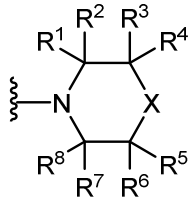
Claims

1. A composition comprising:

a solid surface; and

a polymer covalently or non-covalently bound to the solid surface;

wherein the polymer comprises a backbone and a plurality of pendant moieties of formula (I):



(I)

wherein:

X is selected from O, S, S(O), and $S(O)_2$; and

R^1, R^2, R^3, R^4, R^5, R^6, R^7, and R^8 are each independently selected from hydrogen, C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_1-C_6 haloalkyl, C_3-C_6 cycloalkyl, aryl, heteroaryl, heterocyclyl, halo, cyano, nitro, $-OR^a$, $-SR^b$, $-C(O)OR^c$, $-C(O)NR^dR^e$, $-OC(O)NR^fR^g$, $-NR^hC(O)NR^iR^j$, and $-NR^hC(S)NR^iR^j$, wherein each R^a, R^b, R^c, R^d, R^e, R^f, R^g, R^h, R^i, and R^j is independently selected from hydrogen, C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_1-C_6 haloalkyl, C_3-C_6 cycloalkyl, and aryl;

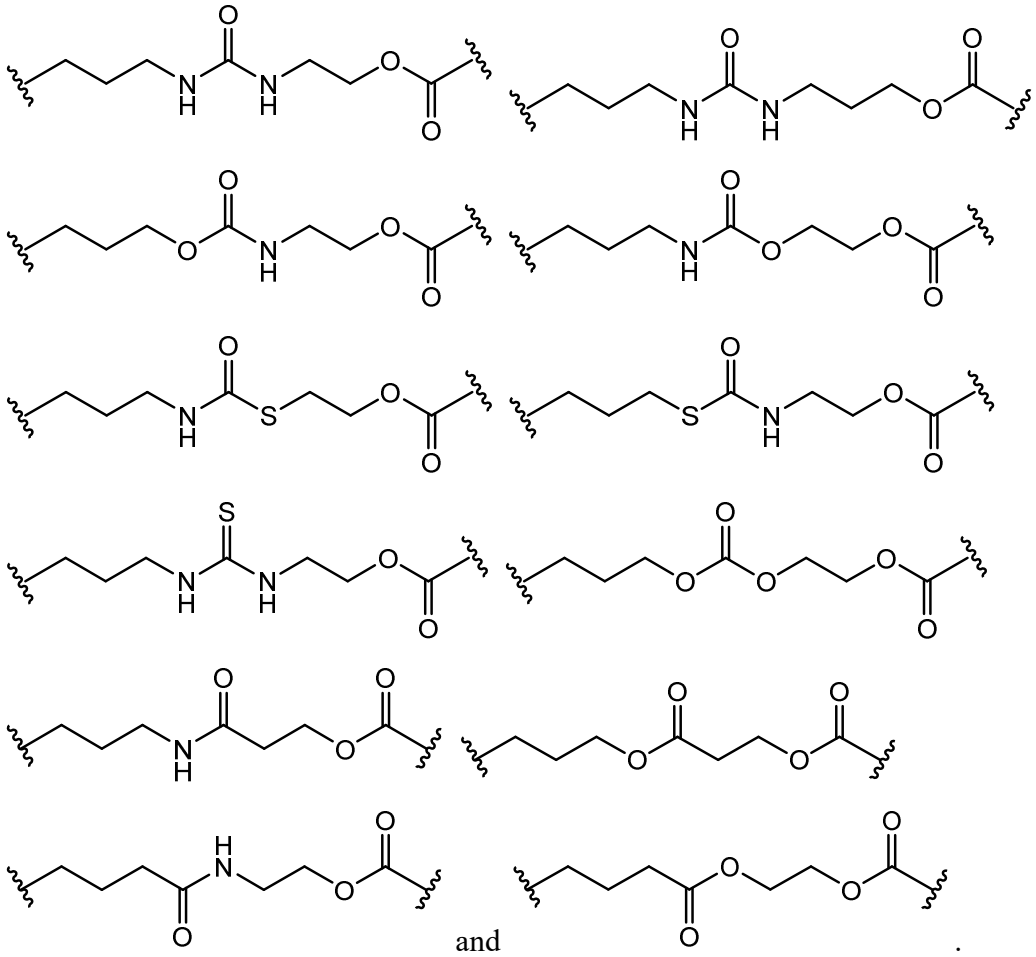
wherein each pendant moiety of formula (I) is bound to the backbone via a linker having a structure:

$$–(CH_2)_{n1}\text{-}Z^1\text{-}(CH_2)_{n2}\text{-}Z^2–$$

wherein n1 and n2 are each independently selected from 1, 2, 3, 4, 5, 6, 7, and 8, and Z^1 and Z^2 are each independently selected from -NHC(O)NH-, -C(O)NH-, -OC(O)NH-, -OC(O)O-, -NHC(O)S-, -NHC(S)NH-, -O-, and -C(O)O-.

2. The composition of claim 1, wherein the solid surface comprises a material selected from silica, glass, a polymer, and a metal, and wherein the solid surface is in the form of a bead, a resin, a magnetic particle, a membrane, a vial, a plate, a film, a tube, a syringe, a cartridge, a cassette, a pipette tip, a microfluidic cartridge, or a cuvette.

3. The composition of claim 1 or claim 2, wherein the linker is selected from:



and

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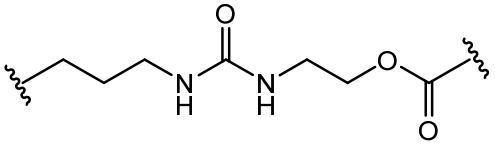
4. The composition of claim 3, wherein the linker is:



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5. The composition of any one of claims 1-4, wherein X is O, and wherein R^1, R^2, R^3, R^4, R^5, R^6, R^7, and R^8 are each hydrogen.

6. The composition of any one of claims 1-5, wherein the polymer further comprises one or more (meth)acrylate or (meth)acrylamide monomer units, wherein at least one (meth)acrylate or (meth)acrylamide monomer unit comprises a trialkoxysilyl group.

7. The composition of any one of claims 1-6, wherein the polymer is covalently bound to the solid surface.

8. The composition of any one of claims 1-6, wherein the polymer is non-covalently bound to the solid surface.

9. A method of isolating a nucleic acid from a sample, comprising:

(a) providing a sample containing a nucleic acid;

(b) contacting the sample with a composition of any one of claims 1-8 at a pH of less than about 8.0, wherein the nucleic acid binds to the composition to provide a nucleic acid bound composition; and

(c) separating the nucleic acid bound composition from the sample.

10. The method of claim 9, wherein step (b) is conducted at a pH of about 6.0 to about 7.5, and wherein step (b) comprises contacting the sample with the composition for about 1 minute to about 5 minutes.

11. The method of claim 9 or claim 10, further comprising a step of contacting the nucleic acid bound composition with an elution solution for about 1 minute to about 5 minutes, to release the nucleic acid from the composition, wherein the elution solution comprises an aqueous buffer and has a pH of about 8.5 to about 9.5.

12. The method of claim 9 or claim 10, further comprising performing a polymerase chain reaction on the nucleic acid bound composition.

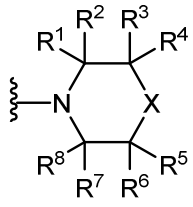
13. A method of isolating a nucleic acid from a sample, comprising:

(a) providing a sample containing a nucleic acid;

(b) contacting the sample with a polymer at a pH of less than about 8.0, wherein the nucleic acid binds to the polymer to provide a nucleic acid bound polymer; and

(c) separating the nucleic acid bound polymer from the sample,

wherein the polymer comprises a backbone and a plurality of pendant moieties of formula (I):



(I)

wherein:

X is selected from O, S, S(O), and $S(O)_2$; and

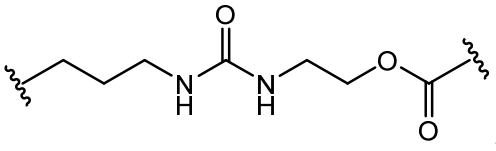
R^1, R^2, R^3, R^4, R^5, R^6, R^7, and R^8 are each independently selected from hydrogen, C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_1-C_6 haloalkyl, C_3-C_6 cycloalkyl, aryl, heteroaryl, heterocyclyl, halo, cyano, nitro, $-OR^a$, $-SR^b$, $-C(O)OR^c$, $-C(O)NR^dR^e$, $-OC(O)NR^fR^g$, $-NR^hC(O)NR^iR^j$, and $-NR^hC(S)NR^iR^j$, wherein each R^a, R^b, R^c, R^d, R^e, R^f, R^g, R^h, R^i, and R^j is independently selected from hydrogen, C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_1-C_6 haloalkyl, C_3-C_6 cycloalkyl, and aryl;

wherein each pendant moiety of formula (I) is bound to the backbone via a linker having a structure:

$$–(CH_2)_{n1}\text{-}Z^1\text{-}(CH_2)_{n2}\text{-}Z^2–$$

wherein n1 and n2 are each independently selected from 1, 2, 3, 4, 5, 6, 7, and 8, and Z^1 and Z^2 are each independently selected from -NHC(O)NH-, -C(O)NH-, -OC(O)NH-, -OC(O)O-, -NHC(O)S-, -NHC(S)NH-, -O-, and -C(O)O-.

14. The method of claim 13, wherein the linker is:



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15. The method of claim 13 or claim 14, wherein X is O, and wherein R^1, R^2, R^3, R^4, R^5, R^6, R^7, and R^8 are each hydrogen.

16. The method of any one of claims 13-15, wherein the polymer further comprises one or more (meth)acrylate monomer units, wherein at least one (meth)acrylate monomer unit comprises a trialkoxysilyl group.

17. The method of any one of claims 13-16, wherein step (b) is conducted at a pH of about 6.0 to about 7.5, and wherein step (b) comprises contacting the sample with the polymer for about 1 minute to about 5 minutes.

18. The method of any one of claims 13-17, further comprising a step of contacting the nucleic acid bound polymer with an elution solution for about 1 minute to about 5 minutes, to release the nucleic acid from the polymer, wherein the elution solution comprises an aqueous buffer and has a pH of about 8.5 to about 9.5.

19. The method of any one of claims 13-17, further comprising performing a polymerase chain reaction on the nucleic acid bound polymer.

20. The method of any one of claims 9-19, wherein the nucleic acid is DNA selected from total DNA, mtDNA (mitochondrial DNA), gDNA (genomic DNA), cfDNA (cell-free DNA), ccfDNA (circulating cell-free DNA), cffDNA (cell free fetal DNA), bacterial DNA, viral DNA, and ctDNA (circulating tumor DNA).