovalent end group selected from the group consisting of hydrogen and C_1-C_{15} moieties,

each P^c is a polymer chain consisting essentially of I) about 85 mol% to 99.9 mol% of cationic carbonate repeat units, and II) 0.1 mol% to about 15 mol% of a carbonate repeat unit comprising a covalently bound form of a steroid and/or a vitamin compound, wherein i) the cationic polymer has a total number of repeat units of about 5 to about 45, ii) each of the cationic carbonate repeat units comprises a polymer backbone portion and a C_6-C_{25} cationic side chain portion linked to the polymer backbone portion, and iii) each cationic side chain portion comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain group comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain group comprising 6 to 9 carbons.

[0007a] In another aspect, there is provided an antimicrobial cationic random copolymer of formula (16):

Z^c-P^c-C'-P^c-Z^c (16),

wherein

C' is a C_2-C_{15} divalent linking group joining polymer chains P^b, wherein C' comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur,

each Z^c is an independent monovalent end group selected from the group consisting of hydrogen and C_1-C_{15} moieties,

each P^c is a polymer chain consisting essentially of I) about 85 mol% to 99.9 mol% of cationic carbonate repeat units, and II) 0.1 mol% to about 15 mol% of a carbonate repeat unit comprising a covalently bound form of a steroid and/or a vitamin compound, designated H', wherein i) the cationic polymer has a total number of repeat units of about 5 to about 45, ii) each of the cationic carbonate repeat units comprises a polymer backbone portion and a C_6-C_{25} cationic side chain portion linked to the polymer backbone portion, and iii) each cationic side chain portion comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain group comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain group comprising 6 to 9 carbons.

[0008] Another antimicrobial cationic random copolymer having a structure in accordance with formula (18):

Y^c-P^b-C'-P^b-Y^d (18),

wherein

C' is a C_2-C_{15} divalent linking group joining polymer chains P^b, wherein C' comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur,

Y^c is an independent monovalent first end group selected from the group consisting of hydrogen, groups comprising a covalently bound form of a steroid, and groups comprising a covalently bound form of a vitamin,

Y^d is an independent monovalent second end group selected from the group consisting of hydrogen, groups comprising a covalently bound form of a steroid, and groups comprising a covalently bound form of a vitamin,

each polymer chain P^b consists essentially of cationic carbonate repeat units, wherein i) the cationic polymer comprises a total of 5 to about 45 cationic carbonate repeat units, ii) each of the cationic carbonate repeat units comprises a backbone portion of the polymer chain and a cationic side chain linked to the backbone portion, and iii) the cationic side chain comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of all the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain comprising 6 to 9 carbons.

[0008a] In another aspect, there is provided an antimicrobial cationic polymer has a structure in accordance with formula (18):

Y^c-P^b-C'-P^b-Y^d (18),

wherein

C' is a C_2-C_{15} divalent linking group joining polymer chains P^b, wherein C' comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur,

Y^c is an independent monovalent first end group selected from the group consisting of hydrogen, groups comprising a covalently bound form of a steroid, and groups comprising a covalently bound form of a vitamin,

Y^d is an independent monovalent second end group selected from the group consisting of hydrogen, groups comprising a covalently bound form of a steroid, and groups comprising a covalently bound form of a vitamin,

each polymer chain P^b consists essentially of cationic carbonate repeat units, wherein i) the cationic polymer comprises a total of 5 to about 45 cationic carbonate repeat units, ii) each of the cationic carbonate repeat units comprises a backbone portion of the polymer chain and a cationic side chain linked to the backbone portion, and iii) the cationic side chain comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of all the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain comprising 6 to 9 carbons.

[0008b] In another aspect, there is provided an aqueous composition for killing a microbe comprising the cationic polymer as defined herein.

[0008c] In another aspect, there is provided a method of killing microbe, comprising contacting the microbe with the cationic polymer as defined herein.

[0009] Also disclosed is a method comprising,

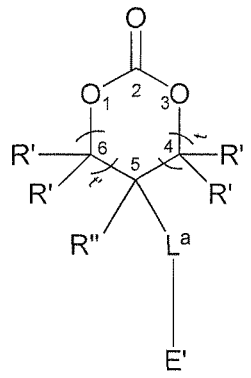
forming a polycarbonate by an organocatalyzed ring opening polymerization (ROP) of a cyclic carbonate monomer, wherein the ROP is initiated by a di-nucleophilic compound selected from the group consisting of steroids, vitamins, compounds comprising a covalently bound form of the foregoing steroids and vitamins, and combinations thereof;

optionally endcapping the polycarbonate; and

treating the polycarbonate with a quaternizing agent, thereby forming an antimicrobial cationic polymer;

and wherein

the cyclic carbonate monomer has the structure formula (15):



(15),

wherein

the ring atoms are shown numbered 1 to 6,

t is a positive integer having a value of 0 to 2,

t' is a positive integer having a value of 0 to 2,

t and t' cannot both be zero,

L^a is a divalent linking group comprising 3 or more carbons,

E' is a group capable of reacting to form a cationic moiety ($Q'(R^a)_{u'}$) linked to L^a, wherein Q' is a tetravalent positive-charged nitrogen or phosphorus, u' has a value of 1 to 3, and each R^a is an independent radical having a valency of 1 to 3, wherein each R^a comprises 1 or more carbons,

each R' is an independent monovalent radical selected from the group consisting of hydrogen and methyl, and

R" is a monovalent radical selected from the group consisting of hydrogen, methyl and ethyl.

[0009a] In another aspect, there is provided a method comprising,

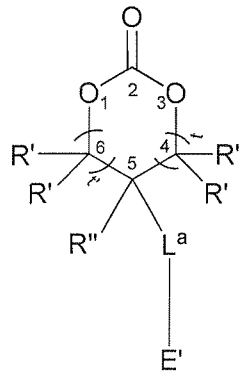
forming a polycarbonate by an organocatalyzed ring opening polymerization (ROP) of a cyclic carbonate monomer, wherein the ROP is initiated by a di-nucleophilic compound selected from the group consisting of steroids, vitamins, compounds comprising a covalently bound form of the foregoing steroids and vitamins, and combinations thereof;

optionally endcapping the polycarbonate; and

treating the polycarbonate with a quaternizing agent, thereby forming an antimicrobial cationic polymer;

and wherein

the cyclic carbonate monomer has the structure formula (15):



(15),

wherein

the ring atoms are shown numbered 1 to 6,

t is a positive integer having a value of 0 to 2,

t' is a positive integer having a value of 0 to 2,

t and t' cannot both be zero,

L^a is a divalent linking group comprising 3 or more carbons,

E' is a group capable of reacting to form a cationic moiety ($Q'(R^a)_{u'}$) linked to L^a, wherein Q' is a tetravalent positive-charged nitrogen or phosphorus, u' has a value of 1 to 3, and each R^a is an independent radical having a valency of 1 to 3, wherein each R^a comprises 1 or more carbons,

each R' is an independent monovalent radical selected from the group consisting of hydrogen and methyl, and

R" is a monovalent radical selected from the group consisting of hydrogen, methyl and ethyl.

[0010] The above-described and other features and advantages of the present ~~invention~~ disclosure will be appreciated and understood by those skilled in the art from the following detailed description, drawings, and appended claims.

CLAIMS

What is claimed is:

1. An antimicrobial cationic polymer of formula (12):

Z^c-P^b-C'-P^b-Z^c (12),

wherein

C' is a C_2-C_{15} divalent linking group joining polymer chains P^b, wherein C' comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur,

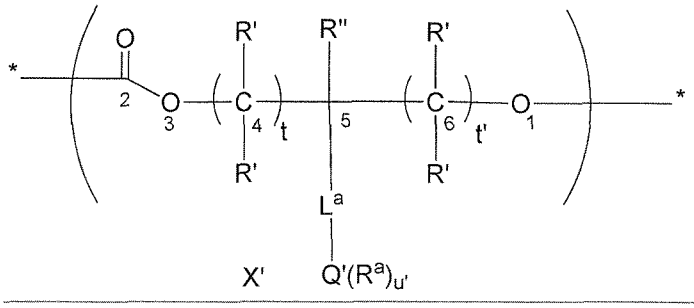
each Z^c is an independent monovalent end group selected from the group consisting of hydrogen and C_1-C_{15} moieties,

each polymer chain P^b consists essentially of cationic carbonate repeat units, wherein i) the cationic polymer comprises a total of 5 to about 45 cationic carbonate repeat units, ii) each of the cationic carbonate repeat units comprises a backbone portion of the polymer chain and a cationic side chain linked to the backbone portion, and iii) the cationic side chain comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of all the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain comprising 6 to ~~9~~ 12 carbons.

2. The cationic polymer of claim 1, wherein the cationic carbonate repeat units have a structure according to formula (2):



(2),

wherein

L^a-$Q'(R^a)_{u'}$ is a C_6-C_{25} cationic side chain comprising a quaternary ammonium group and/or quaternary phosphonium group, wherein L^a is a divalent linking group comprising at least 3 carbons, Q' is a tetravalent positive-charged nitrogen or phosphorus, u' has a value of 1 to 3, each R^a is an independent radical having a valency of 1 to 3, and each R^a comprises at least 1 carbon,

each R' is an independent monovalent radical selected from the group consisting of hydrogen, halogens, methyl, and ethyl,

R" is a monovalent radical selected from the group consisting of hydrogen, halogens, and alkyl groups comprising 1 to 6 carbons,

t is a positive integer having a value of 0 to 2,

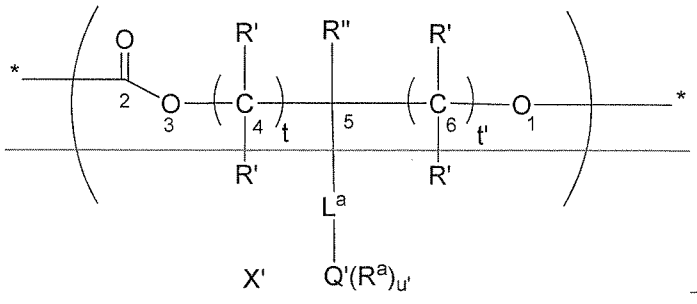
t' is a positive integer having a value of 0 to 2,

t and t' cannot both be zero, and

X' is a negative-charged ion.

3. The cationic polymer of claim ~~1~~2, wherein the first cationic carbonate repeat units have ~~a~~ the cationic side chain L^a-$Q'(R^a)_{u'}$ comprising 13 to about 25 carbons, and the second cationic carbonate repeat units have ~~a~~ the cationic side chain L^a-$Q'(R^a)_{u'}$ comprising 6 to 12 carbons.

3.4. The cationic polymer of claim ~~1~~2, wherein ~~the cationic repeat units have a structure according to formula (2):~~



~~(2),~~

~~wherein~~

~~L^a-Q'$(R^a)_{u'}$ is a C_6-C_{25} cationic side chain comprising a quaternary ammonium group and/or quaternary phosphonium group, wherein L^a is a divalent linking group comprising at least 3 carbons, Q' is a tetravalent positive-charged nitrogen or phosphorus, u' has a value of 1 to 3, each R^a is an independent radical having a valency of 1 to 3, and each R^a comprises at least 1 carbon,~~

~~each R' is an independent monovalent radical selected from the group consisting of hydrogen, halogens, methyl, and ethyl,~~

~~R'' is a monovalent radical selected from the group consisting of hydrogen, halogens, and alkyl groups comprising 1 to 6 carbons,~~

~~t is a positive integer having a value of 0 to 2,~~

~~t' is a positive integer having a value of 0 to 2,~~

~~t and t' cannot both be zero, and~~

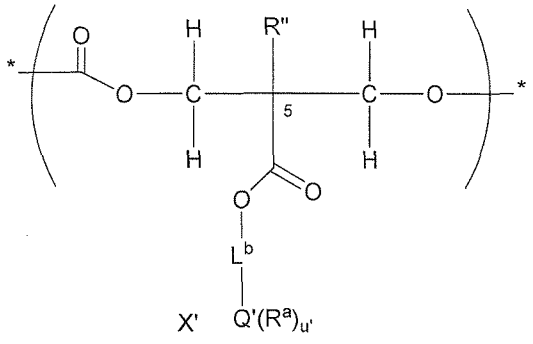
~~X' is a negative-charged ion;~~

~~and wherein~~

the first cationic carbonate repeat units have ~~a~~ the cationic side chain L^a-Q'$(R^a)_{u'}$ comprising 10 to about 25 carbons, and

the second cationic carbonate repeat units have ~~a~~ the cationic side chain L^a-Q'$(R^a)_{u'}$ comprising 6 to 9 carbons.

4.5. The cationic polymer of claim 1, wherein the cationic repeat units have a structure according to formula (3):



(3),

wherein

L^b-$Q'(R^a)_{u'}$ is a C_5-C_{24} cationic moiety comprising a quaternary ammonium group and/or quaternary phosphonium group, wherein L^b is a divalent linking group comprising at least 2 carbons, Q' is a tetravalent positive-charged nitrogen or phosphorus, u' has a value of 1 to 3, each R^a is an independent radical having a valency of 1 to 3, and each R^a comprises at least 1 carbon,

R" is a monovalent radical selected from the group consisting of hydrogen, halogens, and alkyl groups comprising 1 to 6 carbons, and

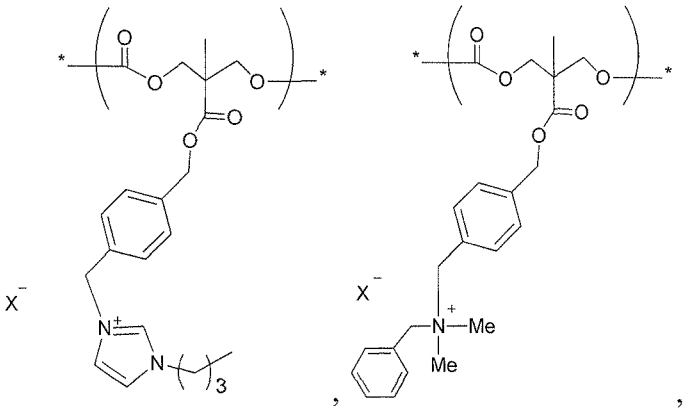
X' is a negative-charged ion;

and wherein

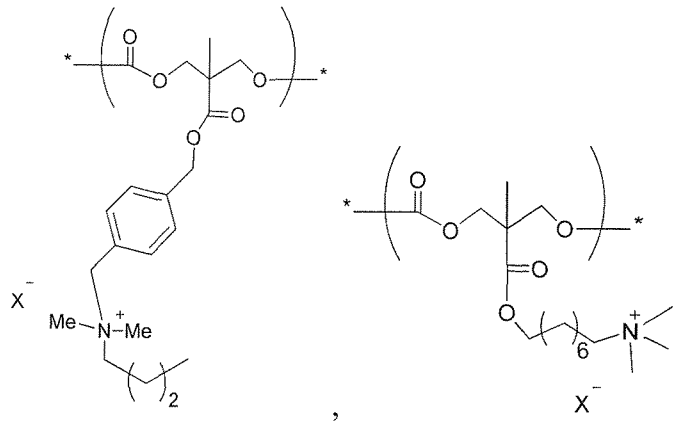
the first cationic carbonate repeat units have a cationic side chain C(=O)O-L^b-$Q'(R^a)_{u'}$ comprising 10 to about 25 carbons, and

the second cationic carbonate repeat units have a cationic side chain C(=O)O-L^b-$Q'(R^a)_{u'}$ comprising 6 to 9 carbons.

~~5.~~6. The cationic polymer of claim 45, wherein the first cationic carbonate repeat units have a structure selected from the group consisting of

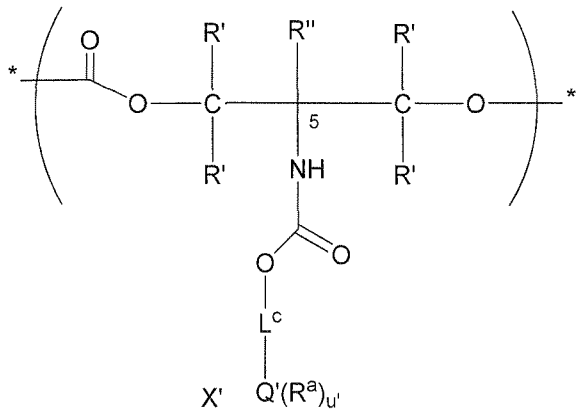


,



and combinations thereof, wherein X^- is a negative-charged ion.

6.7. The cationic polymer of claim 1, wherein the cationic repeat units have a structure according to formula (4):



(4),

wherein

L^c-$Q'(R^a)_{u'}$ is a C_5-C_{24} cationic moiety comprising a quaternary ammonium group and/or quaternary phosphonium group, wherein L^c is a divalent linking group comprising at least 2 carbons, Q' is a tetravalent positive-charged nitrogen or phosphorus, u' has a value of 1 to 3, and each R^a is an independent radical having a valency of 1 to 3, wherein each R^a comprises at least 1 carbon,

each R' is an independent monovalent radical selected from the group consisting of hydrogen, halogens, methyl, and ethyl,

R" is a monovalent radical selected from the group consisting of hydrogen, halogens, and alkyl groups comprising 1 to 6 carbons, and

X' is a negative-charged ion;

and wherein

the first cationic carbonate repeat units have a cationic side chain NHC(=O)O-L^c-$Q'(R^a)_{u'}$ comprising 10 to about 25 carbons, and

the second cationic carbonate repeat units have a cationic side chain group NHC(=O)O-L^c-$Q'(R^a)_{u'}$ comprising 6 to 9 carbons.

~~7.~~ 8. The cationic polymer of claim 1, wherein the cationic polymer is effective in killing a microbe selected from the group consisting of Staphylococcus epidermidis (S. epidermidis), Staphylococcus aureus (S. aureus), Escherichia coli (E. coli), Pseudomonas aeruginosa (P. aeruginosa), Candida albicans (C. albicans), Methicillin-resistant Staphylococcus aureus (MRSA), Vancomycin-resistant Enterococcus (VRE), Acinetobacter baumannii (A. baumannii), Cryptococcus neoformans (C. neoformans), Klebsiella pneumoniae (K. pneumoniae), and combinations thereof.

~~8.~~ 9. An antimicrobial cationic polymer of formula (14):

Z^c-P^b-C"-P^b-Z^c (14),

wherein

C" is a divalent linking group joining polymer chains P^b, wherein C" comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and iii) a covalently bound form of a compound selected from the group consisting of steroids, non-steroid hormones, vitamins, and drugs,

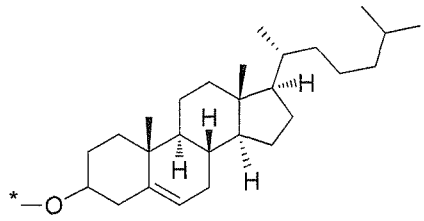
each Z^c is an independent monovalent end group selected from the group consisting of hydrogen and C_1-C_{15} moieties,

each polymer chain P^b consists essentially of cationic carbonate repeat units, wherein i) the cationic polymer comprises a total of 5 to about 45 cationic carbonate repeat units, ii) each of the cationic carbonate repeat units comprises a backbone portion of the polymer chain and a C_6-C_{25} cationic side chain linked to the backbone portion, and iii) the cationic side chain comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain group comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain group comprising 6 to 9 carbons.

~~9.~~10. The cationic polymer of claim ~~8~~9, wherein C" comprises a cholesteryl group:



~~10.~~11. The cationic polymer of claim ~~8~~9, wherein C" comprises a covalently bound form of vitamin.

~~11.~~12. The cationic polymer of claim ~~8~~9, wherein the vitamin is selected from the group consisting of vitamin E compounds, vitamin D compounds, and combinations thereof.

~~12.~~13. An antimicrobial cationic random copolymer of formula (16):

Z^c-P^c-C'-P^c-Z^c (16),

wherein

C' is a C_2-C_{15} divalent linking group joining polymer chains P^b, wherein C' comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur,

each Z^c is an independent monovalent end group selected from the group consisting of hydrogen and C_1-C_{15} moieties,

each P^c is a polymer chain consisting essentially of I) about 85 mol% to 99.9 mol% of cationic carbonate repeat units, and II) 0.1 mol% to about 15 mol% of a carbonate repeat unit comprising a covalently bound form of a steroid and/or a vitamin compound, designated H', wherein i) the cationic polymer has a total number of repeat units of about 5 to about 45, ii) each of the cationic carbonate repeat units comprises a polymer backbone portion and a C_6-C_{25} cationic side chain portion linked to the polymer backbone portion, and iii) each cationic side chain portion comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain group comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain group comprising 6 to 9 carbons.

~~13.~~14. The random copolymer of claim ~~12~~13, wherein H' is a covalently bound form of alpha-tocopherol.

~~14.~~15. The random copolymer of claim ~~12~~13, wherein H' is a covalently bound form of ergocalciferol.

~~15.~~16. An antimicrobial cationic polymer has a structure in accordance with formula (18):

$$Y^c\text{-}P^b\text{-}C'\text{-}P^b\text{-}Y^d \quad (18),$$

wherein

C' is a C_2-C_{15} divalent linking group joining polymer chains P^b, wherein C' comprises i) a first heteroatom linked to a first polymer chain P^b, wherein the first heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur, and ii) a second heteroatom linked to a second polymer chain P^b, wherein the second heteroatom is selected from the group consisting of nitrogen, oxygen, and sulfur,

Y^c is an independent monovalent first end group selected from the group consisting of hydrogen, groups comprising a covalently bound form of a steroid, and groups comprising a covalently bound form of a vitamin,

Y^d is an independent monovalent second end group selected from the group consisting of hydrogen, groups comprising a covalently bound form of a steroid, and groups comprising a covalently bound form of a vitamin,

each polymer chain P^b consists essentially of cationic carbonate repeat units, wherein i) the cationic polymer comprises a total of 5 to about 45 cationic carbonate repeat units, ii) each of the cationic carbonate repeat units comprises a backbone portion of the polymer chain and a cationic side chain linked to the backbone portion, and iii) the cationic side chain comprises a positive-charged heteroatom Q' of a quaternary ammonium group and/or quaternary phosphonium group,

about 25% to 100% of all the cationic carbonate repeat units of the cationic polymer, designated first cationic carbonate repeat units, have a cationic side chain comprising 10 to about 25 carbons, and

0% to about 75% of the cationic carbonate repeat units of the cationic polymer, designated second cationic carbonate repeat units, have a cationic side chain comprising 6 to 9 carbons.

~~16.~~17. An aqueous composition for killing a microbe comprising the cationic polymer of claim 1.

~~17.~~18. The composition of claim ~~16~~17, wherein the composition can be administered by injection.

~~18.~~19. The composition of claim ~~16~~17, wherein the concentration of the cationic polymer is below the critical micelle concentration of the cationic polymer.

~~19.~~20. A method of killing a microbe, comprising contacting the microbe with the cationic polymer of claim 1.

~~20.~~21. A method comprising,

forming a polycarbonate by an organocatalyzed ring opening polymerization (ROP) of a cyclic carbonate monomer, wherein the ROP is initiated by a di-

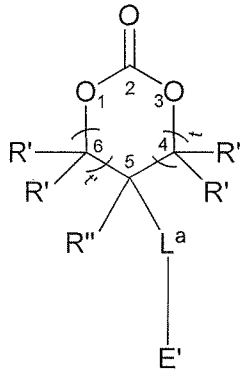
nucleophilic compound selected from the group consisting of steroids, vitamins, compounds comprising a covalently bound form of the foregoing steroids and vitamins, and combinations thereof;

optionally endcapping the polycarbonate; and

treating the polycarbonate with a quaternizing agent, thereby forming an antimicrobial cationic polymer;

and wherein

the cyclic carbonate monomer has the structure formula (15):



(15),

wherein

the ring atoms are shown numbered 1 to 6,

t is a positive integer having a value of 0 to 2,

t' is a positive integer having a value of 0 to 2,

t and t' cannot both be zero,

L^a is a divalent linking group comprising 3 or more carbons,

E' is a group capable of reacting to form a cationic moiety ($Q'(R^a)_{u'}$) linked to L^a, wherein Q' is a tetravalent positive-charged nitrogen or phosphorus, u' has a value of 1 to 3, and each R^a is an independent radical having a valency of 1 to 3, wherein each R^a comprises 1 or more carbons,

each R' is an independent monovalent radical selected from the group consisting of hydrogen and methyl, and

R" is a monovalent radical selected from the group consisting of hydrogen, methyl and ethyl.

~~21.~~22. The method of claim ~~20~~21, wherein the quaternizing agent is selected from the group consisting of tertiary amine, tertiary phosphine, and combinations thereof.

~~22.~~23. The method of claim ~~20~~21, wherein the quaternizing agent is a tertiary phosphine.

~~23.~~24. The method of claim ~~20~~21, wherein the initiator is Chol-MPA:

