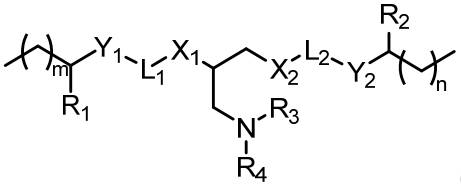
CLAIMS

1. A compound of formula (I),



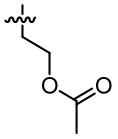
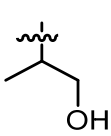
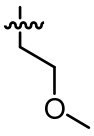
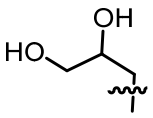
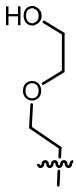
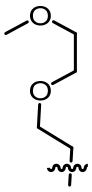
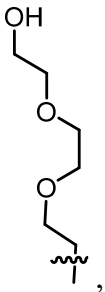
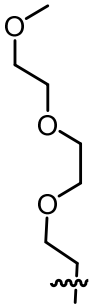
(I)

or a pharmaceutically acceptable salt, prodrug or stereoisomer thereof, wherein

X_1 and X_2 are each independently -OC(=O)-, -C(=O)O-, -NHC(=O)-, or -C(=O)NH-;

Y_1 and Y_2 are each independently -OC(=O)-, -C(=O)O-, -NR_5C(=O)-, -C(=O)NR_5-bond, optionally substituted C1-C8 alkylene, or optionally substituted C2-C8 alkenylene, wherein R_5 is selected from hydrogen or linear or branched C1-C8 hydrocarbyl;

L_1 and L_2 are each independently a bond, or optionally substituted C1-C10 alkylene;

R_3 and R_4 are each independently methyl, ethyl, propyl, hydroxymethyl, hydroxyethyl, hydroxypropyl, hydroxybutyl, , , , , , , , or ; or R_3 and R_4, together with the nitrogen attached thereto, form a cyclic moiety, wherein R_3 or R_4 are selected from a group containing hydrogen or deuterium, and the cyclic moiety is 4- to 8-membered heterocycloalkyl selected from azetidin-1-yl, pyrrolidinyl, piperidin-1-yl, 4-hydroxypiperidin-1-yl, azepan-1-yl, morpholinyl, and 4-acetylpiperazin-1-yl;

R_1 and R_2 are each independently H or deuterium or linear or branched C1-C8 hydrocarbyl;

m is an integer of 1-13;

n is an integer of 1-13.

2. The compound or the pharmaceutically acceptable salt, prodrug or stereoisomer thereof according to claim 1, wherein the compound is selected from compounds shown in Table 1.

3. A lipid nanoparticle, comprising the compound or the pharmaceutically acceptable salt, prodrug or stereoisomer thereof according to claim 1.

4. The lipid nanoparticle according to claim 3, further comprising a helper lipid, wherein the helper lipid is selected from one or more of a phospholipid, a steroid, a polymer-conjugated lipid, and a modifiable lipid.

5. The lipid nanoparticle according to claim 4, wherein the phospholipid is selected from any one of DOPE, DSPC, DPPC, DMPC, DOPC, POPC, and SM, or a combination thereof.

6. The lipid nanoparticle according to claim 4, wherein the steroid is selected from one or more of cholesterol, sitosterol, stigmasterol, and ergosterol, further preferably, the steroid is cholesterol and sitosterol.

7. The lipid nanoparticle according to claim 4, wherein the polymer-conjugated lipid is selected from a lipid conjugated with polyethylene glycol, polylactic acid, polyamide, cationic polymer, polysarcosine (pSar), poly lactic-co-glycolic acid (PLGA), polyamino acid, polypeptide or polypeptoid.

8. The lipid nanoparticle according to claim 7, wherein the polymer-conjugated lipid is a polyethylene glycol-conjugated lipid selected from one or more of ALC-0159, PEG1000-DMG, PEG5000-DMG, PEG2000-DMG, and PEG2000-DSPE.

9. The lipid nanoparticle according to claim 4, wherein the molar ratio of the compound or the pharmaceutically acceptable salt, prodrug or stereoisomer thereof according to claim 1 to the helper lipid is 1:(0.5-2), preferably 1:(0.6-1.5), further preferably 1:(0.8-1.2).

10. The lipid nanoparticle according to any one of claims 3 to 9 for use in targeted delivery, wherein preferably, a target organ for the targeted delivery is the following organ: lung, heart, brain, spleen, lymph node, bone, skeletal muscle, stomach, small intestine, large intestine/colorectum, kidney, bladder, breast, testis, ovary, uterus, spleen, thymus, brainstem, cerebellum, spinal cord, eye, ear, tongue, or skin; preferably, the target organ is spleen.

11. Use of the lipid nanoparticle according to any one of claims 3 to 9 for the manufacture of a medicament for targeted delivery, wherein preferably, a target organ for the targeted delivery is the following organ: lung, heart, brain, spleen, lymph node, bone, skeletal muscle, stomach, small intestine, large intestine/colorectum, kidney, bladder, breast, testis, ovary, uterus, spleen, thymus, brainstem, cerebellum, spinal cord, eye, ear, tongue, or skin; preferably, the target organ is spleen.

12. A composition, comprising the lipid nanoparticle according to any one of claims 3 to 9 and a therapeutic/prophylactic agent, wherein preferably, the therapeutic/prophylactic agent is a nucleic acid; further preferably, the nucleic acid is selected from a single-stranded DNA, a double-stranded DNA, a single-stranded RNA, a double-stranded RNA, a short isomer, a plasmid DNA, a complementary DNA/cDNA, an antisense oligonucleotide/ASO, a small interference nucleic

acid/siRNA, a small activating nucleic acid/saRNA, an asymmetric interfering nucleic acid/aiRNA, a micro nucleic acid/miRNA, a miRNA inhibitor (agomir or antagomir), a Dicer-substrate nucleic acid, a small hairpin nucleic acid (shRNA), a transfer RNA (tRNA), a messenger RNA/mRNA, a circular RNA/circRNA, a self-amplifying mRNA/samRNA, or an aptamer.

13. The composition according to claim 12, wherein the nucleic acid comprises a natural nucleotide, a nucleotide mimic, a functional analog, or a chemically modified nucleotide.

14. The composition according to any one of claims 12 and 13, wherein the composition has an average particle size of 90 nm to 600 nm, preferably 200 nm to 400 nm, further preferably 200 nm to 300 nm.

15. The composition according to any one of claims 12 and 13, wherein the composition has a polydispersity index (PDI) of 0.001 to 0.5, preferably 0.001 to 0.45, further preferably 0.001 to 0.4.

16. The composition according to any one of claims 12 and 13, wherein the mass ratio of the lipid nanoparticle to the therapeutic/prophylactic agent in the composition is 10:1 to 100:1, preferably 20:1 to 50:1, further preferably 20:1 to 30:1.

17. An agent, comprising the composition according to any one of claims 12 to 16 and a pharmaceutically acceptable auxiliary material.