WHAT IS CLAIMED IS:

1. A nanocage comprising a plurality of first fusion proteins and a plurality of second fusion proteins, wherein each first fusion protein comprises a nanocage monomer or a subunit thereof and an Fab fragment capable of specifically binding to an antigen, and wherein each second fusion protein comprises a nanocage monomer or a subunit thereof and an Fc fragment.

2. The nanocage of claim 1, wherein the nanocage monomer is selected from ferritin, apoferritin, encapsulin, sulfur oxygen reductase (SOR), lumazine synthase, pyruvate dehydrogenase, carboxysome, vault proteins, GroEL, heat shock protein, E2P, MS2 coat protein, fragments thereof, and variants thereof.

3. The nanocage of claim 2, wherein the nanocage monomer is apoferritin or ferritin.

4. The nanocage of claim 3, wherein the nanocage monomer is a ferritin light chain.

5. The nanocage of claim 3 or 4, wherein the nanocage monomer does not include any ferritin heavy chains.

6. A nanocage comprising a plurality of first fusion proteins and a plurality of second fusion proteins, wherein

(a) (i) the first fusion protein comprises a ferritin light chain and an Fab fragment capable of specifically binding to a first antigen, and

(ii) the second fusion protein comprises a ferritin light chain and an Fab fragment capable of specifically binding to a second antigen, or

(b) (i) the first fusion protein comprises N-ferritin and an Fab fragment capable of specifically binding to a first antigen, and

(ii) the second fusion protein comprises C-ferritin and an Fab fragment capable of specifically binding to a second antigen,

wherein, within each fusion protein, the Fab fragment is fused to the N-terminus of

the ferritin light chain, the N-ferritin, or the C-ferritin, and wherein the first antigen is distinct from the second antigen.

7. A nanocage comprising a plurality of first fusion proteins, a plurality of second fusion proteins, and a plurality of third fusion proteins, wherein

(a) the first fusion protein comprises a ferritin light chain and an Fab fragment capable of specifically binding a first antigen,

(b) the second fusion protein comprises a C-ferritin and an Fab fragment capable of specifically binding a second antigen, and

(c) the third fusion protein comprises an N-ferritin and an Fc fragment, wherein, within each fusion protein the Fab or Fc fragment is fused to the N-terminus of the ferritin light chain, the C-ferritin, or the N-ferritin, and

wherein the first antigen is distinct from the second antigen.

8. The nanocage of claim 6 or 7, further comprising a plurality of fourth fusion proteins, wherein, the fourth fusion protein comprises a C-ferritin and an Fab fragment capable of specifically binding a third antigen, wherein the third antigen is distinct from the first and second antigens.

9. The nanocage of any one of claims 6-8, wherein the Fab fragments are Fab fragments of a neutralizing antibody.

10. The nanocage of any one of claims 6-9, wherein the first and second antigens are each associated with an infectious agent.

11. The nanocage of claim 10, wherein the first and second antigens are associated with the same infectious agent.

12. The nanocage of claim 10 or 11, wherein the infectious agent is a virus.

13. The nanocage of claim 12, wherein the virus is a human immunodeficiency virus (HIV).

14. The nanocage of claim 9, wherein the first and second antigens are each associated with a virus, wherein the nanocage is capable of neutralizing 100% of pseudoviruses in a panel of pseudoviruses, and wherein the panel of pseudoviruses comprises, for each Fab fragment within the nanocage capable of specifically binding to an antigen associated with the virus, at least one pseudovirus resistant to a neutralizing antibody corresponding to that Fab fragment.

15. The nanocage of claim 14, wherein the panel of pseudoviruses comprises at least 10, at least 11, at least 12, at least 13, or at least 14 pseudoviruses.

16. The nanocage of any one of claims 9, 14, or 15, wherein the first and second antigens are each associated with a virus, wherein the nanocage is capable of neutralizing a panel of pseudoviruses with an IC_{50} of less than 1 nM, less than 500 pM, less than 250 pM, less than 100 pM, less than 50 pM, less than 10 pM, or less than 5 pM, and
wherein the panel of pseudoviruses comprises, for each Fab fragment within the nanocage capable of specifically binding to an antigen associated with the virus, at least one pseudovirus resistant to a neutralizing antibody corresponding to that Fab fragment.

17. The nanocage of any one of claims 9 or 14-16, wherein the first and second antigens are each associated with a virus, wherein the nanocage is capable of neutralizing a panel of pseudoviruses with an IC_{50} (molar concentration) of at least 10-fold, at least 20-fold, at least 30-fold, at least 40-fold, at least 50-fold, at least 60-fold, at least 70-fold, at least 80-fold, at least 90-fold, or at least 100-fold lower than that of one or more controls, and wherein the panel of pseudoviruses comprises, for each Fab fragment within the nanocage capable of specifically binding to an antigen associated with the virus, at least one pseudovirus resistant to a neutralizing antibody corresponding to that Fab fragment.

18. The nanocage of claim 17, wherein the one or more controls comprise a neutralizing antibody corresponding to a Fab fragment within the nanocage, which Fab fragment is capable of specifically binding to an antigen associated with the virus.

19. The nanocage of claim 18, wherein the neutralizing antibody is an IgG antibody.

20. The nanocage of any one of claims 17-19, wherein the one or more controls comprise a cocktail of neutralizing antibodies, wherein the cocktail comprises, for each Fab fragment within the nanocage capable of specifically binding to an antigen associated with the virus, a neutralizing antibody corresponding to that Fab fragment.

21~~1~~. A fusion protein comprising:

a first nanocage monomer subunit of a nanocage monomer; and

a bioactive moiety linked to the first nanocage monomer subunit;

wherein the fusion protein self-assembles with a protein comprising a second nanocage monomer subunit to form a nanocage monomer.

22~~2~~. The fusion protein of claim 21~~1~~, wherein the bioactive moiety decorates the interior and/or exterior surface of the assembled nanocage.

23~~3~~. The fusion protein of claim 21 or 22~~1 or 2~~, wherein the bioactive moiety comprises an antibody or fragment thereof, an antigen, a detectable moiety, a pharmaceutical agent, a diagnostic agent, or combinations thereof.

24~~4~~. The fusion protein of claim 23~~3~~, wherein the antibody or fragment thereof comprises an Fc fragment.

25~~5~~. The fusion protein of claim 24~~4~~, wherein the Fc fragment is an IgG1 Fc fragment.

26~~6~~. The fusion protein of claim 24 or 25~~4 or 5~~, wherein the Fc fragment comprises one or more mutations, such as LS, YTE, LALA, and/or LALAP, that modulate the half-life of the fusion protein from, for example, minutes or hours to several days, weeks, or months.

27~~7~~. The fusion protein of claim 23~~3~~, wherein the antibody or fragment thereof comprises a Fab fragment.

28~~8~~. The fusion protein of claim 23~~3~~, wherein the antibody or fragment thereof comprises a scFab fragment, a scFv fragment, or a sdAb fragment.

29~~9~~. The fusion protein of claim 23~~3~~, wherein the antibody or fragment thereof comprises a heavy and/or light chain of a Fab fragment.

30~~10~~. The fusion protein of claim 29~~9~~, wherein the antibody or fragment thereof comprises both a light chain and a heavy chain, or in the case of a Fc fragment, a first and a second chain, optionally separated by a linker.

31~~11~~. The fusion protein of claim 30~~10~~, wherein the linker comprises or consists of a sequence at least 70% (such as at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100%) identical to:
GGSSGSGSGSTGTSSSGTGTSAGTTGTSASTSGSGSGGGGGSGGGGSAGGTAT
AGASSGSGSSGSSSSGGTG.

32~~12~~. The fusion protein of claim 29~~9~~, in association with a separately produced Fab light chain and/or heavy chain.

33~~13~~. The fusion protein of any one of claims 23 to 32~~3 to 12~~, wherein the antibody or fragment thereof binds specifically to an antigen associated with an antibody-preventable and/or antibody-treatable condition.

34~~14~~. The fusion protein of claim 33~~13~~, wherein antigen is associated with an infectious agent, including a virus (e.g., HIV, including HIV-1, influenza, RSV, rotavirus), bacteria (e.g., TB, C. difficile) parasite (e.g., malaria), fungus, or yeast, a cancer (e.g., CD19, CD22, CD79, BCMA, or CD20), including solid and liquid cancers, or an immune disease, including an autoimmune disease.

35~~15~~. The fusion protein of claim 34~~14~~, wherein the antigen is associated with HIV-1 and the antibody or fragment thereof comprises, for example, Ibalizumab-A12P, 10E8,

10E8.v4, N49P7, PGDM1400, 10-1074, VRC01, or combinations thereof.

36~~16~~. The fusion protein of claim 35~~15~~, wherein the antibody or fragment thereof comprises or consists of a sequence at least 70% (such as at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100%) identical to:

Fc chain 1:

DKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVD
GVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISK
AKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPV
LDSDGSFFLYSKLTVDKSRWQQGNVFSCSVLHEALHSHYTQKSLSLSPGK;

Fc chain 2:

DKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVD
GVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISK
AKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPV
LDSDGSFFLYSKLTVDKSRWQQGNVFSCSVLHEALHSHYTQKSLSLSPGK;

Ibalizumab-A12P light chain:

DIVMTQSPDSLPVSLGERVTMNCKSSQSLLYSTNQKNYLAWYQQKPGQSPKLLIYWAST
RESGVPDRFSGSGSGTDFTLTISSVQAEDVAVYYCQQYYSYRTFGGGTKLEIKRTVAAPS
VFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTY
SLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC;

Ibalizumab-A12P heavy chain:

QVQLQQSGPEVVKPGASVKMSCKASGYTFTSYVIHWVRQKPGQGLDWIGYINPYNDGT
DYDEKFKGKATLTSDTSTSTAYMELSSLRSEDTAVYYCAREKDNYATGAWFAYWGQG
TLVTVSSASTKGPSVFPLAPCSRSTSESTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFP
AVLQSSGLYSLSSVVTVPSSSLGTKTYTCNVDHKPSNTKVDKRVESKYGSR;

10E8.v4 light chain:

SELTQDPAVSVALKQTVTITCRGDSLRSHYASWYQKKPGQAPVLLFYGKNNRPSGIPDRF
SGSASGNRASLTITGAQAEDEADYYCSSRDKSGSRLSVFGGGTKLTVLSQPKAAPSVTLF
PPSSEELQANKATLVCLISDFYPGAVTVAWKADSSPVKAGVETTTPSKQSNNKYAASSY
LSLTPEQWKSHRSYSCQVTHEGSTVEKTVAPTEC;

10E8.v4 heavy chain:

EVRLVESGGGLVKPGGSLRLSCSASGFDFDNAWMTWVRQPPGKGLEWVGRITGPGEGW
SVDYAESVKGRFTISRDNTKNTLYLEMNNVRTEDTGYYFCARTGKYYDFWSGYPPGEE
YFQDWGQGTLVIVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGA
LTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCSR;

N49P7 light chain:

QSALTQPRSVSASPGQSVTISCTGTHNLVSWCQHQPGRAPKLLIYDFNKRPSGVPDRFSG
SGSGGTASLTITGLQDDDDAEYFCWAYEAFGGGTKLTVLGQPKAAPSVTLFPPSSEELQA
NKATLVCLISDFYPGAVTVAWKADSSPVKAGVETTTPSKQSNNKYAASSYLSLTPEQWK
SHRSYSCQVTHEGSTVEKTVAPTEC;

N49P7 heavy chain:

ADLVQSGAVVKKPGDSVRISCEAQGYRFPDYIIHWIRRAPGQGPEWMGWMNPMGGQV
NIPWKFQGRVSMTRDTSIETAFLDLRGLKSDDTAVYYDRSNGSGKRFESSNWFLDLWGR
GTAVTIQSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHT
FPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDSR;

PGDM1400 light chain:

DFVLTQSPHSLSVTPGESASISCKSSHSLIHGDRNNYLAWYVQKPGRSPQLLIYLASSRAS
GVPDRFSGSGSDKDFTLKISRVETEDVGTYYCMQGRESPWTFGQGTKVDIKRTVAAPSV
FIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSL
SSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC;

PGDM1400 heavy chain:

QAQLVQSGPEVRKPGTSVKVSCKAPGNTLKTYDLHWVRSVPGQGLQWMGWISHEGDK
KVIVERFKAKVTIDWDRSTNTAYLQLSGLTSGDTAVYYCAKGSKHRLRDYALYDDDGA
LNWAVDVDYLSNLEFWGQGTAVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYF
PEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTK
VDKKVEPKSCDSR; or

combinations thereof.

37~~17~~. The fusion protein of any one of claims 23 to 36~~3 to 16~~, wherein the antibody or fragment thereof is conjugated to or associated with a further moiety, such as an antigen, a detectable moiety (e.g., a small molecule, fluorescent molecule, radioisotope, or magnetic particle), a pharmaceutical agent, a diagnostic agent, or combinations thereof.

38~~18~~. The fusion protein of claim 37~~17~~, wherein the antibody or fragment thereof comprises an antibody-drug conjugate.

39~~19~~. The fusion protein of claim 23~~3~~, wherein the antigen is associated with a vaccine-preventable and/or vaccine-treatable condition.

40~~20~~. The fusion protein of claim 39~~19~~, wherein antigen is associated with an infectious agent, including a virus, bacteria, parasite, fungus, or yeast, a cancer, including solid and liquid cancers, or an immune disease, including an autoimmune disease.

41~~21~~. The fusion protein of claim 23~~3~~, wherein the detectable moiety comprises a fluorescent protein, such as GFP, EGFP, Ametrine, and/or a flavin-based fluorescent protein, such as a LOV-protein, such as iLOV.

42~~22~~. The fusion protein of claim 23~~3~~, wherein the pharmaceutical agent comprises a small molecule, peptide, lipid, carbohydrate, or toxin.

43~~23~~. The fusion protein of any one of claims 21 to 42~~1 to 22~~, wherein from about 3 to about 100 nanocage monomers, such as 24, 32, or 60 monomers, or from about 4 to about 200 nanocage monomer subunits, such as 4, 6, 8, 10, 12, 14, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, or more, optionally in combination with one or more whole nanocage monomers, self-assemble to form a nanocage.

44~~24~~. The fusion protein of any one of claims 21 to 43~~1 to 23~~, wherein the nanocage monomer is selected from ferritin, apoferritin, encapsulin, SOR, lumazine synthase, pyruvate dehydrogenase, carboxysome, vault proteins, GroEL, heat shock protein, E2P, MS2 coat

protein, fragments thereof, and variants thereof.

45~~25~~. The fusion protein of claim 44~~24~~, wherein the nanocage monomer is apoferritin.

46~~26~~. The fusion protein of claim 45~~25~~, wherein the first and second nanocage monomer subunits interchangeably comprise the "N" and "C" regions of apoferritin.

47~~27~~. The fusion protein of claim 46~~26~~, wherein the "N" region of apoferritin comprises or consists of a sequence at least 70% (such as at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100%) identical to:
MSSQIRQNYSTDVEAAVNSLVNLYLQASYTYLSLGFYFDRDDVALEGVSHFFRELA
EEKREGYERLLKMQNQRGGRALFQDIKKPAEDEW.

48~~28~~. The fusion protein of claim 46 or 47~~26 or 27~~, wherein the "C" region of apoferritin comprises or consists of a sequence at least 70% (such as at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100%) identical to:
GKTPDAMKAAMALEKKLNQALLDLHALGSARTDPHLCDFLETHFLDEEVKLIKKMG
OHLTNLHRLGGPEAGLGEYLFERLTLRHD.

49~~29~~. The fusion protein of any one of claims 21 to 48~~1 to 28~~, further comprising a linker between the nanocage monomer subunit and the bioactive moiety.

50~~30~~. The fusion protein of claim 49~~29~~, wherein the linker is flexible or rigid and comprises from about 1 to about 30 amino acid residues, such as from about 8 to about 16 amino acid residues.

51~~31~~. The fusion protein of claim ~~29 or 30~~49 or 50, wherein the linker comprises a GGS repeat, such as 1, 2, 3, 4, or more GGS repeats.

52~~32~~. The fusion protein of claim 49~~29~~, wherein the linker comprises or consists of a sequence at least 70% (such as at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%,

or 100%) identical to:

ASTASSASSGGGGGGSGGSGGSGGS.

53~~33~~. The fusion protein of any one of claims 21 to 52~~1 to 32~~, further comprising a C-terminal linker.

54~~34~~. The fusion protein of claim 53~~33~~, wherein the C-terminal linker comprises or consists of a sequence at least 70% (such as at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100%) identical to:
GGSGGSGGSGGSGGGASGGS.

55~~35~~. A pair of the fusion proteins of any one of claims 21 to 54~~1 to 34~~, wherein the pair self-assembles to form a nanocage monomer, wherein the first and second nanocage monomer subunits are fused to different bioactive moieties.

56~~36~~. A nanocage comprising at least one fusion protein of any one of claims 21 to 54~~1 to 34~~ and at least one second nanocage monomer subunit that self-assembles with the fusion protein to form a nanocage monomer.

57~~37~~. A nanocage comprising at least one pair of claim 55~~35~~.

58~~38~~. The nanocage of claim 56 or 57~~36 or 37~~, wherein each nanocage monomer comprises the fusion protein of any one of claims 21 to 54~~1 to 34~~ or the pair of claim 55~~35~~.

59~~39~~. The nanocage of claim 56 or 57~~36 or 37~~, wherein from about 20% to about 80% of the nanocage monomers comprise the fusion protein of any one of claims 21 to 54~~1 to 34~~ or the pair of claim 55~~35~~.

60~~40~~. The nanocage of any one of claims 56 to 59~~36 to 39~~, comprising at least 2, 3, 4, 5, 6, 7, 8, 9, or 10 different bioactive moieties.

61~~41~~. The nanocage of any one of claims ~~36 to 40~~56 to 60, comprising at least one whole nanocage monomer, optionally fused to a bioactive moiety that may be the same or different from the bioactive moiety of any one of claims ~~1 to 37~~21 to 57.

62~~42~~. The nanocage of any one of claims 56 to 61~~36 to 41~~, wherein the nanocage is multivalent and/or multispecific.

63~~43~~. The nanocage of any one of claims 56 to 62~~36 to 42~~, comprising a first, second, and third fusion protein of any one of claims 21 to 54~~1 to 34~~, and at least one whole nanocage monomer, optionally fused to a bioactive moiety, wherein the bioactive moieties of the first, second, and third fusion proteins and of the whole nanocage monomer are all different from one another.

64~~44~~. The nanocage of claim 63~~43~~, wherein the first, second, and third fusion proteins each comprise an antibody or fragment thereof fused to N- or C-ferritin, wherein at least one of the first, second, and third fusion proteins is fused to N-ferritin and at least one of the first, second, and third fusion proteins is fused to C-ferritin.

65~~45~~. The nanocage of claim 64~~44~~, wherein the antibody or fragment thereof of the first fusion protein is an Fc fragment; wherein the second and third fusion proteins each comprise an antibody or fragment thereof specific for a different antigen of a virus such as HIV or wherein one of the second and third fusion proteins comprises an antibody or fragment thereof specific for an antigen of a virus such as HIV and the third fusion protein comprises an antibody or fragment thereof specific for a different antigen, such as the CD4 receptor; and wherein the whole nanocage monomer is fused to a bioactive moiety that is specific for another different antigen, optionally of the same virus such as HIV.

66~~46~~. The nanocage of claim 65~~45~~, wherein the Fc fragment comprises one or more mutations, such as LS, YTE, LALA, and/or LALAP, that modulate the half-life of the fusion protein from, for example, minutes or hours to several days, weeks, or months.

67~~47~~. The nanocage of claim 65 or 66~~45 or 46~~, wherein the antibody or fragment thereof of

the second fusion protein is N49P7 or iMab A12P; wherein the antibody or fragment thereof of the third fusion protein is 10E8v4.

68~~48~~. The nanocage of claim 67~~47~~, comprising the following four fusion proteins:

a. PGDM1400 (optionally scPGDM1400) fused to full length ferritin;

b. Fc (optionally scFc) fused to N-ferritin;

c. N49P7 or iMab A12P (optionally scN49P7 or sciMab A12P) fused to C-ferritin; and

d. 10E8v4 (optionally sc10E8v4) fused to C-ferritin.

69~~49~~. The nanocage of claim 68~~48~~, comprising a 4:2:1 :1: ratio of a:b:c:d.

70~~50~~. The nanocage of claim 68 or 69~~48 or 49~~, comprising or consisting of sequences at least 70% (such as at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100%) identical to one or more of the following sequences, where ferritin subunits are in bold, linkers are underlined, light chains are italicized, and heavy chains are in lowercase:

a. PGDM1400-hFerr:

DFVLTQSPHSLSVTPGESASISCKSSHSLIHGDRNNYLAWYVQKPGRSPQLLIYLASSRA
SGVPDRFSGSGSDKDFTLKISRVETEDVGTYYCMQGRESPWTFGQGTKVDIKRTVAAP
SVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDS
*TYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC*GGSSGSGSGSTGTSSS
GTGTSAGTTGTSASTSGSGSGGGGSGGGGSAGGTATAGASSGSGSSGSSSSGGT
Gqaqlvqsgpevrkpgtsvkvsckapgntlktydlhwvrsvpgqglqwmgwishegdkkviverfkakvtidwdrstn
taylqlsgltsgdtavyycakgskhrlrdyalydddgalnwavdvdylsnlefwgqgtavtvssastkgpsvfplapssksts
ggtaalgclvkdyfpepvtvswnsgaltsgvhtfpavlqssglyslssvvtvpssslgtqtyicnvnhkpsntkvdkkvepks
cdsrASTASSASSGGGGGGSGGSGGSGGS**MSSQIRQNYSTDVEAAVNSLVNLYL**
QASYTYLSLGFYFDRDDVALEGVSHFFRELAEEKREGYERLLKMQNQRGG
RALFQDIKKPAEDEWGKTPDAMKAAMALEKKLNQALLDLHALGSARTDPH
LCDFLETHFLDEEVKLIKKMGDHLTNLHRLGGPEAGLGEYLFERLTLRHDG
GSGGSGGSGGSGGGASGGS;

b. Fc-N-hFerr LS

DKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNW
YVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKT
ISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKT
*TPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVLHEALHSHYTQKSLSLSPGK*GGSS
GSGSGSTGTSSSGTGTSAGTTGTSASTSGSGSGGGGSGGGGSAGGTATAGASSG
SGSSGSSSSGGTGdkthtcppcpapellggpsvflfppkpkdtlmisrtpevtcvvvdvshedpevkfnwyvdgv

evhnaktkpreeqynstyrvvsvltvlhqdwlngkeykckvsnkalpapiektiskakgqprepqvytlppsreemtknq
vsltclvkgfypsdiavewesngqpennykttppvldsdgsfflyskltvdksrwqqgnvfscsvlhealhshytqkslslsp
gksrASTASSASSGGGGGGSGGSGGSGGS**MSSQIRQNYSTDVEAAVNSLVNLYL**
QASYTYLSLGFYFDRDDVALEGVSHFFRELAEEKREGYERLLKMQNQRGG
RALFQDIKKPAEDEW;

c1. N49P7-C-hFerr

QSALTQPRSVSASPGQSVTISCTGTHNLVSWCQHQPGRAPKLLIYDFNKRPSGVPDRF
SGSGSGGTASLTITGLQDDDDAEYFCWAYEAFGGGTKLTVLGQPKAAPSVTLFPPSSE
ELQANKATLVCLISDFYPGAVTVAWKADSSPVKAGVETTTPSKQSNNKYAASSYLSLTP
*EQWKSHRSYSCQVTHEGSTVEKTVAPTEC*GGSSGSGSGSTGTSSSGTGTSAGTTGTS
ASTSGSGSGGGGGSGGGGSAGGTATAGASSGSGSSGSSSSGGTGadlvqsgavvkkpgd
svrisceaqgyrfpdyiihwirrapgqgpewmgwmnpmggqvnipwkfqgrvsmtrdtsietafldlrglksddtavyy
cvrdrsngsgkrfessnwfldlwgrgtavtiqsastkgpsvfplapsskstsggtaalgclvkdyfpepvtvswnsgaltsgv
htfpavlqssglyslssvvtvpssslgtqtyicnvnhkpsntkvdkkvepkscdsrASTASSASSGGGGGGSGG
SGGSGGS**GKTPDAMKAAMALEKKLNQALLDLHALGSARTDPHLCDFLETH**
FLDEEVKLIKKMGDHLTNLHRLGGPEAGLGEYLFERLTLRHDGGSGGSGGS
GGSGGGASGGS;

c2. Ibalizumab-A12P-C-hFerr

DIVMTQSPDSLPVSLGERVTMNCKSSQSLLYSTNQKNYLAWYQQKPGQSPKLLIYWAS
TRESGVPDRFSGSGSGTDFTLTISSVQAEDVAVYYCQQYYSYRTFGGGTKLEIKRTVAA
PSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKD
*STYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC*GGSSGSGSGSTGTSS
SGTGTSAGTTGTSASTSGSGSGGGGGSGGGGSAGGTATAGASSGSGSSGSSSSGG
TGqvqlqqsgpevvkpgasvkmsckasgytftsyvihwvrqkpgqgldwigyinpyndgtdydekfkgkatltsdtsts
taymelsslrsedtavyycarekdnyatgawfaywgqgtlvtvssastkgpsvfplapcsrstsestaalgclvkdyfpepvt
vswnsgaltsgvhtfpavlqssglyslssvvtvpssslgtktytcnvdhkpsntkvdkrveskygsrASTASSASSGG
GGGGSGGSGGSGGS**GKTPDAMKAAMALEKKLNQALLDLHALGSARTDPHL**
CDFLETHFLDEEVKLIKKMGDHLTNLHRLGGPEAGLGEYLFERLTLRHDGG
SGGSGGSGGSGGGASGGS; or

d. 10E8.v4-C-hFerr

SELTQDPAVSVALKQTVTITCRGDSLRSHYASWYQKKPGQAPVLLFYGKNNRPSGIPD
RFSGSASGNRASLTITGAQAEDEADYYCSSRDKSGSRLSVFGGGTKLTVLSQPKAAPSV
TLFPPSSEELQANKATLVCLISDFYPGAVTVAWKADSSPVKAGVETTTPSKQSNNKYAA
*SSYLSLTPEQWKSHRSYSCQVTHEGSTVEKTVAPTEC*GGSSGSGSGSTGTSSSGTGTS
AGTTGTSASTSGSGSGGGGGSGGGGSAGGTATAGASSGSGSSGSSSSGGTGevrlve
sggglvkpggslrlscsasgfdfdnawmtwvrqppgkglewvgritgpgegwsvdyaesvkgrftisrdntkntlylemn
nvrtedtgyyfcartgkyydfwsgyppgeeyfqdwgqgtlvivssastkgpsvfplapsskstsggtaalgclvkdyfpepv
tvswnsgaltsgvhtfpavlqssglyslssvvtvpssslgtqtyicnvnhkpsntkvdkkvepkscsrASTASSASSG
GGGGSGGSGGSGGS**GKTPDAMKAAMALEKKLNQALLDLHALGSARTDPH**

LCDFLETHFLDEEVKLIKKMGDHLTNLHRLGGPEAGLGEYLFERLTLRHDGGSGGSGGSGGSGGGASGGS.

71~~51~~. The nanocage of any one of claims 56 to 70~~36 to 50~~, carrying a cargo molecule, such as a pharmaceutical agent, a diagnostic agent, and/or an imaging agent.

72~~52~~. The nanocage of claim 71~~51~~, wherein the cargo molecule is not fused to the fusion protein and is contained in the nanocage internally.

73~~53~~. The nanocage of claim 71~~51~~, wherein the cargo molecule is a protein and is fused to the fusion protein such that the cargo molecule is contained in the nanocage internally.

74~~54~~. The nanocage of any one of claims 71 to 73~~51 to 53~~, wherein the cargo molecule is a fluorescent protein, such as GFP, EGFP, Ametrine, and/or a flavin-based fluorescent protein, such as a LOV-protein, such as iLOV.

75~~55~~. The nanocage of any one of claims 71 to 74~~51 to 54~~, wherein the cargo molecule is contained internally to provide T-cell epitopes, but optionally not B-cell epitopes.

76~~56~~. The nanocage of any one of claims 71 to 74~~51 to 54~~, wherein the cargo molecule is fused to the fusion protein and contained internally to provide T-cell epitopes, but optionally not B-cell epitopes.

77~~57~~. The nanocage of claim 71 or 72~~51 or 52~~, wherein the cargo molecule is a small molecule, radioisotope, or magnetic particle.

78~~58~~. The nanocage of any one of claims 56 to 77~~36 to 57~~, further comprising an antigen on the surface.

79~~59~~. The nanocage of claim 78~~58~~, wherein the antigen is expressed as a fusion protein with a nanocage monomer.

8060. A vaccine comprising the nanocage of any one of claims 56 to 7936 to 59.

8161. A therapeutic or prophylactic composition comprising the nanocage of any one of claims 56 to 7936 to 59.

8262. A nucleic acid molecule encoding the fusion protein of any one of claims 21 to 541 to 34 or the pair of claim 5535.

8363. A vector comprising the nucleic acid molecule of claim 8262.

8464. A host cell comprising the vector of claim 8363 and producing the fusion protein of any one of claims 21 to 541 to 34 or the pair of claim 5535.

8565. A method of immunizing a subject, the method comprising administering the nanocage of any one of claims 56 to 7936 to 59 or the vaccine of claim 8060.

~~66. A method for treating and/or preventing a disease or condition, the method comprising administering the nanocage of any one of claims 36 to 59 or the vaccine of claim 60.~~

~~67. The method of claim 66, wherein the disease or condition is cancer, an infectious disease such as HIV, malaria, influenza, RSV, rotavirus, or an autoimmune disease.~~

8668. A method for diagnostic imaging, the method comprising administering the nanocage of any one of claims 56 to 7936 to 59 to a subject, tissue, or sample, wherein the nanocage comprises a diagnostic label, such as a fluorescent protein or magnetic imaging moiety, and imaging the subject, tissue, or sample.

8769. Use of the nanocage of any one of claims 56 to 7936 to 59 or the vaccine of claim 8060 for immunizing a subject.

88~~70~~. Use of the nanocage of any one of claims 56 to 79~~36 to 59~~ or the vaccine of claim 80~~60~~ for treating and/or preventing a disease or condition.

89~~71~~. ~~The u~~Use of the nanocage of any one of claims ~~70~~56 to 79 in the manufacture of a medicinal product, or use of the vaccine of claim 80 as the medicinal product, ~~wherein the disease or condition is~~for treating cancer, an infectious disease such as HIV, malaria, influenza, RSV, rotavirus, or an autoimmune disease.

90~~72~~. Use of the nanocage of any one of claims 56 to 79~~36 to 59~~ for diagnostic imaging of a subject, tissue, or sample, wherein the nanocage comprises a diagnostic label, such as a fluorescent protein or magnetic imaging moiety, and imaging the subject, tissue, or sample.

91~~73~~. Use of the fusion protein of any one of claims 21 to 54~~1 to 34~~, the pair of claim 55~~35~~, or the nanocage of any one of claims 56 to 79~~36 to 59~~ as a research tool, such as in FACS or in an ELISA.

92~~74~~. The nanocage of any one of claims 56 to 79~~36 to 59~~ or the vaccine of claim 80~~60~~ for use in immunizing a subject.

93~~75~~. The nanocage of any one of claims 56 to 79~~36 to 59~~ or the vaccine of claim 80~~60~~ for use in treating and/or preventing a disease or condition.

94~~76~~. The nanocage of claim 93~~70~~, wherein the disease or condition is cancer, an infectious disease such as HIV, malaria, influenza, RSV, rotavirus, or an autoimmune disease.

95~~77~~. The nanocage of any one of claims 56 to 79~~36 to 59~~ for use in diagnostic imaging of a subject, tissue, or sample, wherein the nanocage comprises a diagnostic label, such as a fluorescent protein or magnetic imaging moiety, and imaging the subject, tissue, or sample.

9678. The fusion protein of any one of claims 21 to 541 to 34, the pair of claim 5535, or the nanocage of any one of claims 56 to 7936 to 59 for use as a research tool, such as in FACS or in an ELISA.

9779. A nanocage comprising a plurality of fusion proteins, wherein each fusion protein comprises a ferritin light chain and an Fab fragment, wherein each Fab fragment is capable of specifically binding to an antigen, wherein each Fab fragment decorates the exterior surface of the nanocage, and wherein the plurality comprises at least 12 fusion proteins.

9880. The nanocage of claim 9779, wherein the plurality comprises at least 19 fusion proteins.

9981. The nanocage of claim 9880, wherein the plurality comprises at least 24 fusion proteins.

10082. The nanocage of claim 9982, wherein the plurality is 24 fusion proteins.

10183. The nanocage of any one of claims 97-100,79-82 wherein the Fab fragments of the plurality of fusion proteins are capable of specifically binding to the same antigen.

10284. The nanocage of any one of claims 97-10179-83, wherein the nanocage does not include any ferritin heavy chains.

10385. The nanocage of any one of claims 97-10279-84, wherein the Fab fragments are Fab fragments of a neutralizing antibody.

10486. The nanocage of any one of claims 97-10379-85, wherein the antigen is associated with an infectious agent.

10587. The nanocage of claim 10486, wherein the infectious agent is a virus.

10688. The nanocage of claim 10587, wherein the virus is a human immunodeficiency virus (HIV).

10789. The nanocage of any one of claims 85-88103-106, wherein the nanocage is capable of neutralizing the infectious agent with a neutralizing activity of at least 100-fold, 150-fold, 200-fold, 250-fold, 300-fold, 350-fold, 400-fold, 450-fold, or 500-fold greater relative to a control.

10890. The nanocage of claim 10789, wherein the control comprises a full length version of the neutralizing antibody.

10991. The nanocage of claim 10890, wherein the neutralizing antibody is an IgG antibody.

92. A nanocage comprising a plurality of first fusion proteins and a plurality of second fusion proteins, wherein each first fusion protein comprises a nanocage monomer or a subunit thereof and an Fab fragment capable of specifically binding to an antigen, and wherein each second fusion protein comprises a nanocage monomer or a subunit thereof and an Fc fragment.

93. The nanocage of claim 92, wherein the nanocage monomer is selected from ferritin, apoferritin, encapsulin, sulfur oxygen reductase (SOR), lumazine synthase, pyruvate dehydrogenase, carboxysome, vault protiens, GroEL, heat shock protein, E2P, MS2 coat protein, fragments thereof, and variants thereof.

94. The nanocage of claim 93, wherein the nanocage monomer is apoferritin or ferritin.

95. The nanocage of claim 93, wherein the nanocage monomer is a ferritin light chain.

96. The nanocage of claim 94 or 95, wherein the nanocage monomer does not include any ferritin heavy chains.

97. A nanocage comprising a plurality of first fusion proteins and a plurality of second fusion proteins, wherein

(a) (i) the first fusion protein comprises a ferritin light chain and an Fab fragment capable of specifically binding to a first antigen, and

(ii) the second fusion protein comprises a ferritin light chain and an Fab fragment capable of specifically binding to a second antigen, or

(b) (i) the first fusion protein comprises N-ferritin and an Fab fragment capable of specifically binding to a first antigen, and

(ii) the second fusion protein comprises C-ferritin and an Fab fragment capable of specifically binding to a second antigen,

wherein, within each fusion protein, the Fab fragment is fused to the N-terminus of the ferritin light chain, the N-ferritin, or the C-ferritin, and wherein the first antigen is distinct from the second antigen.

98. A nanocage comprising a plurality of first fusion proteins, a plurality of second fusion proteins, and a plurality of third fusion proteins, wherein

(a) the first fusion protein comprises a ferritin light chain and an Fab fragment capable of specifically binding a first antigen,

(b) the second fusion protein comprises a C-ferritin and an Fab fragment capable of specifically binding a second antigen, and

(c) the third fusion protein comprises an N-ferritin and an Fc fragment, wherein, within each fusion protein the Fab or Fc fragment is fused to the N-terminus of the ferritin light chain, the C-ferritin, or the N-ferritin, and

wherein the first antigen is distinct from the second antigen.

99. The nanocage of claim 97 or 98, further comprising a plurality of fourth fusion proteins, wherein, the fourth fusion protein comprises a C-ferritin and an Fab fragment capable of specifically binding a third antigen, wherein the third antigen is distinct from the first and second antigens.

100. The nanocage of claim 97, 98, or 99, wherein the Fab fragments are Fab fragments of a neutralizing antibody.

101. The nanocage of any one of claims 97-100, wherein the first and second antigens are each associated with an infectious agent.

102. The nanocage of claim 101, wherein the first and second antigens are associated with the same infectious agent.

103. The nanocage of claims 101 or 102, wherein the infectious agent is a virus.

104. The nanocage of claim 103, wherein the virus is a human immunodeficiency virus (HIV).

105. The nanocage of claim 100, wherein the first and second antigens are each associated with a virus, wherein the nanocage is capable of neutralizing 100% of pseudoviruses in a panel of pseudoviruses, and wherein the panel of pseudoviruses comprises, for each Fab fragment within the nanocage capable of specifically binding to an antigen associated with the virus, at least one pseudovirus resistant to a neutralizing antibody corresponding to that Fab fragment.

106. The nanocage of claim 105, wherein the panel of pseudoviruses comprises at least 10, at least 11, at least 12, at least 13, or at least 14 pseudoviruses.

107. The nanocage of any one of claims 100, 105, or 106, wherein the first and second antigens are each associated with a virus, wherein the nanocage is capable of neutralizing a panel of pseudoviruses with an IC_{50} of less than 1 nM, less than 500 pM, less than 250 pM, less than 100 pM, less than 50 pM, less than 10 pM, or less than 5 pM, and
wherein the panel of pseudoviruses comprises, for each Fab fragment within the nanocage capable of specifically binding to an antigen associated with the virus, at least one pseudovirus resistant to a neutralizing antibody corresponding to that Fab fragment.

108. The nanocage of any one of claims 100 and 105-107, wherein the first and second antigens are each associated with a virus, wherein the nanocage is capable of neutralizing a panel of pseudoviruses with an IC_{50} (molar concentration) of at least 10-fold, at least 20-fold, at least 30-fold, at least 40-fold, at least 50-fold, at least 60-fold, at least 70-fold, at least 80-fold, at least 90-fold, or at least 100-fold lower than that of one or more controls, and wherein the panel of pseudoviruses comprises, for each Fab fragment within the nanocage capable of specifically

~~binding to an antigen associated with the virus, at least one pseudovirus resistant to a neutralizing antibody corresponding to that Fab fragment.~~

~~109. The nanocage of claim 108, wherein the one or more controls comprise a neutralizing antibody corresponding to a Fab fragment within the nanocage, which Fab fragment is capable of specifically binding to an antigen associated with the virus.~~

~~110. The nanocage of claim 109, wherein the neutralizing antibody is an IgG antibody.~~

~~111. The nanocage of claim 108, 109, or 110, wherein the one or more controls comprise a cocktail of neutralizing antibodies, wherein the cocktail comprises, for each Fab fragment within the nanocage capable of specifically binding to an antigen associated with the virus, a neutralizing antibody corresponding to that Fab fragment.~~