WHAT IS CLAIMED IS:

1. An antibody that binds to human transferrin receptor, comprising a heavy chain variable region (VH) comprising VH complementarity determining region (CDR)1, VH CDR2, and VH CDR3, wherein:

the VH CDR1 comprises the amino acid sequence GIDFSSSGYMX (SEQ ID NO:149), wherein X is any amino acid;

the VH CDR2 comprises the amino acid sequence XIYTYSSNTYYAXXXKG (SEQ ID NO:151), wherein X is any amino acid; and

the VH CDR3 comprises the amino acid sequence GTYGYTGYTYTMGYFSL (SEQ ID NO:106); and

wherein the antibody comprises a light chain variable region (VL) comprising VL CDR1, VL CDR2, and VL CDR3, wherein:

the VL CDR1 comprises the amino acid sequence QASQNINSYLA (SEQ ID NO:107);

the VL CDR2 comprises the amino acid sequence RASXLXS (SEQ ID NO:153), wherein X is any amino acid; and

the VL CDR3 comprises the amino acid sequence QSYYYSGSSNYNA (SEQ ID NO:110).

2. The antibody of claim 1, wherein:

the VH CDR1 comprises the amino acid sequence GIDFSSSGYMX$_1$ (SEQ ID NO:150), wherein X$_1$ is C, A, or H;

the VH CDR2 comprises the amino acid sequence X$_2$IYTYSSNTYYAX$_3$X$_4$X$_5$KG (SEQ ID NO:152), wherein X$_2$ is C or A, wherein X$_3$ is S or A, wherein X$_4$ is W or S, and wherein X$_5$ is A or V;

the VH CDR3 comprises the amino acid sequence GTYGYTGYTYTMGYFSL (SEQ ID NO:106);

the VL CDR1 comprises the amino acid sequence QASQNINSYLA (SEQ ID NO:107);

the VL CDR2 comprises the amino acid sequence RASX$_6$LX$_7$S (SEQ ID NO:154), wherein X$_6$ is T or S, and wherein X$_7$ is A or E; and

the VL CDR3 comprises the amino acid sequence QSYYYSGSSNYNA (SEQ ID NO:110).

3. The antibody of claim 1, wherein the VH-CDR1, the VH-CDR2, and the VH-CDR3 each correspond to the VH CDRs set forth in Fig. 1A for a single VH clone, and wherein the VL-CDR1, the VL-CDR2, and the VL-CDR3 each correspond to the VL CDRs set forth in Fig. 1C for a single VL clone.

4. The antibody of claim 1, wherein the VH-CDR1, the VH-CDR2, the VH-CDR3, the VL-CDR1, the VL-CDR2, and the VL-CDR3 each correspond to the VH and VL CDRs set forth in Table 1A for a single clone.

5. The antibody of claim 1, wherein:

(a) the VH CDR1 comprises the amino acid sequence GIDFSSSGYMC (SEQ ID NO:101); the VH CDR2 comprises the amino acid sequence CIYTYSSNTYYASWAKG (SEQ ID NO:104); the VH CDR3 comprises the amino acid sequence GTYGYTGYTYTMGYFSL (SEQ ID NO:106); the VL CDR1 comprises the amino acid sequence QASQNINSYLA (SEQ ID NO:107); the VL CDR2 comprises the amino acid sequence RASTLAS (SEQ ID NO:109); and the VL CDR3 comprises the amino acid sequence QSYYYSGSSNYNA (SEQ ID NO:110);

(b) the VH CDR1 comprises the amino acid sequence GIDFSSSGYMH (SEQ ID NO:102); the VH CDR2 comprises the amino acid sequence AIYTYSSNTYYASWAKG (SEQ ID NO:105); the VH CDR3 comprises the amino acid sequence GTYGYTGYTYTMGYFSL (SEQ ID NO:106); the VL CDR1 comprises the amino acid sequence QASQNINSYLA (SEQ ID NO:107); the VL CDR2 comprises the amino acid sequence RASSLES (SEQ ID NO:108); and the VL CDR3 comprises the amino acid sequence QSYYYSGSSNYNA (SEQ ID NO:110);

(c) the VH CDR1 comprises the amino acid sequence GIDFSSSGYMC (SEQ ID NO:101); the VH CDR2 comprises the amino acid sequence CIYTYSSNTYYAASVKG (SEQ ID NO:103); the VH CDR3 comprises the amino acid sequence GTYGYTGYTYTMGYFSL (SEQ ID NO:106); the VL CDR1 comprises the amino acid sequence QASQNINSYLA (SEQ ID NO:107); the VL CDR2 comprises the amino acid sequence RASSLES (SEQ ID NO:108); and the VL CDR3 comprises the amino acid sequence QSYYYSGSSNYNA (SEQ ID NO:110); or

(d) the VH CDR1 comprises the amino acid sequence GIDFSSSGYMC (SEQ ID NO:101); the VH CDR2 comprises the amino acid sequence CIYTYSSNTYYASWAKG (SEQ ID NO:104); the VH CDR3 comprises the amino acid sequence GTYGYTGYTYTMGYFSL (SEQ ID NO:106); the VL CDR1 comprises the amino acid sequence QASQNINSYLA (SEQ ID NO:107); the VL CDR2 comprises the amino acid sequence RASSLES (SEQ ID NO:108); and the VL CDR3 comprises the amino acid sequence QSYYYSGSSNYNA (SEQ ID NO:110).

6. The antibody of any one of the preceding claims, wherein:

(i) the VH is at least 80%, 85%, 90%, 95%, 99%, or 100% identical to any one of SEQ ID NOs:12, or 15-18; and

(ii) the VL is at least 80%, 85%, 90%, 95%, 99%, or 100% identical to any one of SEQ ID NOs:35-37.

7. The antibody of claim 1, wherein the VH comprises the amino acid sequence of any one of SEQ ID NOs:4, 12, or 15-18 and the VL comprises the amino acid sequence of SEQ ID NOs:34-37.

8. The antibody of claim 1, wherein:

(a) the VH comprises the amino acid sequence of SEQ ID NO:4 and the VL comprises the amino acid sequence of SEQ ID NO:34;

(b) the VH comprises the amino acid sequence of SEQ ID NO:12 and the VL comprises the amino acid sequence of SEQ ID NO:35;

(c) the VH comprises the amino acid sequence of SEQ ID NO:15 and the VL comprises the amino acid sequence of SEQ ID NO:35;

(d) the VH comprises the amino acid sequence of SEQ ID NO:16 and the VL comprises the amino acid sequence of SEQ ID NO:35;

(e) the VH comprises the amino acid sequence of SEQ ID NO:17 and the VL comprises the amino acid sequence of SEQ ID NO:35; or

(f) the VH comprises the amino acid sequence of SEQ ID NO:18 and the VL comprises the amino acid sequence of SEQ ID NO:35.

9. An antibody that binds to human transferrin receptor and competes for binding to human transferrin receptor with an antibody comprising:

(a) a VH comprising the amino acid sequence of SEQ ID NO:4 and a VL comprising the amino acid sequence of SEQ ID NO:34;

(b) a VH comprising the amino acid sequence of SEQ ID NO:12 and a VL comprising the amino acid sequence of SEQ ID NO:35;

(c) a VH comprising the amino acid sequence of SEQ ID NO:15 and a VL comprising the amino acid sequence of SEQ ID NO:35;

(d) a VH comprising the amino acid sequence of SEQ ID NO:16 and a VL comprising the amino acid sequence of SEQ ID NO:35;

(e) a VH comprising the amino acid sequence of SEQ ID NO:17 and a VL comprising the amino acid sequence of SEQ ID NO:35; or

(f) a VH comprising the amino acid sequence of SEQ ID NO:18 and a VL comprising the amino acid sequence of SEQ ID NO:35.

10. An antibody that binds to human transferrin receptor, comprising a heavy chain variable region (VH) comprising VH complementarity determining region (CDR)1, VH CDR2, and VH CDR3, wherein:

the VH CDR1 comprises the amino acid sequence GFSFSNSYWIX (SEQ ID NO:155), wherein X is any amino acid;

the VH CDR2 comprises the amino acid sequence XINTDADSTNYAXXXXG (SEQ ID NO:157), wherein X is any amino acid; and

the VH CDR3 comprises the amino acid sequence QNNVFDPGYNL (SEQ ID NO:119); and

wherein the antibody comprises a light chain variable region (VL) comprising VL CDR1, VL CDR2, and VL CDR3, wherein:

the VL CDR1 comprises the amino acid sequence XASQNIGSNLA (SEQ ID NO:159);

the VL CDR2 comprises the amino acid sequence DASKLXS (SEQ ID NO:161), wherein X is any amino acid; and

the VL CDR3 comprises the amino acid sequence QXTVRGGAYGXA (SEQ ID NO:163), wherein X is any amino acid.

11. The antibody of claim 10, wherein:

the VH CDR1 comprises the amino acid sequence GFSFSNSYWIX_1 (SEQ ID NO:156), wherein X_1 is C, A, or H;

the VH CDR2 comprises the amino acid sequence X_2INTDADSTNYA$X_3X_4X_5X_6$G (SEQ ID NO:158), wherein X_2 is C or A, wherein X_3 is S or D, wherein X_4 is W or S, wherein X_5 is A or V, and wherein X_6 is R or K;

the VH CDR3 comprises the amino acid sequence QNNVFDPGYNL (SEQ ID NO:119);

the VL CDR1 comprises the amino acid sequence X_7ASQNIGSNLA (SEQ ID NO:160), wherein X_7 is Q or R;

the VL CDR2 comprises the amino acid sequence DASKLX_8S (SEQ ID NO:162), wherein X_8 is A or E; and

the VL CDR3 comprises the amino acid sequence QX_9TVRGGAYGX_{10}A (SEQ ID NO:164), wherein X_9 is C, Q, A, S, T, or V, and wherein X_{10} is N or L.

12. The antibody of claim 10, wherein the VH-CDR1, the VH-CDR2, and the VH-CDR3 each correspond to the VH CDRs set forth in Fig. 1B for a single VH clone, and wherein the VL-CDR1, the VL-CDR2, and the VL-CDR3 each correspond to the VL CDRs set forth in Fig. 1D for a single VL clone.

13. The antibody of claim 10, wherein the VH-CDR1, the VH-CDR2, the VH-CDR3, the VL-CDR1, the VL-CDR2, and the VL-CDR3 each correspond to the VH and VL CDRs set forth in Table 2A for a single clone.

14. The antibody of claim 10, wherein:

(a) the VH CDR1 comprises the amino acid sequence GFSFSNSYWIC (SEQ ID NO:116); the VH CDR2 comprises the amino acid sequence CINTDADSTNYASWARG (SEQ ID NO:117); the VH CDR3 comprises the amino acid sequence QNNVFDPGYNL (SEQ ID NO:119); the VL CDR1 comprises the amino acid sequence QASQNIGSNLA (SEQ ID NO:121); the VL CDR2 comprises the amino acid sequence DASKLAS (SEQ ID NO:123); and the VL CDR3 comprises the amino acid sequence QCTVRGGAYGNA (SEQ ID NO:124);

(b) the VH CDR1 comprises the amino acid sequence GFSFSNSYWIC (SEQ ID NO:116); the VH CDR2 comprises the amino acid sequence CINTDADSTNYADSVKG (SEQ ID NO:118); the VH CDR3 comprises the amino acid sequence QNNVFDPGYNL (SEQ ID NO:119); the VL CDR1 comprises the amino acid sequence RASQNIGSNLA (SEQ ID NO:120); the VL CDR2 comprises the amino acid sequence DASKLES (SEQ ID NO:122); and the VL CDR3 comprises the amino acid sequence QCTVRGGAYGNA (SEQ ID NO:124);

(c) the VH CDR1 comprises the amino acid sequence GFSFSNSYWIC (SEQ ID NO:116); the VH CDR2 comprises the amino acid sequence CINTDADSTNYASWARG (SEQ ID NO:117); the VH CDR3 comprises the amino acid sequence QNNVFDPGYNL (SEQ ID NO:119); the VL CDR1 comprises the amino acid sequence RASQNIGSNLA (SEQ ID NO:120); the VL CDR2 comprises the amino acid sequence DASKLES (SEQ ID NO:122); and the VL CDR3 comprises the amino acid sequence QCTVRGGAYGNA (SEQ ID NO:124);

(d) the VH CDR1 comprises the amino acid sequence GFSFSNSYWIC (SEQ ID NO:116); the VH CDR2 comprises the amino acid sequence CINTDADSTNYASWARG (SEQ ID NO:117); the VH CDR3 comprises the amino acid sequence QNNVFDPGYNL (SEQ ID NO:119); the VL CDR1 comprises the amino acid sequence RASQNIGSNLA (SEQ ID NO:120); the VL CDR2 comprises the amino acid sequence DASKLES (SEQ ID NO:122); and the VL CDR3 comprises the amino acid sequence QSTVRGGAYGNA (SEQ ID NO:125);

(e) the VH CDR1 comprises the amino acid sequence GFSFSNSYWIC (SEQ ID NO:116); the VH CDR2 comprises the amino acid sequence CINTDADSTNYASWARG (SEQ ID NO:117); the VH CDR3 comprises the amino acid sequence QNNVFDPGYNL (SEQ ID NO:119); the VL CDR1 comprises the amino acid sequence RASQNIGSNLA (SEQ ID NO:120); the VL CDR2 comprises the amino acid sequence DASKLES (SEQ ID NO:122); and the VL CDR3 comprises the amino acid sequence QTTVRGGAYGNA (SEQ ID NO:126); or

(f) the VH CDR1 comprises the amino acid sequence GFSFSNSYWIC (SEQ ID NO:116); the VH CDR2 comprises the amino acid sequence CINTDADSTNYASWARG (SEQ ID NO:117); the VH CDR3 comprises the amino acid sequence QNNVFDPGYNL (SEQ ID NO:119); the VL CDR1 comprises the amino acid sequence RASQNIGSNLA (SEQ ID NO:120); the VL CDR2 comprises the amino acid sequence DASKLES (SEQ ID NO:122); and the VL CDR3 comprises the amino acid sequence QVTVRGGAYGNA (SEQ ID NO:127).

15. The antibody of any one of claims 10-14, wherein:

(i) the VH is at least 80%, 85%, 90%, 95%, 99%, or 100% identical to any one of SEQ ID NOs:30-33; and

(ii) the VL is at least 80%, 85%, 90%, 95%, 99%, or 100% identical to any one of SEQ ID NOs:41-44.

16. The antibody of claim 10, wherein the VH comprises the amino acid sequence of any one of SEQ ID NOs:30-33 and the VL comprises the amino acid sequence of any one of SEQ ID NOs: 41-44.

17. The antibody of claim 10, wherein:

(a) the VH comprises the amino acid sequence of SEQ ID NO:19 and the VL comprises the amino acid sequence of SEQ ID NO:38;

(b) the VH comprises the amino acid sequence of SEQ ID NO:30 and the VL comprises the amino acid sequence of SEQ ID NO:41;

(c) the VH comprises the amino acid sequence of SEQ ID NO:31 and the VL comprises the amino acid sequence of SEQ ID NO:41;

(d) the VH comprises the amino acid sequence of SEQ ID NO:32 and the VL comprises the amino acid sequence of SEQ ID NO:41;

(e) the VH comprises the amino acid sequence of SEQ ID NO:33 and the VL comprises the amino acid sequence of SEQ ID NO:41;

(f) the VH comprises the amino acid sequence of SEQ ID NO:33 and the VL comprises the amino acid sequence of SEQ ID NO:42;

(g) the VH comprises the amino acid sequence of SEQ ID NO:33 and the VL comprises the amino acid sequence of SEQ ID NO:43; or

(h) the VH comprises the amino acid sequence of SEQ ID NO:33 and the VL comprises the amino acid sequence of SEQ ID NO:44.

18. An antibody that binds to human transferrin receptor and competes for binding to human transferrin receptor with an antibody comprising:

(a) a VH comprising the amino acid sequence of SEQ ID NO:19 and a VL comprising the amino acid sequence of SEQ ID NO:38;

(b) a VH comprising the amino acid sequence of SEQ ID NO:30 and a VL comprising the amino acid sequence of SEQ ID NO:41;

(c) a VH comprising the amino acid sequence of SEQ ID NO:31 and a VL comprising the amino acid sequence of SEQ ID NO:41;

(d) a VH comprising the amino acid sequence of SEQ ID NO:32 and a VL comprising the amino acid sequence of SEQ ID NO:41;

(e) a VH comprising the amino acid sequence of SEQ ID NO:33 and a VL comprising the amino acid sequence of SEQ ID NO:41;

(f) a VH comprising the amino acid sequence of SEQ ID NO:33 and a VL comprising the amino acid sequence of SEQ ID NO:42;

(g) a VH comprising the amino acid sequence of SEQ ID NO:33 and a VL comprising the amino acid sequence of SEQ ID NO:43; or

(h) a VH comprising the amino acid sequence of SEQ ID NO:33 and a VL comprising the amino acid sequence of SEQ ID NO:44.

19. The antibody of any one of claims 1 to 18, which is an Fab fragment or an Fab' fragment.

20. The antibody of any one of claims 1 to 18, which is a bispecific antibody, single chain antibody, an Fab fragment, an $F(ab')_2$ fragment, an Fab' fragment, an Fsc fragment, an Fv fragment, an scFv, an $sc(Fv)_2$, or a diabody.

21. The antibody of any one of claims 1 to 19, comprising a constant heavy chain (CH) domain and a constant light chain (CL) domain.

22. The antibody of claim 21, wherein the CH domain comprises a CH1 domain comprising the amino acid sequence set forth in any one of SEQ ID NOs:45-52.

23. The antibody of claim 22, wherein the CH1 domain comprises the amino acid sequence set forth in any one of SEQ ID NOs:45, 47, and 49.

24. The antibody of claim 23, wherein the CH1 domain is fused to a hinge comprising the amino acid sequence set forth in any one of SEQ ID NOs:53-55 and 57.

25. The antibody of claim 22, wherein the CH1 domain comprises the amino acid sequence set forth in SEQ ID NO:51.

26. The antibody of claim 25, wherein the CH1 domain is fused to a hinge comprising the amino acid sequence ES or the amino acid sequence set forth in SEQ ID NO:56.

27. The antibody of claim 23 or 25, wherein the CH1 domain is fused to a hinge comprising the amino acid sequence ES, ESK, or the amino acid sequence set forth in any one of SEQ ID NOs: 53-90.

28. The antibody of any one of claims 21 to 27, wherein the CL domain comprises the amino acid sequence set forth in SEQ ID NO:91 or 92.

29. The antibody of claim 21, wherein the antibody comprises:

(i) a heavy chain comprising the amino acid sequence set forth in SEQ ID NO:93, and a light chain comprising the amino acid sequence set forth in SEQ ID NO:94;

(ii) a heavy chain comprising the amino acid sequence set forth in SEQ ID NO:95, and a light chain comprising the amino acid sequence set forth in SEQ ID NO:96;

(iii) a heavy chain comprising the amino acid sequence set forth in SEQ ID NO:97, and a light chain comprising the amino acid sequence set forth in SEQ ID NO:96;

(iv) a heavy chain comprising the amino acid sequence set forth in SEQ ID NO:98, and a light chain comprising the amino acid sequence set forth in SEQ ID NO:96; or

(v) a heavy chain comprising the amino acid sequence set forth in SEQ ID NO:99, and a light chain comprising the amino acid sequence set forth in SEQ ID NO:100.

30. A nucleic acid or nucleic acids encoding the antibody of any one of claims 1 to 29.

31. An expression vector or expression vectors comprising the nucleic acid or nucleic acids of claim 30 operably linked to a promoter.

32. An isolated cell comprising the nucleic acid or nucleic acids of claim 30 or the expression vector or expression vectors of claim 31.

33. An isolated cell comprising a first expression vector comprising a first nucleic acid encoding a first polypeptide comprising the VH of the antibody of any one of claims 1 to 20 operably linked to a promoter, and a second expression vector comprising a second nucleic acid encoding a second polypeptide comprising the VL of the antibody of any one of claims 1 to 20 operably linked to a promoter.

34. A method of making the antibody of any one of claims 1 to 29, comprising culturing the cell of claim 32 or 33 and isolating the antibody.

35. A pharmaceutical composition comprising the antibody of any one of claims 1 to 29 and a pharmaceutically acceptable carrier.

36. A conjugate comprising the antibody of any one of claims 1 to 29 and an agent.

37. The conjugate of claim 36, wherein the agent is a nucleic acid.

38. The conjugate of claim 37, wherein the nucleic acid is an mRNA, a siRNA, an antisense oligonucleotide, microRNA (miRNA), guide RNA (gRNA), or a phosphoroamidate morpholino oligomer (PMO).

39. The conjugate of claim 37, wherein the nucleic acid is an antisense oligonucleotide.

40. The conjugate of any one of claims 36 to 39, wherein the agent is linked to the antibody via a linker.

41. Use of the conjugate of any one of claims 36 to 40 in the manufacture of a medicament for treating a disease in a human subject, wherein

(a) the human subject has a muscular disease, a muscular atrophy disease, an arteriosclerotic disease, a cardiac-related disease, or a lysosomal storage disease, and the conjugate is to be delivered to muscle tissue;

(b) the human subject has a brain disease and the conjugate is to be delivered to brain tissue;

(c) the human subject has a hepatic disease and the conjugate is to be delivered to hepatocytes;

(d) the human subject has cancer and the conjugate is to be delivered to tumor cells; or

(e) the human subject has an immune condition and the conjugate is to be delivered to immune cells.