CLAIMS

1. A composition comprising a combination of a first therapeutic agent that inhibits mitochondrial biogenesis and targets the large mitochondrial ribosome, a second therapeutic agent that inhibits mitochondrial biogenesis and targets the small mitochondrial ribosome, and a third therapeutic agent that induces mitochondrial oxidative stress.

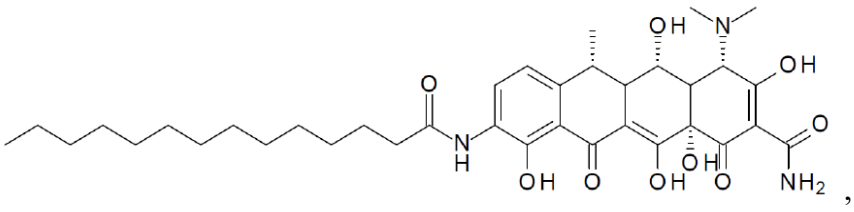
2. The composition of claim 1, wherein the first therapeutic agent comprises azithromycin, the second therapeutic agent comprises doxycycline, and the third therapeutic agent comprises Vitamin C.

3. The composition of claim 1, wherein the first therapeutic agent comprises an erythromycin family member conjugated with a first fatty acid, the second therapeutic agent comprises a tetracycline family member conjugated with a second fatty acid, and the third therapeutic agent comprises at least one of Vitamin C and ascorbyl palmitate.

4. The composition of claim 3, wherein at least one of the first fatty acid and the second fatty acid comprises myristic acid.

5. The composition of claim 1, wherein at least one therapeutic agent comprises a conjugate with a fatty acid moiety.

6. The composition of claim 1, wherein the second therapeutic agent comprises one of:



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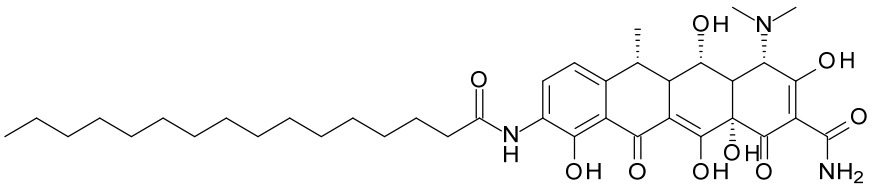

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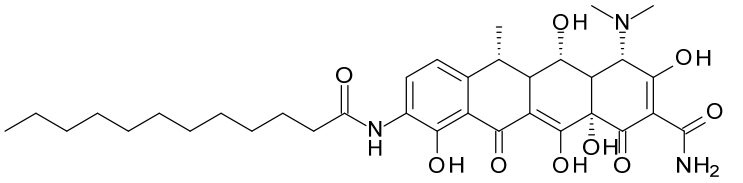

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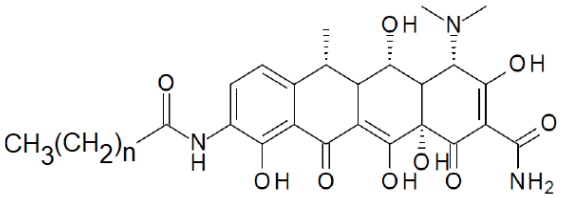
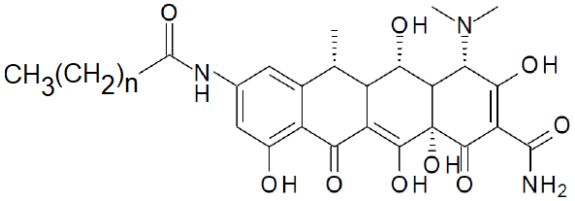
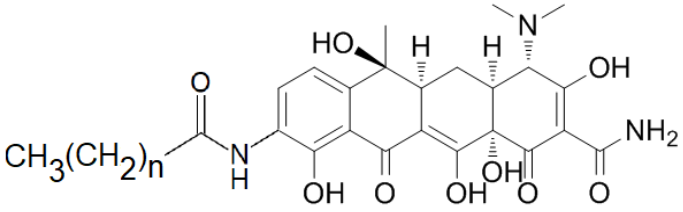


, wherein n is an integer from 1-20;



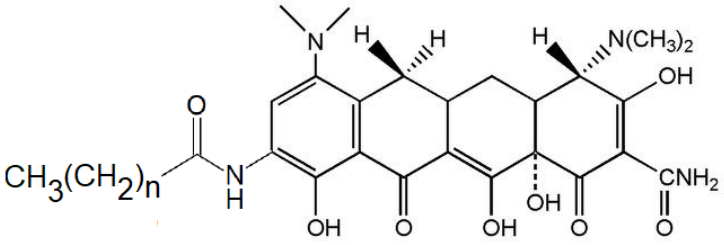
, wherein n is an integer from 1-20; and



, wherein n is an integer from 1-20.

7. The composition of claim 1, wherein at least one of the first therapeutic agent and the second therapeutic agent comprises a conjugate with a TPP moiety.

8. The composition of claim 1, wherein the second therapeutic agent comprises one of:



, wherein n is an integer from 1-20.

9. The composition of claim 2, wherein the concentration of at least one of azithromycin and doxycycline is sub-antimicrobial.

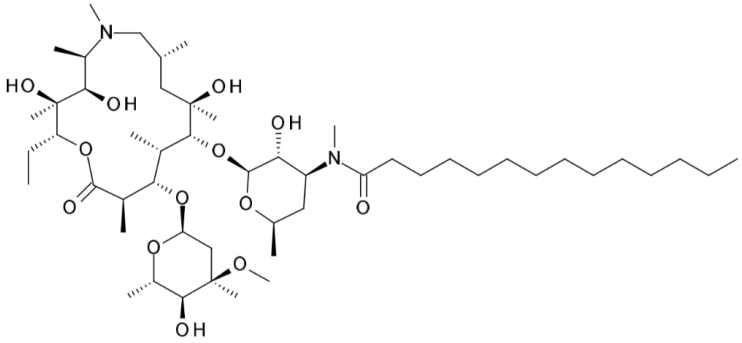
10. The composition of claim 2, wherein the concentration of both azithromycin and doxycycline is sub-antimicrobial.

11. The composition of claim 1, wherein the third therapeutic agent comprises Vitamin C administered orally at a concentration sufficient to achieve a peak Vitamin C concentration between 100 μM and 250 μM in at least one of blood, serum, and plasma.

12. The composition of claim 1, wherein the first therapeutic agent is a member of the erythromycin family or a conjugate of a member of the erythromycin family and a fatty acid.

13. The composition of claim 1, wherein the second therapeutic agent is a member of the tetracycline family or a conjugate of a member of the doxycycline family and a fatty acid.

14. The composition of claim 1, wherein the first therapeutic agent comprises one of:



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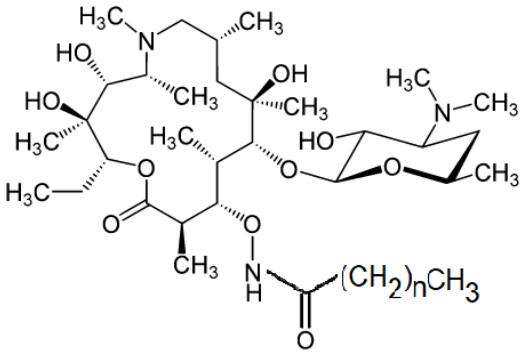
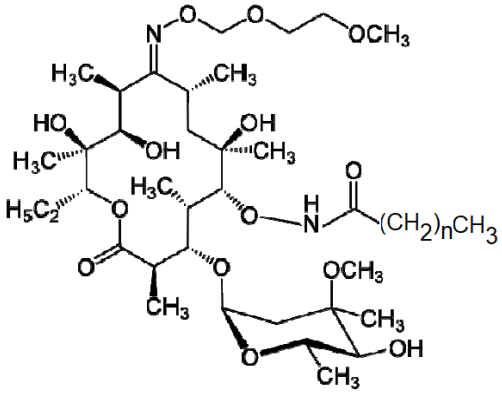
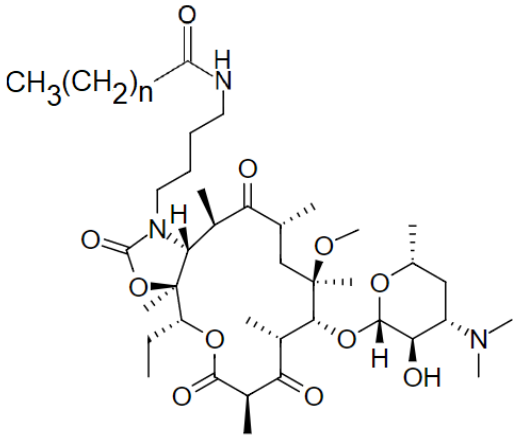


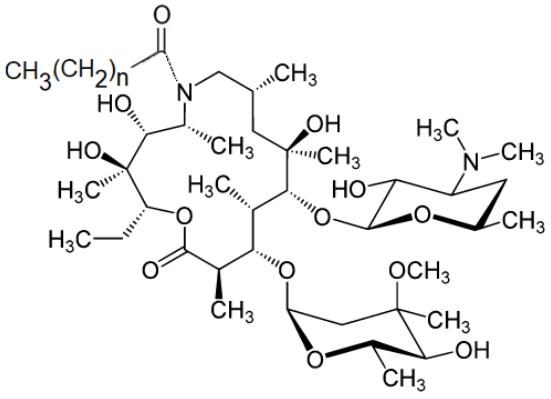
, wherein n is an integer from 1-20;



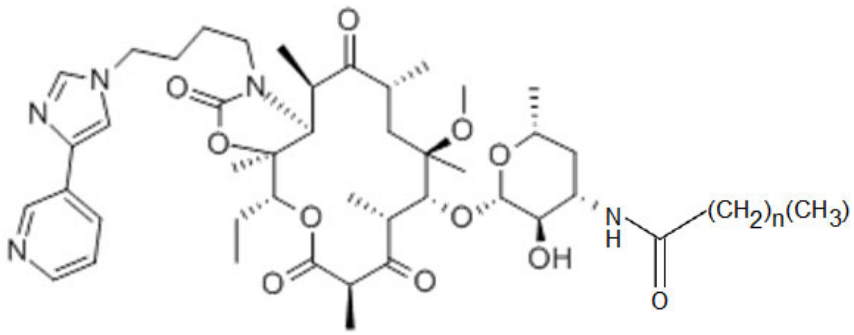
, wherein n is an integer from 1-20;



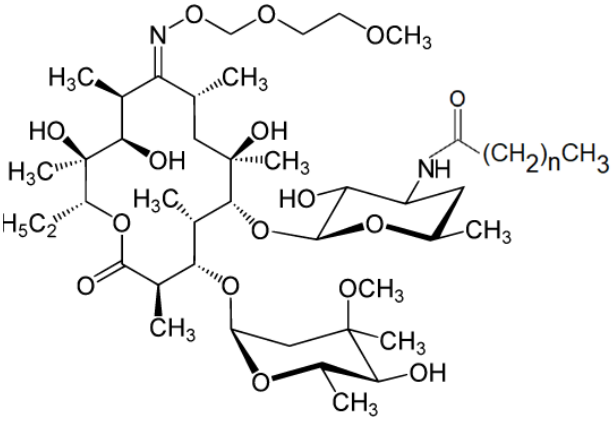
, wherein n is an integer from 1-20;



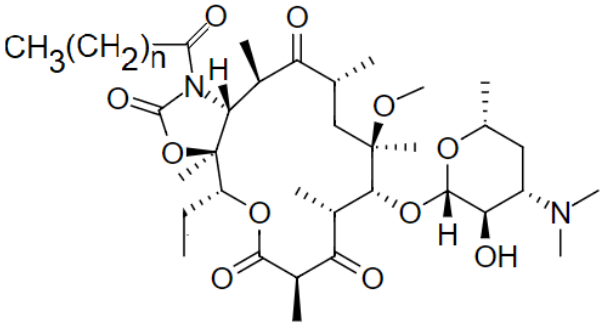
, wherein n is an integer from 1-20;



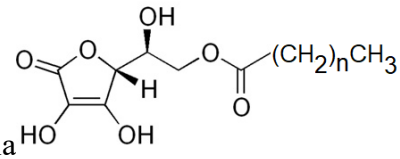
, wherein n is an integer from 1-20;



, wherein n is an integer from 1-20; and



, wherein n is an integer from 1-20.

15. The composition of claim 1, wherein the third therapeutic agent is a compound having the formula , wherein n is an integer from 1-20.

16. The composition of claim 1, wherein the first therapeutic agent is a conjugate of azithromycin and myristic acid, the second therapeutic agent is a conjugate of doxycycline and

myristic acid, and the third therapeutic agent is one of Vitamin C, ascorbyl palmitate, and an ascorbate derivative.

17. The composition of claim 16, wherein the first therapeutic agent, the second therapeutic agent, and the third therapeutic agent are encapsulated in a liposomal drug delivery system.

18. The composition of claim 1, wherein at least one therapeutic agent is chemically modified with at least one of TPP; a TPP-derivative; 2-butene-1,4-bis-TPP; 2-chlorobenzyl-TPP; 3-methylbenzyl-TPP; 2,4-dichlorobenzyl-TPP; 1-naphthylmethyl-TPP; p-xylylenebis-TPP; a derivative of 2-butene-1,4-bis-TPP; a derivative of 2-chlorobenzyl-TPP; a derivative of 3-methylbenzyl-TPP; a derivative of 2,4-dichlorobenzy-TPP; a derivative of 1-naphthylmethyl-TPP; a derivative of p-xylylenebis-TPP; guanidinium; a guanidinium derivative; quinolinium; a quinolinium-based moiety; a choline ester; rhodamine; a rhodamine derivative; pyridinium; (E)-4-(1H-Indol-3-ylvinyl)-N-methylpyridinium iodide (F16); a sulfonyl-urea derivative; diazoxide; and 10-N-nonyl acridine orange.

19. The composition of claim 1, wherein the composition possesses anti-cancer activity and at least one of radiosensitizing activity and photosensitizing activity.

20. The composition of claim 1, wherein the composition sensitizes cancer cells to at least one of chemotherapeutic agents, natural substances, and caloric restriction.

21. The composition of claim 1, wherein the composition selectively kills senescent cells.

22. The composition of claim 1, wherein the composition, prevents acquisition of a senescence-associated secretory phenotype.

23. The composition of claim 1, wherein the composition, facilitates tissue repair and regeneration.

24. The composition of claim 1, wherein the composition, increases at least one of organismal life-span and health-span.

25. Use of: a first therapeutic agent that inhibits mitochondrial biogenesis and targets the large mitochondrial ribosome, a second therapeutic agent that inhibits mitochondrial biogenesis and targets the small mitochondrial ribosome, and a third therapeutic agent that induces mitochondrial oxidative stress, in the manufacture of a medicament for treating and eradicating cancer cells.

26. The use of claim 25, wherein the first therapeutic agent comprises azithromycin, the second therapeutic agent comprises doxycycline, and the third therapeutic agent is Vitamin C.

27. The use of claim 25, wherein the third therapeutic agent is one of Vitamin C and ascorbyl palmitate, the first therapeutic agent comprises an erythromycin family member conjugated with a first fatty acid, and the second therapeutic agent comprises a tetracycline family member conjugated with a second fatty acid.

28. The use of claim 27, wherein at least one of the first fatty acid and the second fatty acid comprises myristic acid.

29. The use of claim 25, wherein at least one therapeutic agent comprises a conjugate with a fatty acid moiety.

30. The use of claim 25, wherein the first therapeutic agent comprises one of the compounds of claim 14, and the second therapeutic agent comprises a doxycycline and myristic acid conjugate.

31. The use of claim 25, wherein at least one therapeutic agent comprises a conjugate with a TPP moiety.

32. The use of claim 25, wherein the third therapeutic agent is radiation.

33. The use of claim 26, wherein the concentration of at least one of azithromycin and doxycycline is sub-antimicrobial, and the concentration of Vitamin C is sufficient to achieve a peak Vitamin C concentration between 100 μM and 250 μM in at least one of blood, serum, and plasma.

34. The use of claim 25, wherein the cancer cells comprise at least one of cancer stem cells, energetic cancer stem cells, circulating tumor cells, and therapy-resistant cancer cells.

35. A pharmaceutical composition for treating cancer, the pharmaceutical composition comprising the combination of a first therapeutic agent that inhibits mitochondrial biogenesis and targets the large mitochondrial ribosome, a second therapeutic agent that inhibits mitochondrial biogenesis and targets the small mitochondrial ribosome, and a third therapeutic agent that induces mitochondrial oxidative stress.

36. The composition of claim 35, wherein the first therapeutic agent comprises azithromycin, the second therapeutic agent comprises doxycycline, and the third therapeutic agent comprises one of Vitamin C, ascorbyl palmitate, and an ascorbate derivative.

37. The composition of claim 36, wherein the concentration of at least one of azithromycin and doxycycline is sub-antimicrobial, and the concentration of the at least one of Vitamin C and an ascorbate derivative is sufficient to achieve a peak Vitamin C concentration of between 100 μM and 250 μM in at least one of blood, plasma, and serum.

38. The composition of claim 35, wherein the first therapeutic agent comprises one of the compounds of claim 14, the second therapeutic agent comprises a conjugate of doxycycline

and a second fatty acid, and the third therapeutic agent comprises at least one of Vitamin C, ascorbyl palmitate, and an ascorbate derivative.

39. The composition of claim 38, wherein at least one of the first fatty acid and the second fatty acid is myristic acid.

40. Use of: a first therapeutic agent that inhibits mitochondrial biogenesis and targets the large mitochondrial ribosome, a second therapeutic agent that inhibits mitochondrial biogenesis and targets the small mitochondrial ribosome, and a third therapeutic agent that induces mitochondrial oxidative stress in the manufacture of a medicament for the treating and preventing of at least one of tumor recurrence, metastasis, drug resistance, radiotherapy resistance, and cachexia.

41. The use of claim 40, wherein the first therapeutic agent comprises one of the compounds of claim 14, the second therapeutic agent comprises doxycycline or a conjugate of doxycycline and a second fatty acid, and the third therapeutic agent comprises at least one of Vitamin C, an ascorbate derivative, a chemotherapeutic, and radiation therapy.

42. The use of claim 41, wherein the concentration of at least one of the first therapeutic agent and the second therapeutic agent is sub-antimicrobial, and the third therapeutic agent is Vitamin C at a concentration sufficient to achieve a peak Vitamin C concentration between 100 μM and 250 μM in at least one of blood, plasma, and serum.

43. The use of claim 40, wherein the medicament is suitable for administering at least one of prior to a cancer treatment, with a cancer treatment, and following a cancer treatment.

44. A pharmaceutical composition for preventing at least one of tumor recurrence, metastasis, drug resistance, cachexia, and radiotherapy resistance, the pharmaceutical composition comprising the combination of a first therapeutic agent that inhibits mitochondrial biogenesis and

targets the large mitochondrial ribosome, a second therapeutic agent that inhibits mitochondrial biogenesis and targets the small mitochondrial ribosome, and a third therapeutic agent that induces mitochondrial oxidative distress.

45. The composition of claim 44, wherein the first therapeutic agent comprises azithromycin or a conjugate of azithromycin and a first fatty acid, the second therapeutic agent comprises doxycycline or a conjugate of doxycycline and a second fatty acid, and the third therapeutic agent comprises one of Vitamin C, ascorbyl palmitate, and an ascorbate derivative.

46. The composition of claim 45, wherein the concentration of at least one of the first therapeutic agent and the second therapeutic agent is sub-antimicrobial, and the concentration of the third therapeutic agent is sufficient to achieve a peak Vitamin C concentration between 100 μM and 250 μM in at least one of blood, plasma, and serum.

47. The composition of claim 44, wherein the first therapeutic agent comprises one of the compounds of claim 14.

48. The use of claim 25, wherein the medicament is suitable for administering at least one of prior to a cancer treatment, with a cancer treatment, and following a cancer treatment.

49. The use of claim 25, wherein the first therapeutic agent comprises azithromycin or a conjugate of azithromycin and a first fatty acid, the second therapeutic agent comprises doxycycline or a conjugate of doxycycline and a second fatty acid, and the third therapeutic agent comprises Vitamin C.

50. The use of claim 49, wherein the concentration of at least one of the first therapeutic agent and the second therapeutic agent is sub-antimicrobial, and the concentration of Vitamin C is sufficient to achieve a peak Vitamin C concentration between 100 μM and 250 μM in at least one of blood, plasma, and serum.

51. The use of claim 25, wherein the third therapeutic agent is at least one of Vitamin C, ascorbyl palmitate, an ascorbate derivative, a chemotherapeutic, and radiation therapy.

52. The use of claim 25, wherein at least one therapeutic agent is chemically modified with one of a membrane-targeting signal and a mitochondria-targeting signal.

53. The use of claim 25, wherein the first therapeutic agent comprises one of the compounds of claim 14.

54. The use of claim 25, wherein the treating and eradicating cancer cells comprises increases cancer cell sensitivity to at least one of chemotherapy, radiotherapy, chemotherapeutic agents, natural substances, and caloric restriction.

55. The use of claim 25, wherein the treating and eradicating cancer cells comprises at least one of kills senescent cells; prevents acquisition of a senescence-associated secretory phenotype, and facilitates tissue repair and regeneration.