CLAIMS

1. A method of identifying proteins in a sample, comprising:

(a) incubating a particle panel, comprising a plurality of superparamagnetic iron oxide nanoparticles (SPIONs) with distinct surface chemistries, with the sample to form a plurality of distinct biomolecule coronas corresponding to distinct ~~particle~~SPION types of the particle panel;

(b) magnetically isolating the particle panel from unbound protein in the sample to enrich proteins in the plurality of distinct biomolecule coronas; and

(c) assaying the plurality of distinct biomolecule coronas to identify at least 500 unique proteins from the enriched proteins~~, wherein the assaying is capable of identifying one or more protein groups~~.

2. The method of claim 1, wherein the assaying ~~is capable of identifying~~ identifies from ~~1~~500 to 20,000 unique proteins from the enriched proteins ~~groups~~.

3. The method of claim 1 or 2, wherein the assaying identifies~~is capable of identifying~~ from 1,000 to 5,000 unique proteins from the enriched proteins ~~groups~~.

4. The method of any one of claims 1-3, wherein the assaying identifies~~is capable of identifying~~ from 1,200 to 2,200 unique proteins from the enriched proteins ~~groups~~.

5. The method of any one of claims 1-4, wherein an individual protein ~~group~~ of the unique proteins ~~groups~~ comprises a peptide sequence having a minimum length of 7 amino acid residues.

6. The method of any one of claims 1-5, wherein the assaying ~~is capable of identifying from 1,000 to 10,000 proteins~~comprises using mass spectrometry to identify the unique proteins in the sample.

7. The method of any one of claims 1-6, wherein the sample comprises a plurality of samples.

8. The method of claim 7, wherein the plurality of samples comprises at least two or more spatially isolated samples.

9. The method of claim 7 or 8, wherein the plurality of samples comprises at least 10 spatially isolated samples~~, at least 50 spatially isolated samples, at least 100 spatially isolated samples, at least 150 spatially isolated samples, at least 200 spatially isolated samples, at least 250 spatially isolated samples, or at least 300 spatially isolated samples~~.

10. The method of claim 8 or 9, wherein the incubating comprises contacting the sample, which is provided in at least two or more spatially isolated samples with the particle panel at the same time, or wherein the magnetically isolating comprises magnetically isolating the particle panel from unbound protein in the at least two or more spatially isolated samples of the plurality of samples at the same time.

11. The method of any one of claims 1-10, further comprising repeating steps (a)-(c)~~-~~, wherein, when repeated, the incubating, isolating, and assaying yields a percent quantile normalized coefficient (QNCV) of variation of 20% or less, as determined by comparing a peptide mass spectrometry feature from at least three full-assay replicates for each particle type in the particle panel.

12. The method of any one of claims 1-11, wherein the assaying is capable of identifying proteins over a dynamic range of at least 7~~, at least 8, at least 9, or at least 10~~.

13. The method of any one of claims 1-12, further comprising washing the particle panel at least one time ~~or at least two times~~ after the magnetically isolating the particle panel from the unbound protein.

14. The method of any one of claims 1-13, further comprising washing the particle panel at least two times after the magnetically isolating the particle panel from the unbound protein.

~~14~~15. The method of any one of claims 1-~~14~~13, further comprising, ~~after~~before the assaying of (c), (i) lysing the enriched proteins in the plurality of distinct biomolecule coronas, (ii) digesting

the enriched proteins in the plurality of distinct biomolecule coronas to generate digested peptides, or (iii) purifying the digested peptides.

16. The method of claim 15, wherein the digesting the enriched proteins is performed in the presence of the plurality of SPIONs.

17. The method of claim 15 or 16, wherein the digesting is performed using a protease.

~~15~~18. The method of any one of claims 1-17~~14~~, wherein the assaying of (c) comprises using mass spectrometry to identify the unique proteins in the sample.

~~16~~19. The method of any one of claims 1-18~~15~~, wherein the assaying of (c) is performed in ~~about~~ 2 to ~~about~~ 4 hours.

~~17~~20. The method of any one of claims 1-19~~16~~, wherein the method is performed in ~~about~~ 1 to ~~about~~ 20 hours~~, in about 2 to about 10 hours, or in about 4 to about 6 hours~~.

~~18~~21. The method of any one of claims 1-20~~17~~, wherein the isolating takes no more than ~~about~~ 30 minutes~~, no more than about 15 minutes, no more than about 10 minutes, no more than about 5 minutes, or no more than about 2 minutes~~.

~~19~~22. The method of any one of claims 1-21~~18~~, wherein the particle panel comprises at least 2 distinct SPION ~~particle~~ types~~, at least 3 distinct particle types, at least 4 distinct particle types, at least 5 distinct particle types, at least 6 distinct particle types, at least 7 distinct particle types, at least 8 distinct particle types, at least 9 distinct particle types, at least 10 distinct particle types, at least 11 distinct particle types, at least 12 distinct particle types, at least 13 distinct particle types, at least 14 distinct particle types, at least 15 distinct particle types, at least 20 distinct particle types, at least 25 particle types, or at least 30 distinct particle types~~.

~~20~~23. The method of any one of claims 1-22~~19~~, wherein the particle panel comprises a first distinct SPION~~particle~~ type and a second distinct SPION~~particle~~ type, wherein the first distinct SPION~~particle~~ type and the second distinct SPION~~particle~~ type share at least one physicochemical property and differ by at least one physicochemical property, such that the first distinct SPION~~particle~~ type and the second distinct SPION~~particle~~ type are different.

~~21~~24. The method of any one of claims 1-~~23~~20, wherein the particle panel comprises a first distinct SPION~~particle~~ type, a second distinct SPION~~particle~~ type, and a third distinct SPION~~particle~~ type, wherein the first distinct SPION~~particle~~ type, the second distinct SPION~~particle~~ type, and the third distinct SPION~~particle~~ type comprise iron oxide cores, polymer shells, and are less than ~~about~~ 500 nm in diameter, and wherein the first distinct SPION~~particle~~ type comprises a negative charge, the second distinct SPION~~particle~~ type comprises a positive charge, and the third distinct SPION~~particle~~ type comprises a neutral charge, wherein the diameter is a mean diameter as measured by dynamic light scattering.

~~22~~25. The method of any one of claims 1-~~24~~21, wherein at least two SPION~~particle~~ types in the distinct SPION~~particle~~ types of the particle panel differ by at least one surface chemical group.

~~23~~26. The method of claim ~~22~~25, wherein the first distinct SPION~~particle~~ type comprises a silica coating, the second distinct SPION~~particle~~ type comprises a poly(N-(3-(dimethylamino)propyl) methacrylamide) (PDMAPMA), and the third distinct SPION~~particle~~ type comprises a poly(oligo(ethylene glycol) methyl ether methacrylate) (POEGMA) coating.

~~24~~27. The method of any one of claims 1-~~26~~23, wherein each SPION~~particle~~ of the particle panel comprises an iron oxide material.

~~25. The method of any one of claims 1-24, wherein at least one distinct particle type of the particle panel is a microparticle, a nanoparticle, or a superparamagnetic iron oxide particle.~~

~~26. The method of any one of claims 1-25, wherein each distinct particle type of the particle panel is a microparticle, a nanoparticle, or a superparamagnetic iron oxide particle.~~

~~27~~28. The method of any one of claims 1-~~27~~26, wherein at least one distinct SPION~~particle~~ type of the particle panel has an iron oxide core or a polystyrene core with iron oxide crystal embedded therein.

~~28~~29. The method of any one of claims 1-~~28~~27, wherein each distinct SPION~~particle~~ type of the particle panel has an iron oxide core or a polystyrene core with iron oxide crystal embedded therein.

~~29~~30. The method of any one of claims 1-29~~28~~, wherein at least one distinct SPION~~particle~~ type of the particle panel comprises a carboxylated polymer, an aminated polymer, a zwitterionic polymer, or any combination thereof.

~~30~~31. The method of any one of claims 1-30~~29~~, wherein at least one SPION~~particle~~ type of the particle panel comprises an iron oxide core with a silica shell coating, an iron oxide core with a poly(N-(3-(dimethylamino)propyl) methacrylamide) (PDMAPMA) coating, or an iron oxide core with a poly(oligo(ethylene glycol) methyl ether methacrylate) (POEGMA) coating.

~~31~~32. The method of any one of claims 1-31~~30~~, wherein at least one distinct SPION~~particle~~ type of the particle panel comprises a negative surface charge.

~~32~~33. The method of any one of claims 1-32~~31~~, wherein at least one distinct SPION~~particle~~ type of the particle panel comprises a positive surface charge.

~~33~~34. The method of any one of claims 1-33~~32~~, wherein at least one distinct SPION~~particle~~ type of the particle panel comprises a neutral surface charge.

~~34~~35. The method of any one of claims 1-34~~33~~, wherein the sample is a biological sample, and wherein the biological sample is plasma, serum, CSF, urine, tear, cell lysates, tissue lysates, cell homogenates, tissue homogenates, nipple aspirates, fecal samples, synovial fluid and whole blood, or saliva.

36. The method of claim 35, wherein the sample is plasma or serum.

~~35. The method of any one of claims 1-34, wherein the assaying identifies at least 100 protein groups.~~

~~36. The method of any one of claims 1-35, wherein the particle panel comprises one particle type that is capable of identifying 200 to 600 unique proteins.~~

~~37. A composition comprising three or more distinct magnetic particle types that differ by two or more physicochemical properties, wherein a subset of the three or more distinct magnetic particle types share a physicochemical property of the two or more physicochemical properties and wherein such particle types of the subset bind different proteins.~~

~~38. The composition of claim 37, wherein the three or more distinct magnetic particle types adsorb proteins from a sample over a dynamic range of at least 7, at least 8, at least 9, or at least 10.~~

~~39. The composition of claim 37 or 38, the three or more distinct magnetic particle types are capable of adsorbing one or more proteins groups from a sample.~~

~~40. The method of any one of claims 1-36 or the composition of any one of claims 37-39, wherein the sample is a non-biological sample.~~

~~41~~37. The method of any one of claims 1-36~~claim 40 or the composition of claim 40~~, wherein the ~~non-biological sample is water, milk, solvents, or a homogenized sample~~plurality of SPIONs comprise a heterogeneous size distribution.

38. The method of any one of claims 1-36, wherein the plurality of SPIONs comprise a homogeneous size distribution.

39. The method of any one of claims 1-38, wherein each distinct SPION type of the particle panel comprises a polydispersity index of less than 0.5.

40. The method of claim 39, wherein each distinct SPION type of the particle panel comprises a polydispersity index of less than 0.2.

41. The method of claim 40, wherein each distinct SPION type of the particle panel comprises a polydispersity index of less than 0.1.