

(19) **DANMARK**



Patent- og
Varemærkestyrelsen

(10) **DK/EP 3618928 T5**

(12) **Rettet oversættelse af
europæisk patentskrift**

-
- (51) Int.Cl.: **A 61 P 19/02 (2006.01)** **A 61 P 25/28 (2006.01)** **A 61 P 27/06 (2006.01)**
A 61 P 31/04 (2006.01) **C 07 K 16/28 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2024-09-02**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2023-01-18**
- (86) Europæisk ansøgning nr.: **19746306.0**
- (86) Europæisk indleveringsdag: **2019-07-12**
- (87) Den europæiske ansøgnings publiceringsdag: **2020-03-11**
- (86) International ansøgning nr.: **US2019041614**
- (87) Internationalt publikationsnr.: **WO2020014617**
- (30) Prioritet: **2018-07-13 US 201862698007 P** **2019-06-11 US 201962860184 P**
2019-06-28 US 201962868849 P
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
- (73) Patenthaver: **Alector LLC, 131 Oyster Point Boulevard, Suite 600, South San Francisco CA 94080, USA**
- (72) Opfinder: **SCHWABE, Tina, c/o ALECTOR LLC, 131 Oyster Point Boulevard, Suite 600, South San Francisco, California 94080, USA**
KURNELLAS, Michael, c/o ALECTOR LLC, 131 Oyster Point Boulevard, Suite 600, South San Francisco, California 94080, USA
ROSENTHAL, Arnon, c/o ALECTOR LLC, 131 Oyster Point Boulevard, Suite 600, South San Francisco, California 94080, USA
PEJCHAL, Robert, c/o ALECTOR LLC, 131 Oyster Point Boulevard, Suite 600, South San Francisco, California 94080, USA
COOPER, Anthony B., c/o ALECTOR LLC, 131 Oyster Point Boulevard, Suite 600, South San Francisco, California 94080, USA
- (74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**
- (54) Benævnelse: **Anti-Sortilin-antistoffer og fremgangsmåder til anvendelse deraf**
- (56) Fremdragne publikationer:
WO-A1-2016/164608
WO-A1-2016/164637
WO-A1-2017/009327
Andrew D. Nguyen ET AL: "Progranulin: at the interface of neurodegenerative and metabolic diseases", Trends in Endocrinology and Metabolism, vol. 24, no. 12, 1 December 2013 (2013-12-01), pages 597-606, XP055219828, US ISSN: 1043-2760, DOI: 10.1016/j.tem.2013.08.003
ANDREW D. NGUYEN ET AL: "Progranulin: at the interface of neurodegenerative and metabolic diseases", TRENDS IN ENDOCRINOLOGY AND METABOLISM, vol. 24, no. 12, 1 December 2013 (2013-12-01), US, pages

Fortsættes ...

DESCRIPTION

FIELD

[0001] This present disclosure relates to anti-Sortilin antibodies, and therapeutic uses of such antibodies.

BACKGROUND

[0002] Sortilin is a Type I transmembrane protein that acts both as a receptor of several ligands, and in the sorting of select cargo from the trans-Golgi network (TGN) to late endosomes and lysosomes for degradation. Sortilin harbors a large extracellular domain that is part of the VPS10 family, homologous to yeast VPS10P, and contains of a 1 0-blade beta-propeller structure and a cysteine-rich 10CC module (Nykjaer, A et al., (2012) Trends Neurosci 35: 261-270; and Zheng, Y et al., (2011) PLoS One 6: (21023). A small fraction of Sortilin may be shed by activity of ADAM10 or gamma-Secretase (<5%) (Nykjaer, A et al., (2012) Trends Neurosci 35: 261-270; and Willnow, TE et al., (2011) Curr Opin Lipidol 22: 79-85).

[0003] Sortilin binds the secreted protein Progranulin (PGRN) and targets it for lysosomal degradation, thus negatively regulating extracellular levels of PGRN (Hu, F et al. (2010) Neuron 68, 654-667. In line with this, deficiency of Sortilin significantly increases plasma PGRN levels both in mouse models *in vivo* and human cells *in vitro* (Carrasquillo, M.M et al., (2010) Am J Hum Genet 87, 890-897; Lee, W.C et al., (2014) Hum Mol Genet 23, 1467-1478). Moreover, a polymorphism in Sortilin was shown to be strongly associated with PGRN serum levels in humans (Carrasquillo M.M et al., (2010), Am J Hum Genet. 10; 87(6):890-7).

[0004] Progranulin (PGRN) is a secreted, growth factor-like, trophic, and anti-inflammatory protein, which also plays a role as an adipokine involved in diet-induced obesity and insulin resistance (Nguyen DA et al., (2013). Trends in Endocrinology and Metabolism, 24, 597- 606). Progranulin deficiency accounts for roughly 25% of all heritable forms of frontotemporal dementia (FTD), an early-onset neurodegenerative disease. Patients with heterozygous loss-of-function mutations in PGRN have ~50% reduced extracellular levels of the protein and they will invariably develop FTD, making PGRN a causal gene for the disease (Baker, M et al., (2006) Nature 442, 916-919; Carecchio M et al., (2011) J Alzheimers Dis 27, 781-790; Cruts, M et al., (2008) Trends Genet 24, 186-194; Galimberti, D et al., (2010) J Alzheimers Dis 19, 171-177). In addition, PGRN mutant alleles have been identified in Alzheimer's disease patients (Seelaar, H et al., (2011). Journal of neurology, neurosurgery, and psychiatry 82, 476-486). Importantly, PGRN acts protectively in several disease models with increased PGRN levels, accelerating behavioral recovery from ischemia (Tao, J et al., (2012) Brain Res 1436, 130-136; Egashira, Y. et al., (2013). J Neuroinflammation 10, 105), suppressing locomotor deficits in a Parkinson's disease model (Van Kampen, J.M et al. (2014). PLoS One 9, e97032), attenuating pathology in a model of amyotrophic lateral sclerosis (Laird, A.S et al., (2010). PLoS One 5, e13368.) and arthritis (Tang, W et al., (2011). Science 332, 478-484) and preventing memory deficits in an Alzheimer's disease model (Minami, S.S et al., (2014). Nat Med 20, 1157-1164).

[0005] Sortilin also binds directly to pro-neurotrophins, such as pro-nerve growth factor (pro-NGF), pro-BDNF, pro-neurotrophin-3, *etc.*, which harbor a pro-domain and are typically pro-apoptotic. Such pro-neurotrophin precursors are released during stress, and Sortilin is involved in regulating their release as well as binding on the receiving cell and stimulation of apoptosis in conjunction with p75NTR (Willnow, TE et al., (2008) Nat Rev Neurosci 9: 899-909; Nykjaer, A et al., Trends Neurosci 35: 261-270; and Nykjaer, A et al., (2004) Nature 427: 843-848; Hiroko Yano et al., (2009) J Neurosci., 29: 14790-14802.Teng U.K., et al., J. Neurosci. 25:5455-5463(2005)). Sortilin also binds to p75NTR directly (Skeldal S et al., (2012) J Biol Chem., 287:43798). Sortilin also binds to neurotensin in a region that partially overlaps with Progranulin binding (Quistgaard, EM et al., (2009) Nat Struct Mol Biol 16: 96-98; and Zheng, Y et al., PLoS One 6: e21023). Sortilin also interacts with the Trk receptors NTRK1, NTRK2, and NTRK3; and can regulate their anterograde axonal transport and signaling (Vaegter, CB et al., (2011) Nat. Neurosci. 14:54-61). Sortilin also interacts with and regulates the processing and trafficking of amyloid precursor protein and the resulting production of pathological beta amyloid peptides (Gustafsen C et al., (2013). J Neurosci., 2:33(1):64-71).

[0006] Sortilin has also been shown to bind to apolipoproteins and lipoprotein lipase; thus, deficiency leads to reduced VLDL release from liver and reduced cholesterol (Willnow, TE et al., (2011) Curr Opin Lipidol 22: 79-85; Kjolb, M et al., (2010) Cell Metab 12: 213-223; Nilsson, SK et al., (2007) Biochemistry 46: 3896-3904.; Nilsson, SK et al., (2008) J Biol Chem 283: 25920-25927; and Klinger, SC et al., (2011) J Cell Sci 124: 1095-1105). Recently, Sortilin has also been implicated in binding to APP directly (Gustafsen, C et al., (2013) J. Neurosci. 33:64-71) and also to the APP processing enzyme BACE1 (Gustafsen, C et al., (2013) J. Neurosci. 33:64-71; and Finan, GM et al., J Biol Chem 286: 12602-12610). Sortilin also binds to apolipoprotein E (APOE), to the A beta peptide (Carlo, AS et al., (2013) J. Neurosci. 33: 358-370), and to PCSK9 (Gustafsen et al., (2014) Cell Metab, 19: 310-318). Sortilin has also been shown to bind to and regulate extracellular levels of PCSK9, which directs low-density lipoprotein receptor for degradation in lysosomes, resulting in increased levels of LDL cholesterol (Gustafsen C et al., (2014). Cell Metab. 2014 Feb 4;19(2):310-8).

[0007] When present at intracellular vesicles such as endosomes, the amino-terminal extracellular domain of Sortilin is directed towards the lumen, where cargo of the vesicle is present. The carboxy-terminal intracellular/cytoplasmic domain of Sortilin, however, binds to a series of adaptor proteins, which regulate its trafficking from the surface and within intracellular compartments. These include AP2 (a clathrin adaptor to modulate endocytosis from the cell surface), and the Retromer Complex/AP1, which modulate movement from early endosomes to Golgi for recycling; and interaction with GGA (Golgi-localizing, gamma-ear containing, ADP-ribosylation factor binding) family proteins for movement from Golgi directly to early endosomes, usually for subsequent degradation through lysosomes. Thus, Sortilin can bind to ligands at its luminal domain, while engaging the cytoplasmic adaptors that determine its destination to determine intracellular fates, such as degradation for Progranulin and other factors.

[0008] Through its various interactions with proteins, such as Progranulin, Sortilin and its multiple ligands have been shown to be involved in various diseases, disorders, and conditions, such as frontotemporal dementia, amyotrophic lateral sclerosis, amyotrophic lateral sclerosis-frontotemporal dementia phenotypes, Alzheimer's disease, Parkinson's disease, depression, neuropsychiatric disorders, vascular dementia, seizures, retinal dystrophy, age related macular degeneration, glaucoma, traumatic brain injury, aging, seizures, wound healing, stroke, arthritis, and atherosclerotic vascular diseases.

[0009] Accordingly, there is a need for therapeutic antibodies that specifically bind Sortilin proteins and block the binding of Sortilin to its ligands, such as Progranulin, or otherwise modulate the effective concentration of the ligands, in order to treat one or more diseases, disorders, and conditions associated with Sortilin activity.

[0010] WO2016164637, WO2017009327 and WO2016164608 disclose anti-sortilin antibodies.

SUMMARY

[0011] The present disclosure is generally directed to compositions that include antibodies, e.g., monoclonal, chimeric, humanized antibodies, antibody fragments, *etc.*, that specifically bind human Sortilin, and to methods of using such compositions.

[0012] Any mentions in the description to methods of treatment refer to the compounds, pharmaceutical compositions and medicaments of the present invention for use in a method of treatment of the human (or animal) body by therapy.

[0013] The invention is defined by the appended claims. Any aspects, embodiments and examples of the present disclosure which do not fall under the scope of the appended claims do not form part of the invention and are merely provided for illustrative purposes.

[0014] In a first aspect, the present invention provides an antibody that binds to a human Sortilin protein, wherein the antibody comprises a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 56 and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 57.

[0015] In a second aspect, the present invention provides an antibody that binds to a human Sortilin protein, wherein the antibody comprises a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 56 and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 60.

[0016] In some embodiments that may be combined with any of the previous aspects, an anti-Sortilin antibody of the present invention is of the IgG class, the IgM class, or the IgA class. In certain specific embodiments, the anti-Sortilin antibody is of the IgG class and has an IgG1, IgG2, IgG3, or IgG4 isotype. In some embodiments of the present invention, provided is an anti-Sortilin antibody of the IgG1, IgG2, IgG3, or IgG4 isotype, wherein (a) the antibody is an IgG1 or IgG2 isotype and the Fc region comprises an amino acid substitution at position P331S, wherein the numbering of the residue position is according to EU numbering; (b) the antibody is an IgG1 isotype and the Fc region comprises amino acid substitutions at positions L234A, L235A, and P33 IS, wherein the numbering of the residue position is according to EU numbering; (c) the antibody is an IgG1, IgG2, or IgG4 isotype and the Fc region comprises an amino acid substitution at position N297A, wherein the numbering of the residue position is according to EU numbering; or (d) the Fc region comprises an amino acid substitution at positions S267E and L328F, wherein the numbering of the residue position is according to EU numbering. In some embodiments, the antibody is an IgG1 isotype and the Fc region comprises amino acid substitutions at positions L234A, L235A, and P33 IS, wherein the numbering of the residue position is according to EU numbering.

[0017] In some aspects, the present invention provides an antibody that binds to a human Sortilin protein, wherein the antibody comprises a heavy chain comprising the amino acid sequence of SEQ ID NO: 137 and a light chain comprising the amino acid sequence of SEQ ID NO: 142.

[0018] In some aspects, the present invention provides an antibody that binds to a human Sortilin protein, wherein the antibody comprises a heavy chain comprising the amino acid sequence of SEQ ID NO: 138 and a light chain comprising the amino acid sequence of SEQ ID NO: 142.

[0019] In the present invention the human Sortilin protein may comprise the amino acid sequence of SEQ ID NO: 81.

[0020] In some embodiments that may be combined with any of the previous embodiments, the antibody is a human antibody, a bispecific antibody, a monoclonal antibody, a multivalent antibody, a conjugated antibody, or a chimeric antibody. In certain embodiments, an anti-Sortilin antibody of the present invention is a monoclonal antibody.

[0021] In some embodiments, an anti-Sortilin antibody of the present invention is a bispecific antibody recognizing a Sortilin protein and a second antigen. In certain embodiments, bispecific antibodies of the present invention recognize both Sortilin and an antigen facilitating transport across the blood-brain-barrier. In some specific embodiments, the first antigen is Sortilin and the second antigen is Sortilin, transferrin receptor (TR), insulin receptor (HIR), insulin-like growth factor receptor (IGFR), low-density lipoprotein receptor related proteins 1 and 2 (LPR-1 and 2), diphtheria toxin receptor, CRM197, a llama single domain antibody, TMEM 30(A), a protein transduction domain, TAT, Syn-B, penetratin, a poly-arginine peptide, an angiopep peptide, basigin, Glut1, CD98hc, or ANG1005.

[0022] In certain embodiments of the present invention, the anti-Sortilin antibody is an antibody fragment that binds to a human Sortilin protein. In certain embodiments that may be combined with any of the preceding embodiments, the anti-Sortilin antibody fragment is an Fab, Fab', Fab'-SH, F(ab')₂, Fv, or scFv fragment. In some aspects, the present invention provides an isolated nucleic acid comprising a nucleic acid sequence encoding an anti-Sortilin antibody according to the claims. Accordingly, some aspects provide a vector containing a nucleic acid encoding the anti-Sortilin antibody, and some aspects provide an isolated host cell containing such a vector. In certain aspects, the present invention provides a method of producing an anti-Sortilin antibody that binds to Sortilin, comprising culturing such an isolated host cell so that the anti-Sortilin antibody is produced. In certain embodiments, the method further comprises recovering the antibody produced by the cell.

[0023] In another aspect, the present invention relates to a pharmaceutical composition comprising any of the anti-Sortilin antibodies according to the claims and a pharmaceutically acceptable carrier. In some embodiments, the present invention relates to an antibody according to the claims for use as a medicament. In some embodiments, the antibody is for use in a method of preventing, reducing risk for or treating a disease, disorder or injury selected from frontotemporal dementia, Alzheimer's disease, vascular dementia, seizures, retinal dystrophy, amyotrophic lateral sclerosis, traumatic brain injury, a spinal cord injury, neuropathic pain, dementia, stroke, Parkinson's disease, retinal degeneration, multiple sclerosis, septic shock, arthritis, or osteoarthritis.

[0024] In certain aspects, provided herein is an antibody according to the claims for use in a method of inhibiting neuroinflammation, or axonopathy characterized by short axonal outgrowth and aberrant branching.

[0025] In certain aspects, provided herein is an antibody according to the claims for use in a method of promoting wound healing.

[0026] In certain aspects, provided herein is an antibody according to the claims for use in a method at preventing, reducing risk, or treating arthritis, or an inflammatory disorder.

[0027] In some aspects, provided herein is an in vitro method of inhibiting the interaction between Sortilin and Progranulin, the method comprising exposing a cell expressing Sortilin to an anti-Sortilin antibody or a pharmaceutical composition of the present claims. In some embodiments, the method further comprises decreasing the level of Sortilin expressed on the cell surface. In some embodiments, extracellular levels of Progranulin are increased. In some embodiments, the individual has one or more mutations in the gene encoding Progranulin. In some the individual is heterozygous for one or more loss-of-function mutations in the gene encoding Progranulin. The individual has a c9orf72 hexanucleotide repeat expansion. The individual has or is at risk for frontotemporal dementia, Alzheimer's disease, or amyotrophic lateral sclerosis.

[0028] In some embodiments that may be combined with any of the previous aspects or embodiments, the anti-Sortilin antibody comprises two or more anti-Sortilin antibodies.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIGS. 1A-1C provide pharmacokinetic and pharmacodynamic studies of non-human primates administered single doses of anti-Sortilin antibody S-60-15.1 [N33T] LALAPS (S-60-15.1 [N33T] with hulG1 with L234A/L235A/P331S mutations). **FIG. 1A** provides the level of SORT1 in peripheral white blood cells as a percentage from baseline at the indicated times after treatment (hours) with the specified anti-Sortilin antibody doses. SORT1 expression decreased with all of the anti-Sortilin antibody doses tested. Higher antibody doses (60 mg/kg, 200 mg/kg) resulted in both an earlier and more prolonged decrease of SORT1 levels compared to lower anti-Sortilin antibody doses (5mg/kg, 20 mg/kg). **FIG. 1B** provides the levels of PGRN in the plasma as a percentage from baseline at the indicated times after treatment (hours) with the specified anti-Sortilin antibody doses. The levels of PGRN increased in a time- and dose-dependent manner. In particular, plasma PGRN levels increased 3- to 4-fold at C_{max}, compared to baseline levels, for all anti-Sortilin antibody doses tested and remained elevated for longer periods of time at the higher antibody doses. **FIG. 1C** provides the levels of PGRN in CSF as a percentage from baseline at the indicated times after treatment (hours) with the specified anti-Sortilin antibody doses. CSF PGRN levels increased 2- to 3-fold above baseline in animals administered either 20 mg/kg, 60 mg/kg, or 200 mg/kg. As observed with plasma PGRN levels (**FIG. 1B**), CSF PGRN levels remained elevated over time in the higher antibody dose groups. For **FIGS. 1A-1C**, n = 3 animals per dose.

FIGS. 2A-2C provide pharmacokinetic and pharmacodynamic studies of non-human primates administered repeat doses of anti-Sortilin antibody S-60-15.1 [N33T] LALAPS. Animals (2 males and 2 females) were administered anti-Sortilin antibody S-60-15.1 [N33T] LALAPS at a dose of 60mg/kg once per week for four weeks. The days on which dosing occurred are represented by the vertical dashed lines. **FIG. 2A** provides the mean (+/- standard deviation) of the concentration of SORT1 in peripheral white blood cells (WBCs) as a percentage of baseline at the indicated times (days). SORT1 levels in peripheral white blood cells remained decreased throughout the duration of the study. **FIG. 2B** provides the mean (+/- standard deviation) of the concentration of PGRN in plasma as a percentage of baseline (normalized) at the indicated times (days). Plasma PGRN levels increased to 5- to 6-fold above baseline at peak levels. A decrease in plasma PGRN was observed following the fourth and final administration of anti-Sortilin antibody; however, the plasma PGRN levels remained elevated by 2-fold above baseline. **FIG. 2C** provides the mean (+/- standard deviation) of the concentration of PGRN in CSF as a percentage of baseline (normalized) at the indicated times (days). CSF PGRN levels were increased 3- to 4-fold above baseline (**FIG. 2C**).

DETAILED DESCRIPTION

Definitions

[0030] As used herein, the term "*preventing*" includes providing prophylaxis with respect to occurrence or recurrence of a particular disease, disorder, or condition in an individual. An individual may be predisposed to, susceptible to a particular disease, disorder, or condition, or at risk of developing such a disease, disorder, or condition, but has not yet been diagnosed with the disease, disorder, or condition.

[0031] As used herein, an individual "*at risk*" of developing a particular disease, disorder, or condition may or may not have detectable disease or symptoms of disease, and may or may not have displayed detectable disease or symptoms of disease prior to the treatment methods described herein. "At risk" denotes that an individual has one or more risk factors, which are measurable parameters that correlate with development of a particular disease, disorder, or condition, as known in the art. An individual having one or more of these risk factors has a higher probability of developing a particular disease, disorder, or condition than an individual without one or more of these risk factors.

[0032] As used herein, the term "*treatment*" refers to clinical intervention designed to alter the natural course of the individual being treated during the course of clinical pathology. Desirable effects of treatment include decreasing the rate of progression, ameliorating or palliating the pathological state, and remission or improved prognosis of a particular disease, disorder, or condition. An individual is successfully "treated", for example, if one or more symptoms associated with a particular disease, disorder, or condition are mitigated or eliminated.

[0033] An "*effective amount*" refers to at least an amount effective, at dosages and for periods of time necessary, to achieve the desired therapeutic or prophylactic result. An effective amount can be provided in one or more administrations. An effective amount herein may vary according to factors such as the disease state, age, sex, and weight of the individual, and the ability of the treatment to elicit a desired response in the individual. An effective amount is also one in which any toxic or detrimental effects of the treatment are outweighed by the therapeutically beneficial effects. For prophylactic use, beneficial or desired results include results such as eliminating or reducing the risk, lessening the severity, or delaying the onset of the disease, including biochemical, histological and/or behavioral symptoms of the disease, its complications and intermediate pathological phenotypes presenting during development of the disease. For therapeutic use, beneficial or desired results include clinical results such as decreasing one or more symptoms resulting from the disease, increasing the quality of life of those suffering from the disease, decreasing the dose of other medications required to treat the disease, enhancing effect of another medication such as via targeting, delaying the progression of the disease, and/or prolonging survival. An effective amount of drug, compound, or pharmaceutical composition is an amount sufficient to accomplish prophylactic or therapeutic treatment either directly or indirectly. As is understood in the clinical context, an effective amount of a drug, compound, or pharmaceutical composition may or may not be achieved in conjunction with another drug, compound, or pharmaceutical composition. Thus, an "effective amount" may be considered in the context of administering one or more therapeutic agents, and a single agent may be considered to be given in an effective amount if, in conjunction with one or more other agents, a desirable result may be or is achieved.

[0034] As used herein, administration "*in conjunction*" with another compound or composition includes simultaneous administration and/or administration at different times. Administration in conjunction also encompasses administration as a co-formulation or administration as separate compositions, including at different dosing frequencies or intervals, and using the same route of administration or different routes of administration.

[0035] An "*individual*" for purposes of treatment, prevention, or reduction of risk refers to any animal classified as a mammal, including humans, domestic and farm animals, and zoo, sport, or pet animals, such as dogs, horses, rabbits, cattle, pigs, hamsters, gerbils, mice, ferrets, rats, cats, and the like. Preferably, the individual is human.

[0036] The terms "Sortilin" or "Sortilin polypeptide" are used interchangeably herein refer herein to any native Sortilin from any mammalian source, including primates (e.g., humans and cynos) and rodents (e.g., mice and rats), unless otherwise indicated. In some embodiments, the term encompasses both wild-type sequences and naturally occurring variant sequences, e.g., splice variants or allelic variants. In some embodiments, the term encompasses "full-length," unprocessed Sortilin as well as any form of Sortilin that results from processing in the cell. In some embodiments, the Sortilin is human Sortilin. In some embodiments, the amino acid sequence of an exemplary human Sortilin is SEQ ID NO: 81.

[0037] The terms "anti- Sortilin antibody," an "antibody that binds to Sortilin," and "antibody that specifically binds Sortilin" refer to an antibody that is capable of binding Sortilin with sufficient affinity such that the antibody is useful as a diagnostic and/or therapeutic agent in targeting Sortilin. In one embodiment, the extent of binding of an anti- Sortilin antibody to an unrelated, non- Sortilin polypeptide is less than about 10% of the binding of the antibody to Sortilin as measured, e.g., by a radioimmunoassay (RIA). In certain embodiments, an antibody that binds to Sortilin has a dissociation constant (KD) of < 1 μ M, < 100 nM, < 10 nM, < 1 nM, < 0.1 nM, or < 0.01 nM, or < 0.001 nM (e.g., 10-8 M or less, e.g. from 10-8 M to 10-13 M, e.g., from 10-9 M to 10-13 M). In certain embodiments, an anti-Sortilin antibody binds to an epitope of Sortilin that is conserved among Sortilin from different species.

[0038] The term "*immunoglobulin*" (Ig) is used interchangeably with "*antibody*" herein. The term "antibody" herein is used in the broadest sense and specially covers monoclonal antibodies, polyclonal antibodies, multispecific antibodies (e.g., bispecific antibodies) including those formed from at least two intact antibodies, and antibody fragments so long as they exhibit the desired biological activity.

[0039] "*Native antibodies*" are usually heterotetrameric glycoproteins of about 150,000 Daltons, composed of two identical Light ("L") chains and two identical heavy ("H") chains. Each light chain is linked to a heavy chain by one covalent disulfide bond, while the number of disulfide linkages varies among the heavy chains of different immunoglobulin isotypes. Each heavy and light chain also has regularly spaced intra-chain disulfide bridges. Each heavy chain has at one end a variable domain (V_H) followed by a number of constant domains. Each light chain has a variable domain at one end (V_L) and a constant domain at its other end; the constant domain of the light chain is aligned with the first constant domain of the heavy chain, and the light chain variable domain is aligned with the variable domain of the heavy chain. Particular amino acid residues are believed to form an interface between the light chain and heavy chain variable domains.

[0040] For the structure and properties of the different classes of antibodies, see, e.g., Basic and Clinical Immunology, 8th Ed., Daniel P. Stites, Abba I. Terr and Tristram G. Parslow (eds.), Appleton & Lange, Norwalk, CT, 1994, page 71 and Chapter 6.

[0041] The light chain from any vertebrate species can be assigned to one of two clearly distinct types, called kappa ("κ") and lambda ("λ"), based on the amino acid sequences of their constant domains. Depending on the amino acid sequence of the constant domain of their heavy chains (CH), immunoglobulins can be assigned to different classes or isotypes. There are five classes of immunoglobulins: IgA, IgD, IgE, IgG, and IgM, having heavy chains designated alpha ("α"), delta ("δ"), epsilon ("ε"), gamma ("γ"), and mu ("μ"), respectively. The γ and α classes are further divided into subclasses (isotypes) on the basis of relatively minor differences in the CH sequence and function, e.g., humans express the following subclasses: IgG1, IgG2, IgG3, IgG4, IgA1, and IgA2. The subunit structures and three-dimensional configurations of different classes of immunoglobulins are well known and described generally in, for example, Abbas et al., Cellular and Molecular Immunology, 4th ed. (W.B. Saunders Co., 2000).

[0042] The "*variable region*" or "*variable domain*" of an antibody, such as an anti-Sortilin antibody of the present disclosure, refers to the amino-terminal domains of the heavy or light chain of the antibody. The variable domains of the heavy chain and light chain may be referred to as "V_H" and "V_L", respectively. These domains are generally the most variable parts of the antibody (relative to other antibodies of the same class) and contain the antigen binding sites.

[0043] The term "*variable*" refers to the fact that certain segments of the variable domains differ extensively in sequence among antibodies, such as anti-Sortilin antibodies of the present disclosure. The variable domain mediates antigen binding and defines the specificity of a particular antibody for its particular antigen. However, the variability is not evenly distributed across the entire span of the variable domains. Instead, it is concentrated in three segments called hypervariable regions (HVRs) both in the light-chain and the heavy chain variable domains. The more highly conserved portions of variable domains are called the framework regions (FR). The variable domains of native heavy and light chains each comprise four FR regions, largely adopting a beta-sheet configuration, connected by three HVRs, which form loops connecting, and in some cases forming part of, the beta-sheet structure. The HVRs in each chain are held together in close proximity by the FR regions and, with the HVRs from the other chain, contribute to the formation of the antigen-binding site of antibodies (see Kabat et al., Sequences of Immunological Interest, Fifth Edition, National Institute of Health, Bethesda, MD (1991)). The constant domains are not involved directly in the binding of antibody to an antigen, but exhibit various effector functions, such as participation of the antibody in antibody-dependent-cellular toxicity.

[0044] An "*isolated*" antibody, such as an anti-Sortilin antibody of the present disclosure, is one that has been identified, separated and/or recovered from a component of its production environment (e.g., naturally or recombinantly). Preferably, the isolated polypeptide is free of association with all other contaminant components from its production environment. Contaminant components from its production environment, such as those resulting from recombinant transfected cells, are materials that would typically interfere with research, diagnostic or therapeutic uses for the antibody, and may include enzymes, hormones, and other proteinaceous or non-proteinaceous solutes. In preferred embodiments, the polypeptide will be purified: (1) to greater than 95% by weight of antibody as determined by, for example, the Lowry method, and in some embodiments, to greater than 99% by weight; (2) to a degree sufficient to obtain at least 15 residues of N-terminal or internal amino acid sequence by use of a spinning cup sequenator, or (3) to homogeneity by SDS-PAGE under

non-reducing or reducing conditions using Coomassie blue or, preferably, silver stain. Isolated antibody includes the antibody *in situ* within recombinant T cells since at least one component of the antibody's natural environment will not be present. Ordinarily, however, an isolated polypeptide or antibody will be prepared by at least one purification step.

[0045] The term "*monoclonal antibody*" as used herein refers to an antibody, such as a monoclonal anti-Sortilin antibody of the present disclosure, obtained from a population of substantially homogeneous antibodies, *i.e.*, the individual antibodies comprising the population are identical except for possible naturally occurring mutations and/or post-translation modifications (e.g., isomerizations, amidations, etc.) that may be present in minor amounts. Monoclonal antibodies are highly specific, being directed against a single antigenic site. In contrast to polyclonal antibody preparations which typically include different antibodies directed against different determinants (epitopes), each monoclonal antibody is directed against a single determinant on the antigen. In addition to their specificity, the monoclonal antibodies are advantageous in that they are synthesized by the hybridoma culture, uncontaminated by other immunoglobulins. The modifier "monoclonal" indicates the character of the antibody as being obtained from a substantially homogeneous population of antibodies, and is not to be construed as requiring production of the antibody by any particular method. For example, the monoclonal antibodies to be used in accordance with the present invention may be made by a variety of techniques, including, but not limited to one or more of the following methods, immunization methods of animals including, but not limited to rats, mice, rabbits, guinea pigs, hamsters and/or chickens with one or more of DNA(s), virus-like particles, polypeptide(s), and/or cell(s), the hybridoma methods, B-cell cloning methods, recombinant DNA methods, and technologies for producing human or human-like antibodies in animals that have parts or all of the human immunoglobulin loci or genes encoding human immunoglobulin sequences.

[0046] The terms "*full-length antibody*," "*intact antibody*" or "*whole antibody*" are used interchangeably to refer to an antibody, such as an anti-Sortilin antibody of the present disclosure, in its substantially intact form, as opposed to an antibody fragment. Specifically, whole antibodies include those with heavy and light chains including an Fc region. The constant domains may be native sequence constant domains (e.g., human native sequence constant domains) or amino acid sequence variants thereof. In some cases, the intact antibody may have one or more effector functions.

[0047] An "*antibody fragment*" comprises a portion of an intact antibody, preferably the antigen binding and/or the variable region of the intact antibody. Examples of antibody fragments include Fab, Fab', F(ab')₂ and Fv fragments; diabodies; linear antibodies (see U.S. Patent 5,641,870, Example 2; Zapata et al., Protein Eng. 8(10): 1057-1062 (1995)); single-chain antibody molecules and multispecific antibodies formed from antibody fragments.

[0048] Papain digestion of antibodies, such as anti-Sortilin antibodies of the present disclosure, produces two identical antigen-binding fragments, called "*Fab*" fragments, and a residual "*Fc*" fragment, a designation reflecting the ability to crystallize readily. The Fab fragment consists of an entire L chain along with the variable region domain of the H chain (V_H), and the first constant domain of one heavy chain (C_H1). Each Fab fragment is monovalent with respect to antigen binding, *i.e.*, it has a single antigen-binding site. Pepsin treatment of an antibody yields a single large F(ab')₂ fragment which roughly corresponds to two disulfide linked Fab fragments having different antigen-binding activity and is still capable of cross-linking antigen. Fab' fragments differ from Fab fragments by having a few additional residues at the carboxy terminus of the C_H1 domain including one or more cysteines from the antibody hinge region. Fab'-SH is the designation herein for Fab' in which the cysteine residue(s) of the constant domains bear a free thiol group. F(ab')₂ antibody fragments originally were produced as pairs of Fab' fragments which have hinge cysteines between them. Other chemical couplings of antibody fragments are also known.

[0049] The Fc fragment comprises the carboxy-terminal portions of both H chains held together by disulfides. The effector functions of antibodies are determined by sequences in the Fc region, the region which is also recognized by Fc receptors (FcR) found on certain types of cells.

[0050] "*Fv*" is the minimum antibody fragment which contains a complete antigen-recognition and -binding site. This fragment consists of a dimer of one heavy- and one light-chain variable region domain in tight, non-covalent association. From the folding of these two domains emanate six hypervariable loops (3 loops each from the H and L chain) that contribute the amino acid residues for antigen binding and confer antigen binding specificity to the antibody. However, even a single variable domain (or half of an Fv comprising only three HVRs specific for an antigen) has the ability to recognize and bind antigen, although at a lower affinity than the entire binding site.

[0051] "*Single-chain Fv*" also abbreviated as "*sFv*" or "*scFv*" are antibody fragments that comprise the V_H and V_L antibody domains connected into a single polypeptide chain. Preferably, the sFv polypeptide further comprises a polypeptide linker between the V_H and V_L domains which enables the sFv to form the desired structure for antigen binding. For a review of the sFv, see Pluckthun in The Pharmacology of Monoclonal Antibodies, vol. 113, Rosenberg and Moore eds., Springer-Verlag, New York, pp. 269-315 (1994).

[0052] "*Functional fragments*" of antibodies, such as anti-Sortilin antibodies of the present disclosure, comprise a portion of an intact antibody, generally including the antigen binding or variable region of the intact antibody or the F region of an antibody which retains or has modified FcR binding capability. Examples of antibody fragments include linear antibody, single-chain antibody molecules and multispecific antibodies formed from antibody fragments.

[0053] The term "*diabodies*" refers to small antibody fragments prepared by constructing sFv fragments (see preceding paragraph) with short linkers (about 5-10) residues) between the V_H and V_L domains such that inter-chain but not intra-chain pairing of the variable domains is achieved, thereby resulting in a bivalent fragment, *i.e.*, a fragment having two antigen-binding sites. Bispecific diabodies are heterodimers of two "crossover" sFv fragments in which the V_H and V_L domains of the two antibodies are present on different polypeptide chains.

[0054] As used herein, a "chimeric antibody" refers to an antibody (immunoglobulin), such as a chimeric anti-Sortilin antibody of the present disclosure, in which a portion of the heavy and/or light chain is identical with or homologous to corresponding sequences in antibodies derived from a particular species or belonging to a particular antibody class or subclass, while the remainder of the chain(s) is(are) identical with or homologous to corresponding sequences in antibodies derived from another species or belonging to another antibody class or subclass, as well as fragments of such antibodies, so long as they exhibit the desired biological activity. Chimeric antibodies of interest herein include PRIMATIZED® antibodies wherein the antigen-binding region of the antibody is derived from an antibody produced by, e.g., immunizing macaque monkeys with an antigen of interest. As used herein, "humanized antibody" is used a subset of "chimeric antibodies."

[0055] "*Humanized*" forms of non-human (e.g., murine) antibodies, such as humanized forms of anti-Sortilin antibodies of the present disclosure, are chimeric antibodies comprising amino acid residues from non-human HVRs and amino acid residues from human FRs. In certain embodiments, a humanized antibody will comprise substantially all of at least one, and typically two, variable domains, in which all or substantially all of the HVRs (e.g., CDRs) correspond to those of a non-human antibody, and all or substantially all of the FRs correspond to those of a human antibody. A humanized antibody optionally may comprise at least a portion of an antibody constant region derived from a human antibody. A "humanized form" of an antibody, e.g., a non-human antibody, refers to an antibody that has undergone humanization.

[0056] A "*human antibody*" is one that possesses an amino-acid sequence corresponding to that of an antibody, such as an anti-Sortilin antibody of the present disclosure, produced by a human and/or has been made using any of the techniques for making human antibodies as disclosed herein. This definition of a human antibody specifically excludes a humanized antibody comprising non-human antigen-binding residues. Human antibodies can be produced using various techniques known in the art, including phage-display libraries and yeast-based platform technologies. Human antibodies can be prepared by administering the antigen to a transgenic animal that has been modified to produce such antibodies in response to antigenic challenge, but whose endogenous loci have been disabled, e.g., immunized xenomice as well as generated via a human B-cell hybridoma technology.

[0057] The term "*hypervariable region*," "*HVR*," or "*HV*," when used herein refers to the regions of an antibody-variable domain, such as that of an anti-Sortilin antibody of the present disclosure, that are hypervariable in sequence and/or form structurally defined loops. Generally, antibodies comprise six HVRs; three in the V_H (H1, H2, H3), and three in the V_L (L1, L2, L3). In native antibodies, H3 and L3 display the most diversity of the six HVRs, and H3 in particular is believed to play a unique role in conferring fine specificity to antibodies. Naturally occurring camelid antibodies consisting of a heavy chain only are functional and stable in the absence of light chain.

[0058] A number of HVR delineations are in use and are encompassed herein. In some embodiments, the HVRs may be Kabat complementarity-determining regions (CDRs) based on sequence variability and are the most commonly used (Kabat et al., *supra*). In some embodiments, the HVRs may be Chothia CDRs. Chothia refers instead to the location of the structural loops (Chothia and Lesk J. Mol. Biol. 196:901-917 (1987)). In some embodiments, the HVRs may be AbM HVRs. The AbM HVRs represent a compromise between the Kabat CDRs and Chothia structural loops, and are used by Oxford Molecular's AbM antibody-modeling software. In some embodiments, the HVRs may be "contact" HVRs. The "contact" HVRs are based on an analysis of the available complex crystal structures. The residues from each of these HVRs are noted below.

Loop	Kabat	AbM	Chothia	Contact
L1	L24-L34	L24-L34	L26-L32	L30-L36
L2	L50-L56	L50-L56	L50-L52	L46-L55

L3 L89-L97	L89-L97	L91-L96	L89-L96
H1 H31-H35B	H26-H35B	H26-H32	H30-H35B (Kabat numbering)
H1 H31-H35	H26-H35	H26-H32	H30-H35 (Chothia numbering)
H2 H50-H65	H50-H58	H53-H55	H47-H58
H3 H95-H102	H95-H102	H96-H101	H93-H101

[0059] HVRs may comprise "extended HVRs" as follows: 24-36 or 24-34 (L1), 46-56 or 50-56 (L2), and 89-97 or 89-96 (L3) in the VL, and 26-35 (H1), 50-65 or 49-65 (a preferred embodiment) (H2), and 93-102, 94-102, or 95-102 (H3) in the VH. The variable-domain residues are numbered according to Kabat et al., *supra*, for each of these extended-HVR definitions.

[0060] "Framework" or "FR" residues are those variable-domain residues other than the HVR residues as herein defined.

[0061] An "acceptor human framework" as used herein is a framework comprising the amino acid sequence of a V_L or V_H framework derived from a human immunoglobulin framework or a human consensus framework. An acceptor human framework "derived from" a human immunoglobulin framework or a human consensus framework may comprise the same amino acid sequence thereof, or it may comprise pre-existing amino acid sequence changes. In some embodiments, the number of pre-existing amino acid changes are 10 or less, 9 or less, 8 or less, 7 or less, 6 or less, 5 or less, 4 or less, 3 or less, or 2 or less. Where pre-existing amino acid changes are present in a VH, preferable those changes occur at only three, two, or one of positions 71H, 73H and 78H; for instance, the amino acid residues at those positions may be 71A, 73T and/or 78A. In one embodiment, the VL acceptor human framework is identical in sequence to the V_L human immunoglobulin framework sequence or human consensus framework sequence.

[0062] A "human consensus framework" is a framework that represents the most commonly occurring amino acid residues in a selection of human immunoglobulin V_L or V_H framework sequences. Generally, the selection of human immunoglobulin V_L or V_H sequences is from a subgroup of variable domain sequences. Generally, the subgroup of sequences is a subgroup as in Kabat et al., Sequences of Proteins of Immunological Interest, 5th Ed. Public Health Service, National Institutes of Health, Bethesda, MD (1991). Examples include for the V_L , the subgroup may be subgroup kappa I, kappa II, kappa III or kappa IV as in Kabat et al., *supra*. Additionally, for the V_H , the subgroup may be subgroup I, subgroup II, or subgroup III as in Kabat et al., *supra*.

[0063] An "amino acid modification" at a specified position, e.g., of an anti-Sortilin antibody of the present disclosure, refers to the substitution or deletion of the specified residue, or the insertion of at least one amino acid residue adjacent the specified residue. Insertion "adjacent" to a specified residue means insertion within one to two residues thereof. The insertion may be N-terminal or C-terminal to the specified residue. The preferred amino acid modification herein is a substitution.

[0064] An "affinity-matured" antibody, such as an anti-Sortilin antibody of the present disclosure, is one with one or more alterations in one or more HVRs thereof that result in an improvement in the affinity of the antibody for antigen, compared to a parent antibody that does not possess those alteration(s). In one embodiment, an affinity-matured antibody has nanomolar or even picomolar affinities for the target antigen. Affinity-matured antibodies are produced by procedures known in the art. For example, Marks et al., Bio/Technology 10:779-783 (1992) describes affinity maturation by VH- and VL-domain shuffling. Random mutagenesis of HVR and/or framework residues is described by, for example: Barbas et al. Proc Nat. Acad. Sci. USA 91:3809-3813 (1994); Schier et al. Gene 169:147-155 (1995); Yelton et al. J. Immunol. 155:1994-2004 (1995); Jackson et al., J. Immunol. 154(7):3310-9 (1995); and Hawkins et al. J. Mol. Biol. 226:889-896 (1992).

[0065] As used herein, the term "specifically recognizes" or "specifically binds" refers to measurable and reproducible interactions such as attraction or binding between a target and an antibody, such as an anti-Sortilin antibody of the present disclosure, that is determinative of the presence of the target in the presence of a heterogeneous population of molecules including biological molecules. For example, an antibody, such as an anti-Sortilin antibody of the present disclosure, that specifically or preferentially binds to a target or an epitope is an antibody that binds this target or epitope with greater affinity, avidity, more readily, and/or with greater duration than it binds to other targets or other epitopes of the target. It is also understood by reading this definition that, for example, an antibody (or a moiety) that specifically or preferentially binds to a first target may or may not specifically or preferentially bind to a second target. As such, "specific binding" or "preferential binding" does not necessarily require (although it can include) exclusive binding. An antibody that specifically binds to a target may have an association constant of at least about 10^3 M^{-1} or 10^4 M^{-1} , sometimes about 10^5 M^{-1} or 10^6 M^{-1} , in other instances about 10^6 M^{-1} or 10^7 M^{-1} , about 10^8 M^{-1} to 10^9 M^{-1} , or about 10^{10} M^{-1} to 10^{11} M^{-1} or higher. A variety of immunoassay formats can be used to select antibodies specifically immunoreactive with a particular protein. For example, solid-phase ELISA immunoassays are routinely used to select monoclonal antibodies specifically immunoreactive with a protein. See, e.g., Harlow and Lane (1988) Antibodies, A Laboratory Manual, Cold Spring Harbor Publications, New York, for a description of immunoassay formats and conditions that can be used to determine specific immunoreactivity.

[0066] As used herein, an "interaction" between a Sortilin protein and a second protein encompasses, without limitation, protein-protein interaction, a physical interaction, a chemical interaction, binding, covalent binding, and ionic binding. As used herein, an antibody "inhibits interaction" between two proteins when the antibody disrupts, reduces, or completely eliminates an interaction between the two proteins. An antibody of the present disclosure, or fragment thereof, "inhibits interaction" between two proteins when the antibody or fragment thereof binds to one of the two proteins.

[0067] An "agonist" antibody or an "activating" antibody is an antibody, such as an agonist anti-Sortilin antibody of the present disclosure, that induces (e.g., increases) one or more activities or functions of the antigen after the antibody binds the antigen.

[0068] A "blocking" antibody, an "antagonist" antibody, or an "inhibitory" antibody is an antibody, such as an anti-Sortilin antibody of the present disclosure, that inhibits or reduces (e.g., decreases) antigen binding to one or more ligand after the antibody binds the antigen, and/or that inhibits or reduces (e.g., decreases) one or more activities or functions of the antigen after the antibody binds the antigen. In some embodiments, blocking antibodies, antagonist antibodies, or inhibitory antibodies substantially or completely inhibit antigen binding to one or more ligand and/or one or more activities or functions of the antigen.

[0069] Antibody "effector functions" refer to those biological activities attributable to the Fc region (a native sequence Fc region or amino acid sequence variant Fc region) of an antibody, and vary with the antibody isotype.

[0070] The term "Fc region" herein is used to define a C-terminal region of an immunoglobulin heavy chain, including native-sequence Fc regions and variant Fc regions. Although the boundaries of the Fc region of an immunoglobulin heavy chain might vary, the human IgG heavy-chain Fc region is usually defined to stretch from an amino acid residue at position Cys226, or from Pro230, to the carboxyl-terminus thereof. The C-terminal lysine (residue 447 according to the EU numbering system) of the Fc region may be removed, for example, during production or purification of the antibody, or by recombinantly engineering the nucleic acid encoding a heavy chain of the antibody. Accordingly, a composition of intact antibodies may comprise antibody populations with all K447 residues removed, antibody populations with no K447 residues removed, and antibody populations having a mixture of antibodies with and without the K447 residue. Suitable native-sequence Fc regions for use in the antibodies of the present disclosure include human IgG1, IgG2, IgG3 and IgG4.

[0071] A "native sequence Fc region" comprises an amino acid sequence identical to the amino acid sequence of an Fc region found in nature. Native sequence human Fc regions include a native sequence human IgG1 Fc region (non-A and A allotypes); native sequence human IgG2 Fc region; native sequence human IgG3 Fc region; and native sequence human IgG4 Fc region as well as naturally occurring variants thereof.

[0072] A "variant Fc region" comprises an amino acid sequence which differs from that of a native sequence Fc region by virtue of at least one amino acid modification, preferably one or more amino acid substitution(s). Preferably, the variant Fc region has at least one amino acid substitution compared to a native sequence Fc region or to the Fc region of a parent polypeptide, e.g. from about one to about ten amino acid substitutions, and preferably from about one to about five amino acid substitutions in a native sequence Fc region or in the Fc region of the parent polypeptide. The variant Fc region herein will preferably possess at least about 80% homology with a native sequence Fc region and/or with an Fc region of a parent polypeptide, and most preferably at least about 90% homology therewith, more preferably at least about 95% homology therewith.

[0073] "Fc receptor" or "FcR" describes a receptor that binds to the Fc region of an antibody. The preferred FcR is a native sequence human FcR. Moreover, a preferred FcR is one which binds an IgG antibody (a gamma receptor) and includes receptors of the FcγRI, FcγRII, and FcγRIII subclasses, including allelic variants and alternatively spliced forms of these

receptors, FcγRTI receptors include FcγRIIA (an "activating receptor") and FcγRIIB (an "inhibiting receptor"), which have similar amino acid sequences that differ primarily in the cytoplasmic domains thereof. Activating receptor FcγRIIA contains an immunoreceptor tyrosine-based activation motif ("ITAM") in its cytoplasmic domain. Inhibiting receptor FcγRIIB contains an immunoreceptor tyrosine-based inhibition motif ("ITIM") in its cytoplasmic domain. Other FcRs, including those to be identified in the future, are encompassed by the term "FcR" herein. FcRs can also increase the serum half-life of antibodies. As used herein, "*percent (%) amino acid sequence identity*" and "*homology*" with respect to a peptide, polypeptide or antibody sequence refers to the percentage of amino acid residues in a candidate sequence that are identical with the amino acid residues in the specific peptide or polypeptide sequence, after aligning the sequences and introducing gaps, if necessary, to achieve the maximum percent sequence identity, and not considering any conservative substitutions as part of the sequence identity. Alignment for purposes of determining percent amino acid sequence identity can be achieved in various ways that are within the skill in the art, for instance, using publicly available computer software such as BLAST, BLAST-2, ALIGN or MEGALIGN™ (DNASTAR) software. Those skilled in the art can determine appropriate parameters for measuring alignment, including any algorithms known in the art needed to achieve maximal alignment over the full length of the sequences being compared.

[0074] An "*isolated*" cell is a molecule or a cell that is identified and separated from at least one contaminant cell with which it is ordinarily associated in the environment in which it was produced. In some embodiments, the isolated cell is free of association with all components associated with the production environment. The isolated cell is in a form other than in the form or setting in which it is found in nature. Isolated cells are distinguished from cells existing naturally in tissues, organs, or individuals. In some embodiments, the isolated cell is a host cell of the present disclosure.

[0075] An "*isolated*" nucleic acid molecule encoding an antibody, such as an anti-Sortilin antibody of the present disclosure, is a nucleic acid molecule that is identified and separated from at least one contaminant nucleic acid molecule with which it is ordinarily associated in the environment in which it was produced. Preferably, the isolated nucleic acid is free of association with all components associated with the production environment. The isolated nucleic acid molecules encoding the polypeptides and antibodies herein is in a form other than in the form or setting in which it is found in nature. Isolated nucleic acid molecules therefore are distinguished from nucleic acid encoding the polypeptides and antibodies herein existing naturally in cells.

[0076] The term "*vector*," as used herein, is intended to refer to a nucleic acid molecule capable of transporting another nucleic acid to which it has been linked. One type of vector is a "plasmid," which refers to a circular double stranded DNA into which additional DNA segments may be ligated. Another type of vector is a phage vector. Another type of vector is a viral vector, wherein additional DNA segments may be ligated into the viral genome. Certain vectors are capable of autonomous replication in a host cell into which they are introduced (*e.g.*, bacterial vectors having a bacterial origin of replication and episomal mammalian vectors). Other vectors (*e.g.*, non-episomal mammalian vectors) can be integrated into the genome of a host cell upon introduction into the host cell, and thereby are replicated along with the host genome. Moreover, certain vectors are capable of directing the expression of genes to which they are operatively linked. Such vectors are referred to herein as "recombinant expression vectors," or simply, "expression vectors." In general, expression vectors of utility in recombinant DNA techniques are often in the form of plasmids. In the present specification, "plasmid" and "vector" may be used interchangeably as the plasmid is the most commonly used form of vector.

[0077] "*Polynucleotide*," or "*nucleic acid*," as used interchangeably herein, refer to polymers of nucleotides of any length, and include DNA and RNA. The nucleotides can be deoxyribonucleotides, ribonucleotides, modified nucleotides or bases, and/or their analogs, or any substrate that can be incorporated into a polymer by DNA or RNA polymerase or by a synthetic reaction.

[0078] A "*host cell*" includes an individual cell or cell culture that can be or has been a recipient for vector(s) for incorporation of polynucleotide inserts. Host cells include progeny of a single host cell, and the progeny may not necessarily be completely identical (in morphology or in genomic DNA complement) to the original parent cell due to natural, accidental, or deliberate mutation. A host cell includes cells transfected *in vivo* with a polynucleotide(s) of the present disclosure.

[0079] "Carriers" as used herein include pharmaceutically acceptable carriers, excipients, or stabilizers that are nontoxic to the cell or mammal being exposed thereto at the dosages and concentrations employed.

[0080] The term "*about*" as used herein refers to the usual error range for the respective value readily known to the skilled person in this technical field. Reference to "*about*" a value or parameter herein includes (and describes) embodiments that are directed to that value or parameter *per se*.

[0081] As used herein and in the appended claims, the singular forms "a," "an," and "the" include plural reference unless the context clearly indicates otherwise. For example, reference to an "antibody" is a reference to from one to many antibodies, such as molar amounts, and includes equivalents thereof known to those skilled in the art, and so forth.

[0082] It is understood that aspect and embodiments of the present disclosure described herein include "comprising," "consisting," and "consisting essentially of" aspects and embodiments.

Overview

[0083] The present disclosure relates, in part, to anti-Sortilin antibodies that exhibit one or more improved and/or enhanced functional characteristics relative to an anti-Sortilin antibody, S-60, having a heavy chain variable region and a light chain variable region as described in WO2016164637. Nonlimiting improved and/or enhanced functional properties include, for example, antibodies capable of binding Sortilin with higher affinity, reducing cell surface levels of Sortilin, decreasing the half-maximal effective concentration (EC₅₀) to reduce cell surface levels of Sortilin, improving the maximal reduction of cell surface levels of Sortilin, increasing extracellular secretion of a Sortilin ligand: *e.g.* Progranulin (PGRN), decreasing the half-maximal effective concentration (EC₅₀) to block PGRN binding to Sortilin, improving the maximal blocking of PGRN binding to Sortilin, or any combination thereof. Also contemplated herein are anti-Sortilin antibodies with different Fc variants that exhibit one or more improved and/or enhanced functional characteristics, including decreasing the half-maximal effective concentration (EC₅₀) to reduce cell surface levels of Sortilin, improving the maximal reduction of cell surface levels of Sortilin, increasing extracellular secretion of a Sortilin ligand: *e.g.* Progranulin (PGRN), decreasing the half-maximal effective concentration (EC₅₀) to block PGRN binding to Sortilin, and improving the maximal blocking of PGRN binding to Sortilin.

[0084] In some embodiments, anti-Sortilin antibodies of the present disclosure have higher potencies in reducing cell surface levels of Sortilin relative to an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60. In some embodiments, potency is measured by half maximal effective concentration (EC₅₀) for reduction of cell surface cell levels of SORT 1.

[0085] The present disclosure further relates to methods of making and using anti-Sortilin antibodies as described herein; pharmaceutical compositions containing such antibodies; nucleic acids encoding such antibodies; and host cells containing nucleic acids encoding such antibodies.

[0086] In some embodiments, the anti-Sortilin antibodies of the present disclosure may have one or more activities that are due, at least in part, to the ability of the antibodies to reduce levels (*e.g.*, cell surface levels) of Sortilin by inducing degradation, down regulation, cleavage, receptor desensitization, and/or lysosomal targeting of Sortilin. In some embodiments, the anti-Sortilin antibodies exhibit one or more of the following properties: a. have a dissociation constant (K_D) for human Sortilin that is lower than that of an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60; b. decrease cell surface levels of Sortilin (*e.g.*, decrease cell surface levels of Sortilin on engineered cells expressing human Sortilin *in vitro*) with a half-maximal effective concentration (EC₅₀) that is lower than that of an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60; c. have a dissociation constant (K_D) for human Sortilin that may range from about 0.560 nM to about 1.63 nM, for example when the K_D is determined by fluorescent activated cell sorting (FACS); d. have a dissociation constant (K_D) for human Sortilin that may range from about 0.270 nM to about 2.910 nM, for example when the K_D is determined by BioLayer Interferometry; e. decrease cell surface levels of Sortilin (*e.g.*, decreases cell surface levels of Sortilin on engineered cells expressing human Sortilin *in vitro*) with a half-maximal effective concentration (EC₅₀) that may range from about 72.58 pM to about 103.6 pM, for example when the EC₅₀ is determined *in vitro* by FACS; f. reduce cell surface levels of Sortilin with a maximum reduction that may range from about 51.33% to 88.76%; g. increase extracellular secretion of PGRN higher than that of an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60; h. block PGRN binding to Sortilin (*e.g.*, block binding of PGRN to Sortilin on engineered cells expressing human Sortilin *in vitro*) with a half-maximal effective concentration (EC₅₀) that may range from about .325 nM to about 2.27 nM, for example when the EC₅₀ is determined *in vitro* by FACS; and/or i. improve the maximal blocking of PGRN binding to Sortilin higher than that of an anti-Sortilin antibody having a heavy chain

variable region and a light chain variable region corresponding to S-60.

[0087] Advantageously, anti-Sortilin antibodies of the present disclosure reduce cell surface levels (*e.g.*, up to approximately 3.02-fold) of Sortilin more potently (*e.g.*, with a lower EC_{50}) as compared to a control anti-Sortilin antibody (*e.g.*, a control anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60) (See *e.g.*, **Example 2**). In some embodiments, anti-Sortilin antibodies of the present disclosure reduce binding of PGRN to Sortilin with a lower EC_{50} (up to approximately 5.36 -fold) more potently as compared to a control anti-Sortilin antibody (*e.g.*, a control anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60) (See *e.g.*, **Example 3**). Moreover, advantageously, anti-Sortilin antibodies of the present disclosure have a higher affinity (*e.g.*, up to approximately 2.79-fold higher affinity) for Sortilin (*e.g.*, a lower K_D value as measured by FACS or BioLayer Interferometry) as compared to a control anti-Sortilin antibody (*e.g.*, a control anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60) (See *e.g.*, **Examples 1 and 4**). Surprisingly, higher affinity for Sortilin does not necessarily correlate with an increase in ability or potency of reduction of cell surface levels of Sortilin (See, *e.g.*, **Examples 2 and 4**) nor an increase in ability or potency of blocking binding of PGRN to Sortilin (See, *e.g.*, **Examples 3 and 4**).

[0088] The present disclosure further relates to anti-Sortilin antibodies with improved stability during manufacturing, storage, and *in vivo* administration. In some embodiments, anti-Sortilin antibodies of the present disclosure have improved stability under various stress conditions (See, *e.g.*, **Example 4**).

Sortilin proteins

[0089] In one aspect, the present disclosure provides antibodies, such as isolated (*e.g.*, monoclonal) antibodies, that interact with or otherwise bind to a region, such as an epitope, within a Sortilin protein of the present disclosure. In some embodiments, the antibodies interact with or otherwise bind to a region, such as an epitope, within a Sortilin protein of the present disclosure with improved/enhanced kinetics (*e.g.*, relative to an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, the antibodies interact with or otherwise bind to a region, such as an epitope, within a human Sortilin protein, with a half-maximal effective concentration (EC_{50}) that is lower than that of a control antibody (*e.g.*, relative to an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a Sortilin protein and modulate one or more Sortilin activities after binding to the Sortilin protein, for example, an activity associated with Sortilin expression on a cell. Sortilin proteins of the present disclosure include, without limitation, a mammalian Sortilin protein, human Sortilin protein, mouse Sortilin protein, and rat Sortilin protein. Exemplary Sortilin protein sequences are shown in **Table 32**.

[0090] Sortilin is variously referred to as sortilin 1, SORT1, 100 kDa NT receptor, glycoprotein 95 (GP95), Progranulin receptor (PGRN-R), and neurotensin receptor 3 (NT-3 or NTR-3). Sortilin is an 831 amino acid protein that encodes a type I membrane receptor. Various Sortilin homologs are known, including without limitation, human Sortilin, rat Sortilin, and mouse Sortilin. The amino acid sequence of human Sortilin is set forth below as SEQ ID NO: 81 (with key amino acid residues predicted to participate in Progranulin binding depicted in bold and, and the predicted pro-NGF binding region underlined):

```

10      20      30      40      50
MERFWGALTC LSRWPSGLGL LLLQLLEPS TLQQRIDAP PPSAAFLRW
60      70      80      90     100
SPGTVSNGL RAAAGSGATE PGRWRSPAR GEDEECQVR DEVAIANHT
110     120     130     140     150
HGRVDEERC SVLWVVGDE TQVILVLEF HTVIVINTFC QSKLYNSEDY
160     170     180     190     200
GGRKQITDL IHTTFIRTF EM AIGGFNSG KVVITAEVSG GSRGGRFES
210     220     230     240     250
SEFRENFWT DLFFHGLTQM HYSFGNDYT LALSTENGSL VERNFGQWE
260     270     280     290     300
ELHKAVALAK WSDNTTFPT TVANGSCVD LCALEARTS DLKRSFKTC
310     320     330     340     350
VLYSPGLGG RLFAAVMAU KPTFRIRVS TDQGVNSMA QLEPVGCECF
360     370     380     390     400
YRIANQDM VSHVVDGSD TQPTITPDS DRGIVYSKL DRHLYTTGG
410     420     430     440     450
EIDPTNITSL RAYTSVLS ENSIQTHIT PQCGSPHTL RSPENSEDA
460     470     480     490     500
TAKRNKCNL NHAHYSLS MAVEAPLS EPHAVGLIA ESEVGDALISV
510     520     530     540     550
HWPGVILSL GGSFVTLGL SHHTILDS GGLIVADLS SRFINVAKS
560     570     580     590     600
YDNGQRQTY ITKRPIYYT GLASFGARS HNYSINGTF SELFSQWVSV
610     620     630     640     650
TIDKILERS KSGKDYTTW LNSTDPEDY EUGCLSTKE QFGLRKSIV
660     670     680     690     700
QGNRDTVVF RQSTGLAL ELIKDPGY RPNHUSKYR QPRKQHTS
710     720     730     740     750

POLYKREHL TINGTKTF DRQGGVNF REVDLKKK TSNFLSEK
760     770     780     790     800
NEKSNVELI LAIVELMNT VAGLVLEIK VVGGRFVH RYSLQQAHE
810     820     830
ANGVDGLAL DTSRTNKG YHDSDELL E

```

[0091] The amino acid sequence of mouse Sortilin is set forth in SEQ ID NO: 82:

```

MERFRAAG LRAFLGLLL LQGLLPAAV GGRIDATF PAFPLRWAS PVGVSGDLA
AAPGQVERA GRWRGAPAE QDCGRLEDF IAKLTNITFC HVEDLSSGV SLRWGDSFG
VILVITTFGV FLVIVSGQS KLYRSEDYGR NPKETILIN HTPIITFPGM AIGFENSQV
ILCPVSGGS RGRVFRSSD FARNFVQTL FHELTQMY SEQNSDYLLA LSTENGAVS
KPFENWPEI HPAVGLANG PNTITFTTH VAGSKADLS ALALNTSPH GATPFTGVK
LYSGLGSEF LPAQVADKL TTRSHVSTD QGDWNSMQL PSVQGEFYS ILAANDNVE
MWDPEGDIG TQPTITSDR GIVVRSGLR NLYTTGGET DFINVSLRS VYLTSLSD
NSQSKITFD QGRWESHQK PRNSKQADA KNNVCSLRT RASYTSQKI NPMRFLSEF
NAVIVLHAG SVGDALSYMV ENVTSODGS YSNAGLEGF RYVTLDSGS ILVADENSR
PIKVLKSTD EAGQNSVYV SQEPVYTHG ASFGARENN ISMGFTKSF LKNGQSVYI
DFKILERNQ EDNYTTWLA HSTDEGVYK GCILOYKEF LRLRMSVQC RGRDVPVAGQ
PFCPCSLSD FLCDPGYFR ENASECVBP ELKHELEFC LYKSEHLEI NGYRKIPGR
QGSNNPARE VKDLKQCIS NEIENKONS KSNVYFILA IVGLMLVTV AGVLIVKGV
CGRFLVRY SVLQQAED GVEALDSSH ACSYHDSST EDLSE

```

[0092] The amino acid sequence of rat Sortilin is set forth in SEQ ID NO: 83:

```

MERFKAAGG LKRPITGLL LQGLLPAAV GGRIDAPFP PAFPLRWAS PVGVSGDLA
AAPGQVERA GRWRGAPAE QDCGRLEDF IAKLTNITFC HVEDLSSGV SLRWGDSFG
VILVITTFGV FLVIVSGQS KLYRSEDYGR NPKETILIN HTPIITFPGM AIGFENSQV
ILCPVSGGS RGRVFRSSD FARNFVQTL FHELTQMY SEQNSDYLLA LSTENGAVS
KPFENWPEI HPAVGLANG PNTITFTTH VAGSKADLS ALALNTSPH GATPFTGVK
LYSGLGSEF LPAQVADKL TTRSHVSTD QGDWNSMQL PSVQGEFYS ILAANDNVE
MWDPEGDIG TQPTITSDR GIVVRSGLR NLYTTGGET DFINVSLRS VYLTSLSD
NSQSKITFD QGRWESHQK PRNSKQADA KNNVCSLRT RASYTSQKI NPMRFLSEF
NAVIVLHAG SVGDALSYMV ENVTSODGS YSNAGLEGF RYVTLDSGS ILVADENSR
PIKVLKSTD EAGQNSVYV SQEPVYTHG ASFGARENN ISMGFTKSF LKNGQSVYI
DFKILERNQ EDNYTTWLA HSTDEGVYK GCILOYKEF LRLRMSVQC RGRDVPVAGQ
PFCPCSLSD FLCDPGYFR ENASECVBP ELKHELEFC LYKSEHLEI NGYRKIPGR
QGSNNPARE VKDLKQCIS NEIENKONS KSNVYFILA IVGLMLVTV AGVLIVKGV
CGRFLVRY SVLQQAED GVEALDSSH ACSYHDSST EDLSE

```

[0093] In some embodiments, the Sortilin is a preprotein that includes a signal sequence. In some embodiments, the Sortilin is a mature protein. In some embodiments, the mature Sortilin protein does not include a signal sequence. In some embodiments, the mature Sortilin protein is expressed on a cell,

[0094] Sortilin proteins of the present disclosure include several domains, including without limitation, a signal sequence, a propeptide, a luminal domain, a Vps10p domain, a 10 CC domain, a transmembrane domain and a cytoplasmic domain. Additionally, proteins of the present disclosure are expressed at high levels in a number of tissues, including without limitation, the brain, spinal cord, heart and skeletal muscle, thyroid, placenta, and testis.

[0095] Accordingly, as used herein a "Sortilin" protein of the present disclosure includes, without limitation, a mammalian Sortilin protein, human Sortilin protein, primate Sortilin protein, mouse Sortilin protein, and rat Sortilin protein. Additionally, anti-Sortilin antibodies of the present disclosure may bind an epitope within one or more of a mammalian Sortilin protein, human Sortilin protein, primate Sortilin, mouse Sortilin protein, and rat Sortilin protein.

Sortilin protein domains

[0096] Sortilin proteins of the present disclosure contain several domains, such as a Vps10p domain that contains an Asp-box motif, a ten-bladed beta-propeller structure, and a hydrophobic loop; and a 10 CC domain.

[0097] As disclosed herein, interactions between Sortilin proteins of the present disclosure and pro-neurotrophins or neurotrophins are mediated by the Vps10p domain that contains a ten-bladed beta-propeller structure and an Asp-box motif. In certain embodiments, Sortilin proteins of the present disclosure contain a Vps10 domain that includes a ten-bladed beta-propeller structure and is located within amino acid residues 78-611 of human Sortilin (SEQ ID NO: 81) or amino acid residues of a mammalian Sortilin that correspond to amino acid residues 78-611 of SEQ ID NO: 81. In certain embodiments, amino acid residues 190-220 of human Sortilin (SEQ ID NO: 81) or amino acid residues of a mammalian Sortilin that correspond to amino acid residues 190-220 of SEQ ID NO: 81 are located within the Vps10p domain.

[0098] Vps10p domains of the present disclosure may include an Asp-box motif. As used herein, Asp-box motifs have the following sequence: (S/T)-X-(D/N)-X-X-X-X-(W/F/Y) (SEQ ID NO: 84), or X-X-(S/T)-X-(D/N)-X-G-X-(T/S)-(W/F/Y)-X (SEQ ID NO: 85), where X represents any amino acid. In human Sortilin, the Asp-box motif is SSDFAKNF (SEQ ID NO:86), located at amino acid residues 200-207 of human Sortilin. Accordingly, in certain embodiments, an Asp-box motif is located at amino acid residues 200-207 of human Sortilin (SEQ ID NO: 81) or amino acid residues of a mammalian Sortilin that correspond to amino acid residues 200-207 of SEQ ID NO: 81.

[0099] As disclosed herein, interactions between Sortilin proteins of the present disclosure and p75 are mediated by the 10CC domain of the hydrophobic loop of the Vps10p domain.

[0100] In certain embodiments, Sortilin proteins of the present disclosure contain a 10CC domain that is located within amino acid residues 610-757 of human Sortilin (SEQ ID NO: 81) or amino acid residues of a mammalian Sortilin that correspond to amino acid residues 610-757 of SEQ ID NO: 81. In preferred embodiments, amino acid residues 592-593, 610-660, and/or 667-749 of human Sortilin (SEQ ID NO: 81) or amino acid residues of a mammalian Sortilin that correspond to amino acid residues 592-593, 610-660, and/or 667-749 of SEQ ID NO: 81 are located within the 10CC domain of Sortilin.

[0101] In other embodiments, Sortilin proteins of the present disclosure contain a hydrophobic loop within the Vps10p domain that is located within amino acid residues 130-141 of human Sortilin (SEQ ID NO: 81) or amino acid residues of a mammalian Sortilin that correspond to amino acid residues 130-141 of SEQ ID NO: 81.

[0102] As one of skill in the art will appreciate, the beginning and ending residues of the domains of the present disclosure may vary depending upon the computer modeling program used or the method used for determining the domain.

Sortilin binding partners

[0103] Sortilin proteins of the present disclosure can interact with (e.g., bind to) one or more proteins including, without limitation, Progranulin (PGRN) protein; neurotrophins, such as pro-neurotrophins, pro-neurotrophin-3, neurotrophin-3, pro-neurotrophin-4/5, neurotrophin-4/5, pro-nerve growth factor (Pro-NGF), nerve growth factor (NGF), pro-brain-derived neurotrophic factor (Pro-BDNF), and brain-derived neurotrophic factor (BDNF); neurotensin, p75, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), amyloid precursor protein, A beta peptide, PCSK9, p75NTR, and receptor associated protein (RAP).

Progranulin (PGRN)

[0104] Sortilin proteins of the present disclosure have been shown to interact (e.g., bind to) directly with Progranulin and mediate the degradation of Progranulin (e.g., Zheng, Y et al., (2011) PLoS ONE 6(6): e21023).

[0105] Progranulin is variously referred to as PGRN, proepithelin, granulin-epithelin precursor, PC (prostate cancer) cell-derived growth factor (PCDGF), and acrogranin. Progranulin is a 593 amino acid protein that encodes a 68.5 kD a secreted glycoprotein that has 7.5 repeats of smaller granulin (epithelin) motifs, ranging from 6-25 kDa, which can be proteolytically cleaved from the precursor PGRN. Examples of Progranulin cleavage products include, without limitation, granulin A/ Epithelins 1, granulin B Epithelins 2, granulin C, granulins D, granulin E, granulin F, granulin G and any other known peptide products derived from Progranulin.

[0106] Accordingly, anti-Sortilin antibodies of the present disclosure that increase Progranulin levels, decrease cell surface levels of Sortilin, and/or block the interaction (e.g., binding) between Sortilin and Progranulin would be beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased levels of Progranulin expression and/or activity, cell death (e.g., neuronal cell death), frontotemporal dementia, Alzheimer's disease, vascular dementia, seizures, retinal dystrophy, a traumatic brain injury, a spinal cord injury, long-term depression, atherosclerotic vascular diseases, undesirable symptoms of normal aging, dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, Crohn's disease, inflammatory bowel disease, ulcerative colitis, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, intervertebral disc degeneration, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomatous disorders, Sarcoidosis, diseases of aging, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, inflammatory disorders, arthritis, multiple sclerosis, metabolic disorder, obesity, insulin resistance, type 2 diabetes, tissue or vascular damage, an injury, and/or one or more undesirable symptoms of normal aging. Additionally, anti-Sortilin antibodies of the present disclosure that increase Progranulin levels, decrease cell surface levels of Sortilin, and/or block the interaction (e.g., binding) between Sortilin and Progranulin may inhibit interaction between Sortilin and Progranulin, may induce one or more Progranulin activities, may reduce the endosomal internalization of Progranulin, or fragments thereof, and/or may increase the effective concentration of Progranulin.

[0107] In some embodiments, anti-Sortilin antibodies of the present disclosure that increase Progranulin levels, decrease cell surface levels of Sortilin, and/or block the interaction (e.g., binding) between Sortilin and Progranulin bind to one or more amino acids within amino acid residues 131-138, 175-181, 190-220, 199-220, 190-211, 196-207, 196-199, 200-207, 203-207, 207-231, 207-227, 212-221, 233-243, 237-247, 237-260, 297-317, 314-338, 367-391, 429-443, 623-632, and/or 740-749 of human Sortilin (SEQ ID NO: 81); or within amino acid residues of a mammalian Sortilin that corresponds to amino acid residues 131-138, 175-181, 190-220, 199-220, 190-211, 196-207, 196-199, 200-207, 203-207, 207-231, 207-227, 212-221, 233-243, 237-247, 237-260, 297-317, 314-338, 367-391, 429-443, 623-632, and/or 740-749 of SEQ ID NO: 81. In other embodiments, anti-Sortilin antibodies of the present disclosure that increase Progranulin levels, decrease cell surface levels of Sortilin, and/or block the interaction (e.g., binding) between Sortilin and Progranulin may bind one or more amino acids of amino acid residues His131, Val132, Pro133, Leu134, Val135, Ile136, Met137, Thr138, Arg196, Phe198, Arg199, Phe203, Lys205, Phe207, Thr210, Thr218, Tyr222, Ser223, Ser227, Ser242, Lys243, Lys248, Lys254, Lys260, Ser305, Phe306, Gly307, Arg311, Phe314, Ser316, Arg325, Arg326, Ile327, Phe350, Tyr351, Ser352, Ile353, Asn373, Ser379, Arg382, Tyr386, Ser595, and/or Glu700 of human Sortilin (SEQ ID NO: 81); or of amino acid residues of a mammalian Sortilin that corresponds to one or more amino acid residues His131, Val132, Pro133, Leu134, Val135, Ile136, Met137, Thr138, Arg196, Phe198, Arg199, Phe203, Lys205, Phe207, Thr210, Thr218, Tyr222, Ser223, Ser227, Ser242,

Lys243, Lys248, Lys254, Lys260, Ser305, Phe306, Gly307, Arg311, Phe314, Ser316, Arg325, Arg326, Ile327, Phe350, Tyr351, Ser352, Ile353, Asn373, Ser379, Arg382, Tyr386, Ser595, and/or Glu700 of SEQ ID NO: 81.

Other Sortilin Ligands

[0108] Sortilin proteins of the present disclosure have been shown to interact (e.g., bind) directly with pro-neurotrophins (e.g., pro-NGF), which harbor a pro-domain and are typically pro-apoptotic. This binding may be mediated through a linear epitope on Sortilin that corresponds to amino acid residues 163-174 of SEQ ID NO: 81. Sortilin proteins of the present disclosure also have been shown to interact (e.g., bind) with neurotensin within the beta-propeller structure of Sortilin, and an important contact has been shown to at serine 283 of human Sortilin.

[0109] Sortilin proteins of the present disclosure have also been shown to interact (e.g., bind) with the low affinity nerve growth factor (NGF) receptor (p75) within the 10CC domain of Sortilin or the hydrophobic loop of the Vps10p domain of Sortilin. As disclosed herein, Sortilin proteins of the present disclosure can function as a co-receptor with p75 for pro-neurotrophins, which induce apoptotic signaling. Sortilin proteins of the present disclosure have further been shown to interact (e.g., bind) with amyloid precursor protein (APP).

[0110] Sortilin proteins of the present disclosure have been shown to interact (e.g., bind) with the lipoprotein lipase (LpL). As disclosed herein, Sortilin proteins of the present disclosure bind to and modify the degradation of LpL. Sortilin proteins of the present disclosure have been shown to interact (e.g., bind) with the apolipoprotein AV (APOA5). As disclosed herein, Sortilin proteins of the present disclosure bind to and modify the degradation of APOA5.

[0111] Sortilin proteins of the present disclosure have been shown to interact (e.g., bind) with the apolipoprotein E (APOE, APOE2, APOE3, APOE4). As disclosed herein, Sortilin proteins of the present disclosure bind to and modify the degradation and transport of APOE as well as agents that APOE carries such as the A beta peptide. In addition, Sortilin proteins of the present disclosure have been shown to interact (e.g., bind) with receptor-associate protein (RAP). Further, Sortilin proteins of the present disclosure have been shown to interact (e.g., bind) with Proprotein convertase subtilisin/kexin type 9 (PCSK9), and secrete it to the circulation.

[0112] In some embodiments of any of the anti-Sortilin antibodies, anti-Sortilin antibodies of the present disclosure may also inhibit (e.g., block) the interaction between Sortilin and one or more other Sortilin ligands of the present disclosure. In some embodiments, the one or more other ligands is one or more of pro-neurotrophins, neurotensin, low affinity nerve growth factor (NGF) receptor (p75), amyloid precursor protein, lipoprotein lipase, apolipoprotein AV, apolipoprotein, receptor-associated protein, and/or proprotein convertase subtilisin/kexin type 9. Such antibodies may be beneficial for preventing, lowering the risk of, or treating conditions and/or diseases associated with decreased levels of one or more other Sortilin ligands expression and/or activity, cell death (e.g., neuronal cell death). In some embodiments, the one or more other ligands is one or more of pro-neurotrophins, neurotensin, low affinity nerve growth factor (NGF) receptor (p75), amyloid precursor protein, lipoprotein lipase, apolipoprotein AV, apolipoprotein, receptor-associated protein, and/or proprotein convertase subtilisin/kexin type 9.

[0113] Anti-Sortilin antibodies of the present disclosure that inhibit (e.g., block) the interaction between Sortilin and one or more other Sortilin ligands of the present disclosure may also prevent cell death (e.g., apoptosis) induced by one or more other Sortilin ligands. In some embodiments, the one or more other ligands is one or more of pro-neurotrophins, neurotensin, low affinity nerve growth factor (NGF) receptor (p75), amyloid precursor protein, lipoprotein lipase, apolipoprotein AV, apolipoprotein, receptor-associated protein, and/or proprotein convertase subtilisin/kexin type 9.

[0114] In some embodiments of any of the anti-Sortilin antibodies, anti-Sortilin antibodies of the present disclosure that inhibit (e.g., block) the interaction between Sortilin and one or more Sortilin ligands of the present disclosure bind one or more amino acids within amino acid residues within amino acid residues 131-138, 175-181, 190-220, 199-220, 190-211, 196-207, 196-199, 200-207, 203-207, 207-231, 207-227, 212-221, 233-243, 237-247, 237-260, 297-317, 314-338, 367-391, 429-443, 623-632, and/or 740-749 of human Sortilin (SEQ ID NO: 81); or within amino acid residues of a mammalian Sortilin that corresponds to amino acid residues 131-138, 175-181, 190-220, 199-220, 190-211, 196-207, 196-199, 200-207, 203-207, 207-231, 212-221, 233-243, 237-247, 237-260, 297-317, 314-338, 367-391, 429-443, 623-632, and/or 740-749 of SEQ ID NO: 81. In some embodiments, the one or more other ligands is one or more of pro-neurotrophins, neurotensin, low affinity nerve growth factor (NGF) receptor (p75), amyloid precursor protein, lipoprotein lipase, apolipoprotein AV, apolipoprotein, receptor-associated protein, and/or proprotein convertase subtilisin/kexin type 9.

[0115] In other embodiments of any of the anti-Sortilin antibodies, anti-Sortilin antibodies of the present disclosure that inhibit (e.g., block) the interaction between Sortilin and one or more Sortilin ligands of the present disclosure bind one or more amino acids of amino acid residues His131, Val132, Pro133, Leu134, Val135, Ile136, Met137, Thr138, Arg196, Phe198, Arg199, Phe203, Lys205, Phe207, Thr210, Thr218, Tyr222, Ser223, Ser227, Ser242, Lys243, Lys248, Lys254, Lys260, Ser305, Phe306, Gly307, Arg311, Phe314, Ser316, Arg325, Arg326, Ile327, Phe350, Tyr351, Ser352, Ile353, Asn373, Ser379, Arg382, Tyr386, Ser595, and/or Glu700 of human Sortilin (SEQ ID NO: 81); or of amino acid residues of a mammalian Sortilin that corresponds to one or more amino acid residues His131, Val132, Pro133, Leu134, Val135, Ile136, Met137, Thr138, Arg196, Phe198, Arg199, Phe203, Lys205, Phe207, Thr210, Thr218, Tyr222, Ser223, Ser227, Ser242, Lys243, Lys248, Lys254, Lys260, Ser305, Phe306, Gly307, Arg311, Phe314, Ser316, Arg325, Arg326, Ile327, Phe350, Tyr351, Ser352, Ile353, Asn373, Ser379, Arg382, Tyr386, Ser595, and/or Glu700 of SEQ ID NO: 81. In some embodiments, the one or more other ligands is one or more of pro-neurotrophins, neurotensin, low affinity nerve growth factor (NGF) receptor (p75), amyloid precursor protein, lipoprotein lipase, apolipoprotein AV, apolipoprotein, receptor-associated protein, and/or proprotein convertase subtilisin/kexin type 9.

Sortilin antibodies

[0116] Certain aspects of the present disclosure relate to anti-Sortilin antibodies comprising one or more improved and/or enhanced functional characteristics. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise one or more improved and/or enhanced functional characteristics relative to an anti-Sortilin antibody, S-60, having a heavy chain variable region and a light chain variable region as described in WO2016164637. In some embodiments, anti-Sortilin antibodies of the present disclosure have an affinity for Sortilin (e.g., human Sortilin) that is higher than that of a control anti-Sortilin antibody (e.g., a control anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure decrease cellular levels (e.g., cell surface levels) of Sortilin to a greater degree and with a half-maximal effective concentration (EC50) that is lower than that of a control antibody (e.g., a control anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure improve the maximal reduction of cell surface levels of Sortilin relative to an anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60. In some embodiments, anti-Sortilin antibodies of the present disclosure increase the secretion of extracellular Progranulin (PGRN) relative to an anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60. In some embodiments, anti-Sortilin antibodies of the present disclosure blocking binding of PGRN to Sortilin to a greater degree and with a half-maximal effective concentration (EC50) that is lower than that of a control antibody (e.g., a control anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure improve the maximal blocking of PGRN binding to Sortilin relative to an anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60.

[0117] Also contemplated herein are anti-Sortilin antibodies with different Fc variants that exhibit one or more improved and/or enhanced functional characteristics relative to an anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60, including decreasing the half-maximal effective concentration (EC50) to reduce cell surface levels of Sortilin, improving the maximal reduction of cell surface levels of Sortilin, increasing extracellular secretion of PGRN, decreasing the half-maximal effective concentration (EC50) to block PGRN binding to Sortilin, and improving the maximal blocking of PGRN binding to Sortilin,

[0118] In some embodiments, an anti-Sortilin antibody of the present disclosure is a human antibody, a bispecific antibody, a monoclonal antibody, a multivalent antibody, a conjugated antibody, or a chimeric antibody

[0119] In a preferred embodiment, an anti-Sortilin antibody of the present disclosure is a monoclonal antibody.

Anti-Sortilin antibody binding, epitope

[0120] In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a Sortilin protein of the present disclosure and/or naturally occurring variants. In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a Sortilin protein, wherein the Sortilin protein is a human protein. In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a Sortilin protein, wherein the Sortilin protein is a wild-type protein. In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a Sortilin protein, wherein the Sortilin protein is a naturally occurring variant.

[0121] In certain preferred embodiments, anti-Sortilin antibodies of the present disclosure bind specifically to a human Sortilin protein.

[0122] Certain aspects of the present disclosure provide anti-Sortilin antibodies that bind a discontinuous Sortilin epitope. In some embodiments, the discontinuous Sortilin epitope comprises two or more peptides, three or more peptides, four or more peptides, five or more peptides, six or more peptides, seven or more peptide, eight or more peptides, nine or more peptides, or 10 or more peptides. In some embodiments, each of the peptides comprise five or more, six or more, seven or more, eight or more, nine or more, 10 or more, 11 or more, 12 or more, 13 or more 14 or more, 15 or more, 16 or more, 17 or more, 18 or more, 19 or more, 20 or more, 21 or more, 22 or more, 23 or more, 24 or more, 25 or more, 26 or more, 27 or more, 28 or more, 29 or more, or 30 or more amino acid residues of the amino acid sequence of SEQ ID NO: 81; or five or more, six or more, seven or more, eight or more, nine or more, 10 or more, 11 or more, 12 or more, 13 or more 14 or more, 15 or more, 16 or more, 17 or more, 18 or more, 19 or more, 20 or more, 21 or more, 22 or more, 23 or more, 24 or more, 25 or more, 26 or more, 27 or more, 28 or more, 29 or more, or 30 or more amino acid residues on a mammalian Sortilin protein corresponding to the amino acid sequence of SEQ ID NO: 81. Other aspects of the present disclosure provide anti-Sortilin antibodies that bind to a conformational epitope of Sortilin.

[0123] Certain aspects of the present disclosure provide anti-Sortilin antibodies that bind to one or more amino acids within amino acid residues 207-231 of human Sortilin (SEQ ID NO: 81); or within amino acid residues on a mammalian Sortilin corresponding to amino acid residues 207-231 of SEQ ID NO: 81. In some embodiments, the anti-Sortilin antibodies bind to one or more amino acids of amino acid residues Thr218, Tyr222, Ser223, and/or Ser227 of human Sortilin (SEQ ID NO: 81); or of amino acid residues on a mammalian Sortilin corresponding to amino acid residues Thr218, Tyr222, Ser223, and/or Ser227 of SEQ ID NO: 81. In some embodiments, the anti-Sortilin antibodies bind to one or more amino acids of amino acid residues F105, L108, R109, G110, 1537, F569, E590, F592, L593, S595, and/or W597 of human Sortilin (SEQ ID NO: 81); or of amino acid residues on a mammalian Sortilin corresponding to amino acid residues F105, L108, R109, G110, 1537, F569, E590, F592, L593, S595, and/or W597 of SEQ ID NO: 81. Other aspects of the present disclosure provide anti-Sortilin antibodies that bind to an epitope having amino acid residues (S/T)-X-(D/N)-X-X-X-X-(W/F/Y), where X represents any amino acid (SEQ ID NO: 84).

[0124] In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a Sortilin protein of the present disclosure expressed on the surface of cell and the naked antibodies inhibit interaction (e.g., binding) between the Sortilin protein and a protein selected from Progranulin (PGRN), a pro-neurotrophin, a neurotrophin, pro-neurotrophin-3, neurotrophin-3, pro-neurotrophin-4/5, neurotrophin-4/5, pro-nerve growth factor (pro-NGF), nerve growth factor (NGF), pro-brain-derived neurotrophic factor (pro-BDNF), brain-derived neurotrophic factor (BDNF), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), PCSK9, and receptor associated protein (RAP). In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a Sortilin protein of the present disclosure expressed on the surface of cell and the naked antibodies inhibit interaction (e.g., binding) between the Sortilin protein and PGRN.

[0125] In some embodiments, anti-Sortilin antibodies of the present disclosure that bind to a Sortilin protein of the present disclosure inhibit interaction (e.g., binding) between the Sortilin protein and Progranulin, a pro-neurotrophin, a neurotrophin, pro-neurotrophin-3, neurotrophin-3, pro-neurotrophin-4/5, neurotrophin-4/5, pro-nerve growth factor (pro-NGF), nerve growth factor (NGF), pro-brain-derived neurotrophic factor (pro-BDNF), brain-derived neurotrophic factor (BDNF), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), PCSK9, and receptor associated protein (RAP) by reducing the effective levels of Sortilin that is available to interact with these proteins either on the cell surface or inside the cell.

[0126] In some embodiments, anti-Sortilin antibodies of the present disclosure that bind to a Sortilin protein of the present disclosure inhibit interaction (e.g., binding) between the Sortilin protein and Progranulin, a pro-neurotrophin, a neurotrophin, pro-neurotrophin-3, neurotrophin-3, pro-neurotrophin-4/5, neurotrophin-4/5, pro-nerve growth factor (pro-NGF), nerve growth factor (NGF), pro-brain-derived neurotrophic factor (pro-BDNF), brain-derived neurotrophic factor (BDNF), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), PCSK9, and receptor associated protein (RAP) by inducing degradation of Sortilin.

[0127] In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a human Sortilin, or a homolog thereof, including without limitation, a mammalian Sortilin protein, or a non-human primate Sortilin protein. In some embodiments, anti-Sortilin antibodies of the present disclosure specifically bind to human Sortilin. In some embodiments, anti-Sortilin antibodies of the present disclosure bind to human Sortilin and are not cross-reactive with Sortilin orthologs or homologs from other species.

Anti-Sortilin antibody competitive binding

[0128] In some embodiments, anti-Sortilin antibodies of the present disclosure competitively inhibit binding of at least one other anti-Sortilin antibody selected from any of the antibodies listed in Tables 1-29. In some embodiments, anti-Sortilin antibodies of the present disclosure competitively inhibit binding of at least one antibody selected from: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33V], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16; S-60-18, S-60-19, S-60-24; and any combination thereof.

[0129] In some embodiments, an anti-Sortilin antibody of the present disclosure competes with one or more anti-Sortilin antibodies selected from: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33V], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16; S-60-18, S-60-19, S-60-24 and any combination thereof, for binding to Sortilin when the anti-Sortilin antibody reduces the binding of one or more antibodies selected from: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33V], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16; S-60-18, S-60-19, S-60-24; and any combination thereof to Sortilin by an amount the ranges from about 50% to 100%, as compared to binding to Sortilin in the absence of the anti-Sortilin antibody.

[0130] In some embodiments, an anti-Sortilin antibody of the present disclosure competes with one or more anti-Sortilin antibodies selected from: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33V], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16; S-60-18, S-60-19, S-60-24, and any combination thereof, for binding to Sortilin when the anti-Sortilin antibody reduces the binding of one or more antibodies selected from: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33V], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16; S-60-18, S-60-19, S-60-24; and any combination thereof to Sortilin by at least 50%, at least 55%, by at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or 100%, as compared to binding to Sortilin in the absence of the anti-Sortilin antibody.

[0131] In some embodiments, an anti-Sortilin antibody of the present disclosure that reduces the binding of one or more antibodies selected from: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33V], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16; S-60-18, S-60-19, S-60-24, and any combination thereof, to Sortilin by 100% indicates that the anti-Sortilin antibody essential completely blocks the binding of one or more antibodies selected from S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33V], S-60-15.12 [N33F], S-

S-60-15.13 [N33J], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24, and any combination thereof, to Sortilin. In some embodiments, the anti-Sortilin antibody and the one or more antibodies selected from S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33J], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24, and any combination thereof, are present in an amount that corresponds to a 10:1 ratio, 9:1 ratio, 8:1 ratio, 7:1 ratio, 6:1 ratio, 5:1 ratio, 4:1 ratio, 3:1 ratio, 2:1 ratio, 1:1 ratio, 0.75:1 ratio, 0.5:1 ratio, 0.25:1 ratio, 0.1:1 ratio, 0.075:1 ratio, 0.050:1 ratio, 0.025:1 ratio, 0.01:1 ratio, 0.0075:1 ratio, 0.0050:1 ratio, 0.0025:1 ratio, 0.001:1 ratio, 0.00075:1 ratio, 0.00050:1 ratio, 0.00025:1 ratio, 0.0001:1 ratio, 1:10 ratio, 1:9 ratio, 1:8 ratio, 1:7 ratio, 1:6 ratio, 1:5 ratio, 1:4 ratio, 1:3 ratio, 1:2 ratio, 1:0.75 ratio, 1:0.5 ratio, 1:0.25 ratio, 1:0.1 ratio, 1:0.075 ratio, 1:0.050 ratio, 1:0.025 ratio, 1:0.01 ratio, 1:0.0075 ratio, 1:0.0050 ratio, 1:0.0025 ratio, or 1:0.0001 ratio of anti-Sortilin antibody to one or more antibodies selected from S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33J], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24, and any combination thereof. In some embodiments, the anti-Sortilin antibody is present in excess by an amount that ranges from about 1.5-fold to 100-fold, or greater than 100-fold compared to the amount of the one or more antibodies selected from S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33J], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24, and any combination thereof. In some embodiments, the anti-Sortilin antibody is present in an amount that is about a 2-fold, 3-fold, 4-fold, 5-fold, 6-fold, 7-fold, 8-fold, 9-fold, 10-fold, 15-fold, 20-fold, 25-fold, 30-fold, 35-fold, 40-fold, 45-fold, 50-fold, 55-fold, 60-fold, 65-fold, 70-fold, 75-fold, 80-fold, 90-fold, 95-fold, or 100-fold excess compared to the amount of the one or more antibodies selected from S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33J], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24, and any combination thereof.

[0132] In some embodiments, anti-Sortilin antibodies of the present disclosure bind to an epitope of human Sortilin that is the same as or overlaps with the Sortilin epitope bound by at least one antibody selected from any of the antibodies listed in Tables 1-29. In some embodiments, anti-Sortilin antibodies of the present disclosure bind to an epitope of human Sortilin that is the same as or overlaps with the Sortilin epitope bound by at least one antibody selected from: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33J], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24; and any combination thereof. In some embodiments, anti-Sortilin antibodies of the present disclosure bind essentially the same Sortilin epitope bound by at least one antibody selected from any of the antibodies listed in Tables 1-29. In some embodiments, anti-Sortilin antibodies of the present disclosure bind essentially the same Sortilin epitope bound by at least one antibody selected from: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33J], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24; and any combination thereof. Detailed exemplary methods for mapping an epitope to which an antibody binds are provided in Morris (1996) "Epitope Mapping Protocols," in Methods in Molecular Biology vol. 66 (Humana Press, Totowa, NJ).

[0133] Any suitable competition assay or Sortilin binding assay known in the art, such as BiAcCore analysis, ELISA assays, or flow cytometry, may be utilized to determine whether an anti-Sortilin antibody competes with one or more antibodies selected from: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 (described in WO2016164637); or S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33J], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24; and any combination thereof for binding to Sortilin. In an exemplary competition assay, immobilized Sortilin or cells expressing Sortilin on the cell surface are incubated in a solution comprising a first labeled antibody that binds to Sortilin (e.g., human or non-human primate) and a second unlabeled antibody that is being tested for its ability to compete with the first antibody for binding to Sortilin. The second antibody may be present in a hybridoma supernatant. As a control, immobilized Sortilin or cells expressing Sortilin is incubated in a solution comprising the first labeled antibody but not the second unlabeled antibody. After incubation under conditions permissive for binding of the first antibody to Sortilin, excess unbound antibody is removed, and the amount of label associated with immobilized Sortilin or cells expressing Sortilin is measured. If the amount of label associated with immobilized Sortilin or cells expressing Sortilin is substantially reduced in the test sample relative to the control sample, then that indicates that the second antibody is competing with the first antibody for binding to Sortilin. See, Harlow and Lane (1988) Antibodies: A Laboratory Manual ch. 14 (Cold Spring Harbor Laboratory, Cold Spring Harbor, NY).

[0134] In some embodiments, an anti-Sortilin antibody of the present disclosure competes with an antibody comprising the heavy chain variable domain and the light chain variable domain of an antibody selected from the group consisting of S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-16, S-60-18, S-60-19, S-60-24, and any combination thereof for binding to Sortilin.

[0135] In some embodiments, an anti-Sortilin antibody of the present disclosure binds essentially the same Sortilin epitope as an antibody comprising the heavy chain variable domain and the light chain variable domain of an antibody selected from the group consisting of S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-16, S-60-18, S-60-19, and S-60-24.

[0136] Additional anti-Sortilin antibodies, e.g., antibodies that specifically bind to a Sortilin protein of the present disclosure, may be identified, screened, and/or characterized for their physical/chemical properties and/or biological activities by various assays known in the art.

Anti-Sortilin antibody heavy chain and light chain variable regions

A. Heavy chain HVRs

[0137] In some embodiments, anti-Sortilin antibodies of the present disclosure include a heavy chain variable region comprising one or more (e.g., one or more, two or more, or all three) HVRs selected from HVR-H1, HVR-H2, and HVR-H3 (as shown in Tables 14-16). In some embodiments, the heavy chain variable region comprises an HVR-H1, an HVR-H2, and an HVR-H3 (as shown in Tables 14-16).

[0138] In some embodiments, the HVR-H1 comprises a sequence of YSISGGYYWG (SEQ ID NO: 1). In some embodiments, the HVR-H2 comprises a sequence according to Formula I: TIYHSGSTYYNPSLX₁S (SEQ ID NO: 4), wherein X₁ is K or E. In some embodiments, the HVR-H2 comprises a sequence selected from SEQ ID NOs: 2-3. In some embodiments, the HVR-H3 comprises a sequence according to Formula II: ARQGSIX₁QGYYGMVDV (SEQ ID NO: 7). In some embodiments, the HVR-H3 comprises a sequence selected from SEQ ID NOs: 5-6.

[0139] In some embodiments, the HVR-H1 comprises an amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence of SEQ ID NO: 1. In some embodiments, the HVR-H1 comprises an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence of SEQ ID NO: 1), but retains the ability to bind to Sortilin. In certain embodiments, up to 1, up to 2, up to 3, up to 4, or up to 5 amino acids been substituted, inserted, and/or deleted in the HVR-H1 amino acid sequence of SEQ ID NO: 1. In some embodiments, the HVR-H2 comprises an amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence selected from SEQ ID NOs: 2-3. In some embodiments, the HVR-H2 comprises an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence selected from SEQ ID NOs: 2-3), but retains the ability to bind to Sortilin. In certain embodiments, up to 1, up to 2, up to 3, up to 4, or up to 5 amino acids been substituted, inserted, and/or deleted in the HVR-H2 amino acid sequence selected from SEQ ID NOs: 2-3. In some embodiments, the HVR-H3 comprises an

amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence selected from SEQ ID NOs: 5-6. In some embodiments, the HVR-H3 comprises an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence selected from SEQ ID NOs: 5-6), but retains the ability to bind to Sortilin. In certain embodiments, up to 1, up to 2, up to 3, up to 4, or up to 5 amino acids been substituted, inserted, and/or deleted in the HVR-H3 amino acid sequence selected from SEQ ID NOs: 5-6.

[0140] In some embodiments, the heavy chain variable region comprises an HVR-H1 comprising a sequence of YSISGGYYWG (SEQ ID NO: 1), an HVR-H2 comprising a sequence according to Formula I, and an HVR-H3 comprising a sequence according to Formula II.

[0141] In some embodiments, the heavy chain variable region comprises an HVR-H1 comprising a sequence of SEQ ID NO: 1, an HVR-H2 comprising a sequence selected from SEQ ID NOs: 2-3, and an HVR-H3 comprising a sequence selected from SEQ ID NOs: 5-6.

[0142] In some embodiments, the heavy chain variable region comprises the HVR-H1 HVR-H2, and HVR-H3 of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24, or any combination thereof (as shown in **Tables 14-16**).

[0143] In some embodiments, anti-Sortilin antibodies of the present disclosure include a heavy chain variable region, wherein the heavy chain variable region comprises one or more of: (a) an HVR-H1 comprising an amino acid sequence with at least 85%, at least 86%, at least 87%, at least 88%, at least 89%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to an HVR-H1 amino acid sequence of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24; (b) an HVR-H2 comprising an amino acid sequence with at least 85%, at least 86%, at least 87%, at least 88%, at least 89%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to an HVR-H2 amino acid sequence of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24; and (c) an HVR-H3 comprising an amino acid sequence with at least 85%, at least 86%, at least 87%, at least 88%, at least 89%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to an HVR-H3 amino acid sequence of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24.

[0144] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise an HVR-H1 comprising the amino acid sequence YSISGGYYWG (SEQ ID NO: 1), an HVR-H2 comprising the amino acid sequence TIYHSGSTYYNPSLKS (SEQ ID NO: 2), and an HVR-H3 comprising the amino acid sequence ARQGSIKQGYGMDV (SEQ ID NO: 6).

B. Light chain HVRs

[0145] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain variable region comprising one or more (e.g., one or more, two or more, or all three) HVRs selected from HVR-L1, HVR-L2, and HVR-L3 (as shown in **Tables 17-19**). In some embodiments, the light chain variable region comprises an HVR-L1, an HVR-L2, and an HVR-L3 (as shown in **Tables 17-19**).

[0146] In some embodiments, the HVR-L1 comprises a sequence according to Formula III: $RSSQX_1LLX_2Sx_3GYNYLD$ (SEQ ID NO: 28), wherein X_1 is S or G, X_2 is R or H, and X_3 is N, T, S, G, R, D, H, K, Q, Y, E, W, F, I, V, A, M, or L. In some embodiments, the HVR-L1 comprises a sequence selected from SEQ ID NOs: 8-27. In some embodiments, the HVR-L1 comprises a sequence of RSSQSLLRSGYNYLD (SEQ ID NO: 8), RSSQSLLRSTGYNYLD (SEQ ID NO: 9), RSSQS LLRSGYNYLD (SEQ ID NO: 10), RSSQSLLRSGGYNYLD (SEQ ID NO: 11), RSSQSLLRSG YNYLD (SEQ ID NO: 12), RSSQSLLRSDGYNYLD (SEQ ID NO: 13), RSSQSLLRSHGYNYLD (SEQ ID NO: 14), RSSQSLLRSGKGYNYLD (SEQ ID NO: 15), RSSQSLLRSGQGYNYLD (SEQ ID NO: 16), RSSQSLLRSGYNYLD (SEQ ID NO: 17), RSSQSLLRSEGYNYLD (SEQ ID NO: 18), RSSQSLLRSMGYNYLD (SEQ ID NO: 19), RSSQSLLRSEGYNYLD (SEQ ID NO: 20), RSSQSL LRSGYNYLD (SEQ ID NO: 21), RSSQSLLRSGVGYNYLD (SEQ ID NO: 22), RSSQSLLRSG YNYLD (SEQ ID NO: 23), RSSQSLLRSMGYNYLD (SEQ ID NO: 24), RSSQSLLRSEGYNYLD (SEQ ID NO: 25), RSSQSLLRHSGYNYLD (SEQ ID NO: 26), or RSSQSLLRSGYNYLD (SEQ ID NO: 27). In one specific embodiment, the HVR-L1 comprises a sequence of RSSQSLLRSGYNYLD (SEQ ID NO: 8). In another specific embodiment, the HVR-L1 comprises a sequence of RSSQSLLRSTGYNYLD (SEQ ID NO: 9) (as shown in **Table 19**).

[0147] In some embodiments, the HVR-L2 comprises a sequence according to Formula IV: $LGSNRX_1S$ (SEQ ID NO: 31), wherein X_1 is A or V. In some embodiments, the HVR-L2 comprises a sequence selected from SEQ ID NOs: 29-30.

[0148] In some embodiments, the HVR-L3 comprises a sequence according to Formula V: $MQQXEX_1PLT$ (SEQ ID NO: 34), wherein X_1 is A or T. In some embodiments, the HVR-L3 comprises a sequence selected from SEQ ID NOs: 32-33.

[0149] In some embodiments, the HVR-L1 comprises an amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence selected from SEQ ID NOs: 8-27. In some embodiments, the HVR-L1 comprises an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence selected from SEQ ID NOs: 8-27), but retains the ability to bind to Sortilin. In certain embodiments, up to 1, up to 2, up to 3, up to 4, or up to 5 amino acids been substituted, inserted, and/or deleted in the HVR-L1 amino acid sequence selected from SEQ ID NOs: 8-27. In some embodiments, the HVR-L2 comprises an amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence selected from SEQ ID NOs: 29-30. In some embodiments, the HVR-L2 comprises an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence selected from SEQ ID NOs: 29-30), but retains the ability to bind to Sortilin. In certain embodiments, up to 1, up to 2, up to 3, up to 4, or up to 5 amino acids been substituted, inserted, and/or deleted in the HVR-L2 amino acid sequence selected from SEQ ID NOs: 29-30. In some embodiments, the HVR-L3 comprises an amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence selected from SEQ ID NOs: 32-33. In some embodiments, the HVR-L3 comprises an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence selected from SEQ ID NOs: 32-33), but retains the ability to bind to Sortilin. In certain embodiments, up to 1, up to 2, up to 3, up to 4, or up to 5 amino acids been substituted, inserted, and/or deleted in the HVR-L3 amino acid sequence selected from SEQ ID NOs: 32-33.

[0150] In some embodiments, the light chain variable region comprises an HVR-L1 comprising a sequence according to Formula III, an HVR-L2 comprising a sequence according to Formula IV, and an HVR-L3 comprising a sequence according to Formula V. In some embodiments, the light chain variable region comprises an HVR-L1 comprising a sequence selected from SEQ ID NOs: 8-27, an HVR-L2 comprising a sequence selected from SEQ ID NOs: 29-30, and an HVR-L3 comprising a sequence selected from SEQ ID NOs: 32-33.

[0151] In some embodiments, the light chain variable region comprises the HVR-L1, HVR-L2, and HVR-L3 of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24, or any combination thereof (as shown in **Tables 17-19**).

[0152] In some embodiments, anti-Sortilin antibodies of the present disclosure include a light chain variable region, wherein the light chain variable region comprises one or more of: (a) an HVR-L1 comprising an amino acid sequence with at least 85%, at least 86%, at least 87%, at least 88%, at least 89%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to an HVR-L1 amino acid sequence of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-

[0162] In some embodiments, an anti-Sortilin antibody of the present disclosure comprises a heavy chain variable region comprising the HVR-H1 comprising the amino acid sequence YSSGGYQQG (SEQ ID NO: 1), the HVR-H2 comprising the amino acid sequence TIYHSGSTYYNPSLKS (SEQ ID NO: 2), the HVR-H3 comprising the amino acid sequence ARSGGYYQGGYGMVD (SEQ ID NO: 5) and a light chain variable region comprising the HVR-L1 comprising the amino acid sequence RSSQSLRSRNGNYLD (SEQ ID NO: 8), the

HVR-L2 comprising the amino acid sequence LGSNRVS (SEQ ID NO: 30), and the HVR-L3 comprising the amino acid sequence MQQQETPLT (SEQ ID NO: 33).

[0163] In some embodiments, an anti-Sortilin antibody of the present disclosure comprises a heavy chain variable region comprising the HVR-H1 comprising the amino acid sequence YSISSGYWVG (SEQ ID NO: 1), the HVR-H2 comprising the amino acid sequence TIYHSGSTYYNPSLES (SEQ ID NO: 3), the HVR-H3 comprising the amino acid sequence ARQGSIQGGYYGMDV (SEQ ID NO: 5); and a light chain variable region comprising the HVR-L1 comprising the amino acid sequence RSSQSLLRSGYNYLD (SEQ ID NO: 8), the HVR-L2 comprising the amino acid sequence LGSNRAS (SEQ ID NO: 29), and the HVR-L3 comprising the amino acid sequence MQQQEAPLT (SEQ ID NO: 32).

[0164] In some aspects, an anti-Sortilin antibody of the present disclosure comprises a heavy chain variable region comprising the HVR-H1 comprising the amino acid sequence YSISSGYWVG (SEQ ID NO: 1), the HVR-H2 comprising the amino acid sequence TIYHSGSTYYNPSLKS (SEQ ID NO: 2), the HVR-H3 comprising the amino acid sequence ARQGSIQGGYYGMDV (SEQ ID NO: 6); and a light chain variable region comprising the HVR-L1 comprising the amino acid sequence RSSQSLLRSGYNYLD (SEQ ID NO: 8), the HVR-L2 comprising the amino acid sequence LGSNRAS (SEQ ID NO: 29), and the HVR-L3 comprising the amino acid sequence MQQQEAPLT (SEQ ID NO: 32).

[0165] In some aspects, an anti-Sortilin antibody of the present disclosure comprises a heavy chain variable region comprising the HVR-H1 comprising the amino acid sequence YSISSGYWVG (SEQ ID NO: 1), the HVR-H2 comprising the amino acid sequence TIYHSGSTYYNPSLKS (SEQ ID NO: 2), the HVR-H3 comprising the amino acid sequence ARQGSIQGGYYGMDV (SEQ ID NO: 6); and a light chain variable region comprising the HVR-L1 comprising the amino acid sequence RSSQSLLRSGYNYLD (SEQ ID NO: 9), the HVR-L2 comprising the amino acid sequence LGSNRAS (SEQ ID NO: 29), and the HVR-L3 comprising the amino acid sequence MQQQEAPLT (SEQ ID NO: 32).

[0166] In some embodiments, an anti-Sortilin antibody of the present disclosure comprises a heavy chain variable region comprising the HVR-H1 comprising the amino acid sequence YSISSGYWVG (SEQ ID NO: 1), the HVR-H2 comprising the amino acid sequence TIYHSGSTYYNPSLKS (SEQ ID NO: 2), the HVR-H3 comprising the amino acid sequence ARQGSIQGGYYGMDV (SEQ ID NO: 6); and a light chain variable region comprising the HVR-L1 comprising the amino acid sequence RSSQSLLRSGYNYLD (SEQ ID NO: 8), the HVR-L2 comprising the amino acid sequence LGSNRAS (SEQ ID NO: 29), and the HVR-L3 comprising the amino acid sequence MQQQETPLT (SEQ ID NO: 33).

[0167] In some embodiments, an anti-Sortilin antibody of the present disclosure comprises a heavy chain variable region comprising the HVR-N1 comprising the amino acid sequence YSISSGYWVG (SEQ ID NO: 1), the HVR-H2 comprising the amino acid sequence TIYHSGSTYYNPSLKS (SEQ ID NO: 2), the HVR-H3 comprising the amino acid sequence ARQGSIQGGYYGMDV (SEQ ID NO: 5); and a light chain variable region comprising the HVR-L1 comprising the amino acid sequence RSSQSLLRSGYNYLD (SEQ ID NO: 26), the HVR-L2 comprising the amino acid sequence LGSNRAS (SEQ ID NO: 29), and the HVR-L3 comprising the amino acid sequence MQQQETPLT (SEQ ID NO: 33).

[0168] In some embodiments, an anti-Sortilin antibody of the present disclosure comprises a heavy chain variable region comprising the HVR-H1 comprising the amino acid sequence YSISSGYWVG (SEQ ID NO: 1), the HVR-H2 comprising the amino acid sequence TIYHSGSTYYNPSLKS (SEQ ID NO: 2), the HVR-H3 comprising the amino acid sequence ARQGSIQGGYYGMDV (SEQ ID NO: 6); and a light chain variable region comprising the HVR-L1 comprising the amino acid sequence RSSQSLLRSGYNYLD (SEQ ID NO: 27), the HVR-L2 comprising the amino acid sequence LGSNRAS (SEQ ID NO: 29), and the HVR-L3 comprising the amino acid sequence MQQQEAPLT (SEQ ID NO: 32).

D. Heavy chain variable region

[0169] In some embodiments, anti-Sortilin antibodies of the present disclosure include a heavy chain variable region comprising an amino acid sequence selected from SEQ ID NOs: 54-56. In some embodiments, the heavy chain variable region comprises an amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence selected from SEQ ID NOs: 54-56. In some embodiments, the heavy chain variable region comprises an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence selected from SEQ ID NOs: 54-56), but retains the ability to bind to Sortilin. In certain embodiments, up to 1, up to 2, up to 3, up to 4, up to 5, up to 6, up to 7, up to 8, up to 9, or up to 10 amino acids been substituted, inserted, and/or deleted in the heavy chain variable region amino acid sequence selected from SEQ ID NOs: 54-56.

[0170] In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 56.

[0171] In some embodiments, anti-Sortilin antibodies of the present disclosure include a heavy chain variable region of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24 (as shown in **Table 30**).

[0172] In some embodiments, anti-Sortilin antibodies of the present disclosure include a heavy chain variable region comprising an HVR-H1 comprising the amino acid sequence YSISSGYWVG (SEQ ID NO: 1), an HVR-H2 comprising the amino acid sequence TIYHSGSTYYNPSLKS (SEQ ID NO: 2), and an HVR-H3 comprising the amino acid sequence ARQGSIQGGYYGMDV (SEQ ID NO: 6).

E. Light chain variable region

[0173] In some embodiments, anti-Sortilin antibodies of the present disclosure include a light chain variable region comprising an amino acid sequence selected from SEQ ID NOs: 57-80. In some embodiments, the light chain variable region comprises an amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence selected from SEQ ID NOs: 57-80. In some embodiments, the light chain variable region comprises an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence selected from SEQ ID NOs: 57-80), but retains the ability to bind to Sortilin. In certain embodiments, up to 1, up to 2, up to 3, up to 4, up to 5, up to 6, up to 7, up to 8, up to 9, or up to 10 amino acids been substituted, inserted, and/or deleted in the light chain variable region amino acid sequence selected from SEQ ID NOs: 57-80.

[0174] In some embodiments, the light chain variable region includes the amino acid sequence of SEQ ID NO: 57. In some embodiments, the light chain variable region includes the amino acid sequence of SEQ ID NO: 60.

[0175] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain variable region of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24 (as shown in **Table 31**).

[0176] In some embodiments, anti-Sortilin antibodies of the present disclosure include a light chain variable region comprising an HVR-L1 comprising the amino acid sequence RSSQSLLRSGYNYLD (SEQ ID NO: 8), an HVR-L2 comprising the amino acid sequence LGSNRAS (SEQ ID NO: 29), and an HVR-L3 comprising the amino acid sequence MQQQEAPLT (SEQ ID NO: 32).

[0177] In some embodiments, anti-Sortilin antibodies of the present disclosure include a light chain variable region comprising an HVR-L1 comprising the amino acid sequence RSSQSLLRSGYNYLD (SEQ ID NO: 9), an HVR-L2 comprising the amino acid sequence LGSNRAS (SEQ ID NO: 29), and an HVR-L3 comprising the amino acid sequence MQQQEAPLT (SEQ ID NO: 32).

F. Heavy chain variable region and light chain variable region

[0178] In some aspects, an anti-Sortilin antibody of the present disclosure includes a heavy chain variable region comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 54-56; and/or a light chain variable region comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 57-80. In some

embodiments, the heavy chain variable region comprises an amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence selected from SEQ ID NOs: 54-56, and the light chain variable region comprises an amino acid sequence with at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, at least about 99%, or 100% identity to an amino acid sequence selected from SEQ ID NOs: 57-80. In some embodiments, an anti-Sortilin antibody of the present disclosure includes a heavy chain variable region comprising an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence selected from SEQ ID NOs: 54-56), and a light chain variable region comprising an amino acid sequence containing substitutions (e.g., conservative substitutions, insertions, or deletions relative to an amino acid sequence selected from SEQ ID NOs: 57-80), but retains the ability to bind to Sortilin. In certain embodiments, up to 1, up to 2, up to 3, up to 4, up to 5, up to 6, up to 7, up to 8, up to 9, or up to 10 amino acids have been substituted, inserted, and/or deleted in the heavy chain variable region amino acid sequence selected from SEQ ID NOs: 54-56; and up to 1, up to 2, up to 3, up to 4, up to 5, up to 6, up to 7, up to 8, up to 9, or up to 10 amino acids have been substituted, inserted, and/or deleted in the light chain variable region amino acid sequence selected from SEQ ID NOs: 57-80.

[0179] In some aspects, an anti-Sortilin antibody of the present disclosure includes a heavy chain variable region comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 54-56; and/or a light chain variable region comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 57-58, 60-78, and 80.

[0180] In some embodiments, an anti-Sortilin antibody of the present disclosure binds to a Sortilin protein, wherein the antibody includes a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 54, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 57; a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 54, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 58; a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 54, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 59; a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 55, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 57; a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 55, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 58; a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 56, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 57; a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 56, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 77; a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 56, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 78; a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 54, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 79; or a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 56, and a light chain variable region comprising the amino acid sequence of SEQ ID NO: 80.

[0181] In one aspect, an anti-Sortilin antibody of the present disclosure includes a heavy chain variable region having the amino acid sequence of SEQ ID NO: 56, and a light chain variable region having the amino acid sequence of SEQ ID NO: 57.

[0182] In one aspect, an anti-Sortilin antibody of the present disclosure includes a heavy chain variable region having the amino acid sequence of SEQ ID NO: 56, and a light chain variable region having the amino acid sequence of SEQ ID NO: 60.

[0183] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable region of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24 (as shown in **Table 30**), and a light chain variable region of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24 (as shown in **Table 31**).

[0184] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 56, and a light chain variable region comprising an amino acid sequence selected from SEQ ID NOs: 56 and 60. In some embodiments, the antibody comprises a heavy chain variable region of S-60-15 [N33 (wt)] (as shown in **Table 30**), and a light chain variable region of antibody S-60-15 [N33 (wt)] (as shown in **Table 31**). In some embodiments, the antibody comprises a heavy chain variable region of S-60-15.1 [N33T] (as shown in **Table 30**), and a light chain variable region of antibody S-60-15.1 [N33T] (as shown in **Table 31**).

Exemplary anti-Sortilin antibodies

[0185] In some embodiments, the anti-Sortilin antibody is an anti-Sortilin monoclonal antibody comprising the heavy chain variable region and the light chain variable region of an antibody selected from S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24. In some embodiments, the anti-Sortilin antibody is an anti-Sortilin monoclonal antibody comprising the heavy chain and the light chain of an antibody selected from S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24.

(1) S-60-10

[0186] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable domain and a light chain variable domain, wherein the heavy chain variable domain comprises an amino acid sequence with at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a heavy chain variable domain amino acid sequence of antibody S-60-10 or to the amino acid sequence of SEQ ID NO: 54; and/or the light chain variable domain comprises an amino acid sequence with at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a light chain variable domain amino acid sequence of antibody S-60-10 or to the amino acid sequence of SEQ ID NO: 57. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable domain comprising an amino acid sequence with at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a heavy chain variable domain amino acid sequence of antibody S-60-10 or to the amino acid sequence of SEQ ID NO: 54, wherein the heavy chain variable domain comprises the HVR-H1, HVR-H2, and HVR-H3 amino acid sequences of antibody S-60-10. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain variable domain comprising an amino acid sequence with at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a light chain variable domain amino acid sequence of antibody S-60-10 or to the amino acid sequence of SEQ ID NO: 57, wherein the light chain variable domain comprises the HVR-L1, HVR-L2, and HVR-L3 amino acid sequences of antibody S-60-10. In some embodiments, the anti-Sortilin antibody comprises a heavy chain variable domain (VH) sequence having at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a heavy chain variable domain amino acid sequence of antibody S-60-10 or to the amino acid sequence of SEQ ID NO: 54 and contains substitutions (e.g., conservative substitutions, insertions, or deletions relative to the reference sequence), but the anti-Sortilin antibody comprising that sequence retains the ability to bind to Sortilin. In certain embodiments, a total of 1 to 10 amino acids have been substituted, inserted, and/or deleted in the heavy chain variable domain amino acid sequence of antibody S-60-10 or the amino acid sequence of SEQ ID NO: 54. In certain embodiments, a total of 1 to 5 amino acids have been substituted, inserted and/or deleted in the heavy chain variable domain amino acid sequence of antibody S-60-10 or the amino acid sequence of SEQ ID NO: 54. In certain embodiments, substitutions, insertions, or deletions occur in regions outside the HVRs (i.e., in the FR regions). In some embodiments, the substitutions, insertions, or deletions occur in the FR regions. Optionally, the anti-Sortilin antibody comprises the VH sequence of antibody S-60-10 or of SEQ ID NO: 54, including post-translational modifications of that sequence. In a particular embodiment, the VH comprises one, two or three HVRs selected from: (a) the HVR-H1 amino acid sequence of antibody S-60-10, (b) the HVR-H2 amino acid sequence of antibody S-60-10, and (c) the HVR-H3 amino acid sequence of antibody S-60-10. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain variable domain (VL) sequence having at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a light chain variable domain amino acid sequence of antibody S-60-10 or to the amino acid sequence of SEQ ID NO: 57 and contains substitutions (e.g., conservative substitutions, insertions, or deletions relative to the reference sequence), but the anti-Sortilin antibody comprising that sequence retains the ability to bind to Sortilin. In certain embodiments, a total of 1 to 10 amino acids have been substituted, inserted, and/or deleted in the light chain variable domain amino acid sequence of antibody S-60-10 or the amino acid sequence of SEQ ID NO: 57. In certain embodiments, a total of 1 to 5 amino acids have been substituted, inserted and/or deleted in the light chain variable domain amino acid sequence of antibody S-60-10 or the amino acid sequence of SEQ ID NO: 57. In certain embodiments, substitutions, insertions, or deletions occur in regions outside the HVRs (i.e., in the FR regions). In some

(2) S-60-11

[0189] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain comprising the amino acid sequence of SEQ ID NO: 105 or SEQ ID NO: 106. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain comprising the amino acid sequence of SEQ ID NO: 140. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain comprising the amino acid sequence of SEQ ID NO: 105 or SEQ ID NO: 106 and a light chain comprising the amino acid sequence of SEQ ID NO: 140.

(3) S-60-12

[0191] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain comprising the amino acid sequence of SEQ ID NO: 105 or SEQ ID NO: 106. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain comprising the amino acid sequence of SEQ ID NO: 141. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain comprising the amino acid sequence of SEQ ID NO: 105 or SEQ ID NO: 106 and a light chain comprising the amino acid

(7) S-60-15.1

(8) S-60-16

[0200] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable domain and a light chain variable domain, wherein the heavy chain variable domain comprises an amino acid sequence with at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a heavy chain variable domain amino acid sequence of antibody S-60-16 or to the amino acid sequence of SEQ ID NO: 56; and/or the light chain variable domain comprises an amino acid sequence with at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a light chain variable domain amino acid sequence of antibody S-60-16 or to the amino acid sequence of SEQ ID NO: 77. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable domain comprising an amino acid sequence with at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a heavy chain variable domain amino acid sequence of antibody S-60-16 or to the amino acid sequence of SEQ ID NO: 56; and/or the light chain variable domain comprises an amino acid sequence with at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or 100% identity to a light chain variable domain amino acid sequence of antibody S-60-16 or to the amino acid sequence of SEQ ID NO: 77.

[0212] In some embodiments, the anti-Sortilin antibody is anti-Sortilin monoclonal antibody S-60-13. In some embodiments, the anti-Sortilin antibody is an isolated antibody which binds essentially the same Sortilin epitope as S-60-13. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region of monoclonal antibody S-60-13. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the light chain variable region of monoclonal antibody S-60-13. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region and the light chain variable region of monoclonal antibody S-60-13.

[0213] In some embodiments, the anti-Sortilin antibody is anti-Sortilin monoclonal antibody S-60-14. In some embodiments, the anti-Sortilin antibody is an isolated antibody which binds essentially the same Sortilin epitope as S-60-14. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region of monoclonal antibody S-60-14. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the light chain variable region of monoclonal antibody S-60-14. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region and the light chain variable region of monoclonal antibody S-60-14.

[0214] In some embodiments, the anti-Sortilin antibody is anti-Sortilin monoclonal antibody S-60-15. In some embodiments, the anti-Sortilin antibody is an isolated antibody which binds essentially the same Sortilin epitope as S-60-15. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region of monoclonal antibody S-60-15. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the light chain variable region of monoclonal antibody S-60-15. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region and the light chain variable region of monoclonal antibody S-60-15.

[0215] In some embodiments, the anti-Sortilin antibody is anti-Sortilin monoclonal antibody S-60-15.1. In some embodiments, the anti-Sortilin antibody is an isolated antibody which binds essentially the same Sortilin epitope as S-60-15.1. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region of monoclonal antibody S-60-15.1. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the light chain variable region of monoclonal antibody S-60-15.1. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region and the light chain variable region of monoclonal antibody S-60-15.1.

[0216] In some embodiments, the anti-Sortilin antibody is anti-Sortilin monoclonal antibody S-60-16. In some embodiments, the anti-Sortilin antibody is an isolated antibody which binds essentially the same Sortilin epitope as S-60-16. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region of monoclonal antibody S-60-16. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the light chain variable region of monoclonal antibody S-60-16. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region and the light chain variable region of monoclonal antibody S-60-16.

[0217] In some embodiments, the anti-Sortilin antibody is anti-Sortilin monoclonal antibody S-60-18. In some embodiments, the anti-Sortilin antibody is an isolated antibody which binds essentially the same Sortilin epitope as S-60-18. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region of monoclonal antibody S-60-18. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the light chain variable region of monoclonal antibody S-60-18. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region and the light chain variable region of monoclonal antibody S-60-18.

[0218] In some embodiments, the anti-Sortilin antibody is anti-Sortilin monoclonal antibody S-60-19. In some embodiments, the anti-Sortilin antibody is an isolated antibody which binds essentially the same Sortilin epitope as S-60-19. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region of monoclonal antibody S-60-19. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the light chain variable region of monoclonal antibody S-60-19. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region and the light chain variable region of monoclonal antibody S-60-19.

[0219] In some embodiments, the anti-Sortilin antibody is anti-Sortilin monoclonal antibody S-60-24. In some embodiments, the anti-Sortilin antibody is an isolated antibody which binds essentially the same Sortilin epitope as S-60-24. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region of monoclonal antibody S-60-24. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the light chain variable region of monoclonal antibody S-60-24. In some embodiments, the anti-Sortilin antibody is an isolated antibody comprising the heavy chain variable region and the light chain variable region of monoclonal antibody S-60-24.

[0220] In certain embodiments, the anti-Sortilin antibody is an antagonist antibody. In certain embodiments, the anti-Sortilin antibody is an agonist antibody. In some embodiments, anti-Sortilin antibodies of the present disclosure are of the IgG class the IgM class, or the IgA class. In some embodiments, anti-Sortilin antibodies of the present disclosure are of the IgG class and have an IgG1, IgG2, IgG3, or IgG4 isotype.

[0221] Additional anti-Sortilinantibodies, *e.g.*, antibodies that specifically bind to a Sortilin protein of the present disclosure, may be identified, screened, and/or characterized for their physical/chemical properties and/or biological activities by various assays known in the art.

[0222] Certain aspects of the present disclosure relate to the use of two or more anti-Sortilin antibodies that when utilized together display additive or synergistic effects, as compared to utilization of a corresponding single anti-Sortilin antibody.

[0223] In some embodiments, an anti-Sortilin antibody of the present disclosure is an antibody fragment that binds to a human Sortilin protein.

[0224] In some embodiments, an anti-Sortilin antibody of the present disclosure is an antibody fragment that binds to one or more human proteins selected from the group consisting of human Sortilin, a naturally occurring variant of human Sortilin, and a disease variant of human Sortilin.

[0225] In some embodiments, an anti-Sortilin antibody of the present disclosure is antibody fragment, wherein the antibody fragment is an Fab, Fab', Fab -SH, F(ab')₂, Fv, or scFv fragment.

Antibody frameworks

[0226] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable region comprising one or more (*e.g.*, one or more, two or more, three or more, or all four) framework regions selected from VH FR1, VH FR2, VH FR3, and VH FR4 (as shown in **Tables 20-23**). In some embodiments, the VH FR1 comprises a sequence of QVQLQESGPGLVKPSSETLSL TCAVSG (SEQ ID NO: 35). In some embodiments, the VH FR2 comprises a sequence of VMRQPPGKGLEVMG (SEQ ID NO: 36). In some embodiments, the VH FR3 comprises the sequence according to Formula VI: X₁VTISVDTSKNQFSLX₂LSSVTAADTAVYYC (SEQ ID NO: 39), wherein X₁ is Q or R, and X₂ is E or K. In some embodiments, VH FR3 comprises a sequence selected from the group consisting of SEQ ID NOs: 37-38. In some embodiments, VH FR4 comprises a sequence of WGQGTTVTVSS (SEQ ID NO: 40). In some embodiments, an antibody comprises a heavy chain variable region comprising a VH FR1 comprising the sequence of SEQ ID NO: 35, a VH FR2 comprising the sequence of SEQ ID NO: 36, a VH FR3 according to Formula VI, and a VH FR4 comprising the sequence of SEQ ID NO: 40.

[0227] In some embodiments, an antibody comprises a heavy chain variable region comprising a VH FR1 comprising the sequence of SEQ ID NO: 35, a VH FR2 comprising the sequence of SEQ ID NO: 36, a VH FR3 comprising the sequence selected from SEQ ID NOs: 37-38, and a VH FR4 comprising the sequence of SEQ ID NO: 40.

[0228] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable region comprising a VH FR1, a VH FR2, a VH FR3, and VH FR4 of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24 (as shown in **Tables 20-23**).

[0229] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain variable region comprising one or more (*e.g.*, one or more, two or more, three or more, or all four) framework regions selected from VL FR1, VL FR2, VL FR3, and VL FR4 (as shown in **Tables 24-27**). In some embodiments, the VL FR1 comprises a sequence according to Formula VII: DIVMTQSPFLSPVTPGX₁X₂ASISC (SEQ ID NO: 44), wherein X₁ is E or G, and X₂ is P or S. In some embodiments, VL FR1 comprises a sequence selected from the group consisting of SEQ ID NOs: 41-43. In some embodiments, the VL FR2 comprises a sequence according to Formula VIII: WYLLQKPGQX₁PQLLIY (SEQ ID NO: 47), wherein X₁ is S or P. In some embodiments, VL FR2 comprises a sequence selected from the group consisting of SEQ ID NOs: 45-46. In some embodiments, the VL FR3 comprises a sequence according to Formula IX: GVPDRX₁SGSGSGT DFTLKISRXX₂EAEDVGGX₃YYC (SEQ ID NO: 52), wherein X₁ is F or L, X₂ is A or V, and X₃ is V or A. In some embodiments, VL FR3 comprises a sequence selected from the group consisting of SEQ ID NOs: 48-51. In some embodiments, the VL FR4 comprises a sequence of FGGGTKVEIK (SEQ ID NO: 53). In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain variable region comprising a VL FR1 comprising the sequence according to Formula VII, a VL FR2 comprising the sequence according to Formula VIII, a VL FR3 comprising the sequence according to Formula IX, and a VL FR4 comprising the sequence of SEQ ID NO: 53.

[0230] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain variable region comprising a VL FR1 comprising the sequence selected from SEQ ID NOs: 41-43, a VL FR2 comprising the sequence selected from SEQ ID NOs: 45-46, a VL FR3 comprising the sequence selected from SEQ ID NOs: 48-51, and a VL FR4 comprising

the sequence of SEQ ID NO: 53.

[0231] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a light chain variable region comprising a VL FR1, a VL FR2, a VL FR3, and VL FR4 of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24 (as shown in **Tables 24-27**).

[0232] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable region comprising one or more (*e.g.*, one or more, two or more, three or more, or all four) framework regions selected from VH FR1, VH FR2, VH FR3, and VH FR4 (as shown in **Tables 20-23**), and a light chain variable region comprising one or more (*e.g.*, one or more, two or more, three or more, or all four) framework regions selected from VL FR1, VL FR2, VL FR3, and VL FR4 (as shown in **Tables 24-27**). In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable region comprising a

[0233] VH FR1 comprising the sequence of SEQ ID NO: 35, a VH FR2 comprising the sequence of SEQ ID NO: 36, a VH FR3 according to Formula VI, and a VH FR4 comprising the sequence of SEQ ID NO: 41; and a light chain variable region comprising a VL FR1 comprising the sequence according to Formula VII, a VL FR2 comprising the sequence according to Formula VIII, a VL FR3 comprising the sequence according to Formula IX, and a VL FR4 comprising the sequence of SEQ ID NO: 53. In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable region comprising a VH FR1 comprising the sequence of SEQ ID NO: 35, a VH FR2 comprising the sequence of SEQ ID NO: 36, a VH FR3 comprising the sequence selected from SEQ ID NOs: 37-38, and a VH FR4 comprising the sequence of SEQ ID NO: 40; a light chain variable region comprising a VL FR1 comprising the sequence selected from SEQ ID NOs: 41-43, a VL FR2 comprising the sequence selected from SEQ ID NOs: 45-46, a VL FR3 comprising the sequence selected from SEQ ID NOs: 48-51, and a VL FR4 comprising the sequence of SEQ ID NO: 53.

[0234] In some embodiments, anti-Sortilin antibodies of the present disclosure comprise a heavy chain variable region comprising a VH FR1, a VH FR2, a VH FR3, and VH FR4 of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24 (as shown in **Tables 20-23**), and a light chain variable region comprising a VL FR1, a VL FR2, a VL FR3, and VL FR4 of antibody S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, or S-60-24 (as shown in **Tables 24-27**).

Anti-Sortilin Antibody Activities

[0235] In certain aspects of any of the anti-Sortilin antibodies, anti-Sortilin antibodies of the present disclosure can inhibit one or more activities of a Sortilin protein, including, but not limited to, decreasing cellular levels of Sortilin (*e.g.*, cell surface levels of Sortilin, intracellular levels of Sortilin, and/or total levels of Sortilin); increasing Progranulin levels (*e.g.*, extracellular levels of Progranulin and/or cellular levels of Progranulin); and inhibiting the interaction (*e.g.*, binding) between Progranulin and Sortilin. As contemplated herein, anti-Sortilin antibodies of the present disclosure may inhibit additional activities of a Sortilin protein, including but not limited to inhibiting interaction (*e.g.*, binding) with one or more of pro-neurotrophins of the present disclosure (pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, *etc.*), neurotrophins of the present disclosure (neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), and receptor associated protein (RAP), decreasing secretion of PCSK9, decreasing production of beta amyloid peptide..

[0236] In certain embodiments, the present disclosure provides an anti-Sortilin antibody, wherein (a) the anti-Sortilin antibody increases extracellular levels of Progranulin, decreases cellular levels of Sortilin, inhibits interaction between Sortilin and Progranulin, or any combination thereof; (b) the anti-Sortilin antibody decreases cell surface levels of Sortilin, increases extracellular levels of Progranulin, inhibits interaction between Sortilin and Progranulin, or any combination thereof; (c) the anti-Sortilin antibody decreases cell surface levels of Sortilin, decreases intracellular levels of Sortilin, decreases total levels of Sortilin, or any combination thereof; (d) the anti-Sortilin antibody induces Sortilin degradation, Sortilin cleavage, Sortilin internalization, Sortilin down regulation, or any combination thereof; (e) the anti-Sortilin antibody decreases cellular levels of Sortilin and inhibits the interaction between Sortilin and Progranulin; (f) the anti-Sortilin antibody decreases cellular levels of Sortilin and increases cellular levels of Progranulin; and/or (g) the anti-Sortilin antibody increases the effective concentration of Progranulin.

[0237] In certain embodiments, the present disclosure provides an anti-Sortilin antibody, wherein the anti-Sortilin antibody decreases cell surface levels of Sortilin, increases extracellular levels of Progranulin, inhibits interaction between Sortilin and Progranulin, or any combination thereof.

[0238] In some embodiments, an anti-Sortilin antibody of the present disclosure (a) reduces cell surface levels of Sortilin with a half maximal effective concentration (EC_{50}) that is less than 150 pM, as measured by flow cytometry; (b) reduces cell surface levels of Sortilin by more than about 50% at 1.25 nM IgG, by more than about 80% at 0.63 nM IgG, or by more than about 69% at 150 nM IgG relative to control, as measured by flow cytometry; increases Progranulin secretion by more than about 1.13 fold over control at 0.63 nM IgG, or by more than about 1.22 fold over control at 50 nM IgG, as measured by standard ELISA; blocks binding of Progranulin to Sortilin with a half maximal effective concentration (EC_{50}) that is less than .325 nM, as measured by flow cytometry; (e) blocks binding of Progranulin to Sortilin by more than about 88% at 50 nM IgG, or by more than about 27.5% at 150 nM IgG relative to control, as measured by flow cytometry; or (f) any combination thereof (*see, e.g.*, **Examples 2-4**).

[0239] In some embodiments, an anti-Sortilin antibody of the present disclosure (a) reduces cell surface levels of Sortilin with a half maximal effective concentration (EC_{50}) that is less than 681 pM, as measured by flow cytometry; (b) reduces cell surface levels of Sortilin by more than about 40% at 1.25 nM IgG, by more than about 29% at 0.6 nM IgG, or by more than about 62% at 150 nM IgG relative to control, as measured by flow cytometry; (c) increases Progranulin secretion by more than about 1.11 fold over control at 0.63 nM IgG, or by more than about 1.75 fold over control at 50 nM IgG, as measured by standard ELISA; (d) blocks binding of Progranulin to Sortilin with a half maximal effective concentration (EC_{50}) that is less than 0.751 nM, as measured by flow cytometry; (e) blocks binding of Progranulin to Sortilin by more than about 90% at 50 nM IgG, or by more than about 95% at 150 nM IgG relative to control, as measured by flow cytometry; or (f) any combination thereof (*see, e.g.*, **Examples 2-4**).

Decreasing Sortilin levels

[0240] In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a Sortilin protein of the present disclosure expressed on the surface of a cell and modulate (*e.g.*, induce or inhibit) one or more Sortilin activities of the present disclosure after binding to the surface-expressed Sortilin protein,

[0241] In some embodiments, anti-Sortilin antibodies of the present disclosure decrease cellular levels of Sortilin *in vitro*. In some embodiments, anti-Sortilin antibodies of the present disclosure may decrease cellular levels of Sortilin *in vivo* (*e.g.*, in the brain, and/or peripheral organs of an individual). In some embodiments, a decrease in cellular levels of Sortilin comprises a decrease in cell surface levels of Sortilin. As used herein, an anti-Sortilin antibody decreases cell surface levels of Sortilin if it induces a decrease at saturating antibody concentrations (*e.g.*, 0.6 nM, 0.63 nM, 1.25 nM, 50 nM or 150 nM) and/or relative to a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60) in cell surface levels of Sortilin as measured by any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art. In some embodiments, a decrease in cellular levels of Sortilin comprises a decrease in intracellular levels of Sortilin. As contemplated herein, an anti-Sortilin antibody decreases intracellular levels of Sortilin if it induces a decrease at saturating antibody concentrations and/or relative to a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60) in intracellular levels of Sortilin as measured by any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art. In some embodiments, a decrease in cellular levels of Sortilin comprises a decrease in total levels of Sortilin. As contemplated herein, an anti-Sortilin antibody decreases total levels of Sortilin if it induces a decrease at saturating antibody concentrations and/or relative to a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60) in total levels of Sortilin as measured by any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art.

[0242] As used herein, levels of Sortilin may refer to expression levels of the gene encoding Sortilin; to expression levels of one or more transcripts encoding Sortilin; to expression

levels of Sortilin protein; and/or to the amount of Sortilin protein present within cells and/or on the cell surface. Any methods known in the art for measuring levels of gene expression, transcription, translation, and/or protein abundance or localization may be used to determine the levels of Sortilin.

[0243] Cellular levels of Sortilin may refer to, without limitation, cell surface levels of Sortilin, intracellular levels of Sortilin, and total levels of Sortilin. In some embodiments, a decrease in cellular levels of Sortilin comprises decrease in cell surface levels of Sortilin. In some embodiments, anti-Sortilin antibodies of the present disclosure that decrease cellular levels of Sortilin (*e.g.*, cell surface levels of Sortilin) have one or more of the following characteristics: (1) inhibits or reduces one or more Sortilin activities; (2) the ability to inhibit or reduce binding of a Sortilin to one or more of its ligands; (3) the ability to reduce Sortilin expression in Sortilin-expressing cells; (4) the ability to interact, bind, or recognize a Sortilin protein; (5) the ability to specifically interact with or bind to a Sortilin protein; and (6) the ability to treat, ameliorate, or prevent any aspect of a disease or disorder described or contemplated herein.

[0244] In some embodiments, an isolated anti-Sortilin antibody of the present disclosure induces downregulation of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure induces cleavage of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure induces internalization of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure induces shedding of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure induces degradation of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure induces desensitization of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure acts as a ligand mimetic to transiently activate Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure acts as a ligand mimetic and transiently activates Sortilin before inducing a decrease in cellular levels of Sortilin and/or inhibition of interaction (*e.g.*, binding) between Sortilin and one or more Sortilin ligands. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure acts as a ligand mimetic and transiently activates Sortilin before inducing degradation of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure acts as a ligand mimetic and transiently activates Sortilin before inducing cleavage of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure acts as a ligand mimetic and transiently activates Sortilin before inducing internalization of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure acts as a ligand mimetic and transiently activates Sortilin before inducing shedding of Sortilin. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure acts as a ligand mimetic and transiently activates Sortilin before inducing downregulation of Sortilin expression. In some embodiments, an isolated anti-Sortilin antibody of the present disclosure acts as a ligand mimetic and transiently activates Sortilin before inducing desensitization of Sortilin.

[0245] In certain embodiments, anti-Sortilin antibodies of the present disclosure may decrease cellular levels of Sortilin (*e.g.*, cell surface levels of Sortilin, intracellular levels of Sortilin, and/or total levels of Sortilin) by inducing Sortilin degradation. Accordingly, in some embodiments, anti-Sortilin antibodies of the present disclosure induce Sortilin degradation.

[0246] Anti-Sortilin antibodies of the present disclosure may decrease cellular levels (*e.g.*, cell surface levels) of Sortilin with a half-maximal effective concentration (EC_{50}) (*e.g.*, when measured *in vitro*) in the picomolar range. In certain embodiments, the EC_{50} of the antibody is less than about 680.9 pM. In certain embodiments, the EC_{50} of the antibody is about 72.58 pM to about 680.9 nM. In certain embodiments, the EC_{50} of the antibody is about 103.6 pM to about 680.9 nM. In certain embodiments, the EC_{50} of the antibody is less than about 600 pM, 500 pM, 400 pM, 300 pM, 200 pM, 100 pM, 50 pM, 40 pM, 30 pM, 20 pM, 10 pM, 1 pM, or 0.5 pM.

[0247] In some embodiments, the EC_{50} of the antibody is less than about or equal to about 675 pM, 650 pM, 625 pM, 600 pM, 575 pM, 550 pM, 525 pM, 500 pM, 475 pM, 450 pM, 425 pM, 400 pM, 375 pM, 350 pM, 325 pM, 300 pM, 275 pM, 250 pM, 225 pM, 200 pM, 175 pM, 150 pM, 125 pM, 100 pM, 90 pM, 80 pM, 70 pM, 60 pM, 50 pM, 40 pM, 30 pM, 20 pM, 10 pM, 9 pM, 8 pM, 7 pM, 6 pM, 5 pM, 4 pM, 3 pM, 2 pM, 1 pM, or 0.5 pM.

[0248] In some embodiments, the EC_{50} of the antibody is less than about 680.9 pM. In some embodiments, the EC_{50} of the antibody is greater than about or equal to about 0.1 pM, 0.5 pM, 1 pM, 10 pM, 20 pM, 30 pM, 40 pM, 50 pM, 60 pM, 70 pM, 80 pM, 90 pM, 100 pM, 125 pM, 150 pM, 175 pM, 200 pM, 225 pM, 250 pM, 275 pM, 300 pM, 325 pM, 350 pM, 375 pM, 400 pM, 425 pM, 450 pM, 475 pM, 500 pM, 525 pM, 550 pM, 575 pM, 600 pM, 625 pM, 650 pM, 675 pM. That is, the EC_{50} of the antibody can be any of a range having an upper limit of about 675 pM, 650 nM, 650 pM, 625 pM, 600 pM, 575 pM, 550 pM, 525 pM, 500 pM, 475 pM, 450 pM, 425 pM, 400 pM, 375 pM, 350 pM, 325 pM, 300 pM, 275 pM, 250 pM, 225 pM, 200 pM, 175 pM, 150 pM, 125 pM, 100 pM, 90 pM, 80 pM, 70 pM, 60 pM, 50 pM, 40 pM, 30 pM, 20 pM, 10 pM, 1 pM, or 0.5 pM, and an independently selected lower limit of about 0.1 pM, 0.5 pM, 1 pM, 10 pM, 20 pM, 30 pM, 40 pM, 50 pM, 60 pM, 70 pM, 80 pM, 90 pM, 100 pM, 125 pM, 150 pM, 175 pM, 200 pM, 225 pM, 250 pM, 275 pM, 300 pM, 325 pM, 350 pM, 375 pM, 400 pM, 425 pM, 450 pM, 475 pM, 500 pM, 525 pM, 550 pM, 575 pM, 600 pM, 625 pM, 650 pM, or 675 pM, wherein the lower limit is less than the upper limit. In some embodiments, the EC_{50} of the antibody is any of about 1 pM, 2 pM, 3 pM, 4 pM, 5 pM, 6 pM, 7 pM, 8 pM, 9 pM, 10 pM, 15 pM, 20 pM, 25 pM, 30 pM, 35 pM, 40 pM, 45 pM, 50 pM, 55 pM, 60 pM, 65 pM, 70 pM, 75 pM, 80 pM, 85 pM, 90 pM, 95 pM, 100 pM, 105 pM, 110 pM, 115 pM, 120 pM, 125 pM, 130 pM, 135 pM, 140 pM, 145 pM, 150 pM, 155 pM, 160 pM, 165 pM, 170 pM, 175 pM, 180 pM, 185 pM, 190 pM, 195 pM, or 200 pM.

[0249] In some embodiments, an anti-Sortilin antibody of the present disclosure reduces cell surface levels of Sortilin with a half maximal effective concentration (EC_{50}) that is less than 150 pM, as measured by flow cytometry. In some embodiments, the EC_{50} of an anti-Sortilin antibody of the present disclosure is about 103.6 pM. In some embodiments, the EC_{50} of an anti-Sortilin antibody of the present disclosure is about 72.58 pM.

[0250] In some embodiments, an anti-Sortilin antibody of the present disclosure reduces cell surface levels of Sortilin by more than about 40% at 1.25 nM IgG or by more than about 80% at 0.63 nM IgG, as measured by flow cytometry. In some embodiments, an anti-Sortilin antibody of the present disclosure reduces cell surface levels of Sortilin by about 60.92% at 1.25 nM IgG, as measured by flow cytometry. In some embodiments, an anti-Sortilin antibody of the present disclosure reduces cell surface levels of Sortilin by about 69.3% at 150 nM IgG, as measured by flow cytometry. In some embodiments, an anti-Sortilin antibody of the present disclosure reduces cell surface levels of Sortilin by about 70.3% at 150 nM IgG, as measured by flow cytometry.

[0251] Various methods of measuring antibody EC_{50} values are known in the art, including, for example, by flow cytometry (See *e.g.*, **Example 2**). In some embodiments, the EC_{50} is measured *in vitro* using cells engineered to express human Sortilin. In some embodiments, the EC_{50} is measured at a temperature of approximately 4°C. In some embodiments, the EC_{50} is measured at a temperature of approximately 25°C. In some embodiments, the EC_{50} is measured at a temperature of approximately 35°C. In some embodiments, the EC_{50} is measured at a temperature of approximately 37°C. In some embodiments, the EC_{50} is determined using a monovalent antibody (*e.g.*, a Fab) or a full-length antibody in a monovalent form. In some embodiments, the EC_{50} is determined using antibodies containing constant regions that demonstrate enhanced Fc receptor binding. In some embodiments, the EC_{50} is determined using antibodies containing constant regions that demonstrate reduced Fc receptor binding.

[0252] In some embodiments, anti-Sortilin antibodies of the present disclosure have higher potencies in reducing cell surface levels of Sortilin relative to a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure decrease cellular levels (*e.g.*, cell surface levels) of Sortilin with a lower EC_{50} (*e.g.*, as measured *in vitro*) than a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure decrease cellular levels (*e.g.*, cell surface levels) of Sortilin with an EC_{50} that is at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 99% lower than the EC_{50} of a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure decrease cellular levels (*e.g.*, cell surface levels) of Sortilin with an EC_{50} that is at least about 1-fold, at least about 1.1-fold, at least about 1.5-fold, at least about 2-fold, at least about 3-fold, at least about 4-fold, at least about 5-fold, at least about 6-fold, at least about 7-fold, at least about 8-fold, at least about 9-fold, at least about 10-fold, at least about 12.5-fold, at least about 15-fold, at least about 17.5-fold, at least about 20-fold, at least about 22.5-fold, at least about 25-fold, at least about 27.5-fold, at least about 30-fold, at least about 50-fold, or at least about 100-fold lower than the EC_{50} of a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60).

[0253] In some embodiments, anti-Sortilin antibodies of the present disclosure have an EC_{50} that is at least 1.5-fold lower than control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure have an EC_{50} that is at least 1.1-fold lower than control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60).

[0254] In some embodiments, an anti-Sortilin antibody of the present disclosure (a) reduces cell surface levels of Sortilin with a half maximal effective concentration (EC_{50}) that is less than 681 pM, as measured by flow cytometry; (b) reduces cell surface levels of Sortilin by more than about 40% at 1.25 nM IgG, by more than about 29% at 0.6 nM IgG, or by more

than about 62% at 150 nM IgG relative to control, as measured by flow cytometry; (c) increases Progranulin secretion by more than about 1.11 fold over control at 0.63 nM IgG, or by more than about 1.75 fold over control at 50 nM IgG, as measured by standard ELISA; (d) blocks binding of Progranulin to Sortilin with a half maximal effective concentration (EC₅₀) that is less than 0.751 nM, as measured by flow cytometry; (e) blocks binding of Progranulin to Sortilin by more than about 90% at 50 nM IgG, or by more than about 95% at 150 nM IgG relative to control, as measured by flow cytometry; or (f) any combination thereof (*see, e.g., Examples 2-4*).

Increasing Progranulin levels

[0255] In some embodiments, anti-Sortilin antibodies of the present disclosure increase extracellular levels of Progranulin *in vitro*. In some embodiments, anti-Sortilin antibodies of the present disclosure may increase cellular levels of Progranulin or *in vivo* (*e.g.*, in the brain, blood, and/or peripheral organs of an individual). As used herein, an anti-Sortilin antibody increases extracellular levels of Progranulin if it induces an increase at saturating antibody concentrations (*e.g.*, 0.6 nM, 0.63 nM, 1.25 nM, 50 nM or 150 nM) and/or relative to a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60) in extracellular levels of Progranulin as measured by any *in vitro* cell-based assays or in tissue-based (such as brain tissue-based) assays described herein or known in the art. As contemplated herein, an anti-Sortilin antibody increases cellular levels of Progranulin if it induces an increase at saturating antibody concentrations (*e.g.*, 0.6 nM, 0.63 nM, 1.25 nM, 50 nM or 150 nM) and/or relative to a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60) in cellular levels of Progranulin as measured by any *in vitro* cell-based assays or in tissue-based (such as brain tissue-based) assays described herein or known in the art.

[0256] As used herein, levels of Progranulin may refer to expression levels of the gene encoding Progranulin; to expression levels of one or more transcripts encoding Progranulin; to expression levels of Progranulin protein; and/or to the amount of Progranulin protein secreted from cells and/or present within cells. Any methods known in the art for measuring levels of gene expression, transcription, translation, protein abundance, protein secretion, and/or protein localization may be used to determine the levels of Progranulin.

[0257] As used herein, Progranulin levels may refer to, without limitation, extracellular levels of Progranulin, intracellular levels of Progranulin, and total levels of Progranulin; In some embodiments, an increase in levels of Progranulin comprises an increase in extracellular levels of Progranulin.

[0258] In some embodiments, an anti-Sortilin antibody of the present disclosure increases Progranulin secretion by more than about 1.11 fold over control at 0.63 nM IgG, as measured by standard ELISA. In some embodiments, an anti-Sortilin antibody of the present disclosure increases Progranulin secretion by about 1.42 fold over control at 0.63 nM IgG, as measured by standard ELISA. In some embodiments, an anti-Sortilin antibody of the present disclosure increases Progranulin secretion by more than about 1.75 fold over control at 50 nM IgG, as measured by standard ELISA. In some embodiments, an anti-Sortilin antibody of the present disclosure increases Progranulin secretion by about 1.97 fold over control at 50 nM IgG, as measured by standard ELISA. In some embodiments, an anti-Sortilin antibody of the present disclosure increases Progranulin secretion by about 2.29 fold over control at 50 nM IgG, as measured by standard ELISA.

[0259] Various methods of measuring Progranulin secretion are known in the art, including, for example, by ELISA (*See e.g., Examples 2 and 4*). In some embodiments, the EC₅₀ is measured *in vitro* using cells expressing human Sortilin. In some embodiments, Progranulin secretion is determined using a monovalent antibody (*e.g.*, a Fab) or a full-length antibody in a monovalent form. In some embodiments, Progranulin secretion is determined using antibodies containing constant regions that demonstrate enhanced Fc receptor binding. In some embodiments, Progranulin secretion is determined using antibodies containing constant regions that demonstrate reduced Fc receptor binding.

[0260] In some embodiments, anti-Sortilin antibodies of the present disclosure have higher potencies in increasing levels of Progranulin relative to a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure increase levels (*e.g.*, extracellular levels) of Progranulin with a lower EC₅₀ (*e.g.*, as measured *in vitro*) than a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure increase levels (*e.g.*, extracellular levels) of Progranulin by at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 99% than a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure increase levels (*e.g.*, extracellular levels) of Progranulin by about 1-fold, at least about 1.1-fold, at least about 1.5-fold, at least about 2-fold, at least about 3-fold, at least about 4-fold, at least about 5-fold, at least about 6-fold, at least about 7-fold, at least about 8-fold, at least about 9-fold, at least about 10-fold, at least about 12.5-fold, at least about 15-fold, at least about 17.5-fold, at least about 20-fold, at least about 22.5-fold, at least about 25-fold, at least about 27.5-fold, at least about 30-fold, at least about 50-fold, or at least about 100-fold higher than a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60).

[0261] In some embodiments, anti-Sortilin antibodies of the present disclosure increase Progranulin levels by about 1.1-fold higher than a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure increase Progranulin levels by about 1.3-fold higher than a control antibody (*e.g.* an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60).

[0262] In some embodiments, anti-Sortilin antibodies of the present disclosure increase the effective concentration of Progranulin. The effective concentration of Progranulin refers to the concentration of Progranulin in plasma or cerebrospinal fluid. In some embodiments, an increase in the effective concentration of Progranulin is an increase of greater than 1.5 fold. In some embodiments, the effective concentration of Progranulin is increased for 7-28 days.

Decreasing interaction between Sortilin and binding partner

[0263] In certain embodiments, the anti-Sortilin antibodies inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and one or more proteins selected from Progranulin, a pro-neurotrophin, a neurotrophin, pro-neurotrophin-3, neurotrophin-3, pro-neurotrophin-4/5, neurotrophin-4/5, pro-nerve growth factor (pro-NGF), nerve growth factor (NGF), pro-brain-derived neurotrophic factor (pro-BDNF), brain-derived neurotrophic factor (BDNF), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), PCSK9, and receptor associated protein (RAP), and/or naturally occurring variants. In a specific embodiment, anti-Sortilin antibodies of the present disclosure inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and Progranulin;

[0264] In some embodiments, the anti-Sortilin antibodies may inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and a neurotrophin of the present disclosure, such as a pro-neurotrophin, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, and BDNF. In other embodiments, the anti-Sortilin antibodies may inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and neurotensin. In other embodiments, the anti-Sortilin antibodies inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and p75. In other embodiments, the anti-Sortilin antibodies may inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and a Sort-pro. In other embodiments, the anti-Sortilin antibodies may inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and APP. In other embodiments, the anti-Sortilin antibodies may inhibit the production of the A beta peptide. In other embodiments, the anti-Sortilin antibodies may inhibit the transport and secretion of PCSK9. In other embodiments, the anti-Sortilin antibodies may inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and LpL. In other embodiments, the anti-Sortilin antibodies may inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and APOA5. In other embodiments, the anti-Sortilin antibodies may inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and APOE. In other embodiments, the anti-Sortilin antibodies may inhibit interaction (*e.g.*, binding) between a Sortilin protein of the present disclosure and RAP.

[0265] In some embodiments, anti-Sortilin antibodies of the present disclosure bind to a Sortilin protein of the present disclosure expressed on the surface of cell and the naked antibodies inhibit interaction (*e.g.*, binding) between the Sortilin protein and one or more Sortilin ligands. In some embodiments, anti-Sortilin antibodies of the present disclosure that bind to a Sortilin protein of the present inhibit interaction (*e.g.*, binding) between the Sortilin protein and one or more Sortilin ligands by reducing the effective levels of Sortilin that is available to interact with these proteins either on the cell surface or inside the cell. In some embodiments, anti-Sortilin antibodies of the present disclosure that bind to a Sortilin protein of the present inhibit interaction (*e.g.*, binding) between the Sortilin protein and one or more Sortilin ligands by inducing degradation of Sortilin.

A. Decreasing interaction between Sortilin and Progranulin

[0266] In some embodiments, anti-Sortilin antibodies of the present disclosure increase Progranulin levels and/or decrease cellular levels of Sortilin while blocking (e.g. inhibiting) the interaction (e.g., binding) between Sortilin and Progranulin. Accordingly, in some embodiments, anti-Sortilin antibodies of the present disclosure block the interaction (e.g., binding) between Sortilin and Progranulin; As used herein, an anti-Sortilin antibody blocks the interaction (e.g., binding) between Sortilin and Progranulin if it decreases Progranulin binding to Sortilin relative to a control antibody (e.g. an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60) at saturating antibody concentrations (e.g., 0.6 nM, 0.63 nM, 1.25 nM, 50 nM or 150 nM) in any *in vitro* assay or cell-based culture assay described herein or known in the art.

[0267] Anti-Sortilin antibodies of the present disclosure may decrease Progranulin binding to Sortilin with a half-maximal effective concentration (EC₅₀) (e.g., when measured *in vitro*) in the picomolar range. In certain embodiments, the EC₅₀ of the antibody is less than about 2.2 nM. In certain embodiments, the EC₅₀ of the antibody is less than about 1.22 nM. In certain embodiments, the EC₅₀ of the antibody is less than about 751 pM. In certain embodiments, the EC₅₀ of the antibody is about 325 pM to about 751 nM. In certain embodiments, the EC₅₀ of the antibody is about 405 pM to about 751 nM. In certain embodiments, the EC₅₀ of the antibody is about 588 pM to about 751 nM. In certain embodiments, the EC₅₀ of the antibody is less than about 2.2 nM, 2.1 nM, 2.0 nM, 1.9 nM, 1.8 nM, 1.7 nM, 1.6 nM, 1.5 nM, 1.4 nM, 1.3 nM, 1.2 nM, 1.1 nM, 1.0 nM, 900 pM, 800 pM, 700 pM, 600 pM, 500 pM, 400 pM, 300 pM, 200 pM, 100 pM, 50 pM, 40 pM, 30 pM, 20 pM, 10 pM, 1 pM, or 0.5 pM.

[0268] In some embodiments, the EC₅₀ of the antibody for decreasing Progranulin binding to Sortilin is less than about or equal to about 2.2 nM, 2.1 nM, 2.0 nM, 1.9 nM, 1.8 nM, 1.7 nM, 1.6 nM, 1.5 nM, 1.4 nM, 1.3 nM, 1.2 nM, 1.1 nM, 1.0 nM, 900 pM, 800 pM, 700 pM, 600 pM, 500 pM, 475 pM, 450 pM, 425 pM, 400 pM, 375 pM, 350pM, 325 pM, 300 pM, 275 pM, 250 pM, 225 pM, 200 pM, 175 pM, 150 pM, 125 pM, 100 pM, 90 pM, 80 pM, 70 pM, 60 pM, 50 pM, 40 pM, 30 pM, 20 pM, 10 pM, 9 pM, 8 pM, 7 pM, 6 pM, 5 pM, 4 pM, 3 pM, 2 pM, 1 pM, or 0.5 pM.

[0269] In some embodiments, the EC₅₀ of an anti-Sortilin antibody of the present disclosure is about 1.22 nM. In some embodiments, the EC₅₀ of an anti-Sortilin antibody of the present disclosure is about 588 pM. In some embodiments, the EC₅₀ of an anti-Sortilin antibody of the present disclosure is about 405 pM. In some embodiments, the EC₅₀ of an anti-Sortilin antibody of the present disclosure is about 325 pM.

[0270] Various methods of measuring antibody EC₅₀ values are known in the art, including, for example, by flow cytometry (See e.g., **Example 3**). In some embodiments, the EC₅₀ for decreasing Progranulin binding to Sortilin is measured *in vitro* using cells expressing human Sortilin. In some embodiments, the EC₅₀ is measured at a temperature of approximately 4°C. In some embodiments, the EC₅₀ is measured at a temperature of approximately 25°C. In some embodiments, the EC₅₀ is measured at a temperature of approximately 35°C. In some embodiments, the EC₅₀ is measured at a temperature of approximately 37°C. In some embodiments, the EC₅₀ for decreasing Progranulin binding to Sortilin is determined using a monovalent antibody (e.g., a Fab) or a full-length antibody in a monovalent form. In some embodiments, the EC₅₀ is determined using antibodies containing constant regions that demonstrate enhanced Fc receptor binding. In some embodiments, the EC₅₀ for decreasing Progranulin binding to Sortilin is determined using antibodies containing constant regions that demonstrate reduced Fc receptor binding.

[0271] In some embodiments, anti-Sortilin antibodies of the present disclosure have higher potencies in reducing Progranulin binding to Sortilin relative to a control antibody (e.g. an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure decrease Progranulin binding to Sortilin with a lower EC₅₀ (e.g., as measured *in vitro*) than a control antibody (e.g. an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure decrease Progranulin binding to Sortilin with an EC₅₀ that is at least about 5%, at least about 10%, at least about 5%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 99% lower than the EC₅₀ of a control antibody (e.g. an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure decrease Progranulin binding to Sortilin with an EC₅₀ that is at least about -fold, at least about 1.1-fold, at least about 1.5-fold, at least about 2-fold, at least about 3-fold, at least about 4-fold, at least about 5-fold, at least about 6-fold, at least about 7-fold, at least about 8-fold, at least about 9-fold, at least about 10-fold, at least about 12.5-fold, at least about 15-fold, at least about 17.5-fold, at least about 20-fold, at least about 22.5-fold, at least about 25-fold, at least about 27.5-fold, at least about 30-fold, at least about 50-fold, or at least about 100-fold lower than the EC₅₀ of a control antibody (e.g. an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60).

[0272] In some embodiments, anti-Sortilin antibodies of the present disclosure have an EC₅₀ that is at least 1.3-fold lower than control antibody (e.g. an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure have an EC₅₀ that is at least 1.8-fold lower than control antibody (e.g. an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure have an EC₅₀ that is at least .9-fold lower than control antibody (e.g. an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60). In some embodiments, anti-Sortilin antibodies of the present disclosure have an EC₅₀ that is at least 2.3-fold lower than control antibody (e.g. an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60).

[0273] Any *in vitro* cell-based assays or suitable *in vivo* model described herein or known in the art may be used to measure inhibition or reduction of interaction (e.g., binding) between Sortilin and one or more Sortilin ligands. In some embodiments, anti-Sortilin antibodies of the present disclosure inhibit or reduce interaction (e.g., binding) between Sortilin and one or more Sortilin ligands by reducing Sortilin expression (e.g., by reducing cell surface levels of Sortilin). In some embodiments, anti-Sortilin antibodies of the present disclosure inhibit or reduce interaction (e.g., binding) between Sortilin and one or more Sortilin ligands by at least 21%, at least 22%, at least 23%, at least 24%, at least 25%, at least 26%, at least 27%, at least 28%, at least 29%, at least 30%, at least 31%, at least 32%, at least 33%, at least 34%, at least 35%, at least 36%, at least 37%, at least 38%, at least 39%, at least 40%, at least 41%, at least 42%, at least 43%, at least 44%, at least 45%, at least 46%, at least 47%, at least 48%, at least 49%, at least 50%, at least 51%, at least 52%, at least 53%, at least 54%, at least 55%, at least 56%, at least 57%, at least 58%, at least 59%, at least 60%, at least 61%, at least 62%, at least 63%, at least 64%, at least 65%, at least 66%, at least 67%, at least 68%, at least 69%, at least 70%, at least 71%, at least 72%, at least 73%, at least 74%, at least 75%, at least 76%, at least 77%, at least 78%, at least 79%, at least 80%, at least 81%, at least 82%, at least 83%, at least 84%, at least 85%, at least 86%, at least 87%, at least 88%, at least 89%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, at least 99%, or more at saturating antibody concentrations utilizing any *in vitro* assay or cell-based culture assay described herein or known in the art.

[0274] In some embodiments, an anti-Sortilin antibody of the present disclosure blocks Progranulin binding to Sortilin by more than about 90% at 50 nM IgG or by more than about 96% at 150 nM IgG, as measured by flow cytometry. In some embodiments, an anti-Sortilin antibody of the present disclosure blocks Progranulin binding to Sortilin by about 90.74% at 50 nM IgG, as measured by flow cytometry. In some embodiments, an anti-Sortilin antibody of the present disclosure blocks Progranulin binding to Sortilin by about 96.5% at 150 nM IgG, as measured by flow cytometry. In some embodiments, an anti-Sortilin antibody of the present disclosure blocks Progranulin binding to Sortilin by about 96.9% at 150 nM IgG, as measured by flow cytometry.

Decreasing expression of pro-inflammatory mediators

[0275] In some embodiments, anti-Sortilin antibodies of the present disclosure may decrease the expression of pro-inflammatory mediators after binding to a Sortilin protein expressed in a cell.

[0276] As used herein, pro-inflammatory mediators are proteins involved either directly or indirectly (e.g., by way of pro-inflammatory signaling pathways) in a mechanism that induces, activates, promotes, or otherwise decreases an inflammatory response. Any method known in the art for identifying and characterizing pro-inflammatory mediators may be used.

[0277] Examples of pro-inflammatory mediators include, without limitation, cytokines, such as type I and II interferons, IL-6, IL12p70, IL12p40, IL-1β, TNF-α, IL-8, CRP, IL-20 family members, IL-33, LIF, OSM, CNTF, GM-CSF, IL-11, IL-12, IL-17, IL-18, and CRP. Further examples of pro-inflammatory mediators include, without limitation, chemokines, such as

CXCL1, CCL2, CCL3, CCL4, and CCL5.

[0278] In some embodiments, the anti-Sortilin antibodies of the present disclosure may decrease functional expression and/or secretion of pro-inflammatory mediators, IL-6, IL12p70, IL12p40, IL-1 β , TNF- α , CXCL1, CCL2, CCL3, CCL4, and CCL5. In certain embodiments, decreased expression of the pro-inflammatory mediators occurs in macrophages, dendritic cells, monocytes, osteoclasts, Langerhans cells of skin, Kupffer cells, T cells, and/or microglial cells. Decreased expression may include, without limitation, a decrease in gene expression, a decrease in transcriptional expression, or a decrease in protein expression. Any method known in the art for determining gene, transcript (e.g., mRNA), and/or protein expression may be used. For example, Northern, blot analysis may be used to determine pro-inflammatory mediator gene expression levels, RT-PCR may be used to determine the level of pro-inflammatory mediator transcription, and Western blot analysis may be used to determine pro-inflammatory mediator protein levels.

[0279] As used herein, a pro-inflammatory mediator may have decreased expression if its expression in one or more cells of a subject treated with a Sortilin agent, such as an agonist anti-Sortilin antibody of the present disclosure is more than the expression of the same pro-inflammatory mediator expressed in one or more cells of a corresponding subject that is not treated with the agonist anti-Sortilin antibody. In some embodiments, the anti-Sortilin antibody of the present disclosure may decrease pro-inflammatory mediator expression in one or more cells of a subject by at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 100%, at least 110%, at least 115%, at least 120%, at least 125%, at least 130%, at least 135%, at least 140%, at least 145%, at least 150%, at least 160%, at least 170%, at least 180%, at least 190%, or at least 200% for example, as compared to pro-inflammatory mediator expression in one or more cells of a corresponding subject that is not treated with the anti-Sortilin antibody. In other embodiments, the anti-Sortilin antibody may decrease pro-inflammatory mediator expression in one or more cells of a subject by at least at least 1.5 fold, at least 1.6 fold, at least 1.7 fold, at least 1.8 fold, at least 1.9 fold, at least 2.0 fold, at least 2.1 fold, at least 2.15 fold, at least 2.2 fold, at least 2.25 fold, at least 2.3 fold, at least 2.35 fold, at least 2.4 fold, at least 2.45 fold, at least 2.5 fold, at least 2.55 fold, at least 3.0 fold, at least 3.5 fold, at least 4.0 fold, at least 4.5 fold, at least 5.0 fold, at least 5.5 fold, at least 6.0 fold, at least 6.5 fold, at least 7.0 fold, at least 7.5 fold, at least 8.0 fold, at least 8.5 fold, at least 9.0 fold, at least 9.5 fold, or at least 10 fold, for example, as compared to pro-inflammatory mediator expression in one or more cells of a corresponding subject that is not treated with the anti-Sortilin antibody.

[0280] In some embodiments, an anti-Sortilin antibody according to any of the above embodiments may incorporate any of the features, singly or in combination, as described in Sections 1-7 below:

(1) Anti-Sortilin antibody binding affinity

[0281] In some embodiments of any of the antibodies provided herein, the antibody has a dissociation constant (K_d) of < 1 μ M, < 100 nM, < 10 nM, < 1 nM, < 0.1 nM, < 0.01 nM, or < 0.001 nM (e.g., 10^{-8} M or less, e.g., from 10^{-8} M to 10^{-13} M, e.g., from 10^{-8} M to 10^{-13} M).

[0282] Anti-Sortilin antibodies of the present disclosure may have nanomolar or even picomolar affinities for the target antigen (e.g., human Sortilin or mammalian Sortilin). In certain embodiments, the binding affinity of an anti-Sortilin antibody of the present disclosure for target antigen (e.g., human Sortilin or mammalian Sortilin) is measured by the dissociation constant, K_D . Dissociation constants may be determined through any analytical technique, including any biochemical or biophysical technique such as fluorescent activated cell sorting (FACS), flow cytometry, enzyme-linked immunosorbent assay (ELISA), surface plasmon resonance (SPR), BioLayer interferometry (see, e.g., Octet System by ForteBio), meso scale discover (see, e.g., MSD-SET), isothermal titration calorimetry (ITC), differential scanning calorimetry (DSC), circular dichroism (CD), stopped-flow analysis, and colorimetric or fluorescent protein melting analyses; or a cell binding assay. In some embodiments, the K_D for Sortilin is determined at a temperature of approximately 25°C. In some embodiments, the dissociation constant (K_D) may be measured at 4°C or room temperature utilizing, for example, FACS or BioLayer interferometry assay.

[0283] In some embodiments, the K_D for Sortilin is determined at a temperature of approximately 4°C. In some embodiments, the K_D is determined using a monovalent antibody (e.g., a Fab) or a full-length antibody in a monovalent form. In some embodiments, the K_D is determined using a bivalent antibody and monomeric recombinant Sortilin protein.

[0284] In certain embodiments, the K_D of an anti-Sortilin antibody of the present disclosure for human Sortilin, mammalian Sortilin, or both, is measured using FACS as described herein (see, e.g., **Examples 1 and 4**). In certain embodiments, the K_D of an anti-Sortilin antibody of the present disclosure for human Sortilin, mammalian Sortilin, or both, is measured using BioLayer Interferometry as described herein (see, e.g., **Example 4**).

[0285] In some embodiments, the anti-Sortilin antibody has a dissociation constant (K_D) for human Sortilin that is up to 2.5-fold lower than an anti-Sortilin antibody comprising a heavy chain variable region comprising the sequence of SEQ ID NO: 56 and a light chain variable region comprising the sequence of SEQ ID NO: 79, wherein the K_D is determined by FACS (see, e.g., **Example 1**). In some embodiments, the anti-Sortilin antibody has a dissociation constant (K_D) for human Sortilin that ranges from about 1.10E-8 M to about 4.68E-10 M wherein the K_D is determined by FACS (see, e.g., **Example 1**), or about 270 to about 2910 pM wherein the K_D is determined by Bio-layer interferometry (see, e.g.,

Example 4).

[0286] In certain embodiments, the K_D of an anti-Sortilin antibody of the present disclosure for human Sortilin, mammalian Sortilin, or both, may be less than 100nM, less than 90 nM, less than 80 nM, less than 70 nM, less than 60 nM, less than 50 nM, less than 40 nM, less than 30 nM, less than 20 nM, less than 0 nM, less than 9 nM, less than 8 nM, less than 7 nM, less than 6 nM, less than 5 nM, less than 4 nM, less than 3 nM, less than 2 nM, less than 1 nM, less than 0.95 nM, less than 0.9 nM, less than 0.89 nM, less than 0.88 nM, less than 0.87 nM, less than 0.86 nM, less than 0.85 nM, less than 0.84 nM, less than 0.83 nM, less than 0.82 nM, less than 0.81 nM, less than 0.8 nM, less than 0.75 nM, less than 0.7 nM, less than 0.65 nM, less than 0.64 nM, less than 0.63 nM, less than 0.62 nM, less than 0.61 nM, less than 0.6 nM, less than 0.55 nM, less than 0.5 nM, less than 0.45 nM, less than 0.4 nM, less than 0.35 nM, less than 0.3 nM, less than 0.29 nM, less than 0.28 nM, less than 0.27 nM, less than 0.26 nM, less than 0.25 nM, less than 0.24 nM, less than 0.23 nM, less than 0.22 nM, less than 0.21 nM, less than 0.2 nM, less than 0.15 nM, less than 0.1 nM, less than 0.09 nM, less than 0.08 nM, less than 0.07 nM, less than 0.06 nM, less than 0.05 nM, less than 0.04 nM, less than 0.03 nM, less than 0.02 nM, less than 0.01 nM, less than 0.009 nM, less than 0.008 nM, less than 0.007 nM, less than 0.006 nM, less than 0.005 nM, less than 0.004 nM, less than 0.003 nM, less than 0.002 nM, less than 0.001 nM, or less than 0.001 nM.

[0287] The dissociation constants (K_D) of anti-Sortilin antibodies for human Sortilin, mammalian Sortilin, or both, may be less than 10 nM, less than 9.5 nM, less than 9 nM, less than 8.5 nM, less than 8 nM, less than 7.5 nM, less than 7 nM, less than 6.9 nM, less than 6.8 nM, less than 6.7 nM, less than 6.6 nM, less than 6.5 nM, less than 6.4 nM, less than 6.3 nM, less than 6.2 nM, less than 6.1 nM, less than 6 nM, less than 5.5 nM, less than 5 nM, less than 4.5 nM, less than 4 nM, less than 3.5 nM, less than 3 nM, less than 2.5 nM, less than 2 nM, less than 1.5 nM, less than 1 nM, less than 0.95 nM, less than 0.9 nM, less than 0.89 nM, less than 0.88 nM, less than 0.87 nM, less than 0.86 nM, less than 0.85 nM, less than 0.84 nM, less than 0.83 nM, less than 0.82 nM, less than 0.81 nM, less than 0.8 nM, less than 0.75 nM, less than 0.7 nM, less than 0.65 nM, less than 0.64 nM, less than 0.63 nM, less than 0.62 nM, less than 0.61 nM, less than 0.6 nM, less than 0.55 nM, less than 0.5 nM, less than 0.45 nM, less than 0.4 nM, less than 0.35 nM, less than 0.3 nM, less than 0.29 nM, less than 0.28 nM, less than 0.27 nM, less than 0.26 nM, less than 0.25 nM, less than 0.24 nM, less than 0.23 nM, less than 0.22 nM, less than 0.21 nM, less than 0.2 nM, less than 0.15 nM, less than 0.1 nM, less than 0.09 nM, less than 0.08 nM, less than 0.07 nM, less than 0.06 nM, less than 0.05 nM, less than 0.04 nM, less than 0.03 nM, less than 0.02 nM, less than 0.01 nM, less than 0.009 nM, less than 0.008 nM, less than 0.007 nM, less than 0.006 nM, less than 0.005 nM, less than 0.004 nM, less than 0.003 nM, less than 0.002 nM, or less than 0.001 nM.

[0288] In certain embodiments, the dissociation constant (K_D) of the antibody for Sortilin is from about 0.560 nM to about 1.63 nM, for example when the K_D is determined by FACS. In certain embodiments, the dissociation constant (K_D) of the antibody for Sortilin is from about 0.270 nM to about 2.910 nM, for example when the K_D is determined by BioLayer Interferometry. In some embodiments, the antibody has a dissociation constant (K_D) for human Sortilin, mouse Sortilin, or both, that ranges from about 0.36 nM to about 0.43 nM, or less than 1.02 nM. In some embodiments, the dissociation constant is less than 1.02 nM. In some embodiments, an anti-Sortilin antibody of the present disclosure has a dissociation constant for human Sortilin of .560 nM or less.

[0289] In one specific embodiment, an anti-Sortilin antibody of the present disclosure has a dissociation constant for human Sortilin of about .560 nM. In one specific embodiment, an anti-Sortilin antibody of the present disclosure has a dissociation constant for human Sortilin of about .423 nM. In one specific embodiment, an anti-Sortilin antibody of the present disclosure has a dissociation constant for human Sortilin of about .365 nM. In one specific embodiment, an anti-Sortilin antibody of the present disclosure has a dissociation constant for human Sortilin of about .344 nM. In one specific embodiment, an anti-Sortilin antibody of the present disclosure has a dissociation constant for human Sortilin of about .298 nM. In one specific embodiment, an anti-Sortilin antibody of the present disclosure has a dissociation constant for human Sortilin of about .270 nM. In another specific embodiment, an anti-Sortilin

antibody of the present disclosure has a dissociation constant for human Sortilin of about .260 nM.

[0290] In some embodiments, anti-Sortilin antibodies of the present disclosure have a lower dissociation constant (K_D) for Sortilin than a control anti-Sortilin antibody (e.g., a control anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60. In some embodiments, anti-Sortilin antibodies of the present disclosure have a K_D for a target (e.g., human Sortilin) that is at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 99% lower than the K_D of a control anti-Sortilin antibody for the target (e.g., a control anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60. In some embodiments, anti-Sortilin antibodies of the present disclosure have a K_D for a target (e.g., human Sortilin) that is at least about 1-fold, at least about 1.1-fold, at least about 1.5-fold, at least about 2-fold, at least about 3-fold, at least about 4-fold, at least about 5-fold, at least about 6-fold, at least about 7-fold, at least about 8-fold, at least about 9-fold, at least about 10-fold, at least about 12.5-fold, at least about 15-fold, at least about 17.5-fold, at least about 20-fold, at least about 22.5-fold, at least about 25-fold, at least about 27.5-fold, at least about 30-fold, at least about 50-fold, at least about 100-fold, at least about 200-fold, at least about 300-fold, at least about 400-fold, at least about 500-fold, at least about 600-fold, at least about 700-fold, at least about 800-fold, at least about 900-fold, or at least about 000-fold lower than the K_D of a control anti-Sortilin antibody for the target (e.g., a control anti-Sortilin antibody comprising a heavy chain variable region and a light chain variable region corresponding to S-60.

[0291] In some embodiments, anti-Sortilin antibodies of the present disclosure have a K_D for human Sortilin that is at least 100-fold lower than an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60. In some embodiments, anti-Sortilin antibodies of the present disclosure have a K_D for human Sortilin that is at least 50-fold lower than an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60. In some embodiments, anti-Sortilin antibodies of the present disclosure have a K_D for human Sortilin that is at least 10-fold lower than an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60. In some embodiments, anti-Sortilin antibodies of the present disclosure have a K_D for human Sortilin that is at least 5-fold lower than an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60. In some embodiments, anti-Sortilin antibodies of the present disclosure have a K_D for human Sortilin that is at least 2-fold lower than an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60.

[0292] In a specific embodiment, an anti-Sortilin antibody of the present disclosure has a K_D for human Sortilin that is about 2.79-fold lower than an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60. In another specific embodiment, an anti-Sortilin antibody of the present disclosure has a K_D for human Sortilin that is about 2.05-fold lower than an anti-Sortilin antibody having a heavy chain variable region and a light chain variable region corresponding to S-60.

(2) Antibody fragments

[0293] In some embodiments of any of the antibodies provided herein, the antibody is an antibody fragment. Antibody fragments include, but are not limited to, Fab, Fab', Fab'-SH, F(ab')₂, Fv, and scFv fragments, and other fragments described below. For a review of certain antibody fragments, see Hudson et al. Nat. Med. 9: 129-134 (2003). For a review of scFv fragments, see, e.g., WO 93/16185; and U.S. Patent Nos. 5571894 and 5587458. For discussion of Fab and F(ab')₂ fragments comprising salvage receptor binding epitope residues and having increased *in vivo* half-life, see U.S. Patent No. 5869046.

[0294] Diabodies are antibody fragments with two antigen-binding sites that may be bivalent or bispecific. See, for example, EP404097; WO 1993/01161; Hudson et al. Nat. Med. 9:129-134 (2003). Triabodies and tetrabodies are also described in Hudson et al. Nat. Med. 9:129-134 (2003). Single-domain antibodies are antibody fragments comprising all or a portion of the heavy chain variable domain or all or a portion of the light chain variable domain of an antibody. In certain embodiments, a single-domain antibody is a human single-domain antibody (see, e.g., U.S. Patent No. 6248516).

[0295] Antibody fragments can be made by various techniques, including but not limited to proteolytic digestion of an intact antibody as well as production by recombinant host cells (e.g., *E. coli* or phage), as described herein.

[0296] In some embodiments, the antibody fragment is used in combination with a second Sortilin antibody and/or with one or more antibodies that specifically bind a disease-causing protein selected from: amyloid beta or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, prion protein, PrP^{Sc}, huntingtin, calcitonin, superoxide dismutase, ataxin, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratopithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, proline-arginine (PR) repeat peptides, and any combination thereof.

(3) Chimeric and Humanized antibodies

[0297] In some embodiments of any of the antibodies provided herein, the antibody is a chimeric antibody. Certain chimeric antibodies are described, e.g., in U.S. Patent No. 4816567. In one example, a chimeric antibody comprises a non-human variable region (e.g., a variable region derived from a mouse, rat, hamster, rabbit, or non-human primate, such as a monkey) and a human constant region. In a further example, a chimeric antibody is a "class switched" antibody in which the class or subclass has been changed from that of the parent antibody. Chimeric antibodies include antigen-binding fragments thereof.

[0298] In some embodiments of any of the antibodies provided herein, the antibody is a humanized antibody. Typically, a non-human antibody is humanized to reduce immunogenicity to humans, while retaining the specificity and affinity of the parental non-human antibody. In certain embodiments, a humanized antibody is substantially non-immunogenic in humans. In certain embodiments, a humanized antibody has substantially the same affinity for a target as an antibody from another species from which the humanized antibody is derived. See, e.g., U.S. Pat. No. 5530101, 5693761; 5693762; and 5585089. In certain embodiments, amino acids of an antibody variable domain that can be modified without diminishing the native affinity of the antigen binding domain while reducing its immunogenicity are identified. See, e.g., U.S. Pat. Nos. 5766886 and 5869619. Generally, a humanized antibody comprises one or more variable domains in which HVRs (or portions thereof) are derived from a non-human antibody, and FRs (or portions thereof) are derived from human antibody sequences. A humanized antibody optionally will also comprise at least a portion of a human constant region. In some embodiments, some FR residues in a humanized antibody are substituted with corresponding residues from a non-human antibody (e.g., the antibody from which the HVR residues are derived), for example, to restore or improve antibody specificity or affinity.

[0299] Humanized antibodies and methods of making them are reviewed, for example, in Almagro et al. Front. Biosci. 13: 161 9-1633 (2008), and are further described, e.g., in US Patent Nos. 5821337, 7527791, 6982321, and 7087409. Human framework regions that may be used for humanization include but are not limited to: framework regions selected using the "best-fit" method (see, e.g., Sims et al. J. Immunol. 151:2296 (1993)); framework regions derived from the consensus sequence of human antibodies of a particular subgroup of light or heavy chain variable regions (see, e.g., Carter et al. Proc. Natl. Acad. Sci. USA 89:4285 (1992); and Presta et al., J. Immunol. 151 :2623 (1993)); human mature (somatically mutated) framework regions or human germline framework regions (see, e.g., Almagro and Fransson Front. Biosci. 13: 1619-1633 (2008)); and framework regions derived from screening FR libraries (see, e.g., Baca et al. J. Biol. Chem. 272: 10678-10684 (1997) and Rosok et al. J. Biol. Chem. 271:22611-22618(1996)).

(4) Human Antibodies

[0300] In some embodiments of any of the antibodies provided herein, the antibody is a human antibody. Human antibodies can be produced using various techniques known in the art. Human antibodies are described generally in van Dijk et al. Curr. Opin. Pharmacol. 5:368-74 (2001) and Lonberg Curr. Opin. Immunol. 20:450-459 (2008).

[0301] Human antibodies may be prepared by administering an immunogen to a transgenic animal that has been modified to produce intact human antibodies or intact antibodies with human variable regions in response to antigenic challenge. One can engineer mouse strains deficient in mouse antibody production with large fragments of the human Ig loci in anticipation that such mice would produce human antibodies in the absence of mouse antibodies. Large human Ig fragments can preserve the large variable gene diversity as well as

the proper regulation of antibody production and expression. By exploiting the mouse machinery for antibody diversification and selection and the lack of immunological tolerance to human proteins, the reproduced human antibody repertoire in these mouse strains can yield high affinity fully human antibodies against any antigen of interest, including human antigens. Using the hybridoma technology, antigen-specific human MAbs with the desired specificity can be produced and selected. Certain exemplary methods are described in U.S. Pat. No. 5545807, EP 546073, and EP 546073. See also, for example, U.S. Patent Nos. 6075181 and 6150584 describing XENOMOUSE™ technology; U.S. Patent No. 5770429 describing HUMAB® technology; U.S. Patent No. 7041870 describing K-M MOUSE® technology, and U.S. Patent Application Publication No. US 2007/0061900, describing VELOCIMOUSE® technology. Human variable regions from intact antibodies generated by such animals may be further modified, *e.g.*, by combining with a different human constant region.

[0302] Human antibodies can also be made by hybridoma-based methods. Human myeloma and mouse-human heteromyeloma cell lines for the production of human monoclonal antibodies have been described. (See, *e.g.*, Kozbor J. Immunol. 133:3001 (1984) and Boemer et al. J. Immunol. 147:86 (1991)). Human antibodies generated via human B-cell hybridoma technology are also described in Li et al. Proc. Natl. Acad. Sci. USA, 1 03:3557-3562 (2006). Additional methods include those described, for example, in U.S. Patent No. 7189826 (describing production of monoclonal human IgM antibodies from hybridoma cell lines). Human hybridoma technology (Trioma technology) is also described in Vollmers et al. Histology and Histopathology 20(3): 927-937 (2005) and Vollmers et al. Methods and Findings in Experimental and Clinical Pharmacology 27(3): 185-91 (2005). Human antibodies may also be generated by isolating Fv clone variable domain sequences selected from human-derived phage display libraries. Such variable domain sequences may then be combined with a desired human constant domain. Techniques for selecting human antibodies from antibody libraries are described below.

[0303] In some embodiments of any of the antibodies provided herein, the antibody is a human antibody isolated by *in vitro* methods and/or screening combinatorial libraries for antibodies with the desired activity or activities. Suitable examples include but are not limited to phage display (CAT, Morphosys, Dyax, Biosite/Medarex, Xoma, Symphogen, Alexion (formerly Proliferon), Affimed) ribosome display (CAT), yeast-based platforms (Adimab), and the like. In certain phage display methods, repertoires of VH and VL genes are separately cloned by polymerase chain reaction (PCR) and recombined randomly in phage libraries, which can then be screened for antigen-binding phage as described in Winter et al. Ann. Rev. Immunol. 12: 433-455 (1994). For example, a variety of methods are known in the art for generating phage display libraries and screening such libraries for antibodies possessing the desired binding characteristics. See also Sidhu et al. J. Mol. Biol. 338(2): 299-310, 2004; Lee et al. J. Mol. Biol. 340(5): 1073-1093, 2004; Fellouse Proc. Natl. Acad. Sci. USA 101(34): 12467-12472 (2004); and Lee et al. J. Immunol. Methods 284(-2): 1 19-132 (2004). Phage typically display antibody fragments, either as single-chain Fv (scFv) fragments or as Fab fragments. Libraries from immunized sources provide high-affinity antibodies to the immunogen without the requirement of constructing hybridomas. Alternatively, the naive repertoire can be cloned (*e.g.*, from human) to provide a single source of antibodies to a wide range of non-self and also self-antigens without any immunization as described by Griffiths et al. EMBO J. 12: 725-734 (1993). Finally, naive libraries can also be made synthetically by cloning unarranged V-gene segments from stem cells, and using PCR primers comprising random sequence to encode the highly variable HVR3 regions and to accomplish rearrangement *in vitro*, as described by Hoogenboom et al. J. Mol. Biol., 227: 381-388, 1992. Patent publications describing human antibody phage libraries include, for example: US Patent No. 5750373, and US Patent Publication Nos. 2007/0292936 and 2009/0002360. Antibodies isolated from human antibody libraries are considered human antibodies or human antibody fragments herein.

(5) Constant Regions including Fc regions

[0304] In some embodiments of any of the antibodies provided herein, the antibody comprises an Fc. In some embodiments, the Fc is a human IgG1, IgG2, IgG3, and/or IgG4 isotype. In some embodiments, the antibody is of the IgG class, the IgM class, or the IgA class.

[0305] In certain embodiments of any of the antibodies provided herein, the antibody has an IgG2 isotype. In some embodiments, the antibody contains a human IgG2 constant region. In some embodiments, the human IgG2 constant region includes an Fc region. In some embodiments, the antibody induces the one or more Sortilin activities or independently of binding to an Fc receptor. In some embodiments, the antibody binds an inhibitory Fc receptor. In certain embodiments, the inhibitory Fc receptor is inhibitory Fc-gamma receptor IIB (FcγIIB).

[0306] In certain embodiments of any of the antibodies provided herein, the antibody has an IgG1 isotype. In some embodiments, the antibody contains a mouse IgG1 constant region. In some embodiments, the antibody contains a human IgG1 constant region. In some embodiments, the human IgG1 constant region includes an Fc region. In some embodiments, the antibody binds an inhibitory Fc receptor. In certain embodiments, the inhibitory Fc receptor is inhibitory Fc-gamma receptor IIB (FcγIIB).

[0307] In certain embodiments of any of the antibodies provided herein, the antibody has an IgG4 isotype. In some embodiments, the antibody contains a human IgG4 constant region. In some embodiments, the human IgG4 constant region includes an Fc region. In some embodiments, the antibody binds an inhibitory Fc receptor. In certain embodiments, the inhibitory Fc receptor is inhibitory Fc-gamma receptor IIB (FcγIIB).

[0308] In certain embodiments of any of the antibodies provided herein, the antibody has a hybrid IgG2/4 isotype. In some embodiments, the antibody includes an amino acid sequence comprising amino acids 118 to 260 according to EU numbering of human IgG2 and amino acids 261-447 according to EU numbering of human IgG4 (WO 1997/11971; WO 2007/106585).

[0309] In some embodiments, the Fc region increases clustering without activating complement as compared to a corresponding antibody comprising an Fc region that does not comprise the amino acid substitutions. In some embodiments, the antibody induces one or more activities of a target specifically bound by the antibody. In some embodiments, the antibody binds to Sortilin.

[0310] It may also be desirable to modify an anti-Sortilin antibody of the present disclosure to modify effector function and/or to increase serum half-life of the antibody. For example, the Fc receptor binding site on the constant region may be modified or mutated to remove or reduce binding affinity to certain Fc receptors, such as FcγRI, FcγRII, and/or FcγRIII to reduce Antibody-dependent cell-mediated cytotoxicity. In some embodiments, the effector function is impaired by removing N-glycosylation of the Fc region (*e.g.*, in the CH2 domain of IgG) of the antibody. In some embodiments, the effector function is impaired by modifying regions such as 233-236, 297, and/or 327-331 of human IgG as described in WO 99/58572 and Armour et al. Molecular Immunology 40: 585-593 (2003); Reddy et al. J. Immunology 164: 1925-1933 (2000). In other embodiments, it may also be desirable to modify an anti-Sortilin antibody of the present disclosure to modify effector function to increase finding selectivity toward the ITIM-containing FcγRIIB (CD32b) to increase clustering of Sortilin antibodies on adjacent cells without activating humoral responses including Antibody-dependent cell-mediated cytotoxicity and antibody-dependent cellular phagocytosis.

[0311] To increase the serum half-life of the antibody, one may incorporate a salvage receptor binding epitope into the antibody (especially an antibody fragment) as described in U.S. Patent 5739277, for example. As used herein, the term "*salvage receptor binding epitope*" refers to an epitope of the Fc region of an IgG molecule (*e.g.*, IgG1, IgG2, IgG3, or IgG4) that is responsible for increasing the *in vivo* serum half-life of the IgG molecule. Other amino acid sequence modifications.

(6) Multispecific Antibodies

[0312] Multispecific are antibodies that have binding specificities for at least two different epitopes, including those on the same or another polypeptide (*e.g.*, one or more Sortilin polypeptides of the present disclosure). In some embodiments, the multispecific antibody can be a bispecific antibody. In some embodiments, the multispecific antibody can be a trispecific antibody. In some embodiments, the multispecific antibody can be a tetraspecific antibody. Such antibodies can be derived from full-length antibodies or antibody fragments (*e.g.*, F(ab')₂ bispecific antibodies). In some embodiments, the multispecific antibody comprises a first antigen binding region which binds to first site on Sortilin and comprises a second antigen binding region which binds to a second site on Sortilin. In some embodiment, the multispecific antibodies comprises a first antigen binding region which binds to Sortilin and a second antigen binding region that binds to a second polypeptide.

[0313] Provided herein are multispecific antibodies comprises a first antigen binding region, wherein the first antigen binding region comprises the six HVRs of an antibody described herein, which binds to Sortilin and a second antigen binding region that binds to a second polypeptide. In some embodiments, the first antigen binding region comprises the V_H or V_L of an antibody described herein.

[0314] In some embodiments of any of the multispecific antibodies, the second polypeptide is a) an antigen facilitating transport across the blood-brain-barrier; (b) an antigen facilitating transport across the blood-brain-barrier selected from transferrin receptor (TR), insulin receptor (HIR), insulin-like growth factor receptor (IGFR), low-density lipoprotein receptor related proteins 1 and 2 (LPR-1 and 2), diphtheria toxin receptor, CRM197, a llama single domain antibody, TMEM 30(A), a protein transduction domain, TAT, Syn-B, penetratin, a poly-arginine peptide, an angiopep peptide, and ANG1005; (c) a disease-causing protein selected from amyloid beta, oligomeric amyloid beta, amyloid beta plaques, amyloid precursor protein or fragments thereof, Tau, IAPP, alpha-synuclein, TDP-43, FUS protein, C9orf72 (chromosome 9 open reading frame 72), c9RAN protein, prion protein, PrPSc, huntingtin, calcitonin, superoxide dismutase, ataxin, ataxin 1, ataxin 2, ataxin 3, ataxin 7, ataxin 8, ataxin 10, Lewy body, atrial natriuretic factor, islet amyloid polypeptide, insulin, apolipoprotein AI, serum amyloid A, medin, prolactin, transthyretin, lysozyme, beta 2 microglobulin, gelsolin, keratoepithelin, cystatin, immunoglobulin light chain AL, S-IBM protein, Repeat-associated non-ATG (RAN) translation products, DiPeptide repeat (DPR) peptides, glycine-alanine (GA) repeat peptides, glycine-proline (GP) repeat peptides, glycine-arginine (GR) repeat peptides, proline-alanine (PA) repeat peptides, ubiquitin, and proline-arginine (PR) repeat peptides; (d) ligands and/or proteins expressed on immune cells, wherein the ligands and/or proteins selected from CD40, OX40, ICOS, CD28, CD137/4-1BB, CD27, GITR, PD-L1, CTLA-4, PD-L2, PD-1, B7-H3, B7-H4, HVEM, BTLA, KIR, GAL9, TIM3, A2AR, LAG-3, and phosphatidylserine; and/or (e) a protein, lipid, polysaccharide, or glycolipid expressed on one or more tumor cells and any combination thereof.

[0315] Numerous antigens are known in the art that facilitate transport across the blood-brain barrier (*see, e.g.*, Gabathuler R. Neurobiol. Dis. 37:48-57 (2010)). Such second antigens include, without limitation, transferrin receptor (TR), insulin receptor (HIR), Insulin-like growth factor receptor (IGFR), low-density lipoprotein receptor related proteins 1 and 2 (LPR-1 and 2), diphtheria toxin receptor, including CRM 197 (a non-toxic mutant of diphtheria toxin), llama single domain antibodies such as TMEM 30(A) (Flippase), protein transduction domains such as TAT, Syn-B, or penetratin, poly-arginine or generally positively charged peptides, Angiopep peptides such as ANG1005 (*see, e.g.*, Gabathuler, 2010), and other cell surface proteins that are enriched on blood-brain barrier endothelial cells (*see, e.g.*, Daneman et al. PLoS One 5(10):e13741 (2010)).

[0316] The multivalent antibodies may recognize the Sortilin antigen as well as without limitation additional antigens A β peptide, antigen or an α -synuclein protein antigen or, Tau protein antigen or, TDP-43 protein antigen or, prion protein antigen or, huntingtin protein antigen, or RAN, translation Products antigen, including the DiPeptide Repeats (DPRs peptides) composed of glycine-alanine (GA), glycine-proline (GP), glycine-arginine (GR), proline-alanine (PA), or proline-arginine (PR), Insulin receptor, insulin like growth factor receptor. Transferrin receptor or any other antigen that facilitate antibody transfer across the blood brain barrier. In some embodiments, the second polypeptide is transferrin. In some embodiments, the second polypeptide is Tau. In some embodiments, the second polypeptide is A β . In some embodiments, the second polypeptide is TREM2. In some embodiments, the second polypeptide is α -synuclein.

[0317] The multivalent antibody contains at least one polypeptide chain (and preferably two polypeptide chains), wherein the polypeptide chain or chains comprise two or more variable domains. For instance, the polypeptide chain or chains may comprise VD1-(X1)_n-VD2-(X2)_n-Fc, wherein VD 1 is a first variable domain, VD2 is a second variable domain, Fc is one polypeptide chain of an Fc region, X1 and X2 represent an amino acid or polypeptide, and n is 0 or 1. Similarly, the polypeptide chain or chains may comprise V_R-C_R1-flexible linker-V_H-C_H1-Fc region chain; or V_H-C_H1-V_R-C_H1-Fc region chain. The multivalent antibody herein preferably further comprises at least two (and preferably four) light chain variable domain polypeptides. The multivalent antibody herein may, for instance, comprise from about two to about eight light chain variable domain polypeptides. The light chain variable domain polypeptides contemplated here comprise a light chain variable domain and, optionally, further comprise a CL domain.

[0318] Techniques for making multispecific antibodies include, but are not limited to, recombinant co-expression of two immunoglobulin heavy chain- light chain pairs having different specificities (*see* Milstein and Cuello Nature 305: 537 (1983), WO 93/08829, and Trautnecker et al. EMBO J. 10:3655 (1991)), and "knob-in-hole" engineering (*see, e.g.*, U.S. Patent No. 5731168). *See also* WO 2013/026833 (CrossMab). Multi-specific antibodies may also be made by engineering electrostatic steering effects for making antibody Fc- heterodimeric molecules (WO 2009/089004A1); cross-linking two or more antibodies (*see, e.g.*, US Patent No. 4676980); using leucine; using "diabody" technology for making bispecific antibody fragments (*see, e.g.*, Hollinger et al. Proc. Natl. Acad. Sci. USA 90:6444-6448 (1993)), and using single-chain Fv (scFv) dimers (*see, e.g.*, Gruber et al. J. Immunol. 152:5368 (1994)); and preparing trispecific antibodies as described, *e.g.*, in Tutt et al. J. Immunol. 147: 60 (1991).

[0319] Engineered antibodies with three or more functional antigen binding sites, including "Octopus antibodies," are also included herein (*see, e.g.*, US 2006/0025576). The antibody herein also includes a "Dual Acting FAb" or "DAF" comprising an antigen binding site that binds to multiple Sortilin (*see*, US 2008/0069820, for example).

(7) Antibodies with improved stability

[0320] Amino acid sequence modifications of anti-Sortilin antibodies of the present disclosure, or antibody fragments thereof to improve stability during manufacturing, storage, and *in vivo* administration, are also contemplated. For example, it may be desirable to reduce degradation of the antibodies or antibody fragments of the present disclosure through multiple pathways, including without limitation, oxidation and deamidation. Amino acid sequence variants of the antibodies or antibody fragments are prepared by introducing appropriate nucleotide changes into the nucleic acid encoding the antibodies or antibody fragments, or by peptide synthesis. Such modifications include, for example, deletions from, and/or insertions into and/or substitutions of, residues within the amino acid sequences of the antibody. Any combination of deletion, insertion, and substitution can be made to arrive at the final construct, provided that the final construct possesses the desired characteristics (i.e., reduced susceptibility to degradation).

[0321] In some embodiments, the asparagine (N33) site in the HVR-LI region of an anti-Sortilin antibody of the present disclosure may be susceptible to degradation by means of deamidation. In certain embodiments, the asparagine (N33) site in the HVR-L1 region of S-60-15 (SEQ ID NO:8) may be susceptible to deamidation. Upon deamidation, the asparagine (N33) site in the HVR-L1 region of S-60-15 results in an Asn to Asp/IsoAsp change. In certain embodiments, the asparagine (N33) site in the HVR-LI region of S-60-15 may be substituted to prevent or reduce deamidation. Non-limiting exemplary amino acid sequence variants of S-60-15 having amino acid substitutions in the asparagine (N33) site of the HVR-LI region include S-60-15. 1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], or S-60-15.17 [N33L].

(8) Antibody Variants

[0322] In some embodiments of any of the antibodies provided herein, amino acid sequence variants of the antibodies are contemplated. For example, it may be desirable to improve the binding affinity and/or other biological properties of the antibody.

(i) Substitution, Insertion, and Deletion Variants

[0323] In some embodiments of any of the antibodies provided herein, antibody variants having one or more amino acid substitutions are provided. Amino acid sequence variants of an antibody may be prepared by introducing appropriate modifications into the nucleotide sequence encoding the antibody, or by peptide synthesis. Such modifications include, for example, deletions from, and/or insertions into and/or substitutions of residues within the amino acid sequences of the antibody. **TABLE 37: Amino Acid Substitutions**

Original Residue	Exemplary Substitutions	Preferred Substitutions
Ala (A)	Val, Leu, Ile	Val

Original Residue	Exemplary Substitutions	Preferred Substitutions
Arg (R)	Lys, Gln, Asn	Lys
Asn (N)	Gln, His, Asp, Lys, Arg	Gln
Asp (D)	Glu, Asn	Glu
Cys (C)	Ser, Ala	Ser
Gln (Q)	Asn, Glu	Asn
Glu (E)	Asp, Gln	Asp
Gly (G)	Ala	Ala
His (H)	Asn, Gln, Lys, Arg	Arg

Ile (I)	Leu; Val; Met; Ala; Phe; Norleucine	Leu
Leu (L)	Norleucine; Ile; Val; Met; Ala; Phe	Ile
Lys (K)	Arg; Glu; Asn	Arg
Met (M)	Leu; Phe; Ile	Leu
Phe (F)	Leu; Val; Ile; Ala; Tyr	Tyr
Pro (P)	Ala	Ala
Ser (S)	Thr	Thr
Thr (T)	Ser	Ser
Trp (W)	Lys; Phe	Tyr
Tyr (Y)	Trp; Phe; Thr; Ser	Phe
Val (V)	Ile; Leu; Met; Phe; Ala; Norleucine	Leu

[0324] Substantial modifications in the biological properties of the antibody are accomplished by selecting substitutions that differ significantly in their effect on maintaining (a) the structure of the polypeptide backbone in the area of the substitution, for example, as a sheet or helical conformation, (b) the charge or hydrophobicity of the molecule at the target site, or (c) the bulk of the side chain. Naturally occurring residues are divided into groups based on common side-chain properties:

1. (1) hydrophobic: Norleucine, Met, Ala, Val, Leu, Ile;
2. (2) neutral hydrophilic: Cys, Ser, Thr, Asn, Gln;
3. (3) acidic: Asp, Glu;
4. (4) basic: His, Lys, Arg;
5. (5) residues that influence chain orientation: Gly, Pro; and
6. (6) aromatic: Trp, Tyr, Phe.

[0325] For example, non-conservative substitutions can involve the exchange of a member of one of these classes for a member from another class. Such substituted residues can be introduced, for example, into regions of a human antibody that are homologous with non-human antibodies, or into the non-homologous regions of the molecule.

[0326] In making changes to the polypeptide or antibody described herein, according to certain embodiments, the hydropathic index of amino acids can be considered. Each amino acid has been assigned a hydropathic index on the basis of its hydrophobicity and charge characteristics. They are: isoleucine (+4.5); valine (+4.2); leucine (+3.8); phenylalanine (+2.8); cysteine/cystine (+2.5); methionine (+1.9); alanine (+1.8); glycine (-0.4); threonine (-0.7); serine (-0.8); tryptophan (-0.9); tyrosine (-1.3); proline (-1.6); histidine (-3.2); glutamate (-3.5); glutamine (-3.5); aspartate (-3.5); asparagine (-3.5); lysine (-3.9); and arginine (-4.5).

[0327] The importance of the hydropathic amino acid index in conferring interactive biological function on a protein is understood in the art. Kyte et al. J. Mol. Biol., 157:105-131 (1982). It is known that certain amino acids can be substituted for other amino acids having a similar hydropathic index or score and still retain a similar biological activity. In making changes based upon the hydropathic index, in certain embodiments, the substitution of amino acids whose hydropathic indices are within ± 2 is included. In certain embodiments, those which are within ± 1 are included, and in certain embodiments, those within ± 0.5 are included.

[0328] It is also understood in the art that the substitution of like amino acids can be made effectively on the basis of hydrophilicity, particularly where the biologically functional protein or peptide thereby created is intended for use in immunological embodiments, as in the present case. In certain embodiments, the greatest local average hydrophilicity of a protein, as governed by the hydrophilicity of its adjacent amino acids, correlates with its immunogenicity and antigenicity, i.e., with a biological property of the protein.

[0329] The following hydrophilicity values have been assigned to these amino acid residues: arginine (+3.0); lysine (+3.0+1); aspartate (+3.0 $\pm$ 1); glutamate (+3.0 $\pm$ 1); serine (+0.3); asparagine (+0.2); glutamine (+0.2); glycine (0); threonine (-0.4); proline (-0.5 $\pm$ 1); alanine (-0.5); histidine (-0.5); cysteine (-1.0); methionine (-1.3); valine (-1.5); leucine (-1.8); isoleucine (-1.8); tyrosine (-2.3); phenylalanine (-2.5) and tryptophan (-3.4). In making changes based upon similar hydrophilicity values, in certain embodiments, the substitution of amino acids whose hydrophilicity values are within ± 2 is included, in certain embodiments, those which are within ± 1 are included, and in certain embodiments, those within ± 0.5 are included. One can also identify epitopes from primary amino acid sequences on the basis of hydrophilicity. These regions are also referred to as "epitopic core regions".

[0330] In certain embodiments, substitutions, insertions, or deletions may occur within one or more HVRs so long as such alterations do not substantially reduce the ability of the antibody to bind antigen. For example, conservative alterations (e.g., conservative substitutions as provided herein) that do not substantially reduce binding affinity may be made in HVRs. Such alterations may, for example, be outside of antigen contacting residues in the HVRs. In certain embodiments of the variant VH and VL sequences provided above, each HVR either is unaltered, or contains no more than one, two or three amino acid substitutions.

[0331] Amino acid sequence insertions include amino- and/or carboxyl-terminal fusions ranging in length from one residue to polypeptides comprising a hundred or more residues, as well as intrasequence insertions of single or multiple amino acid residues. Examples of terminal insertions include an antibody with an N-terminal methionyl residue. Other insertional variants of the antibody molecule include the fusion to the N- or C-terminus of the antibody to an enzyme (e.g., for ADEPT) or a polypeptide which increases the serum half-life of the antibody.

[0332] Any cysteine residue not involved in maintaining the proper conformation of the antibody also may be substituted, generally with serine, to improve the oxidative stability of the molecule and prevent aberrant crosslinking. Conversely, cysteine bond(s) may be added to the antibody to improve its stability (particularly where the antibody is an antibody fragment, such as an Fv fragment).

(ii) Glycosylation variants

[0333] In some embodiments of any of the antibodies provided herein, the antibody is altered to increase or decrease the extent to which the antibody is glycosylated. Addition or deletion of glycosylation sites to an antibody may be conveniently accomplished by altering the amino acid sequence such that one or more glycosylation sites is created or removed.

[0334] Glycosylation of antibodies is typically either N-linked or O-linked. N-linked refers to the attachment of the carbohydrate moiety to the side chain of an asparagine residue. The tripeptide sequences asparagine-X-serine and asparagine-X-threonine, where X is any amino acid except proline, are the recognition sequences for enzymatic attachment of the carbohydrate moiety to the asparagine side chain. Thus, the presence of either of these tripeptide sequences in a polypeptide creates a potential glycosylation site. O-linked glycosylation refers to the attachment of one of the sugars N-acetyl/galactosamine, galactose, or xylose to a hydroxyamino acid, most commonly serine or threonine, although 5-hydroxyproline or 5-hydroxylysine may also be used.

[0335] Addition of glycosylation sites to the antibody is conveniently accomplished by altering the amino acid sequence such that it contains one or more of the above-described tripeptide sequences (for N-linked glycosylation sites). The alteration may also be made by the addition of, or substitution by, one or more serine or threonine residues to the sequence of the original antibody (for O-linked glycosylation sites).

[0336] Where the antibody comprises an Fc region, the carbohydrate attached thereto may be altered. Native antibodies produced by mammalian cells typically comprise a branched, biantennary oligosaccharide that is generally attached by an N-linkage to Asn297 according to Kabat numbering of the CH2 domain of the Fc region. The oligosaccharide may include various carbohydrates, for example, mannose, N-acetyl glucosamine (GlcNAc), galactose, and sialic acid, as well as a fucose attached to a GlcNAc in the "stem" of the biantennary oligosaccharide structure. In some embodiments, modifications of the oligosaccharide in an antibody of the invention may be made in order to create antibody *variants* with certain improved properties.

[0337] In one embodiment, antibody *variants* are provided having a carbohydrate structure that lacks fucose attached (directly or indirectly) to an Fc region. See, e.g., US Patent Publication Nos. 2003/0157108 and 2004/0093621. Examples of publications related to "defucosylated" or "fucose-deficient" antibody variants include: US 2003/0157108; US 2003/0115614; US 2002/0164328; US 2004/0093621; US 2004/0132140; US 2004/0110704; US 2004/0110282; US 2004/0109865; Okazaki et al. J. Mol. Biol. 336:1239-1249 (2004); Yamane-Ohnuki et al. Biotech. Bioeng. 87:614 (2004). Examples of cell lines capable of producing defucosylated antibodies include Led 3 CHO cells deficient in protein fucosylation (Ripka et al. Arch. Biochem. Biophys. 249:533-545 (1986); US 2003/0157108), and knockout cell lines, such as alpha-1,6-fucosyltransferase gene, FUT8, knockout CHO cells (see, e.g., Yamane-Ohnuki et al. Biotech. Bioeng. 87: 614 (2004) and Kanda et al. Biotechnol. Bioeng. 94(4):680-688 (2006)).

(iii) Modified Constant regions

[0338] In some embodiments of any of the antibodies provided herein, the antibody Fc is an antibody Fc isotypes and/or modifications. In some embodiments, the antibody Fc isotype and/or modification is capable of binding to Fc gamma receptor.

[0339] In some embodiments of any of the antibodies provided herein, the modified antibody Fc is an IgG1 modified Fc. In some embodiments, the IgG1 modified Fc comprises one or more modifications. For example, in some embodiments, the IgG1 modified Fc comprises one or more amino acid substitutions (e.g., relative to a wild-type Fc region of the same isotype). In some embodiments, the one or more amino acid substitutions are selected from N297A (Bolt S et al. (1993) Eur J Immunol 23:403-41 1), D265A (Shields et al. (2001) R. J. Biol. Chem. 276, 6591-66(4), L234A, L235A (Hutchins et al. (1995) Proc Natl Acad Sci USA, 92:11980-11984; Alegre et al., (1994) Transplantation 57:1537-1543, 31; Xu et al., (2000) Cell Immunol, 200:16-26), G237A (Alegre et al. (1994) Transplantation 57:1537-1543, 31; Xu et al. (2000) Cell Immunol, 200: 16-26), C226S, C229S, E233P, L234V, L234F, L235E (McEarchern et al., (2007) Blood, 109:1185-1192), P331S (Sazinsky et al., (2008) Proc Natl Acad Sci USA 2008, 105:20167-20172), S267E, L328F, A330L, M252Y, S254T, and/or T256E, where the amino acid position is according to the EU numbering convention. In some embodiments of any of the antibodies provided herein, the antibody is an IgG1 isotype and the Fc region comprises amino acid substitutions at positions L234A, L235A, and P331S, wherein the numbering of the residue position is according to EU numbering.

[0340] In some embodiments of any of the IgG1 modified Fc, the Fc comprises N297A mutation according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises D265A and N297A mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises D270A mutations according to EU numbering. In some embodiments, the IgG1 modified Fc comprises L234A and L235A mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises L234A and G237A mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises L234A, L235A and G237A mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises one or more (including all) of P238D, L328E, E233, G237D, H268D, P271G and A330R mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises one or more of S267E/L328F mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises P238D, L328E, E233D, G237D, H268D, P271G and A330R mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises P238D, L328E, G237D, H268D, P271G and A330R mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises P238D, S267E, L328E, G237D, H268D, P271G and A330R mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises C226S, C229S, E233P, L234V, and L235A mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises L234F, L235E, and P331S mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises S267E and L328F mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises S267E mutations according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the Fc comprises a substitute of the constant heavy 1 (CH1) and hinge region of IgG1 with CH1 and hinge region of IgG2 (amino acids 118-230 of IgG2 according to EU numbering) with a Kappa light chain.

[0341] In some embodiments of any of the IgG1 modified Fc, the Fc includes two or more amino acid substitutions that increase antibody clustering without activating complement as compared to a corresponding antibody having an Fc region that does not include the two or more amino acid substitutions. Accordingly, in some embodiments of any of the IgG1 modified Fc, the IgG1 modified Fc is an antibody comprising an Fc region, where the antibody comprises an amino acid substitution at position E430G and one or more amino acid substitutions in the Fc region at a residue position selected from: L234F, L235A, L235E, S267E, K322A, L328F, A330S, P331S, and any combination thereof according to EU numbering. In some embodiments, the IgG1 modified Fc comprises an amino acid substitution at positions E430G, L243A, L235A, and P331S according to EU numbering. In some embodiments, the IgG1 modified Fc comprises an amino acid substitution at positions E430G and P331S according to EU numbering. In some embodiments, the IgG1 modified Fc comprises an amino acid substitution at positions E430G and K322A according to EU numbering. In some embodiments, the IgG1 modified Fc comprises an amino acid substitution at positions E430G, A330S, and P331S according to EU numbering. In some embodiments, the IgG1 modified Fc comprises an amino acid substitution at positions E430G, K322A, A330S, and P331S according to EU numbering. In some embodiments, the IgG1 modified Fc comprises an amino acid substitution at positions E430G, K322A, and A330S according to EU numbering. In some embodiments, the IgG1 modified Fc comprises an amino acid substitution at positions E430G, K322A, and P331S according to EU numbering.

[0342] In some embodiments of any of the IgG1 modified Fc, the IgG1 modified Fc may further comprise herein may be combined with an A330L mutation (Lazar et al. Proc Natl Acad Sci USA, 103:4005-4010 (2006)), or one or more of L234F, L235E, and/or P331S mutations (Sazinsky et al. Proc Natl Acad Sci USA, 105:20167-20172 (2008)), according to the EU numbering convention, to eliminate complement activation. In some embodiments of any of the IgG1 modified Fc, the IgG1 modified Fc may further comprise one or more of A330L, A330S, L234F, L235E, and/or P331S according to EU numbering. In some embodiments of any of the IgG1 modified Fc, the IgG1 modified Fc may further comprise one or more mutations to enhance the antibody half-life in human serum (e.g., one or more (including all) of M252Y, S254T, and T256E mutations according to the EU numbering convention). In some embodiments of any of the IgG1 modified Fc, the IgG1 modified Fc may further comprise one or more of E430G, E430S, E430F, E430T, E345K, E345Q, E345R, E345Y, S440Y, and/or S440W according to EU numbering.

[0343] Other aspects of the present disclosure relate to antibodies having modified constant regions (*i.e.*, Fc regions). An antibody dependent on binding to FcγR receptor to activate targeted receptors may lose its agonist activity if engineered to eliminate FcγR binding (see, e.g., Wilson et al. Cancer Cell 19:101-113 (2011); Armour et al. Immunology 40:585-593 (2003), and White et al. Cancer Cell 27:138-148 (2015)). As such, it is thought that an anti-Sortilin antibody of the present disclosure with the correct epitope specificity can activate the target antigen, *with* minimal adverse effects, when the antibody has an Fc domain from a human IgG2 isotype (CH1 and hinge region) or another type of Fc domain that is capable of preferentially binding the inhibitory FcγRIIB receptors, or a variation thereof.

[0344] In some embodiments of any of the antibodies provided herein, the modified antibody Fc is an IgG2 modified Fc. In some embodiments, the IgG2 modified Fc comprises one or more modifications. For example, in some embodiments, the IgG2 modified Fc comprises one or more amino acid substitutions (e.g., relative to a wild-type Fc region of the same isotype). In some embodiments of any of the IgG2 modified Fc, the one or more amino acid substitutions are selected from V234A (Alegre et al. Transplantation 57:1537-1543 (1994); Xu et al. Cell Immunol, 200:16-26 (2000)); G237A (Cole et al. Transplantation, 68:563-571 (1999)); H268Q, V309L, A330S, P331S (US 2007/0148167; Armour et al. Eur J Immunol 29: 2613-2624 (1999); Armour et al. The Haematology Journal 1(Suppl.1):27 (2000); Armour et al. The Haematology Journal 1(Suppl. 1):27 (2000)), C219S, and/or C220S (White et al. Cancer Cell 27, 138-148 (2015)); S267E, L328F (Chu et al. Mol Immunol. 45:3926-3933 (2008)); and M252Y, S254T, and/or T256E according to the EU numbering convention. In some embodiments of any of the IgG2 modified Fc, the Fc comprises an amino acid substitution at positions V234A and G237A according to EU numbering. In some embodiments of any of the IgG2 modified Fc, the Fc comprises an amino acid substitution at positions C219S or C220S according to EU numbering. In some embodiments of any of the IgG2 modified Fc, the Fc comprises an amino acid substitution at positions A330S and P331S according to EU numbering. In some embodiments of any of the IgG2 modified Fc, the Fc comprises an amino acid substitution at positions S267E and L328F according to EU numbering.

[0345] In some embodiments of any of the IgG2 modified Fc, the Fc comprises a C127S amino acid substitution according to the EU numbering convention (White et al., (2015) Cancer Cell 27, 138-148; Lightle et al. Protein Sci. 19:753-762 (2010); and WO 2008/079246). In some embodiments of any of the IgG2 modified Fc, the antibody has an IgG2 isotype with a Kappa light chain constant domain that comprises a C214S amino acid substitution according to the EU numbering convention (White et al. Cancer Cell 27: 138-148 (2015); Lightle et al. Protein Sci. 19:753-762 (2010); and WO 2008/079246).

[0346] In some embodiments of any of the IgG2 modified Fc, the Fc comprises a C220S amino acid substitution according to the EU numbering convention. In some embodiments of any of the IgG2 modified Fc, the antibody has an IgG2 isotype with a Kappa light chain constant domain that comprises a C214S amino acid substitution according to the EU numbering convention.

[0347] In some embodiments of any of the IgG2 modified Fc, the Fc comprises a C219S amino acid substitution according to the EU numbering convention. In some embodiments of any of the IgG2 modified Fc, the antibody has an IgG2 isotype with a Kappa light chain constant domain that comprises a C214S amino acid substitution according to the EU numbering convention.

convention.

[0348] In some embodiments of any of the IgG2 modified Fc, the Fc includes an IgG2 isotype heavy chain constant domain 1(CH1) and hinge region (White et al. Cancer Cell 27:138-148 (2015)). In certain embodiments of any of the IgG2 modified Fc, the IgG2 isotype CH1 and hinge region comprise the amino acid sequence of 118-230 according to EU numbering. In some embodiments of any of the IgG2 modified Fc, the antibody Fc region comprises a S267E amino acid substitution, a L328F amino acid substitution, or both, and/or a N297A or N297Q amino acid substitution according to the EU numbering convention.

[0349] In some embodiments of any of the IgG2 modified Fc, the Fc further comprises one or more amino acid substitution at positions E430G, E430S, E430F, E430T, E345K, E345Q, E345R, E345Y, S440Y, and S440W according to EU numbering. In some embodiments of any of the IgG2 modified Fc, the Fc may further comprise one or more mutations to enhance the antibody half-life in human serum (e.g., one or more (including all) of M252Y, S254T, and T256E mutations according to the EU numbering convention). In some embodiments of any of the IgG2 modified Fc, the Fc may further comprise A330S and P331S.

[0350] In some embodiments of any of the IgG2 modified Fc, the Fc is an IgG2/4 hybrid Fc. In some embodiments, the IgG2/4 hybrid Fc comprises IgG2 aa 118 to 260 and IgG4 aa 261 to 447. In some embodiments of any IgG2 modified Fc, the Fc comprises one or more amino acid substitutions at positions H268Q, V309L, A330S, and P331S according to EU numbering.

[0351] In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises one or more additional amino acid substitutions selected from A330L, L234F; L235E, or P331S according to EU numbering; and any combination thereof.

[0352] In certain embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises one or more amino acid substitutions at a residue position selected from C127S, L234A, L234F, L235A, L235E, S267E, K322A, L328F, A330S, P331S, E345R, E430G, S440Y, and any combination thereof according to EU numbering. In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises an amino acid substitution at positions E430G, L243A, L235A, and P331S according to EU numbering. In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises an amino acid substitution at positions E430G and P331S according to EU numbering. In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises an amino acid substitution at positions E430G and K322A according to EU numbering. In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises an amino acid substitution at positions E430G, A330S, and P331S according to EU numbering. In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises an amino acid substitution at positions E430G, K322A, A330S, and P331S according to EU numbering. In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises an amino acid substitution at positions E430G, K322A, and P331S according to EU numbering. In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises an amino acid substitution at positions S267E and L328F according to EU numbering. In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises an amino acid substitution at position C127S according to EU numbering. In some embodiments of any of the IgG1 and/or IgG2 modified Fc, the Fc comprises an amino acid substitution at positions E345R, E430G and S440Y according to EU numbering.

[0353] In some embodiments of any of the antibodies provided herein, the modified antibody Fc is an IgG4 modified Fc. In some embodiments, the IgG4 modified Fc comprises one or more modifications. For example, in some embodiments, the IgG4 modified Fc comprises one or more amino acid substitutions (e.g., relative to a wild-type Fc region of the same isotype). In some embodiments of any of the IgG4 modified Fc, the one or more amino acid substitutions are selected from L235A, G237A, S229P, L236E (Reddy et al. J Immunol 164:1925-1933(2000)), S267E, E318A, L328F, M252Y, S254T, and/or T256E according to the EU numbering convention. In some embodiments of any of the IgG4 modified Fc, the Fc may further comprise L235A, G237A, and E318A according to the EU numbering convention. In some embodiments of any of the IgG4 modified Fc, the Fc may further comprise S228P and L235E according to the EU numbering convention. In some embodiments of any of the IgG4 modified Fc, the IgG4 modified Fc may further comprise S267E and L328F according to the EU numbering convention.

[0354] In some embodiments of any of the IgG4 modified Fc, the IgG4 modified Fc comprises may be combined with an S228P mutation according to the EU numbering convention (Angal et al. Mol Immunol. 30:105-108 (1993)) and/or with one or more mutations described in (Peters et al. J Biol Chem. 287(29):24525-33 (2012)) to enhance antibody stabilization.

[0355] In some embodiments of any of the IgG4 modified Fc, the IgG4 modified Fc may further comprise one or more mutations to enhance the antibody half-life in human serum (e.g., one or more (including all) of M252Y, S254T, and T256E mutations according to the EU numbering convention).

[0356] In some embodiments of any of the IgG4 modified Fc, the Fc comprises L235E according to EU numbering. In certain embodiments of any of the IgG4 modified Fc, the Fc comprises one or more amino acid substitutions at a residue position selected from C127S, F234A, L235A, L235E, S267E, K322A, L328F, E345R, E430G, S440Y, and any combination thereof, according to EU numbering. In some embodiments of any of the IgG4 modified Fc, the Fc comprises an amino acid substitution at positions E430G, L243A, L235A, and P331S according to EU numbering. In some embodiments of any of the IgG4 modified Fc, the Fc comprises an amino acid substitution at positions E430G and P331S according to EU numbering. In some embodiments of any of the IgG4 modified Fc, the Fc comprises an amino acid substitution at positions E430G and K322A according to EU numbering. In some embodiments of any of the IgG4 modified Fc, the Fc comprises an amino acid substitution at position E430 according to EU numbering. In some embodiments of any of the IgG4 modified Fc, the Fc region comprises an amino acid substitution at positions E430G and K322A according to EU numbering. In some embodiments of any of the IgG4 modified Fc, the Fc comprises an amino acid substitution at positions S267E and L328F according to EU numbering. In some embodiments of any of the IgG4 modified Fc, the Fc comprises an amino acid substitution at position C127S according to EU numbering. In some embodiments of any of the IgG4 modified Fc, the Fc comprises an amino acid substitution at positions E345R, E430G and S440Y according to EU numbering.

(9) Other antibody modifications

[0357] In some embodiments of any of the antibodies, the antibody is a derivative. The term "derivative" refers to a molecule that includes a chemical modification other than an insertion, deletion, or substitution of amino acids (or nucleic acids). In certain embodiments, derivatives comprise covalent modifications, including, but not limited to, chemical bonding with polymers, lipids, or other organic or inorganic moieties. In certain embodiments, a chemically modified antigen binding protein can have a greater circulating half-life than an antigen binding protein that is not chemically modified. In certain embodiments, a chemically modified antigen binding protein can have improved targeting capacity for desired cells, tissues, and/or organs. In some embodiments, a derivative antigen binding protein is covalently modified to include one or more water soluble polymer attachments, including, but not limited to, polyethylene glycol, polyoxyethylene glycol, or polypropylene glycol. See, e.g., U.S. Pat. Nos. 4640835, 4496689, 4301144, 4670417, 4791 192 and 4179337. In certain embodiments, a derivative antigen binding protein comprises one or more polymer, including, but not limited to, monomethoxy-polyethylene glycol, dextran, cellulose, copolymers of ethylene glycol/propylene glycol, carboxymethylcellulose, polyvinyl pyrrolidone, poly-1, 3-dioxolane, poly-1,3,6-trioxane, ethylene/maleic anhydride copolymer, polyaminoacids (either homopolymers or random copolymers), poly-(N-vinyl pyrrolidone)-polyethylene glycol, propylene glycol homopolymers, a polypropylene oxide/ethylene oxide co-polymer, polyoxyethylated polyols (e.g., glycerol) and polyvinyl alcohol, as well as mixtures of such polymers.

[0358] In certain embodiments, a derivative is covalently modified with polyethylene glycol (PEG) subunits. In certain embodiments, one or more water-soluble polymer is bonded at one or more specific position, for example at the amino terminus, of a derivative. In certain embodiments, one or more water-soluble polymer is randomly attached to one or more side chains of a derivative. In certain embodiments, PEG is used to improve the therapeutic capacity for an antigen binding protein. In certain embodiments, PEG is used to improve the therapeutic capacity for a humanized antibody. Certain such methods are discussed, for example, in U.S. Pat. No. 6133426.

[0359] Peptide analogs are commonly used in the pharmaceutical industry as non-peptide drugs with properties analogous to those of the template peptide. These types of non-peptide compound are termed "peptide mimetics" or "peptidomimetics." Fauchere, J. Adv. Drug Res., 15:29 (1986); and Evans et al. J. Med. Chem., 30:1229 (1987). Such compounds are often developed with the aid of computerized molecular modeling. Peptide mimetics that are structurally similar to therapeutically useful peptides can be used to produce a similar therapeutic or prophylactic effect. Generally, peptidomimetics are structurally similar to a paradigm polypeptide (i.e., a polypeptide that has a biochemical property or pharmacological activity), such as human antibody, but have one or more peptide linkages optionally replaced by a linkage selected from: -CH₂NH-, -CH₂S-, -CH₂-CH₂-, -CH=CH-(cis and trans), -COCH₂-, -CH(OH)CH₂-, and -CH₂SO₂-, by methods well known in the art. Systematic substitution of one or more amino acids of a consensus sequence with a D-amino acid of the same type (e.g., D-lysine in place of L-lysine) can be used in certain embodiments to generate more stable peptides. In addition, constrained peptides comprising a consensus sequence or a substantially identical consensus sequence variation can be generated by methods known in the art (Rizo and Gierasch Ann. Rev. Biochem., 61:387 (1992); for example, by adding internal cysteine residues capable of forming intramolecular disulfide bridges which cyclize the peptide.

[0360] Drug conjugation involves coupling of a biological active cytotoxic (anticancer) payload or drug to an antibody that specifically targets a certain tumor marker (e.g. a polypeptide that, ideally, is only to be found in or on tumor cells). Antibodies track these proteins down in the body and attach themselves to the surface of cancer cells. The biochemical reaction between the antibody and the target protein (antigen) triggers a signal in the tumor cell, which then absorbs or internalizes the antibody together with the cytotoxin. After the ADC is internalized, the cytotoxic drug is released and kills the cancer. Due to this targeting, ideally the drug has lower side effects and gives a wider therapeutic window than other chemotherapeutic agents. Techniques to conjugate antibodies are disclosed are known in the art (see, e.g., Jane de Lartigue One Live July 5, 2012; ADC Review on antibody-drug conjugates; and Ducry et al. Bioconjugate Chemistry 21 (1):5-13 (2010)).

Binding assays and other assays

[0361] Anti-Sortilin antibodies of the present disclosure may be tested for antigen binding activity, e.g., by known methods such as ELISA, surface plasmon resonance (SPR), Western blot, flow cytometry, FACS, Bio-layer interferometry etc.

[0362] In some embodiments, competition assays may be used to identify an antibody that competes with any of the antibodies described herein. In some embodiments, competition assays may be used to identify an antibody that competes with any of the antibodies listed in **Tables 1-30**, or comprising the heavy chain variable region and the light chain variable region of an antibody selected from S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-7, S-60-8, S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, and S-60-24 for binding to Sortilin. In certain embodiments, such a competing antibody binds to the same epitope (e.g., a linear or a conformational epitope) that is bound by any of the antibodies listed in **Tables 1-30**, or comprising the heavy chain variable region and the light chain variable region of an antibody selected from S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-7, S-60-8, S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, and S-60-24. Detailed exemplary methods for mapping an epitope to which an antibody binds are provided in Morris (1996) "Epitope Mapping Protocols," in Methods in Molecular Biology vol. 66 (Humana Press, Totowa, NJ).

[0363] In an exemplary competition assay, immobilized Sortilin or cells expressing Sortilin on a cell surface are incubated in a solution comprising a first labeled antibody that binds to Sortilin (e.g., human or non-human primate) and a second unlabeled antibody that is being tested for its ability to compete with the first antibody for binding to Sortilin. The second antibody may be present in a hybridoma supernatant. As a control, immobilized Sortilin or cells expressing Sortilin is incubated in a solution comprising the first labeled antibody but not the second unlabeled antibody. After incubation under conditions permissive for binding of the first antibody to Sortilin, excess unbound antibody is removed, and the amount of label associated with immobilized Sortilin or cells expressing Sortilin is measured. If the amount of label associated with immobilized Sortilin or cells expressing Sortilin is substantially reduced in the test sample relative to the control sample, then that indicates that the second antibody is competing with the first antibody for binding to Sortilin. See, Harlow and Lane (1988) Antibodies: A Laboratory Manual ch. 14 (Cold Spring Harbor Laboratory, Cold Spring Harbor, NY).

Ligand binding assays

[0364] Further provided herein are methods of screening for anti-Sortilin antibodies that bind His131, Val 132, Pro 133, Leu134, Val135, Ile136, Met137, Thr138, Arg196, Phe198, Arg199, Phe203, Lys205, Phe207, Thr210, Thr218, Tyr222, Ser223, Ser227, Ser242, Lys243, Lys248, Lys254, Lys260, Ser305, Phe306, Gly307, Arg311, Phe314, Ser316, Arg325, Arg326, Ile327, Phe350, Tyr351, Ser352, Ile353, Asn373, Ser379, Arg382, Tyr386, Ser595, and/or Glu700 of human Sortilin (SEQ ID NO:81); or to amino acid residues of a mammalian Sortilin that corresponds to one or more amino acid residues His131, Val132, Pro133, Leu134, Val135, Ile136, Met137, Thr138, Arg196, Phe198, Arg199, Phe203, Lys205, Phe207, Thr210, Thr218, Tyr222, Ser223, Ser227, Ser242, Lys243, Lys248, Lys254, Lys260, Ser305, Phe306, Gly307, Arg311, Phe314, Ser316, Arg325, Arg326, Ile327, Phe350, Tyr351, Ser352, Ile353, Asn373, Ser379, Arg382, Tyr386, Ser595, and/or Glu700 of SEQ ID NO: 81, thereby blocking the interactions between Sortilin and a Sortilin ligand (e.g., Progranulin, pro-neurotrophin, pro-NGF, pro-BDNF, pro-NT3, p75, APP, LpL, APOA5, APOE). In some embodiments, a peptide library can be synthesized in which a Sortilin protein is dissected into consecutive 15-mer and 25-mer peptides separated by one amino acid residue and subsequently spotted onto filters. Binding of a Sortilin ligand can then be tested for its ability to interact with the receptor peptide or with peptides that are, for example, mutated at His131, Val132, Pro133, Leu134, Val135, Ile 136, Met137, Thr138, Arg196, Phe 198, Arg199, Phe203, Lys205, Phe207, Thr210, Thr218, Tyr222, Ser223, Ser227, Ser242, Lys243, Lys248, Lys254, Lys260, Ser305, Phe306, Gly307, Arg311, Phe314, Ser316, Arg325, Arg326, Ile327, Phe350, Tyr351, Ser352, Ile353, Asn373, Ser379, Arg382, Tyr386, Ser595, and/or Glu700 of human Sortilin libraries in the presence or absence of the anti-Sortilin antibodies by SPOT binding analysis (e.g., Frank, R and Overwin, H (1996) Methods. Mol. Biol. 66, 149-169; Reineke, U et al., (2002) J. Immunol. Methods 267, 13-26; and Andersen, OS et al., (2010) J. Biological Chemistry 285, 12210-12222).

[0365] Further provided herein are methods of screening for anti-Sortilin antibodies that block interactions (e.g., binding) Sortilin and a Sortilin ligand (e.g., Progranulin, pro-neurotrophin, pro-NGF, pro-BDNF, pro-NT3, p75, APP, LpL, APOA5, APOE). In some embodiments, the interaction between Sortilin and Sortilin ligands (e.g., Progranulin, pro-neurotrophin, pro-NGF, pro-BDNF, pro-NT3, p75, APP, LpL, APOA5, APOE) may be characterized using surface plasmon resonance analysis (e.g., Skeldal, S et al., (2012) J Biol Chem., 287:43798; and Andersen, OS et al., (2010) The Journal Of Biological Chemistry, 285,12210-12222, a pulldown assay (e.g., Andersen, OS et al., (2010) The Journal Of Biological Chemistry, 285, 12210-12222, cellulose-bound proteins (e.g., Andersen, OS et al., (2010) The Journal Of Biological Chemistry, 285,12210-12222), a proximity ligation assay (e.g., Gustafsen, C et al., (2013) The Journal of Neuroscience, 33:64-71), and/or alkaline phosphatase-tagged ligands in cell binding assays (e.g., Hu, F et al., (2010) Neuron 68, 654-667).

Cell-based assays

[0366] Further provided herein are methods of screening for a Sortilin binding antagonist, such as an anti-Sortilin antibody, that include contacting an agent (e.g., an anti-Sortilin antibody) with a cell expressing a Sortilin protein on its cell surface. In some embodiments, the agent and cell are further contacted with a Sortilin ligand of the present disclosure. In some embodiments, the cell itself expresses a Sortilin ligand of the present disclosure. The cell-based methods are particularly suited for screening and validating Sortilin binding antagonists (e.g., anti-Sortilin antibodies) by assessing the effect on the interaction between Sortilin and a Sortilin ligand in the context of a cell.

[0367] Accordingly, certain aspects of the present disclosure relate to a cell expressing a Sortilin protein of the present disclosure on its cell surface. In some embodiments, the cell endogenously expresses a Sortilin protein of the present disclosure. In some embodiments, the cell is recombinantly engineered to express a Sortilin protein of the present disclosure. In any of these embodiments, the Sortilin protein of the present disclosure (whether endogenous or recombinant) encoded by the polynucleotide will preferably include at least protein domains required for post-translational processing, membrane translocation, and targeting to the cell surface, including without limitation a signal peptide and a transmembrane domain. In some embodiments, the signal peptide and/or transmembrane domain may refer to the endogenous Sortilin signal peptide and/or transmembrane domain. In other embodiments, the signal peptide and/or transmembrane domain may refer to an exogenous signal peptide and/or transmembrane domain known to promote cell surface expression in the desired host cell. In preferred embodiments, the Sortilin protein will also contain a domain sufficient for binding a Sortilin ligand of the present disclosure.

[0368] In these embodiments, any cell that expresses a Sortilin protein of the present disclosure on its cell surface may be used. In some embodiments, the cell endogenously expresses a Sortilin protein of the present disclosure on its cell surface. In some embodiments, the cell is recombinantly engineered to express a Sortilin protein of the present disclosure on its cell surface. Any suitable Sortilin ligand of the present disclosure may be used, such that it retains the ability to bind to the Sortilin protein expressed on the cell surface. The Sortilin ligand need not be fluorescently labeled. Levels of Sortilin ligand may be detected by any assay known in the art, including without limitation ELISA, SPR, Western blotting, mass spectrometry, immunoprecipitation, peptide microarray, and so forth.

[0369] In some embodiments, the methods disclosed herein involve culturing a cell that expresses both a Sortilin protein on its cell surface and a Sortilin ligand in a media under conditions in which the Sortilin protein and the Sortilin ligand are expressed and the Sortilin ligand is released into the media; contacting the cell with an agent (e.g., an anti-Sortilin antibody) under conditions in which the Sortilin protein is capable of binding to the Sortilin ligand; and detecting an increase in the level of the Sortilin ligand in the media, as compared to the level of the Sortilin ligand in the media in the absence of the agent. An increase in the level of the Sortilin ligand indicates that the agent is a Sortilin binding antagonist. Without

wishing to be bound to theory, it is thought that the interaction between the Sortilin protein expressed on the cell surface and the secreted Sortilin ligand will result in endocytosis and lysosomal degradation of the Sortilin ligand. Therefore, it is thought that decreasing this interaction (e.g., by addition of a Sortilin binding antagonist of the present disclosure) leads to an increase in the level of the Sortilin ligand in the media over time.

[0370] In these embodiments, any cell that expresses a Sortilin protein of the present disclosure on its cell surface and expresses and secretes a Sortilin ligand of the present disclosure may be used. In some embodiments, the cell may endogenously express a Sortilin protein of the present disclosure on its cell surface. In some embodiments, the cell may endogenously express and secrete a Sortilin ligand of the present disclosure. In some embodiments, the cell is a U-251 cell, and the Sortilin ligand is a Progranulin protein. In some embodiments, the cell may be recombinantly engineered to express a Sortilin protein of the present disclosure on its cell surface. In some embodiments, the cell may be recombinantly engineered to express and secrete a Sortilin ligand of the present disclosure.

[0371] In any of the cell-based assays described herein, a Sortilin ligand of the present disclosure may be used. In some embodiments, the Sortilin ligand is a Progranulin protein. The Sortilin ligand may be a full-length protein, or it may be a Sortilin-binding peptide fragment thereof.

Nucleic acids, vectors, and host cells

[0372] Anti-Sortilin antibodies of the present disclosure may be produced using recombinant methods and compositions, e.g., as described in U.S. Patent No. 4816567. In some embodiments, isolated nucleic acids having a nucleotide sequence encoding any of the anti-Sortilin antibodies of the present disclosure are provided. Such nucleic acids may encode an amino acid sequence comprising the V_L and/or an amino acid sequence comprising the V_H of the anti-Sortilin antibody (e.g., the light and/or heavy chains of the antibody). In some embodiments, one or more vectors (e.g., expression vectors) comprising such nucleic acids are provided. In some embodiments, a host cell comprising such nucleic acid is also provided. In some embodiments, the host cell comprises (e.g., has been transduced with): (1) a vector comprising a nucleic acid that encodes an amino acid sequence comprising the V_L of the antibody and an amino acid sequence comprising the V_H of the antibody, or (2) a first vector comprising a nucleic acid that encodes an amino acid sequence comprising the V_L of the antibody and a second vector comprising a nucleic acid that encodes an amino acid sequence comprising the V_H of the antibody. In some embodiments, the host cell is eukaryotic, e.g., a Chinese Hamster Ovary (CHO) cell or lymphoid cell (e.g., YO, NS0, Sp20 cell). Host cells of the present disclosure also include, without limitation, isolated cells, *in vitro* cultured cells, and *ex vivo* cultured cells.

[0373] Methods of making an anti-Sortilin antibody of the present disclosure are provided. In some embodiments, the method includes culturing a host cell of the present disclosure comprising a nucleic acid encoding the anti-Sortilin antibody, under conditions suitable for expression of the antibody. In some embodiments, the antibody is subsequently recovered from the host cell (or host cell culture medium).

[0374] For recombinant production of an anti-Sortilin antibody of the present disclosure, a nucleic acid encoding the anti-Sortilin antibody is isolated and inserted into one or more vectors for further cloning and/or expression in a host cell. Such nucleic acid may be readily isolated and sequenced using conventional procedures (e.g., by using oligonucleotide probes that are capable of binding specifically to genes encoding the heavy and light chains of the antibody).

[0375] Suitable vectors comprising a nucleic acid sequence encoding any of the anti-Sortilin antibodies of the present disclosure, or cell-surface expressed fragments or polypeptides thereof polypeptides (including antibodies) described herein include, without limitation, cloning vectors and expression vectors. Suitable cloning vectors can be constructed according to standard techniques, or may be selected from a large number of cloning vectors available in the art. While the cloning vector selected may vary according to the host cell intended to be used, useful cloning vectors generally have the ability to self-replicate, may possess a single target for a particular restriction endonuclease, and/or may carry genes for a marker that can be used in selecting clones comprising the vector. Suitable examples include plasmids and bacterial viruses, e.g., pUC18, pUC19, Bluescript (e.g., pBS SK+) and its derivatives, mpl8, mpl9, pBR322, pMB9, ColE1, pCR1, RP4, phage DNAs, and shuttle vectors such as pSA3 and pAT28. These and many other cloning vectors are available from commercial vendors such as BioRad, Strategene, and Invitrogen.

[0376] Suitable host cells for cloning or expression of antibody-encoding vectors include prokaryotic or eukaryotic cells. For example, anti-Sortilin antibodies of the present disclosure may be produced in bacteria, in particular when glycosylation and Fc effector function are not needed. For expression of antibody fragments and polypeptides in bacteria (e.g., U.S. Patent Nos. 5648237, 5789199, and 5840523. After expression, the antibody may be isolated from the bacterial cell paste in a soluble fraction and can be further purified.

[0377] In addition to prokaryotes, eukaryotic microorganisms, such as filamentous fungi or yeast, are also suitable cloning or expression hosts for antibody-encoding vectors, including fungi and yeast strains whose glycosylation pathways have been "humanized," resulting in the production of an antibody with a partially or fully human glycosylation pattern (e.g., Gemgross Nat. Biotech. 22: 1409-1414 (2004); and Li et al. Nat. Biotech. 24:210-215 (2006)).

[0378] Suitable host cells for the expression of glycosylated antibody can also be derived from multicellular organisms (invertebrates and vertebrates). Examples of invertebrate cells include plant and insect cells. Numerous baculoviral strains have been identified which may be used in conjunction with insect cells, particularly for transfection of *Spodoptera frugiperda* cells. Plant cell cultures can also be utilized as hosts (e.g., U.S. Patent Nos. 5959177, 6040498, 6420548, 7125978, and 6417429, describing PLANTIBODIES™ technology for producing antibodies in transgenic plants),

[0379] Vertebrate cells may also be used as hosts. For example, mammalian cell lines that are adapted to grow in suspension may be useful. Other examples of useful mammalian host cell lines are monkey kidney CV1 line transformed by SV40 (COS-7); human embryonic kidney line (293 or 293 cells as described, e.g., in Graham et al. J. Gen Virol. 36:59 (1977)); baby hamster kidney cells (BHK); mouse sertoli cells (TM4 cells as described, e.g., in Mather, Biol. Reprod. 23:243-251 (1980)); monkey kidney cells (CV1); African green monkey kidney cells (VERO-76); human cervical carcinoma cells (HELA); canine kidney cells (MOCK; buffalo rat liver cells (BRL 3A); human lung cells (W138); human liver cells (Hep G2); mouse mammary tumor (MMT 060562); TRI cells, as described, e.g., in Mather et al. Annals N. Y Acad. Sci. 383:44-68 (1982); MRC 5 cells; and FS4 cells. Other useful mammalian host cell lines include Chinese hamster ovary (CHO) cells, including DHFR- CHO cells (Urlaub et al. Proc. Natl. Acad. Sci. USA 77:4216 (1980)); and myeloma cell lines such as YO, NS0 and Sp2/0. For a review of certain mammalian host cell lines suitable for antibody production, see, e.g., Yazaki and VMU, Methods in Molecular Biology, Vol. 248 (B.K.C. Lo, ed., Humana Press, Totowa, NJ), pp. 255-268 (2003).

Pharmaceutical compositions

[0380] Provided herein are pharmaceutical compositions and/or pharmaceutical formulations comprising the anti-Sortilin antibodies of the present disclosure and a pharmaceutically acceptable carrier.

[0381] In some embodiments, pharmaceutically acceptable carrier preferably are nontoxic to recipients at the dosages and concentrations employed. The antibodies described herein may be formulated into preparations in solid, semi-solid, liquid or gaseous forms. Examples of such formulations include, without limitation, tablets, capsules, powders, granules, ointments, solutions, suppositories, injections, inhalants, gels, microspheres, and aerosols. Pharmaceutically acceptable carriers can include, depending on the formulation desired, pharmaceutically-acceptable, non-toxic carriers of diluents, which are vehicles commonly used to formulate pharmaceutical compositions for animal or human administration. In certain embodiments, the pharmaceutical composition can comprise formulation materials for modifying, maintaining or preserving, for example, the pH, osmolality, viscosity, clarity, color, isotonicity, odor, sterility, stability, rate of dissolution or release, adsorption or penetration of the composition.

[0382] In certain embodiments, pharmaceutically acceptable carriers include, but are not limited to, amino acids (such as glycine, glutamine, asparagine, arginine or lysine); antimicrobials; antioxidants (such as ascorbic acid, sodium sulfite or sodium hydrogen-sulfite); buffers (such as borate, bicarbonate, Tris-HCl, citrates, phosphates or other organic acids); bulking agents (such as mannitol or glycine); chelating agents (such as ethylenediamine tetraacetic acid (EDTA)); complexing agents (such as caffeine, polyvinylpyrrolidone, beta-cyclodextrin or hydroxypropyl-beta-cyclodextrin); fillers; monosaccharides; disaccharides; and other carbohydrates (such as glucose, mannose or dextrans); proteins (such as serum albumin, gelatin or immunoglobulins); coloring, flavoring and diluting agents; emulsifying agents; hydrophilic polymers (such as polyvinylpyrrolidone); low molecular weight polypeptides; salt-forming counterions (such as sodium); preservatives (such as benzalkonium chloride, benzoic acid, salicylic acid, thimerosal, phenethyl alcohol, methylparaben, propylparaben, chlorhexidine, sorbic acid or hydrogen peroxide); solvents (such as glycerin, propylene glycol or polyethylene glycol); sugar alcohols (such as mannitol or sorbitol);

suspending agents; surfactants or wetting agents (such as pluronics, PEG, sorbitan esters, polysorbates such as polysorbate 20, polysorbate 80, triton, tromethamine, lecithin, cholesterol, tyloxapal); stability enhancing agents (such as sucrose or sorbitol); tonicity enhancing agents (such as alkali metal halides, preferably sodium or potassium chloride, mannitol sorbitol); delivery vehicles; diluents; excipients and/or pharmaceutical adjuvants. Further examples of formulations that are suitable for various types of administration can be found in Remington: The Science and Practice of Pharmacy, Pharmaceutical Press 22nd ed. (2013). For a brief review of methods for drug delivery, see, Langer, Science 249:1527-1533 (1990).

[0383] Formulations suitable for parenteral administration include aqueous and non-aqueous, isotonic sterile injection solutions, which can comprise antioxidants, buffers, bacteriostats, and solutes that render the formulation isotonic with the blood of the intended recipient, and aqueous and non-aqueous sterile suspensions that can include suspending agents, solubilizers, thickening agents, stabilizers, and preservatives.

[0384] Formulations may be optimized for retention and stabilization in the brain or central nervous system. When the agent is administered into the cranial compartment, it is desirable for the agent to be retained in the compartment, and not to diffuse or otherwise cross the blood brain barrier. Stabilization techniques include cross-linking, multimerizing, or linking to groups such as polyethylene glycol, polyacrylamide, neutral protein carriers, *etc.* in order to achieve an increase in molecular weight.

[0385] Other strategies for increasing retention include the entrapment of the antibody, such as an anti-Sortilin antibody of the present disclosure, in a biodegradable or bioerodible implant. The rate of release of the therapeutically active agent is controlled by the rate of transport through the polymeric matrix, and the biodegradation of the implant. Implants may be particles, sheets, patches, plaques, fibers, microcapsules and the like and may be of any size or shape compatible with the selected site of insertion. Biodegradable polymeric compositions which may be employed may be organic esters or ethers, which when degraded result in physiologically acceptable degradation products, including the monomers. Anhydrides, amides, orthoesters or the like, by themselves or in combination with other monomers, may find use. The polymers will be condensation polymers. The polymers may be cross-linked or non-cross-linked. Of particular interest are polymers of hydroxyaliphatic carboxylic acids, either homo- or copolymers, and polysaccharides. Included among the polyesters of interest are polymers of D-lactic acid, L-lactic acid, racemic lactic acid, glycolic acid, polycaprolactone, and combinations thereof. Among the polysaccharides of interest are calcium alginate, and functionalized celluloses, particularly carboxymethylcellulose esters characterized by being water insoluble, a molecular weight of about 5 kD to 500 kD, *etc.* Biodegradable hydrogels may also be employed in the implants of the subject invention. Hydrogels are typically a copolymer material, characterized by the ability to imbibe a liquid.

Pharmaceutical dosages

[0386] An antibody provided herein (and any additional therapeutic agent) can be administered by any suitable means, including parenteral, intrapulmonary, intranasal, intralesional administration, intracerebrospinal, intracranial, intraspinal, intrasynovial, intrathecal, oral, topical, or inhalation routes. Parenteral infusions include intramuscular, intravenous administration as a bolus or by continuous infusion over a period of time, intraarterial, intra-articular, intraperitoneal, or subcutaneous administration. In some embodiments, the administration is intravenous administration. In some embodiments, the administration is subcutaneous. Dosing can be by any suitable route, *e.g.* by injections, such as intravenous or subcutaneous injections, depending in part on whether the administration is brief or chronic. Various dosing schedules including but not limited to single or multiple administrations over various time-points, bolus administration, and pulse infusion are contemplated herein.

[0387] Antibodies provided herein would be formulated, dosed, and administered in a fashion consistent with good medical practice. Factors for consideration in this context include the particular disorder being treated, the particular mammal being treated, the clinical condition of the individual patient, the cause of the disorder, the site of delivery of the agent, the method of administration, the scheduling of administration, and other factors known to medical practitioners. The antibody need not be, but is optionally formulated with one or more agents currently used to prevent or treat the disorder in question. The effective amount of such other agents depends on the amount of antibody present in the formulation, the type of disorder or treatment, and other factors discussed above. These are generally used in the same dosages and with administration routes as described herein, or about from 1 to 99% of the dosages described herein, or in any dosage and by any route that is empirically/clinically determined to be appropriate.

[0388] Dosages for a particular anti-Sortilin antibody may be determined empirically in individuals who have been given one or more administrations of the anti-Sortilin antibody. Individuals are given incremental doses of an anti-Sortilin antibody. To assess efficacy of an anti-Sortilin antibody, a clinical symptom of any of the diseases, disorders, or conditions of the present disclosure (*e.g.*, frontotemporal dementia, Alzheimer's disease, vascular dementia, seizures, retinal dystrophy, a traumatic brain injury, a spinal cord injury, long-term depression, atherosclerotic vascular diseases, and undesirable symptoms of normal aging) can be monitored.

[0389] For the prevention or treatment of disease, the appropriate dosage of an antibody of the invention (when used alone or in combination with one or more other additional therapeutic agents) will depend on the type of disease to be treated, the type of antibody, the severity and course of the disease, whether the antibody is administered for preventive or therapeutic purposes, previous therapy, the patient's clinical history and response to the antibody, and the discretion of the attending physician. The antibody is suitably administered to the patient at one time or over a series of treatments.

[0390] Depending on the type and severity of the disease, about 1 µg/kg to 1.5 mg/kg (*e.g.*, 0.1 mg/kg-10 mg/kg) of antibody can be an initial candidate dosage for administration to the patient, whether, for example, by one or more separate administrations, or by continuous infusion. One typical daily dosage might range from about 1 µg/kg to 100 mg/kg or more, depending on the factors mentioned above. For repeated administrations over several days or longer, depending on the condition, the treatment would generally be sustained until a desired suppression of disease symptoms occurs. One exemplary dosage of the antibody would be in the range from about 0.05 mg/kg to about 10 mg/kg. Thus, one or more doses of about 0.5 mg/kg, 2.0 mg/kg, 4.0 mg/kg or 10 mg/kg (or any combination thereof) may be administered to the patient. Such doses may be administered intermittently, *e.g.*, every week or every three weeks (*e.g.*, such that the patient receives from about two to about twenty, or *e.g.*, about six doses of the antibody). In certain embodiments, dosing frequency is three times per day, twice per day, once per day, once every other day, once weekly, once every two weeks, once every four weeks, once every five weeks, once every six weeks, once every seven weeks, once every eight weeks, once every nine weeks, once every ten weeks, or once monthly, once every two months, once every three months, or longer. An initial higher loading dose, followed by one or more lower doses may be administered. However, *other* dosage regimens may be useful. The progress of this therapy is easily monitored by conventional techniques and assays.

Therapeutic uses

[0391] In certain aspects, anti-Sortilin antibodies of the present disclosure can be used for preventing, reducing risk for, or treating an individual having a disease, disorder, or injury. Anti-Sortilin antibodies of the present disclosure can be used to prevent, reduce risk of, or treat cell death (*e.g.*, neuronal cell death), frontotemporal dementia, Alzheimer's disease, vascular dementia, seizures, retinal dystrophy, a traumatic brain injury, a spinal cord injury, long-term depression, atherosclerotic vascular diseases, undesirable symptoms of normal aging, dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, Crohn's disease, inflammatory bowel disease, ulcerative colitis, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, intervertebral disc degeneration, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomatous disorders, Sarcoidosis, diseases of aging, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, inflammatory disorders, arthritis, multiple sclerosis, metabolic disorder, obesity, insulin resistance, type 2 diabetes, tissue or vascular damage, an injury, and/or one or more undesirable symptoms of normal aging.

[0392] In certain aspects, provided herein is a method of preventing, reducing risk for, or treating an individual having a disease, disorder, or injury, comprising administering to an individual in need thereof a therapeutically effective amount of an anti-Sortilin antibody of the present disclosure. In some embodiments, the disease, disorder or injury is selected from the group consisting of frontotemporal dementia, progressive supranuclear palsy, Alzheimer's disease, vascular dementia, seizures, retinal dystrophy, amyotrophic lateral sclerosis, traumatic brain injury, a spinal cord injury, dementia, stroke, Parkinson's disease, acute disseminated encephalomyelitis, retinal degeneration, age related macular degeneration, glaucoma, multiple sclerosis, septic shock, bacterial infection, arthritis, and osteoarthritis.

[0393] Certain aspects of the present disclosure provide methods of increasing Progranulin levels in an individual in need thereof, such as in the brain, blood, and/or peripheral organs of the individual, by administering to the individual a therapeutically effective amount of one or more anti-Sortilin antibodies of the present disclosure. Other aspects of the present disclosure provide methods of increasing extracellular levels of Progranulin, by contacting one or more cells with one or more anti-Sortilin antibodies of the present disclosure. In some embodiments, levels of Progranulin are increased without decreasing cellular levels of Sortilin. Other aspects of the present disclosure provide methods of decreasing cellular levels of

Sortilin in an individual in need thereof, such as in the brain and/or peripheral organs of the individual, by administering to the individual a therapeutically effective amount of one or more anti-Sortilin antibodies of the present disclosure. Other aspects of the present disclosure provide methods of decreasing cellular levels of Sortilin of one or more cells, comprising contacting one or more cells with one or more anti-Sortilin antibodies of the present disclosure.

[0394] Further aspects of the present disclosure provide methods for increasing the effective concentrations of Progranulin and/or reducing the effective concentrations of a neurotrophin of the present disclosure (*e.g.*, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-neurotrophins, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), PCSK9, and receptor associated protein (RAP) in an individual in need thereof, by administering to the individual a therapeutically effective amount of an anti-Sortilin antibody of the present disclosure to inhibit the interaction between Sortilin and Progranulin, a neurotrophin of the present disclosure (*e.g.*, pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), and/or receptor associated protein (RAP).

[0395] The present disclosure also provides methods of inhibiting the interaction between Sortilin and Progranulin, a neurotrophin of the present disclosure (*e.g.*, pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), PCSK9, and/or receptor associated protein (RAP); as well as one or more activities of Sortilin, Progranulin, a neurotrophin of the present disclosure (*e.g.*, pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), and/or receptor associated protein (RAP) in an individual by administering to the individual a therapeutically effective amount of an anti-Sortilin antibody of the present disclosure.

[0396] In certain aspects, provided herein is a method of preventing, reducing risk for or treating an individual having a disease, disorder, or injury, comprising administering to an individual in need thereof a therapeutically effective amount of an anti-Sortilin antibody of the present disclosure.

[0397] As disclosed herein, anti-Sortilin antibodies of the present disclosure may be used for preventing, reducing risk, or treating frontotemporal dementia, Alzheimer's disease, vascular dementia, seizures, retinal dystrophy, a traumatic brain injury, a spinal cord injury, long-term depression, atherosclerotic vascular diseases, undesirable symptoms of normal aging, dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, Crohn's disease, inflammatory bowel disease, ulcerative colitis, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, intervertebral disc degeneration, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomatous disorders, Sarcoidosis, diseases of aging, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, inflammatory disorders, arthritis, multiple sclerosis, metabolic disorder, obesity, insulin resistance, type 2 diabetes, tissue or vascular damage, an injury, and one or more undesirable symptoms of normal aging.

[0398] In some embodiments, the present disclosure provides methods of preventing, reducing risk, or treating an individual having frontotemporal dementia, Alzheimer's disease, vascular dementia, seizures, retinal dystrophy, a traumatic brain injury, a spinal cord injury, long-term depression, atherosclerotic vascular diseases, undesirable symptoms of normal aging, dementia, mixed dementia, Creutzfeldt-Jakob disease, normal pressure hydrocephalus, amyotrophic lateral sclerosis, Huntington's disease, taupathy disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, Crohn's disease, inflammatory bowel disease, ulcerative colitis, malaria, essential tremor, central nervous system lupus, Behcet's disease, Parkinson's disease, dementia with Lewy bodies, multiple system atrophy, intervertebral disc degeneration, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomatous disorders, Sarcoidosis, diseases of aging, age related macular degeneration, glaucoma, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, inflammatory disorders, arthritis, multiple sclerosis, metabolic disorder, obesity, insulin resistance, type 2 diabetes, tissue or vascular damage, an injury, and one or more undesirable symptoms of normal aging, in an individual in need thereof by administering to the individual a therapeutically effective amount of an anti-Sortilin antibody of the present disclosure to: (i) inhibit the interaction between Sortilin and Progranulin, a neurotrophin of the present disclosure (*e.g.*, pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), PCSK9, and/or receptor associated protein (RAP); and/or (ii) inhibit one or more activities of Sortilin, Progranulin, a neurotrophin of the present disclosure (*e.g.*, pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), and/or receptor associated protein (RAP). In some embodiments, the present disclosure provides methods of inducing wound healing in an individual in need thereof by administering to the individual a therapeutically effective amount of an anti-Sortilin antibody of the present disclosure.

[0399] The present disclosure also provides methods of promoting cell survival, such as neuronal cell survival, by administering an anti-Sortilin antibody of the present disclosure to inhibit the interaction between Sortilin and Progranulin, a neurotrophin of the present disclosure (*e.g.*, pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), and the A beta peptide. The anti-Sortilin antibody may be administered to cells *in vitro* to promote cell survival. Alternatively, the anti-Sortilin antibody may be administered *in vivo* (*e.g.*, by administering the antibody to an individual) to promote cell survival.

[0400] In certain aspects, provided herein is a method of inhibiting one or more of neuroinflammation, axonopathy characterized by short axonal outgrowth and aberrant branching, microglial activation, and inflammatory response, comprising administering to the individual a therapeutically effective amount of an anti-Sortilin antibody of the present disclosure.

[0401] The present disclosure provides methods of inhibiting neuroinflammation, axonopathy characterized by short axonal outgrowth and aberrant branching, microglial activation, and inflammatory response and promoting wound healing, autophagy and the clearance of aggregate proteins by administering an anti-Sortilin antibody of the present disclosure to inhibit the interaction between Sortilin and Progranulin, a neurotrophin of the present disclosure (*e.g.*, pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, amyloid precursor protein (APP), and the A beta peptide. The anti-Sortilin antibody may be administered to cells *in vitro*. Alternatively, the anti-Sortilin antibody may be administered *in vivo* (*e.g.*, by administering the antibody to an individual).

[0402] In certain aspects, provided herein is a method of promoting one or more of wound healing, autophagy, and clearance of aggregate proteins, comprising administering to the individual a therapeutically effective amount of an anti-Sortilin antibody of the present disclosure.

[0403] In certain aspects, provided herein is a method of preventing, reducing risk, or treating an individual having arthritis, comprising administering to the individual a therapeutically effective amount of an anti-Sortilin antibody of the present disclosure.

[0404] The present disclosure also provides methods of decreasing expression of one or more pro-inflammatory mediators by administering to an individual in need thereof an anti-Sortilin antibody of the present disclosure. In some embodiments, the one or more pro-inflammatory mediators are selected from IL-6, IL12p70, IL12p40, IL-1 β , TNF- α , CXCL1, CCL2, CCL3, CCL4, and CCL5.

[0405] In some embodiments, a method of the present disclosure includes an anti-Sortilin antibody comprising two or more anti-Sortilin antibodies.

Dementia

[0406] Dementia is a non-specific syndrome (*i.e.*, a set of signs and symptoms) that presents as a serious loss of global cognitive ability in a previously unimpaired person, beyond what might be expected from normal ageing. Dementia may be static as the result of a unique global brain injury. Alternatively, dementia may be progressive, resulting in long-term decline due to damage or disease in the body. While dementia is much more common in the geriatric population, it can also occur before the age of 65. Cognitive areas affected by dementia include, without limitation, memory, attention span, language, and problem solving. Generally, symptoms must be present for at least six months to before an individual is diagnosed with dementia.

[0407] Exemplary forms of dementia include, without limitation, frontotemporal dementia, Alzheimer's disease, vascular dementia, semantic dementia, and dementia with Lewy bodies,

[0408] Without wishing to be bound by theory, it is believed that administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat dementia. In some embodiments, administering an anti-Sortilin antibody may induce one or more Progranulin activities in an individual having dementia (e.g., neurotrophic and/or survival activity on neurons, and anti-inflammatory activity).

Frontotemporal dementia

[0409] Frontotemporal dementia (FTD) is a condition resulting from the progressive deterioration of the frontal lobe of the brain. Over time, the degeneration may advance to the temporal lobe. Second only to Alzheimer's disease (AD) in prevalence, FTD accounts for 20% of pre-senile dementia cases. The clinical features of FTD include memory deficits, behavioral abnormalities, personality changes, and language impairments (Cruts, M. & Van Broeckhoven, C., Trends Genet. 24:186-194 (2008); Neary, D., et al., Neurology 51:1546-1554 (1998); Rathavalli, E., Brayne, C., Dawson, K. & Hodges, J. R. Neurology 58:1615-1621 (2002)).

[0410] A substantial portion of FTD cases are inherited in an autosomal dominant fashion, but even in one family, symptoms can span a spectrum from FTD with behavioral disturbances, to Primary Progressive Aphasia, to Cortico-Basal Ganglionic Degeneration. FTD, like most neurodegenerative diseases, can be characterized by the pathological presence of specific protein aggregates in the diseased brain. Historically, the first descriptions of FTD recognized the presence of intraneuronal accumulations of hyperphosphorylated Tau protein in neurofibrillary tangles or Pick bodies. A causal role for the microtubule associated protein Tau was supported by the identification of mutations in the gene encoding the Tau protein in several families (Hutton, M., et al., Nature 393:702-705 (1998)). However, the majority of FTD brains show no accumulation of hyperphosphorylated Tau but do exhibit immunoreactivity to ubiquitin (Ub) and TAR DNA binding protein (TDP43) (Neumann, M., et al., Arch. Neurol. 64:1388-1394 (2007)). A majority of those FTD cases with Ub inclusions (FTD-U) were shown to carry mutations in the Progranulin gene.

[0411] Progranulin mutations result in haploinsufficiency and are known to be present in nearly 50% of familial FTD cases, making Progranulin mutation a major genetic contributor to FTD. Without wishing to be bound by theory, it is believed that the loss-of-function heterozygous character of Progranulin mutations indicates that in healthy individuals, Progranulin expression plays a dose-dependent, critical role in protecting healthy individuals from the development of FTD. Accordingly, increasing levels of Progranulin by inhibiting the interaction between Sortilin and Progranulin, can prevent, reduce the risk, and/or treat FTD.

[0412] In some embodiments, administering an anti-Sortilin antibody of the present disclosure, can prevent, reduce the risk, and/or treat FTD. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having FTD.

Alzheimer's disease

[0413] Alzheimer's disease (AD) is the most common form of dementia. There is no cure for the disease, which worsens as it progresses, and eventually leads to death. Most often, AD is diagnosed in people over 65 years of age. However, the less-prevalent early-onset Alzheimer's can occur much earlier.

[0414] Common symptoms of Alzheimer's disease include, behavioral symptoms, such as difficulty in remembering recent events; cognitive symptoms, confusion, irritability and aggression, mood swings, trouble with language, and long-term memory loss. As the disease progresses bodily functions are lost, ultimately leading to death. Alzheimer's disease develops for an unknown and variable amount of time before becoming fully apparent, and it can progress undiagnosed for years.

[0415] It has been shown that Sortilin binds to amyloid precursor protein (APP) and the APP processing enzyme BACE1. Without wishing to be bound by theory, it is believed that these interactions are involved in Alzheimer's disease. Accordingly, and without wishing to be bound by theory, it is believed that anti-Sortilin antibodies of the present disclosure can be utilized to inhibit such interactions and prevent, reduce the risk of or treat Alzheimer's disease in individuals in need thereof.

[0416] In some embodiments, and without wishing to be bound by theory, it is believed that anti-Sortilin antibodies of the present disclosure that inhibit the interaction between Sortilin and neurotrophins of the present disclosure (e.g., pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, etc.), p75, amyloid precursor protein (APP), and/or the A beta peptide, or that inhibit one or more activities of Sortilin can be utilized to prevent, reduce the risk of, or treat Alzheimer's disease in individuals in need thereof.

[0417] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat Alzheimer's disease. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having Alzheimer's disease.

Vascular Dementia

[0418] Vascular dementia (VaD) is a subtly progressive worsening of memory and other cognitive functions that is believed to be due to cerebrovascular disease (vascular disease within the brain). Cerebrovascular disease is the progressive change in our blood vessels (vasculature) in the brain (cerebrum). The most common vascular change associated with age is the accumulation of cholesterol and other substances in the blood vessel walls. This results in the thickening and hardening of the walls, as well as narrowing of the vessels, which can result in a reduction or even a complete stopping of blood flow to brain regions supplied by the affected artery. Vascular dementia patients often present with similar symptoms to Alzheimer's disease (AD) patients. However, the related changes in the brain are not due to AD pathology but to chronic reduced blood flow in the brain, eventually resulting in dementia. VaD is considered one of the most common types of dementia in older adults. Symptoms of VaD include difficulties with memory, difficulty with organization and solving complex problems, slowed thinking, distraction or "absent mindedness," difficulty retrieving words from memory, changes in mood or behavior such as depression, irritability, or apathy, and hallucinations or delusions.

[0419] Without wishing to be bound by theory, it is believed that one or more activities of Sortilin, or one or more interactions between Sortilin and Progranulin, neurotrophins of the present disclosure (e.g., pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, etc.), neurotensin, lipoprotein lipase, apolipoprotein AV, and/or receptor-associated protein are involved in vascular dementia. Accordingly, and without wishing to be bound by theory, it is believed that anti-Sortilin antibodies of the present disclosure that inhibit the interaction between Sortilin and neurotrophins of the present disclosure (e.g., pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, etc.), neurotensin, p75, Sortilin propeptide (Sort-pro), amyloid precursor protein (APP), the A beta peptide, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), and/or receptor associated protein (RAP); or that inhibit one or more activities of Sortilin can be utilized to prevent, reduce the risk of, or treat vascular dementia in individuals in need thereof.

[0420] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat VaD. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having VaD.

Seizures, retinal dystrophy, traumatic brain injuries, spinal cord injuries, and long-term depression

[0421] As used herein, retinal dystrophy refers to any disease or condition that involves the degeneration of the retinal. Such diseases or conditions may lead to loss of vision or complete blindness.

[0422] As used herein, seizures also include epileptic seizures, and refer to a transient symptom of abnormal excessive or synchronous neuronal activity in the brain. The outward effect can be as dramatic as a wild thrashing movement or as mild as a brief loss of awareness. Seizures can manifest as an alteration in mental state, tonic or clonic movements, convulsions, and various other psychic symptoms.

[0423] Traumatic brain injuries (TBI), may also be known as intracranial injuries. Traumatic brain injuries occur when an external force traumatically injures the brain. Traumatic brain

injuries can be classified based on severity, mechanism (closed or penetrating head injury), or other features (e.g., occurring in a specific location or over a widespread area).

[0424] Spinal cord injuries (SCI) include any injury to the spinal cord that is caused by trauma instead of disease. Depending on where the spinal cord and nerve roots are damaged, the symptoms can vary widely, from pain to paralysis to incontinence. Spinal cord injuries are described at various levels of "incomplete", which can vary from having no effect on the patient to a "complete" injury which means a total loss of function.

[0425] Long-term depression (LTD) is an activity-dependent reduction in the efficacy of neuronal synapses lasting hours or longer following a long patterned stimulus. Long-term depression can occur in many areas of the central nervous system with varying mechanisms depending upon brain region and developmental progress. Long-term depression can occur in the hippocampus, cerebellum, and in different types of neurons that release various neurotransmitters. Without wishing to be bound by theory, it is believed that long-term depression may be associated with neurodegeneration, dementia, and Alzheimer's disease.

[0426] It has been shown that pro-neurotrophins (e.g., pro-neurotrophin-4/5, neurotrophin-4/5, pro-NGF, pro-BDNF, etc.) play a role in seizures, retinal *dystrophy*, traumatic brain injury, spinal cord injury, and long-term depression.

[0427] Accordingly, and without wishing to be bound by theory, it is believed that anti-Sortilin antibodies of the present disclosure that inhibit the interaction between Sortilin and neurotrophins of the present disclosure (e.g., pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, etc.), or that inhibit one or more activities of Sortilin can be utilized to prevent, reduce the risk of or treat seizures, retinal dystrophy, traumatic brain injuries, spinal cord injuries, and/or long-term depression in individuals in need thereof.

[0428] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat seizures, retinal dystrophy, traumatic brain injuries, spinal cord injuries, and/or long-term depression. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having seizures, retinal dystrophy, traumatic brain injuries, spinal cord injuries, and/or long-term depression.

Atherosclerotic vascular diseases

[0429] As used herein, "atherosclerotic vascular disease," "ASVD," and "atherosclerosis" are used interchangeably and refer to any condition in which an artery wall thickens as a result of the accumulation of fatty materials such as cholesterol, lipids, and triglyceride. Atherosclerotic vascular diseases include, without limitation, any ASVD-associated condition, disorder, or disease, including without limitation, thromboembolism, stroke, ischemia, infarctions, coronary thrombosis, myocardial infarction (e.g., heart attack), and claudication.

[0430] As disclosed herein, Sortilin proteins of the present disclosure are involved in lipid regulation, by binding lipid-associated proteins, such as receptor associated protein, lipoprotein lipase and apolipoproteins APOA5 and APOE.

[0431] Accordingly, and without wishing to be bound by theory, it is believed that anti-Sortilin antibodies of the present disclosure that inhibit the interaction between Sortilin and lipoprotein lipase (LpL), apolipoprotein AV (APOA5), apolipoprotein E (APOE), and/or receptor associated protein (RAP); or that inhibit one or more activities of Sortilin can be utilized to prevent, reduce the risk of, or treat one or more atherosclerotic vascular disease in individuals in need thereof.

[0432] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat atherosclerotic vascular disease. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having atherosclerotic vascular disease.

Undesirable symptoms of aging

[0433] As used herein, undesirable symptoms of aging include, without limitation, memory loss, behavioral changes, dementia, Alzheimer's disease, retinal degeneration, atherosclerotic vascular diseases, hearing loss, and cellular break-down.

[0434] In some embodiments, and without wishing to be bound by theory, it is believed that anti-Sortilin antibodies of the present disclosure that inhibit the interaction between Sortilin and Progranulin, neurotrophins of the present disclosure (e.g., pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, etc.), neurotensin, p75, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), and/or receptor associated protein (RAP); or that inhibit one or more activities of Sortilin can be utilized to prevent, reduce the risk of, or treat one or more undesirable symptoms of aging.

[0435] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat one or more undesirable symptoms of aging. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having one or more undesirable symptoms of aging.

Amyotrophic lateral sclerosis (ALS)

[0436] As used herein, amyotrophic lateral *sclerosis* (ALS) or, motor neuron disease or, Lou Gehrig's disease are used interchangeably and refer to a debilitating disease with varied etiology characterized by rapidly progressive weakness, muscle atrophy and fasciculations, muscle spasticity, difficulty speaking (dysarthria), difficulty swallowing (dysphagia), and difficulty breathing (dyspnea).

[0437] PGRN haploinsufficiency due to heterozygous loss-of-function mutations in the *GRN* gene results in a reduction of CSF PGRN levels and is causal for the development of frontotemporal dementia (FTD) with TDP-43 pathology (Sleegers et al., (2009) Ann Neurol 65:603; Smith et al., (2012) Am J Hum Genet 90:1102). TDP-43 has also been identified as a major pathological protein in ALS, suggesting a similarity between ALS and FTD.

[0438] For example, over twenty dominant mutations in TDP-43 have been identified in sporadic and familial ALS patients (Lagier-Tourenne et al., (2009) Cell 136:1001) and TDP-43 positive aggregates are found in approximately 95% of ALS cases (Prasad et al., (2019) Front Mol Neurosci 12:25). Furthermore, ALS risk genes, such as MOBP, C9ORF72, MOBK2B, NSF and FUS, can also cause FTD (Karch et al., (2018) JAMA Neurol 75:860). In addition, both PGRN and C9ORF72 mutations are associated with abnormal microglial activation, which appears to be another common pathology of FTD and ALS (Haukadal et al., (2019) J Mol Biol 431:1818). Other evidence also suggests that ALS and FTD are closely related conditions with overlapping genetic, neuropathological, and clinical features (Veishaupt et al., (2016) Trends Mol Med 22:769; McCauley et al., (2018) Acta Neuropathol 137:715). Taken together, these results suggest that both diseases could benefit from shared treatments and that PGRN genetic variability acts as a modifier of the course of ALS.

[0439] In some embodiments, and without wishing to be bound by theory, it is believed that anti-Sortilin antibodies of the present disclosure that inhibit the interaction between Sortilin and Progranulin, neurotrophins of the present disclosure (e.g., pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, etc.), neurotensin, p75, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), and/or receptor associated protein (RAP); or that inhibit one or more activities of Sortilin can be utilized to prevent, or treat one or more undesirable symptoms of ALS.

[0440] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat ALS. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having ALS.

Depression

[0441] As used herein, depression or, major depressive disorder (MDD), clinical depression, major depression, unipolar depression, unipolar disorder, recurrent depression or,

dysthymia, are used interchangeably and refer to a mental disorder characterized by episodes of all-encompassing low mood accompanied by low self-esteem and loss of interest or pleasure in normally enjoyable activities.

[0442] Accordingly, and without wishing to be bound by theory, it is believed that anti-Sortilin antibodies of the present disclosure that inhibit the interaction between Sortilin and Progranulin, neurotrophins of the present disclosure (e.g., pro-neurotrophins, pro-neurotrophin-3, pro-neurotrophin-4/5, pro-NGF, pro-BDNF, neurotrophin-3, neurotrophin-4/5, NGF, BDNF, *etc.*), neurotensin, p75, lipoprotein lipase (LpL), apolipoprotein AV (APOA5), and/or receptor associated protein (RAP); or that inhibit one or more activities of Sortilin can be utilized to prevent, or treat one or more undesirable symptoms of depression.

[0443] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat depression. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having depression.

Parkinson's disease

[0444] Parkinson's disease, which may be referred to as idiopathic or primary parkinsonism, hypokinetic rigid syndrome (HRS), or paralysis agitans, is a neurodegenerative brain disorder that affects motor system control. The progressive death of dopamine-producing cells in the brain leads to the major symptoms of Parkinson's. Most often, Parkinson's disease is diagnosed in people over 50 years of age. Parkinson's disease is idiopathic (having no known cause) in most people. However, genetic factors also play a role in the disease.

[0445] Symptoms of Parkinson's disease include, without limitation, tremors of the hands, arms, legs, jaw, and face, muscle rigidity in the limbs and trunk, slowness of movement (bradykinesia), postural instability, difficulty walking, neuropsychiatric problems, changes in speech or behavior, depression, anxiety, pain, psychosis, dementia, hallucinations, and sleep problems.

[0446] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat Parkinson's disease. In some embodiments, administering an anti-Sortilin antibody may induce one or more Progranulin activities in an individual having Parkinson's disease. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having Parkinson's disease.

Huntington's disease

[0447] Huntington's disease (HD) is an inherited neurodegenerative disease caused by an autosomal dominant mutation in the Huntingtin gene (HTT). Expansion of a cytosine-adenine-guanine (CAG) triplet repeat within the Huntingtin gene results in production of a mutant form of the Huntingtin protein (Htt) encoded by the gene. This mutant Huntingtin protein (mHtt) is toxic and contributes to neuronal death. Symptoms of Huntington's disease most commonly appear between the ages of 35 and 44, although they can appear at any age.

[0448] Symptoms of Huntington's disease, include, without limitation, motor control problems, jerky, random movements (chorea), abnormal eye movements, impaired balance, seizures, difficulty chewing, difficulty swallowing, cognitive problems, altered speech, memory deficits, thinking difficulties, insomnia, fatigue, dementia, changes in personality, depression, anxiety, and compulsive behavior.

[0449] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat Huntington's disease. In some embodiments, administering an anti-Sortilin antibody may induce one or more Progranulin activities in an individual having Huntington's disease. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having Huntington's disease.

Tauopathy disease

[0450] Tauopathy diseases, or Tauopathies, are a class of neurodegenerative disease caused by aggregation of the microtubule-associated protein tau within the brain. Alzheimer's disease (AD) is the most well-known tauopathy disease, and involves an accumulation of tau protein within neurons in the form of insoluble neurofibrillary tangles (NFTs). Other tauopathy diseases and disorders include progressive supranuclear palsy, dementia pugilistica (chronic traumatic encephalopathy), frontotemporal dementia and parkinsonism linked to chromosome 17, Lytico-Bodig disease (Parkinson-dementia complex of Guam), Tangle-predominant dementia, Gmiglioglioma and gangliocytoma, Meningioangiomatosis, Subacute sclerosing panencephalitis, lead encephalopathy, tuberous sclerosis, Hallervorden-Spatz disease, lipofuscinosis, Pick's disease, corticobasal degeneration, Argyrophilic grain disease (AGD), Huntington's disease, and frontotemporal lobar degeneration.

[0451] In some embodiments, administering an anti-Sortilin antibody of the present disclosure, can prevent, reduce the risk, and/or treat tauopathy disease. In some embodiments, administering an anti-Sortilin antibody may induce one or more Progranulin activities in an individual having a tauopathy disease. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having a tauopathy disease.

Multiple sclerosis

[0452] Multiple sclerosis (MS) can also be referred to as disseminated sclerosis or encephalomyelitis disseminata. MS is an inflammatory disease in which the fatty myelin sheaths around the axons of the brain and spinal cord are damaged, leading to demyelination and scarring as well as a broad spectrum of signs and symptoms.

[0453] Symptoms of MS include, without limitation, changes in sensation, such as loss of sensitivity or tingling; pricking or numbness, such as hypoesthesia and paresthesia; muscle weakness; clonus; muscle spasms; difficulty in moving; difficulties with coordination and balance, such as ataxia; problems in speech, such as dysarthria, or in swallowing, such as dysphagia; visual problems, such as nystagmus, optic neuritis including phosphemes, and diplopia; fatigue; acute or chronic pain; and bladder and bowel difficulties; cognitive impairment of varying degrees; emotional symptoms of depression or unstable mood; Uhthoff's phenomenon, which is an exacerbation of extant symptoms due to an exposure to higher than usual ambient temperatures; and Lhermitte's sign, which is an electrical sensation that runs down the back when bending the neck.

[0454] In some embodiments, administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat multiple sclerosis. In some embodiments, administering an anti-Sortilin antibody may induce one or more Progranulin activities in an individual having multiple sclerosis. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having multiple sclerosis.

Glaucoma and macular degeneration

[0455] Glaucoma describes, without limitation, a group of diseases that are characterized by a damaged optic nerve, resulting in vision loss and blindness. Glaucoma is usually caused by increased fluid pressure (= intraocular pressure) in the anterior chamber underneath the cornea. Glaucoma results in the successive loss of retinal ganglion cells that are important for vision. Age-related macular degeneration usually affects older people and primarily causes loss of vision in the macula, the central field of vision. Macular degeneration causes, without limitation, drusen, pigmentary changes, distorted vision, hemorrhages of the eye, atrophy, reduced visual acuity, blurred vision, central scotomas, reduced color vision and reduced contrast sensitivity.

[0456] Without wishing to be bound by theory, it is believed that administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat glaucoma and macular degeneration. In some embodiments, administering an anti-Sortilin antibody may induce one or more Progranulin activities in an individual having glaucoma or macular degeneration. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having glaucoma or macular degeneration.

Degenerative disc disease (DDD)

[0457] Degenerative disc disease (DDD) describes, without limitation, a group of diseases in which intervertebral disc (IVD) undergoes extensive morphological as well as biomechanical changes, and usually manifests clinically in patients with lower back pain. Degenerative discs typically show degenerative fibrocartilage and clusters of chondrocytes, suggestive of repair. Inflammation may or may not be present. The pathologic findings in DDD include protrusion, spondylolysis, and/or subluxation of vertebrae (spondylolisthesis) and spinal stenosis.

[0458] Without wishing to be bound by theory, it is believed that administering an anti-Sortilin antibody of the present disclosure can prevent, reduce the risk, and/or treat DDD. In some embodiments, administering an anti-Sortilin antibody may induce one or more Progranulin activities in an individual having DDD. In some embodiments, administering an anti-Sortilin antibody may modulate one or more Sortilin activities in an individual having DDD.

Pain

[0459] Pain describes, without limitation, neuropathic pain arising from nerve injury, e.g., from trauma or disease. Such injury may include injury to peripheral nerves and/or the spinal cord. Sortilin antagonists have been shown to alleviate neuropathic pain. (Rieler M *et al.* (2019) *Sci. Adv.* 5: eaav9946.)

Kits/Articles of Manufacture

[0460] Provided herein are articles of manufacture (e.g., kit) comprising an anti-Sortilin antibody described herein. Article of manufacture may include one or more containers comprising an antibody described herein. Containers may be any suitable packaging including, but is not limited to, vials, bottles, jars, flexible packaging (e.g., sealed Mylar or plastic bags), and the like. The containers may be unit doses, bulk packages (e.g., multi-dose packages) or sub-unit doses.

[0461] In some embodiments, the kits may further include a second agent. In some embodiments, the second agent is a pharmaceutically-acceptable buffer or diluting agent including, but not limited to, such as bacteriostatic water for injection (BWI), phosphate- buffered saline, Ringer's solution and dextrose solution. In some embodiments, the second agent is a pharmaceutically active agent.

[0462] In some embodiments of any of the articles of manufacture, the article of manufactures further include instructions for use in accordance with the methods of this disclosure. The instructions generally include information as to dosage, dosing schedule, and route of administration for the intended treatment. In some embodiments, these instructions comprise a description of administration of the isolated antibody of the present disclosure (e.g., an anti-Sortilin antibody described herein) to prevent, reduce risk, or treat an individual having a disease, disorder, or injury selected from dementia, frontotemporal dementia, Alzheimer's disease, gaucher's disease, vascular dementia, seizures, retinal dystrophy, a traumatic brain injury, a spinal cord injury, atherosclerotic vascular diseases, undesirable symptoms of normal aging, amyotrophic lateral sclerosis (ALS), *long-term* depression, Parkinson's disease, Huntington's disease, Taupathy disease, multiple sclerosis, age related macular degeneration, glaucoma, degenerative disc disease (DDD), Creutzfeldt-Jakob disease, normal pressure hydrocephalus, Nasu-Hakola disease, stroke, acute trauma, chronic trauma, lupus, acute and chronic colitis, Crohn's disease, inflammatory bowel disease, ulcerative colitis, malaria, essential tremor, central nervous system lupus, Behcet's disease, mixed dementia, dementia with Lewy bodies, multiple system atrophy, Shy-Drager syndrome, progressive supranuclear palsy, cortical basal ganglionic degeneration, acute disseminated encephalomyelitis, granulomatous disorders, sarcoidosis, diseases of aging, retinitis pigmentosa, retinal degeneration, respiratory tract infection, sepsis, eye infection, systemic infection, lupus, arthritis, and wound healing, according to any methods of this disclosure. In some embodiments, the disease, disorder, or injury is frontotemporal dementia. In some embodiments, the instructions include instructions for use of the anti-Sortilin antibody and the second agent (e.g., second pharmaceutically active agent).

Diagnostic uses

[0463] The isolated antibodies of the present disclosure (e.g., an anti-Sortilin antibody described herein) also have diagnostic utility. This disclosure therefore provides for methods of using the antibodies of this disclosure, or functional fragments thereof, for diagnostic purposes, such as the detection of a Sortilin protein in an individual or in tissue samples derived from an individual.

[0464] In some embodiments, the individual is a human. In some embodiments, the individual is a human patient suffering from, or at risk for developing a disease, disorder, or injury of the present disclosure. In some embodiments, the diagnostic methods involve detecting a Sortilin protein in a biological sample, such as a biopsy specimen, a tissue, or a cell. An anti-Sortilin antibody described herein is contacted with the biological sample and antigen-bound antibody is detected. For example, a biopsy specimen may be stained with an anti-Sortilin antibody described herein in order to detect and/or quantify disease-associated cells. The detection method may involve quantification of the antigen-bound antibody. Antibody detection in biological samples may occur with any method known in the art, including immunofluorescence microscopy, immunocytochemistry, immunohistochemistry, ELISA, FACS analysis, immunoprecipitation, or micro-positron emission tomography. In certain embodiments, the antibody is radiolabeled, for example with ¹⁸F and subsequently detected utilizing micro-positron emission tomography analysis. Antibody-binding may also be quantified in a patient by non-invasive techniques such as positron emission tomography (PET), X-ray computed tomography, single-photon emission computed tomography (SPECT), computed tomography (CT), and computed axial tomography (CAT).

[0465] An isolated antibody of the present disclosure (e.g., an anti-Sortilin antibody described herein) may be used to detect and/or quantify, for example, microglia in a brain specimen taken from a preclinical disease model (e.g., a non-human disease model). As such, an isolated antibody of the present disclosure (e.g., an anti-Sortilin antibody described herein) may be useful in evaluating therapeutic response after treatment in a model for a nervous system disease or injury such as frontotemporal dementia, Alzheimer's disease, vascular dementia, seizures, retinal *dystrophy*, atherosclerotic vascular diseases, Nasu-Hakola disease, or multiple sclerosis, as compared to a control.

[0466] The present disclosure will be more fully understood by reference to the following Examples. They should not, however, be construed as limiting the scope of the present disclosure.

EXAMPLES

[0467] Examples 1-3 describe the generation of affinity-matured variants of an anti-human Sortilin antibody, S-60, and the characterization of those variants with respect to not only their binding affinity for SORT1 but also their biological activity in down-regulating SORT1 expression, increasing PGRN secretion, and blocking PGRN-SORT1 binding. Surprisingly, it was found that improved biological activity did not necessarily correlate with increased affinity.

Example 1: Generation of S-60 Variants and Measurement of SORT1 Binding Affinity

[0468] The purpose of the following Example was to generate affinity-matured variants of an anti-human Sortilin antibody, S-60, and to characterize the binding of the affinity-matured antibodies to human Sortilin (SORT1).

S-60 affinity matured variants

[0469] Affinity-matured antibodies against human Sortilin (SORT1) were generated and their binding to SORT1 measured. The anti-SORT1 antibody, S-60, as well as S-60-1, S-60-2, S-60-3, S-60-4, S-60-5, S-60-6, S-60-7, S-60-8, and S-60-9 have been described in WO2016164637. The V_H and V_L sequences for S-60-9 and S60 in WO2016164637 are identical, and S-60 will be used herein to refer to the antibody. The V_H and V_L sequences for S-60-5, S-60-6, and S-60-7 in WO2016164637 are identical, and S-60-7 will be used herein to refer to the antibody. S-60 was found to be both a potent downregulator of SORT1 levels and a potent blocker of binding between SORT1 and PGRN (see, e.g., Tables 8-10 and FIGs 6A and 10D in WO2016164637). Therefore, S-60 was selected for further affinity maturation.

[0470] Tire anti-SORT1 variants S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15, S-60-16, S-60-18, S-60-19, and S-60-24 were generated as described below.

Production of S-60 affinity matured variants

[0471] The anti-SORT1 antibody S-60 was affinity-matured. Briefly, diversified antibody libraries were created in yeast for each of the starting parental antibodies. The diversity in the first round of affinity maturation was created by utilizing standard molecular cloning techniques to combine the parental heavy chain HVR-H3 and light chain (LC) with pre-existing genetic diversity in the HVR-H1 and HVR-H2 regions of the heavy chain (HC) (termed "H1/H2" optimization). For the second round of affinity maturation, both heavy chain variable region (V_H) and light chain variable region (V_L) sequences were optimized, with a particular focus on HVR-H3.

[0472] Selection pressures used for screening the libraries included human SORT1 antigen equilibrium titration, parental antibody Fab competition kinetics, and the use of poly specificity reagent deselection. FACS flow cytometry was then employed to visualize and select antibodies, using standard techniques (see, e.g., Chao et al. Nature Protocols, 2006). The desired population was then carried forward into additional selection rounds.

[0473] The affinity-matured anti-SORT1 antibodies were purified as follows: clones were grown to saturation and then induced for 48 h at 30°C with shaking. After induction, yeast cells were pelleted and the supernatants were harvested for purification. Immunoglobulins were purified using a Protein A column and eluted with acetic acid, pH 2.0. Fab fragments were generated by papain digestion and purified over CaptureSelect IgG-CH1 affinity matrix (LifeTechnologies).

Measurement of binding affinity to SORT1

[0474] The anti-SORT1 antibody S-60 and affinity-matured variants thereof were tested and compared in a SORT1 binding assay. For the binding assay, stable HEK293T cells expressing human SORT1 were harvested by trypsinization, washed in PBS, counted and plated on 96-well u-bottom plates at 1×10^5 cells/ well. The plates were spun at 1,400 rpm for 3 minutes and primary anti-SORT1 or control antibodies were added in FACS buffer (PBS + 2 FBS) and incubated on ice for one hour. Cells were subsequently centrifuged as before and washed thrice with FACS buffer. Cells were then incubated with anti-human APC conjugated secondary antibody (BD Biosciences) in FACS buffer for 30 minutes on ice. Cells were again washed three times with FACS buffer and analyzed on a BD FACS Canto or an Intellicyt Flow Cytometer. Binding was measured as median fluorescent intensity (MFI) in the PE channel of the GFP positive cell population.

Results

[0475] The binding affinities of the anti-SORT1 antibodies to SORT1 are shown below in Table 1. All antibodies were tested on the hulG1 backbone.

Table 1: Binding Affinity to SORT1		
Antibody ID	K _d (M)	Fold change from: S-60
S-60	1.15E-09	
S-60-1	1.22E-09	0.15
S-60-2	1.101E-08	0.10
S-60-3	8.56E-10	1.34
S-60-4	8.34E-10	1.81
S-60-7	7.87E-10	1.46
S-60-8	4.58E-10	2.46
S-60-10	6.5E-10	1.77
S-60-11	6.5E-10	1.77
S-60-12	8.9E-10	1.29
S-60-13	7.5E-10	1.53
S-60-14	1.05E-09	1.10
S-60-15	5.60E-10	2.05
S-60-16	7.80E-10	1.47
S-60-18	1.63E-09	0.71
S-60-19	8.00E-10	1.44
S-60-24	7.55E-10	1.52

Note: K_d values represent the average of two experiments.

[0476] Anti-SORT1 antibodies S-60-3, S-60-4, S-60-7, S-60-8, S-60-10, S-60-11, S-60-13, S-60-15, S-60-16, S-60-19, and S-60-24 showed significantly improved affinity for binding to SORT1 compared to S-60. In particular, S-60-8 and S-60-15 demonstrated the highest binding affinities to SORT1 of the tested variants, having a 2.46- and 2.05-increased fold change, respectively, compared to the binding affinity of the parental antibody, S-60.

Example 2: Effect of S-60 Variants on SORT1 Expression and PGRN Secretion

[0477] The purpose of the following Example was to characterize the effect of affinity-matured variants of an anti-human SORT1 antibody, S-60, on SORT1 expression and extracellular levels of Progranulin (PGRN).

SORT1 Expression and PGRN Secretion Assays

[0478] Affinity matured variants of S-60 were generated as described in Example 1 and were subsequently screened by FACS for their abilities to downregulate SORT1 and to elevate extracellular levels of PGRN. In order to assay the effect of the anti-SORT1 antibodies on SORT1 expression and PGRN secretion, U251 cells that endogenously express SORT1 and secrete PGRN were incubated with anti-SORT1 antibody S-60 and affinity-matured variants. Cell surface levels of SORT1 at different antibody concentrations were measured by FACS as follows: anti-SORT1 antibody S-60 and affinity-matured variants were added to U251 cells seeded at 3×10^3 cells/well in 96 well plates with a serial dilution from 0.023nM to 150nM. After 72 h, cells were harvested with Trypsin, washed in PBS and labeled with Dylight-650 conjugated anti-SORT1 antibody S-2-11 (described in WO2016164637) to quantify the levels of SORT1 protein remaining. After cells were incubated with 5 µg/ml S-2-11 conjugated to DyLight-650 (Invitrogen) for one hour on ice, cells were washed three times in PBS+ 2 FBSand binding was quantified using a FACSCanto™ or Intellicyt Flow cytometer as median fluorescence intensity (MFI) of APC.

[0479] The amount of PGRN secreted into the cell supernatant over the course of the 72h was measured by standard ELISA as follows: cells were harvested and the media was collected; the concentration of PGRN in the media samples was measured using an R&D Systems human PGRN DuoSet ELISA kit, according to manufacturer's instructions. Data were analyzed in Microsoft Excel and GraphPad Prism.

Results

[0480] The half maximal effective concentration (EC_{50}) for down-regulation (DR) of cell surface levels of SORT1 for each of the tested S-60 variants is shown in Table 2. SORT1 DR was quantified for each S-60 variant tested and expressed as a percent of the control (untreated cells) (Tables 2-4). Additionally, the level of extracellular PGRN secretion was quantified and expressed as a fold change relative to the untreated control as shown in Tables 2-4. Independent experiments are represented in separate tables (Tables 2-4). All antibodies were tested on the hulgG1 WT backbone.

Table 2: Percent SORT1 Downregulation (DR) and PGRN Secretion for S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-7, and S-60-8

Antibody ID	DR EC_{50} (M)	DR at 0.6 nM antibody (IgG)	PGRN secretion (fold over control) 0.62 or 0.63 nM antibody (IgG)
S-60	6.81E-10	29.3	1.38
S-60-1	2.73E-10	50.4	1.60
S-60-2	4.20E-10	49.3	1.75
S-60-3	2.69E-10	45.0	1.77
S-60-4	4.18E-10	39.6	1.61
S-60-7	4.47E-10	32.6	1.40
S-60-8	5.76E-10	22.0	1.54

Table 3: Percent SORT1 Downregulation (DR) and PGRN Secretion for S-60, S-60-3, S-60-24, S-60-15, S-60-16, S-60-18, and S-60-19

Antibody ID	DR at 1.25nM antibody (IgG)	PGRN secretion (fold over control), 0.63nM antibody (IgG)
S-60	40.17	1.11
S-60-3	61.50	1.32
S-60-24	65.20	1.35

S-60-15	60.92	1.42
S-60-16	70.14	1.42
S-60-18	51.23	1.13
S-60-19	55.46	1.55

Table 4: Percent SORT1 Downregulation (DR) and PGRN Secretion for S-60-24, S-60-10, S-60-11, S-60-12, S-60-13, and S-60-14

Antibody ID	DR at 0.63nM antibody (IgG)	PGRN secretion (fold over control), 0.63nM antibody (IgG)
S-60-24	81.48	1.62
S-60-10	85.41	1.85
S-60-11	88.76	1.89
S-60-12	87.58	1.89
S-60-13	82.35	1.77
S-60-14	80.47	1.81

[0481] In a first experiment analyzing the SORT1 DR EC_{50} , the percent of SORT1 DR using a saturating antibody concentration of 0.6 nM IgG, and PGRN secretion using a saturating antibody concentration of 0.62 or 0.63 nM IgG, the following variants were tested: S-60, S-60-1, S-60-2, S-60-3, S-60-4, S-60-7, and S-60-8. As shown in Table 2, S-60-3 demonstrated the lowest DR EC_{50} (.269 nM) and the highest PGRN secretion, a 1.77-fold increase relative to the control, and an improvement over S-60, which showed a 1.38-fold increase over the control. Using 0.6 nM IgG, S-60-1 exhibited the most substantial effect on SORT1 expression of the variants tested, down-regulating SORT1 by 50.4% compared to the control, whereas S-60 down-regulated SORT1 by 29.3%.

[0482] In a subsequent experiment, the percent of DR using a saturating antibody concentration of 1.25 nM IgG, and PGRN secretion using a saturating antibody concentration of 0.63 nM IgG was analyzed for the following variants: S-60, S-60-3, S-60-24, S-60-15, S-60-16, S-60-18, and S-60-19. As shown in Table 3, both S-60-15 and S-60-16 demonstrated the highest levels of extracellular PGRN secretion with a 1.42-fold increase compared to the control, an improvement over S-60 which showed a 1.11-fold increase over the control. Indeed, these two variants also significantly reduced SORT1 expression compared to S-60, down-regulating SORT1 by 60.92% and 70.14%, respectively, relative to the control, whereas S-60 down-regulated SORT1 by only 40.17%.

[0483] In a third experiment, the percent of DR using a saturating antibody concentration of 0.63 nM IgG, and PGRN secretion using a saturating antibody concentration of 0.63 nM IgG was analyzed for the following variants: S-60-24, S-60-10, S-60-11, S-60-12, S-60-13, and S-60-14. As shown in Table 4, S-60-11 and S-60-12 displayed the highest amount of extracellular PGRN secretion with a 1.89-fold increase compared to the control. S-60-11 also demonstrated the highest SORT1 DR at 0.63 nM IgG, down-regulating SORT1 by 88.76% relative to the control.

Conclusion

[0484] As shown in Table 1 in Example 1, S-60-8 and S-60-15 demonstrated the highest affinities for binding to SORT1 compared to S-60 and the other S-60 variants tested with the lowest K_D values of 4.68E-10M and 5.60E-10M, respectively. However, when compared to a specific variant, S-60-3, having a higher K_D value of 8.56E-10M (Table 1), S-60-8 displayed a smaller increase in PGRN secretion (Table 2) while S-60-15 displayed a higher fold increase in PGRN secretion than did S-60-3 (Table 3). Additionally, S-60-8 (at a saturating concentration of 0.6 nM IgG) demonstrated a smaller percent reduction of SORT1 expression (Table 2) compared to S-60-3 and S-60-15 (at a saturating concentration of 1.25 nM IgG), which down-regulated SORT1 by 61.50% and 60.92%, respectively (Table 3). Thus, S-60-15 performed better than S-60-3 with respect to increasing PGRN secretion and exhibited a similar effect compared to S-60-3 in down-regulating cell surface levels of SORT1, whereas S-60-8 performed worse than S-60-3 with respect to increasing PGRN secretion and down-regulating cell surface levels of SORT1.

[0485] The results of this study indicate that the relative efficacy of anti-SORT1 S-60 antibody variants with respect to down-regulating SORT1 expression or increasing PGRN secretion was not predicted by their relative binding affinities for Sortilin.

[0486] Furthermore, S-60-15 showed the greatest increase in PGRN secretion compared to S-60 and certain S-60 variants (Table 3, last column), including S-60-3. S-60-3, in turn, showed increased PGRN secretion relative to S-60-1, -2, -4, -7, and -8 (Table 2, last column). Therefore S-60-15 is an effective antibody for increasing PGRN secretion relative to those S-60 variants. The ability to increase PGRN secretion is an important property in selecting a therapeutic antibody for treatment of diseases such as FTD and other pathologies in which PGRN deficiency plays a direct causal role. Such an antibody would be useful in restoring PGRN levels to, or closer to, wild-type levels, thereby treating the disease. Moreover, this property is an important pharmacodynamic parameter in assessing antibody activity *in vivo* (see below, Example 5).

Example 3: S-60 variants block binding of PGRN to SORT1

[0487] The purpose of the following Example was to characterize the effect of affinity-matured variants of an anti-human SORT1 antibody, S-60, on the binding interaction between SORT1 and a natural ligand, PGRN.

SORT1-PGRN Blocking Assay

[0488] The ability of S-60 variants to block the binding of PGRN to SORT1 was also tested. Recombinant human PGRN (PGRN) (Adipogen) was biotinylated with an EZ-Link Micro NHS-PEG4 kit from ThermoScientific/Pierce according to the manufacturer's instructions. A stable cell line expressing full-length untagged human SORT1 (SORT1) was established by viral infection of HEK293T cells, and positive selection with hygromycin (Genscript custom project). As control cells, parental HEK293T cells were utilized.

[0489] SORT1-expressing cells or control cells were harvested and washed in PBS. Biotinylated human PGRN was added in PBS+ 2% FBS with or without a titration of anti-SORT1 antibodies or control human IgG1 isotype antibodies and incubated on ice for 2h. After washing cells 3 times in PBS+ 2% FBS, cells were incubated in Streptavidin-APC (BD Biosciences, 1:100) on ice for 30 min. Then cells were washed again, resuspended in PBS+ 2% FBS and analyzed on a FACSCanto™ flow cytometer (BD Biosciences, Mississauga, ON). PGRN binding was measured as the median fluorescence intensity (MFI) of APC of the SORT1 expressing cell population. Binding of biotinylated PGRN to SORT1 expressed on HEK293T cells was measured by FACS in absence or presence of S-60 and its variant antibodies.

Results

[0490] The half maximal effective concentration (EC₅₀) for blocking PGRN binding to SORT1 for each of the tested S-60 variants is shown in **Tables 5-7**. Additionally, the maximum level of blocking PGRN to SORT1 was quantified and expressed as a percentage of the maximum block achieved using a saturating concentration of 50 nM IgG or 150 nM IgG (**Table 5-7**). Independent experiments are shown in separate tables below.

Table 5: Blocking of PGRN binding to SORT1 expressed on HEK293T cells for S-60-1, S-60-2, S-60-3, S-60-4, S-60-7, S-60-8, and S-60.

Antibody ID	PGRN binding block EC ₅₀ (nM)	PGRN binding block (% max at 150nM antibody (IgG))
S-60-1	5.986	95.2
S-60-2	7.509	94.5
S-60-3	0.733	95.5
S-60-4	0.584	95.7
S-60-7	6.944	96.5
S-60-8	0.985	95.6
S-60	0.751	95.9

Table 6: Blocking of PGRN binding to SORT1 expressed on HEK293T cells for S-60, S-60-3, S-60-24, S-60-15, S-60-16, S-60-18, and S-60-19.

Antibody ID	PGRN binding block EC ₅₀ (nM)	PGRN binding block (% max at 50nM antibody (IgG))
-------------	--	---

Antibody ID	PGRN binding block EC ₅₀ (nM)	PGRN binding block (% max at 50nM antibody (IgG))
S-60	2.20E-09	90.13
S-60-3	1.76E-09	90.44
S-60-24	1.11E-09	88.94
S-60-15	1.22E-09	90.74
S-60-16	1.20E-09	90.44
S-60-18	2.27E-09	89.33
S-60-19	1.53E-09	90.15

Table 7: Blocking of PGRN binding to SORT1 expressed on HEK293T cells for S-60-24, S-60-10, S-60-11, S-60-12, S-60-13, and S-60-14.

Antibody ID	PGRN binding block EC ₅₀ (nM)	PGRN binding block (% max at 50nM antibody (IgG))
S-60-24	4.70E-10	95.64
S-60-10	4.60E-10	95.84
S-60-11	4.10E-10	94.97
S-60-12	6.10E-10	95.26
S-60-13	5.60E-10	95.83
S-60-14	6.00E-10	95.67

[0491] In a first experiment analyzing the PGRN binding block EC₅₀ and the percentage of PGRN binding block to SORT1 with a saturating concentration of 150 nM IgG, the following variants were tested: S-60-1, S-60-2, S-60-3, S-60-4, S-60-7, S-60-8, and S-60. As shown in **Table 5**, S-60-4 demonstrated the lowest EC₅₀ value (0.584 nM), achieving a 95.7% block of PGRN binding to SORT1. Of the variants analyzed, S-60-7 displayed the greatest reduction in the PGRN binding, blocking 96.5% of PGRN binding to SORT1, though it displayed lower efficiency at blocking PGRN binding (higher EC₅₀ value) than S-60 and variants S-60-3 and S-60-4.

[0492] In a subsequent experiment analyzing the PGRN binding block EC₅₀ and the percentage of PGRN binding block to SORT1 with a saturating concentration of 50 nM IgG, the following variants were tested: S-60, S-60-3, S-60-24, S-60-15, S-60-16, S-60-18, and S-60-19. As shown in **Table 6**, S-60-24, S-60-15, and S-60-16 displayed the lowest EC₅₀ values compared to S-60, ranging from 1.11 nM to 1.22 nM. Furthermore, the S-60-15 variant demonstrated the strongest potency compared to S-60, achieving a 90.74% block of PGRN binding to SORT1.

[0493] In a third experiment, the following variants were tested: S-60-24, S-60-10, S-60-11, S-60-12, S-60-13, and S-60-14. As shown in **Table 7**, S-60-11 demonstrated the lowest EC₅₀ (0.410 nM), achieving a 94.97% block of PGRN binding to SORT1. Of the variants analyzed, S-60-24 displayed the greatest reduction in the PGRN binding, blocking 95.64% of PGRN binding to SORT1.

Conclusion

[0494] As shown in **Table 1** in **Example 1**, both S-60-8 and S-60-15 demonstrated the highest affinities for binding to SORT1 relative to S-60 and the other S-60 variants tested, with S-60-8 having the highest affinity for SORT1. However, when compared to S-60, S-60-8 displayed a lower efficiency at blocking binding to PGRN (higher EC₅₀ value relative to S-60) (**Table 5**) whereas S-60-15 displayed a higher efficiency at blocking binding to PGRN (reduced EC₅₀ value relative to S-60) (**Table 6**). Moreover, S-60-8 demonstrated a smaller percent maximal blocking of PGRN binding to SORT1 compared to S-60 (**Table 5**) whereas S-60-15 demonstrated a greater percent maximal blocking of PGRN binding to SORT1 relative to S-60 (**Table 6**). Thus, S-60-15 performed better than S-60-8 when compared to S-60 with respect to EC₅₀ value in blocking PGRN binding to SORT1 and the maximum percentage of blocking PGRN binding to SORT1, despite the fact that S-60-8 showed higher affinity binding to SORT1 compared to S-60-15.

[0495] Thus, the results of this study indicate, unexpectedly, that the relative efficacy of anti-SORT1 S-60 antibody variants with respect to blocking the degree of PGRN binding to SORT1 was not predicted by their relative binding affinities for SORT1.

Example 4: S-60-15 Stability and Stress Testing Analysis

[0496] The purpose of the following Example was to characterize S-60-15, an affinity-matured variant of S-60 described in previous Examples, for stability under various stress testing conditions.

[0497] Stability of a therapeutic antibody is important for clinical efficacy. During manufacturing, storage, and *in vivo* administration, therapeutic antibodies are at risk for degradation via multiple pathways. The factors that are responsible for such degradation remain poorly understood. Given that S-60-15 demonstrated a high binding affinity for SORT1 (see **Example 1**), effectively reduced cell surface levels of SORT1 and increased extracellular PGRN secretion (see **Example 2**), as well substantially blocked PGRN binding to SORT1 (see **Example 3**), and unexpectedly performed these functional tests better than S-60-8 which showed higher affinity for SORT1, S-60-15 was further evaluated for stability.

pH and Temperature Stress Testing

[0498] In order to measure the stability of the amino acid residues within S-60-15, samples of S-60-15 were subjected to pH and temperature stress conditions to emulate stress conditions that occur during manufacturing, storage, and *in vivo* administration. Briefly, individual samples of S-60-15 were subjected to stress testing at pH 3.5 or pH 5.0 and at 40°C or 50°C. The samples were tested at various time points - 0, 1, 3 and 5 days for the two pH conditions, and 0, 7, 14 and 30 days for the high temperature stress conditions - by treatment with DTT and IAA followed by trypsin digestion. The digested samples were analyzed by Liquid Chromatography with Mass Spectrometry detection using a Waters ACQUITY UPLC coupled to a Xevo G2-XS QTOF mass spectrometer using a BEH C18 column. Results are shown in **Table 8**.

Table 8. Stochasticity: Percentage Table (% at each peptide with the modifier). Denat (denaturation). Oxid (oxidation). CAM (carbamidomethyl).

Substrate Peptide	Non- sites	pH5 d0	pH5 d1	pH5 d3	pH5 d5	pH2.5 d0	pH2.5 d1	pH2.5 d3	pH2.5 d5	T40 d7	T40 d14	T40 d30	T50 d7	T50 d14	T50 d30
AGFSLK (SEQ ID NO:453)	1.1	1.5	1.3	1.2	0.9	1.2	1.4	1.3	1.4	1.2	1.3	1.2	1.2	1.3	1.1
AGVYGD (SEQ ID NO:454)	6.2	6.8	6.3	6.6	8.8	6.2	6.8	6.6	6.4	5.7	5.1	5.6	5.7	5.4	1.1
AGVYGD (SEQ ID NO:455)	6.5	6.6	6.5	6.6	0.7	0.6	3.6	0.6	0.5	0.4	1.0	1.0	1.1	2.3	3.6
AGVYGD (SEQ ID NO:456)	1.3	3.3	3.3	3.5	3.8	3.4	3.4	3.4	3.2	3.2	3.1	0.6	3.2	3.1	3.2
AGVYGD (SEQ ID NO:457)	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.5	0.8	0.7	1.0	1.3
AGVYGD (SEQ ID NO:458)	1.1	3.6	3.1	3.4	3.4	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
AGVYGD (SEQ ID NO:459)	1.4	1.1	1.2	1.3	1.7	1.5	1.2	1.4	1.3	0.7	6.3	1.5	1.1	1.2	5.3
AGVYGD (SEQ ID NO:460)	1.8	7.2	6.7	6.9	6.5	7.0	6.9	7.0	6.8	8.1	8.4	9.3	9.5	1.6	17.0
AGVYGD (SEQ ID NO:461)	0.3	0.5	0.2	0.0	1.5	0.2	0.4	0.4	0.5	0.8	6.0	3.0	0.8	1.2	1.1
AGVYGD (SEQ ID NO:462)	3.9	2.1	2.9	4.0	1.7	2.0	2.0	2.0	1.9	1.9	2.1	1.9	2.1	2.5	2.6
AGVYGD (SEQ ID NO:463)	5.2	4.9	5.1	5.0	6.4	5.0	5.2	4.9	7.0	8.9	9.6	1.1	1.1	1.1	4.9
AGVYGD (SEQ ID NO:464)	3.8	4.0	5.0	4.4	4.4	3.9	3.0	4.0	3.9	3.7	3.9	3.9	4.4	6.5	6.5
AGVYGD (SEQ ID NO:465)	1.6	1.8	1.8	1.8	1.9	1.8	1.8	1.9	1.8	1.8	1.9	2.6	2.2	2.6	5.1
AGVYGD (SEQ ID NO:466)	0.7	3.8	0.4	0.8	0.8	0.8	0.7	0.8	0.7	0.8	0.8	1.1	1.1	1.1	2.0
AGVYGD (SEQ ID NO:467)	6.9	5.1	5.2	5.4	6.5	6.0	5.4	6.5	5.8	7.2	6.9	7.0	6.8	7.2	6.6

Table 8. Stochasticity: Percentage Table (% at each peptide with the modifier). Denat (denaturation). Oxid (oxidation). CAM (carbamidomethyl).

Substrate Peptide	Non- sites	pH5 d0	pH5 d1	pH5 d3	pH5 d5	pH2.5 d0	pH2.5 d1	pH2.5 d3	pH2.5 d5	T40 d7	T40 d14	T40 d30	T50 d7	T50 d14	T50 d30
AGVYGD (SEQ ID NO:468)	1.1	1.5	1.3	1.2	0.9	1.2	1.4	1.3	1.4	1.2	1.3	1.2	1.2	1.3	1.1
AGVYGD (SEQ ID NO:469)	6.2	6.8	6.3	6.6	8.8	6.2	6.8	6.6	6.4	5.7	5.1	5.6	5.7	5.4	1.1
AGVYGD (SEQ ID NO:470)	6.5	6.6	6.5	6.6	0.7	0.6	3.6	0.6	0.5	0.4	1.0	1.0	1.1	2.3	3.6
AGVYGD (SEQ ID NO:471)	1.3	3.3	3.3	3.5	3.8	3.4	3.4	3.4	3.2	3.2	3.1	0.6	3.2	3.1	3.2
AGVYGD (SEQ ID NO:472)	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.5	0.8	0.7	1.0	1.3
AGVYGD (SEQ ID NO:473)	1.1	3.6	3.1	3.4	3.4	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
AGVYGD (SEQ ID NO:474)	1.4	1.1	1.2	1.3	1.7	1.5	1.2	1.4	1.3	0.7	6.3	1.5	1.1	1.2	5.3
AGVYGD (SEQ ID NO:475)	1.8	7.2	6.7	6.9	6.5	7.0	6.9	7.0	6.8	8.1	8.4	9.3	9.5	1.6	17.0
AGVYGD (SEQ ID NO:476)	0.3	0.5	0.2	0.0	1.5	0.2	0.4	0.4	0.5	0.8	6.0	3.0	0.8	1.2	1.1
AGVYGD (SEQ ID NO:477)	3.9	2.1	2.9	4.0	1.7	2.0	2.0	2.0	1.9	1.9	2.1	1.9	2.1	2.5	2.6
AGVYGD (SEQ ID NO:478)	5.2	4.9	5.1	5.0	6.4	5.0	5.2	4.9	7.0	8.9	9.6	1.1	1.1	1.1	4.9
AGVYGD (SEQ ID NO:479)	3.8	4.0	5.0	4.4	4.4	3.9	3.0	4.0	3.9	3.7	3.9	3.9	4.4	6.5	6.5
AGVYGD (SEQ ID NO:480)	1.6	1.8	1.8	1.8	1.9	1.8	1.8	1.9	1.8	1.8	1.9	2.6	2.2	2.6	5.1
AGVYGD (SEQ ID NO:481)	0.7	3.8	0.4	0.8	0.8	0.8	0.7	0.8	0.7	0.8	0.8	1.1	1.1	1.1	2.0
AGVYGD (SEQ ID NO:482)	6.9	5.1	5.2	5.4	6.5	6.0	5.4	6.5	5.8	7.2	6.9	7.0	6.8	7.2	6.6

S-60 1

[0499] Amino acids having the potential to incur post-translational modifications (PTMs) upon stress were identified, and the corresponding peptide fragments generated from the stressed samples were tracked kinetically. The results confirm that two asparagine-glycine sites, one in the Fc region of the heavy chain (SEQ ID NO: 11) and one in the Fab region of the light chain (SEQ ID NO:15) of S-60-15, were the most susceptible to PTM, exhibiting 45.9% and 65.6% deamidation, respectively, after being subjected to 50°C storage for 30 days. No other PTM or cleavage site exhibited notable PTM or degradation upon stress testing.

Deamidation of the asparagine (N33) site

[0500] Any deamidation in the Fc region of the heavy chain of S-60-15 should not affect the binding affinity of S-60-15 to SORT1, as that region does not directly interact with SORT1. However, the asparagine (N33) site in the Fab region of S-60-15 is in tire HVR-L1 (SEQ ID NO:8), the complementarity determining region of the light chain, which participates in antigen binding. Thus, deamidation of the asparagine (N33) site in the Fab region of S-60-15 may affect the binding affinity of S-60-15 to SORT1. Upon deamidation, the asparagine (N33) site in the Fab region of S-60-15 undergoes an Asn to Asp/IsoAsp change.

[0501] Site-directed mutagenesis was utilized to test the effects of tire deamidation of the asparagine (N33) site in the Fab region of S-60-15 and the potential amino acid substitution to reduce the likelihood of degradation and deamidation and resulting manufacturing liability. Seventeen different point mutations to the HVR-L1 N33 position of S-60-15 (heJG17 were produced and sequenced using standard procedures. The G1m3 or G1m(f) allotype with L234A/L233A/P3315 ("LALAPS" motif) mutations was used as a background (Juefferis R and Lefranc M-P, *Mabs*, 2009 Jul-Aug; 1(4): 332-338). The LALAPS point mutations are intended to improve overall safety by minimizing effector functions such as Fc gamma receptor binding, complement activation, and antibody dependent cell mediated cytotoxicity (ADCC). Reduction of Fc gamma receptor binding, complement activation and ADCC as a result of LALAPS mutations have been observed in various experiments (data not shown). Bio-layer interferometry (BLI) data was collected at a rate of 5 Hz at 25°C on a Pall ForteBio Octet RED96 instrument. Data analysis was performed using ForteBio Data Analysis Software, version 9.0. Standard kinetic buffer (PBS, 0.1 BSA, 0.02 Tween-20, pH 7.2) was used for the assay and for preparing reagents. For all assays, sensor tips were equilibrated in buffer prior to analysis.

[0502] For the initial off-rate screen, S-60-15 LALAPS N33 and N33X mutants (1 $\mu\text{g/mL}$, 300 s loading time) were captured on Anti-Human IgG Fc Capture Dip and Read Biosensors (Pall ForteBio, Menlo Park, CA). Twenty nM histidine-tagged human SORT1 (R&D Systems, Minneapolis, MN) was then bound to the captured anti-SORT1 surface (200 s association time, 1200 s dissociation time). The resulting BLI signal was obtained as the difference in response from the reference (1 $\mu\text{g/mL}$ S60-15 + 0 nM SORT1) sensor. A zero-ligand control (0 $\mu\text{g/mL}$ IgG + 20 nM SORT1) showed no measurable nonspecific binding of antigen to the sensor tip surface. Full, local fitting using a 1:1 interaction model was applied to extract association and dissociation rate constants (k_a and k_d , respectively) for each N33 mutant. Affinity constants (K_D) were calculated from the ratio k_d/k_a . Different amino acid substitutions were made at N33 and tested for binding to SORT1 in an off- rate screen (under non-stress conditions) as shown in **Table 9**.

Table 2: Extracted k_1 , k_2 , and K_D for S-60-15 N33X Monomers binding to SORT1 III

S-60-15 Variants	k_{on} ($\text{M}^{-1}\text{s}^{-1}$)	k_{off} (s^{-1})	K_{D} (μM)
S-60-15 [N33 (wt)]	$5.12\text{E}+05$	$1.41\text{E}-01$	270
S-60-15.1 [N33T]	$4.7\text{E}+05$	$1.67\text{E}-01$	344
S-60-15.2 [p-N33S]	$5.63\text{E}+05$	$2.47\text{E}-01$	443
S-60-15.3 [N33G]	$4.98\text{E}+05$	$4.11\text{E}-01$	825
S-60-15.4 [N33R]	$5.24\text{E}+05$	$4.60\text{E}-01$	883
S-60-15.5 [N33D]	$5.96\text{E}+05$	$6.10\text{E}-01$	1690
S-60-15.6 [N33H]	$5.48\text{E}+05$	$4.60\text{E}-01$	873
S-60-15.7 [N32K]	$5.63\text{E}+05$	$5.47\text{E}-01$	965
S-60-15.8 [N23Q]	$6.09\text{E}+05$	$6.52\text{E}-01$	905
S-60-15.9 [N33V]	$5.11\text{E}+05$	$6.75\text{E}-01$	1285
S-60-15.10 [N38E]	$6.76\text{E}+05$	$4.30\text{E}-01$	2807
S-60-15.11 [N23W]	$6.03\text{E}+05$	$5.79\text{E}-01$	960
S-60-15.12 [N33F]	$2.80\text{E}-03$	$8.16\text{E}-01$	2910
S-60-15.13 [N53I]	$4.91\text{E}+05$	$2.28\text{E}-01$	463
S-60-15.14 [N23V]	$4.45\text{E}+05$	$3.06\text{E}-01$	693
S-60-15.15 [N33A]	$4.93\text{E}+05$	$3.15\text{E}-01$	625
S-60-15.16 [N53M]	$4.95\text{E}+05$	$4.23\text{E}-01$	850
S-60-15.17 [N38T]	$4.17\text{E}+03$	$4.75\text{E}-01$	1050

Note: k_0 , k_1 , and K_0 represent an average value from multiple experiments.

[0503] Screening this N33X mutant panel showed that the S-60-15.5 antibody (N33D), which mimics deamidation of N33, led to a significant reduction in binding, with a K_D of 1000 pM compared to 270 pM for N33 wild-type (wt) (Table 9). In contrast, the S-60-15.1 antibody (N33T) had the best retention of S-60-15 affinity to SORT1, displaying the smallest K_D difference from wild-type in the panel (Table 9).

[0504] In addition, complete kinetic analysis using multiple concentrations of SORT1 was performed for S-60-15.1 [N33T] as hulgG1 and hulgG1 LALAPS in an independent experiment. The kinetic data are displayed in **Table 10**. Kinetic data demonstrate that S60-15.1 [N33T] is a high affinity antibody both as hulgG1 and hulgG1 LALAPS.

Table 10: SOST binding kinetic data for S-60-15. [SOST] as hufuG1 and hufuG1 LALAPS

Antibody ID	k_a (M ⁻¹ s ⁻¹)	k_d (s ⁻¹)	K_D (pM)
S-60-15.1 [N33T]	$5.99\text{E}+05$	$1.79\text{E}-04$	298
S-60-15.1 [N33T] 1 ALAPS	$4.70\text{E}+05$	$1.27\text{E}-04$	260

Cell Binding and Functionality

[0505] S-60-15.1 [N33T], both as hulG1 and hulG1 LALAPS, and S-60-15.5 [N33D] were subsequently tested for cell binding and functionality as described below.

[0506] Affinity matured antibodies S-60, S-60-15.1 [N33T] and S-60-15.5 [N33D] were tested side-by-side for binding to human SORT1 expressed on HEK293T cells as described earlier. The results are shown in **Table 11**. S-60-15.1 [N33T] as hulgG1 or hulgG1 LALAPS showed a higher affinity than S-60 (**Table 11**), with a lower K_d and a higher B_{max} . The Fc variant did not appear to have an effect on affinity, having only marginal differences in K_d and B_{max} of S-60-15.1 [N33T] hulgG1 vs. hulgG1 LALAPS. The completely deamidated version of S-60-15.5 [N33D] did not show any significant binding (**Table 11**, N.B. (No Binding)) to human SORT1 expressing cells, suggesting that amidation of the N33 residue is essential for target binding.

Table 11: Cell binding affinity values as measured by FACS.

Antibody ID	K_d (nM)	B_{max} (MF)
S60	1.02	758381
S-60-15.5 [N33D]	N.E.	N.B.
S-60-15.1 [N337]	0.5651	791596
S-60-15.1 (N337T1) A.D.S.	0.4231	592791

[0507] U251 cells that endogenously express SORT1 and secrete PGRN were incubated with anti-SORT1 antibody S-60, S-60-15.1 [N33T] or S-60-15.5 [N33D] at different concentrations, and cell surface levels of SORT1 were measured by FACS as described in **Example 2**. The control was untreated cells. In order to quantify the percentage of Sortilin down-regulation, a saturating antibody concentration of 150 nM IgG was used. For quantification of PGRN secretion, a saturating antibody concentration of 50 nM IgG was utilized.

Results are shown in **Table 12**. S-60-15.1 [N33T] as hulgG1 or hulgG1 LALAPS resulted in significant downregulation of SORT1 and an increase in PGRN secretion. Both tire level of downregulation of SORT1 and the level of increase in PGRN secretion were significantly improved in S-60-15.1 [N33T] as hulgG1 or hulgG1 LALAPS as compared to S-60, S-60-15.1 [N33T] as hulgG1 displayed only a minor reduction in EC₅₀ and percent SORT1 down-regulation, having a minor fold increase in PGRN secretion compared to S-60-15.1 [N33T] as hulgG1 LALAPS. In contrast, the completely deamidated version of S-60-15.5 [N33D] performed worse than S-60 in each of these functional assays; it did not show significant downregulation of SORT1 and had only minimal change in secreted PGRN levels.

Table 12. Downregulation (DR) of cell surface SORT1 by S60 antibody variants

Antibody ID	EC ₅₀ (pM)	% DR at 150nM antibody (IgG)	PGRN secretion, fold overcontrol at 50nM antibody (IgG)
S-60	687.9	62.5	1.75
S-60-15.5 [N33D]	n.d.	3.4	1.25
S-60-15.1 [N33T]	72.58	69.3	2.29
S-60-15.1 [N33T] LALAPS	103.6	70.3	1.97

[0508] Binding of biotinylated PGRN to SORT1 expressed on HEK293T cells was measured by FACS in the absence or presence of anti-SORT1 antibody S-60, S-60-15.1 [N33T] and S-60-15.5 [N33D] as described in **Example 3**. Results are shown in **Table 13**. A saturating antibody concentration of 150 nM IgG was used for quantifying the percentage of blocking of PGRN binding to SORT1.

Table 13. Block of PGRN binding to SORT1 expressed on HEK293T cells

Antibody ID	EC ₅₀ (nM)	Percentage block at 150nM antibody (IgG)
S60	0.751	95.5
S-60-15.5 [N33D]	0.588	27.5
S-60-15.1 [N33T]	0.325	95.5
S-60-15.1 [N33T] LALAPS	0.405	96.9

[0509] The S-60-15.1 [N33T] variants, both with and without LALAPS, displayed the lowest EC₅₀ values and the highest level of blocking PGRN binding to SORT1 as compared to S-60-15.5 as well as compared to S-60. Thus, S-60-15.1 [N33T] performed better than S-60 and S-60-15.5 in blocking PGRN binding to SORT1.

[0510] summary, S-60-15 was found to undergo extensive deamidation at N33 under storage stress (see **Table 8**), which increases the likelihood of degradation and resulting manufacturing liability. The previously described anti-SORT1 antibody S-60 and variants S-60-1, S-60-2, S-60-3, S-60-4, S-60-7, and S-60-8 also contain an asparagine at position 33 in the V_L. In particular, the location of the N33 deamidation site within the HVR-L1 site is likely to affect the binding of S-60-15 to SORT1. S-60-15.1 [N33T], one of several tested S-60-15 variants, retained significant binding affinity to SORT1 as compared to S-60-15 (see **Table 9**) and showed significantly improved binding affinity to SORT1 as compared to S-60 (see **Table 11**; compare to S-60-15 WT in **Table 1**). This high retention of binding affinity was unexpected for an antibody having a non-preferred substitution within HVR-L1 because the HVR-L1 residues may contact antigen. Also, unexpectedly, the S-60-15.1 [N33T] variant retained increased downregulation of SORT1, increased secretion of PGRN, and increased blocking of PGRN binding to SORT1 as compared to S-60 (see **Tables 12 and 13**). These results were also unexpected because a non-preferred substitution in an HVR sequence would likewise have been expected to negatively affect the functional characteristics of an antibody. Instead, S-60-15.1 [N33T] retains the desirable properties of downregulating cell-surface SORT1, increasing PGRN secretion, and blocking binding of PGRN to SORT1 in addition to being more stable than previously described antibodies by removal of a manufacturing liability at position 33 in the V_L.

Example 5: Anti-Sortilin Antibody PK and PD in Non Human Primates

[0511] In this Example, the pharmacokinetics (PK) and pharmacodynamics (PD) of intravenously (IV) administered anti-Sortilin antibody S-60-15.1 [N33T] LALAPS were determined in non-human primates.

Materials and Methods

Single dose pharmacokinetic and pharmacodynamic studies

[0512] For single dose pharmacokinetic studies, cynomolgus monkeys were administered anti-Sortilin antibody by single IV dose of 5mg/kg, 20mg/kg, 60mg/kg, or 200mg/kg on Day 0 (n = 3 animals per dose). Blood and CSF were drawn from the animals at multiple time-points thereafter to obtain anti-Sortilin antibody concentrations in plasma and cerebrospinal fluid (CSF), which are measurements of anti-Sortilin antibody pharmacokinetics. Progranulin (PGRN) concentration and the levels of Sortilin (SORT1) on white blood cells (WBCs), which are measurements of pharmacodynamics, were also determined.

[0513] Anti-Sortilin antibody concentrations were assayed using an ELISA assay with anti-Sortilin antibody -specific anti-idiotypic antibodies. PGRN concentrations were assayed with a commercially-available ELISA kit. Levels of SORT1 on white blood cells were assayed using an ELISA assay, and normalized to protein concentration.

Results

[0514] **Table 14** provides the plasma mean C_{max}, mean AUC, and t_{1/2} for each of the tested anti-Sortilin antibody doses.

Table 14. C_{max}, mean AUC, and t_{1/2} for the indicated anti-Sortilin antibody doses (n=3 for each dose).

Antibody Dose	Mean C _{max} (ng/ml)	Mean AUC (ng x hr/ml)	t _{1/2} hours
5mg/kg	156	5,879	4.7
20mg/kg	697	25,500	13.3
60mg/kg	2,570	118,000	42
200mg/kg	7,910	366,000	73.6

[0515] As shown in **FIG. 1A**, SORT1 expression levels in peripheral white blood cells decreased after treatment of non-human primates with any of the anti-Sortilin antibody doses tested. The higher anti-Sortilin antibody doses (60 mg/kg, 200 mg/kg) resulted in both an earlier and more prolonged decrease of SORT1 levels in peripheral white blood cells compared to lower anti-Sortilin antibody doses (5mg/kg, 20 mg/kg).

[0516] The levels of PGRN increased in the plasma of non-human primates administered a single IV injection of anti-Sortilin antibody in a time- and dose-dependent manner (**FIG. 1B**). In particular, plasma PGRN levels increased 3- to 4-fold at C_{max}, compared to baseline levels, for all anti-Sortilin antibody doses tested. Plasma PGRN levels remained elevated for longer periods of time at the higher antibody doses. Additionally, increased plasma PGRN levels were correlated with decreased expression levels of SORT1 in peripheral white blood cells.

[0517] The levels of PGRN in CSF were also increased in non-human primates administered a single IV injection of anti-Sortilin antibody. As shown in **FIG. 1C**, CSF PGRN levels increased 2- to 3-fold above baseline in animals administered either 20 mg/kg, 60 mg/kg, or 200 mg/kg. As observed with plasma PGRN levels, CSF PGRN levels remained elevated over time in the higher antibody dose groups.

[0518] Table 15 provides the CSF mean C_{max} , mean AUC, and $t_{1/2}$ for each of the tested anti-Sortilin antibody doses in non-human primates. Anti-Sortilin antibody CSF concentrations were on average around 0.1% the amount observed in plasma.

TABLE 15. Anti-Sortilin antibody CSF PK parameters and estimated half-life in non-human primates

[1] Level	Dose	C _{max} (µg/mL)	AUC ₀₋₂₄ (h ² µg/mL)	CL (mL/h/kg)	T _{1/2} hours (days)
5mg/kg	20	184	20692	32.3 (1.34)	
20mg/kg	2243	35717	745	23.8 (1)	
60mg/kg	6842	113573	623	38.3 (1.6)	
200mg/kg	4595	346187	1037	72.4 (3.02)	

Repeat dose pharmacokinetic and pharmacodynamic studies

[0519] Further pharmacokinetic and pharmacodynamic studies were performed in non-human primates administered anti-Sortilin antibody following a repeat-dose regimen. In these studies, animals (2 males and 2 females) were administered anti-Sortilin antibody at a dose of 60mg/kg once per week for four weeks. At various timepoints thereafter, SORTI expression levels in peripheral white blood cells were determined. In addition, plasma and CSF levels of the anti-Sortilin antibody, were determined.

[0520] As shown in FIG. 2A, SORT1 levels in peripheral white blood cells remained decreased throughout the duration of the study. Plasma PGRN levels increased to 5- to 6-fold above baseline at peak levels (FIG. 2B). A decrease in plasma PGRN was observed following the fourth and final administration of anti-Sortilin antibody; however, the plasma PGRN levels remained elevated by 2-fold above baseline. Additionally, CSF PGRN levels were increased 3- to 4-fold above baseline (FIG. 2C).

[0521] The systemic anti-Sortilin antibody exposure, assessed by mean Cmax and AUC₀₋₁₆₈, was 2100 µg/mL and 114,000 µg/mL × hr on Day 1, and 3020 µg/mL and 174,000 µg/mL × hr on Day 22. These results showed that exposure was higher on Day 22 compared to Day 1, indicating some accumulation of the antibody.

[0522] CSF concentration of anti-Sortilin antibody in these animals ranged from 0.03% to 0.12% of that observed in plasma, consistent with the distribution of other antibodies in the CSF (Pestalozzi et al., (2000) J Clin Oncol 18(11):2349-51, Petereit et al., (2009) Mult Scler 15(2):189-92).

[0523] Taken together, these results indicate that the S-60-15.1 [N33T] variant, in spite of having a relatively short half-life, has sustained activity *in vivo*, decreasing SORT1 levels in peripheral white blood cells and increasing plasma and CSF PGRN levels.

[0524] Moreover, IV administration of S-60-15.1 [N33T] to cynomolgous monkeys in both a 4-week and a 26-week repeat dose toxicology study was well tolerated at up to 200 mg/kg weekly, and there were no adverse findings that would preclude the conduct of clinical studies in humans based on those and other toxicology studies which included assessments of cytokine release, mortality, body weight, respiratory rate and depth, and local tolerability at injection site. Therefore, S-60-15.1 [N33T] is suitable for testing in human clinical studies of FTD and other indications as contemplated herein.

[0525] Lack of adverse findings with respect to toxicity from administration of an anti-Sortilin antibody was surprising in view of the fact that Sortilin acts as a receptor of several ligands and has multiple roles in cellular transport and signaling (Nykjaer, A et al., (2012) Trends Neurosci 35: 261-270). Due to Sortilin's multiple ligands and functional roles, administration of an anti-Sortilin antibody might have been expected to cause off-target effects; however, the S-60-15.1 [N33T] antibody was well tolerated at the administered doses.

Sequences of the V_H regions of the S-60 antibody variants, alignment to S-60, and HVR locations

[0526]

[illegible][illegible]Sequences of the V_L regions of the S-60 antibody variants, alignment to S-60, and HVR locations

[0527]

3-40 (REQ ID NO: 79) EXVHTG80H4PVYD9F4STSCFASQSLINSHWYNYLWTCGTGQSPGSLIYEGNKA A

3-44-1 (REQ ID NO: 113) EXVHTG80L54PVYD9F4STSCFASQSLINSHWYNYLWTCGTGQSPGSLIYEGNKA A

[illegible]

Table 16: Heavy chain HVR III sequences of anti-SORT1 antibodies

Ab(s)	I/V/R/H	SEQ ID NO:
S-60; S-60-10; S-60-11; S-60-12; S-60-13; S-60-14; S-60-15 [N33 (wt); [N33T]; S-60-15.2 [N33S]; S-60-15.3 [N33L]; S-60-15.4 [N33R]; S-60-15.5 [N33D]; S-60-15.6 [N33H]; S-60-15.7 [N33K]; S-60-15.8 [N33Q]; S-60-15.9 [N33V]; S-60-15.10 [N33E]; S-60-15.11 [N33I]; S-60-15.12 [N33T]; S-60-15.13 [N33L]; S-60-15.14 [N33V]; S-60-15.15 [N33M]; S-60-15.16 [N33M]; S-60-15.17 [N33L]; S-60-16; S- 60-18; S-60-19; S-60-24	YSISSGGYYWG	1

Table 17: Heavy chain HVR H2 sequences of anti-SORT1 antibodies

AluI	HVR II2	SEQ ID NO:
S-60; S-60-10; S-60-11; S-60-12; S-60-17 [N33 (wt)]; S-60-18; [N33T]; S-60-15.2 [N33S]; S-60-15.3 [N33G]; S-60-15.4 [N33K]; S-60-15.5 [N33Q]; S-60-15.6 [N33H]; S-60-15.7 [N32K]; S-60-15.8 [N33Q]; S-60-15.9 [N33V]; S-60-15.10 [N32E]; S-60-15.11 [N33W]; S-60-15.12 [N23P]; S-60-15.13 [N33I]; S-60-15.14 [N33V]; S-60-15.15 [N23A]; S-60-15.16 [N33M]; S-60-15.17 [N33H]; S-60-16; S-60-18; S-60-19; S-60-24	TYHSGSTVYNPSSL KS	2
S-60-13; S-60-14	TYHSGSTVYNPSSL ES	3
Formula i	TYHSGSTVYNPSSL XS X ₁ is K or E	4

Table 18: Heavy chain HVR B3 sequences of anti-SORT1 antibodies

Abj		RVR RJ	SEQ ID NO:
S-60-10; S-60-11; S-60-12; S-60-13; S-60-14; S-60-19		ARCGSQCGYGYGM DV	5
S-60; S-60-15 [N33] (x); S-60-15-1 [N33]; S-60-18-2 [N33]; S-60-15-3 [N33G]; S-60-15-4 [N33K]; S-60-15-5 [N33D]; S-60-15-6 [N33I]; S-60-15-7 [N33K]; S-60-15-8 [N33Q]; S-60-15-9 [N33Y]; S-60-15-10 [N33T]; S-60-15-11 [N33W]; S-60-15-12 [N32T]; S-60-15-13 [N33I]; S-60-15-14 [N33V]; S-60-15-16 [N33A]; S-60-15-15 [N33M]; S-60-15-17 [N33E]; S-60-16; S-60-18; S-60-21		ARCGSRQGGYGYGM DV	6
Formula II		ARGSIXQGYGYGM DV x DV y	7

Table 19: Light chain HVR L1 sequences of anti-SORT1 antibodies

Ab(t)	BVR LI	SEQ ID NO:
S-60-10; S-60-11; S-60-12; S-60-13; S-60-14; S-60-15 [N33 [wt]] S-60-16; S-60-18	RSSQSLLRSNGYNY LD	8
S-60-15.1 [N33T]	RSSQSLLRSTGYNYI D	9
S-60-15.2 [N33S]	RSSQSLLRSSGYNYL	10

Ab(s)	HYRLI	SEQ ID NO.
S-60-15.3 [N33G]	RSSQSLRSQGYNY LD	11
S-60-15.4 [N33R]	RSSQSILRSQGYNY LD	12
S-60-15.5 [N33D]	RSSQSLRLSDGYNY LD	13
S-60-15.6 [N33I]	RSSQSLRLSUGYNY LD	14
S-60-15.7 [N33K]	RSSQSLRLSKGYNY LD	15
S-60-15.8 [N33Q]	RSSQSLRLSQGYNY LD	16
S-60-15.9 [N33Y]	RSSQSLRLSYGYNY LD	17
S-60-15.10 [N33W]	RSSQSLRLSAGYNYL D	18
S-60-15.11 [N33V]	RSSQSLRLSWGYN LD	19
S-60-15.12 [N33P]	RSSQSLRLSPGYNYL D	20
S-60-15.13 [N33I]	RSSQSLRLSIGYNYL D	21
S-60-15.14 [N33V]	RSSQSLRLSVGYN LD	22
S-60-15.15 [N33A]	RSSQSLRLSAGYN	23

S-60-15.16 [N33M]	RSSQSLRLSMGYNY LD	24
S-60-15.17 [N33L]	RSSQSLRLSLGYNYL D	25
S-60, S-60-19	RSSQSLRLHNGYNY LD	26
S-60-24	RSSQGLRLSNGYNY LD	27
Formula III	RSSQX ₁ LLX ₂ XX ₃ GYN YLD X ₁ is S or G X ₂ is R or H X ₃ is N, T, S, G, R, D, H, K, Q, Y, E, W, F, I, V, A, M, or L	28

Table 20: Light chain HVRI.2 sequences of anti-SORT1 antibodies

Ab(s)	HVR L2	SEQ ID NO:
S-60, S-60-10, S-60-11, S-60-12, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15	LGSNRAS	29

Ab(s)	HVR L2	SEQ ID NO:
[N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24	LGSNRVS	30
Formula IV	LGSNRX ₁ S X ₁ is A or V	31

Table 21: Light chain HVRI.3 sequences of anti-SORT1 antibodies

Ab(s)	HVR L3	SEQ ID NO:
S-60-10, S-60-11, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-24	MQQQEAPLT	32
S-60, S-60-12, S-60-18, S-60-19	MQQQEPLT	33
Formula V	MQQQEX ₁ PLT X ₁ is A or T	34

Table 22: Heavy chain framework 1 sequences of anti-SORT1 antibodies

Ab(s)	VH FR1	SEQ ID NO:
S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24	QVQLQESGPGLVKP SETLSLTCAVSG	35

Table 23: Heavy chain framework 2 sequences of anti-SORT1 antibodies

Ab(s)	VH FR2	SEQ ID NO:
S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24	WIROPAGKGLEWIG	36

Table 24: Heavy chain framework 3 sequences of anti-SORT1 antibodies

Ab(s)	VH FR3	SEQ ID NO:
S-60-10, S-60-11, S-60-12, S-60-19	QVTVSDTSKNQFSL ELSSVTAADTAVVY C	37
S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24	RVTVSDTSKNQFSL KLSSVTAADTAVVY	38

Ab(s)	VH FR3	SEQ ID NO:
13.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-24	C	
Formula VI	X ₁ VTISVDTSKNQFS LX ₁ LSVTAADTAVVY YC X ₁ is Q or R X ₂ is E or K	39

Table 25: Heavy chain framework 4 sequences of anti-SORT1 antibodies

Ab(s)	VH FR4	SEQ ID NO:
S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24	WGQGTVTVVSS	40

Table 26: Light chain framework 1 sequences of anti-SORT1 antibodies

Ab(s)	VL FR1	SEQ ID NO:
S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33I], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24	DIVMTQSPISLPVTP GEFASISC	41
S-60-18	DIVMTQSPISLPVTP GGPASTSC	42
S-60-24	DIVMTQSPISLPVTP GESASISC	43
Formula VII	DIVMTQSPISLPVTP GX ₁ X ₂ ASISC X ₁ is E or G X ₂ is P or S	44

Table 27: Light chain framework 2 sequences of anti-SORT1 antibodies

Ab(s)	VL FR2	SEQ ID NO:
S-60-10, S-60-11, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7	WYLQPGQSPQLL	45

[N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33V], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16	Y	
--	---	--

Ab(s)	VL FR2	SEQ ID NO:
[N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24	WYIQKPGQPFQLLY	46
S-60-12	Y	
Formula VIII	WYIQKPGQX ₁ PQLLY Y X ₁ is S or P	47

Table 28: Light chain framework 3 sequences of anti-SORT1 antibodies

Ab(s)	VL FR3	SEQ ID NO:
S-60-19, S-60-13, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33V], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L]	GVPDRFSGSGSGTD FTLKISRVEAEDVGV YYC	48
S-60-11, S-60-17, S-60-14, S-60-19, S-60-24	GVPDRFSGSGSGTD FTLKISRVEAEDVGV YYC	49
S-60-16	GVPDRFSGSGSGTD FTLKISRVEAEDVGA YYC	50
S-60-18	GVPDRFSGSGSGTD FTLKISRVEAEDVGV YYC	51
Formula IX	GVPDRX ₁ SGSGSGTD FTLKISRVEAEDVGV X ₁ YYC X ₁ is F or L X ₂ is A or V X ₃ is V or A	52

Table 29: Light chain framework 4 sequences of anti-SORT1 antibodies

Ab(s)	VL FR4	SEQ ID NO:
S-60-10, S-60-11, S-60-12, S-60-13, S-60-14, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33V], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24	FGCGTKVEIK	53

Table 30: Heavy chain variable region sequences of anti-SORT1 antibodies

Ab(s)	HCVR	SEQ ID NO:
S-60-10, S-60-11, S-60-12, S-60-19	QVQLQESGPGLVKPSETLSLTCAVSG YSISGGYWGWIROPKGLFWIGTIY HSGSTYYNPSLKSQVTSVETSENQES	54

Ab(s)	HCVR	SEQ ID NO:
S-30-12, S-60-14	LELSSVTAADTAVYYCARQGSIQQGY YGMDEVWGQCTTVTVSS QVQLQESGPGLVKPSETLSLTCAVSG YSISGGYWGWIROPKGLFWIGTIY HSGSTYYNPSLKSQVTSVETSENQES LELSSVTAADTAVYYCARQGSIQQGY YGMDEVWGQCTTVTVSS	55
S-60, S-60-15 [N33 (wt)], S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33Y], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33F], S-60-15.13 [N33V], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-19, S-60-24	QVQLQESGPGLVKPSETLSLTCAVSG YSISGGYWGWIROPKGLFWIGTIY HSGSTYYNPSLKSQVTSVETSENQES LELSSVTAADTAVYYCARQGSIQQGY YGMDEVWGQCTTVTVSS	56

Table 31: Light chain variable region sequences of anti-SORT1 antibodies

Ab(s)	LCVR	SEQ ID NO:
S-60-10, S-60-13, S-60-15 [N33 (wt)]	DIVMTQSPFLSPVTGEPASISCRSSQS LLRSNGYNLDWYLOKPGQSPQLLIY LGSNRAAGVDRFSGSGSDFTLKIS RAEAEDVGYYCMQOQEAPLTFGGG TKVEIK	57
S-60-11, S-60-14	DIVMTQSPFLSPVTGEPASISCRSSQS LLRSNGYNLDWYLOKPGQSPQLLIY LGSNRAAGVDRFSGSGSDFTLKIS RVEAEDVGYYCMQOQEAPLTFGGG TKVEIK	58
S-60-12	DIVMTQSPFLSPVTGEPASISCRSSQS LLRSNGYNLDWYLOKPGQSPQLLIY LGSNRAAGVDRFSGSGSDFTLKIS RVEAEDVGYYCMQOQEAPLTFGGG TKVEIK	59
S-60-15.1 [N33T]	DIVMTQSPFLSPVTGEPASISCRSSQS LLRSNGYNLDWYLOKPGQSPQLLIY LGSNRAAGVDRFSGSGSDFTLKIS RAEAEDVGYYCMQOQEAPLTFGGG TKVEIK	60
S-60-15.2 [N33S]	DIVMTQSPFLSPVTGEPASISCRSSQS LLRSNGYNLDWYLOKPGQSPQLLIY LGSNRAAGVDRFSGSGSDFTLKIS RAEAEDVGYYCMQOQEAPLTFGGG TKVEIK	61
S-60-15.3 [N33G]	DIVMTQSPFLSPVTGEPASISCRSSQS LLRSNGYNLDWYLOKPGQSPQLLIY LGSNRAAGVDRFSGSGSDFTLKIS RAEAEDVGYYCMQOQEAPLTFGGG TKVEIK	62
S-60-15.4 [N33R]	DIVMTQSPFLSPVTGEPASISCRSSQS	63

Ab(s)	LCVR	SEQ ID NO:
S-60-15.5 [N33D]	DIVMTQSPFLSPVTGEPASISCRSSQS LLRSNGYNLDWYLOKPGQSPQLLIY LGSNRAAGVDRFSGSGSDFTLKIS RAEAEDVGYYCMQOQEAPLTFGGG TKVEIK	64
S-60-15.6 [N33H]	DIVMTQSPFLSPVTGEPASISCRSSQS LLRSNGYNLDWYLOKPGQSPQLLIY LGSNRAAGVDRFSGSGSDFTLKIS RAEAEDVGYYCMQOQEAPLTFGGG TKVEIK	65
S-60-15.7 [N33K]	DIVMTQSPFLSPVTGEPASISCRSSQS LLRSNGYNLDWYLOKPGQSPQLLIY	

	LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	66
S-60-15.8 [N59Q]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	67
S-60-15.9 [N35Y]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	68
S-60-15.10 [N35E]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	69
S-60-15.11 [N35W]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	70
S-60-15.12 [N35F]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	71
S-60-15.13 [N35I]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	72
S-60-15.14 [N35V]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS	73

Ab(s)	LCVR	SEQ ID NO:
S-60-15.15 [N35A]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	74
S-60-15.16 [N35M]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	75
S-60-15.17 [N35L]	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	76
S-60-16	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	77
S-60-18	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	78
S-60, S-60-19	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	79
S-60-24	DIVMTQSPSLPVTGEPASISCRSSOS LLRSYGYNLDWYLOKPGQSPQLLY LGSNRASGVDPDRFSGSGSGDTFTLKIS RAEADVGYYVCMQQQEAFLTFGGG TKVEIK	80

Table 22: Scitabin amino acid sequences

Description	Sequence	SEQ ID NO
Human Scitabin	90 100 110 120 130 140 150 160 170 180 190 200 RSPFNGADG LKIDNGALL LLLDGLPSS TDSQDLATP PTPPLPFRP 60 70 80 90 100 RPTLVNGL RAALNGASR RSGWRPSAE GDEEATVRV DNVNLLNNT 110 120 130 140 150 QNHVDDLS DYSLWVDS YGVLLVTE YVSLVINGE QSKLYSEPY 160 170 180 190 200 QNHFDLID LNVFIRLP QNATGPNAG KVVLTAEVSG GSPKATPS 210 220 230 240 250 DEFLKHPVOT LQPHILQW HSSQNSDEL DALSTENCAR VSKNFGKGE 260 270 280 290 300 KIRKAVCAAK NGSTNTTPT TVANGSNAD LGALPLWPS DQKSTYLLS	81

Description	Sequence	SEQ ID NO
Mouse Scitabin	310 320 330 340 350 RKLYQVSGS PFLNPNVAV ALTRKIRPS TPGQVWQRA QLPVQVQRP 360 370 380 390 400 VZILAFNIDN VTHNVDEGD TPGTITPDS RRGVYVRSQ TRPATTTGS 410 420 430 440 450 RSPFNVTSR RSVVTVSLS EWSIQPHIT PDNNGHPTL RPEKAKDA 460 470 480 490 500 TAKKHQESL IIRASYSLG KLVNMAPLS EPNVGVVLA RGSVDALEV 510 520 530 540 550 NVQVLLSDQ QDLSWVGLS QNYVTLDS GGLVALLRS RPLVIRPS 560 570 580 590 600 TEGQGVQVY TPTPLVYET GRASRRARD HRTISNGPTL DELTQNVQY 610 620 630 640 650 VTPNDLER NCERDVTIM LAHSDEEDV EDGILLGVK QPLRLRQSV 660 670 680 690 700 QNHQVYPT RQPIGLSL EPLQGRVY RPEVDSKTE QRLVGSLLP 710 720 730 740 750 PLVGRFPHL TIRGYKTPC KQCGGVVPP KVKDLKRC TSNLSPKQ 760 770 780 790 800 NEKNSVPII LAIVGLHVT VNVGLVLRK YVQVQRLVR RYVQLQHLE 810 820 830 ANGVGVVAD DPAHTRSG VHDNSRDLE R 840 850 860 870 880 890 900 RSPFNGADG LKIDNGALL LLLDGLPSS TDSQDLATP PTPPLPFRP 910 920 930 940 950 960 970 980 990 RPTLVNGL RAALNGASR RSGWRPSAE GDEEATVRV DNVNLLNNT 1000 1010 1020 1030 1040 1050 1060 1070 1080 1090 1100 QNHVDDLS DYSLWVDS YGVLLVTE YVSLVINGE QSKLYSEPY 1110 1120 1130 1140 1150 1160 1170 1180 1190 1200 QNHFDLID LNVFIRLP QNATGPNAG KVVLTAEVSG GSPKATPS 1210 1220 1230 1240 1250 1260 1270 1280 1290 1300 DEFLKHPVOT LQPHILQW HSSQNSDEL DALSTENCAR VSKNFGKGE 1310 1320 1330 1340 1350 1360 1370 1380 1390 1400 KIRKAVCAAK NGSTNTTPT TVANGSNAD LGALPLWPS DQKSTYLLS	82

[illegible]

Table 33: S-GG-15 peptide sequences

Description	Sequence	SEO ID NO
Asp-box motif	(S/T) - X - (D/N) - X - X - X - X - (S/T/Y) X is any amino acid	84
Asp-box motif	X - X - (S/T) - X - (D/N) - X - (S - Z - (Y/S) - (W/T/Z) - C X is any amino acid	85
Asp-box motif in human Sorcin (residue 200- 207)	3SDFAKH ²	86
S-60-15 Peptide	WQFLK	87
S-60-15 Peptide	GGYTDVVFQGETIVTQASAK	88
S-60-15 Peptide	DYTPRPVTVWNGGSGVSGVSTVQVQVSSVYSLSVYVQSSSLGK	89
S-60-15 Peptide	DTMILIR	90
S-60-15 Peptide	TPNVICVWVWQQLDVGVMHNVGVGVWYK	91
S-60-15 Peptide	VNVVLVLEWQLNGR	92
S-60-15 Peptide	EEQVITLDFQREHWK	92
S-60-15 Peptide	WVSLTCLAW	94
S-60-15 Peptide	LEFNSVAVFESMGGPNNYK	95
S-60-15 Peptide	WQGNFVSGVSMHAIKRYFCK	96
S-60-15 Peptide	DLQVQVTSVPTVGTQASISGR	97
S-60-15 Peptide	GGSLIR	98
S-60-15 Peptide	GGVNVLLVSLKNGQSGQSLVLSGND	99
S-60-15 Peptide	ASPDVGVVYCMGGQVSLFQGGCK	100
S-60-15 Peptide	SGSLVVLGILPYR	101
S-60-15 Peptide	VHNGSGHSLVSGGR	102

Table 34: Fe domain amino acid sequences

Description	Sequence	SEO ID NO
bulG	ASTKQPSVFPLAPSSKSLGGLAALGLKLYDKVPPEPTVTVSWNSGALTSGVHTFPAVLQSGSYLSASSVTPVSSSLQGTQYKCDMLHPDSKITK	193
LALAPS	DEKVFEPKSCDKTKCPNCPKAAAGGSPVLEPKPKDNLNLSNPTVETCTVYVDVSDHEPVEFNVYVDGVEVHNAKTPREEQYNSYTRYVSLVTHODMLNGKEYKCKCKSNKALPSIKETSKAGQDPRDQV	

Description	Sequence	SEQ ID NO
	YTLPPSRDELTKNQVSLTCLVKGFYPSD.AVEWESNGGFENNYKFT PPVLDSQGFPLYSKLTKSRWQQGNVFSVVMHEALHNHYTQK SLSLSPGK	
halGf	ASTSGVSVFLAPSSKTSQGTAAQLGCLVKDYFPEPVTVSWNSGALT SGVTHPAAVLDSQGLYFSESVTLTPSSSLGLTCTHWGKQVFLP DKTEVPSKQDTHITPCCPAAAGGPSVFLAPKPKQYTIMISIRPE YRKYVDVSDHEPPEVGVYDGVVHNAAKPKREQYNTSTYRV VSVLTVLHQDWLNKGEYKGRVSNALPASIKETISKAKGGPREPV YTLPPSRDELTKNQVSLTCLVKGFYPSD.AVEWESNGGFENNYKFT PPVLDSQGFPLYSKLTKSRWQQGNVFSVVMHEALHNHYTQK SLSLSPGK	104

Table 35: Full-length heavy chain amino acid sequences

Description	Sequence	SEQ ID NO
S-60-10, S-60-11, S-60-12, S-60-19 with Fe LALAPS with C-terminal Lysine	QYQLQPSGPGLEWGFHTSIETSLCAVSGYSSGYYWGW IRQPPGKGLVIGFTYHISGTYVNSPLSKSVTYSVDS KNQPSLELSSVAADTAVYVCARQSGIQQGYGMGV WGGQGTVTSSASTKGPSVPLAPSSKTSGGTAAAG CLVKDYFPPEPVTVSWNSGALTSGVHTFPAVLQSSGL YLSSSVTVPPSSLTGTQTYCINNVNHPKNTVDKKVPE KSCDKTHTCPCPAPEAAAGQSVFLEPKPKDILMSR PEVCVTVVDVPSHLEDFEVRKVVYVDGVEVFNAKTK PREQGNSTYRVNSVLTVTHQWDVNGKREYKCKVNS RALPASKEKSKAGQPREQFYVTLTPEPSDELTKNON SLTCLVGFQYPSDIAVEWESNCPQENNVKTPPLVLS DGSFPLYSKLTVDKSRWQQGNVEYSCSVYMHEALHNH YTQKSLSLSPG	103
S-60-10, S-60-11, S-60-12, S-60-19 with Fe LALAPS without C-terminal Lysine	QYQLQESPGGLVKEPSETLSLTCVAVSGYSSGYYWGW IRQPPGKGLVIGFTYHISGTYVNSPLSKSVTYSVDS KNQPSLELSSVAADTAVYVCARQSGIQQGYGMGV WGGQGTVTSSASTKGPSVPLAPSSKTSGGTAAAG CLVKDYFPPEPVTVSWNSGALTSGVHTFPAVLQSSGL YLSSSVTVPPSSLTGTQTYCINNVNHPNTYVDKKVPE KSCDKTHTCPCPAPEAAAGQSVFLEPKPKDILMSR PEVCVTVVDVPSHLEDFEVRKVVYVDGVEVFNAKTK PREQGNSTYRVNSVLTVTHQWDVNGKREYKCKVNS RALPASKEKSKAGQPREQFYVTLTPEPSDELTKNON SLTCLVGFQYPSDIAVEWESNCPQENNVKTPPLVLS DGSFPLYSKLTVDKSRWQQGNVEYSCSVYMHEALHNH YTQKSLSLSPG	106
S-60-13, S-60-14 with Fe LALAPS with C-terminal Lysine	QYQLQESPGLEWGFHTSIETSLCAVSGYSSGYYWGW IRQPPGKGLVIGFTYHISGTYVNSPLSKSVTYSVDSK NQPSLELSSVAADTAVYVCARQSGIQQGYGMGV WGGQGTVTSSASTKGPSVPLAPSSKTSGGTAAAG CLVKDYFPPEPVTVSWNSGALTSGVHTFPAVLQSSGL YLSSSVTVPPSSLTGTQTYCINNVNHPKNTVDKKVPE KSCDKTHTCPCPAPEAAAGQSVFLEPKPKDILMSR PEVCVTVVDVPSHLEDFEVRKVVYVDGVEVFNAKTK PREQGNSTYRVNSVLTVTHQWDVNGKREYKCKVNS RALPASKEKSKAGQPREQFYVTLTPEPSDELTKNON SLTCLVGFQYPSDIAVEWESNCPQENNVKTPPLVLS DGSFPLYSKLTVDKSRWQQGNVEYSCSVYMHEALHNH YTQKSLSLSPG	105

Description	Sequence	SEQ ID NO
	TPETCTCVVDVSHEDPEVKFWYVDGVEVFNATK	

	PREBOYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPASEKTISKAKGQPREFOVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTTPVLDSDGSEFLYSLKLTVDKSRWQQGNVSCFVSMHEALHNHYTQKSLSLSPGK	
S-60-13, S-60-14 with Fe 1 A1APS without C-terminal Lysine	QVQLQESGPGLVKPSETLSLTCAVSGYSISSGYVWGWIRQPPGKGLEWIGITVYHSGSTYNNPSLRSVTSNDTSKNQFSLKLSVTAADTAVVYCARQGSIKQQGYGMDVWVGQGTITVTSSASTKGPSVPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVTVPSSSLGTQTYICNVNHPKPSNTKVDKKVEPKSCDKTHICPKPAPEAAGGPSVFLPPPKFDLTLMISRTEPVTCVVDVSHEDPEVKFNWYVDGVEVHNAKTRPREBOYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPASEKTISKAKGQPREFOVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTTPVLDSDGSEFLYSLKLTVDKSRWQQGNVSCFVSMHEALHNHYTQKSLSLSPGK	136
S-60, S-60-15 [N33] (wt), S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33P], S-60-15.13 [N33M], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-24 with Fe 1A1APS with C-terminal Lysine	QVQLQESGPGLVKPSETLSLTCAVSGYSISSGYVWGWIRQPPGKGLEWIGITVYHSGSTYNNPSLRSVTSNDTSKNQFSLKLSVTAADTAVVYCARQGSIKQQGYGMDVWVGQGTITVTSSASTKGPSVPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVTVPSSSLGTQTYICNVNHPKPSNTKVDKKVEPKSCDKTHICPKPAPEAAGGPSVFLPPPKFDLTLMISRTEPVTCVVDVSHEDPEVKFNWYVDGVEVHNAKTRPREBOYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPASEKTISKAKGQPREFOVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTTPVLDSDGSEFLYSLKLTVDKSRWQQGNVSCFVSMHEALHNHYTQKSLSLSPGK	137
S-60, S-60-15 [N33] (wt), S-60-15.1 [N33T], S-60-15.2 [N33S], S-60-15.3 [N33G], S-60-15.4 [N33R], S-60-15.5 [N33D], S-60-15.6 [N33H], S-60-15.7 [N33K], S-60-15.8 [N33Q], S-60-15.9 [N33V], S-60-15.10 [N33E], S-60-15.11 [N33W], S-60-15.12 [N33P], S-60-15.13 [N33M], S-60-15.14 [N33V], S-60-15.15 [N33A], S-60-15.16 [N33M], S-60-15.17 [N33L], S-60-16, S-60-18, S-60-24	QVQLQESGPGLVKPSETLSLTCAVSGYSISSGYVWGWIRQPPGKGLEWIGITVYHSGSTYNNPSLRSVTSNDTSKNQFSLKLSVTAADTAVVYCARQGSIKQQGYGMDVWVGQGTITVTSSASTKGPSVPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSVTVPSSSLGTQTYICNVNHPKPSNTKVDKKVEPKSCDKTHICPKPAPEAAGGPSVFLPPPKFDLTLMISRTEPVTCVVDVSHEDPEVKFNWYVDGVEVHNAKTRPREBOYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPASEKTISKAKGQPREFOVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTTPVLDSDGSEFLYSLKLTVDKSRWQQGNVSCFVSMHEALHNHYTQKSLSLSPGK	138

Description	Sequence	SEQ ID NO
with Fe 1A1APS without C-terminal Lysine		

Table 36: Full-length light chain amino acid sequences

Description	Sequence	SEQ ID NO
S-60-10; S-60-13; S-60-15 [N33] (wt)	DIYMTQSPPLSPVTTPGEPASISCRSSQSLRSNGYNVLDWVYLOKPGQSPQLLYLGSRNRSAGVPDRFSGSGSGTDFTLKISRVEAEDVGVVYCMQOQEAAPLTGGGTRKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITSLSTLTLSKADYERHKVYACEVTHQGLSSPVTKSFNRGEC	139
S-60-11; S-60-14	DIYMTQSPPLSPVTTPGEPASISCRSSQSLRSNGYNVLDWVYLOKPGQSPQLLYLGSRNRSAGVPDRFSGSGSGTDFTLKISRVEAEDVGVVYCMQOQEAAPLTGGGTRKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITSLSTLTLSKADYERHKVYACEVTHQGLSSPVTKSFNRGEC	140
S-60-12	DIYMTQSPPLSPVTTPGEPASISCRSSQSLRSNGYNVLDWVYLOKPGQSPQLLYLGSRNRSAGVPDRFSGSGSGTDFTLKISRVEAEDVGVVYCMQOQEAAPLTGGGTRKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITSLSTLTLSKADYERHKVYACEVTHQGLSSPVTKSFNRGEC	141
S-60-15.1 [N33T]	DIYMTQSPPLSPVTTPGEPASISCRSSQSLRSNGYNVLDWVYLOKPGQSPQLLYLGSRNRSAGVPDRFSGSGSGTDFTLKISRVEAEDVGVVYCMQOQEAAPLTGGGTRKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITSLSTLTLSKADYERHKVYACEVTHQGLSSPVTKSFNRGEC	142

Description	Sequence	SEQ ID NO
S-60-15.2 [N33S]	DIYMTQSPPLSPVTTPGEPASISCRSSQSLRSNGYNVLDWVYLOKPGQSPQLLYLGSRNRSAGVPDRFSGSGSGTDFTLKISRVEAEDVGVVYCMQOQEAAPLTGGGTRKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITSLSTLTLSKADYERHKVYACEVTHQGLSSPVTKSFNRGEC	143
S-60-15.3 [N33G]	DIYMTQSPPLSPVTTPGEPASISCRSSQSLRSNGYNVLDWVYLOKPGQSPQLLYLGSRNRSAGVPDRFSGSGSGTDFTLKISRVEAEDVGVVYCMQOQEAAPLTGGGTRKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITSLSTLTLSKADYERHKVYACEVTHQGLSSPVTKSFNRGEC	144

S-60-15.4 [N33R]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	145
S-60-15.5 [N33D]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	146
S-60-15.6 [N33I]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK	119

Description	Sequence	SEQ ID NO
	ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	
S-60-15.7 [N33K]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	120
S-60-15.8 [N33Q]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	121
S-60-15.9 [N33Y]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	122
S-60-15.10 [N33E]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	123
S-60-15.11 [N33W]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE	124

Description	Sequence	SEQ ID NO
	AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	
S-60-15.12 [N33F]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	125
S-60-15.13 [N33I]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYLQ KPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	126
S-60-15.14 [N33V]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIPEPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSITYSLSTLTLSK ADYEKHKVYACEVTHQGLSS PVTKEFNRGEC	127
S-60-15.15 [N33A]	DIVMTQSPSLPVTGPEPASIS CRSSQSLRSRGYNVLDWYL QKPCQSPQLLYLGSNRASGV PDRFSGSGGTDFTLKISRAEA	

	EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSYSTLSSTLTLSK ADYERHKVYACEVTHQGLSS PVTLSFNRGEC	128
S-60-15.16 [N33M]	DIVMTQSPFLSPVTPGEPASIS CRSSQSLRLSNGVNYLDWYL QKPGQSPQLLYLGSNRASGV PDRFSGSGSGTDFTLKISRVEA EDVGVVYCMQQQEAPLTFGG	129

Description	Sequence	SEQ ID NO
	GTKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSYSTLSSTLTLSK ADYERHKVYACEVTHQGLSS PVTLSFNRGEC	
S-60-15.17 [N33L]	DIVMTQSPFLSPVTPGEPASIS CRSSQSLRLSNGVNYLDWYL QKPGQSPQLLYLGSNRASGV PDRFSGSGSGTDFTLKISRVEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSYSTLSSTLTLSK ADYERHKVYACEVTHQGLSS PVTLSFNRGEC	130
S-60-16	DIVMTQSPFLSPVTPGEPASIS CRSSQSLRLSNGVNYLDWYL QKPGQSPQLLYLGSNRASGV PDRFSGSGSGTDFTLKISRVEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSYSTLSSTLTLSK ADYERHKVYACEVTHQGLSS PVTLSFNRGEC	131
S-60-18	DIVMTQSPFLSPVTPGEPASIS CRSSQSLRLSNGVNYLDWYL QKPGQSPQLLYLGSNRASGV PDRFSGSGSGTDFTLKISRVEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSYSTLSSTLTLSK ADYERHKVYACEVTHQGLSS PVTLSFNRGEC	132
S-60, S-60-19	DIVMTQSPFLSPVTPGEPASIS CRSSQSLRLSNGVNYLDWYL QKPGQSPQLLYLGSNRASGV PDRFSGSGSGTDFTLKISRVEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSYSTLSSTLTLSK ADYERHKVYACEVTHQGLSS PVTLSFNRGEC	133
S-60-24	DIVMTQSPFLSPVTPGEPASIS CRSSQSLRLSNGVNYLDWYL QKPGQSPQLLYLGSNRASGV	134

Description	Sequence	SEQ ID NO
	PDRFSGSGSGTDFTLKISRVEA EDVGVVYCMQQQEAPLTFGG GTKVEIKRTVAAPSVFIFPPSD EQLKSGTASVVCLLNNFYPRE AKVQWKVDNALQSGNSQES VTEQDSKDSYSTLSSTLTLSK ADYERHKVYACEVTHQGLSS PVTLSFNRGEC	

REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO2016164637A [0010] [0080] [0146] [0128] [0129] [0129] [0130] [0131] [0131] [0131] [0131] [0131] [0131] [0132] [0132] [0133] [0466] [0468] [0469] [0478]
- WO2017093327A [0018]
- WO2016164608A [0010]
- US5641870A [0047]
- WO9316135A [0283]
- US5571864A [0293]
- US5387468A [0283]
- US5690469A [0283]
- EP040497A [0284]
- WO199301151A [0294]
- US6248518B [0294]
- US4816667A [0297] [0372]
- US5530101A [0289]
- US5693751A [0289]
- US5893762A [0289]
- US5585089A [0289]
- US5786886A [0289]

- US5889619A [0288]
- US5821317A [0289]
- US7527791B [0290]
- US682321E [0291]
- US7087409B [0292]
- US646807A [0301]
- EP546073A [0301] [0301]
- US6275181A [0301]
- US6150684A [0301]
- US770429A [0301]
- US7041870B [0301]
- US2007008190A [0301]
- US7182425E [0302]
- US5750373A [0303]
- US2007029293A [0303]
- US2009032380A [0303]
- WO199711971A [0308]
- WO2007106586A [0308]
- WO20080572A [0310]
- US6732277A [0311]
- WO2008229A [0318]
- US5731102A [0319]
- WO2010026834 [0318]
- WO2009019004A1 [0318]
- US4876980A [0318]
- US2006022578A [0318]
- US200909220A [0318]
- US20090157105A [0337] [0337] [0337]
- US2004003661A [0337] [0337]
- US20030115614A [0337]
- US20020164328A [0337]
- US20040132140A [0337]
- US20040110704A [0337]
- US20040110282A [0337]
- US2004010885A [0337]
- US20070148167A [0344]
- WO2008073248A [0345] [0345]
- US4840835A [0357]
- US4196889A [0357]
- US4301144A [0357]
- US4870417A [0357]
- US4791120A [0357]
- US417937A [0357]
- US43426A [0358]
- US5648237A [0378]
- US6782192A [0378]
- US5840823A [0378]
- US5859177A [0379]
- US20040488A [0378]
- US420548E [0378]
- US7125978E [0378]
- US417429E [0378]

Non-patent literature cited in the description

- NYKJAER, A et al. Trends Neurosci, 2012, vol. 35, 261-270 [0002] [0002] [0525]
- ZHENG, Y et al. PLoS One, 2011, vol. 6, 21023- [0002]
- WILLNOW, TE et al. Curr Opin Lipidol, 2011, vol. 22, 79-85 [0002] [0008]
- HU, F et al. Neuron, 2010, vol. 68, 654-667 [0002] [0005]
- CARRASQUILLO, M.M et al. Am J Hum Genet, 2010, vol. 87, 890-897 [0002]
- LEE, W.C et al. Hum Mol Genet, 2014, vol. 23, 1467-1478 [0002]
- CARRASQUILLO MM Am J Hum Genet., 2010, vol. 87, 6890-7 [0002]
- NGUYEN DA et al. Trends in Endocrinology and Metabolism, 2013, vol. 24, 597-606 [0004]
- BAKER, M et al. Nature, 2006, vol. 442, 916-919 [0004]
- CARECCHIO M et al. J Alzheimers Dis, 2011, vol. 27, 781-790 [0004]
- CRUTS, M et al. Trends Genet, 2008, vol. 24, 186-194 [0004]
- GALIMBERTI, D et al. J Alzheimers Dis, 2010, vol. 19, 171-177 [0004]
- SEELAAR, H et al. Journal of neurology, neurosurgery, and psychiatry, 2011, vol. 82, 476-486 [0004]
- TAO, J et al. Brain Res, 2012, vol. 1436, 130-136 [0004]
- EGASHIRA, Y. et al. J Neuroinflammation, 2013, vol. 10, 105- [0004]
- VAN KAMPEN, J.M et al. PLoS One, 2014, vol. 9, e97032- [0004]
- LAIRD, A.S et al. PLoS One, 2010, vol. 5, ex13368- [0004]
- TANG, W et al. Science, 2011, vol. 332, 478-484 [0004]
- MINAMI, S.S et al. Nat Med, 2014, vol. 20, 1157-1164 [0004]
- WILLNOW, TE et al. Nat Rev Neurosci, 2008, vol. 9, 899-909 [0005]
- NYKJAER, A et al. Trends Neurosci, vol. 35, 261-270 [0005]
- NYKJAER, A et al. Nature, 2004, vol. 427, 843-848 [0005]
- HIROKO YANO et al. J Neurosci., 2009, vol. 29, 14790-14802 [0005]
- TENG U.K. et al. J. Neurosci., 2005, vol. 25, 5455-5463 [0005]
- SKELDAL S et al. J Biol Chem, 2012, vol. 287, 43798- [0005]
- QUISTGAARD, EM et al. Nat Struct Mol Biol, 2009, vol. 16, 96-98 [0005]
- ZHENG, Y et al. PLoS One, vol. 6, e21023- [0005]

- VAEGTER, CB et al. *Nat. Neurosci.*, 2011, vol. 14, 54-61 [\[0005\]](#)
- GUSTAFSEN C et al. *J. Neurosci.*, 2013, vol. 33, 164-71 [\[0005\]](#)
- KJOLB, M et al. *Cell Metab.*, 2010, vol. 12, 213-223 [\[0005\]](#)
- NILSSON, SK et al. *Biochemistry*, 2007, vol. 46, 3896-3904 [\[0005\]](#)
- NILSSON, SK et al. *J. Biol. Chem.*, 2008, vol. 283, 25920-25927 [\[0008\]](#)
- KLINGER, SC et al. *J. Cell Sci.*, 2011, vol. 124, 1095-1105 [\[0005\]](#)
- GUSTAFSEN, C et al. *J. Neurosci.*, 2013, vol. 33, 64-71 [\[0008\]](#)
- GUSTAFSEN, C et al. *J. Neurosci.*, 2013, vol. 33, 64-71 [\[0005\]](#)
- FINAN, GM et al. *J. Biol. Chem.*, vol. 286, 12602-12610 [\[0008\]](#)
- CARLO, AS et al. *J. Neurosci.*, 2013, vol. 33, 358-370 [\[0005\]](#)
- GUSTAFSEN et al. *Cell Metab.*, 2014, vol. 19, 310-318 [\[0008\]](#)
- GUSTAFSEN C et al. *Cell Metab.*, 2014, vol. 19, 2310-8 [\[0008\]](#)
- Basic and Clinical Immunology Appleton & Lange 1994 000071- [\[0005\]](#)
- ABBAS et al. *Cellular and Molecular Immunology* W.B. Saunders Co. 2000 0000 [\[0005\]](#)
- KABAT et al. *Sequences of Immunological Interest* National Institute of Health 1991 0000 [\[0005\]](#)
- ZAPATA et al. *Protein Eng.*, 1995, vol. 8, 101057-1062 [\[0007\]](#)
- PLUCKTHUN *The Pharmacology of Monoclonal Antibodies* Springer-Verlag 1994 0000 vol. 113, 269-315 [\[0005\]](#)
- CHOTHIA LESKJ. *Mol. Biol.*, 1987, vol. 196, 901-917 [\[0005\]](#)
- KABAT et al. *Sequences of Proteins of Immunological Interest* Public Health Service, National Institutes of Health 1991 0000 [\[0005\]](#)
- MARKS et al. *Bio/Technology*, 1992, vol. 10, 779-783 [\[0005\]](#)
- BARBAS et al. *Proc. Natl. Acad. Sci. USA*, 1994, vol. 91, 3809-3813 [\[0005\]](#)
- SCHIER et al. *Gene*, 1995, vol. 169, 147-155 [\[0005\]](#)
- YELTON et al. *J. Immunol.*, 1995, vol. 155, 1994-2004 [\[0005\]](#)
- JACKSON et al. *J. Immunol.*, 1995, vol. 154, 73310-9 [\[0005\]](#)
- HAWKINS et al. *J. Mol. Biol.*, 1992, vol. 226, 889-896 [\[0005\]](#)
- HARLOW LANE *Antibodies, A Laboratory Manual* Cold Spring Harbor Publications 1988 0000 [\[0005\]](#)
- ZHENG, Y et al. *PLoS ONE*, 2011, vol. 6, 6e21023- [\[0005\]](#)
- Epitope Mapping Protocols MORRIS *Methods in Molecular Biology* Humana Press 1996 0000 vol. 66, [\[0005\]](#) [\[0005\]](#)
- HARLOW LANE *Antibodies: A Laboratory Manual* Cold Spring Harbor Laboratory 1988 0000 [\[0005\]](#) [\[0005\]](#)
- HUDSON et al. *Nat. Med.*, 2003, vol. 9, 129-134 [\[0005\]](#) [\[0005\]](#) [\[0005\]](#)
- ALMAGRO et al. *Front. Biosci.*, 2008, vol. 13, 161 9-1633 [\[0005\]](#)
- SIMS et al. *J. Immunol.*, 1993, vol. 151, 2296- [\[0005\]](#)
- CARTER et al. *Proc. Natl. Acad. Sci. USA*, 1992, vol. 89, 4285- [\[0005\]](#)
- PRESTA et al. *J. Immunol.*, 1993, vol. 151, 2623- [\[0005\]](#)
- ALMAGRO FRANSSON *Front. Biosci.*, 2008, vol. 13, 1619-1633 [\[0005\]](#)
- BACA et al. *J. Biol. Chem.*, 1997, vol. 272, 10678-10684 [\[0005\]](#)
- ROSOK et al. *J. Biol. Chem.*, 1996, vol. 271, 22611-22618 [\[0005\]](#)
- VAN DIJK et al. *Curr. Opin. Pharmacol.*, 2001, vol. 5, 368-74 [\[0005\]](#)
- LONBERG *Curr. Opin. Immunol.*, 2008, vol. 20, 450-459 [\[0005\]](#)
- OZBORJ. *Immunol.*, 1984, vol. 133, 3001- [\[0005\]](#)
- BOEMER et al. *J. Immunol.*, 1991, vol. 147, 86- [\[0005\]](#)
- LI et al. *Proc. Natl. Acad. Sci. USA*, 2006, vol. 1, 033557-3562 [\[0005\]](#)
- VOLLMEERS et al. *Histology and Histopathology*, 2005, vol. 20, 3927-937 [\[0005\]](#)
- VOLLMEERS et al. *Methods and Findings in Experimental and Clinical Pharmacology*, 2005, vol. 27, 3185-91 [\[0005\]](#)
- WINTER et al. *Ann. Rev. Immunol.*, 1994, vol. 12, 433-455 [\[0005\]](#)
- SIDHU et al. *J. Mol. Biol.*, 2004, vol. 338, 2299-310 [\[0005\]](#)
- LEE et al. *J. Mol. Biol.*, 2004, vol. 340, 51073-1093 [\[0005\]](#)
- FELLOUSE *Proc. Natl. Acad. Sci. USA*, 2004, vol. 101, 3412467-12472 [\[0005\]](#)
- LEE et al. *J. Immunol. Methods*, 2004, vol. 284, 21-19132- [\[0005\]](#)
- GRIFFITHS et al. *EMBO J.*, 1993, vol. 12, 725-734 [\[0005\]](#)
- HOOGENBOOM et al. *J. Mol. Biol.*, 1992, vol. 227, 381-388 [\[0005\]](#)
- ARMOUR et al. *Molecular Immunology*, 2003, vol. 40, 585-593 [\[0005\]](#)
- REDDY et al. *J. Immunology*, 2000, vol. 164, 1925-1933 [\[0005\]](#)
- GABATHULER R. *Neurobiol. Dis.*, 2010, vol. 37, 48-57 [\[0005\]](#)
- DANEMAN et al. *PLoS One*, 2010, vol. 5, 10e13741- [\[0005\]](#)
- MILSTEIN CUELLO *Nature*, 1983, vol. 305, 537- [\[0005\]](#)
- TRAUNCKER et al. *EMBO J.*, 1991, vol. 10, 3655- [\[0005\]](#)
- HOLLINGER et al. *Proc. Natl. Acad. Sci. USA*, 1993, vol. 90, 6444-6448 [\[0005\]](#)
- GRUBER et al. *J. Immunol.*, 1994, 5368- [\[0005\]](#)
- TUTT et al. *J. Immunol.*, 1991, vol. 147, 60- [\[0005\]](#)
- KYTE et al. *J. Mol. Biol.*, 1982, vol. 157, 105-131 [\[0005\]](#)
- OKAZAKI et al. *J. Mol. Biol.*, 2004, vol. 336, 1239-1249 [\[0005\]](#)
- YAMANE-OHNUKI et al. *Biotech. Bioeng.*, 2004, vol. 87, 614- [\[0005\]](#) [\[0005\]](#)
- RIPKA et al. *Arch. Biochem. Biophys.*, 1986, vol. 249, 533-545 [\[0005\]](#)
- KANDA et al. *Biotechnol. Bioeng.*, 2006, vol. 94, 4680-688 [\[0005\]](#)
- BOLT S et al. *Eur. J. Immunol.*, 1993, vol. 23, 403-411 [\[0005\]](#)
- SHIELDS et al. *R. J. Biol. Chem.*, 2001, vol. 276, 6591-66 [\[0005\]](#)
- HUTCHINS et al. *Proc. Natl. Acad. Sci. USA*, 1995, vol. 92, 11980-11984 [\[0005\]](#)
- ALEGRE et al. *Transplantation*, 1994, vol. 57, 1537-1543 [\[0005\]](#) [\[0005\]](#)
- XU et al. *Cell Immunol.*, 2000, vol. 200, 16-26 [\[0005\]](#) [\[0005\]](#) [\[0005\]](#)
- ALEGRE et al. *Transplantation*, 1994, vol. 57, 1534-1543 [\[0005\]](#)
- MCEARCHEM et al. *Blood*, 2007, vol. 109, 1185-1192 [\[0005\]](#)
- SAZINSKY et al. *Proc. Natl. Acad. Sci. USA*, 2008, vol. 105, 20167-20172 [\[0005\]](#)
- LAZAR et al. *Proc. Natl. Acad. Sci. USA*, 2006, vol. 103, 4005-4010 [\[0005\]](#)
- SAZINSKY et al. *Proc. Natl. Acad. Sci. USA*, 2008, vol. 105, 20167-20172 [\[0005\]](#)
- WILSON et al. *Cancer Cell*, 2011, vol. 19, 101-113 [\[0005\]](#)
- ARMOUR *Immunology*, 2003, vol. 40, 585-593 [\[0005\]](#)
- WHITE et al. *Cancer Cell*, 2015, vol. 27, 138-148 [\[0005\]](#) [\[0005\]](#) [\[0005\]](#) [\[0005\]](#) [\[0005\]](#)
- COLE et al. *Transplantation*, 1999, vol. 68, 563-571 [\[0005\]](#)
- ARMOUR et al. *Eur. J. Immunol.*, 1999, vol. 29, 2613-2624 [\[0005\]](#)
- ARMOUR et al. *The Haematology Journal*, 2000, vol. 1, 127- [\[0005\]](#) [\[0005\]](#)
- CHU et al. *Mol. Immunol.*, 2008, vol. 45, 3926-3933 [\[0005\]](#)
- LIGHTLE et al. *Protein Sci.*, 2010, vol. 19, 753-762 [\[0005\]](#) [\[0005\]](#)
- REDDY et al. *J. Immunol.*, 2000, vol. 164, 1925-1933 [\[0005\]](#)
- ANGAL et al. *Mol. Immunol.*, 1993, vol. 30, 105-108 [\[0005\]](#)
- PETERS et al. *J. Biol. Chem.*, 2012, vol. 287, 2924525-33 [\[0005\]](#)

- FAUCHEREJ. Adv. Drug Res., 1986, vol. 15, 29- [\[0358\]](#)
- EVANS et al.J. Med. Chem., 1987, vol. 30, 1229- [\[0333\]](#)
- RIZOGIERASCHAnn. Rev. Biochem., 1992, vol. 61, 387- [\[0358\]](#)
- Jane de Lartigue One Live, 2012, [\[0360\]](#)
- DUCRY et al.Bioconjugate Chemistry, 2010, vol. 21, 15-13 [\[0360\]](#)
- FRANK, ROVERWIN, HMethods. Mol. Biol., 1996, vol. 66, 149-169 [\[0364\]](#)
- REINEKE, U et al.J. Immunol. Methods, 2002, vol. 267, 13-26 [\[0364\]](#)
- ANDERSEN, OS et al.J. Biological Chemistry, 2010, vol. 285, 12210-12222 [\[0364\]](#)
- SKELDAL, S et al.J Biol Chem., 2012, vol. 287, 43798- [\[0385\]](#)
- ANDERSEN, OS et al.The Journal Of Biological Chemistry, 2010, vol. 285, 12210-12222 [\[0365\]](#) [\[0365\]](#) [\[0365\]](#)
- GUSTAFSEN, C et al.The Journal of Neuroscience, 2013, vol. 33, 64-71 [\[0385\]](#)
- Gerngross Nat. Biotech., 2004, vol. 22, 1409-1414 [\[0377\]](#)
- LI et al.Nat. Biotech., 2006, vol. 24, 210-215 [\[0377\]](#)
- GRAHAM et al.J. Gen Virol., 1977, vol. 36, 59- [\[0379\]](#)
- MATHERBiol. Reprod., 1980, vol. 23, 243-251 [\[0378\]](#)
- MATHER et al.Annals N. Y Acad. Sci., 1982, vol. 383, 44-68 [\[0379\]](#)
- URLAUB et al.Proc. Natl. Acad. Sci. USA, 1980, vol. 77, 4216- [\[0378\]](#)
- YAZAKIWUMethods in Molecular BiologyHumana Press20030000vol. 248, 255-268 [\[0378\]](#)
- Remington: The Science and Practice of PharmacyPharmaceutical Press20130000 [\[0382\]](#)
- LANGERScience, 1990, vol. 249, 1527-1533 [\[0382\]](#)
- CRUTS, M.VAN BROECKHOVEN, C.Trends Genet., 2008, vol. 24, 186-194 [\[0408\]](#)
- NEARY, D. et al., Neurology, 1998, vol. 51, 1546-1554 [\[0408\]](#)
- RATNAVALI, E.BRAYNE, C.DAWSON, K.HODGES, J. RNeurology, 2002, vol. 58, 1615-1621 [\[0409\]](#)
- HUTTON, M. et al.Nature, 1998, vol. 393, 702-705 [\[0410\]](#)
- NEUMANN, M. et al.. Arch. Neurol, 2007, vol. 64, 1388-1394 [\[0410\]](#)
- SLEEGERS et al.Ann Neurol, 2009, vol. 65, 603- [\[0437\]](#)
- SMITH et al.Am J Hum Genet, 2012, vol. 90, 1102- [\[0437\]](#)
- LAGIER-TOURENNE et al.Cell, 2009, vol. 136, 1001- [\[0438\]](#)
- PRASAD et al.Front Mol Neurosci, 2019, vol. 12, 25- [\[0438\]](#)
- KARCH et al.JAMA Neurol, 2018, vol. 75, 860- [\[0438\]](#)
- HAUKEDAL et al.J Mol Biol, 2019, vol. 431, 1818- [\[0438\]](#)
- WEISHAUPPT et al.Trends Mol Med, 2016, vol. 22, 769- [\[0438\]](#)
- MCCAULEY et al.Acta Neuropathol, 2018, vol. 137, 715- [\[0438\]](#)
- CHAO et al.Nature Protocols, 2006, [\[0474\]](#)
- JEFFERIS RLEFRANC M-PMabs, 2009, vol. 1, 4332-338 [\[0501\]](#)
- PESTALOZZI et al.J Clin Oncol, 2000, vol. 18, 112349-51 [\[0522\]](#)
- PETERBIT et al.Mult Scler, 2009, vol. 15, 2189-92 [\[0522\]](#)

P a t e n t k r a v

5 **1.** Antistof, der binder til et humant Sortilin-protein, hvor antistoffet omfatter en tungkæde-variabel region omfattende aminosyresekvensen med SEQ ID NO: 56 og en letkæde-variabel region omfattende aminosyresekvensen med SEQ ID NO: 60.

10 **2.** Antistof, der binder til et humant Sortilin-protein, hvor antistoffet omfatter en tungkæde-variabel region omfattende aminosyresekvensen med SEQ ID NO: 56 og en letkæde-variabel region omfattende aminosyresekvensen med SEQ ID NO: 57.

15 **3.** Antistof, der binder til et humant Sortilin-protein, hvor antistoffet omfatter en tung kæde omfattende aminosyresekvensen med SEQ ID NO: 137 og en let kæde omfattende aminosyresekvensen med SEQ ID NO: 142.

20 **4.** Antistof, der binder til et humant Sortilin-protein, hvor antistoffet omfatter en tung kæde omfattende aminosyresekvensen med SEQ ID NO: 138 og en let kæde omfattende aminosyresekvensen med SEQ ID NO: 142.

5. Antistof ifølge et af kravene 1 til 4, hvor det humane Sortilin-protein omfatter aminosyresekvensen med SEQ ID NO: 81.

25 **6.** Antistof ifølge krav 1 eller krav 2, hvor antistoffet er af IgG-klassen, IgM-klassen eller IgA-klassen.

7. Antistof ifølge krav 6, hvor antistoffet er af IgG-klassen og har en IgG1-, IgG2-, IgG3- eller IgG4-isotype.

30 **8.** Antistof ifølge krav 7, hvor:
(a) antistoffet er en IgG1- eller IgG2-isotype, og Fc-regionen omfatter en aminosyresubstitution ved position P331S, hvor nummereringen af restpositionen er i henhold til EU-nummerering;

(b) antistoffet er en IgG1-isotype, og Fc-regionen omfatter aminosyresubstitutioner ved positionerne L234A, L235A og P331S, hvor nummereringen af restpositionen er i henhold til EU-nummerering;

5 (c) antistoffet er en IgG1-, IgG2- eller IgG4-isotype, og Fc-regionen omfatter en aminosyresubstitution ved position N297A, hvor nummereringen af restpositionen er i henhold til EU-nummerering; eller

(a) Fc-regionen omfatter en aminosyresubstitution ved positionerne S267E og L328F, hvor nummereringen af restpositionen er i henhold til EU-nummerering.

10

9. Antistof ifølge krav 8, hvor antistoffet er en IgG1-isotype, og Fc-regionen omfatter aminosyresubstitutioner ved positionerne L234A, L235A og P331S, hvor nummereringen af restpositionen er i henhold til EU-nummerering.

15

10. Antistof ifølge et af kravene 1-9, hvor antistoffet er et humant antistof, et bispecifikt antistof, et monoklonalt antistof, et multivalent antistof eller et konjugeret antistof.

20

11. Antistof ifølge krav 10, hvor antistoffet er et bispecifikt antistof, der genkender et Sortilin-protein og et andet antigen.

12. Antistof ifølge krav 11, hvor det andet antigen er et antigen, der faciliterer transport på tværs af blod-hjerne-barrieren.

25

13. Antistof ifølge krav 12, hvor det andet antigen er udvalgt fra gruppen bestående af transferrinreceptor (TR), insulinreceptor (HIR), insulinlignende vækstfaktorreceptor (IGFR), lavdensitetslipoproteinreceptor-relaterede proteiner 1 og 2 (LPR-1 og 2), difteritoksinreceptor, CRM197, et llama-enkeltdomæneantistof, TMEM 30(A), et proteintransduktionsdomæne, TAT, Syn-B, penetratin, et poly-argininpeptid, et angiopep-peptid, basigin, Glut1, CD98hc og ANG1005.

30

14. Antistof ifølge krav 1 eller 2, hvor antistoffet er et antistoffragment, der binder til et humant Sortilin-protein.
- 5 15. Antistof ifølge krav 14, hvor antistoffragmentet er et Fab, Fab', Fab'-SH, F(ab')₂, Fv eller scFv-fragment.
16. Isoleret nukleinsyre omfattende en nukleinsyresekvens, der koder for antistoffet ifølge et af kravene 1-15.
- 10 17. Vektor omfattende nukleinsyren ifølge krav 16.
18. Isoleret værtselle omfattende vektoren ifølge krav 17.
- 15 19. Fremgangsmåde til produktion af et antistof, der binder til Sortilin, omfattende dyrkning af værtscellen ifølge krav 18, således at antistoffet produceres.
- 20 20. Fremgangsmåde ifølge krav 19, yderligere omfattende at udvinde antistoffet produceret af værtscellen.
21. Farmaceutisk sammensætning omfattende antistoffet ifølge et af kravene 1-15 og et farmaceutisk acceptabelt bærerstoff.
22. Antistof ifølge et af kravene 1-15 til anvendelse som et medikament.
- 25 23. Antistof ifølge et af kravene 1-15, til anvendelse i en fremgangsmåde til at forebygge, mindske risikoen for eller behandle en sygdom, lidelse eller skade udvalgt fra gruppen bestående af frontotemporal demens, Alzheimers sygdom, vaskulær demens, krampeanfald, retinal dystrofi, amyotrofisk lateral sklerose, traumatisk hjerneskade, en rygmarvsskade, demens, stroke, Parkinsons sygdom, retinal degeneration, multipel sklerose, septisk chok, arthritis, osteoarthritis og neuropatisk smerte.
- 30 24. Antistof ifølge et af kravene 1-15, til anvendelse i en fremgangsmåde til at forebygge, mindske risikoen for eller behandle en sygdom, lidelse eller skade

5 udvalgt fra gruppen bestående af frontotemporal demens, Alzheimers sygdom, vaskulær demens, krampeanfald, retinal dystrofi, amyotrofisk lateral sklerose, traumatisk hjerneskade, en rygmarvsskade, demens, stroke, Parkinsons sygdom, retinal degeneration, multipel sklerose, septisk chok, arthritis og osteoarthritis.

10 **25.** Antistof til anvendelse ifølge krav 24, hvor sygdommen, lidelsen eller skaden er udvalgt fra gruppen bestående af frontotemporal demens, Alzheimers sygdom, amyotrofisk lateral sklerose og Parkinsons sygdom.

26. Antistof til anvendelse ifølge krav 25, hvor sygdommen, lidelsen eller skaden er frontotemporal demens.

15 **27.** Antistof ifølge et af kravene 1-15 til anvendelse i en fremgangsmåde til at forebygge, mindske risikoen for eller behandle en inflammatorisk lidelse.

20 **28.** Antistof ifølge et af kravene 1-15 til anvendelse i en fremgangsmåde til at hæmme neuroinflammation eller axonopati **kendetegnet ved** kort aksonal udvækst og aberrerende forgrening hos et individ med behov herfor.

29. Antistof ifølge et af kravene 1-15 til anvendelse i en fremgangsmåde til at fremme sårheling.

25 **30.** Antistof ifølge et af kravene 1-15 til anvendelse i en fremgangsmåde til at forebygge, mindske risikoen for eller behandle arthritis hos et individ med behov herfor.

30 **31.** In vitro-fremgangsmåde til at hæmme interaktionen mellem Sortilin eksprimeret på en celle og Progranulin, hvilken fremgangsmåde omfatter at eksponere en celle, der eksprimerer Sortilin til anti-Sortilin-antistoffet ifølge et af kravene 1-15 eller den farmaceutiske sammensætning ifølge krav 21.

32. Fremgangsmåde ifølge krav 31, hvor fremgangsmåden til at hæmme interaktionen mellem Sortilin eksprimeret på en celle og Progranulin yderligere

omfatter at reducere niveauet af Sortilin eksprimeret på celleoverfladen.

5 **33.** Fremgangsmåde ifølge krav 31 eller 32, hvor fremgangsmåden til at hæmme interaktionen mellem Sortilin eksprimeret på en celle og Progranulin yderligere omfatter at øge de ekstracellulære niveauer af Progranulin.

10 **34.** Antistof til anvendelse ifølge et af kravene 23-26, hvor fremgangsmåden til at forebygge, mindske risikoen for eller behandle sygdommen, lidelsen eller skaden omfatter at indgive antistoffet til et individ med en eller flere mutationer i genet, der koder for Progranulin.

35. Antistof til anvendelse ifølge krav 34, hvor individet er heterozygot for en eller flere funktionstabsmutationer i genet, der koder for Progranulin.

15 **36.** Antistof til anvendelse eller fremgangsmåde ifølge et af kravene 23-35, hvor anti-Sortilin-antistoffet omfatter to eller flere anti-Sortilin-antistoffer.

DRAWINGS

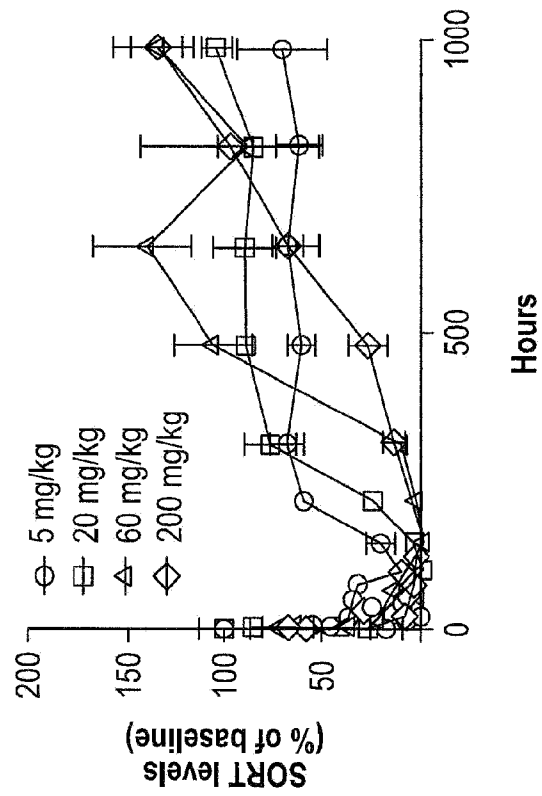


FIG. 1A

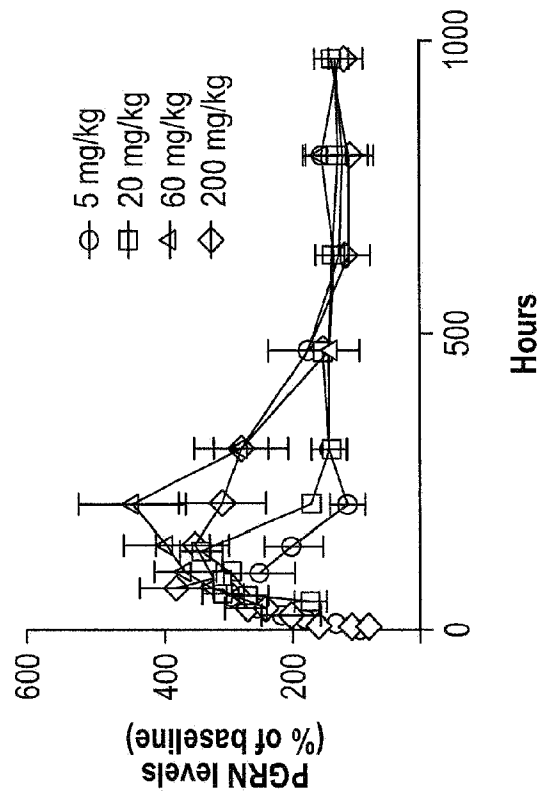


FIG. 1B

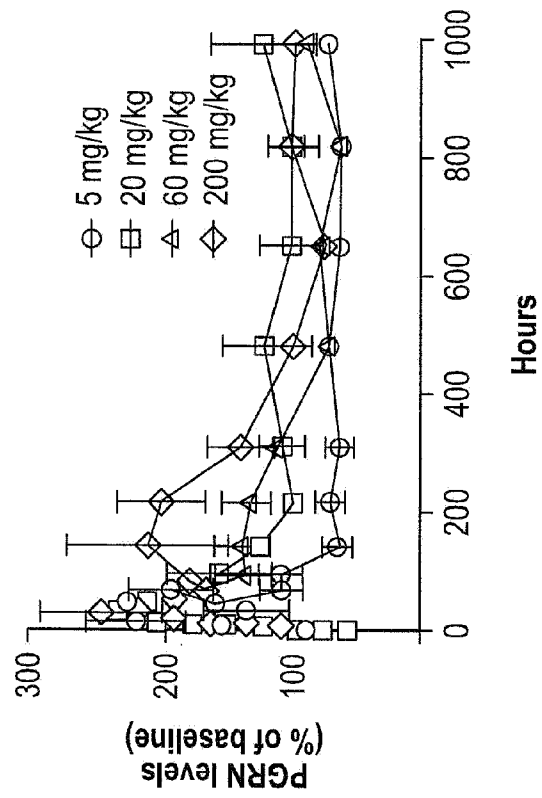


FIG. 1C

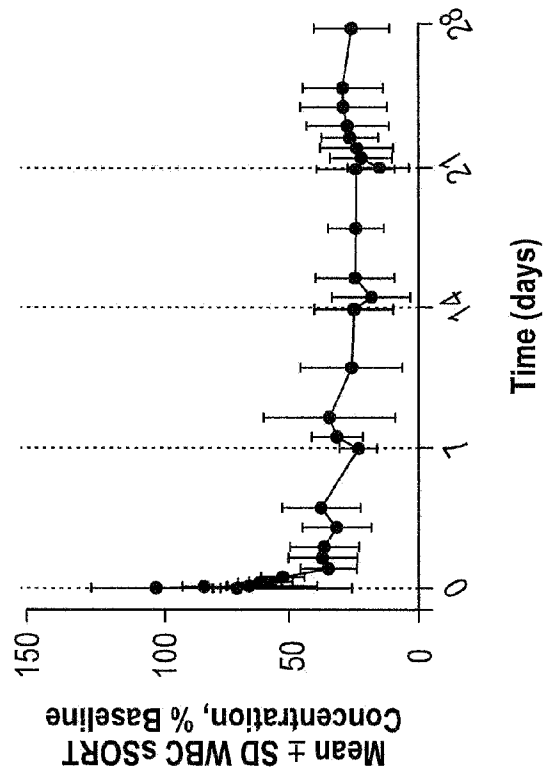


FIG. 2A

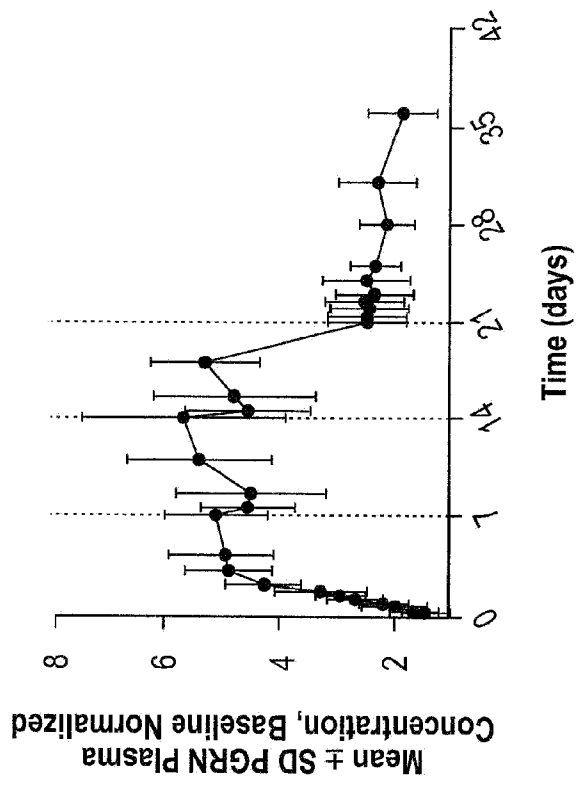


FIG. 2B

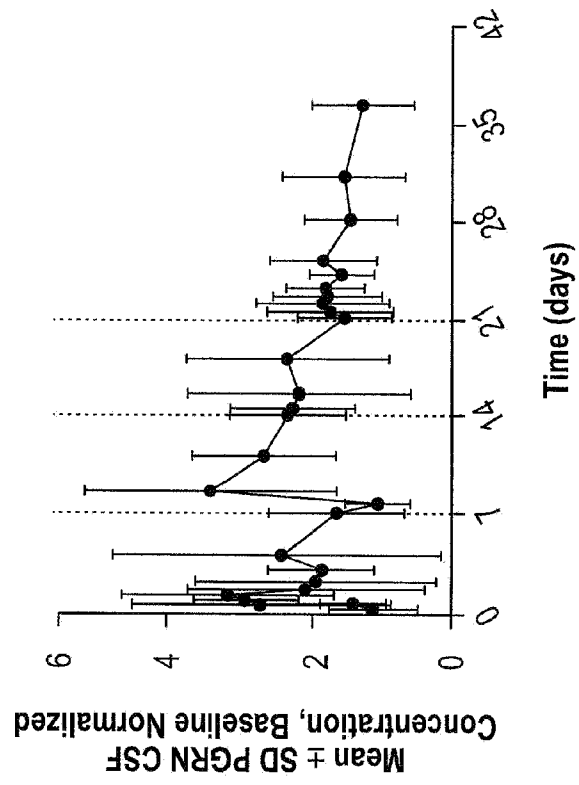


FIG. 2C

SEKVENSLISTE

Sekvenslisten er udeladt af skriftet og kan hentes fra det Europæiske Patent Register.

The Sequence Listing was omitted from the document and can be downloaded from the European Patent Register.

