CLAIMS

1. A delivery vehicle comprising a lipid composition, wherein said lipid composition comprises,
at least one saturated lipid,
at least one unsaturated cationic lipid or at least one unsaturated non-cationic lipid, and
at least one bile salt.

2. The delivery vehicle of claim 1, wherein the at least one unsaturated cationic lipid comprises at least two (2) unsaturated cationic lipids.

3. The delivery vehicle of claim 2, wherein the lipid composition comprises a conjugated lipid.

4. The delivery vehicle of claim 2, wherein the at least two unsaturated cationic lipids comprises at least one of: Dimethyldioctadecylammonium, 1,2-dialkyl-sn-glycero-3-ethylphosphocholine, 1,2-dialkyl-3-dimethylammonium-propane, 1,2-dialkyl-3-trimethylammonium-propane, 1,2-di-O-alkyl-3-trimethylammonium propane, 1,2-dialkyloxy-3-dimethylaminopropane, N,N-dialkyl-N,N-dimethylammonium, N-(4-carboxybenzyl)-N,N-dimethyl-2,3-bis(alkyloxy)propan-1-aminium, 1,2-dialkyl-sn-glycero-3-[(N-(5-amino-1-carboxypentyl)iminodiacetic acid)succinyl], N1-[2-((1S)-1-[(3-aminopropyl)amino]-4-[di(3-amino-propyl)amino]butylcarboxamido)ethyl]-3,4-di[alkyl]-benzamide, 1,2-Dialkyloxy-N,N-dimethylaminopropane, 4-(2,2-diocta-9,12-dienyl-[1,3]dioxolan-4-ylmethyl)-dimethylamine, O-alkyl ethylphosphocholines, 1,2-Dioleyloxy-3-(dimethylamino)propane (DODMA), 6Z,9Z,28Z,31Z)-heptatriaconta-6,9,28,31-tetraen-19-yl 3-(dimethylamino)propanoate (MC2), 3ß-[N-(N',N'-dimethylaminoethane)-carbamoyl]cholesterol, N4-Cholesteryl-Spermine, 7-(4-(dimethylamino)butyl)-7-hydroxytridecane-1,13-diyl dioleate (CL1H6), N 1-[2-((l S)-1-[(3 -aminopropyl)amino]-4-[di(3 amino-propyl)amino]butylcarboxamido)ethyl]-3,4-di[oleyloxy]-benzamide (MVL5) and any combinations thereof.

5. The delivery vehicle of claim 1, wherein the at least one saturated lipid comprises a saturated non-cationic lipid.

6. The delivery vehicle of claim 5, wherein the concentration of the at least one unsaturated cationic lipid or unsaturated non-cationic lipid in the lipid composition is less than 50 mole % of the total lipid concentration of the lipid composition, and wherein the saturated non-cationic lipid that has a phase transition temperature of at least about 37 ºC.

7. The delivery vehicle according to claim 1, wherein the delivery vehicle is stable in a high bile salt environment, compared to an otherwise identical delivery vehicle that does not comprise the bile salt, optionally wherein the high bile salt environment comprises the environment in the gastrointestinal environment.

8. The delivery vehicle of claim 7, wherein the delivery vehicle demonstrates an increased stability in a solution containing at least about 5 g/L of the bile salt, compared to an otherwise identical delivery vehicle that does not comprise the bile salt, wherein the stability is measured by relative fluorescence intensity of a fluorescent lipid incorporated into the lipid nanoparticle, in a Forster resonance energy transfer (FRET) assay.

9. The delivery vehicle of claim 7, wherein the high bile salt environment comprises the environment in the gastrointestinal environment.

10. The delivery vehicle of claim 1, wherein the at least one bile acid comprises at least one of cholic acid, cholate, deoxycholic acid, deoxycholate, hyodeoxycholic acid, hyodeoxycholate, glycocholic acid, glycocholate, taurocholic acid, taurocholate, chenodeoxycholic acid, chenodeoxycholate, lithocholic acid, lithocolate, and the like, or salts thereof. In some embodiments, a bile acid is ursodiol, isolithocholate, alloisolithocholate, dehydrolithochlate, 5-beta-cholanic acid, and any combination thereof.

11. A delivery vehicle comprising a lipid nanoparticle, wherein the lipid nanoparticle comprises,

at least one multivalent cationic lipid,
at least one unsaturated cationic lipid,
at least one structural lipid, and
at least one bile salt.

12. The delivery vehicle of claim 11, wherein the at least one multivalent cationic lipid comprises at least one of MVL5, N4-Cholesteryl-Spermine HCl (GL67), and any combinations thereof.

13. The delivery vehicle of claim 12, wherein the at least one unsaturated cationic lipid comprises at least one of: Dimethyldioctadecylammonium, 1,2-dialkyl-sn-glycero-3-ethylphosphocholine, 1,2-dialkyl-3-dimethylammonium-propane, 1,2-dialkyl-3-trimethylammonium-propane, 1,2-di-O-alkyl-3-trimethylammonium propane, 1,2-dialkyloxy-3-dimethylaminopropane, N,N-dialkyl-N,N-dimethylammonium, N-(4-carboxybenzyl)-N,N-dimethyl-2,3-bis(alkyloxy)propan-1-aminium, 1,2-dialkyl-sn-glycero-3-[(N-(5-amino-1-carboxypentyl)iminodiacetic acid)succinyl], N1-[2-((1S)-1-[(3-aminopropyl)amino]-4-[di(3-amino-propyl)amino]butylcarboxamido)ethyl]-3,4-di[alkyl]-benzamide, 1,2-Dialkyloxy-N,N-dimethylaminopropane, 4-(2,2-diocta-9,12-dienyl-[1,3]dioxolan-4-ylmethyl)-dimethylamine, O-alkyl ethylphosphocholines, DODMA, MC2, 3ß-[N-(N',N'-dimethylaminoethane)-carbamoyl]cholesterol, CL1H6, and any combinations thereof.

14. The delivery vehicle of claim 13, wherein the concentration of the at least one unsaturated cationic lipid is about 50 mole % or less of the total lipid concentration.

15. The delivery vehicle of claim 12, wherein the concentration of the at least one multivalent cationic lipid is about 50 mole % or less of the total lipid concentration.

16. The delivery vehicle of claim 11, wherein the delivery vehicle comprises least one of distearoylphosphatidylcholine (DSPC), phosphatidylcholine l,2-dimyristoyl-sn-glycero-3-phosphocholine (DMPC), 1,2-Distearoyl-sn-glycero-3-phospho-L-serine (DSPS),

dioleoylphosphatidylcholine (DOPC), dipalmitoylphosphatidylcholine (OPEC), dioleoylphospbatidylglycerol (DOPG), dipahnitoylphosphatidylglycerol (DPPG), dioleoyl-phosphatidylethanolamine (DOPE), palmitoyloleoylphosphatidylcholine (POPC), palmitoylolmyl-phosphatidylethanolamine (POPE) and dioleoyl-phosphatidylethanolamine 4-(4-maleimidomethyl)cyelohexane-1-carboxylate (DOPE-teal), dipahnitoyl phosphatidyl ethanolamine (DPPE), dimyristoylphosphoetbanolamine (DMPE), distearoyl-phosphatidylethanolamine (DSPE), 16-O-monomethyl PE, 16-0dimethyl PE, 18-1-trans PE, 1-stearoyl-2-oleoyl-phosphatidyethanolamine (SOPS), 1,2-dielaidoyl-sn-glycero-3-phophoethanolamine (transDOPE), and any combinations thereof.

17. The delivery vehicle of claim 16, wherein the at least one bile acid comprises at least one of cholic acid, cholate, deoxycholic acid, deoxycholate, hyodeoxycholic acid, hyodeoxycholate, glycocholic acid, glycocholate, taurocholic acid, taurocholate, chenodeoxycholic acid, chenodeoxycholate, lithocholic acid, lithocolate, and the like, or salts thereof. In some embodiments, a bile acid is ursodiol, isolithocholate, alloisolithocholate, dehydrolithochlate, 5-beta-cholanic acid, and any combination thereof.

18. The delivery vehicle of claim 17, wherein the concentration of the at least one bile salt is between about 80 mole % to about 10 mole %.

19. The delivery vehicle of claim 11, comprising at least one conjugated lipid.

20. The delivery vehicle according to claim 11, wherein the delivery vehicle is stable in a high bile salt environment, compared to an otherwise identical delivery vehicle that does not comprise the bile salt wherein the stability is measured by relative fluorescence intensity of a fluorescent lipid incorporated into the lipid nanoparticle, in a FRET assay.