Title:

BIOLOGICALLY FORMED NANOSCALE DEVICES

United States Patent Application 20150307570 **Kind Code:** A1

Abstract:

The invention in suitable embodiments is directed to biologically formed nanoscale devices and components employing in whole or in part isolated bio-nanoparticle elements. In one aspect, one or more device, formed in whole or in part from isolated, synthetic and or recombinant amino acid residues comprising in whole or in part one or more types of isolated clathrin protein and/or non-clathrin coatomer proteins of one or more isoforms, form one or one or more types and forms of nanoscale devices and/or components thereof for use in vivo or in vitro.

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38. An isolated protein platform up to 100 nanometers in diameter and self-assembled from one or more isolated SEQ ID NO: 1 for use as a scalable technique to assemble in whole and/or in part a nanoscale device, comprising: a selected nanoscale device configuration; one or more additional techniques for optional use in assembling the selected configuration; one or more elements for use in functionalizing the selected configuration; an energy resource capable of generating at least one form of energy and usable by the selected configuration, wherein the assembled nanoscale device is capable of utilizing at least some of the generated energy to provide one or more function in vivo or in vitro.

39. The isolated protein platform according to claim 38, wherein the isolated SEQ ID NO: 1 is also configured with one or more isolated sequence selected from an isolated SEQ ID NO: 12, SEQ ID NO: 13, SEQ ID NO: 14, and combinations thereof.

40. The isolated protein platform according to claim 38, wherein the isolated SEQ ID NO: 1 is substituted in whole or in part with one more isolated sequence selected from an isolated SEQ ID NO: 2, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 6, SEQ ID NO: 7, SEQ ID NO: 8, SEQ ID NO: 9, SEQ ID NO: 10, SEQ ID NO: 11, and combinations thereof.

41. The isolated protein platform according to claim 38, wherein the isolated SEQ ID NO: 1 is substituted in whole or in part with one more isolated sequence selected from an isolated SEQ ID NO: 15, SEQ ID NO: 16, SEQ ID NO: 17, SEQ ID NO: 18, SEQ ID NO: 19, SEQ ID NO: 20, SEQ ID NO: 21, SEQ ID NO: 22, SEQ ID NO: 23, SEQ ID NO: 24, SEQ ID NO: 25, SEQ ID NO: 26, SEQ ID NO: 27, SEQ ID NO: 28, SEQ ID NO: 29, SEQ ID NO: 30, and combinations thereof.

42. The isolated protein platform of any of claims 38-**40**, wherein said isolated sequence comprises in whole or in part a plurality of clathrin coatomer protein molecules selected from purified, isolated, synthetic, recombinant, biologically modified, chemically modified, genetically modified, hybridized, chiral clathrin coatomer protein molecules, and combinations thereof.

43. The isolated protein platform according to claim 41, wherein said isolated sequence comprises in whole or in part a plurality of non-clathrin-coat protein molecules selected from purified, isolated, synthetic, recombinant, biologically modified, chemically modified, genetically modified, hybridized, chiral non-clathrin-coat protein molecules, and combinations thereof.

44. The isolated protein platform according to claim 38, wherein the isolated SEQ ID NO: 1 comprises in whole or in part a purified clathrin heavy chain element.

45. The isolated protein platform according to claim 44, wherein the purified clathrin heavy chain element comprises in whole or in part one or more interaction site elements, distinctive domain elements, heavy chain subunit elements, light chain subunit elements, and combinations thereof.

46. The isolated protein platform according to claim 38, wherein a configuration of one or more of the isolated SEQ ID NO: 1 forms in whole or in part one or more legs of an isolated clathrin triskelion element.

47. The isolated protein platform according to claim 38, wherein the isolated protein platform comprises one or more preparations of isolated heterotetrameric adaptor protein elements selected from an isolated AP-1, AP-2, AP-3, AP-4, AP-5, AP-6, AP-1A, AP-1B, AP-3B, b-arrestin, tubulin protein, dynamin protein, epsin protein, endophilin protein, synaptotagmin, Golgi-localizing, Gamma-adaptin ear domain homology, ARF-binding element, and combinations thereof.

48. The isolated protein platform according to claim 38, wherein the isolated protein platform is greater than one nanometer in diameter.

49. The isolated protein platform according to claim 38, wherein the isolated protein platform is at least about 50 nanometers in diameter.

50. The isolated protein platform according to claim 38, wherein the isolated protein platform is at least about 100 nanometers in diameter.

51. The isolated protein platform according to claim 38, wherein the step of assembling comprises in whole or in part in vivo or in vitro self-assembly, disassembly, and/or a response of the isolated protein platform.

52. The isolated protein platform according to claim 51, wherein the step of assembling includes use of one or more pH factor and/or a heat shock cognate protein.

53. The isolated protein platform according to claim 38, wherein the additional technique is selected from the group consisting of an adduct, bio-molecular, biochemical, biodegradable, bioengineered, chemical, chromatographic, enzyme, externally directed, glass surface, imprint, imprinted membrane, imprinted polymer, lithographic, mechanically assembled, mechanistically directed, mimic, molded, molecular imprint, monolith, nanofabrication, print, polymer, protein-based, scalable, self-assembling, shape imprinted, shape programmable, shaped scaffolding, silica wafer, site-specific, site directed mutagenesis, structured, surface imprint, template, thin film technique, and combinations thereof.

54. The isolated protein platform according to claim 38, wherein the nanoscale device configuration is selected from the group consisting of an acoustic, algorithmic, analog, assay, agriculture, autonomous, battery, biochemical, biochip, biological, biomedical, biomolecular, Casimir, cell control, cell communication, cell enhancing, cell regenerating, cell regulation, cell repair, cell replacement, cell supplement, chemical, communication, control, Coulomb blockade, cybernetic, cytometry, digital, delivery, diagnostic, dosing, drug, electrical, electronic component, electrical current, electromagnetic, enhancement, energy conduction, energy conversion, energy producing, energy storage, environmental, extracellular, enzyme, fabrication, genetic,

55. The isolated protein platform according to claim 38, wherein the energy resource is selected from the group consisting of an acoustical, biochemical, bioluminescent, biological, chemical, laser, electrical, electrical field, electromagnetic, enzyme, light emitting diode, luminescent, magnetic field, mechanical, metabolic, pH, ordinary light, photoisomerisable species, optoelectronic, photodetector, photoelectric, photonic, photosensitive, photovoltaic, quantum dot, quantum mechanical, thermal energy resource, and combinations thereof.

56. The isolated protein platform according to claim 38, wherein the functionalization element is selected from the group consisting of an active, amino acid, biological, capsid, carbon, chemical, circuit, conductor, control, crystal, diagnostic, dendrimer, DNA, electrical, electromagnetic, endohedral, ferroelectric, ferromagnetic, fluorescent, fluid, Fullerene, gas, geometrically derived, hydrophilic, hydrophobic, imaging, in situ, in vitro, in vivo, insulator, label, large molecule, linear, liposome, liquid, macromolecule, magnetic, magnetic domain, magnetic ring, media, medicament, metal, metalloprotein, micelle, micro-electromechanical, nanoparticle, nanotube, nonlinear, optical, opto-electronic, paramagnetic, passive, peptide, pH, photonic, polarized, polymer, protein, quantum mechanical, RNA, RNA variant, radioactive, regulating, semiconductor, sensor, small molecule, storage, switch, temperature, transistor, transition metal, vapor element, and combinations thereof.

57. The isolated protein platform according to claim 45, wherein the step of assembling optionally or exclusively comprises configuring one or more of the purified clathrin heavy chain elements for arrangement in an electron conduction and/or transfer system.

58. The isolated protein platform according to claim 45, wherein the step of assembling optionally or exclusively comprises configuring one or more of the purified clathrin heavy chain elements for arrangement in an electrically or optically induced and/or controlled color change system.

59. The isolated protein platform according to claim 45, wherein the step of assembling optionally or exclusively comprises configuring one or more of the purified clathrin heavy chain elements for arrangement in an electronic switching system.

60. The isolated protein platform according to claim 45, wherein the step of assembling optionally or exclusively comprises configuring one or more of the purified clathrin heavy chain elements for arrangement in an electrical or photonic energy storage system.

61. The isolated protein platform according to claim 45, wherein the step of assembling optionally or exclusively comprises configuring one or more of the purified clathrin heavy chain elements for arrangement in an optical or an electrical signal amplification system.

62. The isolated protein platform according to claim 45, wherein the step of assembling optionally or exclusively comprises configuring one or more of the purified clathrin heavy chain elements for arrangement in a data processing, storage, and/or transmission system.

63. The isolated protein platform according to claim 45, wherein the step of assembling optionally or exclusively comprises configuring one or more of the purified clathrin heavy chain elements for use as functionalization elements arrangement in an operational system.

64. The isolated protein platform according to claim 38, wherein one or more of the functionalization elements are fused with the isolated protein platform.

65. The isolated protein platform according to claim 38, wherein one or more of the functionalization elements are hybridized with the isolated protein platform.

66. The isolated protein platform according to claim 38, wherein one or more of the functionalization elements are bound to the isolated protein platform by a linker.

67. The isolated protein platform according to claim 38, wherein a masking moiety is bound to any of the components by a linker.

68. The isolated protein platform according to claim 38, wherein a targeting moiety is bound to any of the components by a linker.

69. The isolated protein platform of any of claims 66-**68**, wherein said linker comprises one or more linkers selected from the group consisting of amino acid, biotin-avidin coupler, chemical, covalent bond, non-covalent bond, cross-linker, cysteamine, lysine, ionic, molecular bridge, PEG, peptide, molecular bridge, molecular tether, spacer, and combinations thereof.

70. The isolated nanoscale platform according to claim 38, wherein the components and/or the nanoscale device respond in whole or in part to an internal and/or external event.

71. The isolated nanoscale platform according to claim 70, wherein the event comprises one or more stimulus of any type, including but not limited to acoustical, biochemical, biological, chemical, covalent, disease, disorder, electrical, electromagnetic, fluidic, genotype, ionic, magnetic, mechanical, metabolic, non-covalent, optical, pathogen, pathology, pH, phenotype, photonic, quantum mechanical, radioactive, radiological, sonic, temperature, toxin stimuli type and combinations thereof.

72. The isolated nanoscale platform according to claim 70, wherein the response comprises at least one step selected from an activation, algorithmic, alteration, amplification, analysis, assay, autonomous, cellular process, change of color, change of state, communication, computation, conduction, control, deactivation, decoding, detection, diagnostic, electronic, encoding, execution, inhibition, input, intermixing, labeling, measuring, optical, output, photonic, processing, programmed, promoting, reading, regulation, reporting, signal generation, storing, switching, tagging, testing, therapeutic, transduction, transfer, transmitting, treating step, and combinations thereof.

preceding action selected from enabling, enhancing, functionalizing, modifying, delivering, repurposing, transporting the nanoscale device, and combinations thereof.

75. The isolated protein platform according to claim 38, wherein the isolated protein platform comprises multiple: functionalization elements, assembly techniques, nanoscale devices, energy resources, configurations, isolated SEQ ID NO: 1.

76. The isolated protein platform according to claim 38, wherein the nanoscale device comprises a composition suitable for in vivo or in vitro use in a human or animal.

77. The isolated protein platform according to claim 38, wherein the nanoscale device comprises a composition suitable for commercial or industrial use.

78. The isolated protein platform according to claim 38, wherein the nanoscale device comprises a composition suitable for research use.

79. A method for forming a nanoscale device comprising: forming an isolated protein platform up to 100 nanometers in diameter and self-assembled from one or more isolated SEQ ID NO: 1 for use as a scalable technique to assemble in whole and/or in part a nanoscale device, comprising: a selected nanoscale device configuration; one or more additional techniques for optional use in assembling the selected configuration; one or more elements for use in functionalizing the selected configuration; an energy resource capable of generating at least one form of energy and usable by the selected configuration, wherein the assembled nanoscale device is capable of utilizing at least some of the generated energy to provide one or more function in vivo or in vitro.

Description:

This is a division of pending USPTO Utility application Ser. No. 12/399,906, with the title, “DYNAMIC BIO-NANOPARTICLE ELEMENTS”, originally filed on Mar. 6, 2009, and claims priority to that date. The invention relates generally to the field of nanoparticles, and more specifically, in one embodiment, to dynamic bio-nanoparticle elements formed from materials comprised of self-assembling protein molecules, which are capable of executing one or more functions and or effect one or more ends, in vivo and or in vitro. In another invention embodiment, the invention relates to a multifunction nanoscale bio-nanoparticle platform, such as a biomedical platform, bio-molecular platform, electronics platform, information processing platform, and the like, using such dynamic bio-nanoparticle elements.

FIELD OF THE INVENTION

Background of the Invention

Structures at the nanoscale are sometimes referred to as nanoparticles. Some nanoparticles comprise cage elements that form cavities and or comprise vesicle elements; examples of which in the prior art teach elements such as nano-carbon endohedral cages (Fullerenes); capsids, the protein shell of a virus; liposomes; lipids; heat shock proteins; ferritins; vault ribonucleoprotein particles; Clathrin protein cages; and Coatomer I/II protein cages, among other various cage- or vesicle-forming elements. Additionally, prior art teaches that protein cage elements can coat vesicle elements; for example, Clathrin and Coatomer coated vesicles (CCV's). Additionally, prior art teaches that one or more types of cargo elements can be located internally with respect to a cage and vesicle element.

A cavity forming protein cage and a cage coated vesicle implementation is taught in issued U.S. Pat. No. 7,393,924 (Jul. 1, 2008, Vitaliano et al.) The cage and cage coated vesicle elements are formed in vitro from a plurality of isolated Clathrin/Coatomer protein subunits. As taught in U.S. Pat. No. 7,393,924, the enhanced functionalization capabilities of the isolated Clathrin and Coatomer I/II protein molecules enable a number of properties and features that make them superior to other cage and cage coated vesicle elements in the prior art.

But the instant invention teaches nanoscale element fabrication, assembly, operation, behavior and properties that are unique from prior protein art that encompasses various types of cavity-forming cage structures formed in vitro from a plurality of self-assembling subunits. For example, a fully formed Clathrin cage element as taught in U.S. Pat. No. 7,393,924, and generally speaking taught in other Clathrin art, is comprised of a plurality of 3-legged triskelia, each triskelion having 6 protein subunits; 3 Clathrin heavy chain and 3 Clathrin light chain subunits.

In marked contrast, the instant invention teaches that complete cages comprised of a plurality of 3-legged triskelia are not required to comprise one or more types of efficacious elements. Instead, in its most essential embodiment the instant invention teaches one or more nanoscale elements of one or more types formed from isolated, synthetic and or recombinant amino acid residues comprising in whole or in part one or more types of Clathrin and or Coatomer I/II proteins of one or more isoforms, including cloned isoforms. These isoforms with their differing amino acid sequences comprise (in this example, humans) the various types of Clathrin heavy chains, the various types of Clathrin light chains, encompass the distinct heavy chain and light chain segments and domains, and in the case of Coatomer, comprise and encompass its domains and subunits, with different combinations of the latter known to exist within Coatomer complexes. Examples of amino acid sequences comprising Clathrin and Coatomer proteins, and their respective isoforms are listed in SEQ ID NO:1 to SEQ ID NO:30. Accordingly, one or more instant invention embodiments may also comprise minimalist, non-cage elements of one or more types. The minimalist element structure afforded by the instant invention affords a much broader and richer variety of element configurations and embodiments than those taught in prior Clathrin or other protein cage art.

For example, freed of the constraints of only forming cavity-forming protein cages in vitro, one or more non-cage invention elements may also form one or more other types of nanoscale elements and structures, enabling new classes and types of applications. Example non-cage embodiments include, but are not limited to, functionalized nano-tubule structures; protein-based nano-dendrimers suitable for biomedical and bio-molecular applications; and self-assembling, stable, bioactive, protein-based, hydrogel nanoparticles (nanogels). In other embodiments, one or more nanoscale elements and structures may be additionally formed and comprised of one or more non-invention elements of one or more types. Such structural plasticity and flexible element functionality are not taught in prior protein cage art.

Prior art often teaches one or more types of protein cages that carry one or more types of additional elements, e.g., cargo, to enable overall

In another embodiment, one or more elements and or their additional elements in whole or in part may require only minimal functionalization to be efficacious; e.g., they may not require PEGylation or other types of functionalization to operate effectively.

In another embodiment, one or more elements carry one or more types of cargo and the cargo acts as the efficacious element. In another embodiment, one or more elements together with cargo elements act in efficacious concert.

In another embodiment, one or more elements are penetrating elements that enter one or more cells and gain access to the cytosol and intracellular elements of one or more types, including one or more cell organelles. Such elements may, in one embodiment, require minimal functionalization. In another embodiment, one or more elements may comprise one or more membrane fusion elements. These various features are not taught in prior protein cage art. In one embodiment, using cell crossing techniques yield efficacious cancer treatments, gene therapy, and the like.

Further, in cage, cavity, and vesicle prior art, one or more types of additional elements, e.g., cargo, are often inserted into a complex, fully formed structure, a sometimes difficult and laborious process. But the invention, in one or more embodiments, teaches that using utilizing non-cage elements of one or more types makes the addition of one or more elements less difficult as there is no insertion process into a cage, cavity, or vesicle to contend with. In another embodiment, additional element functionalization is simplified by decorating just the external surface of a cage, a feature not taught in prior Clathrin art.

In another embodiment, one or more assay, diagnostic, therapeutic, and prosthetic applications and the like can be performed ensemble using the same bioengineered element.

These various functionalization capabilities enable a highly flexible nano-platform that features improved stability, rigidity, functionality and loading capacity relative to other nanoparticles, and being comprised of ubiquitous proteins, features low antigenicity in one or more embodiments. In one illustrative embodiment, one or more elements may be harmlessly dissolved, passed, and or excreted from the body.

In one embodiment, the current application teaches one or more elements comprising one or more types of hybrid elements and arrangements, which can produce efficacious results. In one embodiment, one or more invention elements are conjugated to natural biological/molecular elements, like cells, but not limited to, forming one or more types of hybrid elements in vitro and or in vivo. Such hybrid elements may operate alone or with additional elements, e.g., with cargo. In another embodiment, such hybrid elements may fuse in vitro and or in vivo with non-invention elements, such as those comprising natural elements in cells, but not limited to. This type of hybrid/fusion capability and flexibility is not taught in the prior art.

In another embodiment, the current application teaches one or more elements, functioning alone or with one or more additional elements, which comprise efficacious replacements for one or more elements of one or more types, including non-invention elements. In one embodiment, one or more elements may replace one or more types of naturally occurring cell elements, to efficacious effect. This replacement capability is not taught in the prior art.

In one embodiment, the instant invention teaches one or more elements, functioning alone or with one or more additional elements, which comprise one or more cellular repair elements, of one or more types; a capability not taught in the prior art. In another embodiment the elements are cellular regeneration elements.

Prior art also does not teach that cage, vesicle elements, or their various subunit elements efficaciously operate in the extra-cellular spaces, e.g., in the synaptic spaces between neurons. But the instant invention teaches one or more types of elements capable of such extracellular operation, including for the in situ remediation, removal and or sequestration of undesirable organic and or non-organic elements.

The invention further teaches a biological model that is consistent, not from the complete cage element level up, but from the minimalist, non-cage element level up, in vitro and in vivo, making drug discovery safer, more efficacious, more time and cost effective, and overall, a much more rapid process than prior art.

In another embodiment, one or more elements may comprise one or more types of minimalist, non-cage elements than that taught in prior art for doing clinical trials of one or more types of agents, including their targeted agent delivery, including high precision dosing.

In one embodiment, the instant invention teaches one or more elements that in whole or in part execute one or more types of actions for creating, spawning, comprising, modifying, repairing, regenerating, reassembling, and or control and regulation of one or more cells, cellular elements, cell organelles, including like actions and behaviors involving cellular processes such as endocytosis, exocytosis, mitosis, trafficking and signaling, communication between cells, receptor upregulation and downregulation, other behaviors, and the like. Failures and defects in any of these cellular elements and processes can lead to diseases, for example, cancer. This type of efficacious behavior is not taught in prior art, including in protein cage art.

In one invention embodiment, one or more elements, with or without additional elements, and in some embodiments with minimal functionalization, enter the central nervous system, including passing the blood brain barrier (BBB) for efficacious effect. Although different protein cage types, e.g., viruses, have been investigated as MRI nano-probes, some types of these cages in prior art did not cross the BBB, and other types in prior art were shown to be immunogenic after crossing the BBB.

In one embodiment, the invention enables post administration delivery of one or more types of agents into the CNS in 30 minutes or less. In other embodiments, delivery of agents occurs in 30 minutes or more. In another embodiment, agents operate in the inter-neuronal spaces. Prior art does not teach such flexible CNS delivery arrangements.

The instant invention teaches self-directing, self-replicating, self-adapting, self-repairing, self-regulating, and or self-regenerating methods for one or more minimalist, non-cage elements, which can also perform on-the-fly target prioritization. Prior protein cage art does not teach such self-modifying methods at a minimalist, non-cage element level.

Prior art does not teach enabling and or utilizing quantum mechanical effects using just one or more minimalist, non-cage elements. But in one embodiment, the instant invention teaches enabling and utilizing such quantum mechanical effects

Thus, there exists a need for an improved bio-nano-structure element that overcomes the limitations in the prior art for various types of in vivo and in vitro applications.

SUMMARY OF THE INVENTION

The invention, in one aspect, remedies the deficiencies of the prior art by teaching modifiable, interactive, dynamic bio-nanoparticle elements, some of which may comprise minimalist, non-cage embodiments, with or without one or more additional elements of one or more types located on and or in one or more elements; whose applications, in one or more embodiments, focus on forming in whole or in part one or more nanoscale elements and structures of one or more types that execute one or more functions and or effect one or more ends in vivo and or in vitro.

In one illustrative embodiment, the invention is an improvement over other in vivo biodegradable polymer nanospheres, liposomes, lipids, capsids agent delivery systems, as well as endohedral Fullerenes and other bio-nanoparticles in the prior art because the invention enables, among other unique features:

- Simplified nanoscale fabrication
- Simplified cargo and other element type attachment.
- Cell and organelle crossing, and or membrane fusion.
- Low antigenic, “green” nanotechnology.
- Interaction, control, and regulation of cellular processes, like endocytosis, exocytosis, mitosis, trafficking and signaling, communication between cells, receptor upregulation and downregulation, other cellular behaviors, and the like.
- Entering the CNS, including passing the blood brain barrier, and in some cases, in less than 30 minutes post administration.
- One or more elements that carry no additional elements, like cargo, and operating alone produce an efficacious effect, acting like a drug, for example.
- Hybrid invention elements comprised of one or more types of non-invention elements, e.g., natural cell elements.
- Self-modifying, orchestrated actions at a minimalist, non-cage level using natural control laws that govern biological elements.
- Methods and behaviors defined by algorithms.

In one particular embodiment, one or more of self-assembling Clathrin and or Coatomer elements are functionalized, modified and or bioengineered using commercially available biotechnology tools and other tools and techniques known in the art, which makes the invention more versatile and cost-effective than the existing art.

In another embodiment, one or more elements are also comprised of one or more non-invention elements, e.g., one or more invention elements are conjugated to natural biological/molecular elements, like cells, but not limited to, forming one or more types of hybrid elements in vitro and or in vivo.

In one illustrative embodiment, one or more elements can be of any suitable size. According to an illustrative embodiment, one or more elements are nanoscale elements.

The invention, in one embodiment, teaches one or more elements that dynamically and interactively respond to changing in vivo and or in vitro environments; e.g., change of pH, temperature, biochemical, or biological conditions, and the like.

In one embodiment, one or more elements, in one or more configurations, utilize self-directing, self-adapting, self-assembling, self-repairing, self-regenerating, self-regulating, and or self-replicating methods.

In one embodiment, one or more elements, in one or more configurations, utilize goal directed methods.

In one embodiment, one or more elements utilize, respond to, and or exhibit one or more effects, such as quantum mechanical, mechanical, photonic, acoustic, electrical, biochemical and chemical, and the like.

The invention, in one embodiment, provides one or more elements that maintain structural and or functional integrity long enough to do useful work, in vivo and or in vitro.

According to one feature, one or more elements re-supply, repair, reassemble and or regenerate defective, destroyed and or inoperable elements of one or more types, including non-invention elements, in vivo and or in vitro.

In another embodiment, one or more types of elements, unlike other nanoparticles in the art; such as nano-carbon, virus capsids, as well as nano-coating elements like polysorbate; may exhibit no or limited immunogenic, toxic, and or environmental impact effects, and depending on cargo and other element type also may require little or no functionalization,

In another embodiment, elements maintain structural integrity at room temperature in vitro and vivo, which eliminates the need for elaborate structure stabilizing mechanisms, like cooling systems.

Another advantage of the invention is that its protein material does not exhibit extreme hydrophobicity.

According to another feature, one or more elements are protected from the external environment, and the invention is stable with respect to dissociation and any element toxicity is sequestered from the surrounding in vivo and or in vitro environment.

In some embodiments, bonding and or attachment methods of one or more types, e.g., covalent, non-covalent, and any other bond type that can be explained by quantum theory, are used to directly attach one or more elements, internally or externally to one or more other elements in an ordered arrangement.

In one embodiment, one or more elements each may bond with one or more other elements, of one or more types, including invention and non-invention elements.

In one embodiment, one or more elements may additionally have located on and or in them one or more cargo elements of one or more types, formed from one or more types of molecules

In one embodiment, one or more cargo elements and or cargo carrying elements comprise hybrid elements of one or more types.

In one embodiment, one or more elements of one or more types do not carry cargo elements.

In one embodiment, nanoscale ensembles comprising one or more types of elements allow for a large variety and number of possible cargo element configurations.

In one embodiment, one or more elements may additionally have located on and or in them one or more elements such as ligand elements, receptor elements, adaptor protein elements, and the like, formed from one or more types of molecules, which may also comprise one or more hybrid elements formed from one or more non-invention elements.

In another embodiment, one or more elements may be comprised of one or more elements derived in part from one or more types of elements, for example, but not limited to, an amino acid sequence derived from a Clathrin or Coatomer protein.

In another illustrative embodiment, one or more elements, in one or more configurations, are coated in whole or in part with chemicals, metals, biomaterials, and or other substances, of one or more types.

In another illustrative embodiment, one or more elements, in one or more configurations, comprise one or more organic, inorganic, and or synthetic material elements, of one or more types, in one or more forms and or phases, in whole or in part

In one embodiment, one or more elements are radiation shielded, radio frequency (RF) shielded, thermally shielded, chemically shielded, and the like, in whole or in part, and in one or more configurations.

In various embodiments, one or more elements may be of more than one functionalization type, and or express more than one type of functionality.

In one embodiment, one or more elements in whole or in part may require minimal or no functionalization to be efficacious elements, like a drug and the like, but not limited to.

In another embodiment, one or more elements in whole or in part comprise one or more structures, of one or more types.

In another embodiment, one or more elements in whole or in part comprise a shape programmable and or shaped scaffolding system via which one or more elements of one or more types form one or more structures with one or more types of shapes and or functions.

In one embodiment, one or more elements act as one or more types of efficacious replacements for one or more other elements, including non-invention elements, in vitro and or in vivo, e.g., act as replacements for one or more natural elements commonly found in cells, but not limited to. This type of replacement functionality is not taught in prior art, including protein cage art.

According to one approach, various self-assembling and self-directed methods are employed. Elements and or their platforms can be formed from the bottom-up, one element at a time. Another advantage of bottom-up fabrication is that it reduces the amount of superfluous material that surrounds each cargo element, reducing the element's exposure to contaminant background radiation and thereby improving the functional effectiveness of the element.

In one embodiment, the instant application teaches one or more nanoscale elements of one or more types formed from isolated, synthetic and or recombinant amino acid residues comprising in whole or in part one or more types of Clathrin and or Coatomer I/II proteins of one or more isoforms, including cloned isoforms. The efficacious elements may comprise minimalist, non-cage forming elements in one or more embodiments. In other embodiments, one or more Clathrin or Coatomer cage elements comprise efficacious elements.

In one embodiment, one or more elements may additionally comprise a hybrid molecular element formed from one or more other types of molecules.

The instant invention teaches that in one or more non-cage element embodiments it features unique types of dynamic properties and capabilities not found in fully self-assembled, cavity-forming cage structures as taught in the prior art.

In one embodiment, an element is comprised of one or more 3-legged triskelia, each triskelion having 6 protein subunits; 3 Clathrin heavy and 3 light chain subunits. In another example embodiment, the instant invention teaches one or more configurations as being comprised of only 3 Clathrin heavy subunits or only 3 light chain subunits. In another illustrative embodiment, configurations comprised of less than 3 Clathrin heavy or 3 light chain subunits are enabled. In another embodiment, the invention teaches elements comprising in part one or more types of Clathrin and or Coatomer I/II proteins of one or more isoforms

Likewise, the invention teaches one or more highly flexible element embodiments formed from Coatomer I/II proteins. In one embodiment, one or more nanoscale elements of one or more types are formed from isolated, synthetic and or recombinant amino acid residues comprising in whole or in part one or more types of Coatomer I/II proteins of one or more isoforms, including cloned isoforms. Components of both COP1 and Clathrin-adaptor coats share the same structure and the same motif-based cargo recognition and accessory factor recruitment mechanisms, which leads to insights on conserved aspects of coat recruitment, polymerization and membrane deformation. These themes point to the way in which evolutionarily conserved features underpin these diverse cell pathways.

In one example embodiment, one or more elements comprised of Coatomer (COPI and COPII) proteins, which can efficaciously act alone or with additional elements, are used instead of Clathrin proteins, preferably in those applications where Coatomer characteristics would be more desirable than those of Clathrin. Coatomer I/II protein elements may, in one or more embodiments, be comprised of one or more alpha, beta, beta′, gamma, delta, epsilon and or zeta subunits. Different combinations of these subunits are known to exist within Coatomer complexes. According to an illustrative embodiment, a Coatomer subunit is a nanoscale element. In one invention embodiment, Clathrin and Coatomer elements and one or more methods may be used together in one or more configurations, taking advantage of their respective capabilities.

Freed from the constraints of only assembling into cavity forming cages in vitro, one or more non-cage elements of one or more types may self-

physiological environment where biological species can survive or grow. In other embodiments, one or more other types of non-cage forming structures, elements, and forms of materials comprised of invention elements are formed using techniques known in the art.

Unlike cage, cavity, and vesicle systems in the prior art where one or more additional elements, e.g., cargo, are inserted into a complex, fully formed structure; a sometimes difficult and laborious process; the invention, in one embodiment, teaches that it can be functionalized with one or more additional elements at a much more fundamental nano-element level, e.g., by using non-cage elements of one or more types formed from amino acid residues of Clathrin or Coatomer proteins. Such functionalized, minimalist elements may further self-assemble in vitro into one or more nanoscale structure elements, including cages. This makes the addition of one or more elements easier and simpler as there is no insertion process into a completely formed cage, cavity, or vesicle. In another embodiment, additional element functionalization is simplified by decorating just the external surface of a cage.

According to one illustrative configuration, one or more types of elements, such as cargo elements, may interfere with the invention's overall operation if carried in the same element as other element types. Instead, the problematic elements are carried in a separate element that exclusively carries non-interfering elements, thereby inhibiting disruptive interference of invention operations. Such non-interfering elements may be functionally and or physically linked with other elements carrying other element types.

In one embodiment, one or more elements efficaciously operate alone and carry no additional elements, e.g., cargo. In one embodiment, such solo element functionality produces a unique new type of efficacious element, and its unique features correspondingly enable new types of applications.

Some embodiments include a molecule having an unpaired electron, a transition metal ion, which can be found in the active centers of many proteins (metalloproteins), or a material having any defect that produces an unpaired electron.

According to one in vivo application for enhanced medical imaging, paramagnetic lanthanide, transition metal ion complexes, and the like are cargo elements that modify the NMR relaxation times of nearby proton nuclei of H_2O molecules, leading to brighter images and enhanced contrast between areas comprising the contrast agent and the surrounding tissues.

In another illustrative embodiment, one or more elements accept free radical molecules such as nitroxide molecule spin labels for electron paramagnetic resonance (EPR) based invention applications.

In another illustrative embodiment, one or more elements accept and or comprise one or more types of labels and assay strategies, and instruments for detection of one or more such labeled and or assay elements may include, but are not limited to: fluorescence and confocal microscopy, flow cytometry, laser scanning cytometry, fluorescence microplate analysis and biochips, immunoassay systems, nucleic acid-based diagnostics, and the like. In various embodiments, one or more elements meet and or surpass the requirements for label and assay sensitivity, accuracy and convenience.

In another embodiment, one or more types of elements such as comprising in whole or in part one or more large molecule elements, small molecule elements, cargo elements, agent elements, device elements, drug elements, and the like, enter the CNS, including passing the blood brain barrier, in 30 minutes or less and or in 30 minutes or more, post administration, and, depending on cargo and other element type, may require minimal functionalization for such element passage.

In some configurations, one or more elements comprise a cargo element, while in other configurations they comprise multiple elements, of one or more types. In some configurations, one or more or each of the elements and or cargo elements is a metal, and or may include one or more metals. Alternatively, each of the elements and or cargo elements is or includes non-metal elements. In other embodiments, elements and or cargo elements are exclusively non-metal elements that may include gases, as well as other elements like biological elements, drugs, optics, polymers, etc. In another embodiment, one or more elements and or additional elements comprise one or more types of material forms, including a solid, gas, vapor, crystal, and the like. In another embodiment one or more invention and or non-invention elements, in one or more combinations, comprise one or more types of isolated, synthetic and or recombinant elements.

An invention element, in one functionalized configuration, includes receptor molecules; natural, isolated, synthetic and or recombinant, for capturing and ordering the placement of one or more elements, like cargo elements, on one or more elements.

An invention element, in another functionalized configuration, includes adapter molecules; natural, isolated, synthetic and or recombinant, disposed between the receptor molecules and one or more elements to couple the receptor molecules to another element, like to a cargo element.

An invention element, in one functionalized configuration features ligands, natural, isolated, synthetic and or recombinant, including drugs, of one more types attached to receptors and or adapter protein elements.

In one configuration, one or more elements, of one or more types, are attached to one or more types of amino acids on one or more elements.

In another configuration, biotin-avidin is used as a coupler of one or more elements, of one or more types, to one or more elements of one or more types.

In another configurations, PEGylation, a cross-linker, molecular bridge, molecular tether, and the like are used to attach one or more elements, of one or more types, to one or more elements of one or more types.

In one example, molecules of one or more types are attached to a short molecular tether to one or more elements via site directed substitution mutagenesis, followed by reaction of a unique amino acid group with a specific molecular label.

In another embodiment, free radicals, toxic elements, other types of undesirable elements and the like circulating within an in vivo environment are scavenged via molecular tethers, via other elements of one or more types attached to one or more invention elements, and or via direct binding to one or more elements.

In another embodiment, the invention takes full advantage of protein flexibility and plasticity to create elements of one or more types that are bonded,

In another invention embodiment, site directed mutagenesis is used to incorporate one or more elements, of one or more types, into one or more other elements, of one or more types.

In one embodiment site-directed mutagenesis using one or more types of primer; including its reverse complement; are used to insert one or more DNA sequences of one or more types into one or more coding regions of one or more elements.

In another embodiment, cloning is done of one or more genes encoding one or more elements. In another embodiment, one or more amino acids and or their encoder gene are controlled, regulated, modified, and the like, by one or more methods known in the art to produce an efficacious effect, in vivo and or in vitro.

In one embodiment, one or more elements of one or more types comprise targeted and or non-targeted drug elements, biological elements, other forms of healthcare elements, including cosmetic elements, in one or more configurations or combinations, for diagnosing, remedying, inhibiting, mitigating, curing, and or preventing one or more types of diseases, infections, physical or mental trauma, other forms of physical and mental afflictions, and the like, of one or more types, including types featuring minimal immunogenic and or toxic effects.

In one embodiment, one or more elements are used as a means for evaluating drug advancement and efficacy.

The invention teaches a biological model and or method that is consistent from a minimalist component level up, e.g., amino acid residues comprising in part one or more Clathrin and or Coatomer I/II proteins of one or more isoforms, making drug discovery safer, more efficacious, more time and cost effective, and overall, a much more rapid process.

In one personalized medicine embodiment, the invention reduces drug side effect profiles and or produces greater agent efficacy, as well as excludes agents that may have no efficacy in a particular individual. The invention, in one embodiment, provides for individual patient factors such as genotype, phenotype, age, gender, ethnicity etc., to be taken into account by one or more elements and factored into dosing and administration consideration.

In one embodiment, one or more elements comprise one or more types of pluripotent stem cells and or comprise one or more stem cell delivery methods.

According to one feature, one or more elements may be or include one or more research, therapeutic, diagnostic, vaccine, assay, and or prosthetic agents, in one or more configurations, and thereby constitute one or more types of biomedical elements. Such biomedical elements may be, for example, nano-structured and/or include chemical, biological and/or metallic materials. The biomedical elements may be or include organic, inorganic, and or synthetic materials, or a combination thereof.

Medical, biomedical, bioengineered, and or biological applications and platforms of the instant invention may include, but are not limited to, imaging; sensor; genetic and protein assay; diagnostic; drugs and drug delivery; prosthetic; inter- and extra-cellular tissue; whole organ; circulatory system; medical device; implantable defibrillator; pacemaker; coronary stents; angioplasty device; and other like applications.

In one embodiment, one or more elements comprise one or more applications that perform analysis, of one or more types, of disorders of complex inheritance.

In one embodiment, one or more elements comprise one or more applications that perform analysis, of one or more types, of pharmacologic therapy.

In one embodiment, one or more elements comprise one or more types of prognosis and therapy selection—“theradiagnostics”.

In one embodiment, one or more elements comprise one or more genomic applications of one or more types.

In one embodiment, one or more elements comprise one or more oncology applications of one or more types.

In one or more embodiments, one or more elements may use routes of administration comprising one or methods of one or more types, such as those defined by CDER Data Element Number C-DRG-00301 in the US FDA Data Standards manual. Routes of in vitro administration of one or more elements may also comprise one or more forms.

In one or more embodiments, one or more pharmaceutical and drug formulations of one or more types are used, in whole or in part, such as tablet, capsule, soft galantine capsule, topical, injections, eye drops, syrups and liquids, soap and cosmetics, birth control device, and the like, but not limited to, as well as one or more types of biologics, chemical compounds, water soluble compositions, and the like, but not limited to. In vitro formulations may also comprise one or more formulations of one or more types in one or more embodiments.

According to one feature, one or more elements respond to one or more external and/or internal stimuli, which can be, for example, mechanical, chemical, biochemical, biological, metabolic, covalent, non-covalent, photonic, sonic, acoustical, thermal, fluidic, electromagnetic, magnetic, radioactive, quantum mechanical, or electrical in nature. Examples of such a stimulus response is altering a cargo element carried by an element; the altering of the element itself; causing changes in cellular process like endocytosis, exocytosis, mitosis, trafficking and signaling, and the like, including other conformational changes.

In another embodiment, photonic energy impacting one or more elements produces electrical current, and or photonic energy, e.g., a laser.

In general, in another embodiment, one or more element and or platform are physically and/or functionally cooperative with other suitable types or forms of elements, agents, organisms, materials, substances, components, devices, and or systems, including non-invention elements, in vitro and/or in vivo.

The invention, in one embodiment, provides for a plurality of elements comprising aggregated, complex self-assembled nanoscale structures that dynamically bind together one or more types of endogenous, exogenous, homogeneous, and or heterogeneous elements into one or more complex elements, which also may have one or more payload types.

The invention, in one embodiment, provides a capability for in vivo and in vitro integration of one or more types of elements into other elements

In one application, one or more elements, including cargo elements, comprise one or more types of targeted agent delivery systems and or agents in vivo or in vitro, including high precision dosing, using, as appropriate, ligands, targeting moieties, and or other vectors. In one application, one or more targeted elements comprise one or more research, remedial, inhibitory, mitigation, preventive, prosthetic, assay, and or other type of bio-molecular agent or device, in one or more combinations, and may altogether comprise a unified element and or platform.

The invention, in one embodiment, provides for a method for targeted delivery systems that leverage and utilize biological control laws and that may act as self-directed systems.

According to another invention embodiment, one or more targeted elements may use molecular-imprint technology, which is used for the production of molecule-specific cavities that mimic the behavior of receptor binding sites, without the temperature sensitivity of natural systems.

According to another feature, biodegradable films may also be used as a pliable template for one or more targeted elements, which are pressed into a biodegradable film and then removed, leaving a physical mold of the element's shape. The film can then be hardened and used by an element to detect a particular element, which may be, but is not limited to, a particular receptor, protein, or cell, since its complex imprint shape on the film will bind only to that particular biological element.

In one embodiment, the invention provides for a targeting system using biodegradable nanocapsules for delivery of one or more elements in vivo or in vitro.

In another application, a nanoscale platform comprised of a plurality of elements performs molecular-level and or cellular-level target site loitering, monitoring, repair, construction and or dynamic, interactive control and regulation of biological systems, in vitro and in vivo.

In another embodiment, one or more elements, including in whole or in part one or more non-invention elements, operating alone or with one or more additional elements, comprise one or more types of membrane fusion elements. In one embodiment, the resulting biological processes and interactions from such fusion may lead to a series of controlled, regulated, extended, modulated, purposefully, and or self-directed methods and or behaviors of elements.

In one example embodiment, one or more elements in whole or in part execute one or more types of actions involving conformational changes, bonding, attachment, and or the fusion of one or more elements to a cell membrane, one or more of which actions may lead to changes in cellular processes, such as endocytosis, exocytosis mitosis, trafficking and signaling, and the like, and or enable the precise dispatch and sequenced delivery of selected agents from an element to a target cell. Alternatively, a series of interlocking steps between a part of a cell membrane, and all, or a subset of the materials comprising an element may cause the cessation of one or more element's delivery to a target cell, and or enable delivery from other sources.

In another configuration, one or more elements dynamically respond to natural environmental conditions and manifest special functions. The various control laws that regulate biochemical reactions and physiological processes often display features that allow biomolecules or biological structures to perform more tasks than are reasonably expected from a simple mechanical device. In one embodiment, the invention takes deliberate advantage of these biological control laws. Via the use of bio- and genetic engineering methods known in the art, the invention makes use of these control laws to dynamically regulate complex in vivo and in vitro biochemical reactions and physiological processes. An example of biological control laws at work is the automatic self-directed, self-assembly of in vitro and in vivo Clathrin and Coatomer proteins.

In one embodiment, intramolecular dynamics of biomolecules and the concerted and interlocking steps of conformational changes lead to deliberately purposeful actions. For example, one or more elements may fit spatially and each step in a process fits temporally (kinetically) with an element of anticipation of the purposeful outcome.

In another example case, the spatially and temporally defined events between the cell and one or more elements may cause the invention to release diagnostic and monitoring agents to determine the most appropriate course of therapeutic action. The calculated utilization of biological control laws by one or more elements may, for example, provide for a sophisticated drug delivery system that provides optimal dosing by altering its drug delivery behavior, as well as producing minimal side effect profiles.

A further advantage of the invention is that it provides elements that can be bioengineered to prevent in vivo uptake by one or more types of organs, tissue, cells, and bone. In the converse, another advantage is that one or more elements can be bioengineered for highly selective uptake by one or more types of targeted cells, tissue, organs, bone, as well as by other organic and inorganic matter. In another embodiment, one or more elements comprise a non-selective uptake, non-targeted drug delivery system.

In another embodiment, the invention provides for the ability of one or more elements to intelligently monitor, control and regulate, react, and further adjust biological processes after delivery of the payload, enabling high precision dosing.

Another advantage of the invention is that Clathrin can cross cell membranes including the blood brain barrier (Gragera et al 1993) and can move through the synaptic clefts (Granseth et al 2007). In one embodiment, bioengineered Clathrin actively transports substances in and out of cells including neurons and blood brain barrier cells.

In another embodiment, one or more elements, operating alone or with one or more additional elements, comprise one or more types of cell membrane crossing elements and gain access to the cytosol and intracellular elements of one or more types, including one or more cell organelles. Such elements may, in one embodiment, require minimal functionalization to cross the cell membrane and or enter a cell organelle.

In one embodiment, one or more elements, in whole or in part, in one or more combinations, take one or more actions to create, spawn, comprise, modify, regenerate, reassemble, and or control and regulate one or more cells, cellular elements and or cellular processes of one or more types.

In one embodiment, one or more elements, in whole or in part, in one or more combinations, take one or more actions to rectify and or repair failures and defects in cellular processes, such as, endocytosis, exocytosis, mitosis, trafficking and signaling, and the like. Such failures and defects can lead to diseases, for example, cancer.

(chromium), biofilm, synthetic chemicals, and the like.

In one embodiment, some or all elements may also operate under the control and influence of other in vitro and or in vivo elements, including non-invention elements, and altogether may comprise a scalable, nanoscale platform.

In general, in another aspect, the invention is directed to a method of forming one or more types of scalable platforms, including the steps of providing one or more embodiments of the elements to deliberately carry out a series of tasks of one or more types, which tasks and or methods may be externally directed or internally self-directed, or a combination thereof. In other embodiments, one or more nanoscale platforms may be additionally comprised of one or more non-invention elements and platforms of one or more types.

One or more elements, in one platform embodiment, may also modify, process, manipulate, encode and decode, input, output, transmit, communicate, store and or read information using techniques and methods known in the art, in vivo and in vitro.

In one embodiment, scalable information processing platforms use some or all elements as bits that are programmable into a plurality of logical states. In another configuration, the invention features a scalable information-processing platform that may include one or more elements.

As a general characteristic, one or more elements may take any suitable form, and multiple embodiments may be used as elements, and or further combined in any suitable manner to create one or more cargo carrying and or non-cargo carrying nanoscale elements (“elements”), and or multifunction nanoscale platforms (“platforms”) of one or more types, operating in vitro and or in vivo, such as: multiple polypeptide elements and platforms; biological elements and platforms; large molecule elements and platforms; small molecule elements and platforms; biomedical elements and platforms; medical elements and platforms; diagnosis, cure, mitigation, treatment, prevention of disease or other type of drug elements and platforms; targeted and or non-targeted delivery elements and platforms; cell, cell organelles, or cell material crossing elements and platforms; personal medicine elements and platforms; elements and platforms that, post administration, in whole or in part enter the central nervous system, including passing the blood brain barrier in 30 minutes or less and or in 30 minutes or more; healthcare elements and platforms; reproductive health elements and platforms; substance abuse disorder treatment elements and platform; bioengineered elements and platforms; cosmetic elements and platforms; agricultural elements and platforms; sensor elements and platforms; research and development elements and platforms; scientific elements and platforms; crystal elements and platforms; electronic elements and platforms; photonic energy elements and platforms; information processing or storage elements and platforms; energy storage elements and platforms; in situ elements and platforms for remediation, removal and or sequestration of undesirable elements and platforms of one or more types; quantum mechanical elements and platforms; telecommunication elements and platforms; and the like; one or more of which nanoscale elements and platforms may be additionally comprised of one or more non-invention elements and platforms of one or more types, and with or without one or more types of cargo elements located on and or in one or all or a subset of elements.

In general, in a further aspect, the invention is directed to a method of forming one or more formations of nanoscale elements formed in vitro from one or more elements of one or more types formed from isolated, synthetic and or recombinant amino acid residues comprising in whole or in part one or more types of Clathrin and or Coatomer I/II proteins of one or more isoforms, including cloned isoforms; with or without one or more additional elements of one or more types located on and or in one or more elements; forming in whole or in part one or more types of element carrying and or non-element carrying nanoscale elements and structures; one or more of which elements may also comprise one or more non-invention elements of one or more types, forming hybrid elements; wherein one or more elements, using one or more types of methods, executes one or more functions and or effects one or more ends in vivo and or in vitro.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other aspects of the invention may be more fully understood from the following description, when read together with the accompanying drawings in which like reference numbers indicate like parts.

FIG. 1 is a conceptual diagram depicting a Clathrin triskelion comprised of one or more elements of one or more types employed in an illustrative embodiment of the invention.

FIG. 2 is a conceptual cross-sectional view of one or more Clathrin protein, receptor, adaptor protein, and cargo elements in an illustrative embodiment.

FIG. 3 is a computer generated frontal view of an actual Clathrin cage comprised of a plurality of Clathrin triskelia, and, in an illustrative embodiment, comprising one or more invention elements.

FIG. 4 is a flow diagram depicting conceptually the formation of individual Clathrin elements during endocytosis, which also serves to illustrate how the instant invention operates in one or more embodiments.

FIG. 5 is a conceptual diagram depicting Coatomer I/II protein comprised of one or more subunit and domain elements of the type employed in an illustrative embodiment of the invention.

FIG. 6 is an exemplary energy level diagram **600** illustrating the energy levels associated with a hyperfine interaction between electron and nuclear spin in the presence of magnetic fields.

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

The instant invention is comprised of one or more formations of nanoscale elements formed in vitro from one or more elements of one or more types formed from isolated, synthetic and or recombinant amino acid residues comprising in whole or in part one or more types of Clathrin and or Coatomer I/II proteins of one or more isoforms, including cloned isoforms, and which operate in vitro and or in vivo. In one embodiment, one or more elements form one or more configurations of one or more types, described below.

FIG. 1 is a conceptual diagram illustrating the basic unit of Clathrin, a three-leg pinwheel protein structure, and each complete leg is typically called a ‘monomer’. The arrangement of the monomers in the three-dimensional protein is the quaternary structure. Each Clathrin leg monomer is further comprised of two subunits, one 190 kDa subunit (“heavy chain”) and one 24-27 kDa subunit (“light chain”). Three, two-subunit Clathrin monomers self-assemble and combine to create triskelion element **100**. It is this triskelion morphology that allows Clathrin to form its unique polyhedral network

In the case of humans, there are two isoforms each of Clathrin heavy chain (CHC17 and CHC22) and light chain (LCa and LCb) subunits, all encoded by separate genes. CHC17 forms the ubiquitous Clathrin-coated vesicles that mediate membrane traffic. CHC22 is implicated in specialized membrane organization in skeletal muscle. CHC17 is bound and regulated by LCa and LCb, whereas CHC22 does not functionally interact with either light chain.

In one embodiment, a Clathrin triskelion is composed of a trimer of heavy chains **104***a*-**104***c* each bound to a single light chain **106***a*-**106***c*, respectively. In the case of one isoform embodiment, CHC17 (SEQ ID NO:1), a Clathrin heavy chain element is comprised of a 1675 amino acid residue protein, which is encoded by a gene consisting of 32 exons. In the case of another isoform embodiment, CHC22, a Clathrin heavy chain element is comprised of a 1640 amino acid residue protein (SEQ ID NO:2).

In one or more invention embodiments, efficacious elements formed in part from Clathrin amino acid residues include, but are not limited to, a N-terminal globular domain **110***a*-**110***c* (residues 1-494) that interacts with adaptor proteins (e.g., AP-1, AP-2, b-arrestin), a light chain-binding region (residues 1074-1552), and a trimerization domain (residues 1550-1600) near the C-terminus.

One or more of the Clathrin heavy chain amino acid sequences as described in SEQ ID NO:1 and SEQ ID NO:2, but not limited to, and in whole or in part may be modified, altered, adapted or functionalized in one or more ways in one or more embodiments of the invention.

In the illustration, the three Clathrin monomer elements **102***a*-**102***c* are comprised of six subunit elements, three of which subunits are the heavy chain subunit elements **104***a*-**104***c*. The three heavy chain subunits are comprised of several distinct domains and segments, one or more of which may comprise one or more invention elements in one or more embodiments, and may be functionalized via one or more techniques known in the art.

In general, each heavy chain comprises eight repeated motifs (CHCR0-7), which make up the proximal, knee, distal and ankle segments of a Clathrin leg. The heavy-chain amino terminus folds into the terminal domain (TD) and is attached to CHCR0 by a helical linker (Brodsky, 2004). The three Clathrin heavy chains are joined at their C-termini (located within hub element **108**), extending into proximal and distal leg domains ending in globular N-terminal domain elements **110***a*-**110***c*, and which are responsible for peptide binding. The Clathrin heavy chain terminal domains provide multiple interaction sites for a variety of adaptor proteins (AP) that can bind multiple receptors occupied by ligands. These sites prevent chemical interactions between cargo elements. The heavy chain N-terminal domain elements **110***a*-**110***c* are each comprised of a seven-bladed beta-propeller connected to a flexible linker region, respectively. This propeller domain interacts with a host of accessory proteins participating in receptor-mediated endocytosis such as adaptor proteins, non-visual arrestins and the uncoating ATPase, hsc70. The propeller domain is followed by a long filamentous segment, which is interrupted by a bent region between the distal and proximal domains, and ends in the trimerization domain at the C-terminus.

Besides harboring determinants important for driving the association of individual Clathrin molecules during lattice formation, each of the three heavy chain **104***a*-**104***c* proximal domains also include binding sites for attaching the three light chain subunit elements **106***a*-**106***c*, respectively, forming three complete Clathrin monomers. The three light chain subunits are also comprised of several distinct domains and segments, one or more of which may comprise one or more invention elements in one or more embodiments, and may be functionalized via one or more techniques known in the art.

Among other roles, Clathrin light chains prevent Clathrin heavy chains from interacting with each other. On the other hand, assembly proteins bind to light chains and cause a change in them such that they no longer prevent heavy chains from interacting. Clathrin light chains consist of what has been described as a linear array of domains: regions of protein discernable from the primary sequence or with distinct biochemical properties. These are an N-terminal segment, a region that is 100% conserved between light chains, a portion to which Hsc70 binds, a calcium binding domain, a region which binds the heavy chain, a site for neuronal-specific splice inserts and then finally a calmodulin-binding domain at the C-terminus domain (Royle, 2006). The light chain C-terminal residues are also important for enhancing the in vitro assembly of hub 108 at low pH.

One or more of the Clathrin light chain amino acid sequences as described in SEQ ID NO:12 and SEQ ID NO:13 but not limited to, and in whole or in part may be modified, altered, adapted or functionalized in one or more ways in one or more embodiments of the invention.

In one embodiment, each of the 3 heavy chain subunits **104***a*-**104***c* may each have 3 light chains subunits **106***a*-**106***c* attached, respectively, forming the typical, three-monomer Clathrin triskelion structure. But in another embodiment, each leg **102***a*-**102***c* may include only the 3 Clathrin heavy chain subunits **104***a*-**104***c*, respectively, which is distinctly unique from the classic Clathrin monomer configuration. In yet another unique embodiment, only 3, non-attached light chain subunits **106***a*-**106***c* are used.

In one distinctive embodiment of the invention, a 3-legged pinwheel configuration 100 is not enabled, and only partial pinwheel structures are used. In one embodiment, a partial pinwheel configuration of one or two legs (one or two Clathrin monomers) is comprised of one or two Clathrin heavy chains and one or two corresponding light chain subunits. In another embodiment, one or two elements comprised of only one or two Clathrin heavy chain subunits are used; e.g., subunits **102***a*, or **102***a*-**102***b*. In one embodiment, only one or two unattached light chain subunits are used.

In another distinctive embodiment of the invention, one or more elements of one or more types are formed from isolated, synthetic and or recombinant amino acid residues comprising in part one or more types of Clathrin heavy chain and or light chain proteins of one or more isoforms as described in SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:12 and SEQ ID NO:13, respectively.

In one embodiment, one or more N-terminal domain elements, e.g., **110***a*, **110***b* and or **110***c* are bioengineered to facilitate, modify, regulate or control peptide binding of one or more types, as well as interaction sites for one or more types of adaptor proteins.

In one embodiment, one or more domain elements of heavy chain subunits and or light chain subunits are bioengineered to facilitate, modify, regulate or control one or more Clathrin protein characteristics and or behaviors in vivo and or in vitro.

FIG. 2 is a conceptual cross-sectional view of a biological endohedral consisting of Clathrin protein elements. In this illustrative embodiment, one or more elements **102***a*-**102***c*, **106***a*-**106***c*, **104***a*-**104***c*, **110***a*-**110***c*, element **108**, and or one or more types of elements formed from isolated, synthetic and or recombinant amino acid residues comprising in whole or in part one or more Clathrin proteins of one or more isoforms, and with or without one or more additional elements of one or more types, may comprise one or more multiple polypeptide elements of one more types. The latter are labeled in FIG. 2 as elements **206***a*, **204***a*, **202***a*, and **208***a*, which are formed in vitro, and also may operate in vitro and or in vivo. One or more of elements **206***a*, **204***a*, **202***a*, and or **208***a* may comprise one or more types of functionalization, include invention and non-invention elements, express one or more

In another embodiment, one or more elements **206***a* may be comprised of, and or help comprise one or more types of non-invention elements, such as a natural cell element in one embodiment, comprising one or more types of hybrid elements in one or more embodiments.

In another embodiment, one or more elements **206***a* may be comprised of, and or help comprise one or more types of isolated, synthetic, recombinant and or natural molecules in one or more embodiments.

In one illustrative embodiment, but not limited to, one or more elements **202***a* may comprise cargo elements of one or more types, including natural, isolated, synthetic and or recombinant, including natural and or synthetic ligands and or drugs, and may express more than one type of functionality. In one embodiment, one or more other elements, of one or more types, including invention and non-invention elements each may bond with one or more respective cargo elements **202***a*.

In one embodiment, one or more cargo elements **202***a* are cavity forming and are non-permeable, semi-permeable, and or permeable, and or can change from one permeable state to another. In one embodiment, the cavity forming elements comprise one or more types of elements and or agents, including gas, vapor or fluid, with or without dopants. In one embodiment, one or more cargo cavities elements comprise one or more types of elements and or agents, including one or more types of metals.

In another illustrative embodiment, one or more efficacious cargo elements **202***a* carried on one or more elements may comprise the total functionality. In another embodiment, one or more other elements, of one or more types, including invention and non-invention elements may act in concert with one or more cargo elements **202***a* to achieve ensemble efficacy.

In one embodiment, but not limited to, one or more elements **204***a* may comprise attachment and or receptor elements for one or more elements **202***a* of one or more type, and or express more than one type of functionality. In one embodiment, one or more other elements, of one or more types, including invention and non-invention elements each may bond with one or more respective elements **204***a*. In another embodiment, receptor molecules **204***a* can be bioengineered to recognize and associate with specific molecules, which may also be synthetic and or natural ligands and or drugs. In another embodiment, receptor molecules **204***a* can be natural, isolated, synthetic and or recombinant.

In one embodiment, but not limited to, one or more elements **208***a* of the instant invention may comprise the major types of adaptor elements, like the heterotetrameric adaptor protein (AP) elements, and the monomeric GGA (Golgi-localizing, Gamma-adaptin ear domain homology, ARF-binding proteins) adaptors. In one illustrative embodiment, elements **208***a* comprise one or more small sigma subunits of various adaptins from different AP adaptor elements. The AP complex family has six members in mammals: AP-1A, AP-2, AP-3A and AP-4 are ubiquitously expressed. The other two members, AP-5 and AP-6, are cell-type specific isoforms of AP-1A and AP-3A: the epithelium-specific AP-1B and the neuron-restricted AP-3B. (Ohno, 2006). In another embodiment, AP180, like AP-2 and AP-3, binds to N-terminal domains **110***a*-**110***c* of Clathrin. In one embodiment, one or more AP elements may be functionalized at one or more heavy chain terminal domain elements **110***a*-**110***c*. In one embodiment, one or more other elements, of one or more types, including invention and non-invention elements each may bond with one or more respective elements **208***a*. In another embodiment, adapter molecules **208***a* are bioengineered to recognize specific receptor molecules and to couple the receptor molecules to Clathrin and or Coatomer protein elements. In another embodiment, adapter molecules **208***a* can be natural, isolated, synthetic and or recombinant.

In one embodiment, one or more elements **206***a*, **204***a*, and or **208***a* operate alone without cargo element **202***a*, and comprise one or more types of inherently efficacious solo acting elements.

In one embodiment, unlike prior Clathrin art, a plurality of elements **206***a*, **204***a*, and or **208***a* operate without cargo elements **202***a*, and comprise an inherently efficacious cage element **212** of one or more types, like a drug element, for example, which is unlike prior Clathrin art.

In one embodiment, also unlike prior Clathrin art, a plurality of elements **206***a*, with or without one or more additional other elements comprise cage element **212**, and element **212** has one or more elements, of one or more types and affixed via one or methods, located on the outside part of cage element **212**; that is, located outside the cavity formed by cage **212**. In another embodiment, further unlike prior Clathrin art, a plurality of elements **206***a*, with or without one or more additional other elements, comprise cage element **212**, and element **212** has one or more elements, of one or more types and affixed via one or methods, located on both the outside, and inside parts (i.e., located within the cage cavity), of cage element **212**.

According to one invention feature, cargo attachment element **204***a* and or element **208***a* shields cargo element **202***a* in the same element **206***a* from interacting. According to another feature, the shielding properties of element **206***a* shields and inhibits chemical and molecular interactions between it and the external environment. According to a further feature, element **206***a* protectively sequesters cargo elements **202***a* from the external environment.

In another embodiment, one or more non-invention, “natural” Clathrin elements **206***b*-**206***f* (the term “natural” hereinafter generally refers to non-isolated, non-recombinant, and non-synthetic protein elements) join with one or more isolated, recombinant, and or synthetic elements; in this example, **206***a*; to form a natural/invention hybrid Clathrin cage element **212**. In another embodiment, hybrid cage element **212** may also be comprised of natural cage element **220**, which is a vesicle, forming a hybrid Clathrin Coated Vesicle.

FIG. 3 is a computer generated frontal view of a Clathrin cage **300** comprised of a plurality of natural Clathrin triskelia elements **302**-**308**, respectively. In an illustrative embodiment, element **310** is an invention element, comprised of three heavy chain elements **104***a*-**104***c*—which may or may not include three respective light chain elements **106***a*-**106***c*—forming a hybrid or fused cage **300** comprised of natural elements and invention elements. In this role, element **310** comprises an efficacious replacement for a natural triskelia element.

FIG. 4 is a flow diagram **400** depicting, conceptually, the formation of a plurality of natural Clathrin elements **206***b*-**2026***f*, and, in this example, along with invention element (**206***a*) into cage **200**, which at step **440**, shows Clathrin coated vesicle **220**. The process by which natural Clathrin molecules **206***b*-**206***d* obtain natural cargo molecules **202***b*, **202***c*, and **202***d* in this example is known as Clathrin mediated endocytosis (CME), a process wherein a cell takes in macromolecules by forming vesicles derived from the plasma membrane. Endocytosis is crucial to cellular function. Via CME, cells internalize cargo attachment elements, transmembrane channels, transporters and extracellular ligands such as hormones, growth factors and nutrients.

In one embodiment, the instant invention takes or induces one or more efficacious actions involving receptor-mediated endocytosis that encompass nutrient uptake (LDL, transferrin, etc.), membrane recycling, membrane protein recycling, antigen uptake, synaptic vesicle recycling, and signaling receptor down-regulation.

In one or more embodiments, one or more invention elements comprise counterparts to natural Clathrin proteins that may inherently behave as a drug; e.g., one or more invention elements are functionalized for in vivo delivery and carry no additional elements, such as cargo. Such solo acting element embodiments would interact in one or more ways with natural cells and their processes, and by so doing diagnose, regulate and or cure one or more diseases and disorders relating to endocytosis.

An increase of a cellular component is called upregulation. Upregulation is an increase in the number of receptors, e.g., see elements **204***b*, **204***c*, and **204***d* in FIG. 4, on the surface of target cells, making the cells more sensitive to a hormone or another agent. For example, there is an increase in uterine oxytocin receptors in the third trimester of pregnancy, promoting the contraction of the smooth muscle of the uterus. In one or more embodiments, one or more invention elements, either by acting alone and or in part with other elements of one or more types, including natural and or non-invention elements, efficaciously modify, control and regulate, interfere with, create, and or spawn elements, and or induce actions or behaviors that increase the upregulation of one or more types of receptors of the surfaces of target cells.

On the other hand there is downregulation, an example of which is the cellular decrease in the number of receptors to a molecule, such as a hormone or neurotransmitter, which reduces the cell's sensitivity to the molecule. In the literature, downregulation is the process by which a cell decreases the quantity of a cellular component, such as RNA or protein, in response to an external variable. In one or more embodiments, one or more invention elements, either by acting alone and or in part with other elements of one or more types, including natural and or non-invention elements, efficaciously modify, control and regulate, interfere with, create, and or spawn elements, and or induce actions or behaviors that increase the downregulation of one or more types of receptors.

Exocytosis is the reverse process of endocytosis, whereby a cell directs secretory vesicles out of the cell membrane. These membrane-bound vesicles contain soluble proteins to be secreted to the extracellular environment as well as membrane proteins and lipids that are sent to become components of the cell membrane. Exocytotic vesicles are usually not Clathrin-coated; most of them have no coat at all. However, two observations suggest that Clathrin effectively ‘tracks’ vesicle proteins leaving a synapse. In one study (Granseth, et al, 2008) the amount of a Clathrin light chain (LC) tagged with the element mRFP leaving the synapse was proportional to the number of vesicles released by the stimulus, as assessed by the amplitude of a sypHy signal (sypHy is an improved fluorescent reporter of exocytosis). Second, in the same study the movement of LC-mRFP began without a significant delay and peaked with the sypHy signal. The movement of Clathrin out of the synapse together with synaptophysin and synaptobrevin is most easily explained as representing CME (Clathrin mediated endocytosis) of vesicles at sites removed from the active zone. This interpretation is consistent with studies showing that the machinery for CME is not at the active zone, but in the surrounding regions of membrane (Heuser & Reese, 1973; Ringstad et al. 1999; Qualmann et al. 2000; Teng &Wilkinson, 2000). Thus, Clathrin is naturally found in the extracellular space and may play a role in regulating exocytosis and or endocytosis. In one or more illustrative embodiment, one or more elements of one or more types may efficaciously operate in inter- and or extra-cellular spaces of one or more types; for example, perform remediation, sequestration, or removal of one or more types of undesirable elements.

Membrane trafficking only occurs during interphase. As the cell enters mitosis, Clathrin-mediated membrane traffic is rapidly shut down and only resumes in late telophase. Clathrin may therefore have a separate function that is distinct from membrane trafficking, which operates during mitosis. Clathrin is thus a multifunction protein: during interphase its function is in membrane trafficking and during mitosis it has a role in stabilizing spindle fibers (Royle, 2006). In one invention embodiment, mitosis may be efficaciously controlled and regulated, modified, and or induced via one or more methods and instances of the instant invention.

In another embodiment, one or more elements are comprised of, but not limited to, one or more isolated, synthetic, and or recombinant adaptor protein molecules, tubulin protein molecules, dynamin protein molecules, epsin protein molecules, endophilin protein molecules, synaptotagmin protein molecules, and or other types of protein molecules associated with Clathrin and Coatomer proteins and processes, for efficacious effect.

In another embodiment, one or more natural adaptor protein molecules, tubulin protein molecules, dynamin protein molecules, epsin protein molecules, endophilin protein molecules, synaptotagmin protein molecules, and or other types of protein molecules involved with associated with Clathrin and Coatomer proteins and processes form efficacious hybrid elements when also comprised of one or more types of invention elements.

The CME process involves a dynamic interaction between Clathrin and a wide range of other protein molecules, and altering the compositions and behaviors of the various molecular parties involved. For example, the cell uses endocytosis to control and regulate the density of receptors on the cell surface and to acquire nutrients. Endocytosis of ligand-activated cargo attachment elements is essential for the proper attenuation of a variety of signal transduction processes, as well as for co-localization of activated cargo attachment elements with downstream signaling molecules. Endocytosis also counterbalances secretion, preventing continuous expansion of the plasma membrane. Endocytosis thus internalizes macromolecules and fluid, and after sorting, directs the internalized molecules for degradation or recycling.

The endocytosis process begins when proteins bound to cargo attachment elements accumulate in coated pits **404**, which are specialized regions of the cell membrane **402** where it is indented and coated on its cytoplasmic side with a bristle-like coat composed of two natural proteins: Clathrin and protein adapters. Most, if not all, intracellular transport vesicles are encased in a proteinaceous coat, one class of which is Clathrin-coated vesicles (CCVs). CCVs also mediate the transport of lysosomal hydrolases from the trans-Golgi network, as well as the efficient internalization of extracellular solutes such as nutrients, hormones, growth factors, and immunoglobulins at the plasma membrane.

Clathrin also transports proteins from the Golgi to other organelles. In neurons, endocytosis is critical to allow rapid synaptic vesicle regeneration. Besides Clathrin, there are other coat-forming proteins, such as COP I and COP II, which mediate intracellular traffic and there are Clathrin-independent endocytic pathways which mediate internalisation of a variety of cargo (Royle, 2006).

In one invention embodiment, the natural endocytosis process is transformed into a versatile therapeutic method to regulate the intensity, localization, half-life and function of signaling elements (signalosomes) that form in cells upon, for example, binding of growth factors, cytokines and morphogens to

In one embodiment, referring to FIG. 4, a natural Clathrin coated vesicle **220** is desired to form to endocytose over-expressed natural receptor elements **204***b* and **204***c* that are initially located outside cell membrane **402**. The appearance of one or more types of invention elements, such as element (**206***a*) in the illustrative example, outside cell membrane **402** and or by crossing **402**, dynamically begin to create, induce, spawn, mediate, control and regulate, regenerate, and or interact with one or more natural endocytosis processes and behaviors. With the prompting of one or more types of invention Clathrin elements, one or more biological processes acting on cell membrane **402** induce a Clathrin bud **404** to form at **420**.

As shown at **430** and **440**, after forming completely around bud **404**, natural Clathrin elements **206***b*-**206***d* pinch off (scission) from membrane **402** with the desired over expressed receptors **204***b* and **204***c* held inside vesicle **220**. After excision, bud **404** has evolved into a plurality of natural Clathrin elements **206***b*-**206***f*, some of which are attached to one or more types of over expressed receptor elements **204***b* and **204***c*, as well as attached to other receptor elements; which in this example are the normally expressed natural elements **204***d*.

In one illustrative embodiment, the otherwise all-natural plurality of Clathrin elements in FIG. 4 includes one or more non-cargo carrying; solo acting invention elements (**206***a*), forming a “hybrid” CCV **440** with the desired efficacious properties and behavior. This hybrid CCV then follows normal pathways within the cell, causing downregulation of the desired over-expressed receptor elements, which may be associated with one or more types of neurotransmitters, viruses, cholesterol, as well as with other cargo types, restoring a cell to its normal, healthy state.

In another illustrative embodiment, natural Clathrin coated vesicle structure **440** in FIG. 4 is additionally comprised of one or more non-cargo carrying invention receptor element **204***a* and or adaptor element **208***a* (as illustrated in FIG. 2), forming a hybrid or fused Clathrin coated vesicle **440** in FIG. 4, with the desired efficacious properties and behavior. In another embodiment, one or more hybridized and or invention elements may enter the cell nucleus and or other organelles and cell elements.

The fusion and or participatory actions of one or more non-additional element carrying, solo acting invention elements **206***a*, **204***a*, and or **208***a* in FIG. 2 may yield a therapeutic effect, and are an example embodiment of inherently efficacious invention elements in action. In another embodiment, natural or hybrid CCV **440** in FIG. 4 also includes one or more invention cargo molecules (**202***a*) that may have been transported into the cell via their attachment to one or more natural and or invention receptor elements.

Referring again to FIG. 4, in another example embodiment, a therapeutic effect is accomplished via one or more invention elements by regulating EGFR (epidermal growth factor receptor), which exists on the cell surface and is activated by binding of its specific ligands including epidermal growth factor and transforming growth factor a (TGFa).

When these natural cargo attachment elements are activated, cells rapidly clear them from the surface and destroy them. Control of EGF receptor signaling is performed by Clathrin-mediated endocytosis. Natural Clathrin coats also exist on endosomes and are involved in endosomal sorting of the EGFR. A defect in this overall process will likely lead to uninhibited growth of cells and tumors. EGFR expression, over-expression, or mutation is associated with cancer progression, advanced disease, drug resistance, aggressive disease, poor prognosis, and reduced survival. EGFR is considered one of the main proteins elevated in breast, lung, and prostrate cancers, among others. Brain cancer is also implicated with over-expressed EGFR. Other work has shown that using monoclonal antibodies for EGFR, or anti-EGFR, has proven an effective strategy for getting nanoparticles to specifically attach themselves to cancer cells. Additional work has shown effectiveness of EGFR as the cancer-targeting pathway. In one embodiment, CME, cell fusion, cell penetrating, and or one or more types of other participatory actions of one or more solo operating, efficacious invention elements **206***a*, **204***a*, and or **208***a* in FIG. 2 may yield a therapeutic effect in controlling, regulating, or mediating EGFR activity. In another example embodiment of modulating EGFR activity, cargo elements (**202***a*) in FIG. 4 may comprise one or one or more types of cancer drugs or biologicals delivered directly into cells and organelles that are transported into the cell via their attachment to one or more natural and or invention receptor elements during CME, by cell fusion, by directly penetrating cell membrane **402**, and or by one or more types of other participatory actions. In another embodiment, invention cargo elements (**202***a*) may comprise one or more diagnostic agents, or combine one or more diagnostic agents and therapeutic agents in the same payload. In one or more embodiments, one or more invention elements of one or more types may thus comprise an efficacious method for the diagnosis, treatment, remedying, curing, and or prevention of one or more types of cancers, including those cancer types that fall outside the scope of EGFR-related activity.

FIG. 5 is a conceptual diagram illustrating the basic units of Coatomer I and II proteins. COPII and Clathrin cages are both constructed from ∂-solenoid and β-propeller building blocks (Fotin et al., 2004b; ter Haar et al., 1998; Ybe et al., 1999). In various embodiments of the invention, one or more elements of one or more types are formed from isolated, synthetic and or recombinant amino acid residues comprising in whole or in part one or more types of Coatomer proteins of one or more isoforms, including cloned isoforms. Examples of various Coatomer subunit amino sequences are listed in SEQ ID NO:15, SEQ ID NO:18, SEQ ID NO:21, SEQ ID NO:26, SEQ ID NO:27, SEQ ID NO:29, and SEQ ID NO:30. In another embodiment, one or more Coatomer subunit amino acid sequences may be modified, altered, adapted or functionalized in one or more ways in one or more embodiments of the invention.

In one embodiment, Coatomer is comprised of seven distinct subunits: alpha, beta, beta′, gamma, delta, epsilon and zeta subunits, respectively.

In Clathrin, a triskelion assembly unit lies at each vertex, and the ∂-solenoid legs of neighboring triskelia interdigitate extensively as they extend toward the adjacent vertices; the β-propeller is not part of the architectural core and instead projects in toward the membrane to interact with adaptor molecules (Fotin et al., 2004; Kirchhausen, 2000). In contrast, the COPII assembly unit is a rod that constitutes the edge of a cuboctahedron, and four rods converge to form the vertex with no interdigitation of assembly units. ∂-solenoid domains form the core of the edge, but, unlike Clathrin, the COPII vertices are formed from β-propellers. In summary, the COPII and Clathrin lattices seem not to share common construction principles other than the use of ∂-solenoid and β-propeller folds.

Crystallographic analysis of the Coatomer II assembly unit reveals a 28 nm long rod, element **502**, comprising a central solenoid dimer capped by two B propeller domains, elements **504**, at each end. GTPase, elements **508**, bind to adaptor elements **506**, which bind to elements **502**. In the illustration, element **502***a* is an invention element that acts as an efficacious replacement element for one or more natural element **502**, forming a hybrid Coatomer element. The structural geometry and properties of COPI coats remain to be determined. However, by analogy to the COPII and Clathrin structural units, they probably involve a preassembled cage protein (CP) scaffold that is generated by the β-propeller-containing and ∂-solenoid-containing

macromolecules (large molecules) by fusion of vesicles with the plasma membrane. Coatomer-coated vesicles, which are typically less than fifty nanometers in size, are also involved in vesicular transport between the Golgi apparatus, endoplasmic reticulum and plasma membrane. Coatomer I vesicles shuttle elements from the Golgi to the endoplasmic reticulum (ER). Coatomer II vesicles shuttle elements from the ER to the Golgi. Coat-protein I/II subunits (COPs) require ATP to assemble into a coat and unlike Clathrin coats, the Coatomer coat remains on the vesicle until docking occurs. In some instances, Coatomer proteins are also involved in endocytosis, but are unrelated to Clathrin. Thus, while Clathrin also mediates endocytic protein transport from the ER to the Golgi, Coatomers (COPI, COPII) primarily mediate intra-Golgi transport, as well as the reverse Golgi to ER transport of dilysine-tagged proteins. Coatomers reversibly associate with Golgi (non-Clathrin-coated) vesicles to mediate protein transport and for budding from Golgi membranes. In one or more embodiments, one or more COPI/COPII invention elements and or Clathrin invention elements, either by acting alone and or in part with other elements of one or more types, including natural and or non-invention elements, efficaciously modify, control and regulate, interfere with, create, and or spawn elements and or induce actions or behaviors involving exocytosis.

Cells of the mammalian immune system undergo selective changes in protein glycosylation during differentiation, immune activation, and autoimmune disease. In many, if not most of these types of diseases endocytosis and cellular trafficking and signaling plays a role. Referring again to FIGS. 1, **2**, **3**, **4**, (and **5**, in some embodiments), but not limited to, in one embodiment, one or more invention elements of one or more types, in whole or in part selectively interfere with, fuse with, control and regulate, induce, and otherwise modify endocytosis, receptor-specific processing, trafficking and signaling, and other behaviors for efficacious effect in one or more types of autoimmune diseases, including, but not limited to, one or more types of diabetes, CNS autoimmune diseases, and other types of autoimmune diseases that effect the body.

Referring again to FIGS. 1, **2**, **3**, **4**, (and **5** in some embodiments), but not limited to, in one embodiment, one or more invention elements of one or more types selectively interfere with, control and regulate, and or modify secretory products that participate in inflammation and immunoregulation; and also in other embodiments, whereby endocytosis mediated by specific receptors for immunoglobulin or by other opsonins is important in removal of damaged self or foreign particles. In another embodiment, defects in membrane receptor function, whether inherited or acquired, and the pathogenesis of immune diseases may be remedied, inhibited, mitigated, and or prevented.

Referring again to FIGS. 1, **2**, **3**, **4**, and **5**, in one embodiment, but not limited to, one or more invention elements of one or more types efficaciously fuse with and or functionally replace one or more natural elements commonly found in endocytosis, exocytosis, mitosis, trafficking and signaling, and the like, either by acting alone and or in part with other elements of one or more types, including natural and or non-invention elements.

Referring again to FIGS. 1, **2**, **3**, **4**, and **5**, but not limited to, in another embodiment, one or more invention elements of one or more types efficaciously cross over into a cell, its elements, and or its organelles, such as its nucleus, either by acting alone and or in part with other elements of one or more types, including natural and or non-invention elements.

Referring again to FIGS. **1**,**2**,**3**,**4**, and **5**, in another embodiment, but not limited to, one or more invention elements efficaciously create, spawn, comprise, modify, repair, regenerate, reassemble, and or control and regulate one or more natural elements commonly found in endocytosis, exocytosis, mitosis, trafficking and signaling, other cellular behaviors, and the like, either by acting alone and or in part with other elements of one or more types, including natural and or non-invention elements.

Referring again to FIGS. **1**,**2**,**3**,**4**, and **5**, in another embodiment, but not limited to, one or more invention elements efficaciously utilize natural and or genetically engineered elements to encode components of the intracellular sorting machinery that mediate the selective trafficking of lipids and proteins in the secretory and endocytic pathways, to efficacious effect.

Referring again to FIGS. **1**,**2**,**3**,**4**, and **5**, in another embodiment, but not limited to, one or more invention elements efficaciously utilize genetic agents and elements, including, but not limited to, proteins; peptides; DNA and DNA variants; RNA and RNA variants such as mRNA, iRNA and siRNA; RNA-induced silencing complex (RISC), other genetic-modifying agents and methods, and the like.

In another embodiment, but not limited to, one or more invention elements efficaciously utilize one or more oligonucleotides in antisense therapy. These antisense DNA drugs work by binding to messenger RNAs from disease genes, so that the genetic code in the RNA cannot be read, stopping the production of the disease-causing protein.

In another illustrative embodiment, one or more elements may comprise one or more RNAi (RNA interference) elements and or RNAi variants such as small interfering RNA molecules (siRNA), but not limited to, that may collaborate with proteins in the cell and also may form a nanoscale element called a RISC (RNA-Induced Silencing Complex). RNAi and or RISCs may be used to head off a genetic disease before the first symptom appears, based on an analysis of an individual's predisposition to certain diseases. This methodology is a way of silencing a specific gene, for example, genes that direct cancer cells to proliferate or that create overproduction of proteins that cause rheumatoid arthritis. Basically, RNAi works by scanning RNA templates that may cause a disease and cleaving that RNA template, and enzymes then destroying the template before it can complete its actions on the offending DNA. One of the key barriers to successful RNAi therapy is their finding their way to a specific site in the body and then the RNAi not degrading rapidly before it can do useful work. In one illustrative embodiment, RNAi, siRNA, RISC elements and or other suitable methods may be targeted by an invention element such that one or more such RNA elements seek out and destroy potentially harmful genetic elements and or other genetic processes.

As noted in the literature, Clathrin heavy chain is known to be a cytosolic protein that functions as a vesicle transporter. However, the Clathrin heavy chain exists not only in cytosol but also in cell nuclei. The p53 gene, in which mutations have been found in >50% of human cancers, encodes a protein that plays an important role in preventing tumorigenesis. Clathrin heavy chain expression enhances p53-dependent transactivation, whereas the reduction of Clathrin heavy chain expression by RNA interference (RNAi) attenuates its transcriptional activity. Moreover, Clathrin heavy chain binds to the p53-responsive promoter in vivo and stabilizes p53-p300 interaction to promote p53-mediated transcription. Thus, nuclear Clathrin heavy chain is required for the transactivation of p53 target genes and plays a distinct role from Clathrin-mediated endocytosis (Enari, et al 2006). In one embodiment, p53 and or one or more other types of genes, their diseases and disorders, and or RNAi related activities may be efficaciously controlled and regulated, mitigated, prevented, and or modified via one or more embodiments of the instant invention.

Referring again to FIGS. **1**,**2**,**3**,**4**, and **5**, in another embodiment, but not limited to, one or more elements, acting alone or not, would achieve

dopamine receptors. The subsequent cellular response depends on the type of dopamine receptor that is activated and the signal transduction mechanisms that are coupled to these receptors. Disturbances in one or more of the above-mentioned aspects of dopaminergic transmission could lead to severe neurological and neuropsychiatric disorders such as Parkinson's disease, depression, addiction, schizophrenia, attention deficit hyperactivity disorder, restless legs syndrome, Tourette syndrome, and the like, and in or more invention embodiments, one or more such disorders may be efficaciously treated.

Referring again to FIGS. **1**,**2**,**3**,**4**, and **5**, in another embodiment, but not limited to, one or more elements, during some operations may interact with, for example, an externally applied magnetic field, like during NMR. However, since invention protein elements are electrically neutral, only minimal (e.g., no) structural distortion of the elements occurs in the presence of the magnetic field. Therefore, using invention elements to capture other types of elements, which may be, for example, one or more NMR contrast agents for developmental imaging and diagnostic studies, and which contrast agents may also be capable of crossing cellular membranes, protects and extends the utility of the invention.

Referring again to FIGS. **1**,**2**,**3**,**4**, and **5**, in another embodiment, but not limited to, one or more elements may comprise, for example, one or more metal ions including, but not limited to, the gadolinium (III) chelate compounds of DTPA, DO3A, DOTA and other variations of these linear and macrocyclic ligands that act as targeted and or non-targeted contrast agents.

Direct Gd3+-OH2 chemical bonds, which exchange rapidly with other bulk H2O molecules, produce the mechanism whereby unpaired electrons on Gd3+ relax the proton nuclei of many nearby H2O molecules. Accordingly, the behavior of T1 contrast agents, such as those based on gadolinium requires good direct contact with tissue water molecules (spin-lattice relaxation mechanism) to be efficient. Thus, it is often preferable to bind them to the external surface of the carrier. (Hooker, et al. 2007) In one embodiment, one or more elements facilitate better contact to tissue water because one or more contrast agents of one or more types are not located in the interior part of a cage (in its cavity), but rather, located on much more exposed non-cage elements of one or more types. In one embodiment, one or more cage element **212** has one or more contrast agents of one or more types located on the outside part of cage element **212**; or on both the inside and outside parts of element **212**.

In another illustrative embodiment, one or more imaging or study elements comprise one or more treated manganese minerals, such as oxides, silicates, and carbonates for imaging and study enhancement.

Besides Gd3 complexes, there is another important class of contrast agents for MRI that is based on polysaccharide coated iron oxide particles. Their peculiarity stems from the fact that their blood half-life and distribution to different organs of the reticuloendothelial system (RES) depend upon the particle size (Aime, et al 1998). In one embodiment, one or more elements comprise one or more of a wide range of lanthano-invention labeled derivatives for custom-designed contrast agents.

In another embodiment, one or more elements comprise one or more therapeutic agents in addition to one or more imaging contrast and diagnostic agents.

In another illustrative embodiment, targeted and or non-targeted in vivo delivery of one or more elements are internally and or externally monitored, directed, activated, deactivated and or regulated, locally and or at a remote distance by, for example, but not limited to, NMR, ESR, ultrasound, radio transmissions, and or biochemical reactions.

Additionally, in other embodiments, NMR is combined with other techniques, such as ENDOR, which combines the best aspects of ESR and NMR, to yield high sensitivity and nuclear selectivity, respectively, for in vivo and in vitro studies.

In one embodiment, one or more different sized, paramagnetic coated, quantum dots, and or photonic dots are used as one or more contrast markers in magnetic resonance imaging (Mulder, et al., 2009). In other embodiments, one or more different sized quantum dots, and or photonic dots may be used in positron emission tomography (PET) for in-vivo molecular imaging, or as fluorescent tracers in optical microscopy.

In another configuration, one or more types of elements comprise one or more radiodiagnostic agents for nuclear medicine.

Referring again to FIG. 2, in further illustrative embodiments, free-floating cargo may be carried in cavity forming cargo elements **202***a* that comprise a fluid, gas, or vapor; which free-floating cargo, for example, may be one or more molecular ensembles for enhanced medical imaging, and which cargo may also be carrying one or more therapeutic agents.

Referring again to FIGS. 1, **2**, **3**, **4**, and **5**, in another embodiment, but not limited to, one or more invention elements comprise one or more types of elements in whole or in part, such as one or more drug and pharmacological elements; biological elements; biomedical or medical elements; and the like, including healthcare elements; bioengineered elements; cosmetic elements; and the like.

Referring again to FIGS. 1, **2**, **3**, **4**, and **5**, but not limited to, in one embodiment, one or more elements of one or more types comprise targeted and or non-targeted drug delivery elements, including their high precision dosing, or other forms of healthcare elements for diagnosing, remedying, inhibiting, mitigating, curing, and or preventing one or more types of diseases, infections, physical or mental trauma, or other forms of physical and mental afflictions.

Referring again to FIGS. 1, **2**, **3**, **4**, and **5**, but not limited to, in one embodiment, one or more elements comprise an in vitro and or in vivo model and or system for research study, including a model, method, and or system for the research and development of new drugs, therapies, prosthetics, and drug delivery systems, including an accelerated drug discovery process.

Referring again to FIGS. 1, **2**, **3**, **4**, and **5**, in another embodiment, but not limited to, one or more elements, acting alone or not, are utilized for studying, discovering, preventing, curing, mitigating, and or healing one or more types of animal, tree, plant, grain, grass, agricultural, vegetable, and or fungal diseases, disorders, infestations, and or blights.

Referring again to FIGS. **1**,**2**,**3**,**4**, and **5**, in another embodiment, but not limited to, one or more elements are used for studying, discovering, designing, and or enabling of genetically engineered elements, for example, one or more types of genes, cells, and other biological elements and products in animals, trees, plants, grains, grasses, agriculture, vegetables and fungi

of Coatomer I and II vesicles. In cells over-expressing ATPase-deficient hsc70 mutants, uncoating of CCVs is inhibited in vivo. In one embodiment, bioengineered elements may be used to regulate under or over expression of hsc70 and or auxilin. In one example embodiment, using a monoclonal antibody or other agent type as cargo against hsc70 blocks the hsc70-mediated release of invention and or non-invention Clathrin from coated vesicles. In another example embodiment, or more auxilin elements comprise invention elements.

In one illustrative embodiment, one or more elements are stable with respect to dissociation, including one or more associated non-invention elements.

In another illustrative embodiment, disassembly and dissolution of one or more elements are deliberately inhibited and control and regulated, including one or more associated non-invention elements.

In one illustrative embodiment, one or more elements remain stable for a time certain or estimated time before the onset of dissociation, including one or more associated non-invention elements.

In one illustrative embodiment, dissociation of one or more elements may occur in whole or in part, including one or more associated non-invention elements.

In one illustrative embodiment, one or more cargo elements may comprise one or more uncoating and dissociation agents and or use one or more methods for controlled and regulated release of agents or cargo from one or more elements, including one or more associated non-invention elements.

In another embodiment, disassembly and dissolution of one or more elements, including one or more associated non-invention elements are inhibited, controlled and regulated, and or promoted by using one or more specific agents, stimuli, and or other methods.

In one embodiment, but not limited to, one or more invention elements of one or more types are formed in vitro via the following protocols, which may be modified and or substituted by one or more other types of protocols in one or more invention embodiments: (Adapted from Campbell, C et al., Biochemistry 23, 4420-4426 (1984), Pearse & Robinson, EMBO J. 9:1951-7 (1984), and Zhu, et. al., Methods in Enzymology, 328, 2001, Kedersh N, et al., J. Cell Biology 103, 1986.)

(Adapted from Campbell, C et al., Biochemistry 23, 4420-4426 (1984), Pearse & Robinson, EMBO J. 9:1951-7 (1984), and Zhu, et. al., Methods in Enzymology, 328, 2001, Kedersh N, et al., J. Cell Biology 103, 1986.)

Part I. Method of Differential Centrifugation.

1. Make up 1 L of a buffer (buffer A) that comprises: 50 mM Mes pH 6.5, 100 mM NaCl, 1 mM EGTA, 0.5 mM $MgCl_2$, 0.02% NaN_3, 1 mM DTT a day prior to experiment and storage at 4° C.
2. Add 1:100 PMSF proteases inhibitor to buffer A (200 ul/20 ml).
3. Collect and wash 14 rat brains (˜2.0 g) and livers (˜20.0 g). Wash and place the brains in ice-cold buffer A. Perfuse the livers with ice-cold PBS and collect them in ice-cold buffer A.
4. Mince and homogenize the brains in a Potter-Elvehjem grinder with 2 volume of ice-cold buffer A per total brain wet weight (˜90 ml). Do the same with the livers (˜400 ml).
5. Centrifuge the homogenate at 23,000 g (11,900 rpm) in a Sorvall GSA or at 13,000 rpm in a Sorvall SS34 rotor for 45 min at 4° C.
6. Collect the supernatant and centrifuge at 43,000 g (18,000 rpm) in a Sorvall SS34 rotor or at 20,000 rpm in a ti 45 Beckman rotor for 1 h at 4° C.
7. Resuspend the pellet in 10 ml of ice-cold buffer A, use a loose-fitting Teflon-glass Dounce homogenizer.
8. Collect homogenate in a 50 ml conical tube. Wash pestle and glass homogenizer with 5 ml of buffer A, and add this to homogenate until total volume is 15 ml. Add 1:100 PMSF
9. Dilute the homogenate 1:1 with 15 ml of 12.5% Ficoll/12.5% sucrose (both in ice-cold buffer A), and mix by inversion to ensure homogeneity.
10. Centrifuge at 43,000 g (18,000 rpm) in a Sorvall SS34 rotor or at 20,000 rpm in a ti 45 Beckman rotor for 30 min at 4° C.
11. Collect the supernatant in a graduate cylinder and dilute it 1:5 in ice-cold buffer A. Add 1:100 PMSF
12. Centrifuge the supernatant at 100,000 g (33,000 rpm) in a Beckman 70.1Ti rotor or at 31,100 rpm in a ti 45 Beckman rotor for 1 h at 4° C.
13. Collect pellet and resuspend in 5-10 ml of ice-cold buffer A by using a loose-fitting Teflon-glass Dounce homogenizer. Add 1:100 PMSF
14. Leave the homogenate on ice for about 30 min, and take an aliquot of 10 ul for EM, and dilute 1:10 for brain, 1:100 for liver.

Part II. Purification of CCVs Using Density Gradients (Zhu's CCVs and Clathrin Coat Preparation). Submit the Crude Clathrin-Coated Vesicles from Fresh Rat Brain to Discontinuous Sucrose Gradient for Remove Contaminating Vaults.

1. CCVs resuspended in (5-10 ml) buffer A
2. Preparer a discontinuous sucrose gradient in SW28 tubes by carefully layering 5 ml of 40%, 5 ml of 30%, 6 ml of 20%, 8.5 ml of 10%, and 8.5 of 5% sucrose solutions in buffer A from bottom to top.
3. CCVs (5-10 ml) is laid on top of the gradient and centrifuged at 100,000 g (25,000 rpm) in a SW28 rotor for 1 hr at 4° C.
4. Collect twenty-six 1.5 ml factions from the top.
5. Small aliquots from every other faction are analyzed for CCVs using 10% SDS-PAGE. [Fractions comprising the CCVs (typically fractions 12-21 as numbered from the top of the gradient) are combined, diluted with 3 volumes of buffer A, and centrifuge at 112,000 g (31,100 rpm) in a ti 45 Beckman rotor for 1 h at 4° C. or at 33,000 rpm in a Beckman 70.1Ti rotor for 1 h at 4° C. Add 1:100 PMSF]
6. Resuspend the pellet in ice-cold buffer A, do a protein assay to yield an approximate concentration. Usually add 1 to 2 ml of buffer A.
7. Aliquot the homogenate in aliquots of 200 ul and store at −80° C. Take an aliquot of 10 ul each for EM and SDS-gel PAGE.

Part III. Isolation of Triskelia and APs from CCVs Using Keen's Method.

1. Dialyze CCVs against 0.01M Tris buffer, Ph 8.5, 3 mM azide for 5 hours.
2. Centrifuge at 240,000 g (51,200 rpm) for 20 min at 4° C. Because you are using low amount of sample; (IF we have less than 2 mL, Do not use the lid or close the centrifuge tubes of the 70.1 Ti rotor.) The soluble coat proteins comprising triskelial and APs are separated from the residual Clathrin-coat vesicle membranes.
3. Collect the soluble fraction and do protein assay.
4. Take an aliquot of 10 ul for EM and 50 ul for SDS-gel PAGE.

Part IV. Separation by FPLC of AP-1 from AP-2 with Hydroxyapatite Column

buffer (500 ml):	100 mM NaCl	(10 ml of stock)
	0.02% NaN_3	(1 ml of stock)
	0.1% beta-Mercaptoethanol	(0.5 ml)
		(RT)
High PO_4	500 mM NaH_2PO_4; pH 7.1	(100 ml of stock)
buffer (200 ml):	100 mM NaCl	(4 ml of stock)
	0.02% NaN_3	(0.4 ml of stock)
	0.1% beta-Mercaptoethanol	(0.2 ml)
		(RT)

Both buffers need to be filtered and degassed prior to use.

AP Buffer:

100 mM MES, pH 7.0	39 g/2 l
150 mM NaCl	17.5 g/2 l
1 mM EDTA	4 ml of 500 mM solution/2 l
0.02% NaN_3	4 ml of 10% solution/2 l −>
0.5 mM DTT	add just before use (4° C.)

Hydroxyapatite Column:

5 ml Econo-Pac CHT-II from BioRad; the column is stored at 4° C. in low PO_4 buffer

Procedure:

Connect the hydroxyapatite column to the FPLC system via the BioRad adaptors. Put a 0.2μ syringe filter at the inlet of the column.

Use the following FPLC settings:

Sensitivity: 1

Flow: 1 ml/min

Chart Recorder speed: 0.5 cm/min

Make sure the fraction collector is set at “ml” and a volume of “1”

Pump A is used for the low PO_4 buffer; Pump B for the high PO4 buffer. Wash the pumps with Valve 1 in position “3”.

Once the FPLC system is set up, start washing the column with 20 ml of high PO_4 buffer (=20 min). Be sure to switch on UV-Lamp.

This is followed by equilibration of the column with low PO_4 buffer; i.e. until the baseline is stable. The backpressure of the system should be approx. 0.1 MPa and must not exceed 0.35 Mpa.

During the equilibration phase (Valve 1 in position “1”=“Load”), the 50 ml superloop is loaded with the AP sample (Pump C; 5 ml/min).

With the column equilibrated and the superloop loaded, switch Valve 1 into position “2”=“Inject”. The APs are injected over the column at a flow rate of 1 ml/min.

After the injection is completed, continue running low PO_4 buffer over the column until the baseline is stable. Don't forget to prepare 1.5 ml tubes for the fraction collector.

AP-1 and AP-2 are then eluted from the column using Method 6:

0.0	CONC % B	0.0
0.0	VALVE. POS	1.1
0.0	CM/ML	0.50
0.0	PORT. SET	6.1
40.0	CONC % B	0.0
40.0	ML/MIN	1.00
50.0	CONC % B	100

The elution profiles for AP-1 and AP-2 tend to vary considerably from one purification to another; AP-1 is eluted first.

AP-1 tends to be eluted from the column in three to four 1 ml fractions, usually starting at around #13. AP-2 is usually eluted in up to 15 fractions, starting at around #25. The fractions comprising the APs need to be verified by SDS-PAGE (two gels of 10% or 12%)

Wash column with low PO_4 buffer; store at 4° C.

Pooled AP-1 fractions and pooled AP-2 fractions are dialyzed against 1 liter of AP buffer overnight, and for a few more hours after exchanging the buffer (4° C.). The samples are then stored at 4° C.

Typically, the concentration for Clathrin (peak fractions) is approx. 0.5 mg/ml, for AP-1 and AP-2 between 0.3-0.5 mg/ml.

According to one illustrative embodiment, but is not limited to, recombinant Clathrin formation may be achieved in the following exemplar manner. Stoichiometric quantities of adaptor elements **208***a* comprising AP-1 and AP-2 are required for Clathrin self-assembly at physiological pH. However, in vitro Clathrin self-assembly occurs spontaneously below about pH 6.5. Recombinant terminal and distal domain fragments are produced and combined with recombinant-produced hub fragments in assembly buffer as described below in order to induce formation of one or more Clathrin elements, such as those comprising elements **206***a*, for use in the invention.

In one illustrative technique, bovine Clathrin heavy chain cDNA encoding heavy chain amino acids 1-1074 (SEQ ID NO: 1) is cloned into the pET23d vector (Novagen) between the NcoI (234) and XhoI (158) sites. Expression of the cloned sequence results in a terminal and distal domain fragments having a C-terminal polyhistidine tag. Hub fragments corresponding to amino acids 1074-1675 (SEQ ID NO: 1) are cloned into vector pET15b (Novagen) between the BamHI (319) and XhoI (324) sites. Expression of the hub fragments produces the proximal leg domain and central trimerization domain of the Clathrin hub with an N-terminal polyhistidine tag. Vectors comprising the heavy chain and hub domains are expressed in *E. coli* by

In another exemplar technique, Clathrin assembly reactions are performed using expressed heavy chain and hub fragments by overnight dialysis at 4 degrees Celsius in assembly buffer (100 mM 2-(N-morpholino) ethanesulfonic acid, pH 6.7, 0.5 mM MgCl2, 1 mM EGTA, 1 MM Tris(2-carboxyethyl)-phosphine hydrochloride, 3 mM CaCl2. Assembly reactions are centrifuged for 5 minutes at 12,000 rpm. The supernatant is then centrifuged for 45 minutes at 45,000 rpm (100,000×g). The pellets are resuspended in assembly buffer, and protein composition is determined on SDS-PAGE. The efficiency of element **206***a* formation can be determined by electron microscopy by diluting assembly reactions 1:5 in 10 mM Tris pH7.9, and placing aliquots on a glow-discharged carbon-coated grid, using 1% uranyl acetate as the stain.

According to another illustrative embodiment, but is not limited to, recombinant Clathrin formation may be achieved in the following exemplar manner, as described by Rapoport, et al. (MBC 2008): A cDNA encoding rat Clathrin heavy chain (Kirchhausen et al., 1987a) is used as a template to generate full-length (1675 HC), nested C-terminal truncations (1661 HC, 1643 HC, 1637 HC, 1630 HC, and 1596 HC), internal deletions (1675 PIVYGQ HC, 1643 PIVYGQ HC, and 1675 QLMLTA HC), and mutations (1643LML-AAA HC) of the heavy chain; each is then subcloned into the insect cell expression vector pFastBac1 (Invitrogen, Carlsbad, Calif.). A cDNA encoding rat liver Clathrin light chain LCa (Kirchhausen et al., 1987b) is used as the template to subclone the region encoding the full light chain (residues 1-256) into the insect cell expression vector pFastBacHTb. The final construct (rLCa1i) comprises at its N terminus a 6×-His-tag followed by a linker of 20 residues. Baculoviruses suitable for infection and expression are generated with the Bac-to-Bac system (BD Biosciences, San Jose, Calif.). Virus stocks are obtained after four rounds of amplification, and they are kept in the dark at 4° C. The open reading frame of rat brain Clathrin light chain LCa1 is also used as a template to subclone it into the bacterial expression vector pET28b (Novagen, Madison, Wis.) between the NcoI and EcoRI restriction sites so as to generate a native, nontagged light chain. All constructs are verified by DNA sequencing. Clathrin heavy chains together with light chain are expressed in Hi5 insect cells (1 L, 1-1.5 **206***a* cells/ml) grown for 2-3 d in spinner flasks at 27° C. in Excell 420 medium after coinfection with the appropriate viruses. Alternatively, Clathrin heavy chain only is expressed in a similar way. The cells are centrifuged at 1000 rpm for 10 min at room temperature by using an H6000A rotor (Sorvall, Newton, Conn.), and the pellets are resuspended in 20 ml lysis buffer (50 mM Tris, pH 8.0, 300 mM NaCl, 1 mM EDTA, 3 mM mercaptoethanol, and half of a tablet of Complete Protease Inhibitor Cocktail [Roche Applied Science, Indianapolis, Ind.]). The resuspended pellets are sonicated for 1 min on ice (Flat tip at 20% power, Ultrasonic processor XL; Heat Systems, Farmingdale, N.Y.), cell debris is removed by centrifugation at 90,000 rpm for 20 min at 4° C. by using a TLA 100.4 rotor (Beckman Coulter, Fullerton, Calif.), and the supernatant (20 ml) is dialyzed at 4° C. for 12 h against 2×2 l of cage buffer (20 mM [2-(N-morpholino) ethanesulfonic acid] MES, pH 6.2, 2 mM CaCl2, 0.02% NaN3, and 0.5 m Mdithiothreitol [DTT]). The sample is then centrifuged at 4° C., first at low speed (1000 rpm for 10 min) to remove large aggregates and then at high speed (54,000 rpm for 1 h) by using a Ti rotor (Beckman Coulter). The pellet, primarily comprising Clathrin (presumably assembled as cages) is resuspended in 6 ml of 100 mM MES, pH 6.5, 3 mM EDTA, 0.5 mM MgCl2, 0.02% NaN3, 0.5 mM DTT, and 0.5 mM phenylmethylsulfonyl fluoride) followed by addition of 3 ml of 2.4M Tris, pH 7.4, 1 mM DTT, and incubation for 20 min at room temperature, a condition used to dissociate native Clathrin assemblies. The sample is centrifuged at 90,000 rpm for 20 min at 4° C. by using a TLA 100.4 rotor, and most of the Clathrin is recovered in the supernatant. The resulting sample is subjected to gel filtration chromatography (90 cm×0=3 cm column comprising Sephacryl-S 500 [GE Healthcare, Little Chalfont, Buckinghamshire, United Kingdom] in 0.5 M Tris, pH 7.4, 0.04% NaN3, and 0.5 mM DTT) at room temperature and with a flow of 2 ml/min. Fractions of 5.5 ml comprising the Clathrin peak (100 ml) are pooled and then subjected to adsorption chromatography (5 ml, hydroxyapatite, Econo-Pac CHT-II; Bio-Rad, Hercules, Calif.); the column is pre-equilibrated with low phosphate buffer (10 mM NaH2PO4, pH 7.1, 100 mM NaCl, 0.02% NaN3, and 0.5 mM DTT) and eluted with a linear gradient from low to high phosphate concentration (500 mM NaH2PO4, pH 7.1, 100 mM NaCl, 0.02% NaN3, and 0.5 mM DTT) at room temperature with a flow of 1 ml/min. Fractions (1 ml) are collected into microcentrifuge tubes comprising 2 l of 0.5 M EDTA. Typical Clathrin yields are in the range of 3-40 mg per 1 l of cell culture. Western blot analysis is used to confirm the expression of Clathrin heavy and light chains. The rat Clathrin light chain rLCa1b is expressed in *Escherichia coli* strain BL21(DE3). The bacteria are grown in Luria-Bertani (LB) medium comprising 30 mg/l kanamycin at 37° C. with shaking (250 rpm) to an optical density of 0.5. Expression is induced by addition of isopropyl-d-thiogalactoside (IPTG) (final concentration, 0.6 mM). After 3 h, the cell are harvested by centrifugation at 5000 rpm for 10 min at 4° C. by using an H6000A rotor (Sorvall) and resuspended in ice-cold lysis buffer (20 mM Bis-Tris adjusted to pH 6.0 at room temperature, 0.5 mM dithiothreitol, 1 mM EDTA, and Complete Protease Inhibitor Cocktail) by using 20 ml of lysis buffer per 3.5 g of wet cell weight. The suspension is placed into a glass vessel, and the vessel is immersed in boiling water for 4 min and then chilled on ice. The boiled suspension is centrifuged at 54,000 rpm for 30 min at 4° C. by using a 60Ti rotor (Beckman Coulter) to remove the precipitated material. rLCa1b is purified from the filtered supernatant (0.2-m syringe filter) by anion exchange chromatography at 4° C. on a HiTrap MonoQ column equilibrated with buffer A (20 mM Bis-Tris, adjusted to pH 6.0 at room temperature, and 0.5 mM dithiothreitol) and eluted using a linear gradient from 0 to 32% buffer B (20 mM Bis-Tris, adjusted to pH 6.0 at room temperature, 0.5 mM dithiothreitol, and 1 M NaCl). For the in vitro reconstitution of Clathrin, recombinant heavy chain (expressed in insect cells without light chain) is mixed with excess rLCa1b (expressed in bacteria) by using a weight ratio of 3:1 (equivalent to a molar ratio HC:LC of 1:2.4) just before cage or coat assembly for 40 min at room temperature.

Part V. Clathrin Coat Formation
Reagents
1. Coat Formation Buffer

80 mM Mes hydrate pH 6.5	31.23 g/2 L
20 mM NaCl	2.34 g/2 L
2 mM EDTA	8 mL of 500 mM stock solution/2 L
0.4 mM DTT	1.6 mL of 500 mM stock solution/2 L

2. Clathrin
3. AP-2
Procedure
(1) Place a solution of clathrin and AP-2 into a dialysis chamber
clathrin: AP-2=3:1 to 4:1 (w/w)
(2) Dialyze over night against coat formation buffer; replace buffer and dialyze for an additional 3-4 h.
(3) Transfer to a centrifuge tube, centrifuge to remove larger aggregates
rotor: TLA-100.4, 12000 rpm, 4° C., 10 min
(4) Transfer supernatant to fresh centrifuge tube, centrifuge to collect coats

Part VI. Clathrin Cage Formation
Reagents
1. Cage Formation Buffer:

20 mM Mes, pH 6.2 (3.9 g/1) (7.8 g/2 l)
2 mM CaCl2 (2 ml of 1M/l) (4 ml of 1M/2 l)
0.02% NaN3 (2 ml of 10%/l) (4 ml of 10%/2 l)
0.5 mM DTT (1 ml of 500 mM/l) (2 ml of 500 mM/2 l)

2. Clathrin
Procedure

(1) Place a solution of Clathrin (0.5-1 mg/mL) into a dialysis chamber
(2) Dialyze over night against cage formation buffer; replace buffer and dialyze for an additional 3-4 h.
(3) Transfer to a centrifuge tube, centrifuge to remove larger aggregates

rotor: TLA-100.4, 12000 rpm, 4° C., 10 min
(4) Transfer supernatant to fresh centrifuge tube, centrifuge to collect coats
rotor: TLA-100.4, 65000 rpm, 4° C., 12 min
(5) Immediately withdraw supernatant with a 1 mL pipette.
(6) Wash carefully with buffer around the pellet.
(7) Resuspend the pellet by adding buffer, allowing to stand at room temperature for 10-15 min, then slowly wash buffer over the pellet to resuspend using a micropipettor (avoid foaming)

Production of Recombinant Auxilin

A protein chimera of glutathione transferase (GST) with bovine auxilin (spanning residues 547-910) is generated by fusion in the vector pGEX4T-1 and then used for expression in *E. coli* BL21 (Fotin et al., 2004a). The bacteria are grown in LB medium supplemented with ampicillin to an OD600 0.5-0.6 at 37° C. Protein expression is induced by addition of 1 mM IPTG (final concentration) and the cells grown for another 4 h at 25° C. The cells (from 1 l of culture) are centrifuged at 5000 rpm for 15 min at 4° C., and the pellet is kept frozen overnight. The pellet is resuspended in 25 ml of pGEX lysis buffer (20 mM HEPES, pH 7.6, 100 mM KCl, 0.2 mM EDTA, 20% glycerol, 1 mM DTT, and half a tablet of Complete Protease Inhibitor Cocktail) and sonicated on ice using three consecutive sonication cycles of 60, 30, and 30 s (standard microtip, 20% power). The sample is centrifuged at 45,000 rpm for 1 h at 4° C. by using a 60Ti rotor, and the supernatant mixed with 0.5 ml of a 50% (vol/vol) slurry of glutathione-Sepharose 4 beads (GE Healthcare). After 2 h of end-over-end rotation at 4° C., the beads are poured into a propylene Econo-Column (Bio-Rad), washed with 15 ml of pGEX lysis buffer, and then washed with 15 ml of 25 mM HEPES, pH 7.0, 100 mM NaCl, and 0.1 mM EGTA. Elution of GST-auxilin (in 2 ml) is achieved by supplementing the solution with 50 mM glutathione, adjusted to pH 8. These steps are carried out at 4° C. Release of the GST portion is achieved by incubation of 1 mg of GST-auxilin with 1 U of thrombin at room temperature for 6 h. Proteolysis is ended by addition of 1 mg of Pefabloc SC (Roche Applied Science). The 40-Da auxilin fragment is further purified using a Mono S column (Pharmacia, Peapack, N.J.). The sample is first dialyzed overnight against MES buffer A (50 mM MES, pH 6.7, 1 mM EDTA, and 3 mM-mercaptoethanol), and then it is loaded onto the column (pre-equilibrated with MES buffer A) and eluted with a linear gradient of buffer A and with MES buffer B (50 mM MES, pH 6.7, 500 mM NaCl, 1 mM EDTA, and 3 mM-mercaptoethanol) at a flow of 1 ml/min. The auxilin sample is stored at 80° C. with 20% glycerol (final concentration).

Production of Recombinant Hsc70

N-terminal 6×-His-tagged bovine Hsc70 (full length) cloned into the pET21a vector is expressed in *E. coli* BL21. The bacteria are grown at 37° C. in LB supplemented with 0.1 mg/ml ampicillin to an OD600 of 0.5, transferred to 28° C., and induced with 0.1 mM IPTG for 5 h. The cells are centrifuged at 5000 rpm for 15 min at 4° C., and the pellets from 1 l culture resuspended in 25 ml 50 mM Tris, pH 8.0, 300 mM NaCl, 1 mM ATP, 2 mM MgCl2, 10 mM-mercaptoethanol, and half a tablet of Complete Protease Inhibitor Cocktail without EDTA. The supernatant obtained after sonication and centrifugation (as with auxilin) is mixed with 1 ml of 50% (vol/vol) slurry of nickelnitrilotriacetic acid-agarose beads (QIAGEN, Valencia, Calif.) for 4 h by endover-end rotation at 4° C. The beads are placed into an Econo Pac column and then washed with 30 ml of 50 mM Tris, pH 8.0, 300 mM NaCl, 10 mM-mercaptoethanol, 10 mM imidazole, 1 mM ATP, and 1 mM MgCl2). Hsc70 is then eluted at 4° C. with 5-6 ml of the same solution supplemented with 200 mM imidazole. Fractions of 1 ml are collected into microcentrifuge tubes comprising 40 l of 0.1 M EGTA. The samples comprising 20% glycerol (final concentration) are stored at 80° C.

According to another illustrative embodiment, Clathrin and or Coatomer I/II proteins are extracted and prepared from Clathrin and or Coatomer I/II coated vesicles obtained from non-rat, non-bovine organic tissue, including from human tissue, in whole or in part. In another embodiment, Clathrin and or Coatomer I/II coated proteins are extracted and prepared from Clathrin and or Coatomer I/II coated vesicles obtained by donor/recipient tissue matching using established techniques. In another embodiment, Clathrin and or Coatomer I/II proteins are prepared, in whole or in part, by using stem cells, cloning and or other genetic manipulation techniques known in the prior art to produce genetically matched tissue for a donor recipient.

According to one illustrative embodiment, the coat protein I (COPI) assembly process is carried out by preparing Coatomer subunits from cytosolic preparations, including methods, but are not limited to, as essentially described in Spang, et al., Proc. Natl. Acad. Sci. USA. 1998 Sep. 15; 95 (19): 11199-11204. Coatomer, a nanoscale element comprised of seven distinct subunits (alpha, beta, beta′, gamma, delta, epsilon and zeta subunits, respectively) and ADP-ribosylation factor (ARF, an N-myristylated small GTP-binding protein) are the only cytoplasmic proteins needed.

In another illustrative embodiment, the coat protein I (COPI) assembly process is carried out by preparing Coatomer subunits from cytosolic preparations, including methods, but are not limited to, as essentially described in Sheff, et al, The Journal Of Biological Chemistry, Vol. 271, No. 12, Issue Of March 22, Pp. 7230-7236, 1996 *"Purification of Rat Liver Coatomer* (*COPI*")—Purification of rat liver Coatomer is accomplished through a substantial modification of the method of Waters and Rothman (13). Unless otherwise noted, all operations are performed at 4° C. Approximately 250 g of fresh liver from 10-15 adult Sprague-Dawley rats (Harlan Sprague-Dawley) are homogenized in 2 volumes of buffer (25 mM Tris, pH 7.5, 320 mM sucrose, 500 mM KCl, 2 mM EDTA, 1 mM dithiothreitol) comprising protease inhibitors (2 mg/ml pepstatin A, antipain, and leupeptin; 1 mM phenylmethylsulfonyl fluoride) using a polytron homogenizer with 1.5-cm cutter assembly at maximum speed for three 1-min bursts on ice with 1-min

and the precipitate is collected by centrifugation at 10,000 3 g for 15 min. The precipitate is resuspended in 20 ml of G buffer (10 mM Tris, pH 7.5, 0.2 mM ATP, 0.2 mM CaCl2), the insoluble material is removed by centrifugation, and the supernatant is passed over a 20-ml column comprising 250 mg of DNase-I (Sigma) coupled to agarose (Affi-Gel-10, Bio-Rad, prepared according to the manufacturer's directions) to remove contaminating actin and actin binding proteins. Eluent is desalted into cytosol buffer using 10DG desalting columns (Bio-Rad) and applied to a 50-ml DEAE cellulose column (DE52, Whatman) equilibrated in cytosol buffer. COPI is eluted with a 100-400 mM KCl gradient over 200 ml, with the elution of COPI followed by spot blot on nitrocellulose using EAGE antibody. In a final step, peak COPI fractions are pooled, diluted 1:1 with cytosol buffer, and applied to a 1-ml Mono-Q column (Pharmacia) equilibrated in cytosol buffer and mounted on a fast protein liquid chromatography apparatus (Pharmacia). The column is swished with 300 mM NaCl and then eluted with a 350-400 mM NaCl gradient over 20 ml. COPI, as assayed by the presence of b-COP on a spot blot using EAGE antibody, eluted as a single peak. The presence and purity of COPI is confirmed by SDS-PAGE. An alternative final step is employed in preparing samples for two-dimensional dimensional gels. Here, DEAE eluent is concentrated in a Centricon-30 microconcentration (Amicon) to 400 ml and applied to a 24-ml Superose-6 (Pharmacia) column equilibrated in cytosol buffer with 50 mM KCl. As with Mono-Q, COPI eluted in a single peak. This final step produces a somewhat lower yield and comprises some contaminants between 30 and 100 KD by SDS-PAGE. For copurification of labeled CHO cytosol and rat liver COPI, all quantities are divided by 3, 1 ml of labeled cytosol is added to 50 ml of rat liver S100, and the Mono-Q column is used as the final step.

The increasing interest in the targeting of foreign moieties at sites in the body where their activity is required is addressed by the invention in one more embodiments. It is important that agents, like drugs, particularly those having undesirable side effects, are delivered to the site where they are supposed to act. Many molecular species require that they be delivered in a site specific manner, often to particular cells, for example, polynucleotides (anti-sense or ribozymes), metabolic co-factors or imaging agents. One such system has been described by Wu et al., J. Biol. Chem., 263, 14621-14624 and WO-A-9206180, in which a nucleic acid useful for gene therapy is conjugated with polylysine linked to galactose which is recognized by the asialoglycoprotein cargo attachment elements on the surface of cells to be targeted. However, there are many occasions, such as in the delivery of a cytotoxic drug, when it would not be satisfactory to use a delivery system in which the targeting and or masking moiety and or vector to be delivered is so exposed. This need is addressed by various delivery system embodiments of the invention that possess the flexibility to target a wide range of biologically active foreign moieties.

In one embodiment, the invention includes one or more elements having one or more suitable sites for subsequent attachment of a targeting and or masking moiety and or vector, and one or more elements having one or more surfaces and or protein coats to which one or more targeting and or masking moieties and or vectors have already been attached.

In one embodiment, one or more masking moieties are attached to the surface of one or more invention elements. These masking moieties prevent the recognition by a specific cell surface and instead allows for intravenous administration applications. For example, the surface masking characteristics may be provided by poly (ethylene glycol) (PEG) by using various PEG-PLA and PLGA mixtures. PEG conjugation masks the protein's surface, reduces its renal filtration, prevents the approach of antibodies or antigen processing cells and reduces its degradation by proteolytic enzymes. In one embodiment, PEGylated elements significantly improve element stability and prevent leakage of agents from elements. Studies have shown that protein-based nanoparticles and liposomes without PEGs have a short circulation time due to rapid uptake by macrophages of the reticulo-endothelial system (RES), primarily in the liver and spleen. Finally, PEG conveys to molecules its physico-chemical properties and therefore modifies biodistribution and solubility of peptide and non-peptide nanoparticles. Thus, recent studies have used mostly nanoparticles with PEGs. The PEG coating is highly hydrated and this layer protects against interactions with molecular and biological components in the blood stream, as well as nonspecific binding to tissue. In one embodiment, one or more elements, in one or more configurations, are internally and or externally attached, coated, and treated, in whole or in part by using steric stabilizers including, but not limited to, steric stabilizers selected among dipalmitoyl phosphatidyl ethanolamine-PEG, PEG-stearate, the esters of the fatty acids from the myristic acid to the docosanoic acid with methyl ether PEG, the diacylphosphatidyl ethanolamines esterified with methyl ether PEG and the polylactates and the polyglycolactates esterified with methyl ether PEG. In one embodiment, one or more elements are not required to be PEGylated to efficaciously operate.

In another embodiment, one or more elements, and in one or more configurations are internally and or externally coated or treated in whole or in part with surfactants, including, but not limited to, surfactant agents selected among soy-bean phosphatidylcholine, dioleyl phosphatidylcholine, dipalmitoyl phosphatidylcholine, hydrogenated soy-bean phosphatidylcholine, phosphatidylethanolamine and phosphatidylserine), and or with cosurfactants, including, but not limited to cosurfactant agents selected among ethanol, propanol, isopropanol, butanol, sodium taurocholate, sodium glycocholate, propylene glycol, butyric acid and benzoic acid.

In one or more embodiments, ligands can be of one or more efficacious types, such as drugs, and may be bioengineered, and or comprise isolated, recombinant, synthetic, and or cloned elements.

In one embodiment, one or more types of ligands may be functionalized and or attached in one or more ways to one or more elements.

In one embodiment, ligands are natural ligands of one or more types. In another embodiment, one or more types of natural ligands are modified and or functionalized. In another embodiment, invention element ligands and natural element ligands are combined to comprise one or more types of hybrid ligand elements.

In another embodiment, the course of a natural ligand and or invention ligand element during cellular signaling, trafficking, downregulation, upregulation, endocytosis, exocytosis, and other cellular entry or exit, cellular inter- and or intra-actions, and the like, may be efficaciously controlled, regulated, and or modified by one or more elements to yield one or more diagnosis, cure, mitigation, treatment, prevention of disease, or other types of efficacious effects, and the like.

Examples of some natural ligands, but not limited to, that may be subject to efficacious control, modification, and or regulation in one or more invention embodiments are listed below:

Toxins and lectins, e.g.,

Diphtheria Toxin

Rous sarcoma virus
Semliki forest virus
Vesicular stomatitis virus

Adenovirus
Influenza
West Nile
Serum Transport Proteins and Antibodies, e.g.,
Transferrin
Low density lipoprotein

Transcobalamin
Yolk proteins

IgE
Polymeric Ig
Maternal Ig
IgG, via Fc receptors

Hormones and Growth Factors, e.g.,
Insulin
Epidermal Growth Factor
Growth Hormone
Thyroid stimulating hormone

Nerve Growth Factor
Calcitonin
Glucagon
Prolactin
Luteinizing Hormone
Thyroid hormone

Platelet Derived Growth Factor
Interferon
Catecholamines
LDL
Neurotransmitters
Substance P
A neurotransmitter known to stimulate pain receptors

In one or more embodiments, one or more elements are conjugated (bonded) with one or more other elements (e.g., ligands), agents, materials, and or substances of one or more types, including those developed by 3rd parties, which may be used singly or mixed together in one or more configurations for medical and biological research, diagnosis, therapy, or prosthetic purposes. One or more biomedical elements such as ligands and other types of biomedical functionalization elements may be directly and or indirectly attached, bonded, fastened, cross-linked, and or affixed to and or incorporated into one or more invention elements, as well as one or more non-invention and or natural elements. In one embodiment, attachment is achieved via molecular tethers. In another embodiment, no molecular tether is involved. In one configuration, a free radical molecule may be attached directly to one or more invention elements. In another embodiment, one or more elements may be bonded, fastened, and or affixed to one or more elements by being included in a modified protein sequence of one or more elements or bonded elements; by using a spacer; by covalent bonding; by site directed mutagenesis; by genetically engineered mutation and or modification; by peptides; by proteins; by DNA; by antibodies; by monoclonal antibodies; by recombinant elements; and via other bioengineering techniques and methods known in the art.

According to one embodiment, the protein amino acid sequence of one or more elements are modified to provide a site suitable for attachment thereto of an in vivo or in vitro targeting and or masking moiety. In one illustrative embodiment, one or more target-specific ligands and or targeting moieties are directly attached to one or more elements via one or more amino acid groups, and or attached via one or more short molecular tethers.

In another embodiment, one or more functionalization elements, of one or more types, comprise highly specific targeting agents, such as, but not limited to, antibodies, peptides or small molecules, large molecules, and other functional ligands, such as fluorophores and permeation enhancers, and the so functionalized nanoparticles may target receptors, transporter, enzymes and or intracellular processes in vivo with high affinity and specificity.

In one illustrative embodiment, one or more elements such as diagnostic, therapeutic, prosthetic, and or assay agents, but not limited to, are delivered to a target in vivo or in vitro using a variety of guidance techniques, including for example, optical (photonic), acoustic, electric, biological, chemical, mechanical reactions and forces, but not limited to, and one or more elements may be delivered singly and or in one or more configurations to one or more targets.

In another illustrative embodiment, one or more elements comprise one or more diagnostic agents like imaging contrast or radioactive agents to perform site designation, site specificity, and site retention for targeted in vivo delivery of therapeutics; the latter may also comprise part of the same diagnostic payload.

In one illustrative embodiment, the invention enables targeted agent delivery systems that retain their structural integrity and that may also loiter for a calculated period of time at the targeted area of concern after delivery of agent payload.

In one illustrative embodiment, one or more elements comprise molecules arranged in specific patterns. The pattern of elements precisely mirrors or mimics a spatial or physical pattern a target cell in a human or animal body expects to see and will recognize, and one or more elements are accepted by the target cell, which can be a cancer cell or HIV infected cell, for example.

In one embodiment, gold metal nanoparticle probes with cancer ligands and using electrical charges are bonded to one or more elements, and or

In another illustrative embodiment, one or more elements, ligands, targeting moieties, vectors, and the like utilize the method of chirality.

In another illustrative embodiment, reactions and forces arise from one or more ligands and or targeting moieties binding to targets, including covalent and non-covalent interactions, which ligands are tethered and or directly attached to one or more invention elements. Ligand binding to one or more specific targets may produce one or more conformational changes sufficient to deform and or rupture one or one or more elements in whole or in part, thereby causing one or more elements to be released. The targeting moieties can be selected by one of ordinary skill in the art keeping in mind the specific cell surface to be targeted. For example, if one wishes to target the asialoglycoprotein receptor on the hepatocytes in the liver, an appropriate targeting moiety would be clustered trigalactosamine. Once a specific targeting moiety has been selected for a particular cell to target, the different targeting moieties can be attached either by covalent linkage directly onto the surface of one or more invention elements, or by indirect linkage via, for example, a biotin-avidin bridge. In another embodiment, depolymerization (e.g., by cytosolic Hsc 70) of the Clathrin and or Coatomer element exposes one or more transmembrane proteins (V-SNARE) that direct one or more elements to their destinations by binding to a specific T-SNARE protein on the target organelle. The fusion protein SNAP25 causes the one or more elements to fuse with the target membrane

In one embodiment, avidin is attached covalently to the surface of one or more elements and a biotinylated ligand attaches non-covalently to the avidin. In another embodiment, biotin is covalently attached to the surface of one or more invention elements, and then avidin is used as a bridge between the biotinylated polymer and the biotinylated ligand. Targeting agents may also include one or more biocompounds, or portions thereof, that interact specifically with individual cells, small groups of cells, or large categories of cells. Examples of useful targeting agents include, but are not limited to, low-density lipoproteins (LDS's), transferrin, asiaglycoproteins, gp120 envelope protein of the human immunodeficiency virus (HIV), and diphtheria toxin, antibodies, and carbohydrates. A variety of agents that direct compositions to particular cells are known in the prior art (see, for example, Cotten et al., Methods Enzym, 1993, 217, 618).

In another illustrative embodiment, one or more classical structural activity relationships (SARs) based drug discovery approaches are combined with one or more other techniques to form a specific case of targeted drug delivery, for example, but not limited to, one or more structural metabolism relationships (SMRs) that in combination with SARs are sometimes termed as retrometabolic drug design approaches. These active drugs are designed to undergo singular metabolic deactivation after they achieve their therapeutic roles, and may produce specific action at the site of application without affecting the rest of the body.

In another illustrative embodiment, one or more elements comprise one or more agent functionalities and or methods that produce targeting by changing molecular properties of an overall target molecule, as a result of enzymatic conversion, but also, for example, may involve one or more pharmacophores. These elements, sometimes referred to as the targetor (Tor) moiety, are converted by site-specific enzymes to active functions. In addition to the Tor moiety, one or more other functions may be introduced into elements for in vivo use, which can be named as “protector functions” that serve as lipophilicity modifiers or protectors of certain functional groups in therapeutic agent molecules.

In other illustrative embodiments, one or more other types of targeting delivery systems and methods can be used, for example, but not limited to, in whole or in part in one or more configurations: surfactants (surface-active substances) and or cosurfactants; enzymatic physical-chemical-based targeting; site-specific enzyme-activated targeting; vectors, such as ligand-based, non-viral-based, and Protein/DNA polyplex vector targeting; receptor-based chemical targeting; organic and or inorganic synthetic elements; transmembrane proteins (V-SNARE); peptides, including peptides that cross cell membranes and home specifically to certain diseases; nanostructured dendrimers and hyperbranched polymers; molecular Trojan horses; adenovirus, herpes simplex virus, adeno-associated virus or other virus vectors for targeted delivery that do not cause toxicity; antibodies, including monoclonal antibodies; nanoparticles, including polymer nanoparticles like polymer, polybutylcyanoacrylate, and ethyl alcohol nanoparticles; immunotoxins; hormonal therapy; tissue-specific gene expression; gene therapy; pegylated immunoliposomes; anti-sense therapy; biological elements and or agents, including biological elements and agents conjugated with other agents, such as transferrin, but not limited to such; chemical elements and agents; devices, systems, and or mechanisms; liposomes, including liposomes conjugated with transferrin, but not limited to such; conformationally-constrained peptide drugs targeted at the blood-brain barrier; endogenous blood brain barrier and or blood tumor capillary transporters; inhibiting and or modulating blood brain barrier active efflux transporters; air and or other gas bubbles; blood brain barrier breaking and or disrupting elements and agents; blood brain barrier tight junction separating and or endocytoses elements and agents; vector-mediated delivery of opioid peptides to the brain; brain drug delivery of peptides and protein drugs via vector-mediated transport at the blood brain barrier, neurotrophic, neuroprotective, and various peptides and drugs, and the like.

In another illustrative embodiment, one or more elements cross various in vivo biological barriers, such as the transmucosal passage, and may also cross the blood-brain barrier (BBB) and the blood-cerebrospinal fluid (CSF) barrier for targeted and or non-targeted in vivo delivery of CNS agents and elements. In one embodiment, one or more BBB-passing elements comprise small and or large molecule drugs.

Natural Clathrin, and in particular its ability to ‘track’ vesicle proteins leaving a synapse into the extracellular space (Granseth, et al 2007) indicates that the protein is not immediately scavenged by phages and other “housecleaning” elements in the brain, and further, may move freely about CNS spaces. In one embodiment, one or more elements efficaciously move through the CNS spaces and comprise in situ elements for remediation, removal, and or sequestration of one or more types of contaminants, toxic elements, undesirable organic or inorganic elements, and the like.

In another embodiment, extensive modification and functionalization of agents and elements may not be required for CNS entrance and or BBB passage. Only minimal functionalization may be required, depending on cargo and element type.

In another embodiment, one or more CNS-entering and or BBB-passing elements of one or more types may behave as a drug by themselves—i.e., they efficaciously operate alone without carrying additional elements, e.g., cargo elements. In another embodiment, one or more elements of one or more types carry one or more additional elements of one more types past the BBB.

In another illustrative embodiment, one or more elements enter the CNS and or cross the blood brain barrier for targeted delivery of agents and elements, including, but not limited to, small and or large molecules, non-lipid-soluble micromolecules, macromolecules, light sources, hydrophilic and or hydrophobic agents, such as therapeutic, diagnostic, and prosthetic agents, and other structured cargo to specific cells and areas within the brain, and such agents and or cargo may comprise one or more sensor agents, assay agents, diagnostic agents, prosthetic agents, and also may comprise

There are several transport mechanisms and techniques known in the art to be involved in the uptake of nanoparticles by the brain across the BBB (Lockman et al. 2002, Begley, 2004, de Boer et al. 2007), one or more of which may be utilized in one or more invention embodiments. These mechanisms and techniques include: simple diffusion of lipophilic molecules, the BBB-specific influx transporters, including organic anion and cation transporters and transcytosis or endocytosis. In one embodiment, one or more elements are internalized at the BBB by one or two different endocytosis mechanisms: receptor-mediated endocytosis (RME) and adsorptive-mediated endocytosis (AME). AME is triggered by an electrostatic interaction between the positively charged moiety of the peptide and the negatively charged region of the plasma membrane. In contrast, RME is specific to certain peptides such as insulin and transferrin.

In one embodiment, delivery through the blood-brain barrier of one or more types of small or large molecule cargo elements, and or molecules with polar functional groups is accomplished via chimeric peptides. The latter are formed when a transportable vector, such as cationized albumin, lectins, or a receptor-specific monoclonal antibody, is conjugated to a therapeutic compound that is normally not transported through the BBB. In one embodiment, conjugation of drugs to transport vectors is facilitated by, but not limited to, the use of avidin-biotin technology. In another embodiment, chimeric peptides are not required to pass through the blood-brain barrier, depending on cargo and element types.

In another illustrative embodiment, one or more elements may be coated with one or more surfactants and or cosurfactants, including, but not limited to, polysorbate 20, 40, 60 and 80, and or with one or more other materials and substances to cross various biological barriers, such as the transmucosal passage, and also to overcome the blood-brain barrier (BBB), the transmucosal passage, and the blood-cerebrospinal fluid barrier (CSG) for targeted delivery of agents and elements nanoparticles. In another embodiment, surfactants and or cosurfactants are not required to achieve such BBB-passing functionality, depending on cargo and element type. E.g., in the prior art, it has been shown that using such surfactants and co-surfactants can cause an immunogenic response.

In another illustrative embodiment, one or more elements may be cationized to facilitate blood brain barrier passage. In another embodiment, cationization is not required to achieve such functionality, depending on cargo and element type.

In another illustrative embodiment, one or more elements cross the blood brain barrier due to disruption of the barrier by acoustic techniques, such as by using ultrasound.

In another embodiment, zonula occludens toxin and its eukaryotic analogue, zonulin, (zot) are protein ligands attached to one or more invention elements. Zonulin, the natural ligand of the Zot target receptor, interacts with these cargo attachment elements at the blood brain barrier, unlocking the tight junctions (TJ) in the brain that regulate the blood-brain barrier at that receptor. TJ-unlocking allows passage of one or more elements through the BBB, and thereby enables delivery of small and large molecules, non-lipid-soluble micromolecules, macromolecules, light sources, and other structured cargo elements to the brain. In another embodiment, Zonulin is not required to pass through the blood-brain barrier, depending on cargo and element types.

Extracellular pathways circumventing the fluid-brain barriers in humans are comparable in the CNS of rodents and a subhuman primate. The most highly documented extracellular route is through the circumventricular organs (e.g., median eminence, organum *vasculosum* of the lamina terminalis, subfornical organ, and area postrema), all of which comprise fenestrated capillaries and, therefore, lie outside the BBB. In one embodiment, blood-borne macromolecules; specifically fluid-phase molecules released by the invention; escaping fenestrated vessels supplying the circumventricular organs move extracellularly into adjacent brain areas located behind the BBB.

The potential intracellular and extracellular pathways that blood-borne substances carried within one or more elements may follow in various embodiments for circumventing the fluid-brain barriers and entry to the CNS are therefore numerous, and various invention embodiments are used as appropriate. One invention embodiment, for example, uses the nasal cavity as a route for delivery of one or more types of drugs and other agents, especially for systemically acting drugs that are difficult to deliver via routes other than injection. Embodiments for the use of the nasal cavity for drug delivery also extend to circumventing the blood brain barrier. Drugs have been shown to reach the CNS from the nasal cavity by a direct transport across the olfactory region situated at the loft of the nasal cavity. It is the only site in the human body where the nervous system is in direct contact with the surrounding environment. In one embodiment, the nasal route would be important for rapid uptake of one or more types of drugs used in crisis treatments and management, such as for acute pain, epilepsy, psychic agitation, and for one or more other types of centrally acting drugs where the pathway from nose to brain provides a faster and more specific therapeutic effect. Furthermore, in another embodiment, the trigeminal nerve and, in animals, the vomeronasal organ also connects the nasal cavity with the brain tissue. One or more methods of nasal delivery to the CNS, which may also be used by the instant invention, but not limited to, are described in Dhuria, et al, 2008; Ma et al, 2007; and Thorne et al. 1995.

The nasal cavity has a relatively large absorptive surface area and the high vascularity of the nasal mucosa ensures that absorbed compounds are rapidly removed (Mainardes, et al 2006). In one embodiment, two routes, singly or in combination, are used via which one or more types of molecules are transported from the olfactory epithelium into the CNS and/or CSF. The first is the epithelial pathway, where one or more types of compounds pass paracellularly across the olfactory epithelium into the perineural spaces, crossing the cribriform plate and entering the subarachnoid space filled with CSF. From here the molecules can diffuse into the brain tissue or will be cleared by the CSF flow into the lymphatic vessels and subsequently into the systemic circulation. The second embodiment utilizes the olfactory nerve pathway, where compounds may be internalized into the olfactory neurones and pass inside the neuron through the cribriform plate into the olfactory bulb. In another embodiment, it is possible that further transport into the brain can occur by bridging the synapses between the neurons. After reaching the brain tissue, the drugs are cleared either via the CSF flow or via efflux pumps such as p-glycoprotein at the BBB into the systemic circulation. Despite the potential of the nasal route, there are some factors that limit the intranasal absorption of drugs. These barriers include the physical removal from the site of deposition in the nasal cavity by the mucociliary clearance mechanisms, enzymatic degradation in the mucus layer and nasal epithelium and the low permeability of the nasal epithelium removed (Mainardes, et al 2006). Colloidal carriers systems, such as nanoparticles and liposomes have demonstrated great efficacy in increasing drug bioavailability via the nasal route (Illum, 2002) In one invention embodiment, one or more elements comprise a colloidal carrier for enhanced nasal delivery of one or more elements, of one or more types.

Further, in one embodiment, it is possible to greatly improve the nasal absorption of one or more types of drugs and other elements by administering them in combination with an absorption enhancer that promotes the transport of the drug across the nasal membrane. Another invention embodiment

In another illustrative embodiment, one or more elements and in one or more configurations comprise in vivo and or in vitro sensor systems, assay systems, therapeutic drugs and other suitable methods to do genetic-based (trait-based) and or phenotype (state-based) drug dosing. In one embodiment, drugs are delivered at optimally effective and safe doses per each individual.

The invention, in one embodiment, provides for individual patient factors such as genotype, phenotype, age, gender, ethnicity etc., to be taken into account by one or more elements and factored into dosing and administration consideration. It has been demonstrated that inter-individual response variability can be 40-fold or more with practically all classes of psychotropic drugs. This makes it difficult to formulate rational guidelines for dosing and interpretation of biological parameters (such as plasma or serum drug concentrations) that might be associated with a therapeutic response. Although much remains unknown, a number of factors have been characterized as important determinants of patient-to-patient variability. These encompass genetics, disease state, nutritional status, concurrent use of drugs, and other pharmacoactive substances, including demographic factors such as age, gender, and ethnicity. Therefore, there is a requirement for in vivo systems that analyze many of these factors and dynamically adjust dosing accordingly.

In one embodiment, one or more elements comprise one or more personalized medicine elements, and which elements' efficacy may be increased, because responses arising from one or more individual variability factors; such as, but not limited to, genotype, phenotype, disease state, metabolic state, nutritional status, coninstant use of drugs, and other pharmacoactive substances, and also demographic factors such as age, and ethnicity; are factored into the elements, pre-delivery and or post delivery. Side effect profiles may also be reduced via such personalized medicine embodiments.

In one embodiment, one or more elements comprise one or more patented drugs; drugs that are about to go off patent; have already gone off patent (generics); and or their active metabolites, and which drugs' efficacy may be beneficially altered and or enhanced by use of the invention. These beneficial changes in the status of an existing drug may be achieved by the invention in one or more embodiments, for example, but not limited to: the ability to target specific areas in the body; to pass the blood brain barrier; to cross over into cells and their organelles; to fuse with cell membranes; to gain access to the cytosol; to offer the benefits of low antigenicity or minimal immunogenic effects; to modify, regulate, and or control cellular processes; to more efficiently and efficaciously carry drugs; and or to dynamically and or statically adjust the drug's responses and dosages arising from inter-individual variability due to one or more factors, such as, but not limited to, genotype, phenotype, disease state, metabolic state, nutritional status, coninstant use of drugs, and other pharmacoactive substances, and also demographic factors such as age, gender, and ethnicity of the patient. New patent filings for about to go off patent drugs and drugs already off patent may be enabled by one or more invention embodiments, such as affording increased drug efficacy, and or by enabling a better safety profile for the drug in question.

In various embodiments, the instant invention can carry one or more types of biomedical or healthcare elements, for example and without limitation: one or more therapeutic elements; pharmaceutical elements; diagnostic elements; assay elements; cosmetic elements; agents for treating one or more types of autoimmune diseases; agents for treating one or more types of infectious diseases; biological elements; radioactive agents or nuclear medicine agents; contrast agents; nano-scale biosensors; restorative agents; regenerative agents; cell, tissue, organ or circulatory repair elements; drug discovery agents; drug designer agents; drug research and development agents; drug fabrication agents; drug control and regulation agents; drug modifier agents; targeted drug delivery agents; clinical drug trial agents; antibiotics; antibacterials; vaccines; antiviral and anti-parasitic drugs; cytostatics; vitamins; proteins and peptides, including enzymes; hormones or other biological elements; prosthetic elements; intelligent nano-prostheses that supplement or enhance cell, tissue, or organ functioning; surgical elements; magnetic iron oxide nanoparticles; nano-scale biosensors; assays; diagnostic systems or nano-devices for in vivo delivery of targeted therapy to combat diseases, such as cancer and HIV, and the like, including other types and forms of drug elements for the diagnosis, cure, mitigation, treatment, prevention of disease. Some or all such elements may operate under the control and influence of various other elements and or methods and comprise another type of invention platform.

In another illustrative embodiment, one or more elements in whole or in part, cure, mitigate, or treat one or more types of bodily injuries and insults, including traumatic injury, blood clots, and the like, but not limited to.

In one embodiment, nano-engineered scaffolds comprised of a plurality of elements are able to support and promote cellular differentiation and growth in injured or degenerated regions.

In one illustrative embodiment, one or more elements comprise one or more types of small and or large molecules and may utilize one or more methods to enter the CNS and or cross the blood brain barrier, in whole or in part, for delivery of one or more assay, diagnostic, therapeutic agents, and drugs, of one or more types, to cells and or targeted areas within the brain, like, for example: contrast agents; central nervous system drugs; antibiotics; antineoplastic agents, which may be used for treating malignant brain tumors (primary and or metastasized, of one or more types) or benign neoplasms; Parkinson's agents; Multiple Sclerosis agents; epilepsy agents; meningitis agents; Alzheimer's disease agents; HIV infection agents; memory agents; stroke agents; coma agents; and the like; or comprise one or more psychotropic agents or therapies of one or more types to study, diagnose, cure, mitigate, or treat of one or more types of mental health and illness, including, but not limited to, stress; anxiety; depression; mania; bipolar disorder; attention deficit (hyperactivity) disorder; panic attacks; phobias; addictions; anger; rage; suicidal thoughts and tendencies; substance abuse disorder; post traumatic stress disorder; psychoses; mental retardation; autism; delirium symptoms; schizophrenia; neuroses; and or enhancing memory; cognition; cognitive functioning; the effects of cognitive therapy, and the like; including other types and forms of drug elements for the diagnosis, cure, mitigation, treatment, or prevention of one or more types of CNS diseases. In another illustrative embodiment, one or more elements enter the CNS, including crossing the blood brain barrier, in whole or in part, to diagnose, cure, mitigate, or treat one or more types of CNS injuries and insults, including traumatic brain injury, blood clots, and the like, but not limited to.

In one embodiment, one or more elements promote neuroprotection by limiting the damaging effects of free radicals generated after head injury, a major factor contributing to neuropsychiatric degenerative disorders (e.g., Alzheimer's).

In one embodiment, nano-engineered scaffolds comprised of a plurality of elements are able to support and promote neuronal differentiation and growth in injured or degenerated brain regions.

In another illustrative embodiment, one or more elements comprise a light source, for use, for example, but not limited to, in a photodynamic therapy (PDT) system for age related macular degeneracy (AMD).

bond types, so that in a short time many possible combinations can be checked before the correct partners associate, this protocol has proven advantageous. Furthermore, the use of non-covalent interactions in the imprinting step closely resembles the recognition pattern observed in nature. Example invention molecular imprint embodiments in the art include, but are not limited to:

- Fragmented polymer monoliths
- Composite polymer beads
- Polymer beads from suspension, emulsion or dispersion polymerization
- In-situ polymerization
- Polymer particles bound in thin layers
- Polymer membranes
- Surface-imprinted polymer phases

In one illustrative embodiment, the invention uses molecular-imprint technology, wherein biodegradable films are used as a pliable template for elements, which elements are pressed into a film and then removed, leaving a physical mold of the element's shape. In one embodiment, this can facilitate catalysis of certain reactions and may also be used for shape selective separations. In other embodiments, imprinted polymers may facilitate the fabrication of elements to achieve selective diffusion; as chromatographic supports for the separation of enantiomers and oligonucleotides by invention elements; to provide the recognition element for an invention chemical sensor; and for the synthesis of polymeric materials that mimic biological cargo attachment elements and are targeted by invention elements, and or play a role in the design of new drugs. In one embodiment, this invention process provides for imprinted biodegradable capsule production with target or site-specific feature sizes at the molecular level. Other invention embodiments may utilize imprinted membranes and thin films that also function as an artificial cell wall for the selective transport of targeted drugs, peptides and biologically important molecules.

Surface imprinting involves the following steps: The print molecule, usually a large one, is first allowed to form adducts with functional monomers in solution and the formed elements are subsequently allowed to bind to an activated surface such as silica wafers or glass surfaces. Thus, with this technique, a designed imprinted (imaged) surface is obtained. This approach should potentially be valuable for creating specific cell binding surfaces. When preparing molecularly imprinted polymer monoliths against large imprint species, there is a risk of permanent entrapment of the template in the polymer after polymerization. When using thin polymeric layers or imprinted surfaces this drawback may be overcome.

In one embodiment, imprinted nanocapsules using techniques known in the art and as discussed above, one or more elements utilize and or constitute a nanocapsule with manifold, multi-tiered capabilities for in vivo administration and targeted delivery. The imprinted nanocapsule is delivered in vivo to detect and target a particular in vitro imprinted biological element, which may be, but is not limited to, a particular type of receptor, protein, or cell, since its imprint shape on the nanocapsule will only bind in vivo to that particular biological element target. The molecular-level imprint process thereby provides for targeting one or more elements using biodegradable nanocapsules for in vivo agent delivery. In addition, vectors and targeting moieties, and blood brain barrier, transmucosal, and CSF barrier breaching elements, and other elements and substances may also be attached to the surface of the molecular imprint nanocapsule or otherwise be conjugated to it.

In another illustrative embodiment, one or more elements may be used in conjunction with molecularly imprinted polymers known in the art as recognition elements in biosensor-like devices. In one embodiment, imprinted polymer embodiments may be highly resistant sensing element alternatives.

In another illustrative embodiment, one or more elements are encapsulated in whole or in part in one or more biodegradable controlled-release polymers, which polymers may also be conjugated with other elements and agents. The polymer capsule, and or one or more elements may also be coated with one or more surfactants and or cosurfactants and or with other materials and substances. One or more targeting and or masking moieties and or other targeting vectors may also be attached on the polymer surface, and or on one or more elements.

In one embodiment, one or more elements are put into one or more biodegradable controlled-release polymeric capsules, and these elements transform “dumb” polymeric delivery capsules into “smart” systems.

In the instance of polymeric nanocapsules, which may be molecular imprinted or not, illustrative controlled-release polymeric nanocapsule embodiments of the invention may include one or more of the following delivery systems, but not limited to, and in one or more configurations:

1. Diffusion-controlled systems
2. Water penetration-controlled delivery devices
3. Chemically controlled systems
4. Drugs covalently attached to polymer backbone systems, which delivery systems can be further subdivided into soluble systems and insoluble systems. Insoluble systems are used as a subcutaneous or intramuscular implant for the controlled release of the chemically tethered therapeutic agent. Soluble systems are used in targeting applications.
5. Drug release determined predominantly by erosion systems, whereby certain polymers can undergo a hydrolysis reaction at decreasing rates from the surface of a device inward, and under special circumstances the reaction can be largely confined to the outer layers of a solid device. Two such polymers are poly (ortho esters) and polyanhydrides, because the rates of hydrolysis of these polymers can be varied within very wide limits, considerable control over the rate of drug release can be achieved.
6. Poly (ortho esters) systems, which are highly hydrophobic polymers that comprise acid-sensitive linkages in the polymer backbone.
7. Polyanhydrides materials as bioerodible matrices for the controlled release of therapeutic agents. Aliphatic polyanhydrides hydrolyze very rapidly while aromatic polyanhydrides hydrolyze very slowly, and excellent control and regulate over the hydrolysis rate can be achieved by using copolymers of aliphatic and aromatic polyanhydrides. In this way, erosion rates over many days have been demonstrated, and erosions rates measured in years have been projected.

The form in which the foreign moiety, vector and or cargo are held within one or more elements will depend on the release properties and methods required. For release at the targeted site, it will be important to ensure that the right conditions prevail, for example, to permit cell localization and internalization via receptor mediated endocytosis.

2) One or more elements enter one or more target cells, while one or more other elements continue to loiter nearby or stay docked at the cell membrane.
3) The docked and or loitering element elements wait for a time period,
4) The targeted cell produces one or more reactions, for example, manufactures and or secretes an agent in response to the element's docking and or delivering its cargo,
5) The docked element and or loitering elements analyze the new cell behavior and or its secretions,
6) The docked element or loitering elements undergo a conformational change in response to the cell's new behavior,
7) The docked element and or loitering elements self-adapt, producing yet another conformational change in the cell, and or releases another round of one or more agents that are taken up by the targeted cell, and,
8) The foregoing process is repeated as required to achieve an efficacious effect.

In another embodiment, one or more light sources comprised of one or more elements operate in an intelligently staged sequence or orchestrated series of actions, which may be multiplexed or done in parallel by using one or more light and thermal energy emitting sources and methods. By using one or more light and or thermal energy emitting sources, optical and or thermal energies from one or more light sources operate on one or more photosensitive and or thermal sensitive elements comprising one or more elements that also comprise one or more entrapped agents. This method results in a staged series of overall actions that follow an intelligently ordered sequence of events. In an example embodiment, first a diagnostic agent from one or more elements is released by an optical and or thermal trigger, and the agent's positive finding of a disease, like cancer or HIV then causes one or more therapeutic agents to be released from the same and or other one or more other elements by one or more optical and or thermal triggers. Agent dosages are released in calculated amounts, and the dosages may be non-targeted or targeted.

In another illustrative embodiment, cavity-forming cargo elements have one or more compartments that in whole or in part are separated by one or more barriers, for example, but not limited to, one or more phospholipid membrane barriers and or one or more barriers comprised of molecular-imprinted films. The barriers may exhibit structural transitions due to internal or external stimuli. In one embodiment, agents or cargo entrapped within one or more elements remain sequestered within their respective compartments until a change in barrier permeability state is triggered by contact, for example, by a ligand, with one or more specific targets or sites. The subsequent biochemical and or biological reactions cause the barriers to alter states into an opened state and release entrapped cargo and agents from one or more invention elements. In one example embodiment, binary mixtures of therapeutic and or diagnostic agents are mixed together as needed to dynamically and more efficaciously deal with a disease or disorder.

The invention, in one or more embodiments, comprises in whole or in part one or more elements, components, devices, systems, and the like, of one or more types, formed by using one or more engineering disciplines and related engineering technology disciplines of one or more types. Listed below are some such example invention embodiments, but are not limited to.

In one embodiment, the invention remedies the deficiencies of prior art by providing one or more elements of one or more types, a plurality of which may also comprise one or more nanoscale platforms of one or more types. A platform according to the invention may be used, for example, in biomedical, electronics, telecommunications, and information processing applications.

FIG. 6 is an exemplary energy level diagram **600** illustrating the energy levels associated with a hyperfine interaction between electron and nuclear spin in the presence of magnetic fields of the type used to do ESR spin label studies, which may be done in vivo and in vitro in one invention embodiment. The hyperfine interaction is a strictly quantum mechanical phenomenon. In an atom, the electron possesses an intrinsic quantum mechanical quantity known as spin. The nucleus of an atom also possesses spin. Intrinsic spin tends to generate a spin magnetic moment that is capable of interacting with other magnetic moments and fields. Generally, the spin magnetic moment of the nucleus does not interact with the spin magnetic moment of the electron. However, in the presence of a strong magnetic field, the spin magnetic moments of the electron and nucleus become coupled and interact.

In one illustrative embodiment, the electron is excited using pulses of electromagnetic radiation while maintaining its spin configuration. The source of the electromagnetic radiation may be, for example, an ordinary lamp, an LED, a time-varying magnetic field generator, a laser, or an electromagnetic field generator. A hyperfine interaction gives rise to electron nuclear double resonance (ENDOR) techniques. According to one illustrative embodiment of the invention, room temperature EPR and ENDOR techniques known in the art are used for performing in vivo spin probe studies.

In another embodiment, one or more elements comprise one or more diagnostic agents, and during the same NMR/MRI, or EPR, or ESR, or ESEEM, or ENDOR, or PET, or SPECT, or OCT operation, one or more elements use quantum information processing techniques known in the art can modify, process, manipulate, encode and decode, input, output, transmit, communicate, store and read information using one or more modulated signals, methodologies, or carrier signals of one or more types.

In one embodiment, one or more invention elements in one or more configurations, are bonded, tethered, or otherwise incorporated into one or more invention and or non-invention elements, comprising functionalized nanoscale elements, components, devices, systems, and or platforms such as, but not limited to, nano-lasers, quantum dots; photonic dots; nanoscale DNA chips; protein assay chips; assay elements; environmental, protein, phenotype, DNA, and or metabolic assay and analysis elements.

In another embodiment, one or more elements may comprise a bio-lasing structure, in vivo or in vitro.

In one embodiment, one or more elements in one or more configurations comprise nano-sensor elements; including, but not limited to, radioactivity sensors; chemical sensors; biological sensors; electromagnetic sensors; acoustic sensors; visible, infrared, and or ultraviolet wavelength sensors; tactile sensors; pressure sensors; volumetric sensors; flow sensors; and temperature sensors; and one or more of which sensors may constitute a bio-molecular device.

In one embodiment, one or more elements and or platforms utilize and or employ one or more types of transmitter and or receiver elements as sensors and or for transmission of information of one or more types in vivo and in vitro.

In another embodiment, one or more elements and in one or more configurations comprise one or more nanoscale elements, components, devices,

In one embodiment, quantum dots are tagged to one or more elements. The specific wavelength glow of the quantum dots enables the identification of specific pathologies, disorders, metabolic states, proteins or DNA making it possible to diagnose various diseases.

In one embodiment, one or more nanoscale quantum dot assays using tiny permutations of color tag a million or more different proteins or genetic sequences in a process called multiplexing. In one embodiment, one or more quantum dots of various sizes are excited at the same wavelength but have different emission wavelengths, and act as probes in experiments where multiple fluorescent measurements need to be made simultaneously, such as flow cytometry or confocal microscopy.

In another illustrative embodiment, one or more elements are sufficient to implement in vivo or in vitro genetic and protein nanoscale optical biological assay systems and methods. In one illustrative configuration, one or more elements comprise one or more nano-scale DNA chips known in the art, and or one or more nano-scale DNA chips known in the art to detect DNA samples formed from bonding with the target DNA on a chip, and or reference DNA nano-chips.

In another illustrative configuration, one or more elements comprise one or more protein array techniques known in the art. The array surfaces are designed to bind to one or more hydrophobic, hydrophilic (cation or anion) or specific ligands, and also include a protein array reader known in the art.

In another illustrative embodiment, one or more elements are used in a multiplexed analysis system or method that provides a nanoscale replacement for DNA-chip technology and can be used for the analysis of genetic variance, proteomics, and gene expression.

In another embodiment, one or more elements produce specific light emissions and or thermal energies caused by their coming into contact with a particular metabolic state, medical disorder, disease pathology, genotype, phenotype and or other specific stimuli. One or more entrapped agents carried by one or more elements are thereby selectively triggered and released. In doing so, they form a targeted agent delivery system without exposing the entire body—or an indiscriminate area—to a similar dose of light, thermal energy, and or agents. The agents may be delivered in vivo by means known in the art.

In one illustrative embodiment, photonic energies from one or more elements thermally operate on one or more other elements that may have one or more entrapped materials, such as, but not limited to, therapeutic, diagnostic, and or therapeutic agents within an aqueous interior, and or that may have one or more entrapped nanoparticles such as liposomes, micelles, proteins, other biological and or bioengineered elements, including organic, inorganic, and synthetic materials, and or that may have one or more hydrophobic materials bound to a lipid bilayer membrane. The well-known permeability increase at the phase transition temperature provides a means to trigger release of an entrapped agent, like, for example release of a therapeutic agent in locally heated tissues. In one embodiment, efficient in vivo or in vitro release of entrapped agents at non-targeted and or targeted sites are triggered by light emitted by one or more light sources when the one or more elements comprise a photoisomerisable species.

In another embodiment, the method of one or more LuxR proteins and lux bioluminescence genes and or other luminescent causing genes known in the art are utilized and are bioengineered and incorporated into one or more elements, ligands, targeting moieties, and or vectors, which may also be conjugated with one or more other elements, materials, and substances. In one embodiment, luminescent causing genes provide optical pumping sufficient to excite one or more quantum dots and or photonic dots.

In an illustrative embodiment, in vivo release from one or more cargo elements comprised of one or more entrapped liposomal and or non-liposomal-entrapped agents are optically triggered by photons emitted by light sources of one or more types. In one illustrative embodiment, one or more light sources produce specific light wavelength emissions caused by their coming into contact with, for example, a specific disease at in vivo target site and causes diagnostic, therapeutic, and or prosthetic agents comprised in a photosensitive invention delivery system to be triggered and released from one or more invention elements, thereby forming a highly targeted drug delivery system. For example, in one embodiment, one or more cargo elements comprise an amphipathic lipid, such as a phospholipid, having two chains derived from fatty acid that allow the lipid to pack into a bilayer structure. One or more photosensitizers may be incorporated into the entrapped materials' cavity and or membranes.

In one illustrative embodiment, a phospholipid (1,2-(4′-n-butylphenyl)azo-4″(-phenylbutyroyl))-glycero-3-phosphocholine (‘Bis-Azo PC’), is substituted with azobenzene moieties in both acyl chains that can be photoisomerised by a fast nanolaser pulse. One or more other photoisomerisable species can be used in other embodiments. Agent release from one or more cargo elements occurs on the milliseconds timescale and photosensitised cargo elements thereby serve as light sensitive elements to allow for the triggered release of agents from one or more invention elements. In one embodiment, cholesterol additives may be used. The addition of cholesterol may have a marked effect on kinetics of agent release from cargo elements, and in some circumstances can result in substantial enhancement of light sensitivity in one or more photosensitised elements comprising one or more invention elements, In another embodiment, thermal and photosensitive activation systems acting together comprise one or more elements.

The invention, in one embodiment, comprises an in vitro and or in vivo nanoscale, biomolecular electronics element and or nano-electronics element, i.e., bio-molecular devices, which may be employed in a scalable, intelligent, biomolecular electronics device platform and or a nano-electronics device platform. The platform may also be comprised of one or more non-invention elements and devices, such as crystals, conductors, insulators, semiconductors, MEMS, and circuits, but not limited to such. And further, the platform may also be coated in one or more surfactants and or cosurfactants and or metals, elements, materials and substances.

In one embodiment, one or more elements and or platforms are used for biomolecular electronic and or nano-electronic devices. Biological molecules, particularly proteins and lipids are used to perform the basic properties necessary for the functioning of biomolecular electronic devices. These biological materials conduct and transfer molecules from one location to another, are capable of major color changes on application of an electric field or light and can produce cascades that can be used for amplification of an optical or an electronic signal. All these properties can be applied to electronic switches, gates, storage devices, biosensors, biological transistors, to name just a few. In general, the electrical properties of bilayer lipid membranes are easily measurable for signal generation and transduction. In one embodiment, hybrid elements comprising cells with intact plasma membranes can be considered to act as tiny capacitors under the influence of an electric field. Whereas sufficiently high field strength may increase the membrane potential past a critical point leading to the breakdown of the membrane, experimental care must be taken. (Dielectric breakdown of biological membranes occurs at about 1 volt across the membrane.) On the other hand, the use of electrostatic potentials around the lipid molecules is

In one embodiment, one or more elements comprise one or more information processing elements, components, devices, systems and or platforms such as, for example, but not limited to, encoders and decoders, memory, logic gates, registers, circuits, wiring and connectors, input and output elements, analog to digital and digital to analog converters and system architectures known in the art.

In one embodiment, one or more invention elements comprise nanoscale elements, components, devices, systems and or platforms that modify, process, manipulate, encode and decode, input, output, transmit, communicate, store and read various forms and types of information using a variety of suitable techniques known in the art, in vivo and in vitro.

A scalable information-processing invention platform may also include an encoder, e.g., a predetermined or specific DNA sequence that deliberately encodes at least a subset of the elements to take the form of specified sequence, as well as a decoder for reading information from at least a subset of the protein-based information processing elements. Examples of such a bio-system decoder are, but not limited to, a dye-based protein assay, a quantum dot-based assay, or other protein assay methods known in the art. Another example of encoders/decoders is the use of NMR and ESR and other methods known in the art that can effect and discern protein behaviors and their physical characteristics. Another example of encoders/decoders is the use of photons of different wavelengths and photo detectors.

In one embodiment, one or more elements comprise in vitro and or in vivo nanoscale information processing elements, components, devices, systems and or platform, which may follow and execute algorithms of one or more types expressed by or use biological control and regulate laws, processes, and or methods, and or geometrically derived algorithms such as graphs and Lie algebras, including Clifford algebras, but not limited to.

In another embodiment, one or more elements comprise a cognitive information processing element, device, and or platform of one or more types that follow and execute algorithms expressed by or use biological control and regulate laws and or processes, and or geometrically derived algorithms such as graphs and Lie algebras, including Clifford algebras, but not limited to.

In another embodiment, one or more elements comprise a hybrid digital and analog information processing element, device, and or platform of one or more types, wherein enlisting the rich repertoire of biochemical reactions and adopting a nested hierarchical organization makes intermixing of digital an analog processing possible in bio-computing applications.

In one embodiment, one or more elements comprise one or more nanoscale information processing elements, components, devices, systems and or platform that utilize photons emitted by invention light sources of one or more types as the basis of computation and or transmission and communication.

According to one illustrative embodiment, one or more elements comprise one or more nano-computer elements, components, devices, systems and or platforms of one or more types that are programmable, and or autonomous acting, and or do cognitive processing, which bio-nano-computers may also utilize self-replicating, self-adapting, self-repairing, self-regulating, and or self-regenerating methods, and which are used for applications at the cellular, molecular, and nanoscale level that may include, but are not limited to, biomedical imaging, sensors, diagnostic systems, assay systems, therapeutic systems, drug delivery systems, prosthetic systems, cybernetic systems, cellular-level nanofabrication systems, and inter- and intra-cellular imaging, repair, and engineering systems, the monitoring, sensing, imaging, diagnosing, repairing, constructing, fabricating, and or control and regulating of organic and or inorganic elements, and which bio-nano-computer elements and or platforms also may utilize and leverage biological control and regulate laws and or methods, and or geometrically derived algorithms such as graphs and Lie algebras, including Clifford algebras, but not limited to, in the performance of their tasks.

In one illustrative embodiment, one or more element chains are created via a molecular bridge group. To align the elements with respect to one another and also with respect to an external magnetic or electrical field. In one embodiment, one or more elements and or platforms and in one or more configurations are embedded in another material, like liquid crystal.

In one embodiment, one or more elements and or platforms and in one or more configurations are coated completely and or partially in a metal.

In another embodiment, one or more elements and or platforms and in one or more configurations are coated completely and or partially in reflective and or non-reflective coatings.

In one embodiment, one or more elements and or platforms and in one or more configurations are used to coat completely and or partially metals, crystals, insulators, conductors, semiconductor components, wires, and devices.

In another illustrative embodiment, one or more elements and or platforms and in one or more configurations facilitate the externally and or mechanistically directed alignment of, for example, but not limited to, biological elements, various other non-invention nanoparticles, carbon nanotubes, crystals, conductors, semiconductors, insulators, and or other devices, materials and substances, which aligned assemblies may further be coated in one or more surfactants and or metals, elements, materials and substances.

In one embodiment, one or more elements in one or more configurations include other types of nanoparticle elements such as, but not limited to, polymer-based, polybutylcyanoacrylate-based, and cetyl alcohol-based nanoparticles, empty cage Fullerenes, endohedral Fullerenes, carbon nanotubes, cells, liposomes, capsids, dendrimers, micelles, and the like.

In another illustrative embodiment, one or more elements and or platforms of one or more types in whole or in part enable a shape programmable and or scaffolding system to which one or elements of one or more types, including natural and or non-invention elements are affixed and or further form more one or more structures of one more types

In one embodiment, one or more elements and or platforms in one or more configurations form and or include optical elements such as, but not limited to, optics; optoelectronic elements; photoelectric elements; photodetectors; and photosensitive elements, which optical elements may also be coated or treated in whole or in part with materials that affect their optical properties.

In one embodiment, one or more elements and or platforms and in one or more configurations form and or include imaging elements and sensors, such as, but not limited to, CCDs and CMOS optical elements

substances and devices, which circuits also may be coated in one or more surfactants and or cosurfactants and or other materials and substances.

In one embodiment, one or more elements and or platforms are switched on or off and or change states by applying an electric field, and may also comprise one or more transistors or devices in another embodiment.

In another embodiment, one or more elements and or platforms and in one or more configurations; self-assemble, and or are shape-programmed, and or use biological control and regulate laws, processes and methods, and or use geometrically derived algorithms such as graphs and Lie algebras, including Clifford algebras, but not limited to, and or are mechanically assembled via lithography, and or utilize other externally directed techniques and methods known the art, and or some combination thereof; form natural positions that are associated with electronic circuits and or information processing devices, such as atomic and molecular scale device design, their interconnection, nanofabrication and circuit architectures.

According to one illustrative embodiment, one or more elements and or platforms comprise one or more crystal structures and elements, of one or more types.

According to one illustrative embodiment, one or more elements and or platforms comprise one or more desiccated elements, of one or more types.

According to one illustrative embodiment, one or more invention comprise one or more hydrated and or rehydrated elements and or platforms, of one or more types.

According to one illustrative embodiment, one or more elements and or platforms comprise one or more rehydration elements and or platforms, of one or more types.

According to one illustrative embodiment, one or more elements and or platforms are embedded and or incorporated into one or more materials, substances, devices, agents, devices, systems, organisms, and or mechanisms of one or more types.

In another illustrative embodiment, one or more elements and or platforms comprise one or more magnetic nanoparticles of one or more types.

In one embodiment, one or more elements and or platforms are nanoscale recording memory media or components, which may incorporate metals, ferromagnetic materials, and or ferroelectric materials and elements, and or may form into magnetic rings, and or may form vertically polarized magnetic domains and or form magnetic domains on isolated islands of one or more types.

In one embodiment, one or more elements and or platforms are nanoscale photovoltaic cells or components of one or more types.

In one embodiment, one or more elements are nanoscale batteries or components of one or more type for storing electronic charge.

In one embodiment, one or more elements and or platforms comprise a nanoscale environmental hazard-screening device, and or comprise an in situ remediation, removal and or sequestration component or system of one or more types.

In one embodiment, one or more elements and or platforms comprise an opto-electronic device, system or component of one or more types.

In one illustrative embodiment, embodiment, one or more elements comprise one or more nanoscale passive and or active linear or nonlinear optic components, and or particle detectors, and or other elements sufficient to implement in vivo or in vitro optical system arrays and methods.

In another embodiment, one or more elements comprise in vivo or in vitro detection, diagnostic and tracking agents for chemical, biological, and or nuclear elements and activities, but not limited to such.

In one embodiment, one or more elements and or platforms comprise a spin-based electronics element or system of one or more types.

In one embodiment, one or more elements and or platforms exploit the Coulomb blockade-like properties of self-assembled proteins, wherein a single particle at a time may move through a transmembrane protein-based channel.

In one embodiment, one or more elements and or platforms utilize and or exploit the Casimir effect, which is a small attractive force that acts between two closely parallel, uncharged conducting elements. It is due to quantum vacuum fluctuations of the electromagnetic field.

In some illustrative embodiments, one or more elements and or platforms and in one or more configurations are physically linked via molecular addends of one or more types, but are not limited to such addend types.

In other illustrative configurations, one or more elements and or platforms are functionally linked via photonic, chemical, electromagnetic, electrical and/or quantum (non-classical) interactions of one or more types, including the Internet, to work and cooperate locally and/or remotely.

One or more elements and or platforms of one or more types may be encapsulated, packaged, stored, incorporated, and or utilize one or more methods known in the art, including for example, but not limited to: catheters; injections, including intramuscular injections; syringes; droppers and bulbs; pills; intravenous means; oral means; anal means; capsules; nanocapsules; nanoparticles; nano-devices; prescriptions; hospital and medical supplies; dental supplies; non-prescriptions; medications; over the counter products and remedies; alternative medicine supplies, systems, products and devices; hair care products; splints, casts, walkers, crutches, canes, wheelchairs, and other ambulatory aids; natural foods; vitamin and mineral supplements; first aid products; emergency health care procedures, systems, devices, and products, including combat medicine; health care products; grafts; skin patches; bandages; adhesives; wraps; masks; markers; powders; granules; geriatric care products; pediatric care products; diagnostic devices, systems, and products; medical imaging devices, systems, and products; telemedicine devices, systems, and products; in vivo monitoring systems, products, systems, and devices; in vitro monitoring systems, products, systems, and devices; laundry products; chemical, nuclear and biological sensors; sensors; bio-sensors; environmental sensors; combat systems, clothing, uniforms, and protective gear; food preparation products; food testing and safety devices, systems, and products; food storage wraps, systems, devices, and products; water treatment devices, systems and products; waste storage, management, and treatment systems and products; sewerage systems and products; plumbing systems and products; bed and bath products; animal care and veterinary products; animal feed; animal slaughter systems and products; cooking products; cookware; forensic devices, systems and products; home and office cleaning products; home products; office products; personal products; industrial products; home and

finishes; heating, ventilation and air conditioning systems; construction, building, home and office materials; water; milk; food and other edible or chewable substances and items; prostheses; food and drink additives and supplements; drinks; beverages; soaps; creams; ointments; salves; topical agents; cosmetics; beautifying agents; liquids; fluids; oils; gels; adhesives; aerosols; vapors; airborne methods; pumps; fragrances and perfumes; textiles; sporting and athletic goods and devices; physical work out and training systems, devices, and products; sports medicine systems, devices, and products; recreational products and gear; shoes, clothing, and apparel; eyewear; sprays; dyes; biological elements; organ; implants; stents; prosthetic devices; artificial skin, blood, limbs, joints, bones, cells, eyes, organs, and other artificial body parts and biological elements; subcutaneous means; incisions; surgical means; and in-patient and out-patient medical procedures.

The above-described embodiments have been set forth to describe more completely and concretely the present invention, and are not to be construed as limiting the invention. It is further intended that all matter and the description and drawings be interpreted as illustrative and not in a limiting sense. That is, while various embodiments of the invention have been described in detail, other alterations, which will be apparent to those skilled in the prior art, are intended to be embraced within the spirit and scope of the invention.

Previous Patent: HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A2* (HNRNP A2*) AND NUCLEIC ACID ENCODING THE SAME

Next Patent: Stresscopins and their Uses

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