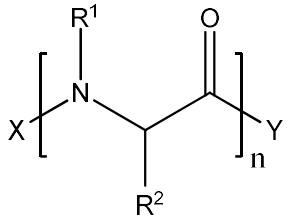
WHAT IS CLAIMED IS:

1. A peptoid polymer according to formula (I):



(I)

a tautomer thereof or stereoisomer thereof,

wherein:

each R^1 is independently selected from the group consisting of H, optionally substituted C_{1-18} alkyl, optionally substituted C_{2-18} alkenyl, optionally substituted C_{2-18} alkynyl, optionally substituted C_{1-18} hydroxyalkyl, optionally substituted alkoxy, optionally substituted C_{1-18} alkylamino, optionally substituted C_{1-18} alkylthio, optionally substituted carboxyalkyl, C_{3-10} cycloalkyl, heterocycloalkyl, aryl, heteroaryl, (C_{3-10} cycloalkyl)alkyl, (heterocycloalkyl)alkyl, arylalkyl, and heteroarylalkyl,

wherein at least 4 instances of R^1 are independently selected optionally substituted C_{1-18} hydroxyalkyl groups, and

wherein any of the cycloalkyl, heterocycloalkyl, aryl, and heteroaryl groups is optionally and independently substituted with one or more R^3 groups;

each R^2 is independently selected from the group consisting of H, optionally substituted C_{1-18} alkyl, optionally substituted C_{2-18} alkenyl, optionally substituted C_{2-18} alkynyl, optionally substituted C_{1-18} hydroxyalkyl, optionally substituted C_{1-18} alkylamino, optionally substituted C_{1-18} alkylthio, and optionally substituted carboxyalkyl;

each R^3 is independently selected from the group consisting of halogen, oxo, thioxo, -OH, -SH, amino, C_{1-8} alkyl, C_{1-8} hydroxyalkyl, C_{1-8} alkylamino, and C_{1-8} alkylthio;

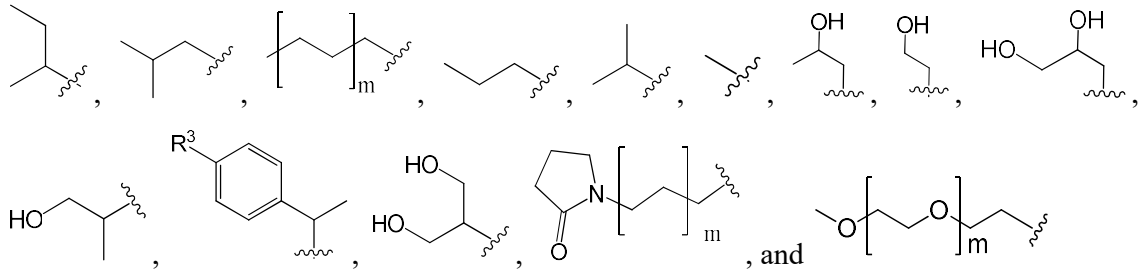
X and Y are independently selected from the group consisting of H, optionally substituted C_{1-8} alkyl, optionally substituted C_{1-8} acyl, optionally substituted C_{1-8} alkylamino, -OH, -SH, $-NH_2$, carboxy, optionally substituted C_{1-8} hydroxyalkyl, optionally substituted C_{1-8} alkylamino, optionally substituted C_{2-8} alkylthio, optionally substituted C_{1-8} carboxyalkyl, and halogen, or

alternatively X and Y are taken together to form a covalent bond; and

the subscript n, representing the number of monomers in the polymer, is between 8 and 50.

2. The peptoid polymer of claim 1, wherein the C_{1-18} hydroxyalkyl groups are independently selected optionally substituted C_{1-6} hydroxyalkyl groups.

3. The peptoid polymer of claim 1, wherein each R^1 is independently selected from the group consisting of



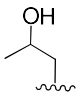
, and

wherein:

m is between 1 and 8; and

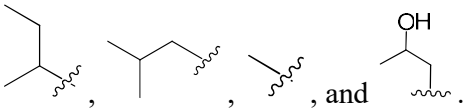
R^3 is selected from the group consisting of H, C_{1-8} alkyl, halogen, hydroxyl, thiol, nitro, amine, oxo, and thioxo.

4. The peptoid polymer of claim 3, wherein one or more R^1 has a structure according to R^{1b}:



R^{1b}.

5. The peptoid polymer of claim 1, wherein each R^1 is independently selected from the group consisting of



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6. The peptoid polymer of claim 1, wherein each instance of R^2 is H.

7. The peptoid polymer of claim 1, wherein n is between 8 and 25.

8. The peptoid polymer of claim 1, wherein n is between 8 and 20.

9. The peptoid polymer of claim 1, wherein n is between 10 and 25.

10. The peptoid polymer of claim 1, wherein X is selected from the group consisting of H, C_{1-8} alkyl, and C_{1-8} acyl; and Y is selected from the group consisting of –OH and amino.

11. The peptoid polymer of claim 1, wherein n is 10 and the peptoid polymer comprises:

4 Nhp monomers and 6 Nsb monomers; or

5 Nhp monomers and 5 Nsb monomers; or

6 Nhp monomers and 4 Nsb monomers; or

7 Nhp monomers and 3 Nsb monomers; or

8 Nhp monomers and 2 Nsb monomers; or

10 Nhp monomers.

12. The peptoid polymer of claim 1, wherein n is 10 and the peptoid polymer comprises:

4 Nhp monomers and 6 Nme monomers; or

5 Nhp monomers and 5 Nme monomers; or

6 Nhp monomers and 4 Nme monomers; or

7 Nhp monomers and 3 Nme monomers; or

8 Nhp monomers and 2 Nme monomers.

13. The peptoid polymer of claim 1, wherein n is 10 and the peptoid polymer comprises:

4 Nhp (2-((2-hydroxypropyl)amino)acetic acid) monomers and 6 Nib (2-(isobutylamino)acetic acid) monomers; or

4 Nhp monomers and 6 Nbu (2-butylamino)acetic acid) monomers; or

4 Nhp monomers and 6 Npr (2-propylamino)acetic acid) monomers; or

4 Nhp monomers and 6 Nip (2-(isopropylamino)acetic acid) monomers.

14. The peptoid polymer of claim 1, wherein n is 14 and the peptoid polymer comprises:

6 Nhp (2-((2-hydroxypropyl)amino)acetic acid) monomers and 8 Nsb (2-(sec-butylamino)acetic acid) monomers; or

7 Nhp monomers and 7 Nsb monomers; or

8 Nhp monomers and 6 Nsb monomers; or

10 Nhp monomers and 4 Nsb monomers; or

14 Nhp monomers.

15. The peptoid polymer of claim 1, wherein n is 14 and the peptoid polymer comprises:

6 Nhp (2-((2-hydroxypropyl)amino)acetic acid) monomers and 8 Nib (2-(isobutylamino)acetic acid) monomers; or

7 Nhp monomers and 7 Nib monomers; or

8 Nhp monomers and 6 Nib monomers; or

10 Nhp monomers and 4 Nib monomers; or

14 Nhp monomers.

16. The peptoid polymer of claim 1, wherein n is 16 and the peptoid polymer comprises:

5 Nhp (2-((2-hydroxypropyl)amino)acetic acid) monomers and 11 Nsb (2-(sec-butylamino)acetic acid) monomers; or

7 Nhp monomers and 9 Nsb monomers; or

8 Nhp monomers and 8 Nsb monomers; or

10 Nhp monomers and 6 Nsb monomers; or

12 Nhp monomers and 4 Nsb monomers; or

16 Nhp monomers.

17. The peptoid polymer of claim 1, wherein n is 22 and the peptoid polymer comprises:

7 Nhp (2-((2-hydroxypropyl)amino)acetic acid) monomers and 15 Nsb (2-(sec-butylamino)acetic acid) monomers; or

10 Nhp monomers and 12 Nsb monomers; or

11 Nhp monomers and 11 Nsb monomers; or

14 Nhp monomers and 8 Nsb monomers; or

17 Nhp monomers and 5 Nsb monomers; or

22 Nhp monomers.

18. The peptoid polymer of claim 1, wherein the peptoid polymer reduces or inhibits ice crystal formation at a temperature within about 0 °C to about -20 °C.

19. The peptoid polymer of claim 1, wherein the peptoid polymer reduces or inhibits ice crystal formation at a temperature within about -20 °C to about -40 °C.

20. The peptoid polymer of claim 1, wherein the peptoid polymer reduces or inhibits ice crystal formation at about -20 °C.

21. The peptoid polymer of claim 1, wherein the peptoid polymer reduces or inhibits ice crystal formation at a temperature within about -40 °C to about -200 °C.

22. A method for preserving a tissue, organ, or cell, the method comprising contacting the tissue, organ, or cell with a peptoid polymer of claim 1.

23. The method of claim 22, wherein the tissue, organ, or cell is selected from the group consisting of heart, liver, lung, kidney, pancreas, intestine, thymus, cornea, nerve cells, blood platelets, sperm cells, oocytes, embryonic cells, stem cells, human pluripotent stem cells, hematopoietic stem cells, lymphocytes, granulocytes, immune system cells, bone cells, organoids, and a combination thereof.

24. A method for preserving a biological macromolecule, the method comprising contacting the biological macromolecule with a peptoid polymer of claim 1.

25. The method of claim 24, wherein the biological macromolecule is selected from the group consisting of a nucleic acid, an amino acid, a protein, an isolated protein, a peptide, a lipid, a composite structure, and a combination thereof.

26. A cosmetic care product comprising a peptoid polymer of claim 1.

27. An antifreeze product comprising a peptoid polymer of claim 1.

28. The antifreeze product of claim 27, wherein the antifreeze product is a deicing or ice-inhibiting product used to prevent, inhibit, or delay the formation of ice on an object selected from the group consisting of an aircraft or a part thereof, a gas pipeline, a window, electrical equipment, a drone, a cable, a power line, mechanical equipment, a car engine, a gear system, and a brake system.

29. A frozen food product comprising a peptoid polymer of claim 1.

30. The peptoid polymer of claim 1, wherein at least 5 instances of R^1 are independently selected optionally substituted $C_{1\text{-}18}$ hydroxyalkyl groups.