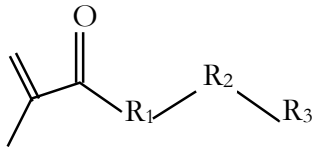
What is Claimed is:

1. A random polymer library comprising a mixture of polymers, wherein the library comprises polymers comprising at least three monomers chosen from:
    a. methyl methacrylate (MMA),
    b. oligo(ethylene glycol) methyl ether methacrylate (OEGMA),
    c. isobutyl methacrylate (IBMA) or butyl methacrylate (BMA), and
    d. a compound of the Formula I,

Formula I:



wherein R_1 is O or NH, R_2 is methyl, ethyl, propyl, or butyl, and R_3 is NH_2 or $N(CH_3)_2$ or a guanidinium group, wherein the library comprises polymers of from 3 to 20 kDa.

2. The random polymer library of claim 1, wherein the library comprises polymers comprising a monomer of the Formula I, wherein the monomer is dimethyl amino methacrylate (DMAEMA), 2-aminoethyl methacrylate, arginine methacrylate, arginine methacrylamide, N-(3-aminopropyl) methacrylamide, N-(3-methacrylamidopropyl) guanidinium chloride (ArgMAm), or N-3-(dimethylamino)propyl methacrylamide.
3. The random polymer library of claim 1 or 2, wherein at least 50%, at least 60%, at least 70%, at least 80%, or at least 90% of the polymers in the library comprise at least three monomers, or wherein the random polymer library consists essentially of polymers comprising at least three monomers.
4. The random polymer library of claim 1 or 2, wherein at least 50%, at least 60%, at least 70%, at least 80%, or at least 90% of the polymers in the library comprise at least four monomers, or wherein the random polymer library consists essentially of polymers comprising at least four monomers.
5. A random polymer library comprising a mixture of polymers, each polymer comprising a mixture of at least three of monomers: methyl methacrylate (MMA), oligo(ethylene glycol) methyl ether methacrylate (OEGMA), isobutyl methacrylate (IBMA), and

dimethyl amino methacrylate (DMAEMA), wherein the library comprises polymers of from 3 to 20 kDa.

6. A random polymer library comprising a mixture of polymers, each polymer comprising a mixture of at least three of monomers: methyl methacrylate (MMA), oligo(ethylene glycol) methyl ether methacrylate (OEGMA), isobutyl methacrylate (IBMA), and N-(3-methacrylamidopropyl) guanidinium chloride (ArgMAm), wherein the library comprises polymers of from 3 to 20 kDa.
7. The random polymer library of any one of claims 1-6, wherein the library comprises polymers of from 3 to 15 kDa, from 5 to 20 kDa, from 5 to 15 kDa, from 5 to 10 kDa, from 10 to 20 kDa, from 7 to 10 kDa, or from 10 to 15 kDa.
8. The random polymer library of any one of claims 1-7, wherein the library comprises OEGMA with a molecular weight of from 300 to 1500 g/mol, optionally,
   a) wherein the OEGMA has a molecular weight of 300, 500, 750, 950, 1000, 1200, or 1500 g/mol or
   b) wherein the OEGMA has a molecular weight of 500 g/mol (i.e., is OEGMA 500).
9. The random polymer library of any one of claims 1-4 or 7 or 8, wherein library comprises polymers comprising three monomers.
10. The random polymer library of claim 9, wherein at least 50%, at least 60%, at least 70%, at least 80%, or at least 90% of the polymers in the library comprise three monomers, or wherein the random polymer library consists essentially of polymers comprising three monomers.
11. The random polymer library of claim 9, wherein the three monomers are MMA, OEGMA, and either IBMA or BMA, optionally
    a) the three monomers are MMA, OEGMA, and IBMA or
    b) the MMA, OEGMA, and IBMA or BMA are present in a ratio of: (a) 5 : 3 : 2, or (b) 3 : 5 : 2, or (c) 5 : 4 : 1.
12. The random polymer library of any one of claims 1-8, wherein the library comprises polymers comprising four monomers.
13. The random polymer library of claim 12, wherein at least 50%, at least 60%, at least 70%, at least 80%, or at least 90% of the polymers in the library comprise three monomers, or wherein the random polymer library consists essentially of polymers comprising three monomers.

14. The random polymer library of claim 12 or 13, wherein the four monomers are MMA, OEGMA, IBMA, and DMAEMA, optionally,

    a) the polymer library comprises polymers comprising 20-50% MMA, 20-50% OEGMA, 5-25% IBMA, and 5-25% DMAEMA by total weight of polymer, or

    b) the polymer library comprises polymers comprising MMA, OEGMA, IBMA, and DMAEMA in a molar ratio of: (a) 5 : 2.5 : 2 : 0.5, (b) 2 : 5 : 2 : 1, (c) 5 : 2.5 : 1 : 1.5, (d) 4 : 4 : 1 : 1; (e) 3 : 4 : 1 : 2; (f) 2 : 4 : 1 : 3; and/or (g) 2 : 3 : 1 : 4, or

    c) the MMA, OEGMA, IBMA, and DMAEMA are in a molar ratio of 5 : 2.5 : 2 : 0.5, wherein the OEGMA has a molecular weight of 500 g/mol (i.e., is OEGMA 500), wherein the library comprises polymers with a molecular weights of 3-15 kDa.

15. The random polymer library of claim 12 or 13, wherein the four monomers are MMA, OEGMA, IBMA, and ArgMAm, optionally

    a) the polymer library comprises polymers comprising 20-50% MMA, 20-50% OEGMA, 5-25% IBMA, and 5-25% ArgMAm by total weight of polymer, or

    b) the polymer library comprises polymers comprising MMA, OEGMA, IBMA, and ArgMAm in a molar ratio of: (a) 5 : 2.5 : 2 : 0.5, (b) 2 : 5 : 2 : 1, (c) 5 : 2 : 1 : 2, (d) 4 : 4 : 1 : 1; (e) 3 : 4 : 1 : 2; (f) 2 : 4 : 1 : 3; and/or (g) 2 : 3 : 1 : 4, or

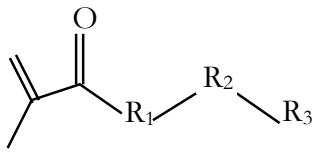
    c) the MMA, OEGMA, IBMA, and ArgMAm are in a molar ratio of 5 : 2 : 1 : 2 or 4 : 4 : 1 : 1, wherein the OEGMA has a molecular weight of 500 g/mol (i.e., is OEGMA 500), wherein the library comprises polymers with a molecular weights of 3-15 kDa.

16. A random polymer library comprising a mixture of polymers, wherein the library comprises polymers comprising at least two monomers chosen from oligo(ethylene glycol) methyl ether methacrylate (OEGMA) and either isobutyl methacrylate (IBMA) or butyl methacrylate (BMA), and/or at least two monomers chosen from oligo(ethylene glycol) methyl ether methacrylate (OEGMA) and N-(3-methacrylamidopropyl) guanidinium chloride (ArgMAm), optionally wherein the OEGMA has a molecular weight of 500 g/mol (i.e., is OEGMA 500), and optionally wherein the library comprises polymers with a molecular weights of 3-15 kDa.

17. A random polymer comprising a mixture of at least three monomers chosen from:

    a. methyl methacrylate (MMA),
    b. oligo(ethylene glycol) methyl ether methacrylate (OEGMA),
    c. isobutyl methacrylate (IBMA) or butyl methacrylate (BMA), and
    d. a compound of the Formula I,

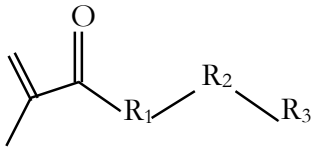
Formula I:



wherein R_1 is O or NH, R_2 is methyl, ethyl, propyl, or butyl, and R_3 is NH_2 or $N(CH_3)_2$ or a guanidinium group, wherein the polymer is from 3 to 20 kDa.

18. The random polymer of claim 17, wherein the polymer comprises a monomer of the Formula I,

Formula I:



wherein the monomer is dimethyl amino methacrylate (DMAEMA), 2-aminoethyl methacrylate, arginine methacrylate, arginine methacrylamide, N-(3-aminopropyl) methacrylamide, N-(3-methacrylamidopropyl) guanidinium chloride (ArgMAm), or N-3-(dimethylamino)propyl methacrylamide.

19. A random polymer comprising a mixture of at least three of monomers: methyl methacrylate (MMA), oligo(ethylene glycol) methyl ether methacrylate (OEGMA), isobutyl methacrylate (IBMA), and dimethyl amino methacrylate (DMAEMA), wherein the polymer is from 3 to 20 kDa.
20. A random polymer comprising a mixture of at least three of monomers: methyl methacrylate (MMA), oligo(ethylene glycol) methyl ether methacrylate (OEGMA), isobutyl methacrylate (IBMA), and N-(3-methacrylamidopropyl) guanidinium chloride (ArgMAm), wherein the polymer is from 3 to 20 kDa.
21. The random polymer of any one of claims 17-20, wherein the polymer is from 3 to 15 kDa, from 5 to 20 kDa, from 5 to 15 kDa, from 5 to 10 kDa, from 10 to 20 kDa, from 7 to 10 kDa, or from 10 to 15 kDa.
22. The random polymer of any one of claims 17-21, wherein the polymer comprises OEGMA with a molecular weight of from 300 to 1500 g/mol, optionally

a) the OEGMA has a molecular weight of 300, 500, 750, 950, 1000, 1200, or 1500 g/mol, or

b) the OEGMA has a molecular weight of 500 g/mol.

23. The random polymer of any one of claims 17, 18, 21 or 22, wherein the polymer comprises three monomers.
24. The random polymer of claim 23, wherein the three monomers are MMA, OEGMA, and either IBMA or BMA, optionally, the three monomers are MMA, OEGMA, and IBMA and optionally the MMA, OEGMA, and IBMA or BMA are present in a ratio of: (a) 5 : 3 : 2, or (b) 3 : 5 : 2, or (c) 5 : 4 : 1.
25. The random polymer of any one of claims 17-22, wherein the polymer comprises four monomers.
26. The random polymer of claim 25, wherein the four monomers are MMA, OEGMA, IBMA, and DMAEMA, optionally

a) the polymer comprises 20-50% MMA, 20-50% OEGMA, 5-25% IBMA, and 5-25% DMAEMA by total weight of polymer, or

b) the polymer comprises MMA, OEGMA, IBMA, and DMAEMA in a molar ratio of: (a) 5 : 2.5 : 2 : 0.5, (b) 2 : 5 : 2 : 1, (c) 5 : 2.5 : 1 : 1.5, (d) 4 : 4 : 1 : 1; (e) 3 : 4 : 1 : 2; (f) 2 : 4 : 1 : 3; or (g) 2 : 3 : 1 : 4, or

c) the MMA, OEGMA, IBMA, and DMAEMA are in a molar ratio of 5 : 2.5 : 2 : 0.5, wherein the OEGMA is OEGMA 500, wherein the polymer has a molecular weight of from 3 to 15 kDa.

27. The random polymer of claim 25, wherein the four monomers are MMA, OEGMA, IBMA, and ArgMAm, optionally

a) the polymer comprises 20-50% MMA, 20-50% OEGMA, 5-25% IBMA, and 5-25% ArgMAm by total weight of polymer, or

b) the polymer comprises MMA, OEGMA, IBMA, and ArgMAm in a molar ratio of: (a) 5 : 2.5 : 2 : 0.5, (b) 2 : 5 : 2 : 1, (c) 5 : 2.5 : 1 : 1.5, (d) 4 : 4 : 1 : 1; (e) 3 : 4 : 1 : 2; (f) 2 : 4 : 1 : 3; or (g) 2 : 3 : 1 : 4, or

c) the MMA, OEGMA, IBMA, and ArgMAm are in a molar ratio of 5 : 2 : 1 : 2 or 4 : 4 : 1 : 1, wherein the OEGMA is OEGMA 500, wherein the polymer has a molecular weight of from 3 to 15 kDa.

28. A random polymer comprising mixture of at least two monomers chosen from oligo(ethylene glycol) methyl ether methacrylate (OEGMA) and either isobutyl

methacrylate (IBMA) or butyl methacrylate (BMA), and/or at least two monomers chosen from oligo(ethylene glycol) methyl ether methacrylate (OEGMA) and N-(3-methacrylamidopropyl) guanidinium chloride (ArgMAm), optionally wherein the OEGMA has a molecular weight of 500 g/mol (i.e., is OEGMA 500), and optionally wherein the polymer has a molecular weight of from 3 to 15 kDa.

29. The random polymer of any one of claims 17-28, wherein the polymer has a molecular weight of from 7 to 10 kDa.
30. A composition comprising a random polymer according to any one of claims 17-29 and at least one protein.
31. The composition of claim 30, wherein the polymer is at a concentration of from 0.01 to 1% w/v, such as 0.01 to 0.1% w/v.
32. The composition of claim 30 or 31, wherein the protein is an antibody, optionally the antibody is an IgG antibody, such as a full-length IgG, a bi-specific IgG, or wherein the antibody is an antigen binding fragment, such as a Fab, Fab', (Fab')2, Fv, or scFv.
33. The composition of any one of claims 30-32, wherein the composition further comprises
    a) at least one buffer, such as histidine, phosphate, or citrate, and/or
    b) at least one surfactant, such as a polysorbate, for example polysorbate 20 or polysorbate 80.
34. The composition of any one of claims 30-33, wherein the antibody is at a concentration of 10 mg/mL to 150 mg/mL, such as 10-100 mg/mL, 20-100 mg/mL, 20-80 mg/mL, 10-50 mg/mL, 10-25 mg/mL, 25-50 mg/mL, 50-80 mg/mL, 50-100 mg/mL, or 70-100 mg/mL.
35. A method of reducing the viscosity and/or inhibiting precipitation of a protein-containing composition, comprising adding a random polymer of any one of claims 17-29 to the composition, optionally wherein the composition comprises the protein and/or excipients of any one of claims 30-34.
36. A method of preparing a random polymer library according to any one of claims 1-16 or a random polymer according to any one of claims 17-29, wherein the method comprises reverse addition/fragmentation chain transfer (RAFT), free radical polymerization (FRP), or atom transfer radical polymerization (ATRP).
37. A method of preparing a random polymer library according to any one of claims 1-16 or a random polymer according to any one of claims 17-29, the method comprising:

exposing the monomers to LED light and/or heat in the presence of a zinc tetraphenyl porphyrin catalyst (ZnTPP) and a chain transfer agent.

38. The method of claim 37, wherein the chain transfer agent is 2-cyano-2-propyl benzodithioate, 2-cyano-2-propyldodecyl trithiocarbonate, 4-((((2-carboxyethyl)thio)carbonothioyl)thio)-4-cyanopentanoic acid, 4-cyano-4-(phenylcarbonothioylthio)pentanoic acid, or 4-cyano-4-[(dodecylsulfanylthiocarbonyl)sulfanyl] pentanoic acid (CDTPA).
39. The method of claim 37 or 38, wherein the monomers are exposed to LED light in the presence of the ZnTPP and chain transfer agent for 3 to 18 hours.
40. The method of any one of claims 37-39, wherein polymerization is ended by removing the LED light.
41. The method of any one of claims 36-40, further comprising performing at least one filtration, buffer exchange, or dialysis step to isolate the polymers.
42. A kit comprising the random polymer library of any one of claims 1-16, for use in testing polymers comprised within the library for their effect on precipitation, viscosity, and/or turbidity of a solution comprising a protein, the kit optionally further comprising instructions for use, optionally the library comprises at least 10, at least 20, at least 50, or at least 80 different individual random polymers.
43. A method of identifying a random polymer excipient for a protein solution, comprising exposing the protein solution to a random polymer library of any one of claims 1-16 or the kit of claim 42 and determining one or more of the viscosity, turbidity, or precipitation of the solution.