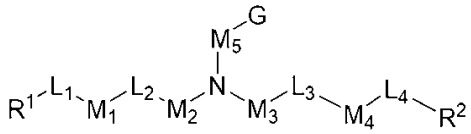
What is claimed is:

1. An amino lipid having the structure as shown in formula (I), or an isomer, a pharmaceutically acceptable salt, a prodrug or a solvate thereof:



(I)

wherein G is selected from H, OR, CN, -C(=O)OR', -OC(=O)R', -C(=O)NR'R", -NR'C(=O)R", -NR'R", or a cycloalkyl comprising at least one heteroatom, wherein the substitutable carbon atoms or heteroatoms in the cycloalkyl are unsubstituted or substituted by one or more groups of hydroxyl, C_1-C_4 alkyl, C_2-C_4 alkenyl, C_3-C_8 cycloalkyl, or C_3-C_8 cycloalkenyl;

M_1, M_2, M_3, and M_4 are identical or different from each other, and each independently selected from C_1-C_{24} alkylene, C_3-C_{24} cycloalkylene, C_2-C_{24} alkenylene, or C_3-C_{24} cycloalkenylene;

R^1 and R^2 are identical or different from each other, and each independently selected from H, C_1-C_{24} alkyl, C_3-C_{24} cycloalkyl, C_2-C_{24} alkenyl, or C_3-C_{24} cycloalkenyl;

L_1, L_2, L_3, and L_4 are identical or different from each other, and each independently selected from -C(=O)O-, -OC(=O)-, -C(=O)S-, -SC(=O)-, -C(=O)NR-, -NRC(=O)-, -S(=O)-, -OS(=O)$_2$-, -S(=O)$_2$O-, -O-, -S-, or -S-S-;

R, R', and R" are identical or different from each other, and each independently selected from H, C_1-C_{10} alkyl, C_3-C_{10} cycloalkyl, C_3-C_{10} alkenyl, C_3-C_{10} cycloalkenyl, C_1-C_{10} alkyl terminated with a tertiary amino group, C_3-C_{10} cycloalkyl terminated with a tertiary amino group, C_3-C_{10} alkenyl terminated with a tertiary amino group, or cycloalkyl comprising at least one heteroatom, the cycloalkyl being unsubstituted or substituted with one or more groups of C_1-C_4 alkyl, C_2-C_4 alkenyl, C_3-C_8 cycloalkyl, or C_3-C_8 cycloalkenyl;

M_5 groups are each independently selected from a single bond, C_1-C_{16} alkylene, C_2-C_{16} alkenylene, C_3-C_8 cycloalkylene, or C_3-C_8 cycloalkenylene.

2. The amino lipid according to claim 1, wherein in the formula (I), G is selected from H,

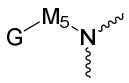
OR or NR'R", wherein R' and R" are identical or different from each other, and each independently selected from H or C_1-C_4 alkyl; or

G is selected from substituted or unsubstituted 5-membered oxacycloalkyl, substituted or unsubstituted 5-membered azacycloalkyl, substituted or unsubstituted 6-membered azacycloalkyl, substituted or unsubstituted 6-membered diazocycloalkyl, or substituted or unsubstituted 6-membered azaoxacycloalkyl;

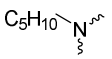
wherein in the formula (I), when G is selected from substituted 6-membered diazocycloalkyl, the substituent is positioned on the nitrogen atom that is not linked with M_5.

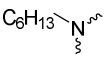
3. The amino lipid according to claim 2, wherein in the formula (I), M_5 is selected from a single bond, C_2-C_{16} alkylene, C_2-C_{16} alkenylene, C_4-C_8 cycloalkylene, or C_3-C_8 cycloalkenylene; or

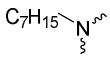
wherein in formula (I), M_5 is selected from a single bond, C_2-C_{16} alkylene, or C_4-C_6 cycloalkylene.

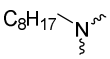
4. The amino lipid according to claim 3, wherein in the formula (I), the 

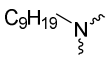
formed by linking of M_5 and G is one selected from A1 to A52:

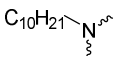

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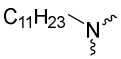

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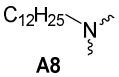

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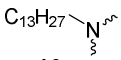

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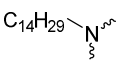

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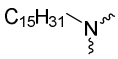

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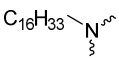

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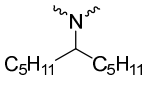

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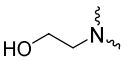

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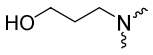

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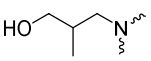

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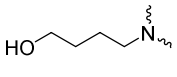

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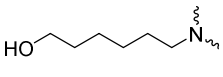

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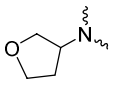

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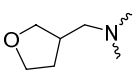

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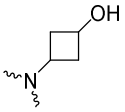

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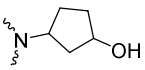

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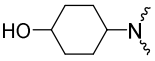

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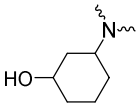

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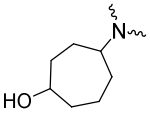

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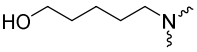

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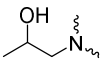

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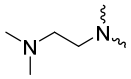

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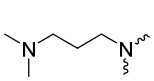

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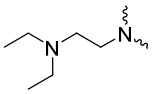

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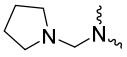

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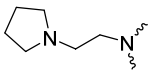

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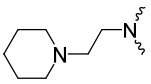

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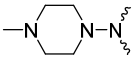

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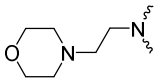

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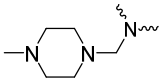

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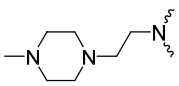

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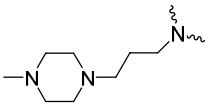

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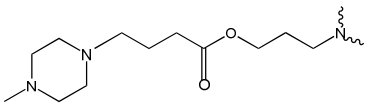

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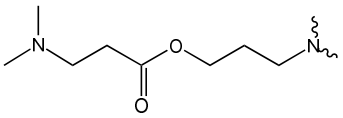

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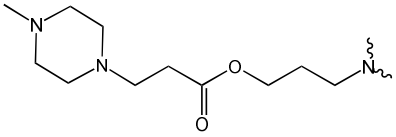
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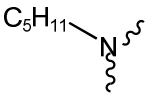
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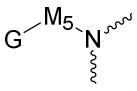
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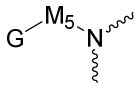
, and 

; or

A51 A52

wherein the 

is one selected from A1-A18, A22-A24, and A28-A38; or

wherein the 

is one selected from A15, A16, A17, A23, A29, A30, A33, A37, A38, and A42.

5. The amino lipid according to any one of claims 1 to 4, wherein in the formula (I), L_1, L_2, L_3, and L_4 are identical or different, and independently selected from -C(=O)O-, -OC(=O)-, -C(=O)NR-, -NRC(=O)-, or -S-S-;

preferably, L_1 and L_4 are the same and are -C(=O)O- or -OC(=O)-;

wherein when L_1, L_2, L_3, and L_4 are independently selected from -C(=O)NR- or -NRC(=O)-, R is independently selected from H or C_1-C_{10} alkyl.

6. The amino lipid according to any one of claims 1 to 5, wherein in the formula (I), M_1, M_2, M_3, and M_4 are identical or different, M_1 and M_4 are each independently selected from branched-chain C_4-C_{22} alkylene, branched-chain C_4-C_{22} cycloalkylene, branched-chain C_4-C_{22} alkenylene, or branched-chain C_4-C_{22} cycloalkenylene, and M_2 and M_3 are each independently selected from C_4-C_{22} alkylene, C_4-C_{22} cycloalkylene, C_4-C_{22} alkenylene, or C_4-C_{22} cycloalkenylene; and/or

wherein in the formula (I), M_2 is the same as M_3 and is a C_4-C_{22} alkylene; and/or

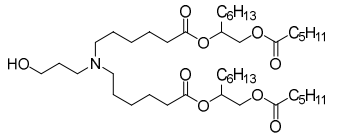
M_1 is the same as M_4, and is a branched-chain C_4-C_{22} alkylene.

7. The amino lipid according to any one of claims 2 to 6, wherein in the formula (I), R^1 and R^2 are identical or different, and each independently selected from C_4-C_{22} alkyl or C_4-C_{22} alkenyl.

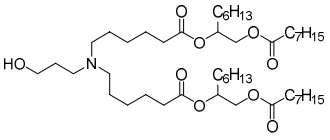
8. The amino lipid according to claim 7, wherein in the formula (I), the R^1-L_1-M_1-L_2-M_2- fragment is R^1-C(=O)O-M_1-OC(=O)-M_2-, the R^2-L_4-M_4-L_3-M_3- fragment is R^2-C(=O)O-M_4-OC(=O)-M_3-.

9. The amino lipid according to claim 8, wherein the structure as shown in formula (I) is

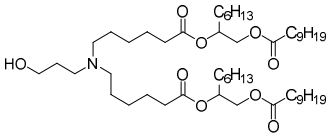
one selected from the following structures:



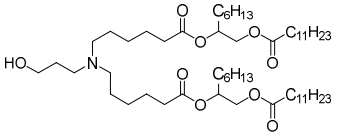
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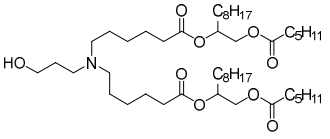
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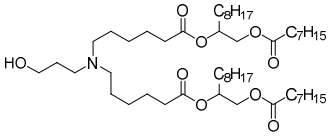
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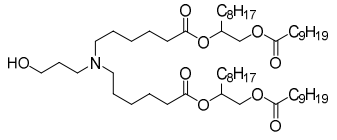
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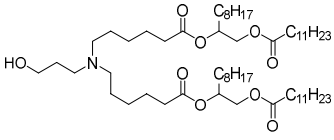
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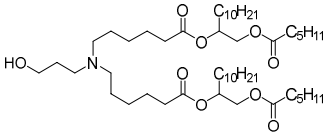
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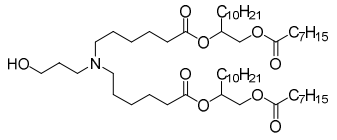
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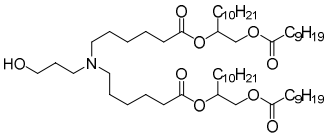
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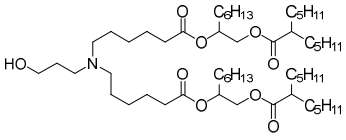
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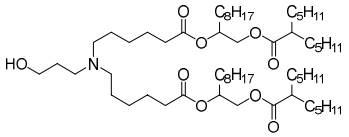
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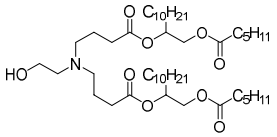
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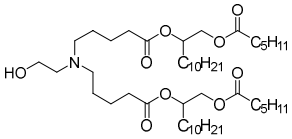
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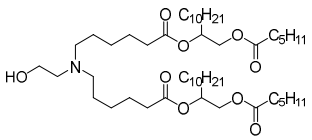
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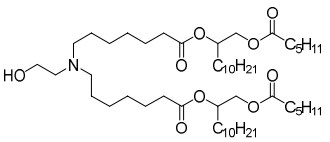
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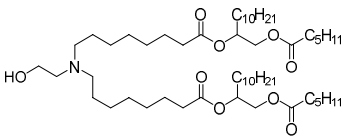
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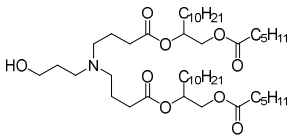
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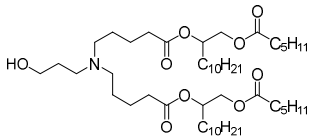
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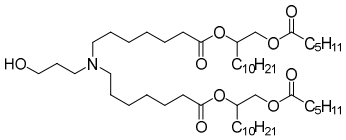
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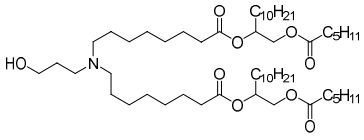
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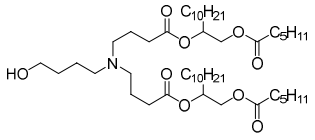
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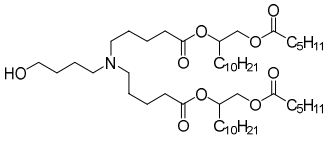
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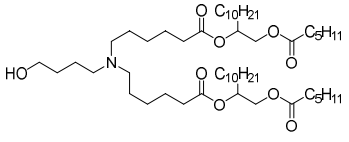
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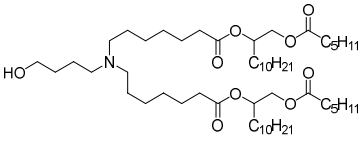
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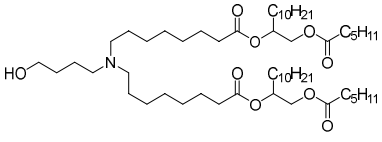
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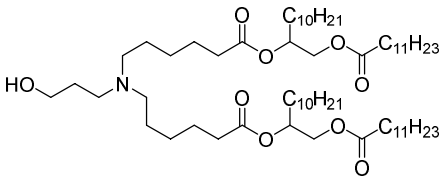
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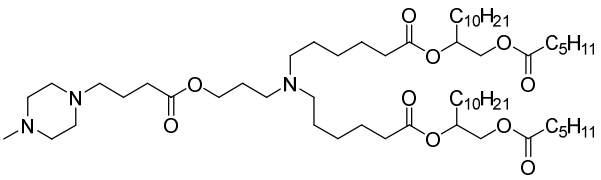
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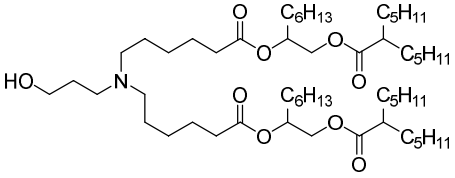
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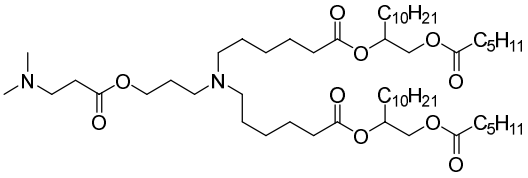
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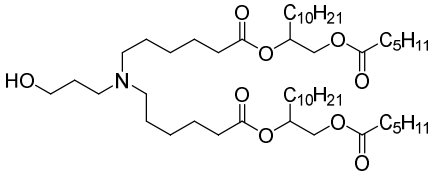
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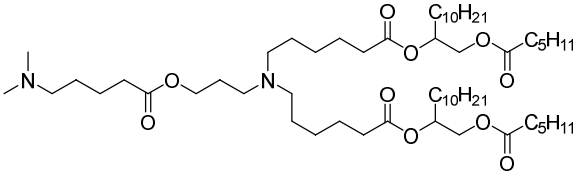
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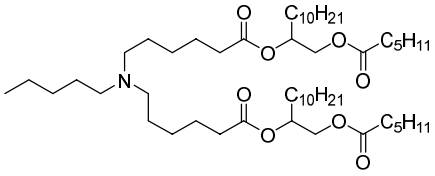
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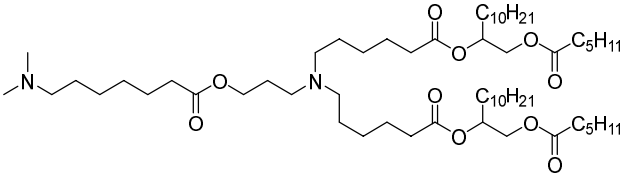
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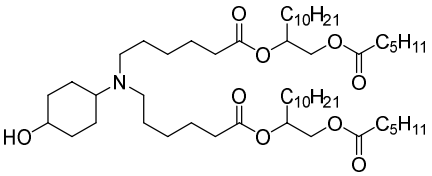
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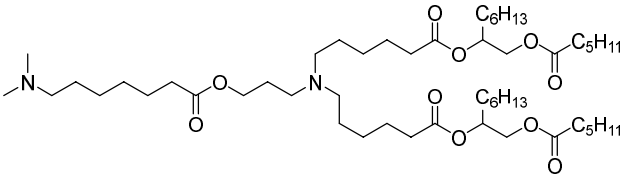
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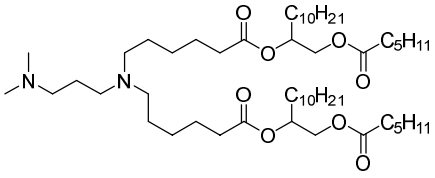
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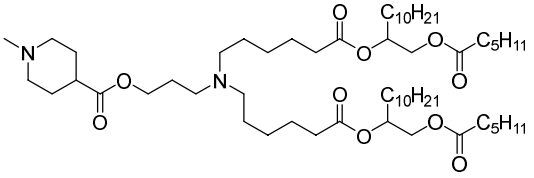
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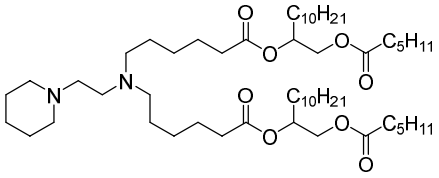
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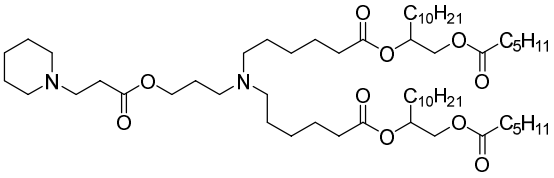
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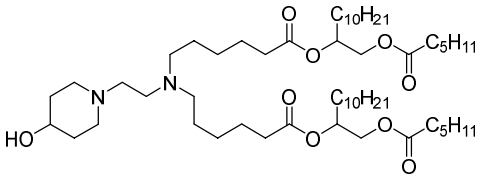
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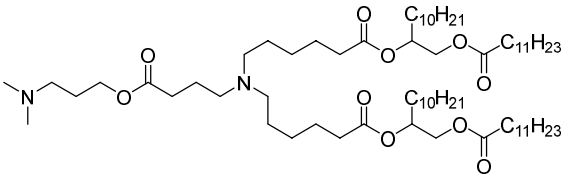
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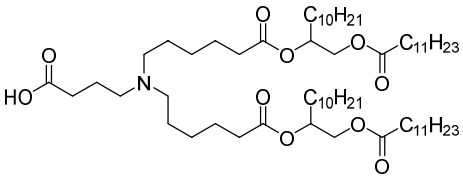
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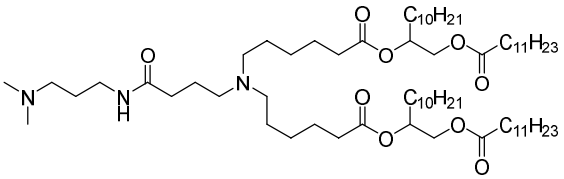
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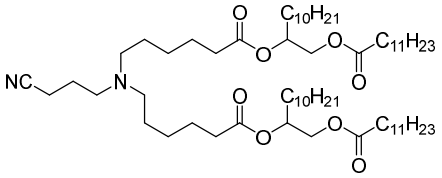
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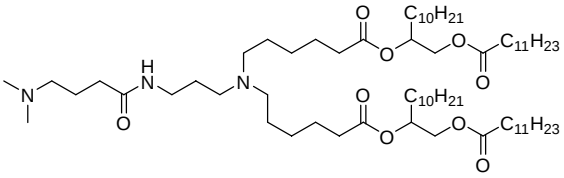
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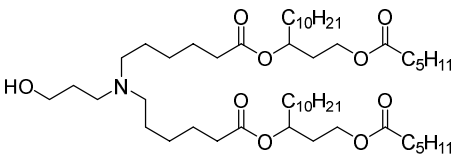
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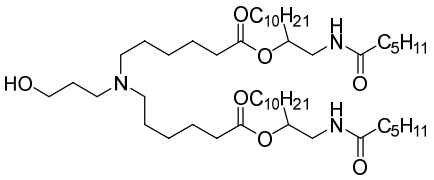
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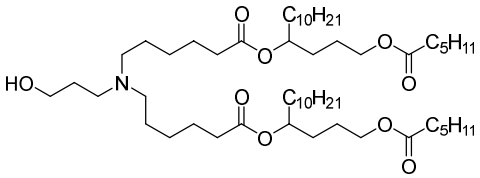
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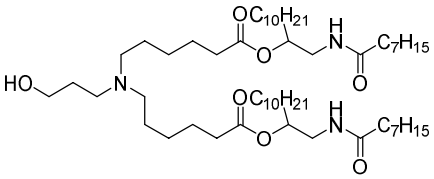
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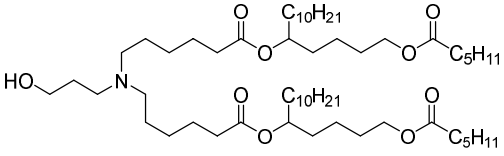
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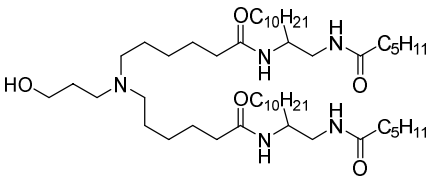
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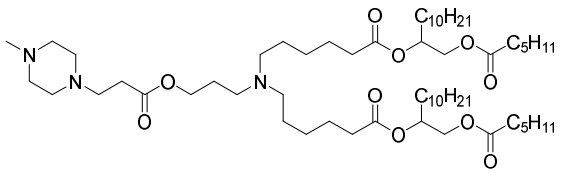
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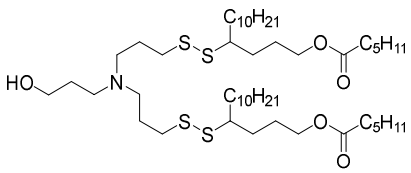


K5LA6B6O3



E12N2LA6B6O3





E12LA6B6O3A2 E12S1LA6B6O3 .

10. A method for preparing the amino lipid according to any one of claims 1 to 9, comprising the following steps:

S1: subjecting an epoxide compound and a carboxylic acid to ring-opening reaction to prepare R^1-L_1-M_1-OH as intermediate 1;

S2: subjecting the intermediate 1 and a carboxylic acid compound as a starting material to a condensation reaction in the presence of a condensation agent to give R^1-L_1-M_1-L_2-M_2-leaving group as intermediate 2; and

S3: subjecting the intermediate 2 and an amino compound as a starting material to one or more substitution reactions, to obtain the target product; or

S1': performing oxidation reaction of a diol undergoing TBS protection, and subjecting the oxidation product and a Grignard reagent to addition reaction, to give HO-M_1-OTBS as intermediate 1';

S2': subjecting the intermediate 1' and a carboxylic acid compound as a starting material to a condensation reaction in the presence of a condensation agent, to give TBSO-M_1-L_2-M_2-leaving group as intermediate 2';

S3': removing the protective group of TBS from the intermediate 2' TBSO-M_1-L_2-M_2-leaving group, allowing the resultant to react with a carboxylic acid to generate R^1-L_1-M_1-L_2-M_2-leaving group as intermediate 2; and

S4': subjecting the intermediate 2 and an amino compound as a starting material to one or more substitution reactions, to obtain the target product.

11. A lipid nanoparticle, comprising the amino lipid according to any one of claims 1 to 9.

12. The lipid nanoparticle according to claim 11, wherein the lipid nanoparticle further comprises a steroid, a neutral lipid and/or a polymer-conjugated lipid;

wherein the polymer-conjugated lipid has a chemical formula of P-Y-L, in which P is a hydrophilic polymer moiety, Y is an optional linker, and L is a lipid moiety;

preferably, the steroid is cholesterol; and/or

the neutral lipid is a phospholipid; and/or

the polymer-conjugated lipid is PEGylated lipids.

13. The lipid nanoparticle according to claim 12, wherein a molar ratio of the amino lipid, the steroid, the neutral lipid, and the polymer-conjugated lipid in the lipid nanoparticles is 30-70:30-65:0-30:0.2-5.

14. A pharmaceutical composition, comprising the lipid nanoparticle according to any one of claims 11 to 13 and a pharmaceutically acceptable carrier.

15. Use of the amino lipid according to any one of claims 1 to 9, the lipid nanoparticle according to any one of claims 11 to 13, or the pharmaceutical composition according to claim 14 in the preparation of a medicament for treating or preventing infectious diseases, cancer, genetic diseases, allergy, toxicity, and autoimmune diseases; or in the preparation of a medicament for gene therapy, genetic vaccination, antisense therapy, delivery of nucleic acids, or treatment through RNA interference;

wherein the cancer includes lung cancer, gastric cancer, liver cancer, esophageal cancer, colon cancer, pancreatic cancer, brain cancer, lymphoma, leukaemia, and prostate cancer.