CLAIMS:

1. A nanoparticle complex comprising

(a) a lipid nanoparticle comprising a surface component;

(b) a bifunctional binder comprising

(i) a self-binder moiety non-covalently binding to the surface component, wherein the lipid nanoparticle comprises an ionizable lipid, a helper lipid, a PEG-modified lipid, and a cholesterol-based lipid; and the surface component is the PEG-modified lipid;

(ii) a target-binder moiety capable of binding to a targeted cell-surface component of a target cell,

wherein the self-binder moiety is linked to the target-binder moiety, and the self-binder moiety is a first antigen binding fragment specifically binding to the surface component; and the first antigen binding fragment specifically binds to PEG; and

(c) a cargo carried by the lipid nanoparticle.

2. The nanoparticle complex of claim 1, wherein the cargo is one or more nucleic acid molecules.

3. The nanoparticle complex of claim 1 or 2, wherein the cargo is DNA or RNA.

4. The nanoparticle complex of any one of claims 1-3, wherein the cargo is an RNA selected from a group consisting of a circular RNA, a mRNA, a noncoding RNA, a dsRNA, a miRNA, an siRNA and a tRNA; preferably the RNA is a circular RNA.

5. The nanoparticle complex of any one of claims 1-4, wherein the ionizable lipid is a cationic lipid selected from the group consisting of HGT4003, HGT5000, HGT5001, HGT5002, DOTMA, DOGS, DOSPA, DOTAP, DODAP, DOTMA, DSDMA, DODMA, DLinDMA, DLenDMA, DODAC, DDAB, DMRIE, CLinDMA, CpLinDMA, DMOBA, DOcarbDAP, DLinDAP, DLincarbDAP, DLinCDAP, DLin-K-XTC2-DMA, DLin-KC2-DMA, AA3-DLinXTC, ALNY-100, NC98-5, C12-200, MC2, MC3, MC4, ALC-0315, SM-102, ATX-001, ATX-100, Lipid 2, Lipid 5, 9A1P9, OF-Deg-Lin, 80-O16B, 93-O17S, 93-O17O, 306-O12B, 113-O16B, 306Oi10, 113-O12B, cKK-E12, 98N12-5, OF-02, TLC053, LP01, BAMEA-O16B, CL1, BP Lipid 310, Lipid A9, L319, and ICE.

6. The nanoparticle complex of any one of claims 1-5, wherein the helper lipid is a non-cationic lipid selected from the group consisting of DSPC, DOPC, DPPC, DOPG, DPPG, DOPE, POPC, POPE, POPG, DEPE, Egg sphingomyelin, DOPE-mal, DPPE, DMPE, DSPE, 16-O-monomethyl PE, 16-O-dimethyl PE, 18-1-trans PE and SOPE.

7. The nanoparticle complex of any one of claims 1-6, wherein the PEG-modified lipid is a polyethylene glycol (PEG) chain covalently attached to a lipid with alkyl chain of C_6-C_{20} length, wherein the PEG chain is of 100-20000 Da.

8. The nanoparticle complex of any one of claims 1-7, wherein the PEG-modified lipid is a glycol (PEG)-modified phospholipid or ceramide, or a combination thereof.

9. The nanoparticle complex of one of claims 1-8, wherein the PEG-modified lipid is DMG-PEG2000, DSPE-PEG2000 or a combination thereof.

10. The nanoparticle complex of any one of claims 1-9, wherein the cholesterol-based lipid is selected from cholesterol, hydroxy cholesterol and its derivatives, DC-cholesterol HCl, HAPC-Cholesterol, MHAPC-Cholesterol, DMHAPC-Cholesterol, DMPAC-Cholesterol, GL-67, LC-10, PEGylated cholesterol or their derivatives, DC-Choi, l,4-bis(3-N-oleylamino-propyl) piperazine, ICE, Vit D2, Vit D3, Calcipotriol, Stigmasterol, b-sitosterol, betulin, lupeol, ursolic acid, oleanolic, lipid derivatives of cholesterol lipid where the lipid could be myristate, oleate, nervonate or hemisuccinate.

11. The nanoparticle complex of any one of claims 1-10, wherein the lipid nanoparticle comprises

(1) ALC-0315, cholesterol, DOPE and DMG-PEG2000; or

(2) ALC-0315, cholesterol, DSPC, DMG-PEG2000 and DSPE-PEG2000; or

(3) SM102, cholesterol, DOPE, DMG-PEG2000, DSPE-PEG2000 and 18:1PG; or

(4) Lipid5, cholesterol, DSPC, DMG-PEG2000, DSPE-PEG2000 and 18:1PG; or

(5) SM102, cholesterol, DSPC and DMG-PEG2000.

12. The nanoparticle complex of any one of claims 1-11, wherein the first antigen binding fragment specifically binds to the methoxy group of PEG or the backbone of PEG.

13. The nanoparticle complex of one of claims 1-12, wherein the first antigen binding fragment is derived from an IgG, an IgA, an IgM, an IgE or an IgD.

14. The nanoparticle complex of one of claim 12, wherein the first antigen binding fragment is a Fab, a VHH antibody, an scFv, an scFab, or a diabody.
15. The nanoparticle complex of any one of claims 1-14, wherein the target-binder moiety is an Fc or a fragment thereof of an IgG, an IgA, an IgM, an IgE or an IgD.
16. The nanoparticle complex of any one of claims 1-15, wherein the targeted cell-surface component of the target cell is a protein, a glycoRNA, a lipid or lipid raft.
17. The nanoparticle complex of claim 16, wherein the protein is a receptor selected from the group consisting of an Fc receptor, FcgR1, FcgR2, FCgr3, FcgR4, FceR1, FceR2, FcaR1, FcuR, FcdR, or an isoform thereof, or C1qR or FcRn.
18. The nanoparticle complex of claim 16, wherein the protein is a receptor selected from the group consisting of CD2, CD3, CD4, CD5, CD7, CD8, CD25, CD45RA, CD45RO, CTLA4 and PD-L1.
19. The nanoparticle complex of any one of claims 1-18, wherein the target cell is an antigen presenting cell, a monocyte, a neutrophil, a macrophage, a dendritic cell, a mast cell, a T cell, a natural killer cell, a Kupffer cell, a B cell or a tumor cell.
20. The nanoparticle complex of claim 19, wherein the T cell is a CD3+ T cell, a CD4+ T cell, a CD8+ T cell, a T regulatory cell, a cytotoxic T cell, or a helper T cell.
21. The nanoparticle complex of any one of claims 1-20, wherein the target-binder moiety is a second antigen binding fragment specifically binding to the receptor.
22. The nanoparticle complex of claim 21, wherein the second antigen binding fragment is a Fab, a VHH antibody, an scFv, an scFab, or a diabody.
23. The nanoparticle complex of any one of claims 1-22, wherein the self-binder moiety is covalently linked to the target-binder moiety.
24. The nanoparticle complex of any one of claims 1-23, wherein the self-binder moiety is linked to the target-binder moiety via a linker.
25. The nanoparticle complex of claim 24, wherein the linker comprises an Fc or a fragment thereof.
26. The nanoparticle complex of claim 25, wherein the linker comprises a multimerization domain.

27. The nanoparticle complex of one of claims 1-26, wherein the self-binder moiety is non-covalently linked to the target-binder moiety.

28. The nanoparticle complex of one of claims 1-27, wherein the nanoparticle complex has at least one of the functions as following, compared to a reference nanoparticle complex:

(a) substantially avoids or reduces uptake by hepatocytes,

(b) substantially contacts cells displaying the targeted cell-surface component of the target cell, and

(c) substantially decreases accelerated blood clearance of the nanoparticle complex,

wherein the reference nanoparticle complex is a nanoparticle complex without the bifunctional binder.

29. A pharmaceutical composition, comprising the nanoparticle complex of any one of claims 1-28 and a pharmaceutically acceptable carrier.

30. The pharmaceutical composition of claim 29, wherein the lipid nanoparticle and the bifunctional binder are packaged in different containers.

31. A method of delivering a cargo molecule to a target cell in a subject, comprising administering to the subject the nanoparticle complex of any one of claims 1-28.