

CLAIMS

What is claimed is:

1. A method of treating a subject having cancer comprising:
identifying a subject having a ferroptosis sensitive malignancy,
administering to the subject a synthetic nanostructure comprising:
a nanostructure core, a shell comprising a lipid surrounding and attached to the nanostructure core, wherein the shell comprises a phospholipid;
wherein the subject has cancer cells and wherein the synthetic nanostructure is administered in an effective amount to induce ferroptosis in the cancer cells.
2. A method of reducing, in a population of cells, the number of cancer cells, the method comprising:
contacting the cancer cells with a synthetic nanostructure comprising:
a nanostructure core, a shell comprising a lipid surrounding and attached to the nanostructure core, wherein the shell comprises a phospholipid;
wherein the synthetic nanostructure is in an effective amount to induce ferroptosis in the cancer cells.
3. The method of any one of claims 1-2, wherein the nanostructure core is gold.
4. The method of any one of claims 1-3, wherein the synthetic nanostructure further comprises an apolipoprotein.
5. The method of any one of claims 1-4, wherein apolipoprotein is apolipoprotein A-I, apolipoprotein A-II, or apolipoprotein E.
6. The method of any one of claims 1-5, wherein the synthetic nanostructure further comprises a cholesterol.

7. The method of any one of claims 1-6, wherein the phospholipid shell comprises a lipid monolayer.
8. The method of any one of claims 1-6, wherein the phospholipid shell comprises a lipid bilayer.
9. The method of claim 8, wherein at least a portion of the lipid bilayer is covalently bound to the nanostructure core.
10. The method of any one of claims 1-9, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 500 nanometers (nm).
11. The method of any one of claims 1-10, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 250 nanometers (nm).
12. The method of any one of claims 1-11, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 100 nanometers (nm).
13. The method of any one of claims 1-12, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 75 nanometers (nm).
14. The method of any one of claims 1-13, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 50 nanometers (nm).
15. The method of any one of claims 1-14, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 30 nanometers (nm).
16. The method of any one of claims 1-15, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 15 nanometers (nm).
17. The method of any one of claims 1-16, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 10 nanometers (nm).

18. The method of any one of claims 1-17, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 5 nanometers (nm).
19. The method of any one of claims 1-18, wherein the nanostructure core has a largest cross-sectional dimension of less than or equal to about 3 nanometers (nm).
20. The method of any one of claims 1-19, wherein the nanostructure core has an aspect ratio of greater than about 1:1.
21. The method of any one of claims 1-20, wherein the nanostructure core has an aspect ratio of greater than 3:1.
22. The method of any one of claims 1-21, wherein the nanostructure core has an aspect ratio of greater than 5:1.
23. The method of any one of claims 1-22, wherein the phospholipid comprise 1,2-dipalmitoyl-sn-glycero-3-phosphocholine (DPPC), 1,2-dioleoyl-sn-glycero-3-phosphocholine (DOPC), 1,2-dipalmitoyl-sn-glycero-3-phosphoethanolamine (16:0 PE), 1,2-distearoyl-sn-glycero-3-phosphoethanolamine (18:0 PE), sphingomyelin, 1,2-dioleoyl-3-trimethylammonium-propane (DOTAP), or a combination thereof.
24. The method of any one of claims 1-23, wherein the subject has been diagnosed with cancer.
25. The method of any one of claims 1-24, wherein the subject has been diagnosed with a ferroptosis sensitive malignancy or cholesterol auxotrophic malignancy.
26. The method of any one of claims 1-25, wherein the cancer is selected from: B-cell lymphoma, renal cell carcinoma, T-cell lymphoma, gastric cancer, ovarian carcinoma, and endometrial adenocarcinoma.

27. The method of any one of claims 1-26, wherein the cancer is selected from: sarcoma, lymphoma, gastric cancer, anaplastic large cell lymphoma, clear cell renal cell carcinoma (ccRCC), ovarian cancer, platinum resistant ovarian cancer, and clear cell ovarian cancer B-cell lymphoma and T-cell lymphoma.
28. The method of any one of claims 1-27, wherein the synthetic nanostructure is administered to the subject or contacted to the cells more than once.
29. The method of claim 28, wherein the synthetic nanostructure is administered to the subject or contacted to the cells at least once per month.
30. The method of any one of claims 28-29, wherein the synthetic nanostructure is administered to the subject or contacted to the cells at least once per week.
31. The method of any one of claims 28-30, wherein the synthetic nanostructure is administered to the subject or contacted to the cells at least once per day.
32. The method of any one of claims 28-31, wherein the synthetic nanostructure is administered to the subject or contacted to the cells twice per day.
33. The method of any one of claims 1-32, wherein the subject is a mammal.
34. The method of any one of claims 1-33, wherein the subject is human.
35. The method of any one of claims 1-33, further comprising administering to the subject a ferroptosis inducer compound.
36. The method of any one of claims 1-33, further comprising determining if the cancer is sensitive to ferroptosis.
37. A method of treating a subject having a ferroptosis sensitive disorder comprising:
identifying a subject having a ferroptosis sensitive disorder; and

administering to the subject a synthetic nanostructure comprising:

a nanostructure core, a shell comprising a lipid surrounding and attached to the nanostructure core, wherein the shell comprises a phospholipid; in an effective amount to induce ferroptosis in diseased cells of the subject.

38. A composition comprising synthetic nanostructure comprising:

a nanostructure core, a shell comprising a lipid surrounding and attached to the nanostructure core, wherein the shell comprises a phospholipid and a ferroptosis inducer compound.

39. A method for inducing ferroptosis in a cell, comprising:

identifying a cell as being a ferroptosis sensitive cell, and contacting the cell with a nanostructure core, a shell comprising a lipid surrounding and attached to the nanostructure core, wherein the shell comprises a phospholipid in an effective amount to induce ferroptosis in the cell.