ANTI-N3pGlu AMYLOID BETA PEPTIDE ANTIBODIES AND USES THEREOF

The present invention relates to antibodies that bind human N3pGlu Amyloid Beta peptide and their use in treating diseases related to Amyloid Beta (herein referred to as Aβ or Abeta) peptide.

The cleavage of the amyloid precursor protein results in Aβ peptides ranging in size from 38 to 43 amino acids. Conversion of Aβ from soluble to insoluble forms having high β-sheet content and the deposition of these insoluble forms as neuritic and cerebrovascular plaques in the brain has been associated with a number of conditions and diseases, including Alzheimer's disease (AD), Down's syndrome, and cerebral amyloid angiopathy (CAA).

The deposits found in plaques are comprised of a heterogeneous mixture of Aβ peptides. N3pGlu Aβ, also referred to as N3pE, pE3-X, or $A\beta_{p3\text{-}X}$, is an N-terminal truncated form of Aβ peptide and is primarily found in plaque. N3pGlu Aβ lacks the first two amino acid residues at the N-terminus of human Aβ and has a pyroglutamate which was derived from the glutamic acid at the third amino acid position. Although N3pGlu Aβ peptide is a minor component of the deposited Aβ in the brain, studies have demonstrated that N3pGlu Aβ peptide has aggressive aggregation properties and accumulates early in the deposition cascade.

Antibodies to N3pGlu Aβ are known in the art. For example, U.S. Patent Number 8,679,498 discloses human N3pGlu Aβ antibodies (e.g. B12L; also known as LY3002813) and methods of treating diseases, such as Alzheimer's disease, with said antibodies. A clinical trial has demonstrated concerns with anti-drug antibodies against an anti- N3pGlu Aβ antibody (LY3002813). Anti-drug antibodies were present in the plasma of almost everyone treated in this trial, and an associated problem with the immune reaction was a shortened half-life of LY3002813. Therefore, there still remains a need for alternative anti-N3pGlu Aβ antibodies.

The antibodies of the present invention seek to provide anti-N3pGlu Aβ antibodies that bind N3pGlu Aβ, lower plaque ($A\beta_{1\text{-}42}$) *in vivo*, but which also demonstrate reduced immunogenicity. Such anti-N3pGlu Aβ antibodies may also demonstrate reduced non-specific binding to plasma proteins. In addition, such anti-

N3pGlu Aβ antibodies may also provide a reduced predicted T-Dependent Ab Response. Such anti-N3pGlu Aβ antibodies may also provide increased antibody half-life and an improved safety profile for a potential human therapeutic with pharmacokinetics for a better dosing schedule. The antibodies within the scope of the present invention seek to possess at least one of these desirable characteristics.

The present invention provides an antibody that binds human N3pGlu Aβ, comprising an LCVR and an HCVR, wherein said LCVR comprises LCDR1, LCDR2, and LCDR3, and wherein said HCVR comprises HCDR1, HCDR2, and HCDR3, and wherein the amino acid sequences are SEQ ID NO:4 or 5 for LCDR1, SEQ ID NO:6 or 7 for LCDR2, SEQ ID NO:8 for LCDR3, SEQ ID NO:1 for HCDR1, SEQ ID NO:2 for HCDR2, and SEQ ID NO:3 for HCDR3. In a particular embodiment, the anti-N3pGlu Aβ antibody comprises the amino sequences of SEQ ID NO:4 for LCDR1, SEQ ID NO:6 for LCDR2, SEQ ID NO:8 for LCDR3, SEQ ID NO: 1 for HCDR1, SEQ ID NO: 2 for HCDR2, and SEQ ID NO:3 for HCDR3. In another particular embodiment, the anti-N3pGlu Aβ antibody comprises the amino sequences of SEQ ID NO:5 for LCDR1, SEQ ID NO:7 for LCDR2, SEQ ID NO:8 for LCDR3, SEQ ID NO: 1 for HCDR1, SEQ ID NO:2 for HCDR2, and SEQ ID NO:3 for HCDR3.

The present invention also provides an antibody that binds human N3pGlu Aβ, wherein said antibody comprises a light chain variable region (LCVR) having the amino acid sequence of SEQ ID NO: 10 or SEQ ID NO: 11, and a heavy chain variable region (HCVR) having the amino acid sequence of SEQ ID NO: 9. In a particular embodiment, the present invention provides an antibody that binds human N3pGlu Aβ, wherein said antibody comprises a light chain variable region (LCVR) having the amino acid sequence of SEQ ID NO: 10, and a heavy chain variable region (HCVR) having the amino acid sequence of SEQ ID NO: 9. In another particular embodiment, the present invention provides an antibody that binds human N3pGlu Aβ, wherein said antibody comprises a light chain variable region (LCVR) having the amino acid sequence of SEQ ID NO: 11, and a heavy chain variable region (HCVR) having the amino acid sequence of SEQ ID NO: 9.

In an embodiment, the present invention provides an antibody that binds human N3pGlu Aβ, comprising a light chain (LC) and a heavy chain (HC), wherein the amino

acid sequence of the LC is SEQ ID NO: 13 or 14, and the amino acid sequence of the HC is SEQ ID NO: 12. In a more particular embodiment, the present invention provides an antibody that binds human N3pGlu Aβ, comprising a light chain (LC) and a heavy chain (HC), wherein the amino acid sequence of the LC is SEQ ID NO: 13, and the amino acid sequence of the HC is SEQ ID NO: 12. In another particular embodiment, the present invention provides an antibody that binds human N3pGlu Aβ, comprising a light chain (LC) and a heavy chain (HC), wherein the amino acid sequence of the LC is SEQ ID NO: 14, and the amino acid sequence of the HC is SEQ ID NO: 12. In a further embodiment, the present invention provides an antibody comprising two LC and two HC, wherein the amino acid sequence of each LC is SEQ ID NO: 13 or 14, and the amino acid sequence of each HC is SEQ ID NO: 12. In a more particular embodiment, the present invention provides an antibody comprising two LC and two HC, wherein the amino acid sequence of each LC is SEQ ID NO: 13, and the amino acid sequence of each HC is SEQ ID NO: 12. In a more particular embodiment, the present invention provides an antibody comprising two LC and two HC, wherein the amino acid sequence of each LC is SEQ ID NO: 14, and the amino acid sequence of each HC is SEQ ID NO: 12.

The present invention further provides pharmaceutical compositions comprising an antibody of the present invention and one or more pharmaceutically acceptable carriers, diluents or excipients. Further, the present invention provides a method of treating a disease characterized by deposition of Aβ, comprising administering to a patient in need thereof a pharmaceutical composition comprising an antibody of the present invention. In another embodiment, the present invention provides a method of treating a disease characterized by deposition of Aβ, comprising administering an effective amount of an antibody of the present invention. Particularly, the present invention provides a method of treating or preventing a condition selected from clinical or pre-clinical Alzheimer's disease, Down's syndrome, and clinical or pre-clinical CAA comprising administering to said patient an effective amount of an antibody of the present invention. In another embodiment, the present invention provides a method of treating or preventing clinical or pre-clinical Alzheimer's disease, Down's syndrome, and clinical or pre-clinical CAA comprising administering to a patient in need thereof an effective amount of a pharmaceutical composition comprising an antibody of the present invention.

In another embodiment, the present invention provides a method of treating or preventing a condition selected from prodromal AD (sometimes also referred to as Aβ-related mild cognitive impairment, or MCI), mild AD, moderate AD, and severe AD, comprising administering to a patient in need thereof an effective amount of an antibody of the present invention. In another embodiment, the present invention provides a method of treating or preventing a condition selected from prodromal AD, mild AD, moderate AD, and severe AD, comprising administering to a patient in need thereof a pharmaceutical composition comprising an antibody of the present invention.

In another embodiment the present invention provides a method of slowing cognitive decline in a patient diagnosed with pre-clinical Alzheimer's disease, clinical Alzheimer's disease, Down's syndrome, or clinical or pre-clinical cerebral amyloid angiopathy, comprising administering a pharmaceutical composition comprising an antibody of the present invention. More particularly, the present invention further provides a method of slowing cognitive decline in a patient diagnosed with a condition selected from prodromal AD, mild AD, moderate AD and severe AD, comprising administering a pharmaceutical composition comprising an antibody of the present invention. In another such embodiment the present invention provides a method of slowing cognitive decline in a patient diagnosed with pre-clinical Alzheimer's disease, clinical Alzheimer's disease, Down's syndrome, or clinical or pre-clinical cerebral amyloid angiopathy, comprising administering an effective amount of an antibody of the present invention. More particularly, the present invention further provides a method of slowing cognitive decline in a patient diagnosed with a condition selected from prodromal AD, mild AD, moderate AD and severe AD, comprising administering an effective amount of an antibody of the present invention.

In another embodiment the present invention provides a method of slowing functional decline in a patient diagnosed with pre-clinical Alzheimer's disease or clinical Alzheimer's disease, comprising administering a pharmaceutical composition comprising an antibody of the present invention. More particularly, the present invention provides a method of slowing functional decline in a patient diagnosed with a condition selected from prodromal AD, mild AD, moderate AD and severe AD, comprising administering a pharmaceutical composition comprising an antibody of the present invention. In another such embodiment the present invention provides a method of slowing functional decline

in a patient diagnosed with pre-clinical Alzheimer's disease or clinical Alzheimer's disease, comprising administering an effective amount of an antibody of the present invention. More particularly, the present invention provides a method of slowing functional decline in a patient diagnosed with a condition selected from prodromal AD, mild AD, moderate AD and severe AD, comprising administering an effective amount of an antibody of the present invention.

In another embodiment the present invention provides a method of reducing brain Aβ amyloid plaque load in a patient diagnosed with pre-clinical or clinical Alzheimer's disease, comprising administering a pharmaceutical composition comprising an antibody of the present invention. More particularly, the present invention provides a method of reducing brain Aβ amyloid plaque load in a patient diagnosed with a condition selected from prodromal AD, mild AD, moderate AD or severe AD, comprising administering a pharmaceutical composition comprising an antibody of the present invention.

In another embodiment the present invention provides a method of preventing memory loss or cognitive decline in an asymptomatic patient comprising administering to the patient a pharmaceutical composition comprising an antibody of the present invention. In a preferred embodiment, the patient has low levels of Aβ1-42 in the cerebrospinal fluid (CSF) or Aβ plaques in the brain.

In another embodiment the present invention provides a method of treating asymptomatic patients known to have an Alzheimer's disease-causing genetic mutation, comprising administering to the said patient a pharmaceutical composition comprising an antibody of the present invention. In a particular embodiment, the present invention provides a method of treating asymptomatic patients known to have a PSEN1 E280A Alzheimer's disease-causing genetic mutation (Paisa mutation), comprising administering to the said patient a pharmaceutical composition comprising an antibody of the present invention. In another particular embodiment, the present invention provides a method of treating asymptomatic patients with a genetic mutation, such as a mutation in the APP, PSEN1, or PSEN2 gene, that causes autosomal-dominant Alzheimer's disease, comprising administering to the said patient a pharmaceutical composition comprising an antibody of the present invention.

In another embodiment the present invention provides a method of preventing memory loss or cognitive decline in asymptomatic patients known to have an Alzheimer's

disease-causing genetic mutation, comprising administering to the said patient a pharmaceutical composition comprising an antibody of the present invention. In a particular embodiment, the present invention provides a method of preventing memory loss or cognitive decline in asymptomatic patients known to have a PSEN1 E280A Alzheimer's disease-causing genetic mutation (Paisa mutation), comprising administering to the said patient a pharmaceutical composition comprising an antibody of the present invention. In another particular embodiment, the present invention provides a method of preventing memory loss or cognitive decline in asymptomatic patients with a genetic mutation that causes autosomal-dominant Alzheimer's disease, comprising administering to the said patient a pharmaceutical composition comprising an antibody of the present invention.

In another embodiment the present invention provides a method of slowing cognitive decline in an asymptomatic patient known to have an Alzheimer's disease-causing genetic mutation, comprising administering to the said patient a pharmaceutical composition comprising an antibody of the present invention. In a particular embodiment, the present invention provides a method of slowing cognitive decline in asymptomatic patients known to have a PSEN1 E280A Alzheimer's disease-causing genetic mutation (Paisa mutation), comprising administering to the said patient a pharmaceutical composition comprising an antibody of the present invention. In another particular embodiment, the present invention provides a method of slowing cognitive decline in asymptomatic patients with a genetic mutation that causes autosomal-dominant Alzheimer's disease, comprising administering to the said patient a pharmaceutical composition comprising an antibody of the present invention.

The present invention also provides an antibody of the present invention for use in therapy. In an embodiment, the present invention provides an antibody of the present invention for use in the treatment of a disease characterized by deposition of Aβ. In another embodiment, the present invention provides an antibody of the present invention for use in treatment of clinical or pre-clinical Alzheimer's disease, Down's syndrome, or clinical or pre-clinical cerebral amyloid angiopathy. In another embodiment, the present invention provides an antibody of the present invention for use in treatment of a condition selected from prodromal AD, mild AD, moderate AD and severe AD. In another embodiment, the present invention provides an antibody of the present invention for use

in slowing cognitive decline in a patient diagnosed with clinical or pre-clinical Alzheimer's disease, Down's syndrome, or clinical or pre-clinical cerebral amyloid angiopathy. In another embodiment, the present invention provides an antibody of the present invention for use in slowing cognitive decline in a patient diagnosed with prodromal AD, mild AD, moderate AD, or severe AD.

The present invention also provides an antibody of the present invention for use in reducing brain Aβ amyloid plaque load. In another embodiment, the present invention provides an antibody of the present invention for use in treating a condition characterized by deposition of Aβ in a patient having the PSEN1 E280A genetic mutation. In another embodiment, the present invention provides an antibody of the present invention for use in treating memory loss or cognitive decline in a patient having the PSEN1 E280A genetic mutation. In another embodiment, the present invention provides an antibody of the present invention for use in preventing memory loss or cognitive decline in a patient having the PSEN1 E280A genetic mutation.

The present invention also provides an antibody of the present invention for use in the prevention of a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA. In another embodiment, the present invention provides an antibody of the present invention for use in the prevention of a condition selected from prodromal AD, mild AD, moderate AD, and severe AD.

Further, the present invention provides a pharmaceutical composition comprising an antibody of the present invention for use in therapy. In an embodiment, the present invention provides a pharmaceutical composition comprising an antibody for use in the treatment of a disease characterized by deposition of Aβ.

The present invention also provides the use of an antibody of the present invention in the manufacture of a medicament for the treatment of a disease characterized by deposition of Aβ. In an embodiment, the present invention provides the use of an antibody of the present invention in the manufacture of a medicament for the treatment of clinical or pre-clinical Alzheimer's disease, Down's syndrome, and clinical or pre-clinical cerebral amyloid angiopathy. In an embodiment, the present invention provides the use of an antibody of the present invention in the manufacture of a medicament for the treatment of prodromal AD, mild AD, moderate AD or severe AD. In another embodiment, the present invention provides the use of an antibody of the present invention in the

manufacture of a medicament for slowing cognitive decline in a patient diagnosed with a condition selected from clinical or pre-clinical Alzheimer's disease, Down's syndrome, and clinical or pre-clinical cerebral amyloid angiopathy. In another embodiment, the present invention provides the use of an antibody of the present invention in the manufacture of a medicament for slowing cognitive decline in a patient diagnosed with a condition selected from prodromal AD, mild AD, moderate AD and severe AD.

The present invention also provides the use of an antibody of the present invention in the manufacture of a medicament for reducing brain Aβ amyloid plaque load. In another embodiment, the present invention provides the use of an antibody of the present invention in the manufacture of a medicament for treating a condition characterized by deposition of Aβ in a patient having the PSEN1 E280A genetic mutation. In another embodiment, the present invention provides the use of an antibody of the present invention in the manufacture of a medicament for treating memory loss or cognitive decline in a patient having the PSEN1 E280A genetic mutation. In another embodiment, the present invention provides the use of an antibody of the present invention in the manufacture of a medicament for preventing memory loss or cognitive decline in a patient. In a preferred embodiment, the patient has the PSEN1 E280A genetic mutation. In another embodiment, the present invention provides the use of an antibody of the present invention in the manufacture of a medicament for preventing a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA. In another embodiment, the present invention provides the use of an antibody of the present invention in the manufacture of a medicament for preventing a condition selected from prodromal AD, mild AD, moderate AD, and severe AD.

In an embodiment, the present invention provides a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12. In an embodiment, the present invention provides a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 13. In an embodiment, the present invention provides a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 14. In a further embodiment, the present invention provides a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12, and comprising a polynucleotide

sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 13. In another embodiment, the present invention provides a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12, and comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 14. In another embodiment, the present invention provides a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12, and a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 13. In another embodiment, the present invention provides a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12, and a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 14. In a particular embodiment the polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12 is SEQ ID NO: 15 and the polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 13 is SEQ ID NO: 16. In a particular embodiment the polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12 is SEQ ID NO: 15, the polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 14 is SEQ ID NO: 17, and the polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 13 is SEQ ID NO: 16.

Further, the present invention provides a mammalian cell comprising a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12 and a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 13 or 14. Preferably the mammalian cell comprises a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12 and a polypeptide having the amino acid sequence SEQ ID NO: 13. In another embodiment, the mammalian cell comprises a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 12 and a polypeptide having the amino acid sequence of SEQ ID NO: 14. In an embodiment the mammalian cell line is a Chinese Hamster Ovary (CHO) or Hamster embryonic kidney (HEK) cell line.

The present invention also provides a mammalian cell comprising a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO:12 and/or a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 13, wherein the cell is capable of expressing an antibody comprising a HC having the amino acid sequence of SEQ ID NO:12 and a LC having the amino acid sequence of SEQ ID NO: 13. Preferably the mammalian cell comprises a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO:12 and a polypeptide having the amino acid sequence SEQ ID NO: 13. The present invention also provides a mammalian cell comprising a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO:12 and/or a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO: 13, wherein the cell is capable of expressing an antibody comprising a HC having the amino acid sequence of SEQ ID NO:12 and a LC having the amino acid sequence of SEQ ID NO: 13. Preferably the mammalian cell comprises a DNA molecule comprising a polynucleotide sequence encoding a polypeptide having the amino acid sequence of SEQ ID NO:12 and a polypeptide having the amino acid sequence SEQ ID NO: 13. In an embodiment the mammalian cell line is a CHO or HEK cell line.

In another embodiment, the present invention provides a process for producing an antibody comprising a LCVR having an amino acid sequence of SEQ ID NO: 10 and a HCVR having an amino acid sequence of SEQ ID NO:9, wherein the process comprises cultivating a mammalian cell comprising a DNA encoding an LCVR having an amino acid sequence of SEQ ID NO: 10 and/or a DNA encoding an HCVR having an amino acid sequence of SEQ ID NO:9 under conditions such that the antibody is expressed, and recovering the expressed antibody. The invention includes an antibody obtainable by the process of the invention as described immediately above. The present invention also provides a process for producing an antibody comprising a LCVR having an amino acid sequence of SEQ ID NO: 11 and a HCVR having an amino acid sequence of SEQ ID NO:9, wherein the process comprises cultivating a mammalian cell comprising a DNA encoding an LCVR having an amino acid sequence of SEQ ID NO: 11 and/or a HCVR having an amino acid sequence of SEQ ID NO:9 under conditions such that the antibody

is expressed, and recovering the expressed antibody. The invention includes an antibody obtainable by the process of the invention as described immediately above.

In another embodiment, the present invention provides a process for producing an antibody comprising a LC having an amino acid sequence of SEQ ID NO: 13 and a HC having an amino acid sequence of SEQ ID NO: 12, wherein the process comprises cultivating a mammalian cell comprising a DNA encoding a LC having an amino acid sequence of SEQ ID NO: 13 and/or a HC having an amino acid sequence of SEQ ID NO: 12 under conditions such that the antibody is expressed, and recovering the expressed antibody. The invention includes an antibody obtainable by the process of the invention as described immediately above. The present invention also provides a process for producing an antibody comprising a LC having an amino acid sequence of SEQ ID NO: 14 and a HC having an amino acid sequence of SEQ ID NO: 12, wherein the process comprises cultivating a mammalian cell comprising a DNA encoding a LC having an amino acid sequence of SEQ ID NO: 14 and/or a HC having an amino acid sequence of SEQ ID NO: 12 under conditions such that the antibody is expressed, and recovering the expressed antibody. The invention includes an antibody obtainable by the process of the invention as described immediately above.

The present invention includes a process for producing an antibody, which antibody comprises two HCs and two LCs, in which the amino sequence of each of the two HCs is SEQ ID NO: 12, and the amino acid sequence of each of the two LCs is SEQ ID NO: 13, and which process comprises: a) cultivating a mammalian cell of the invention, as described above, under conditions such that the antibody is expressed, and b) recovering the expressed antibody. The invention includes an antibody obtainable by the process of the invention as described immediately above. The present invention also includes a process for producing an antibody, which antibody comprises two HCs and two LCs, in which the amino sequence of each of the two HCs is SEQ ID NO: 12 and the amino acid sequence of each of the two LCs is SEQ ID NO: 14, and which process comprises: a) cultivating a mammalian cell of the invention, as described above, under conditions such that the antibody is expressed, and b) recovering the expressed antibody. The invention includes an antibody obtainable by the process of the invention as described immediately above.

The antibodies of the present invention bind to N3pGlu Aβ. The sequence of N3pGlu Aβ is the amino acid sequence of SEQ ID NO: 22, and carboxyl terminal variants thereof. Examples of a carboxyl terminal variants of N3pGlu Aβ include $A\beta_{p3-40}$ and $A\beta_{p3-43}$.

As used herein, an "antibody" is an immunoglobulin molecule comprising two heavy chains (HC) and two light chains (LC) interconnected by disulfide bonds. The amino terminal portion of each LC and HC includes a variable region responsible for antigen recognition via the complementarity determining regions (CDRs) contained therein. The CDRs are interspersed with regions that are more conserved, termed framework regions. Assignment of amino acids to CDR domains within the LCVR and HCVR regions of the antibodies of the present invention is based on the well-known Kabat numbering convention (Kabat, et al., Ann. NY Acad. Sci. 190:382-93 (1971); Kabat et al., Sequences of Proteins of Immunological Interest, Fifth Edition, U.S. Department of Health and Human Services, NIH Publication No. 91-3242 (1991)), and North numbering convention (North et al., A New Clustering of Antibody CDR Loop Conformations, Journal of Molecular Biology, 406:228-256 (2011)).

The antibodies of the present invention include kappa LC and IgG HC. In a particular embodiment, the antibodies of the present invention are IgG1.

The antibodies of the present invention are monoclonal antibodies ("mAbs"). Monoclonal antibodies can be produced, for example, by hybridoma technologies, recombinant technologies, phage display technologies, synthetic technologies, e.g., CDR-grafting, or combinations of such or other technologies known in the art. In another embodiment of the present invention, the antibody, or the nucleic acid encoding the same, is provided in isolated form. As used herein, the term "isolated" refers to a protein, peptide or nucleic acid that is not found in nature and is free or substantially free from other macromolecular species found in a cellular environment. "Substantially free", as used herein, means the protein, peptide or nucleic acid of interest comprises more than 80% (on a molar basis) of the macromolecular species present, preferably more than 90% and more preferably more than 95%.

Following expression and secretion of the antibody, the medium is clarified to remove cells and the clarified media is purified using any of many commonly-used

techniques. The purified antibody may be formulated into pharmaceutical compositions according to well-known methods for formulating proteins and antibodies for parenteral administration, particularly for subcutaneous, intrathecal, or intravenous administration. The antibody may be lyophilized, together with appropriate pharmaceutically-acceptable excipients, and then later reconstituted with a water-based diluent prior to use. Alternatively, the antibody may be formulated in an aqueous solution and stored for up to 1 – 3 years prior to use. In either case, the stored form and the injected form of the pharmaceutical compositions of the antibody will contain a pharmaceutically-acceptable excipient or excipients, which are ingredients other than the antibody. Whether an ingredient is pharmaceutically-acceptable depends on its effect on the safety and effectiveness or on the purity, and potency of the pharmaceutical composition. If an ingredient is judged to have a sufficiently unfavorable effect on safety or effectiveness (or on purity or potency) to warrant it not being used in a composition for administration to humans, then it is not pharmaceutically-acceptable to be used in a pharmaceutical composition of the antibody.

A pharmaceutical composition comprising an antibody of the present invention can be administered to a patient at risk for, or exhibiting, diseases or disorders as described herein by parental routes (e.g., subcutaneous, intravenous, intraperitoneal, intramuscular). Subcutaneous and intravenous routes are preferred. A pharmaceutical composition of the present invention contains an "effective" amount of an antibody of the present invention. An effective amount refers to an amount necessary (at dosages and for periods of time and for the means of administration) to achieve the desired therapeutic result. An effective amount of the antibody may vary according to factors such as the disease state, age, sex, and weight of the individual, and the ability of the antibody to elicit a desired response in the individual. An effective amount can be readily determined by the attending diagnostician or health care professional, as one skilled in the art, by using known techniques and by observing results. Frequency of dosing is dependent on actual pharmacokinetics and pharmacodynamics in humans. Duration of treatment will vary depending on many factors and it will be determined by the patient's diagnostician or treating health care provider, based on experience and skill in the art. Frequency and duration of treatment may vary by indication. The terms "treatment," "treating" or "to treat" and the like include restraining, slowing or stopping the progression or severity of

an existing symptom, condition, disease, or disorder in a patient. The term "patient" refers to a human. The terms "prevent" and "preventing" means prophylactic administration of an antibody of the present invention to an asymptomatic patient in order to keep the patient from having symptoms or clinical features of neurodegenerative diseases such as AD.

The term "condition characterized by deposition of Aβ," is a disease that is pathologically characterized by Aβ deposits in the brain or in brain vasculature. This includes diseases such as Alzheimer's disease, Down's syndrome, and cerebral amyloid angiopathy. A clinical diagnosis, staging or progression of Alzheimer's disease can be readily determined by the attending diagnostician or health care professional, as one skilled in the art, by using known techniques and by observing results. This generally includes some form of brain plaque imagining, mental or cognitive assessment (e.g. Clinical Dementia Rating - summary of boxes (CDR-SB), Mini-Mental State Exam (MMSE) or Alzheimer's Disease Assessment Scale-Cognitive (ADAS-Cog)) or functional assessment (e.g. Alzheimer's Disease Cooperative Study-Activities of Daily Living (ADCS-ADL). "Clinical Alzheimer's disease" as used herein is a diagnosed stage of Alzheimer's disease. It includes conditions diagnosed as prodromal Alzheimer's disease, mild Alzheimer's disease, moderate Alzheimer's disease and severe Alzheimer's disease. The term "pre-clinical Alzheimer's disease" is a stage that precedes clinical Alzheimer's disease, where measurable changes in biomarkers (such as CSF Aβ42 levels or deposited brain plaque load by amyloid PET) indicate the earliest signs of a patient with Alzheimer's pathology, progressing to clinical Alzheimer's disease. This is usually before symptoms such as memory loss and confusion are noticeable.

The following Examples and assays demonstrate that the antibodies of the present invention are useful for treating a disease characterized by deposition of Aβ, such as of Alzheimer's disease, Down's syndrome, and CAA. It should be understood however, that the following Examples are set forth by way of illustration and not limitation, and that various modifications may be made by one of ordinary skill in the art.

Examples

Expression and Purification of Engineered N3pGlu Aβ Antibodies

N3pGlu Aβ antibodies of the present invention can be expressed and purified essentially as follows. A glutamine synthetase (GS) expression vector containing the

DNA sequence encoding the LC amino acid sequence of SEQ ID NO: 13 or 14, and the DNA sequence encoding the HC amino acid sequence of SEQ ID NO: 12 is used to transfect a Chinese hamster ovary cell line (CHO) by electroporation. The expression vector encodes an SV Early (Simian Virus 40E) promoter and the gene for GS. Post-transfection, cells undergo bulk selection with 0-50 μM L-methionine sulfoximine (MSX). Selected bulk cells or master wells are then scaled up in serum-free, suspension cultures to be used for production.

Clarified medium, into which the antibody has been secreted, is applied to a Protein A affinity column that has been equilibrated with a compatible buffer, such as phosphate buffered saline (pH 7.4). The column is washed with 1 M NaCl to remove nonspecific binding components. The bound N3pGlu Aβ antibody is eluted, for example, with sodium citrate at pH (approx.) 3.5 and fractions are neutralized with 1 M Tris buffer. N3pGlu Aβ antibody fractions are detected, such as by SDS-PAGE or analytical size-exclusion, and then are pooled. N3pGlu Aβ antibody of the present invention is concentrated in either PBS buffer at pH 7.4 or 10 mM NaCitrate buffer, 150 mM NaCl at pH around 6. The final material can be sterile filtered using common techniques. The purity of N3pGlu Aβ antibody is greater than 95%. An N3pGlu Aβ antibody of the present invention may be immediately frozen at -70°C or stored at 4°C for several months. Amino acid SEQ ID NOs for exemplified antibodies of the present invention are shown below.

Table 1. Amino acid sequences of exemplified N3pGlu Aβ antibodies.

Antibody SEQ ID NOs				
Antibody	**Light Chain**	**Heavy Chain**	**LCVR**	**HCVR**
201c	13	12	10	9
201cYD	14	12	11	9

Antibody SEQ ID NOs			
Antibody	**LCDR1**	**LCDR2**	**LCDR3**
201c	4	6	8
201cYD	5	7	8

Antibody SEQ ID NOs			
Antibody	**HCDR1**	**HCDR2**	**HCDR3**
201c and 201cYD	1	2	3

Binding Kinetics and Avidity

The binding kinetics and avidity of N3pGlu Aβ antibody to pE3-42 Aβ peptide is measured by surface plasmon resonance using Biacore® 3000 (GE Healthcare). The binding avidity is measured by immobilizing about 120 RU pE3-42 Aβ peptide via amine coupling on a Biacore® CM5 chip, and flowing N3pGlu Aβ antibody, starting from 500 nM in 2-fold serial dilution down to 15.6 nM. The experiments are carried out at 25 °C in HBS-EP buffer (GE Healthcare BR100669; 10 mM HEPES, 150 mM NaCl, 3 mM EDTA, 0.05% surfactant P20, pH 7.4). For each cycle, 250 µL antibody sample is flowed through flow cell 1 and 2 at 50 µl/min, and then dissociated for 10 minutes. The chip surface is regenerated with 5 µL injection of glycine buffer at pH 1.5 at 10 µL/mL flow rate. The data is fit to a 1:1 Langmiur binding model to derive k_{on}, k_{off}, and to calculate K_D. Following procedures essentially as described above, the following parameters (shown in Table 2) were observed.

Table 2. Binding kinetics and avidity.

Antibody		k_{on} (1/Ms)	k_{off} (1/s)	K_D (M)
201c	**Mean**	1.64E+03	6.98E-05	4.57E-08
	S. D.	3.88E+02	1.36E-05	2.06E-08
201cYD	**Mean**	2.41E+03	6.39E-05	2.67E-08
	S. D.	2.01E+02	2.15E-06	2.61E-09

These data demonstrate that the antibodies of the present invention bind pE3-42 Aβ.

***Ex Vivo* Target Engagement**

To determine *ex vivo* target engagement on brain sections from a fixed PDAPP brain, immunohistochemical analysis is performed with exogenously added N3pGlu Aβ antibodies of the present invention or the 201c H3B antibody. The 201c H3B antibody differs by one amino acid from the 201c antibody, and this difference is located in the

heavy chain HCDR3 (Tyr at position 10 in 201c HCDR3 is Phe in 201c H3B). The 201c H3B antibody comprises a heavy chain amino acid sequence given by SEQ ID NO: 20 and a light chain amino acid sequence given by SEQ ID NO: 13.

Cryostat serial coronal sections from aged PDAPP mice (26 or 20-month old) are incubated with 5 μg/mL or 20 μg/mL of an exemplified N3pGlu Aβ antibody of the present invention (201c or 201cYD). Secondary HRP reagents specific for human IgG are employed and the deposited plaques are visualized with DAB-Plus (DAKO). Biotinylated murine 3D6 antibody followed by Step-HRP secondary is used as a positive control.

The exemplified N3pGlu Aβ antibodies of the present invention labeled deposited Aβ in these brain sections. However, a higher background staining for the 201c H3B antibody at the exogenous 20μg/ml concentration was observed. These histological studies demonstrated that the exemplified N3pGlu Aβ antibodies of the present invention engaged deposited Aβ target *ex vivo*.

***Ex vivo* Phagocytosis**

An *ex vivo* phagocytosis assay is performed to investigate whether N3pGlu Aβ antibodies of the present invention can facilitate microglial phagocytosis of plaque. Frozen sections from human Alzheimer's brain (20 μm) are pre-incubated with 10 μg/mL of an exemplified N3pGlu Aβ antibody of the present invention (201c or 201cYD), controls, or the 201c H3B antibody for one hour at 37°C in 24-well plates. There are four wells per treatment. Primary murine microglia cells ($8x10^5$; C57/BL6) are then added and incubated for 24 hours. Tissue in each well is homogenized in 5.2 M guanidine buffer and the $Aβ_{1-42}$ content is evaluated by ELISA. Since the Aβ content can vary over the span of multiple sections, a sister section control is implemented for every test well and the content of the test well is normalized to that of the sister section.

Compared to the positive control samples, exemplified N3pGlu Aβ antibodies of the present invention (201c and 201cYD) and 201c H3B had significantly reduced $Aβ_{1-42}$. The negative control samples had negligible clearance of deposited $Aβ_{1-42}$. Therefore, *ex vivo* phagocytosis analyses show that exemplified N3pGlu Aβ antibodies of the present invention can clear plaque ex *vivo* by phagocytosis.

***In Vivo* Target Engagement**

The ability of N3pGlu Aβ antibodies of the present invention to cross the blood-brain-barrier and bind to deposited plaque *in vivo* is measured. Aged PDAPP transgenic mice (18.5 to 32 months of age) are given intraperitoneal injections with N3pGlu Aβ antibody (201c) or negative control IgG. Six mice per group receive one 40 mg/kg injection of antibody on day 1 and on day 3. *In vivo* target engagement is determined on day 6, when mice are sacrificed and brains are collected for histochemical analyses.

The extent of *in vivo* target engagement is quantified as the percent area positive for the *in vivo* N3pGlu Aβ antibody engagement normalized to the total plaque area as defined by exogenous 3D6 antibody immunostaining on sister sections (TE Ratio). The TE Ratio is generated by measuring the percent of area bound by the antibody and normalizing the value against the total percent of area of possible target (total deposited Aβ visualized by exogenous immunohistochemistry with a positive control antibody (3D6) on a sister section).

Following procedures essentially as described above, the 201c antibody had a TE Ratio of 2.8%. The 201c antibody demonstrated *in vivo* target engagement within the hippocampus and to a limited extent in the cortex, whereas the animals injected with control IgG show no plaque-specific staining.

***In Vivo* Plaque Clearance**

Studies are performed with chimera surrogate antibodies with LCVR and HCVR of 201c or 201c H3B fused to murine constant kappa region and IgG2a Fc to evaluate *in vivo* plaque clearance in aged PDAPP mice. Aged PDAPP mice (21-months of age, n = 23 to 25 per group) are injected subcutaneously once a week for 7 weeks with 12.5 mg/kg of chimera 201c antibody, chimera 201c H3B antibody, or control IgG. Control aged PDAPP mice (sacrificed at the onset of the study) are used to evaluate the levels of pre-existing deposition prior to therapeutic treatment.

At the conclusion of the study, final drug levels are measured in plasma, and brains are evaluated by ELISA for levels of $A\beta_{1-42}$. The aged PDAPP mice are at the plaque ceiling as evidenced by a non-significant further accrual of $A\beta_{1-42}$ over the 7-week

treatment period with the control IgG. The 201c chimera antibody group and the 201c H3B chimera antibody group show significant reduction in $A\beta_{1-42}$ (26%, $p < 0.0182$ and 26%, $p = 0.0121$, respectively) compared to control. Antibody exposure level was measured at the end of 7-week dosing period, and 201c chimera had a level of 91 µg/mL, and 201c H3B had a level of 56 µg/mL. This study demonstrated that the exemplified chimera N3pGlu Aβ antibody 201c was able to lower plaque ($A\beta_{1-42}$) *in vivo*.

Lack of Low Affinity Plasma Binding

In vitro studies are performed to investigate potential low-affinity interactions of anti-N3PG antibodies of the present invention (201c and 201cYD) with plasma proteins. Antibody 201c, 201cYD, or 201c H3B is covalently coupled to Sepharose beads and incubated with 10 mls of normal human plasma for 2 hours at 37°C before performing column chromatography. The bead/plasma mixture was packed into columns and washed. Selectively bound proteins are eluted with glycine (pH 2.5) in different fractions. Each fraction is then analyzed on high-resolution sodium dodecyl sulfate (SDS)–polyacrylamide gel electrophoresis (PAGE) gradient gels (4% to 16%). Silver stain is used to visualize the proteins and bands of interest were excised and analyzed by mass spectrometry. In parallel, multiple control human IgG1 antibodies are analyzed.

Following procedures essentially as described above, visualization of the silver stained gels demonstrated the presence of histidine rich glycoprotein (~64kDa band), fibrinogen alpha-chain (~60kDa band), and fibrinogen beta-chain (~50kDa band) in fraction-5 from the 201c H3B antibody elution as compared to the control IgG1 antibodies. Conversely, the 201c and 201cYD antibodies lacked appreciable low affinity binding to human plasma proteins as compared to the control IgG and the 201c H3B antibody.

***Ex Vivo* T-cell Proliferation EpiScreen Assay**

An EpiScreen® *ex vivo* human T-cell assay is used to measure activation (proliferation, cytokine secretion) of human CD4+ T cells in response to an exemplified N3pGlu Aβ antibody of the present invention (201c) or the 201c H3B antibody. EpiScreen® utilizes samples from 50 healthy donors that best represent the number and

frequency of HLA-DR and DQ allotypes expressed in the European/North American and world populations. Two positive controls are included in the assay: humanized A33, a clinical benchmark antibody that shows high levels of immunogenicity in the clinic (73%) and routinely induces 20-30% T-cell response in the EpiScreen® assay, and KLH (keyhole limpet hemocyanin), a mitogen-like protein containing neoantigens. A matched buffer negative control is also included in the assay.

The percent of T-cell proliferation is calculated from the average of all positive donor responses observed during the time course (days 5-8). The percent T-cell proliferation was 20% and 94% for the positive controls A33 and KLH, respectively, and was 24% for 201c H3B. However, the percent T-cell proliferation was 10% for 201c. These data demonstrate that the 201c antibody has a low T-cell response rate compared to positive controls and the 201c H3B antibody.

In Silico Immunogenicity Analysis

An EpiMatrix® assay scans protein sequences for potential T-cell epitopes and uses an algorithm to predict immunogenicity. It also considers Tregitope content and the effect on negatively regulating immunogenic response. The amino acid sequences of antibodies 201c, 201cYD, and B12L (antibody B12L comprises a heavy chain given by SEQ ID NO: 23 and a light chain given by SEQ ID NO: 24) were analyzed by EpiMatrix®. The EpiMatrix® predicted scores are shown below in Table 3.

Table 3. EpiMatrix® scores.

Antibody	EpiMatrix Protein Score	Tregitope-Adjusted EpiMatrix Protein Score	Predicted T-Dependent Ab Response
201c	39.14	-35.49	0.28%
201cYD	24.76	-49.87	0.00%
B12L	0.44	-17.92	4.03%

These data demonstrate that the predicted T cell-dependent antibody response is lower for the N3pGlu Aβ antibodies of the present invention (201c and 201cYD) as compared to the B12L antibody.

Lack of Anti-Drug Antibody (ADA) Recognition

An Affinity Capture Elution (ACE) Bridge assay using biotin and ruthenium labeled 201c or biotin and ruthenium labeled 201cYD is performed in order to assess whether anti-drug antibodies directed against the LY3002813 antibody could bind to 201c or 201cYD.

In this assay format, the ADA bridge between the two labeled antibodies (e.g. biotin and ruthenium labeled 201c). The complex then binds to a plate coated with streptavidin (via the biotin-labeled antibody) and the detection uses Ruthenium to generate signal in a Mesoscale platform. If the ADA does not recognize either the 201c or 201cYD antibody, no signal will be generated. Rabbit anti-human IgG most likely binds preferentially to the Fc, and is used as a positive control to show that labeled 201c or 201cYD could bind antibodies.

The antibodies directed against LY3002813 include antibodies affinity purified from two patient samples from a clinical trial (I5T-MC-AACC NCT01837641) after LY3002813 administration. These patients had developed ADA response for LY3002813 over time as shown by a positive binding signal in ACE bridge.

Following procedures essentially as described above, no signal was observed above background when detecting binding of either 201c or 201cYD to antibodies against LY3002813. These data demonstrate that ADA directed against LY3002813 in humans does not recognize 201c and 201cYD.

Sequences

Antibody 201c, Antibody 201cYD, and Antibody 201c H3B HCDR1 (SEQ ID NO: 1)

AASGFTFSSYPMS

Antibody 201c, Antibody 201cYD, and Antibody 201c H3B HCDR2 (SEQ ID NO: 2)

AISGSGGSTYYADSVKG

Antibody 201c and Antibody 201cYD HCDR3 (SEQ ID NO: 3)

AREGGSGSYYNGFDY

Antibody 201c and Antibody 201c H3B LCDR1 (SEQ ID NO: 4)

RASQSLGNWLA

Antibody 201cYD LCDR1 (SEQ ID NO: 5)

RASQSLGNYLA

Antibody 201c and Antibody 201c H3B LCDR2 (SEQ ID NO: 6)

YQASTLES

Antibody 201cYD LCDR2 (SEQ ID NO: 7)

YDASTLES

Antibody 201c, Antibody 201cYD, and Antibody 201c H3B LCDR3 (SEQ ID NO: 8)

QHYKGSFWT

Antibody 201c and Antibody 201cYD HCVR (SEQ ID NO: 9)

EVQLLESGGGLVQPGGSLRLSCAASGFTFSSYPMSWVRQAPGKGLEWVSAISGS
GGSTYYADSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYCAREGGSGSYYN
GFDYWGQGTLVTVSS

Antibody 201c and Antibody 201c H3B LCVR (SEQ ID NO: 10)

DIQMTQSPSTLSASVGDRVTITCRASQSLGNWLAWYQQKPGKAPKLLIYQASTLE
SGVPSRFSGSGSGTEFTLTISSLQPDDFATYYCQHYKGSFWTFGQGTKVEIK

Antibody 201cYD LCVR (SEQ ID NO: 11)

DIQMTQSPSTLSASVGDRVTITCRASQSLGNYLAWYQQKPGKAPKLLIYDASTLE
SGVPSRFSGSGSGTEFTLTISSLQPDDFATYYCQHYKGSFWTFGQGTKVEIK

Antibody 201c and Antibody 201cYD Heavy Chain (SEQ ID NO: 12)

EVQLLESGGGLVQPGGSLRLSCAASGFTFSSYPMSWVRQAPGKGLEWVSAISGS
GGSTYYADSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYCAREGGSGSYYN
GFDYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVS

WNSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVD
KKVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSH
EDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYK
CKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSD
IAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHE
ALHNHYTQKSLSLSPG

Antibody 201c and Antibody 201c H3B Light Chain (SEQ ID NO: 13)

DIQMTQSPSTLSASVGDRVTITCRASQSLGNWLAWYQQKPGKAPKLLIYQASTLE
SGVPSRFSGSGSGTEFTLTISSLQPDDFATYYCQHYKGSFWTFGQGTKVEIKRTVA
APSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQ
DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC

Antibody 201cYD Light Chain (SEQ ID NO: 14)

DIQMTQSPSTLSASVGDRVTITCRASQSLGNYLAWYQQKPGKAPKLLIYDASTLE
SGVPSRFSGSGSGTEFTLTISSLQPDDFATYYCQHYKGSFWTFGQGTKVEIKRTVA
APSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQ
DSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC

Exemplified DNA for Expressing Antibody Heavy Chain of SEQ ID NO: 12 (SEQ ID NO: 15)

gaggtgcagctgttggagtctgggggaggcttggtacagcctgggggtccctgagactctcctgtgcagcctctggattcacct
ttagcagctatcctatgagctgggtccgccaggctccagggaaggggctggagtgggtctcagctattagtggtagtggtggtag
cacatactacgcagactccgtgaagggccggttcaccatctccagagacaattccaagaacacgctgtatctgcaaatgaacag
cctgagagccgaggacacggccgtatattactgtgcgagagaggggggctcagggagttattataacggctttgattattgggg
ccagggaaccctggtcaccgtctcctcagcctccaccaagggcccatcggtcttccccgctagcaccctcctccaagagcacctc
tgggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctg
accagcggcgtgcacaccttccccgctgtcctacagtcctcaggactctactccctcagcagcgtggtgaccgtgccctccagc
agcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatc
ttgtgacaaaactcacacatgcccaccgtgcccagcacctgaactcctgggggggaccgtcagtcttcctcttccccccaaaaccc
aaggacaccctcatgatctcccggacccctgaggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagtt
caactggtacgtggacggcgtggaggtgcataatgccaagacaaagccgcgggaggagcagtacaacagcacgtaccgtgt
ggtcagcgtcctcaccgtcctgcaccaggactggctgaatggcaaggagtacaagtgcaaggtctccaacaaagccctcccag
ccccccatcgagaaaaccatctccaaagccaaagggcagccccgagaaccacaggtgtacaccctgccccccatcccgggacg

agctgaccaagaaccaggtcagcctgacctgcctggtcaaaggcttctatcccagcgacatcgccgtggagtgggagagcaat
gggcagccggagaacaactacaagaccacgcctcccgtgctggactccgacggctccttcttcctctatagcaagctcaccgtg
gacaagagcaggtggcagcaggggaacgtcttctcatgctccgtgatgcatgaggctctgcacaaccactacacgcagaagag
cctctccctgtctccgggt

Exemplified DNA for Expressing Antibody Light Chain of SEQ ID NO: 13 (SEQ ID NO: 16)

gacatccagatgacccagtctccttccaccctgtctgcatctgtaggagacagagtcaccatcacttgccgggccagtcagagtct
tggtaactggttggcctggtatcagcagaaaccagggaaagcccctaaactcctgatctatcaggcgtctactttagaatctgggg
tcccatcaagattcagcggcagtggatctgggacagagttcactctcaccatcagcagcctgcagcctgatgattttgcaacttatt
actgccaacattataaaggttcttttggacgttcggccaagggaccaaggtggaaatcaaacggaccgtggctgcaccatctgtc
ttcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgttgtgtgcctgctgaataacttctatcccagagaggcca
aagtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcaaggacagca
cctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatca
gggcctgagctcgcccgtcacaaagagcttcaacaggggagagtgc

Exemplified DNA for Expressing Antibody Light Chain of SEQ ID NO: 14 (SEQ ID NO: 17)

gacatccagatgacccagtctccttccaccctgtctgcatctgtaggagacagagtcaccatcacttgccgggccagtcagagtct
tggtaactatttggcctggtatcagcagaaaccagggaaagcccctaaactcctgatctatgatgcgtctactttagaatctggggt
cccatcaagattcagcggcagtggatctgggacagagttcactctcaccatcagcagcctgcagcctgatgattttgcaacttatta
ctgccaacattataaaggttcttttggacgttcggccaagggaccaaggtggaaatcaaacggaccgtggctgcaccatctgtct
tcatcttcccgccatctgatgagcagttgaaatctggaactgcctctgttgtgtgcctgctgaataacttctatcccagagaggccaa
agtacagtggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggacagcaaggacagcac
ctacagcctcagcagcaccctgacgctgagcaaagcagactacgagaaacacaaagtctacgcctgcgaagtcacccatcag
gcctgagctcgcccgtcacaaagagcttcaacaggggagagtgc

Antibody 201c H3B HCDR3 (SEQ ID NO: 18)

AREGGSGSYFNGFDY

Antibody 201c H3B HCVR (SEQ ID NO: 19)

EVQLLESGGGLVQPGGSLRLSCAASGFTFSSYPMSWVRQAPGKGLEWVSAISGS
GGSTYYADSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYCAREGGSGSYFNG
FDYWGQGTLVTVSS

Antibody 201c H3B Heavy Chain (SEQ ID NO: 20)

EVQLLESGGGLVQPGGSLRLSCAASGFTFSSYPMSWVRQAPGKGLEWVSAISGS
GGSTYYADSVKGRFTISRDNSKNTLYLQMNSLRAEDTAVYYCAREGGSGSYFNG
FDYWGQGTLVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSW
NSGALTSGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDK
KVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHE
DPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKC
KVSNKALPAPIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDI
AVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHE
ALHNHYTQKSLSLSPG

Exemplified DNA for Expressing Antibody Heavy Chain of SEQ ID NO: 20 (SEQ ID NO: 21)

gaggtgcagctgttggagtctgggggaggcttggtacagcctgggggtccctgagactctcctgtgcagcctctggattcacct
ttagcagctatcctatgagctgggtccgccaggctccagggaaggggctggagtgggtctcagctattagtggtagtggtggtag
cacatactacgcagactccgtgaagggccggttcaccatctccagagacaattccaagaacacgctgtatctgcaaatgaacag
cctgagagccgaggacacggccgtatattactgtgcgagagaggggggctcagggagttattttaacggctttgattattggggc
cagggaaccctggtcaccgtctcctcagcctccaccaagggcccatcggtcttccccgctagcaccctcctccaagagcacctct
gggggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcgtggaactcaggcgccctga
ccagcggcgtgcacaccttcccggctgtcctacagtcctcaggactctactccctcagcagcgtggtgaccgtgccctccagca
gcttgggcacccagacctacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagcccaaatct
tgtgacaaaactcacacatgcccaccgtgcccagcacctgaactcctgggggggaccgtcagtcttcctcttccccccaaaaccca
aggacaccctcatgatctcccggacccctgaggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttc
aactggtacgtggacggcgtggaggtgcataatgccaagacaaagccgcgggaggagcagtacaacagcacgtaccgtgtg
gtcagcgtcctcaccgtcctgcaccaggactggctgaatggcaaggagtacaagtgcaaggtctccaacaaagccctcccagc
ccccatcgagaaaaccatctccaaagccaaagggcagccccgagaaccacaggtgtacaccctgcccccatcccgggacga
gctgaccaagaaccaggtcagcctgacctgcctggtcaaaggcttctatcccagcgacatcgccgtggagtgggagagcaatg
ggcagccggagaacaactacaagaccacgcctcccgtgctggactccgacggctccttcttcctctatagcaagctcaccgtgg
acaagagcaggtggcagcaggggaacgtcttctcatgctccgtgatgcatgaggctctgcacaaccactacacgcagaagagc
ctctccctgtctccgggt

N3pGlu Aβ (SEQ ID NO: 22)

[pE]FRHDSGYEVHHQKLVFFAEDVGSNKGAIIGLMVGGVVIA

Antibody B12L Heavy Chain (SEQ ID NO: 23)

QVQLVQSGAEVKKPGSSVKVSCKASGYDFTRYYINWVRQAPGQGLEWMGWINP
GSGNTKYNEKFKGRVTITADESTSTAYMELSSLRSEDTAVYYCAREGITVYWGQ
GTTVTVSSASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALT
SGVHTFPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKS
CDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKF
NWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKA
LPAPIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWES
NGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHY
TQKSLSLSPG

Antibody B12L Light Chain (SEQ ID NO: 24)

DIVMTQTPLSLSVTPGQPASISCKSSQSLLYSRGKTYLNWLLQKPGQSPQLLIYAV
SKLDSGVPDRFSGSGSGTDFTLKISRVEAEDVGVYYCVQGTHYPFTFGQGTKLEI
KRTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQ
ESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC

WE CLAIM:

1. An antibody that binds human N3pGlu Aβ, comprising a light chain variable region (LCVR) and a heavy chain variable region (HCVR), wherein the LCVR comprises LCDR1 having the amino acid sequence of SEQ ID NO: 4 or 5, LCDR2 having the amino acid sequence of SEQ ID NO: 6 or 7, and LCDR3 having the amino acid sequence of SEQ ID NO: 8, and wherein the HCVR comprises HCDR1 having the amino acid sequence of SEQ ID NO: 1, HCDR2 having the amino acid sequence of SEQ ID NO: 2, and HCDR3 having the amino acid sequence of SEQ ID NO: 3.

2. The antibody of Claim 1, wherein LCDR1 has the amino acid sequence of SEQ ID NO: 4 and LCDR2 has the amino acid sequence of SEQ ID NO: 6.

3. The antibody of Claim 1, wherein LCDR1 has the amino acid sequence of SEQ ID NO: 5 and LCDR2 has the amino acid sequence of SEQ ID NO: 7.

4. The antibody of any one of Claims 1-3, wherein the LCVR has the amino acid sequence of SEQ ID NO: 10 or 11, and the HCVR has the amino acid sequence of SEQ ID NO:9.

5. The antibody of Claim 4, comprising a LCVR having the amino acid sequence of SEQ ID NO: 10, and a HCVR having the amino acid sequence of SEQ ID NO:9.

6. The antibody of Claim 4, comprising a LCVR having the amino acid sequence of SEQ ID NO: 11, and a HCVR having the amino acid sequence of SEQ ID NO:9.

7. The antibody of any one of Claims 1-6, comprising a light chain (LC) having the amino acid sequence of SEQ ID NO: 13 or 14, and a heavy chain (HC) having the amino acid sequence of SEQ ID NO: 12.

8. The antibody of Claim 7, comprising a LC having the amino acid sequence of SEQ ID NO: 13 and a HC having the amino acid sequence of SEQ ID NO: 12.

9. The antibody of Claim 7, comprising a LC having the amino acid sequence of SEQ ID NO: 14 and a HC having the amino acid sequence of SEQ ID NO: 12.

10. The antibody of any one of Claims 1-9, comprising two LCs and two HCs, wherein the amino acid sequence of each LC is SEQ ID NO: 13 or 14, and the amino acid sequence of each HC is SEQ ID NO: 12.

11. The antibody of Claim 10, wherein the amino acid sequence of each LC is SEQ ID NO:13, and the amino acid sequence of each HC is SEQ ID NO: 12.

12. The antibody of Claim 10, wherein the amino acid sequence of each LC is SEQ ID NO:14, and the amino acid sequence of each HC is SEQ ID NO: 12.

13. A pharmaceutical composition comprising the antibody of any one of Claims 1 to 12 and one or more pharmaceutically acceptable carriers, diluents or excipients.

14. A method of treating a patient having a condition characterized by deposition of Aβ, comprising administering to the patient an effective amount of the antibody of any one of Claims 1 to 12.

15. The method of Claim 14, wherein the condition is selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA.

16. The method of Claim 14, wherein the condition is selected from prodromal AD, mild AD, moderate AD, and severe AD.

17. The method of Claim 14, wherein the patient has the PSEN1 E280A genetic mutation.

18. The method of Claim 14, wherein the patient has a genetic mutation that causes autosomal-dominant Alzheimer's disease.

19. A method of treating memory loss or cognitive decline in a patient having a condition characterized by deposition of Aβ, comprising administering to the patient an effective amount of the antibody of any one of Claims 1 to 12.

20. The method of Claim 19, wherein the patient has the PSEN1 E280A genetic mutation.

21. The method of Claim 19, wherein the patient has a genetic mutation that causes autosomal-dominant Alzheimer's disease.

22. A method of preventing memory loss or cognitive decline in a patient having the PSEN1 E280A genetic mutation, comprising administering to the patient an effective amount of the antibody of any one of Claims 1 to 12.

23. A method of preventing memory loss or cognitive decline in a patient having a genetic mutation that causes autosomal-dominant Alzheimer's disease., comprising administering to the patient an effective amount of the antibody of any one of Claims 1 to 12.

24. A method of treating an asymptomatic patient having a genetic mutation that causes autosomal-dominant Alzheimer's disease, comprising administering to the patient a pharmaceutical composition comprising the antibody of any one of Claims 1 to 12.

25. In another particular embodiment, the present invention provides a method of preventing memory loss or cognitive decline in an asymptomatic patient having a genetic mutation that causes autosomal-dominant Alzheimer's disease, comprising administering to the patient a pharmaceutical composition comprising the antibody of any one of Claims 1 to 12.

26. In another particular embodiment, the present invention provides a method of slowing cognitive decline in an asymptomatic patient having a genetic mutation that causes autosomal-dominant Alzheimer's disease, comprising administering to the patient a pharmaceutical composition comprising the antibody of any one of Claims 1 to 12.

27. A method of preventing a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA in a patient, comprising administering to the patient an effective amount of the antibody of any one of Claims 1 to 12.

28. A method of preventing a condition selected from prodromal AD, mild AD, moderate AD, and severe AD in a patient, comprising administering to the patient an effective amount of the antibody of any one of Claims 1 to 12.

29. A method of slowing cognitive or functional decline in a patient having a condition characterized by deposition of Aβ, comprising administering to the patient an effective amount of the antibody of any one of Claims 1 to 12.

30. The method of Claim 29, wherein the condition is selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA.

31. The method of Claim 29, wherein the condition is selected from prodromal AD, mild AD, moderate AD, and severe AD.

32. A method of reducing brain Aβ amyloid plaque load in a patient having a condition characterized by deposition of Aβ, comprising administering to the patient an effective amount of the antibody of any one of Claims 1 to 12.

33. The method of Claim 32, wherein the condition is selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA.

34. The method of Claim 32, wherein the condition is selected from prodromal AD, mild AD, moderate AD or severe AD.

35. The antibody of any one of Claims 1 to 12 for use in therapy.

36. The antibody of any one of Claims 1 to 12 for use in the treatment of a condition characterized by deposition of Aβ.

37. The antibody of any one of Claims 1 to 12 for use in the treatment of a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA.

38. The antibody of any one of Claims 1 to 12 for use in the treatment of a condition selected from prodromal AD, mild AD, moderate AD, and severe AD.

39. The antibody of any one of Claims 1 to 12 for use in slowing cognitive or functional decline in a patient diagnosed with a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA.

40. The antibody of any one of Claims 1 to 12 for use in slowing cognitive or functional decline in a patient diagnosed with a condition selected from prodromal AD, mild AD, moderate AD, and severe AD.

41. The antibody of any one of Claims 1 to 12 for use in reducing brain Aβ amyloid plaque load.

42. The antibody of any one of Claims 1 to 12 for use in treating a condition characterized by deposition of Aβ in a patient having the PSEN1 E280A genetic mutation.

43. The antibody of any one of Claims 1 to 12 for use in treating a condition characterized by deposition of Aβ in a patient having a genetic mutation that causes autosomal-dominant Alzheimer's disease.

44. The antibody of any one of Claims 1 to 12 for use in treating memory loss or cognitive decline in a patient having the PSEN1 E280A genetic mutation.

45. The antibody of any one of Claims 1 to 12 for use in treating memory loss or cognitive decline in a patient having a genetic mutation that causes autosomal-dominant Alzheimer's disease.

46. The antibody of any one of Claims 1 to 12 for use in preventing memory loss or cognitive decline in a patient having the PSEN1 E280A genetic mutation.

47. The antibody of any one of Claims 1 to 12 for use in preventing memory loss or cognitive decline in a patient having a genetic mutation that causes autosomal-dominant Alzheimer's disease.

48. The antibody of any one of Claims 1 to 12 for use in the prevention of a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA.

49. The antibody of any one of Claims 1 to 12 for use in the prevention of a condition selected from prodromal AD, mild AD, moderate AD, and severe AD.

50. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for the treatment of a condition characterized by deposition of Aβ.

51. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for the treatment of a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA.

52. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for the treatment of a condition selected from prodromal AD, mild AD, moderate AD, and severe AD.

53. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for slowing cognitive or functional decline in a patient diagnosed with a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA.

54. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for slowing cognitive or functional decline in a patient diagnosed with a condition selected from prodromal AD, mild AD, moderate AD, and severe AD.

55. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for reducing brain Aβ amyloid plaque load.

56. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for treating a condition characterized by deposition of Aβ in a patient having the PSEN1 E280A genetic mutation.

57. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for treating a condition characterized by deposition of Aβ in a patient having a genetic mutation that causes autosomal-dominant Alzheimer's disease.

58. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for treating memory loss or cognitive decline in a patient having the PSEN1 E280A genetic mutation.

59. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for treating memory loss or cognitive decline in a patient having a genetic mutation that causes autosomal-dominant Alzheimer's disease.

60. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for preventing memory loss or cognitive decline in a patient having the PSEN1 E280A genetic mutation.

61. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for preventing memory loss or cognitive decline in a patient

having a genetic mutation that causes autosomal-dominant Alzheimer's disease.

62. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for preventing a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA.

63. Use of the antibody of any one of Claims 1 to 12 in the manufacture of a medicament for preventing a condition selected from prodromal AD, mild AD, moderate AD, and severe AD.

64. A pharmaceutical composition for use in treating a condition characterized by deposition of Aβ, comprising an effective amount of the antibody of any one of Claims 1 to 12.

65. A pharmaceutical composition for use in treating a condition selected from clinical or pre-clinical AD, Down's syndrome, and clinical or pre-clinical CAA, comprising an effective amount of the antibody of any one of Claims 1 to 12.

66. A pharmaceutical composition for use in treating a condition selected from prodromal AD, mild AD, moderate AD, and severe AD, comprising an effective amount of the antibody of any one of Claims 1 to 12.

67. A DNA molecule comprising a polynucleotide that encodes the antibody heavy chain given by the amino acid sequence of SEQ ID NO:12.

68. The DNA molecule of Claim 67, wherein the amino acid sequence of the polynucleotide is SEQ ID NO:15.

69. A DNA molecule comprising a polynucleotide that encodes the antibody light chain given by the amino acid sequence of SEQ ID NO:13.

70. The DNA molecule of Claim 69, wherein the amino acid sequence of the polynucleotide is SEQ ID NO:16.

71. A DNA molecule comprising a polynucleotide that encodes the antibody light chain given by the amino acid sequence of SEQ ID NO:14.

72. The DNA molecule of Claim 71, wherein the amino acid sequence of the polynucleotide is SEQ ID NO:17.

73. A DNA molecule comprising a polynucleotide sequence that encodes the antibody heavy chain having the amino acid sequence of SEQ ID NO: 12

and a polynucleotide sequence that encodes the antibody light chain having the amino acid sequence of SEQ ID NO: 13 or 14.

74. The DNA molecule of Claim 73, wherein the polynucleotide sequence that encodes the antibody heavy chain is SEQ ID NO:15, and the polynucleotide sequence that encodes the antibody light chain is SEQ ID NO:16 or 17.

75. A mammalian cell transformed with the DNA molecule of Claim 67 and the DNA molecule of Claim 69 or Claim 71, wherein the transformed cell is capable of expressing an antibody comprising two heavy chains and two light chains, wherein the amino acid sequence of each heavy chain is given by SEQ ID NO:12 and the amino acid sequence of each light chain is given by SEQ ID NO:13 or 14.

76. A mammalian cell transformed with the DNA molecule of Claim 73, wherein the transformed cell is capable of expressing an antibody comprising two heavy chains and two light chains, wherein the amino acid sequence of each heavy chain is given by SEQ ID NO:12 and the amino acid sequence of each light chain is given by SEQ ID NO:13 or 14.

77. The cell of Claim 75 or 76, wherein the cell is a CHO cell.

78. A process for producing an antibody, wherein the amino sequence of each of the two HCs is SEQ ID NO: 12, and the amino acid sequence of each of the two LCs is SEQ ID NO: 13 or 14, and wherein the process comprises: a) cultivating the mammalian cell of Claim 75 or 76 under conditions such that the antibody is expressed, and b) recovering the expressed antibody.

79. An antibody obtainable by the process of Claim 78.