

WHAT IS CLAIMED

1. A polypeptide comprising an amino acid sequence that is at least 70%, 75%, 80%, 85%, or 90% identical to the amino acid sequence of SEQ ID NO: 273.
2. The polypeptide of claim 1, wherein the polypeptide comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 1-7, 10, 12-219, 221-272, 292-299, or 304-306.
3. The polypeptide of claim 2, wherein the polypeptide comprises two of SEQ ID NOs: 1-7, 10, 12-219, 221-272, 292-299, or 304-306.
4. A polypeptide that binds to human CD71 at a site on CD71 that does not compete with transferrin binding to CD71 wherein the polypeptide comprises an amino acid sequence that is at least 70%, 75%, 80%, 85%, or 90% identical to a polypeptide having the sequence of any one of SEQ ID NO: 273, 1-7, 10, 12-219, 221-272, 292-299, or 304-306.
5. The polypeptide of claim 4, wherein the polypeptide comprises the sequence of SEQ ID NO: 209.
6. The polypeptide of any one of claims 1-5, wherein the polypeptide is conjugated to a detectable label, an oligonucleotide, a therapeutic agent, or any combination thereof.
7. The polypeptide of claim 6, wherein the detectable label is a radioactive isotope, magnetic beads, metallic beads, colloidal particles, a fluorescent dye, an electron-dense reagent, an enzyme, biotin, digoxigenin, or hapten.
8. The polypeptide of claims 6-7, wherein the detectable label is auristatin, monomethyl auristatin phenylalanine, dolostatin, chemotherapeutic agent, a drug, a growth inhibitory agent, a toxin, or a radioactive isotope.
9. The polypeptide of claim 6, wherein the therapeutic agent is a chemotherapeutic agent, a drug, an antibody, a growth inhibitory agent, a toxin, a radioactive isotope, an anti-tubulin agent, a polynucleotide, a siRNA molecule or sense or antisense strand thereof, an antisense molecule or a strand thereof, a RNA molecule, a DNA molecule, DNA minor groove binders, DNA replication inhibitors, alkylating agents, antibiotics, antifolates, antimetabolites, chemotherapy sensitizers, topoisomerase inhibitors, or a vinca alkaloid.
10. The polypeptide of claim 6, wherein the therapeutic agent can elicit one or more cytotoxic effects by modulating gene expression, RNA expression or levels, tubulin

- binding, DNA binding, topoisomerase inhibition, DNA cross linking, chelation, spliceosome inhibition, NAMPT inhibition, or HDAC inhibition.
11. The polypeptide of any of claims 1-10, further comprising a methionine at the N-terminus of the polypeptide.
 12. The polypeptide of any of claims 1-11, wherein the polypeptide is coupled to a half-life extending moiety.
 13. The polypeptide of claim 12, wherein the half-life extending moiety is an albumin binding molecule, a polyethylene glycol (PEG), albumin, albumin variant, at least a portion of an Fc region of an immunoglobulin.
 14. The polypeptide of claim 13, wherein the albumin binding molecule is a second polypeptide that binds albumin or an albumin variant.
 15. The polypeptide of claim 14, wherein the polypeptide is coupled to an oligonucleotide.
 16. The polypeptide of claim 14, wherein the polypeptide is coupled to an siRNA molecule, wherein the siRNA molecule comprises a sense strand and an antisense strand.
 17. The polypeptide of claim 16, wherein the polypeptide is coupled to the sense strand of the siRNA molecule.
 18. The polypeptide of claim 17, wherein the polypeptide is coupled to the 3' end of the sense strand of the siRNA molecule.
 19. The polypeptide of claim 17, wherein the polypeptide is coupled to the 5' end of the sense strand of the siRNA molecule.
 20. The polypeptide of claim 14, wherein the polypeptide is coupled to an antisense molecule.
 21. The polypeptide of claim 14, wherein the polypeptide is coupled to a DNA molecule.
 22. An isolated polynucleotide encoding the polypeptide of any one of claims 1-21.
 23. A vector comprising the polynucleotide of claim 22.
 24. A host cell comprising the vector of claim 23.
 25. A method of producing a polypeptide that binds CD71, comprising culturing the isolated host cell of claim 24 under conditions that the polypeptide is expressed, and purifying the polypeptide.
 26. A pharmaceutical composition comprising the polypeptide of any of claims 1-21 and a pharmaceutically acceptable carrier.
 27. An anti-idiotypic antibody that binds the polypeptide of any of claims 1-21.
 28. A kit comprising the polypeptide of any of claims 1-21.

29. A method of treating cancer in a subject in need thereof, the method comprising administering to the subject a polypeptide provided for herein, such as SEQ ID Nos: 1-7, 10, 12-219, 221-272, 292-299, or 304-306 with a therapeutic agent.
30. The method of claim 29, wherein the cancer is brain cancer.
31. Use of a polypeptide comprising any one of SEQ ID Nos: 1-7, 10, 12-219, 221-272, 292-299, or 304-306, conjugated with an antiviral agent, an immune system modulating agent, or an nucleic acid molecule for the manufacture/preparation of a medicament for the treatment of cancer.
32. The use of claim 31, wherein the cancer disease is glioblastoma.
33. A method of detecting CD71-expressing cancer cells in a tumor tissue, comprising
 - a) obtaining a sample of the tumor tissue from a subject; and
 - b) detecting whether CD71 is expressed in the tumor tissue by contacting the sample of the tumor tissue with a polypeptide comprising the amino acid sequence of any one of SEQ ID NOs: 1-7, 10, 12-219, 221-272, 292-299, or 304-306, and detecting the binding between CD71 and the polypeptide.
34. A method of isolating CD71 expressing cells, comprising
 - a) obtaining a sample from a subject;
 - b) contacting the sample with the polypeptide comprising the amino acid sequence of any one of SEQ ID NOs: 1-7, 10, 12-219, 221-272, 292-299, or 304-306, and
 - c) isolating the cells bound to the polypeptide.
35. A method of detecting CD71-expressing cancer cells in a tumor tissue, comprising
 - a) conjugating the peptide comprising the amino acid sequence of any one of SEQ ID NOs: 1-7, 10, 12-219, 221-272, 292-299, or 304-306 to a detectable label to form a conjugate;
 - b) administering the conjugate to a subject; and
 - c) visualizing the CD71 expressing cancer cells to which the conjugate is bound.
36. Use of the pharmaceutical composition of claim 35, or an nucleic acid molecule for the manufacture/preparation of a medicament for the treatment of a neurological condition and/or a brain tumor.
37. The use of claim 36, wherein the brain tumor is selected from the group consisting of nonmalignant, benign, and malignant brain tumors.
38. The use of claim 37, wherein the malignant brain tumor is selected from the group consisting of astrocytoma, medulloblastoma, glioma, ependymoma, germinoma

- (pinealoma), glioblastoma multiform, oligodendroglioma, schwannoma, retinoblastoma, or a cancer of the spinal cord, e.g., neurofibroma, meningioma, glioma, and sarcoma.
39. The use of claim 37, wherein the brain tumor is a congenital tumor.
 40. The use of claim 36, wherein the neurological condition is selected from the group consisting of stroke, diabetes, seizures, hypertensive encephalopathy, acquired immunodeficiency syndrome, traumatic brain injuries, multiple sclerosis, Parkinson's disease (PD) and Alzheimer disease.
 41. A method of delivering an agent of interest to a CD71 positive cell, the method comprising contacting a cell with the agent of interest coupled to a FN3 domain that binds to CD71, such as a polypeptide of any one of claims 1-23.
 42. The method of claim 41, wherein the agent of interest is internalized into the cell through the CD71 mediated interaction.
 43. The method of claim 41, wherein the FN3 domain does not compete with transferrin binding to CD71.
 44. The method of any one of claims 41-43, wherein the agent of interest is a chemotherapeutic agent, a drug, a growth inhibitory agent, a toxin, a radioactive isotope, an anti-tubulin agent, a polynucleotide, a siRNA molecule, an antisense molecule, a RNA molecule, a DNA molecule, DNA minor groove binders, DNA replication inhibitors, alkylating agents, antibiotics, antifolates, antimetabolites, chemotherapy sensitizers, topoisomerase inhibitors, or a vinca alkaloid.
 45. The method of any one of claims 41-44, wherein the FN3 domain comprises a sequence of SEQ ID NO: 1-7, 10, 12-219, 221-272, 292-299, or 304-306.
 46. The method of any one of claims 41-45, wherein the cell is a muscle cell.
 47. The method of any one of claims 41-46, wherein the cell is a brain cell or cell inside of the blood brain barrier.
 48. A method of identifying a FN3 protein that binds to CD71 at a site that does not compete or inhibit transferrin binding to CD71, the method comprising:
contacting CD71 in the presence of transferrin or an agent that binds to the CD71 transferrin binding site with a test FN3 protein; and
identifying a test FN3 protein that binds to CD71 in the presence of transferrin or an agent that binds to the CD71 transferrin binding site.
 49. The method of claim 48, further comprising isolating the test FN3 protein that binds to

- CD71 in the presence of transferrin or an agent that binds to the CD71 transferrin binding site.
50. The method of claims 48 or 49, further comprising sequencing the test FN3 protein that binds to CD71 in the presence of transferrin or an agent that binds to the CD71 transferrin binding site.
 51. The method of any one of claims 48-50, further comprising preparing or obtaining a nucleic acid sequence encoding the test FN3 protein that binds to CD71 in the presence of transferrin or an agent that binds to the CD71 transferrin binding site.
 52. The method of any one of claims 48-51, further comprising expressing the test FN3 protein that binds to CD71 in the presence of transferrin or an agent that binds to the CD71 transferrin binding site from a nucleic acid sequence encoding the test FN3 protein that binds to CD71 in the presence of transferrin or an agent that binds to the CD71 transferrin binding site.
 53. The method of claim 52, wherein the test FN3 protein is expressed in a cell.
 54. The method of claim 52, further comprising isolating and/or purifying the expressed test FN3 protein.
 55. A FN3 protein identified according to any one of claims 48-54.
 56. A pharmaceutical composition comprising the FN3 protein of claim 55.
 57. An isolated polynucleotide encoding the FN3 protein of claim 55.
 58. A vector comprising the polynucleotide of claim 57.
 59. A host cell comprising the vector of claim 58.