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(71) Applicant: **APRINOIA THERAPEUTICS LIMITED**  
[CN/CN]; 31/F, Chinachem Century Tower, 178 Gloucester  
Road, Wanchai, Hong Kong, Hong Kong (CN).

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(72) Inventors: **JANG, Ming-Kuei**; c/o Aprinoia Therapeutics  
Inc., 17F, No. 3, Park St., Nangang District, Taipei City,  
11503 (TW). **TAI, Chin-Yin**; c/o Aprinoia Therapeutics  
Inc., 17F, No.3, Park St. Nangang District, Taipei City,  
11503 (TW).

(74) Agent: **LEE AND LI - LEAVEN IPR AGENCY LTD.**;  
Unit 2202, Tower A, Beijing Marriott Center, No. 7, Jian  
Guo Men South Avenue, Beijing 100005 (CN).

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(54) Title: ANTIBODIES THAT BIND TO PATHOLOGICAL TAU SPECIES AND USES THEREOF

(57) Abstract: The present disclosure relates to antibodies that bind selectively to pathological Tau, including compositions and methods relating to such antibodies, such as for treating tauopathies, neurodegenerative diseases associated with pathological aggregation of Tau.



## **Antibodies That Bind to Pathological Tau Species and Uses Thereof**

### **CROSS-REFERENCES TO RELATED APPLICATIONS**

[0001] This application claims priority to U.S. Provisional Application No. 62/883,605, filed August 6, 2019, which is incorporated herein in its entirety for all purposes.

### **SEQUENCE LISTING**

[0002] This application contains a Sequence Listing in computer readable form as a ASCII text file named 056239\_501001WO\_ST25.txt; which is 55,716 bytes in size, created August 1, 2020, and electronically submitted via ePCT herewith the application. The Sequence Listing is incorporated herein by reference in its entirety and forms part of the disclosure.

### **FIELD**

[0003] The present disclosure generally relates to antibodies that bind pathological Tau species, including compositions and methods relating to the antibodies, such as for treating neurodegenerative diseases associated with pathological aggregation of Tau.

### **BACKGROUND**

[0004] Neurodegenerative diseases affect an estimated 50 million Americans each year, exacting an incalculable personal toll and an annual economic cost of hundreds of billions of dollars in medical expenses and lost productivity. Tauopathies are a class of neurodegenerative diseases associated with pathological aggregation of Tau protein in the human brain, and include Alzheimer's disease (AD), amyotrophic lateral sclerosis (ALS), Huntington's disease (HD), Parkinson's disease (PD), Pick's Disease (PiD), and Progressive Supranuclear Palsy (PSP). In tauopathy, aggregation of Tau spreads through the brain in a prion-like manner, such as seen in AD brain (Braak, H., & Braak, E. V. A. (1995). *Neurobiology of aging*, 16(3), 271-278; Braak, H., et al. (2006). *Acta neuropathologica*, 112(4), 389-404), where Tau pathology manifests in a consistent spatiotemporal pattern. Tau is normally a highly soluble cytoplasmic protein, but in Alzheimer's disease, Tau is abnormally phosphorylated and accumulates at synapses to exert synaptotoxicity. Tau propagation seeds, consisting mainly of short fibrils, have been found to be significantly enriched in the synaptic fractions of brain regions lacking extensive cellular Tau

pathology, indicating that Tau seeds are able to spread through the human brain along synaptically-connected neuronal networks.

[0005] Despite the many therapeutic approaches aimed at removing aggregated Tau species that have been or are currently being investigated, at present there are no effective treatments for halting, preventing, or reversing the progression of such neurodegenerative diseases. Therefore, there is an urgent need for pharmaceutical agents capable of slowing the progression of these neurodegenerative diseases and/or preventing them from developing.

### SUMMARY

[0006] This section provides a general summary of the disclosure, and is not comprehensive of its full scope or all of its features. The present application provides anti-Tau antibodies or antigen-binding moieties thereof (e.g., an isolated anti-Tau antibody or antigen-binding moiety thereof). Without being bound to theory, in some embodiments, the anti-Tau antibodies or antigen-binding moieties thereof are capable of binding selectively to Tau aggregates that are more abundant in human tauopathy disorders. In some embodiments, the anti-Tau antibodies or antigen-binding moieties thereof are capable of inhibiting Tau seeding and/or Tau aggregation, thus preventing the initiation and/or spreading of such human tauopathies.

[0007] In one aspect, provided herein is an anti-Tau antibody or antigen-binding moiety thereof (e.g., an isolated anti-Tau antibody or antigen-binding moiety thereof) comprising: a) a heavy chain variable region comprising i) a complementary determining region (CDR) 1 comprising the amino acid sequence of any one of SEQ ID NOs: 49-59 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 49-59; ii) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 60-70 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 60-70; and/or iii) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 71-81 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 71-81; and/or b) a light chain variable region comprising iv) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 82-90 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 82-90; v) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 91-95 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 91-95;

and/or vi) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 96-105 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 96-105.

**[0008]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, 1) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively; 2) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 49, 60, and 71, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 49, 60, and 71, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 82, 91, and 96, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 82, 91, and 96, respectively; 3) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 51, 62, and 73, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 51, 62, and 73, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 84, 91, and 98, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 84, 91, and 98, respectively; 4) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 52, 63, and 74, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 52, 63, and 74, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 85, 92, and 99, respectively, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 85, 92, and 99, respectively; 5) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 53, 64, and 75, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 53, 64, and 75, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the

amino acid sequences of SEQ ID NOs: 86, 93, and 100, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 86, 93, and 100, respectively; 6) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 54, 65, and 76, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 54, 65, and 76, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 101, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 87, 93, and 101, respectively; 7) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 55, 66, and 77, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 55, 66, and 77, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 102, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 83, 91, and 102, respectively; 8) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 56, 67, and 78, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 56, 67, and 78, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 88, 94, and 103, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 88, 94, and 103, respectively; 9) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 57, 68, and 79, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 57, 68, and 79, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 89, 91, and 98, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 89, 91, and 98, respectively; 10) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 58, 69, and 80, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 58, 69, and 80, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 90, 95, and 104, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 90, 95, and 104, respectively; or 11) the

heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively.

**[0009]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively.

**[0010]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively.

**[0011]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively.

**[0012]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively.

**[0013]**

**[0014]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106; and/or the light chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107.

**[0015]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, 1) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 3 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 3; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 15 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 15; 2) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 2 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 2; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 14 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 14; 3) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 1 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 1; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 13 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 13; 4) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 4 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 4; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 16 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 16; 5) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 5 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 5; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 17 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 17; 6) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 6 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 6; and the light chain variable region comprises the amino acid

sequence of SEQ ID NO: 18 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 18; 7) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 7 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 7; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 19 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 19; 8) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 8 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 8; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 20 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 20; 9) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 9 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 9; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 21 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 21; 10) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 10 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 10; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 22 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 22; 11) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 11 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 11; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 23 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 23; 12) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 12 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 12; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 24 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 24; or 13) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 106 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 106; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 107 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 107. In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region



comprises the amino acid sequence of SEQ ID NO: 3 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 3; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 15 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 15.

**[0016]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 3; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 15.

**[0017]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 106 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 106; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 107 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 107.

**[0018]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 106; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 107.

**[0019]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the antibody or antigen-binding moiety is a monoclonal antibody.

**[0020]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the antibody or antigen-binding moiety is a human, humanized, or chimeric antibody. In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the antibody or antigen-binding moiety preferably binds to pathological human Tau species relative to normal human Tau species. In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the antibody or antigen-binding moiety specifically binds to pathological human Tau species relative to normal human Tau species. In some embodiments, the pathological human Tau species is from a tauopathy selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD). In some embodiments, the pathological human Tau species is from a tauopathy brain selected from the

group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD). In some embodiments, the pathological human Tau species is Tau Type 1A, IB, 11 A, or MB; misordered Tau; mis-disordered Tau; sarkosyl-insoluble Tau; an extracellular Tau deposit; a Tau aggregate; paired helical filaments; a neurofibrillary pathology; or a hyperphosphorylated form of truncated Tau or full-length Tau. In some embodiments, the pathological human Tau species is a hyperphosphorylated and sarkosyl-insoluble Tau species. In some embodiments, the pathological human Tau species is Tau aggregates and/or abnormally phosphorylated accumulated at synapses of tauopathy brain.

**[0021]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the antibody or antigen-binding moiety binds to a hyperphosphorylated and sarkosyl-insoluble 64 kD Tau species from a human Alzheimer's Disease (AD) brain lysate. In some embodiments, the antibody or antigen-binding moiety i) further binds to sarkosyl-insoluble 58 kD and/or 68 kD Tau species from the human AD brain lysate; and/or ii) does not bind to 140 kD and/or 170 kD Tau species from the human AD brain lysate.

**[0022]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the antibody or antigen-binding moiety is an IgG1, IgG2, IgG3 or an IgG4 antibody. In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the antibody or antigen-binding moiety is an IgG1 or an IgG4 antibody.

**[0023]** In another aspect, provided herein is an isolated nucleic acid encoding an antibody or antigen-binding moiety according to any of the embodiments described above.

**[0024]** In another aspect, provided here is a host cell comprising a nucleic acid according to any of the embodiments described above.

**[0025]** In another aspect, provided herein is a method of producing an antibody or antigen-binding moiety comprising culturing a host cell according to any of the embodiments described above under conditions suitable for producing the antibody or antigen-binding moiety.

**[0026]** In another aspect, provided herein is an immunoconjugate comprising an antibody or antigen-binding moiety according to any of the embodiments described above and a second therapeutic agent.

**[0027]** In another aspect, provided herein is a labeled antibody comprising an antibody or antigen-binding moiety according to any of the embodiments described above and a detectable label.

[0028] In another aspect, provided herein is a pharmaceutical composition comprising an antibody or antigen-binding moiety according to any of the embodiments described above and a pharmaceutically acceptable carrier.

[0029] In another aspect, provided herein is a method of treating or preventing a Tau protein-associated disease in a subject, comprising administering to the subject an antibody or antigen-binding moiety according to any of the embodiments described above or a pharmaceutical composition according to any of the embodiments described above.

[0030] In another aspect, provided herein is a method of retaining or increasing cognitive memory capacity or slowing memory loss in a subject having or at risk of developing a Tau protein-associated disease, comprising administering to the subject an antibody or antigen-binding moiety according to any of the embodiments described above or a pharmaceutical composition according to any of the embodiments described above.

[0031] In another aspect, provided herein is a method of reducing the level of Tau protein in a subject having or at risk of developing a Tau protein-associated disease, comprising administering to the subject an antibody or antigen-binding moiety according to any of the embodiments described above or a pharmaceutical composition according to any of the embodiments described above, wherein i) the level of non-phosphorylated Tau protein, phosphorylated Tau protein, and/or hyperphosphorylated Tau protein is reduced in the subject as compared to their levels in the subject prior to administration of the antibody or antigen-binding moiety; and/or ii) the level of a pathological Tau species is reduced in the subject as compared to its level in the subject prior to administration of the antibody or antigen-binding moiety. In some embodiments, a method of reducing the level of Tau protein aggregates in a subject having or at risk of developing a Tau protein-associated disease comprises administering to the subject an antibody or antigen-binding moiety according to any of the embodiments described above or a pharmaceutical composition according to any of the embodiments described above, wherein i) the level of non-phosphorylated Tau protein, phosphorylated Tau protein, and/or hyperphosphorylated Tau protein is reduced in the subject as compared to their levels in the subject prior to administration of the antibody or antigen-binding moiety; and/or ii) the level of a pathological Tau species is reduced in the subject as compared to its level in the subject prior to administration of the antibody or antigen-binding moiety. In some embodiments, the level of Tau protein aggregates and/or abnormally phosphorylated Tau is reduced in the subject as compared to their levels in the subject prior to

administration of the antibody or antigen-binding moiety

[0032] In another aspect, provided herein is a method of inhibiting and/or reversing the propagation of Tau aggregation in a subject having or at risk of developing a Tau protein-associated disease, comprising administering to the subject an antibody or antigen-binding moiety according to any of the embodiments described above or a pharmaceutical composition according to any of the embodiments described above. In some embodiments, a method of inhibiting the propagation of Tau aggregation in a subject having or at risk of developing a Tau protein-associated disease comprises administering to the subject an antibody or antigen-binding moiety according to any of the embodiments described above or a pharmaceutical composition according to any of the embodiments described above.

[0033] In another aspect, provided herein is a method of inhibiting and/or reversing Tau seeding in a subject having or at risk of developing a Tau protein-associated disease, comprising administering to the subject an antibody or antigen-binding moiety according to any of the embodiments described above or a pharmaceutical composition according to any of the embodiments described above. In some embodiments, a method of inhibiting Tau seeding in a subject having or at risk of developing a Tau protein-associated disease comprises administering to the subject an antibody or antigen-binding moiety according to any of the embodiments described above or a pharmaceutical composition according to any of the embodiments described above.

[0034] In some embodiments, according to any of the methods described above, the Tau protein-associated disease is a tauopathy.

[0035] In some embodiments, the tauopathy is a neurodegenerative tauopathy. In some embodiments, the tauopathy is selected from the group consisting of Alzheimer's Disease (AD), amyotrophic lateral sclerosis (ALS), Huntington's disease (HD), Parkinson's disease (PD), Creutzfeldt-Jacob disease, Dementia pugilistica, Down's Syndrome, Gerstmann-Straussler-Scheinker disease, British dementia, Danish dementia, inclusion-body myositis, prion protein cerebral amyloid angiopathy, traumatic brain injury, Guam Parkinsonism-dementia complex, Non-Guamanian motor neuron disease with neurofibrillary tangles, argyrophilic grain dementia, corticobasal degeneration, diffuse neurofibrillary tangles with calcification, frontotemporal dementia, frontotemporal dementia with parkinsonism linked to chromosome 17, Hallevorden-Spatz disease, multiple system atrophy, Niemann-Pick disease type C, Pallido-ponto-nigral

degeneration, Pick's disease, progressive subcortical gliosis, progressive supranuclear palsy, Subacute sclerosing panencephalitis, Tangle-only dementia, White matter tauopathy with globular glial inclusions, Frontotemporal dementia, Postencephalitic Parkinsonism, Parkinsonism linked to chromosome 17, and Myotonic dystrophy. In some embodiments, the tauopathy is Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), or Pick's disease (PiD).

**[0036]** In some embodiments, according to any of the methods described above, the method further comprises administering to the subject at least one additional therapy. In some embodiments, the at least one additional therapy is selected from neuroprotective agents, neurological drugs, corticosteroids, antibiotics, antiviral agents, anti-Tau antibodies, Tau inhibitors, anti-amyloid beta antibodies, beta-amyloid aggregation inhibitors, anti-BACE1 antibodies, and BACE1 inhibitors. In some embodiments, the at least one additional therapy is selected from neurological drugs, corticosteroids, antibiotics, antiviral agents, anti-Tau antibodies, Tau inhibitors, anti-amyloid beta antibodies, beta-amyloid aggregation inhibitors, anti-BACE1 antibodies, and BACE1 inhibitors. In some embodiments, the at least one additional therapy is a neuroprotective agent for use of in a combination therapy for the prevention or therapeutic treatment of neurodegenerative diseases, including delaying the onset, slowing the progression or ameliorating symptoms of neurodegenerative diseases.

**[0037]** In some embodiments, according to any of the methods described above, the subject is diagnosed as having or being at risk of developing a Tau protein-associated disease. In some embodiments, the subject is diagnosed as having or being at risk of developing a tauopathy selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD).

**[0038]** In another aspect, provided herein is a method of detecting pathological human Tau in a sample comprising i) contacting the sample with an antibody or antigen-binding moiety according to any of the embodiments described above and detecting, directly or indirectly, the antibody or antigen-binding moiety; or ii) contacting the sample with a labeled antibody or antigen-binding moiety according to any of the embodiments described above and detecting the label. In some embodiments, the pathological human Tau is from a tauopathy selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD). In some embodiments, the pathological human Tau is from a

tauopathy brain selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD). In some embodiments, the pathological human Tau is Tau Type 1A, IB, 11 A, or MB; misordered Tau; mis-disordered Tau; sarkosyl-insoluble Tau; an extracellular Tau deposit; a Tau aggregate; paired helical filaments; a neurofibrillary pathology; or a hyperphosphorylated form of truncated Tau or full-length Tau. In some embodiments, the pathological human Tau is hyperphosphorylated and sarkosyl-insoluble Tau. In some embodiments, the sample is a brain sample, a cerebrospinal fluid sample, or a blood sample. In some embodiments, the detecting comprising producing a readout comprising information about the presence of pathological human Tau in the sample. In some embodiments, the sample is from a subject and the method further comprises diagnosing whether the subject has a tauopathy or is likely to develop a tauopathy based on the readout.

[0039] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative embodiments and features described herein, further aspects, embodiments, objects and features of the disclosure will become fully apparent from the drawings and the detailed description and the claims.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0040] FIGS. 1A-1B show western blot analysis of rTg4510 and WT brain lysate by HT7, mAb005, and mAb037.

[0041] FIGS. 2A-2B show western blot analysis of AD and ND brain lysate by HT7, mAb005 and mAb037.

[0042] FIGS. 3A-3B show western blot analysis of AD brain in sarkosyl-soluble and -insoluble fractions by HT7, mAb005 and mAb037.

[0043] FIG. 4A shows subcellular fractionation

[0044] FIG 4B shows dot-blot analysis of HT7, mAb005 and reference antibodies.

[0045] FIG 4C shows dot-blot analysis of mAb005 ("005"), mAb011 ("011"), mAb013 ("013"), mAb010 ("010"), mAb032 ("032"), mAb037 ("037"), mAb020 ("020"), mAb008 ("008"), mAb025 ("025"), mAb033 ("033"), and mAb004 ("004").

[0046] FIGS. 5A and 5B show dot-blot assay on various brain tissues. FIG. 5A shows results of AT8 and HT7 in mid-brain, thalamus, putamen, superior frontal gyrus, and frontal cortex regions of non-demented ("ND"), Alzheimer's disease ("AD"), progressive supranuclear palsy ("PSP"),

corticobasal degeneration (“CBD”), or Pick’s disease (“PiD”) brains. FIG. 5B shows results of mAb005, HT7, and reference antibodies in mid-brain, thalamus, putamen, superior frontal gyrus, frontal cortex, and cerebellum regions of non-demented (“ND”), Alzheimer’s disease (“AD”), progressive supranuclear palsy (“PSP”), corticobasal degeneration (“CBD”), or Pick’s disease (“PiD”) brains.

[0047] FIG. 5C shows dot-blot assay of mAb005 (“005”), mAb011 (“011”), mAb013 (“013”), mAb010 (“010”), mAb032 (“032”), mAb037 (“037”), mAb020 (“020”), mAb008 (“008”), mAb025 (“025”), mAb033 (“033”), and mAb004 (“004”).

[0048] FIG. 6A shows Sucrose-Gradient-Centrifugation (SGC) and western blot analysis of ND and AD brain lysate with HT7 and AT8.

[0049] FIG. 6B shows SGC and dot-blot analysis of ND and AD brain lysate with HT7, AT8, synaptophysin, GAPDH, and mAb005.

[0050] FIG. 7A shows size exclusion chromatography (SEC) and western blot analysis of ND and AD brain lysates with HT7.

[0051] FIG. 7B shows SEC and dot-blot analysis of ND and AD brain lysates with HT7, AT8, synaptophysin (“Synapt”), GAPDH, mAb005, and reference antibodies.

[0052] FIG. 8A shows dot-blot analysis of 1- to 6-month-old rTg4510 (Tg) and wild type (WT) mouse brain lysates with mAb005, HT7, AT8, and reference antibodies.

[0053] FIG. 8B shows SEC and dot-blot analysis of 2.5- and 6-month-old Tg brain lysate, probed with mAb005.

[0054] FIG. 9A shows a schematic representation of Tau spreading through synaptically connected brain areas (modified from Brettschneider, J., et al. (2015). *Nature Reviews Neuroscience*, 16(2), 109).

[0055] FIG. 9B shows immunohistochemical (IHC) staining with mAb005 (also referred to as RAA7) of indicated brain areas of human brain slices with their disease status (ND vs. AD), Braak Stage (I-VI), and ID labelled on top. Outlined photos show positive signals for mAb005-labelled Tau tangles.

[0056] FIG. 9C shows immunohistochemical (IHC) staining with mAb005 (also referred to as RAA7) and mAb037 of indicated brain areas of human brain slices with their disease status (ND vs. AD), Braak Stage (I-VI), and ID labelled on top.

[0057] FIG. 9D shows IHC staining with mAb005 of indicated PSP brain tissues, showing positive

mAb005 signals for each of the tissues.

**[0058]** FIG. 9E shows IHC staining with mAb005 and mAb037 of indicated four PSP brain tissues, showing positive mAb005 signals for each of the tissues.

**[0059]** FIGS. 10A-10B show IHC staining of rTg4510 brain by mAb005. FIG. 10A shows staining in Tg brain at 3 months. FIG. 10B shows staining in Tg brain at 6 months.

**[0060]** FIGS. 11A and 11B show summary graphs of C2N-8E12 (Reference AbbVie) and mAb005 after intraperitoneal injection (i.p.) into 3-mo rTg4510 animals (n = 4-5 animals; mean  $\pm$ SD).

**[0061]** FIG. 12A shows binding affinity of original mouse clone mAb005 and humanized mAb005 to AD and ND brain homogenate.

**[0062]** FIG. 12B shows binding affinity of original mouse clone mAb037 and humanized mAb037 to AD and ND brain homogenate.

**[0063]** FIG. 13A-13B show effects of mAb005 and mAb037 on Tau seeding ability. FIG. 13A shows Tau and DAPI staining with and without mAb005 and isotype control ("mIgG"). FIG. 13B shows Tau and DAPI staining with and without mAb005 and mAb037.

**[0064]** FIGS. 13C-13E show results for an mAb005 immunodepletion assay. FIG. 13C shows Tau spot vs. mAb005 antibody concentration; FIG. 13D shows Tau depletion vs. mAb005 antibody concentration; FIG. 13E shows western blot staining after treatment with mAb005 or Mouse IgG isotype control.

**[0065]** FIG. 14 shows the characterization of mAb005 and mAb037 by conformational epitope mapping using crosslinking coupled mass spectrometry.

### **DETAILED DESCRIPTION OF THE DISCLOSURE**

**[0066]** The present invention relates to antibodies that are capable of binding to pathological (disease-associated) Tau species, including antigen-binding moieties derived from such antibodies (e.g., antigen-binding fragments of the antibodies). Antibodies that bind pathological Tau species with minimal binding to normal (healthy) Tau species are highly desirable. Provided herein are antibodies and antigen-binding moieties that bind to human pathological Tau species and are capable of discriminating between normal and pathological Tau species. Antibodies described herein were found to preferentially bind Tau species, such as insoluble Tau species, located in synaptic fractions of tauopathy brain, and as synapse loss is an early pathological event in tauopathies, these results suggest the suitability of the antibodies and antigen-binding derivatives



thereof (such as humanized forms of mAb005 and mAb037) for use in the clinic, where they have the potential for effecting clearance of pathological Tau with minimal effects on normal/physiological Tau species in the brains of human tauopathy patients. Also provided are methods of using the antibodies and antigen-binding moieties described herein for eliminating and/or preventing Tau seeding and/or propagation, and methods of using the antibodies and antigen-binding moieties described herein for treating or preventing a tauopathy, such as Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), or Pick's disease (PiD).

[0067] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols generally identify similar components, unless context dictates otherwise. The illustrative alternatives described in the detailed description, drawings, and claims are not meant to be limiting. Other alternatives may be used and other changes may be made without departing from the spirit or scope of the subject matter presented here. It will be readily understood that the aspects, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and make part of this application.

[0068] Unless otherwise defined, all terms of art, notations, and other scientific terms or terminology used herein are intended to have the meanings commonly understood by those of skill in the art to which this application pertains. In some cases, terms with commonly understood meanings are defined herein for clarity and/or for ready reference, and the inclusion of such definitions herein should not necessarily be construed to represent a substantial difference over what is generally understood in the art. Many of the techniques and procedures described or referenced herein are well understood and commonly employed using conventional methodology by those skilled in the art.

### **Definitions**

[0069] The terms "pathological Tau" and "disease Tau" include pathological Tau conformers and structures and include, without limitation, all of the following: Tau Type 1A, IB, 11 A, and MB (described in detail in WO2004/007547), misordered Tau, mis-disordered Tau (monomer, dimer, trimer, oligomer), mis-disordered soluble Tau, sarkosyl-insoluble Tau, extracellular Tau deposits, Tau aggregates, paired helical Tau filaments, Tau neurofibrillary pathologies, including

neurofibrillary lesions, tangles, threads, fibrils, and axonal spheroids, highly phosphorylated forms of truncated or full-length Tau, or any other form of Tau associated with AD or another tauopathy that is detectable by the antibodies and/or Tau-binding fragments described herein. The term “tauopathy” includes, without limitation, all neurological diseases that are accompanied by the appearance of abnormal forms of the microtubule-associated protein Tau in the brains of patients. The term includes, but is not limited to, the following diseases: Alzheimer's Disease (AD), amyotrophic lateral sclerosis (ALS), Huntington's disease (HD), Parkinson's disease (PD), Creutzfeldt-Jacob disease, Dementia pugilistica, Down's Syndrome, Gerstmann-Straussler-Scheinker disease, British dementia, Danish dementia, inclusion-body myositis, prion protein cerebral amyloid angiopathy, traumatic brain injury, Guam Parkinsonism-dementia complex, Non-Guamanian motor neuron disease with neurofibrillary tangles, argyrophilic grain dementia, corticobasal degeneration, diffuse neurofibrillary tangles with calcification, frontotemporal dementia, frontotemporal dementia with parkinsonism linked to chromosome 17, Hallevorden-Spatz disease, multiple system atrophy, Niemann-Pick disease type C, Pallido-ponto-nigral degeneration, Pick's disease, progressive subcortical gliosis, progressive supranuclear palsy, Subacute sclerosing panencephalitis, Tangle-only dementia, White matter tauopathy with globular glial inclusions, Frontotemporal dementia, Postencephalitic Parkinsonism, Parkinsonism linked to chromosome 17, and Myotonic dystrophy. *See, e.g., Goedert, M., et al. (2010). Trends in neurosciences, 33(7), 317-325.*

[0070] The terms “a Tau protein associated disease” and “Tau protein associated diseases or disorders” as used herein are meant to be tau-mediated or tau-associated neurodegenerative diseases and/or neurodegenerative pathological conditions, especially of neurodegenerative diseases and/or of neurodegenerative pathological conditions which are tauopathies and/or diseases and/or pathological conditions associated with and/or accompanied by tauopathies, preferably associated with and/or accompanied by tau aggregation.

[0071] The terms “soluble Tau” or “soluble Tau protein,” as used herein, are meant to include solubilized protein species containing monomers and/or oligomers of Tau proteins/peptides, Tau-like peptides/proteins, modified or truncated Tau peptides/proteins, and/or other derivatives of Tau peptides/proteins.

[0072] The terms “insoluble Tau” or “insoluble Tau protein,” as used herein, are meant to include protein species containing aggregated Tau peptides/proteins, Tau-like peptides/proteins, modified

or truncated Tau peptides/proteins, and/or other derivatives of Tau peptides/proteins forming oligomeric or polymeric structures which are insoluble both *in vitro* in aqueous medium and *in vivo* in the mammalian body, more particularly in the mammalian brain. “Insoluble Tau” particularly includes neurofibrillary tangles (NFT).

**[0073]** An “affinity matured” antibody refers to an antibody with one or more alterations in one or more hypervariable regions (HVRs), compared to a parent antibody which does not possess such alterations, such alterations resulting in an improvement in the affinity of the antibody for antigen.

**[0074]** The term “antibody” herein is used in the broadest sense and encompasses various antibody structures, including but not limited to monoclonal antibodies, polyclonal antibodies, multispecific antibodies (e.g., bispecific antibodies), and antibody fragments so long as they exhibit the desired antigen-binding activity.

**[0075]** An “antibody fragment” refers to a molecule other than an intact antibody that comprises a portion of an intact antibody that binds the antigen to which the intact antibody binds. Examples of antibody fragments include but are not limited to Fv, Fab, Fab', Fab'-SH, F(ab')<sub>2</sub>; diabodies; linear antibodies; single-chain antibody molecules (e.g. scFv); and multispecific antibodies formed from antibody fragments.

**[0076]** The term “chimeric antibody” refers to an antibody in which portions of the heavy and/or light chain are derived from different sources or species.

**[0077]** “Effector functions” refer to those biological activities attributable to the Fc region of an antibody, which vary with the antibody isotype. Examples of antibody effector functions include: Clq binding and complement dependent cytotoxicity (CDC); Fc receptor binding; antibody-dependent cell-mediated cytotoxicity (ADCC); phagocytosis; down regulation of cell surface receptors (e.g. B cell receptor); and B cell activation.

**[0078]** An “effective amount” of an agent, e.g., a pharmaceutical formulation, refers to an amount effective, at dosages and for periods of time necessary, to achieve a desired therapeutic or prophylactic result.

**[0079]** The term “Fc region” herein is used to define a C-terminal region of an immunoglobulin heavy chain that contains at least a portion of the constant region. The term includes native sequence Fc regions and variant Fc regions. In some embodiments, a human IgG heavy chain Fc region extends from Cys226, or from Pro230, to the carboxyl-terminus of the heavy chain.

However, the C-terminal lysine (Lys447) of the Fc region may or may not be present. Unless otherwise specified herein, numbering of amino acid residues in the Fc region or constant region is according to the EU numbering system, also called the EU index, as described in Kabat et al., Sequences of Proteins of Immunological Interest, 5th Ed. Public Health Service, National Institutes of Health, Bethesda, MD, 1991.

**[0080]** "Framework" or "FR" refers to variable domain residues other than hypervariable region (HVR) residues or complementarity determining regions (CDRs). The FR of a variable domain generally consists of four FR domains: FR1, FR2, FR3, and FR4. Accordingly, the HVR and FR sequences generally appear in the following sequence in VH (or VL): FR1-H1(L1)-FR2-H2(L2)-FR3-H3(L3)-FR4.

**[0081]** The term "hypervariable region" or "HVR" as used herein refers to each of the regions of an antibody variable domain which are hypervariable in sequence ("complementarity determining regions" or "CDRs") and/or form structurally defined loops ("hypervariable loops") and/or contain the antigen-contacting residues ("antigen contacts"). Generally, antibodies comprise six HVRs or CDRs: three in the VH (H1, H2, H3), and three in the VL (L1, L2, L3).

**[0082]** The terms "full-length antibody," "intact antibody," and "whole antibody" are used herein interchangeably to refer to an antibody having a structure substantially similar to a native antibody structure or having heavy chains that contain an Fc region as defined herein.

**[0083]** The terms "host cell," "host cell line," and "host cell culture" are used interchangeably and refer to cells into which exogenous nucleic acid has been introduced, including the progeny of such cells. Host cells include "transformants" and "transformed cells," which include the primary transformed cell and progeny derived therefrom without regard to the number of passages. Progeny may not be completely identical in nucleic acid content to a parent cell, but may contain mutations. Mutant progeny that have the same function or biological activity as screened or selected for in the originally transformed cell are included herein.

**[0084]** The term "variable region" or "variable domain" refers to the domain of an antibody heavy or light chain that is involved in binding of the antibody to antigen. The variable domains of the heavy chain and light chain (VH and VL, respectively) of a native antibody generally have similar structures, with each domain comprising four conserved framework regions (FRs) and three hypervariable regions (HVRs) or complementarity determining regions (CDRs).

**[0085]** A "humanized" antibody refers to a chimeric antibody 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.

**[0086]** An “isolated” antibody is one which has been separated from a component of its natural environment.

**[0087]** An “isolated” nucleic acid refers to a nucleic acid molecule that has been separated from a component of its natural environment. An isolated nucleic acid includes a nucleic acid molecule contained in cells that ordinarily contain the nucleic acid molecule, but the nucleic acid molecule is present extrachromosomally or at a chromosomal location that is different from its natural chromosomal location.

**[0088]** A “nucleic acid encoding an antibody” refers to one or more nucleic acid molecules encoding antibody heavy and light chains (or fragments thereof), including such nucleic acid molecule(s) in a single vector or separate vectors, and such nucleic acid molecule(s) present at one or more locations in a host cell.

**[0089]** The term “monoclonal antibody” as used herein refers to an antibody obtained from a population of substantially homogeneous antibodies, such as where the individual antibodies of the population are identical and/or bind the same epitope, except for possible variant antibodies, e.g., containing naturally occurring mutations or arising during production of monoclonal antibody preparation, such variants generally being present in minor amounts. In contrast to polyclonal antibody preparations, which typically include different antibodies directed against different determinants (epitopes), each monoclonal antibody of a monoclonal antibody preparation is directed against a single determinant on an antigen. 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 the hybridoma method, recombinant DNA methods, phage-display methods, and methods utilizing transgenic animals containing all or part of the human immunoglobulin loci, such methods and other exemplary methods for making monoclonal antibodies being described herein.

[0090] “Percent (%) amino acid sequence identity” with respect to a reference polypeptide sequence is defined as the percentage of amino acid residues in a candidate sequence that are identical with the amino acid residues in the reference 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 aligning sequences, including any algorithms needed to achieve maximal alignment over the full-length of the sequences being compared.

[0091] The term “pharmaceutical composition” or “pharmaceutical formulation” refers to a preparation which is in such form as to permit the biological activity of an active ingredient contained therein to be effective, and which contains no additional components which are unacceptably toxic to a subject to which the formulation would be administered.

[0092] A “pharmaceutically acceptable carrier” refers to an ingredient in a pharmaceutical composition, other than an active ingredient, which is nontoxic to a subject. Pharmaceutically acceptable carriers include, but are not limited to, buffers, excipients, stabilizers, and preservatives.

[0093] The terms “treatment,” “treating,” and the like are used herein to generally mean obtaining a desired pharmacologic and/or physiologic effect. The effect may be prophylactic in terms of completely or partially preventing a disease or symptom thereof and/or may be therapeutic in terms of a partial or complete cure for a disease and/or adverse effect attributable to the disease. “Treatment” as used herein covers any treatment of a disease or symptom in a mammal, and includes: (a) preventing the disease or symptom from occurring in a subject which may be predisposed to acquiring the disease or symptom but has not yet been diagnosed as having it; (b) inhibiting the disease or symptom, e.g., arresting its development; or (c) relieving the disease, e.g., causing regression of the disease. A therapeutic agent may be administered before, during, or after the onset of disease. In some embodiments, treatment inhibits one or more symptoms by at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or more. In some embodiments, treatment relieves one or more symptoms by at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or more.

[0094] As used herein, “preventing” relates to administration of a therapy (e.g., administration of

an anti-Tau antibody or antigen-binding moiety thereof) to a subject before signs of the disease are detectable in the subject. The subject may be an individual at risk of developing the disease or disorder, such as an individual who has one or more risk factors known to be associated with development or onset of the disease or disorder. In some embodiments, preventing reduces one or more risk factors by at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or more. For example, in some embodiments, the preventing reduces the risk of a subject having a genetic risk factor to develop a tauopathy as known in the art. See, e.g., Avila, J. et al. *Front. Aging Neurosci.* 2015; 7:99.

[0095] The terms “individual” and “subject” are used interchangeably herein and refer to any mammalian subject, e.g., a human. In some cases, a subject for whom diagnosis, treatment, or therapy is desired is a human patient.

[0096] Where a range of values is provided, it is understood that each intervening value, to the tenth of the unit of the lower limit unless the context clearly dictates otherwise, between the upper and lower limit of that range and any other stated or intervening value in that stated range, is encompassed within the disclosure. The upper and lower limits of these smaller ranges may independently be included in the smaller ranges, and are also encompassed within the disclosure, subject to any specifically excluded limit in the stated range. Where the stated range includes one or both of the limits, ranges excluding either or both of those included limits are also included in the disclosure.

[0097] Certain ranges are presented herein with numerical values being preceded by the term “about.” The term “about” is used herein to provide literal support for the exact number that it precedes, as well as a number that is near to or approximately the number that the term precedes. In determining whether a number is near to or approximately a specifically recited number, the near or approximating unrecited number may be a number which, in the context in which it is presented, provides the substantial equivalent of the specifically recited number.

[0098] It is appreciated that certain features of the disclosure, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the disclosure, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination. All combinations of the embodiments pertaining to the disclosure are specifically embraced by the present disclosure and are disclosed herein just as if each and every combination

was individually and explicitly disclosed. In addition, all sub-combinations of the various embodiments and elements thereof are also specifically embraced by the present disclosure and are disclosed herein just as if each and every such sub-combination was individually and explicitly disclosed herein.

### **Anti-Tau Antibodies**

[0099] In one aspect, provided herein is an antibody (e.g., an isolated antibody) or an antigen-binding moiety (e.g., an antigen-binding antibody fragment) that binds to one or more pathological Tau species (such pathological Tau species also referred to herein as “pTau,” and such an antibody also referred to herein as an “anti-pTau antibody”). In some embodiments, the anti-pTau antibody or antigen-binding moiety is capable of discriminating between one or more pathological Tau species and one or more normal Tau species. In some embodiments, the anti-pTau antibody or antigen-binding moiety preferentially binds to Tau species from a tauopathy brain sample (e.g., sample from Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), or Pick's disease (PiD) brain) as compared to Tau species from a corresponding healthy brain sample. In some embodiments, the anti-pTau antibody or antigen-binding moiety binds more pathological Tau species from a tauopathy brain sample as compared to a reference anti-Tau antibody (e.g., HT7, C2N-8E12, or BIIB092). In some embodiments, the anti-pTau antibody or antigen-binding moiety binds fewer normal Tau species from a healthy brain sample as compared to a reference anti-Tau antibody. In some embodiments, the reference anti-Tau antibody is HT7, C2N-8E12 (*see* WO2015/200806), or BIIB092 (*see* U.S. Patent No. 9,567,395). In some embodiments, the tauopathy brain sample is an AD, PSP, CBD, or PiD brain sample. In some embodiments, the brain sample is a whole brain lysate or a frontal cortex lysate, including synaptic fractions and/or sarkosyl-insoluble fractions thereof. In some embodiments, the brain sample is a sarkosyl-insoluble synaptic fraction of a brain lysate.

[0100] In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the anti-pTau antibody or antigen-binding moiety binds a hyperphosphorylated 64 kD Tau species from Tau transgenic mouse rTg4510 brain lysate. In some embodiments, the anti-pTau antibody or antigen-binding moiety does not bind to a 140 kD Tau species from the rTg4510 brain lysate. In some embodiments, the anti-pTau antibody or antigen-binding moiety does not bind to a 170 kD Tau species from the rTg4510 brain lysate.



[0101] In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the anti-pTau antibody or antigen-binding moiety binds a hyperphosphorylated and sarkosyl-insoluble 64 kD Tau species from a human AD brain sample. In some embodiments, the anti-pTau antibody or antigen-binding moiety binds to a 58 kD Tau species from the human AD brain sample. In some embodiments, the anti-pTau antibody or antigen-binding moiety binds to a 68 kD Tau species from the human AD brain sample. In some embodiments, the anti-pTau antibody or antigen-binding moiety does not bind to a 140 kD Tau species from the human AD brain sample. In some embodiments, the anti-pTau antibody or antigen-binding moiety does not bind to a 170 kD Tau species from the human AD brain sample. In some embodiments, the brain sample is a brain lysate, such as a lysate prepared from whole brain, frontal cortex, mid brain, thalamus, putamen, or superior frontal gyrus tissue. In some embodiments, the brain sample is a sarkosyl-insoluble fraction of a brain lysate, such as a lysate prepared from whole brain, frontal cortex, mid brain, thalamus, putamen, or superior frontal gyrus tissue.

Exemplary Anti-pTau Antibodies

[0102] In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising: a) a heavy chain variable region comprising a complementary determining region (CDR) 3 comprising the amino acid sequence of any one of SEQ ID NOS: 71-81 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 71-81; and/or b) a light chain variable region comprising a CDR3 comprising the amino acid sequence of any one of SEQ ID NOS: 96-105 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 96-105. In some embodiments, the heavy chain variable region comprises a CDR3 comprising the amino acid sequence of any one of SEQ ID NOS: 71-81 or a variant thereof having no more than 3 mismatches compared to the amino acid sequence of any one of SEQ ID NOS: 71-81; and/or b) a light chain variable region comprising a CDR3 comprising the amino acid sequence of any one of SEQ ID NOS: 96-105 or a variant thereof having no more than 3 mismatches compared to the amino acid sequence of any one of SEQ ID NOS: 96-105. In some embodiments, the heavy chain variable region comprises a CDR3 comprising the amino acid sequence of any one of SEQ ID NOS: 71-81; and/or b) a light chain variable region comprising a CDR3 comprising

the amino acid sequence of any one of SEQ ID NOs: 96-105.

**[0103]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 72 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 72; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 97 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 97. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 72 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 97. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 50 and 61, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 50 and 61, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 83 and 91, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 83 and 91, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 50 and 61, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 83 and 91, respectively.

**[0104]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 71 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 71; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 96 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 96. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 71 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 96. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 49 and 60, respectively, or variants thereof having at least 80%

sequence identity to the amino acid sequences of SEQ ID NOs: 49 and 60, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 82 and 91, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 82 and 91, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 49 and 60, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 82 and 91, respectively.

**[0105]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 73 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 73; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 98 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 98. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 73 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 98. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 51 and 62, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 51 and 62, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 84 and 91, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 84 and 91, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 51 and 62, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 84 and 91, respectively.

**[0106]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 74 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 74; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 99 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 99. In some embodiments, the heavy

chain CDR3 comprises the amino acid sequence of SEQ ID NO: 74 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 99. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 52 and 63, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 52 and 63, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 85 and 92, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 85 and 92, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 52 and 63, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 85 and 92, respectively.

**[0107]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 75 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 75; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 100 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 100. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 75 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 100. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 53 and 64, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 53 and 64, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 86 and 93, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 86 and 93, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 53 and 64, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 86 and 93, respectively.

**[0108]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising

a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 76 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 76; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 101 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 101. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 76 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 101. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 54 and 65, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 54 and 65, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 87 and 93, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 87 and 93, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 54 and 65, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 87 and 93, respectively.

**[0109]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 77 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 77; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 102 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 102. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 77 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 102. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 55 and 66, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 55 and 66, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 83 and 91, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences

of SEQ ID NOs: 83 and 91, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 55 and 66, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 83 and 91, respectively.

**[0110]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 78 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 78; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 103 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 103. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 78 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 103. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 56 and 67, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 56 and 67, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 88 and 94, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 88 and 94, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 56 and 67, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 88 and 94, respectively.

**[0111]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 79 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 79; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 98 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 98. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 79 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 98. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further

comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 57 and 68, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 57 and 68, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 89 and 91, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 89 and 91, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 57 and 68, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 89 and 91, respectively.

**[0112]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 80 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 80; and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 104 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 104. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 80 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 104. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 58 and 69, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 58 and 69, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 90 and 95, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 90 and 95, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 58 and 69, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 90 and 95, respectively.

**[0113]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR3 and a light chain variable region comprising a CDR3, wherein the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 81 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 81; and the light chain CDR3

comprises the amino acid sequence of SEQ ID NO: 105 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 105. In some embodiments, the heavy chain CDR3 comprises the amino acid sequence of SEQ ID NO: 81 and the light chain CDR3 comprises the amino acid sequence of SEQ ID NO: 105. In some embodiments, the heavy chain variable region further comprises a CDR1 and a CDR2 and the light chain variable region further comprises a CDR1 and a CDR2, wherein the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 59 and 70, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 59 and 70, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 87 and 93, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 87 and 93, respectively. In some embodiments, the heavy chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 59 and 70, respectively; and the light chain CDR1 and CDR2 comprise the amino acid sequences of SEQ ID NOs: 87 and 93, respectively.

**[0114]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising: a) a heavy chain variable region comprising i) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 49-59 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 49-59; ii) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 60-70 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 60-70; and/or iii) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 71-81 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 71-81; and/or b) a light chain variable region comprising iv) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 82-90 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 82-90; v) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 91-95 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 91-95; and/or vi) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 96-105 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 96-105. In some embodiments, a) the heavy chain variable region comprises i) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 49-59 or a variant thereof having no more than 3 mismatches compared to the amino acid sequence of any



one of SEQ ID NOs: 49-59; ii) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 60-70 or a variant thereof having no more than 3 mismatches compared to the amino acid sequence of any one of SEQ ID NOs: 60-70; and/or iii) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 71-81 or a variant thereof having no more than 3 mismatches compared to the amino acid sequence of any one of SEQ ID NOs: 71-81; and/or b) the light chain variable region comprises iv) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 82-90 or a variant thereof having no more than 3 mismatches compared to the amino acid sequence of any one of SEQ ID NOs: 82-90; v) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 91-95 or a variant thereof having no more than 3 mismatches compared to the amino acid sequence of any one of SEQ ID NOs: 91-95; and/or vi) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 96-105 or a variant thereof having no more than 3 mismatches compared to the amino acid sequence of any one of SEQ ID NOs: 96-105. In some embodiments, a) the heavy chain variable region comprises i) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 49-59; ii) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 60-70; and/or iii) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 71-81; and/or b) the light chain variable region comprises iv) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 82-90; v) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 91-95; and/or vi) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 96-105. In some embodiments, the heavy chain and/or light chain CDR sequences are as indicated for a given antibody clone shown in Tables 1 and 2.

**[0115]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72,

respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively.

**[0116]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively.

**[0117]** In some embodiments, according to any of the anti-Tau antibodies or antigen-binding moieties described above, the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively.

**[0118]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 49, 60, and 71, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 49, 60, and 71, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 82, 91, and 96, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 82, 91, and 96, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 49, 60, and 71, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 82, 91, and 96, respectively.

**[0119]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 51, 62, and 73, respectively, or variants thereof having at least 80% sequence

identity to the amino acid sequences of SEQ ID NOs: 51, 62, and 73, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 84, 91, and 98, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 84, 91, and 98, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 51, 62, and 73, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 84, 91, and 98, respectively.

**[0120]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 52, 63, and 74, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 52, 63, and 74, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 85, 92, and 99, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 85, 92, and 99, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 52, 63, and 74, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 85, 92, and 99, respectively.

**[0121]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 53, 64, and 75, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 53, 64, and 75, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 86, 93, and 100, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 86, 93, and 100, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 53, 64, and 75, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 86, 93, and 100, respectively.

**[0122]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 54, 65, and 76, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 54, 65, and 76, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 101, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 87, 93, and 101, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 54, 65, and 76, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 101, respectively.

**[0123]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 55, 66, and 77, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 55, 66, and 77, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 102, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 83, 91, and 102, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 55, 66, and 77, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 102, respectively.

**[0124]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 56, 67, and 78, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 56, 67, and 78, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 88, 94, and

103, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 88, 94, and 103, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 56, 67, and 78, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 88, 94, and 103, respectively.

**[0125]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 57, 68, and 79, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 57, 68, and 79, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 89, 91, and 98, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 89, 91, and 98, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 57, 68, and 79, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 89, 91, and 98, respectively.

**[0126]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 58, 69, and 80, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 58, 69, and 80, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 90, 95, and 104, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 90, 95, and 104, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 58, 69, and 80, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 90, 95, and 104, respectively.

**[0127]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising

a CDR1, a CDR2, and a CDR3 and a light chain variable region comprising a CDR1, a CDR2, and a CDR3, wherein the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively. In some embodiments, the heavy chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively; and the light chain CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively.

**[0128]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of any one of SEQ ID NOs: 1-12 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 1-12; and/or a light chain variable region comprising the amino acid sequence of any one of SEQ ID NOs: 13-24 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 13-24. In some embodiments, where a variable region comprises a variant of a reference amino acid sequence disclosed herein, each of the CDRs in the variable region has at least 80% sequence identity to the corresponding CDR in the reference amino acid sequence. In some embodiments, each of the CDRs in the variable region has 100% sequence identity to the corresponding CDR in the reference amino acid sequence. In some embodiments, the heavy chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 1-12; and/or the light chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 13-24. In some embodiments, the heavy chain and light chain variable regions are as indicated for a given antibody clone shown in Table 3.

**[0129]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 1 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 1; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 13 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 13. In some embodiments, the heavy

chain variable region comprises the amino acid sequence of SEQ ID NOs: 1; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 13.

**[0130]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 2 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 2; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 14 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 14. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 2; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 14.

**[0131]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 3 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 3; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 15 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 15. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 3; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 15.

**[0132]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 4 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 4; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 16 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 16. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 4; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 16.

**[0133]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 5 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 5; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 17 or a variant thereof having at least 80%

sequence identity to the amino acid sequence of SEQ ID NO: 17. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 5; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 17.

**[0134]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 6 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 6; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 18 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 18. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 6; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 18.

**[0135]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 7 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 7; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 19 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 19. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 7; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 19.

**[0136]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 8 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 8; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 20 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 20. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 8; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 20.

**[0137]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 9 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 9; and/or a light chain variable region



comprising the amino acid sequence of SEQ ID NO: 21 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 21. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 9; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 21.

**[0138]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 10 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 10; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 22 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 22. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 10; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 22.

**[0139]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 11 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 11; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 23 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 23. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 11; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 23.

**[0140]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 12 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 12; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 24 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 24. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 12; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 24.

**[0141]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of SEQ ID NO: 106 or a variant thereof having at least 80% sequence

identity to the amino acid sequence of SEQ ID NO: 106; and/or a light chain variable region comprising the amino acid sequence of SEQ ID NO: 107 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 107. In some embodiments, the heavy chain variable region comprises the amino acid sequence of SEQ ID NOs: 106; and/or the light chain variable region comprises the amino acid sequence of SEQ ID NO: 107.

[0142] In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising the following heavy chain CDR1, CDR2, and CDR3 sequences and light chain CDR1, CDR2, and CDR3 sequences according to mAb004, mAb005, mAb008, mAb010, mAb011, mAb013, mAb020, mAb025, mAb032, mAb035, or mAb037:

Antibody clone	Heavy chain CDR1	Heavy chain CDR2	Heavy chain CDR3
mAb004	SYGMS (SEQ ID NO: 49)	TISSGSYTYYPDSVKG (SEQ ID NO: 60)	TYYGAMDY (SEQ ID NO: 71)
mAb005	DYGMH (SEQ ID NO: 50)	YSNSDSTTIYYADTVKG (SEQ ID NO: 61)	SYYSNYVDY (SEQ ID NO: 72)
mAb008	RYWMS (SEQ ID NO: 51)	EINPDGNAINYAPSLKD (SEQ ID NO: 62)	PFPSV (SEQ ID NO: 73)
mAb010	GYGVN (SEQ ID NO: 52)	MIWGDGSTDYNSALKS (SEQ ID NO: 63)	WAFAY (SEQ ID NO: 74)
mAb011	SYWMH (SEQ ID NO: 53)	MIDPSDSETRLNQKFKD (SEQ ID NO: 64)	PYGDLDY (SEQ ID NO: 75)
mAb013	DFYMK (SEQ ID NO: 54)	DIDPNNGDTFYNQKFKG (SEQ ID NO: 65)	DLY (SEQ ID NO: 76)
mAb020	SYAVH (SEQ ID NO: 55)	VMWSGGSTDYNAAFIS (SEQ ID NO: 66)	MGDYDGVAVWFAY (SEQ ID NO: 77)
mAb025	THGMS (SEQ ID NO: 56)	TYSGVPTYTDDEFKG (SEQ ID NO: 67)	SELSWFAY (SEQ ID NO: 78)
mAb032	SYWMN (SEQ ID NO: 57)	QIYPGDGDTDYNGKFKG (SEQ ID NO: 68)	RSPY (SEQ ID NO: 79)
mAb033	TFGMGVG (SEQ ID NO: 58)	HIWWDDDKYYNPALKS (SEQ ID NO: 69)	RGSNALDY (SEQ ID NO: 80)
mAb037	DYNMD (SEQ ID NO: 59)	DINPNTGGTIYNQKFKG (SEQ ID NO: 70)	EGPYYYGTTHPFAY (SEQ ID NO: 81)

Antibody clone	Light chain CDR1	Light chain CDR2	Light chain CDR3
mAb004	RSSQTIVHSNGNTYLE (SEQ ID NO: 82)	KVSNRFS (SEQ ID NO: 91)	FQGS LVPWT (SEQ ID NO: 96)
mAb005	RSSQLVHSNGNTYLH (SEQ ID NO: 83)	KVSNRFS (SEQ ID NO: 91)	FQSTHVPPT (SEQ ID NO: 97)
mAb008	RSSQLVRSNGNTYLE (SEQ ID NO: 84)	KVSNRFS (SEQ ID NO: 91)	FQGS HVPYT (SEQ ID NO: 98)

mAb010	KSSQSLLDSGGKTYLN (SEQ ID NO: 85)	QVSKLDSGVPD (SEQ ID NO: 92)	WQGTHFPLT (SEQ ID NO: 99)
mAb011	KSSQSLLDSGKTYLN (SEQ ID NO: 86)	LVSKLDS (SEQ ID NO: 93)	WQGTHFPPT (SEQ ID NO: 100)
mAb013	KSSQSLLYSNGKTYLN (SEQ ID NO: 87)	LVSKLDS (SEQ ID NO: 93)	VQGTHFPHT (SEQ ID NO: 101)
mAb020	RSSQSLVHSNGNTYLH (SEQ ID NO: 83)	KVSNRFS (SEQ ID NO: 91)	SQSTHVPPWT (SEQ ID NO: 102)
mAb025	RASQISDYLH (SEQ ID NO: 88)	YASQIS (SEQ ID NO: 94)	QNGHSFPYT (SEQ ID NO: 103)
mAb032	RSSQSIIVHSNGNTYLE (SEQ ID NO: 89)	KVSNRFS (SEQ ID NO: 91)	FQGSHVPYT (SEQ ID NO: 98)
mAb033	RSSQSLANSYGNTYLS (SEQ ID NO: 90)	GISNRFS (SEQ ID NO: 95)	LQGTHQPWT (SEQ ID NO: 104)
mAb037	KSSQSLLYSNGKTYLN (SEQ ID NO: 87)	LVSKLDS (SEQ ID NO: 93)	VQGTHFPQT (SEQ ID NO: 105)

**[0143]** In some embodiments, provided herein is an anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof comprising the following heavy chain variable ( $V_H$ ) sequences and light chain variable ( $V_L$ ) sequences according to mAb004, mAb005, humanized mAb005, mAb008, mAb010, mAb011, mAb013, mAb020, mAb025, mAb032, mAb035, mAb037, or humanized mAb037:

Antibody clone (variable region)	Sequence
mAb004 ( $V_H$ )	EVQLVESGGDLVESGGSLKLSCAASGFTFSSYGMSWVRQTPDKRLEWVATISSSGSYTYYPDSVKGRFTISRDNKNTLYLQMSSLNSEDAMYYCADTYYGAMDYWGQGTSVTVSS (SEQ ID NO: 1)
mAb004 ( $V_L$ )	DVLMTQTPLSLPVS LGDQASISCRSSQTIVHSNGNTYLEWYLQKPGQSPKLLIYK VSNRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYYCFQGS LVPWTFGGGTQLEIR (SEQ ID NO: 13)
mAb005 ( $V_H$ )	EVQLVESGGGLVQPGGSLKLSCAASGFTFSDYGMHWVRQAPKGLEWVAYSNSDSTTIYYADTVKGRFTISRDNKSTLFLQMTSLRSEDAMYYCGRSYYSNYVDYWGQGTTTLTVSS (SEQ ID NO: 2)
mAb005 ( $V_L$ )	DIVMTQIPLSLPVS LGDQASISCRSSQSLVHSNGNTYLHWYLQKPGQSPKLLIYK VSNRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYFCFQSTHVPPTFGGGTKLEIK (SEQ ID NO: 14)
Humanized mAb005, ( $V_H$ )	EVQLVESGGGLVQPGGSLRLSCAASGFTFSDYGMHWVRQAPKGLEWVAYSNSDSTTIYYADTVKGRFTISRDNKNSLYLQMNSLRAEDTAVYYCGRSYYSNYVDYWGQGTLVTVSS (SEQ ID NO: 3)
Humanized mAb005, ( $V_L$ )	DVVMTQSPLSLPVT LQGPASISCRSSQSLVHSNGNTYLHWYLQRPQSPRLLIYK VSNRFSGVPDRFSGSGSGTDFTLKISRVEAEDVGVYFCFQSTHVPPTFGQGTKLEIK (SEQ ID NO: 15)
mAb008 ( $V_H$ )	EVKLLQSGGGLVQPGGSLKVS CAASGFDFSRYWMSWVRRAPGKLEWIGEINPDGNAINYAPSLKDKFIVSRDNKNTLYLQMSNVRSEDTALYYCARPFPSVWGTGTTVTVSS (SEQ ID NO: 4)

mAb008 (V <sub>L</sub> )	DVLMQTPLSLPVSLGDQASISCRSSQSLVRSNGNTYLEWYLQNPGQSPKLLIYK VSNRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYYCFQGSHPVPTFGGGTKLE IK (SEQ ID NO: 16)
mAb010 (V <sub>H</sub> )	QVQLKESGPGLVAPSQSLTCTVSGFSLTGYGVNWRQPPGKGLEWLGMIWG DGSTDYNSALKSRLSISKDNSKSQVFLKMNSLQTDDTARYYCANWAFAYWGQ GTLVTVSA (SEQ ID NO: 5)
mAb010 (V <sub>L</sub> )	DVVMTQTPLTSLVTIGQPASISCKSSQSLDSDGKTYLNWLLQRPGQSPKRLIYQ VSKLDSGVPDRFTGSGSGTDFTLKISRVEAEDLGVYYCWQGFHPTFGAGTKL ELK (SEQ ID NO: 17)
mAb011 (V <sub>H</sub> )	QVQLQQSGPQLVRPGASVKISCKASGYSTSYWMHWLQRPGQGLEWIGMIDP SDSETRLNPKFKDKATLTVDKSSSTVYMHLSSTSEDSAVYYCVRPYGDLDYW GQGTTLVSS (SEQ ID NO: 6)
mAb011 (V <sub>L</sub> )	DVVMTQTPLTSLVTIGQPASISCKSSQSLDSDGKTYLNWLLQRPGQSPKRLIYL VSKLDSGVPDRFTGSGSGTDFTLKISRVEAEDLGVYYCWQGFHPTFGSGTKLE IK (SEQ ID NO: 18)
mAb013 (V <sub>H</sub> )	EVQLQQSGPELVKPGASVKMSCKASGYTFTDFYMKWVKQSHGKSFEWIGDIDP NNGDTFYNQKFKGKATLTVDKSSSTAYMQLNSLTSEDSAVYYCARDLYWGQG TTLTVSS (SEQ ID NO: 7)
mAb013 (V <sub>L</sub> )	DVVMTQTPLTSLVTIGQPASISCKSSQSLYSNGKTYLNWLLQRPGQSPKRLIYL VSKLDSGVPDRFTGSGSGTDFTLKISRVEAEDLGVYYCVQGFHPTFGGGTKL EIK (SEQ ID NO: 19)
mAb020 (V <sub>H</sub> )	QVQLKQSGPGLVQPSQSLTCTVSGFSLTSYAVHWVRQSPGKGLEWLGVMWS GGSTDYNAAFISRLSISKDNSKSQVFFKMNSLQADDTAIYYCARMGDYDGVAV FAYWGQGLTVTVSA (SEQ ID NO: 8)
mAb020 (V <sub>L</sub> )	DVVMTQTPLSLPVSLGDQASISCRSSQSLVHSNGNTYLHWYLVKPGQSPKLLIY KVSNRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYFCSQSTHVPVPTFGGGTK LEIK (SEQ ID NO: 20)
mAb025 (V <sub>H</sub> )	QIQLVQSGPELVKPGASVKISCKASGYTFTTHGMSWVKQAPGKGLKWMGWINT YSGVPTYTDDFKGRFAFSLETASTAYLQINNKNEDTATYFCARSELWFAFW GQGLTVTVSA (SEQ ID NO: 9)
mAb025 (V <sub>L</sub> )	DIVMTQSPATLSVTPGDRVSLSCRASQISDYLHWYQKSHESPRLLIKYASQIS GIPSRFSGSGSGSDFTLSINSEPEDVGVYYCQNGHSFPYPTFGGGTKLEIK (SEQ ID NO: 21)
mAb032 (V <sub>H</sub> )	QVQLQQSGAELVKPGASVKISCKASGYAFSSYWMNWVKQRPGKGLEWIGQIYP GDGDTDYNKFKGKATLTADTSSSTAYMQLSSLTSEDSAVYFCASRSPYWGQG TLVTVSA (SEQ ID NO: 10)
mAb032 (V <sub>L</sub> )	DILMTQTPLSLPVSLGDQASISCRSSQSIHNSNGNTYLEWYLQKPGQSPKLLIYKV SNRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYYCFQGSHPVPTFGGGTKLEI K (SEQ ID NO: 22)
mAb033 (V <sub>H</sub> )	QVTLKESGPGILQPSQTLTSLTCSFSGFSLSTFGMGVGVWFRQPSGKGLEWLAHIW WDDDKYYNPALKSRLTISKDTSKNQVFLKIANVDTADTATYYCARRGNSALDY WGQTSVTVSS (SEQ ID NO: 11)
mAb033 (V <sub>L</sub> )	DVVVTQTPLSLPVSGDQVSISCRSSQSLANSYGNTYLSWYLHKPGQSPQLLIYGI SNRFSGVPDRFSGSGSGTDFTLKISTIKPEDLGMYYCLOGTHQPWTFGGGKLEI K (SEQ ID NO: 23)
mAb037 (V <sub>H</sub> )	EVQLQQSGPELVKPGASVKIPCKASGYTFTDYNMDWVKQSHGKSLEWIGDINP NTGGTIYNQKFKGKATLTVDKSSSTAYMELRSLTSEDVAVYYCAGEGPPYYGT

	THPFAYWGQGLTVTVSA (SEQ ID NO: 12)
mAb037 (V <sub>L</sub> )	DVVMQTPTLTLSTIGQPASISCKSSQSLLYSNGKTYLNWLLQRPQSPKRLIYL VSKLDSGVPDRFTGSGSGTDFTLKISRVEAEDLGVYYCVQGTHTFPQTFGGGTKL EIK (SEQ ID NO: 24)
Humanized mAb037 (V <sub>H</sub> )	QVQLVQSGAEVKKPGASVKVSCKASGYTFTDYNMDWVRQAHGQGLEWIGDIN PNTGGTIYNQKFKGRATLTVDTSTAYMELSRRLRSDDTAVYYCAGEGPPYYGT THPFAYWGQGLTVTVSS (SEQ ID NO: 106)
Humanized mAb037 (V <sub>L</sub> )	DVVMTQSPLSLPVTLGQPASISCKSSQSLLYSNGKTYLNWLLQRPQSPRRLIYL VSKLDSGVPDRFSGSGTDFTLKISRVEAEDVGVYYCVQGTHTFPQTFGGGTKL EIK (SEQ ID NO: 107)

**[0144]** In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the antibody or antigen-binding moiety is a monoclonal antibody.

**[0145]** In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the antibody or antigen-binding moiety is a human, humanized, or chimeric antibody.

**[0146]** In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the antibody or antigen-binding moiety is an antibody fragment, e.g., na Fv, Fab, Fab', scFv, diabody, or F(ab')<sub>2</sub> fragment.

**[0147]** In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the antibody or antigen-binding moiety is a full-length antibody.

**[0148]** In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the antibody or antigen-binding moiety binds to one or more pathological human Tau species. In some embodiments, the pathological human Tau species is from a tauopathy selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD). In some embodiments, the pathological human Tau species is from a tauopathy brain selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD).

**[0149]** In some embodiments, the pathological human Tau species is one or more of Tau Type 1A, IB, 11 A, and MB; misordered Tau; mis-disordered Tau; sarkosyl-insoluble Tau; an extracellular Tau deposit; a Tau aggregate; paired helical filaments; a neurofibrillary pathology; and a hyperphosphorylated form of truncated Tau or full-length Tau. In some embodiments, the pathological human Tau is hyperphosphorylated and sarkosyl-insoluble Tau. In some

embodiments, Tau protein aggregates and/or abnormally phosphorylated Tau. In some embodiments, the Tau aggregates and/or abnormally phosphorylated Tau is accumulated at synapses of brain. In some embodiments, the Tau aggregates and/or abnormally phosphorylated Tau is accumulated at synapses of tauopathy brain. In some embodiments, the antibody or antigen-binding moiety is capable of discriminating between one or more pathological Tau species and one or more normal Tau species. In some embodiments, the antibody or antigen-binding moiety preferentially binds to Tau species from a tauopathy brain sample (e.g., sample from Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), or Pick's disease (PiD) brain) as compared to Tau species from a corresponding healthy brain sample. In some embodiments, the antibody or antigen-binding moiety binds more pathological Tau species from a tauopathy brain sample as compared to a reference anti-Tau antibody (e.g., HT7, C2N-8E12, or BIIB092). In some embodiments, the antibody or antigen-binding moiety binds fewer normal Tau species from a healthy brain sample as compared to a reference anti-Tau antibody. In some embodiments, the reference anti-Tau antibody is HT7, C2N-8E12, or BIIB092. In some embodiments, the tauopathy brain sample is an AD, PSP, CBD, or PiD brain sample. In some embodiments, the brain sample is a whole brain lysate or a frontal cortex lysate, including synaptic fractions and/or sarkosyl-insoluble fractions thereof. In some embodiments, the brain sample is a sarkosyl-insoluble synaptic fraction of a brain lysate.

**[0150]** In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the antibody or antigen-binding moiety is an IgG1 or an IgG4 antibody.

**[0151]** In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the antibody or antigen-binding moiety is capable of inhibiting Tau seeding. In some embodiments, the inhibition after administration of the anti-pTau antibody or antigen-binding moiety described herein is at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90% higher than after administration of a reference antibody or antigen-binding moiety, as measured by any of the assays known in the art.

**[0152]** In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the antibody or antigen-binding moiety is capable of inhibiting Tau propagation. In some embodiments, the inhibition after administration of the anti-pTau antibody or antigen-binding moiety described herein is at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90% higher than after administration of a reference antibody or antigen-binding moiety,

as measured by any of the assays known in the art.

[0153] In some embodiments, according to any of the anti-pTau antibodies or antigen-binding moieties described herein, the antibody or antigen-binding moiety is capable of binding Tau species of certain molecular weight. In some embodiments, the anti-pTau antibody or antigen-binding moiety described herein is capable of binding to Tau species of about 64 kD, about 140 kD, and/or about 170 kD.

#### Antibody Affinity

[0154] In certain embodiments, an anti-pTau antibody provided herein has a dissociation constant (KD) of  $\leq 1 \mu\text{M}$ ,  $< 100 \text{ nM}$ ,  $< 10 \text{ nM}$ ,  $< 1 \text{ nM}$ ,  $< 0.1 \text{ nM}$ ,  $< 0.01 \text{ nM}$ , or  $< 0.001 \text{ nM}$ . KD can be measured using any technique known in the art.

#### Humanized Antibodies

[0155] A non-human antibody may be humanized to reduce immunogenicity to humans, while retaining the specificity and affinity of the parental non-human antibody. Generally, a humanized antibody comprises one or more variable domains in which HVRs, e.g., CDRs, (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), e.g., to restore or improve antibody specificity or affinity.

[0156] Humanized antibodies and methods of making them are reviewed, e.g., in Almagro and Fransson, *Front. Biosci.* 13: 1619-1633 (2008), and are further described, e.g., in Riechmann et al., *Nature* 332:323-329 (1988); Queen et al., *Proc. Nat'l Acad. Sci. USA* 86: 10029-10033 (1989); U.S. Patent Nos. 5,821,337, 7,527,791, 6,982,321, and 7,087,409; Kashmiri et al., *Methods* 36:25-34 (2005) (describing specificity determining region (SDR) grafting); Padlan, *Mol. Immunol.* 28:489-498 (1991) (describing "resurfacing"); Dall'Acqua et al., *Methods* 36:43-60 (2005) (describing "FR shuffling"); and Osbourn et al., *Methods* 36:61-68 (2005) and Klimka et al., *Br. J. Cancer*, 83:252-260 (2000) (describing the "guided selection" approach to FR shuffling).

[0157] 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)).

**[0158]** In some embodiments, provided herein is a humanized anti-pTau antibody (e.g., an isolated anti-pTau antibody) or antigen-binding moiety thereof that is a humanized mAb004, mAb005, mAb008, mAb010, mAb011, mAb013, mAb020, mAb025, mAb032, mAb035, or mAb037. In some embodiments, the humanized anti-pTau antibody is a humanized mAb005. In some embodiments, the humanized anti-pTau antibody is a humanized mAb037.

**[0159]** In some embodiments, the humanized anti-pTau antibody has following heavy chain variable ( $V_H$ ) sequences and light chain variable ( $V_L$ ) sequences according to the following humanized mAb005 or humanized mAb037:

Antibody clone (variable region)	Sequence
Humanized mAb005, ( $V_H$ )	EVQLVESGGGLVQPGGSLRLSCAASGFTFSDYGMHWVRQAPGKGLEWVAYSNSDSTTIYYADTVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYCGRSYYSNYVDYWGQGTLVTVSS (SEQ ID NO: 3)
Humanized mAb005, ( $V_L$ )	DVVMTQSPLSLPVTLGQPASISCRSSQSLVHSNGNTYLHWYLQRPQGSPRLLIYK VSNRFSGVPDRFSGSGSGTDFTLKISRVEAEDVGVYFCFQSTHVPPTFGQGTKLEIK (SEQ ID NO: 15)
Humanized mAb037 ( $V_H$ )	QVQLVQSGAEVKKPGASVKVSCKASGYTFTDYNMDWVRQAHGQGLEWIGDINPNTGGTIYNQKFKGRATLTVDTISISTAYMELSRLRSDDTAVYYCAGEGPYYYGTTHPFAYWGQGTLVTVSS (SEQ ID NO: 106)
Humanized mAb037 ( $V_L$ )	DVVMTQSPLSLPVTLGQPASISCKSSQLLYSNGKTYLNWLLQRPQGSPRLLIYL VSKLDSGVPDRFSGSGSGTDFTLKISRVEAEDVGVYYCVQGTHFPQTFGGGTKLEIK (SEQ ID NO: 107)

### Library-Derived Antibodies

**[0160]** Antibodies of the invention may be isolated by screening combinatorial libraries for antibodies with the desired activity or activities. 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. Such methods are reviewed, e.g., in Hoogenboom et al. Methods in Molecular Biology 178: 1 -37 (O'Brien et al, ed., Human Press, Totowa, NJ, 2001) and



further described, e.g., in the McCafferty et al., Nature 348:552-554; Clackson et al, Nature 352: 624-628 (1991); Marks et al., J. Mol. Biol. 222: 581 -597 (1992); Marks and Bradbury, m Methods in Molecular Biology 248: 161 -175 (Lo, ed., Human Press, Totowa, NJ, 2003); 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(1 -2): 1 19-132(2004).

**[0161]** 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). 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 unrearranged V-gene segments from stem cells, and using PCR primers containing random sequence to encode the highly variable CDR3 regions and to accomplish rearrangement *in vitro*, as described by Hoogenboom and Winter, J. Mol. Biol , 227: 381-388 (1992). Patent publications describing human antibody phage libraries include, for example: U.S. Patent No. 5,750,373, and U.S. Patent Publication Nos. 2005/0079574, 2005/0119455, 2005/0266000, 2007/0117126, 2007/0160598, 2007/0237764, 2007/0292936, and 2009/0002360.

**[0162]** Antibodies or antibody fragments isolated from human antibody libraries are considered human antibodies or human antibody fragments herein.

#### Multispecific Antibodies

**[0163]** In certain embodiments, an antibody provided herein is a multispecific antibody, e.g. a bispecific antibody. Multispecific antibodies are monoclonal antibodies that have binding specificities for at least two different sites. In certain embodiments, one of the binding specificities is for Tau and the other is for any other antigen. In certain embodiments, one of the binding specificities is for Tau and the other is for amyloid beta. In certain embodiments, bispecific antibodies may bind to two different epitopes of Tau. Bispecific antibodies may also be used to

localize cytotoxic agents to cells which express Tau. Bispecific antibodies can be prepared as full-length antibodies or antibody fragments.

[0164] 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 Traunecker et al., *EMBO J.* 10: 3655 (1991)), and “knob-in-hole” engineering (see, e.g., U.S. Patent No. 5,731,168). Multispecific antibodies may also be made by engineering electrostatic steering effects for making antibody Fc-heterodimeric molecules (WO 2009/089004 A1); cross-linking two or more antibodies or fragments (see, e.g., U.S. Patent No. 4,676,980, and Brennan et al., *Science*, 229: 81 (1985)); using leucine zippers to produce bi-specific antibodies (see, e.g., Kostelny et al., *J. Immunol.*, 148(5): 1547-1553 (1992)); 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 (sFv) 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).

#### Antibody Variants

[0165] In certain embodiments, amino acid sequence variants of the antibodies provided herein are contemplated. For example, it may be desirable to improve the binding affinity and/or other biological properties of the antibody. 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. 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, e.g., antigen-binding.

[0166] In certain embodiments, antibody variants having one or more amino acid substitutions, such as conservative substitutions, are provided. Sites of interest for substitutional mutagenesis include the HVRs and FRs. Amino acid substitutions may be introduced into an antibody of interest and the products screened for a desired activity, e.g., retained/improved antigen binding, decreased immunogenicity, or improved ADCC or CDC.

[0167] One type of substitutional variant involves substituting one or more hypervariable region residues of a parent antibody (e.g. a humanized or human antibody). Generally, the resulting

variant(s) selected for further study will have modifications (e.g., improvements) in certain biological properties (e.g., increased affinity, reduced immunogenicity) relative to the parent antibody and/or will have substantially retained certain biological properties of the parent antibody. An exemplary substitutional variant is an affinity matured antibody, which may be conveniently generated, e.g., using phage display-based affinity maturation techniques such as those described herein. Briefly, one or more HVR residues are mutated and the variant antibodies displayed on phage and screened for a particular biological activity (e.g. binding affinity).

**[0168]** Alterations (e.g., substitutions) may be made in HVRs, e.g., to improve antibody affinity. Such alterations may be made in HVR “hotspots,” i.e., residues encoded by codons that undergo mutation at high frequency during the somatic maturation process (see, e.g., Chowdhury, *Methods Mol. Biol.* 207: 179-196 (2008)), and/or residues that contact antigen, with the resulting variant VH or VL being tested for binding affinity. Affinity maturation by constructing and reselecting from secondary libraries has been described, e.g., in Hoogenboom et al. *Methods in Molecular Biology* 178: 1-37 (O'Brien et al., ed., Human Press, Totowa, NJ, (2001).) In some embodiments of affinity maturation, diversity is introduced into the variable genes chosen for maturation by any of a variety of methods (e.g., error-prone PCR, chain shuffling, or oligonucleotide-directed mutagenesis). A secondary library is then created. The library is then screened to identify any antibody variants with the desired affinity. Another method to introduce diversity involves HVR-directed approaches, in which several HVR residues (e.g., 4-6 residues at a time) are randomized. HVR residues involved in antigen binding may be specifically identified, e.g., using alanine scanning mutagenesis or modeling. CDR-H3 and CDR-L3 in particular are often targeted.

**[0169]** 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.

**[0170]** A useful method for identification of residues or regions of an antibody that may be targeted for mutagenesis is called “alanine scanning mutagenesis” as described by Cunningham and Wells (1989) *Science*, 244: 1081-1085. In this method, a residue or group of target residues

(e.g., charged residues such as arg, asp, his, lys, and glu) are identified and replaced by a neutral or negatively charged amino acid (e.g., alanine or polyalanine) to determine whether the interaction of the antibody with antigen is affected. Further substitutions may be introduced at the amino acid locations demonstrating functional sensitivity to the initial substitutions. Alternatively, or additionally, a crystal structure of an antigen-antibody complex to identify contact points between the antibody and antigen. Such contact residues and neighboring residues may be targeted or eliminated as candidates for substitution. Variants may be screened to determine whether they contain the desired properties.

**[0171]** Amino acid sequence insertions include amino- and/or carboxyl- terminal fusions ranging in length from one residue to polypeptides containing 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.

**[0172]** In certain embodiments, an antibody provided herein 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.

**[0173]** 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 of the CH2 domain of the Fc region. See, e.g., Wright et al. TIBTECH 15:26-32 (1997). The oligosaccharide may include various carbohydrates, e.g., 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.

**[0174]** In some embodiments, antibody variants are provided having a carbohydrate structure that lacks fucose attached (directly or indirectly) to an Fc region. For example, the amount of fucose in such antibody may be from 1% to 80%, from 1% to 65%, from 5% to 65% or from 20% to 40%. The amount of fucose is determined by calculating the average amount of fucose within the sugar

chain at Asn<sup>297</sup>, relative to the sum of all glycostructures attached to Asn<sup>297</sup> (e. g. complex, hybrid and high mannose structures) as measured by MALDI-TOF mass spectrometry, as described in WO 2008/077546, for example. Asn<sup>297</sup> refers to the asparagine residue located at about position 297 in the Fc region (Eu numbering of Fc region residues); however, Asn<sup>297</sup> may also be located about  $\pm 3$  amino acids upstream or downstream of position 297, i.e., between positions 294 and 300, due to minor sequence variations in antibodies. Such fucosylation variants may have improved ADCC function. See, e.g., U.S. Patent Publication Nos. U.S. 2003/0157108 (Presta, L.); U.S. 2004/0093621 (Kyowa Hakko Kogyo Co., Ltd). Examples of publications related to “defucosylated” or “fucose-deficient” antibody variants include: U.S. 2003/0157108; WO 2000/61739; WO 2001/29246; US 2003/0115614; U.S. 2002/0164328; U.S. 2004/0093621; U.S. 2004/0132140; U.S. 2004/0110704; U.S. 2004/0110282; U.S. 2004/0109865; WO 2003/085119; WO 2003/084570; WO 2005/035586; WO 2005/035778; WO2005/053742; WO2002/031140; 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); U.S. Publication No. 2003/0157108 A1, Presta, L.; and WO 2004/056312 A1, Adams et al., especially at Example 11), 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); Kanda, Y. et al., Biotechnol. Bioeng., 94(4):680-688 (2006); and WO 2003/085107).

**[0175]** Antibodies variants are further provided with bisected oligosaccharides, e.g., in which a biantennary oligosaccharide attached to the Fc region of the antibody is bisected by GlcNAc. Such antibody variants may have reduced fucosylation and/or improved ADCC function. Examples of such antibody variants are described, e.g., in WO 2003/011878 (Jean-Mairet et al.); U.S. Patent No. 6,602,684 (Umana et al.); and U.S. Publication No. 2005/0123546 (Umana et al.). Antibody variants with at least one galactose residue in the oligosaccharide attached to the Fc region are also provided. Such antibody variants may have improved CDC function. Such antibody variants are described, e.g., in WO 1997/30087 (Patel et al.); WO 1998/58964 (Raju, S.); and WO 1999/22764 (Raju, S.).

**[0176]** In certain embodiments, one or more amino acid modifications may be introduced into the Fc region of an antibody provided herein, thereby generating an Fc region variant. The Fc region variant may comprise a human Fc region sequence (e.g., a human IgG1, IgG2, IgG3 or IgG4 Fc

region) comprising an amino acid modification (e.g. a substitution) at one or more amino acid positions.

[0177] In certain embodiments, the invention contemplates an antibody variant that possesses some but not all effector functions, which make it a desirable candidate for applications in which the half life of the antibody *in vivo* is important yet certain effector functions (such as complement and ADCC) are unnecessary or deleterious. *In vitro* and/or *in vivo* cytotoxicity assays can be conducted to confirm the reduction/depletion of CDC and/or ADCC activities. For example, Fc receptor (FcR) binding assays can be conducted to ensure that the antibody lacks FcγR binding (hence likely lacking ADCC activity), but retains FcRn binding ability. The primary cells for mediating ADCC, NK cells, express FcγRIII only, whereas monocytes express FcγRI, FcγRII and FcγRIII. FcR expression on hematopoietic cells is summarized in Table 3 on page 464 of Ravetch and Kinet, *Annu. Rev. Immunol.* 9:457- 492 (1991). Non-limiting examples of *in vitro* assays to assess ADCC activity of a molecule of interest is described in U.S. Patent No. 5,500,362 (see, e.g. Hellstrom, I. et al. *Proc. Nat'l Acad. Sci. USA* 83:7059-7063 (1986)) and Hellstrom, I. et al., *Proc. Nat'l Acad. Sci. USA* 82: 1499-1502 (1985); 5,821,337 (see Bruggemann, M. et al., *J. Exp. Med.* 166: 1351-1361 (1987)). Alternatively, non-radioactive assays methods may be employed (see, for example, ACTI™ non-radioactive cytotoxicity assay for flow cytometry (CellTechnology, Inc. Mountain View, CA; and CytoTox 96® non-radioactive cytotoxicity assay (Promega, Madison, WI). Useful effector cells for such assays include peripheral blood mononuclear cells (PBMC) and Natural Killer (NK) cells. Alternatively, or additionally, ADCC activity of the molecule of interest may be assessed *in vivo*, e.g., in an animal model such as that disclosed in Clynes et al. *Proc. Nat'l Acad. Sci. USA* 95:652-656 (1998). Clq binding assays may also be carried out to confirm that the antibody is unable to bind Clq and hence lacks CDC activity. See, e.g., Clq and C3c binding ELISA in WO 2006/029879 and WO 2005/100402. To assess complement activation, a CDC assay may be performed (see, for example, Gazzano-Santoro et al., *J. Immunol. Methods* 202: 163 (1996); Cragg, M.S. et al., *Blood* 101: 1045-1052 (2003); and Cragg, M.S. and M.J. Glennie, *Blood* 103:2738-2743 (2004)). FcRn binding and *in vivo* clearance/half life determinations can also be performed using methods known in the art (see, e.g., Petkova, S.B. et al., *Int'l. Immunol.* 18(12): 1759-1769 (2006)).

[0178] Antibodies with reduced effector function include those with substitution of one or more of Fc region residues 238, 265, 269, 270, 297, 327 and 329 (U.S. Patent No. 6,737,056). Such Fc

mutants include Fc mutants with substitutions at two or more of amino acid positions 265, 269, 270, 297 and 327, including the so-called “DANA” Fc mutant with substitution of residues 265 and 297 to alanine (U.S. Patent No. 7,332,581).

**[0179]** Certain antibody variants with improved or diminished binding to FcRs are described. (See, e.g., U.S. Patent No. 6,737,056; WO 2004/056312, and Shields et al., *J. Biol. Chem.* 9(2): 6591-6604 (2001)).

**[0180]** In certain embodiments, an antibody variant comprises an Fc region with one or more amino acid substitutions which improve ADCC, e.g., substitutions at positions 298, 333, and/or 334 of the Fc region (EU numbering of residues).

**[0181]** In some embodiments, alterations are made in the Fc region that result in altered (i.e., either improved or diminished) Clq binding and/or Complement Dependent Cytotoxicity (CDC), e.g., as described in U.S. Patent No. 6,194,551, WO 99/51642, and Idusogie et al. *J. Immunol.* 164: 4178-4184 (2000).

**[0182]** Antibodies with increased half lives and improved binding to the neonatal Fc receptor (FcRn), which is responsible for the transfer of maternal IgGs to the fetus (Guyer et al., *J. Immunol.* 117:587 (1976) and Kim et al., *J. Immunol.* 24:249 (1994)), are described in U.S. Publication No. 2005/0014934 A1 (Hinton et al.). Those antibodies comprise an Fc region with one or more substitutions therein which improve binding of the Fc region to FcRn. Such Fc variants include those with substitutions at one or more of Fc region residues: 238, 256, 265, 272, 286, 303, 305, 307, 311, 312, 317, 340, 356, 360, 362, 376, 378, 380, 382, 413, 424 or 434, e.g., substitution of Fc region residue 434 (U.S. Patent No. 7,371,826).

**[0183]** See also Duncan & Winter, *Nature* 322:738-40 (1988); U.S. Patent No. 5,648,260; U.S. Patent No. 5,624,821; and WO 94/29351 concerning other examples of Fc region variants.

**[0184]** In certain embodiments, it may be desirable to create cysteine engineered antibodies, e.g., “thioMAbs,” in which one or more residues of an antibody are substituted with cysteine residues. In particular embodiments, the substituted residues occur at accessible sites of the antibody. By substituting those residues with cysteine, reactive thiol groups are thereby positioned at accessible sites of the antibody and may be used to conjugate the antibody to other moieties, such as drug moieties or linker-drug moieties, to create an immunoconjugate, as described further herein. In certain embodiments, any one or more of the following residues may be substituted with cysteine: V205 (Kabat numbering) of the light chain; A118 (EU numbering) of the heavy chain; and S400

(EU numbering) of the heavy chain Fc region. Cysteine engineered antibodies may be generated as described, e.g., in U.S. Patent No. 7,521,541.

[0185] In certain embodiments, an antibody provided herein may be further modified to contain additional nonproteinaceous moieties that are known in the art and readily available. The moieties suitable for derivatization of the antibody include but are not limited to water soluble polymers. Non-limiting examples of water soluble polymers include, but are not limited to, polyethylene glycol (PEG), copolymers of ethylene glycol/propylene glycol, carboxymethylcellulose, dextran, polyvinyl alcohol, polyvinyl pyrrolidone, poly-1, 3-dioxolane, poly-1, 3, 6-trioxane, ethylene/maleic anhydride copolymer, polyaminoacids (either homopolymers or random copolymers), and dextran or poly(n-vinyl pyrrolidone)polyethylene glycol, propylene glycol homopolymers, polypropylene oxide/ethylene oxide co-polymers, polyoxyethylated polyols (e.g., glycerol), polyvinyl alcohol, and mixtures thereof.

[0186] Polyethylene glycol propionaldehyde may have advantages in manufacturing due to its stability in water. The polymer may be of any molecular weight, and may be branched or unbranched. The number of polymers attached to the antibody may vary, and if more than one polymer are attached, they can be the same or different molecules. In general, the number and/or type of polymers used for derivatization can be determined based on considerations including, but not limited to, the particular properties or functions of the antibody to be improved, whether the antibody derivative will be used in a therapy under defined conditions, etc.

[0187] In another embodiment, conjugates of an antibody and nonproteinaceous moiety that may be selectively heated by exposure to radiation are provided. In some embodiments, the nonproteinaceous moiety is a carbon nanotube (Kam et al., Proc. Natl. Acad. Sci. USA 102: 11600-11605 (2005)). The radiation may be of any wavelength, and includes, but is not limited to, wavelengths that do not harm ordinary cells, but which heat the nonproteinaceous moiety to a temperature at which cells proximal to the antibody-nonproteinaceous moiety are killed.

#### Assays

[0188] Anti-pTau antibodies and antigen-binding moieties provided herein may be identified, screened for, and/or characterized for their physical/chemical properties and/or biological activities by various assays known in the art.

[0189] In one aspect, an antibody or antigen-binding moiety of the invention is tested for its



antigen-binding activity, e.g., by known methods such as ELISA, western blot, etc.

**[0190]** In another aspect, competition assays may be used to identify an antibody or antigen-binding moiety that competes with an antibody or antigen-binding moiety described herein for binding to Tau. Detailed exemplary methods for mapping an epitope to which an antibody binds are provided in Morris (1996) "Epitope Mapping Protocols," *Methods in Molecular Biology* vol. 66 (Humana Press, Totowa, NJ).

**[0191]** In an exemplary competition assay, an immobilized Tau species (e.g., a pathological Tau species) is incubated in a solution comprising a first labeled antibody that binds to the Tau species (e.g., any antibody described herein, such as mAb005 and mAb037) and a second unlabeled antibody that is being tested for its ability to compete with the first antibody for binding to the Tau species. The second antibody may be present in a hybridoma supernatant. As a control, the immobilized Tau species 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 the Tau species, excess unbound antibody is removed, and the amount of label associated with the immobilized Tau species is measured. If the amount of label associated with the immobilized Tau species 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 the Tau species. *See* Harlow and Lane (1988) *Antibodies: A Laboratory Manual* ch. 14 (Cold Spring Harbor Laboratory, Cold Spring Harbor, NY).

**[0192]** In one aspect, assays are provided for identifying anti-Tau antibodies having biological activity. Biological activity may include, e.g., binding of such antibodies to multiple forms of Tau (e.g., monomeric Tau, oligomeric Tau, non-phosphorylated Tau, and phosphorylated Tau) and reducing the level of Tau protein (e.g., total Tau, total soluble Tau, soluble non-phosphorylated Tau, soluble phosphorylated Tau, total insoluble Tau, insoluble non-phosphorylated Tau, insoluble phosphorylated Tau, hyperphosphorylated Tau, or paired helical filaments containing hyperphosphorylated Tau, in the brain, e.g., in the brain synapses, cortex and/or hippocampus).

**[0193]** In certain embodiments, an antibody of the invention is tested for such biological activity. For example, an animal model of tauopathy, such as a Tau transgenic mouse (e.g., P301L), can be used to detect binding of anti-Tau antibodies to brain sections, and for example, to pathological Tau species (e.g., neurofibrillary tangles) in the brains of the transgenic mice. Further, an animal model of tauopathy, such as a Tau transgenic mouse (e.g., P301L), can be treated with anti-Tau

antibodies and experimental techniques known in the art can be used to assess whether such treatment reduces the level of Tau protein (e.g., total Tau, total soluble Tau, soluble phosphorylated Tau, soluble non-phosphorylated Tau, total insoluble Tau, insoluble phosphorylated Tau, insoluble non-phosphorylated Tau, hyperphosphorylated Tau, or paired helical filaments containing hyperphosphorylated Tau) in the mouse brain (e.g., in the brain cortex and/or hippocampus).

### Immunoconjugates

**[0194]** The invention also provides immunoconjugates comprising an anti-Tau antibody herein conjugated to one or more other therapeutic agents or radioactive isotopes.

**[0195]** In some embodiments, an immunoconjugate comprises an antibody or antigen-binding moiety as described herein conjugated to a radioactive atom to form a radioconjugate. A variety of radioactive isotopes are available for the production of radioconjugates. Examples include At<sup>211</sup>, I<sup>131</sup>, I<sup>125</sup>, Y<sup>90</sup>, Re<sup>186</sup>, Re<sup>188</sup>, Sm<sup>153</sup>, Bi<sup>212</sup>, P<sup>32</sup>, Pb<sup>212</sup> and radioactive isotopes of Lu. When the radioconjugate is used for detection, it may comprise a radioactive atom for scintigraphic studies, for example Tc<sup>99m</sup> or I<sup>123</sup>, or a spin label for nuclear magnetic resonance (NMR) imaging (also known as magnetic resonance imaging, MRI), such as iodine-123 again, iodine-131, indium-111, fluorine-19, carbon-13, nitrogen-15, oxygen-17, gadolinium, manganese or iron.

**[0196]** Conjugates of an antibody or antigen-binding moiety may be made using a variety of functional protein coupling agents such as N-succinimidyl-3-(2-pyridyldithio) propionate (SPDP), succinimidyl-4-(N-maleimidomethyl) cyclohexane-1-carboxylate (SMCC), iminothiolane (IT), Afunctional derivatives of imidoesters (such as dimethyl adipimidate HCl), active esters (such as disuccinimidyl suberate), aldehydes (such as glutaraldehyde), bis-azido compounds (such as bis-(p-azidobenzoyl) hexanediamine), bis-diazonium derivatives (such as bis-(p-diazoniumbenzoyl)-ethylenediamine), diisocyanates (such as toluene 2,6-diisocyanate), and bis-active fluorine compounds (such as 1,5-difluoro-2,4-dinitrobenzene). For example, a ricin immunotoxin can be prepared as described in Vitetta et al., Science 238: 1098 (1987). Carbon-14-labeled 1-isothiocyanatobenzyl-3-methyl-diethylene triaminepentaacetic acid (MX-DTPA) is an exemplary chelating agent for conjugation of radionucleotide to the antibody. See WO 94/11026. The linker may be a "cleavable linker" facilitating release of a cytotoxic drug in the cell. For example, an acid-labile linker, peptidase-sensitive linker, photolabile linker, dimethyl linker or disulfide-containing linker (Chari et al., Cancer Res. 52: 127-131 (1992); U.S. Patent No. 5,208,020) may

be used.

[0197] The immunoconjugates herein expressly contemplate, but are not limited to, such conjugates prepared with cross-linker reagents including, but not limited to, BMPS, EMCS, GMBS, HBVS, LC-SMCC, MBS, MPBH, SBAP, SIA, SIAB, SMCC, SMPB, SMPH, sulfo-EMCS, sulfo-GMBS, sulfo-KMUS, sulfo-MBS, sulfo-SIAB, sulfo-SMCC, and sulfo-SMPB, and SVSB (succinimidyl-(4-vinylsulfone)benzoate) which are commercially available (e.g., from Pierce Biotechnology, Inc., Rockford, IL., U.S.A.).

### **Nucleic acids**

[0198] In another aspect, provided herein is nucleic acid encoding an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein. In some embodiments, such nucleic acid is a vector (e.g., a recombinant expression vector).

[0199] In some embodiments, provided herein is nucleic acid encoding an anti-pTau antibody or antigen-binding moiety thereof, wherein the anti-pTau antibody or antigen-binding moiety comprises a) a heavy chain variable region comprising i) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 49-59 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 49-59; ii) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 60-70 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 60-70; and/or iii) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 71-81 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 71-81; and/or b) a light chain variable region comprising iv) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 82-90 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 82-90; v) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 91-95 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 91-95; and/or vi) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 96-105 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 96-105. In some embodiments, the heavy chain and/or light chain CDR sequences are as indicated for a given antibody clone shown in Tables 1 and 2.

[0200] In some embodiments, provided herein is nucleic acid encoding an anti-pTau antibody or

antigen-binding moiety thereof comprising a heavy chain variable region comprising the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106; and/or a light chain variable region comprising the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107. In some embodiments, the heavy chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106; and/or the light chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107. In some embodiments, the heavy chain and light chain variable regions are as indicated for a given antibody clone shown in Table 3.

**[0201]** In some embodiments, provided herein is nucleic acid encoding an anti-pTau antibody or antigen-binding moiety thereof, wherein the nucleic acid comprises a first coding sequence encoding a heavy chain variable region, wherein the first coding sequence comprises the nucleotide sequence of any one of SEQ ID NOs: 25-36 and 108 or a variant thereof having at least 80% sequence identity to the nucleotide sequence of any one of SEQ ID NOs: 25-36 and 108; and/or a second coding sequence encoding a light chain variable region, wherein the second coding sequence comprises the nucleotide sequence of any one of SEQ ID NOs: 37-48 and 109 or a variant thereof having at least 80% sequence identity to the nucleotide sequence of any one of SEQ ID NOs: 37-48 and 109. In some embodiments, the first coding sequence comprises the nucleotide sequence of any one of SEQ ID NOs: 25-36 and 108; and/or the second coding sequence comprises the nucleotide sequence of any one of SEQ ID NOs: 37-48 and 109.

**[0202]** In some embodiments, provided herein nucleic acid encoding an anti-pTau antibody or antigen-binding moiety thereof, wherein the nucleic acid comprises a first coding sequence encoding a heavy chain variable region, and a second coding sequence encoding a light chain variable region, wherein the heavy chain variable region and the light chain variable region is any one of mAb004, mAb005, humanized mAb005, mAb008, mAb010, mAb011, mAb013, mAb020, mAb025, mAb032, mAb033, mAb037, or humanized mAb037, encoded by the following nucleic acid sequences:

25	GAGGTGCAGCTGGTGGAGTCTGGGGGAGACTTAGTGGAGTCTGGAGGGTCC CTAAACTCTCCTGTGCAGCCTCTGGATTCACTTTAGTAGCTATGGCATGTCTT GGGTTCCGACAGCTCCAGACAAGAGGCTGGAGTGGGTCGCAACCATTAGTAG TAGTGGTAGTTACACCTACTATCCAGACAGTGTGAAGGGGCGATTACCATCT CCAGAGACAATGCCAAGAACACCCCTGTACCTGCAAATGAGCAGTCTGAACTCT GAGGACACAGCCATGTATTACTGTGCTGATACTTACTACGGAGCTATGGACTA CTGGGGTCAAGGAACCTCAGTCACCGTCTCCTCA	Mouse mAb004 heavy chain DNA sequence
26	GAGGTGCAGCTGGTGGAGTCTGGGGGAGGCTTAGTGAAGCCTGGAGGGTCC CTGAAACTCTCCTGTGCAGCCTCTGGATTCACTTTAGTAGCTATGGAATGCAC TGGGTTTCGTCAGGCTCCAGAGAAGGGGCTGGAGTGGGTTGCATACAGCAATA GTGACAGTACTACCATCTACTATGCAGACACAGTGAAGGGCCGATTACCATC TCCAGAGACAATGCCAAGAGCACCCCTGTTCTGCAAATGACCAGTCTGAGGTC TGAGGACACGGCCATGTATTATTGTGAAGGAGCTACTATAGTAACTACGTTG ACTACTGGGGCCAAGGCACCACTCTCACAGTCTCCTCA	Mouse mAb005 heavy chain DNA sequence
27	GAGGTGCAGCTGGTTGAATCTGGCGGAGGACTGGTTCAGCCTGGCGGATCTC TGAGACTGTCTTGTGCCGCCAGCGGCTTACCTTCAGCGATTATGGCATGCACT GGGTCCGACAGGCCCTGGCAAAGGACTTGAGTGGGTCGCTACAGCAACAG CGACAGCACCACCATCTACTACGCCGACCCGTGAAGGGCAGATTACCATCA GCCGGGACAACGCCAAGAACAGCCTGTACCTGCAGATGAACTCCCTGAGAGC CGAGGACACCGCGGTGTACTACTGTGGCAGAAGCTACTACTCCAACCTACGTGG ACTACTGGGGCCAGGGCACACTGGTCACAGTGTCTAGC	Humanized mAb005 heavy chain DNA sequence
28	GAGGTGAAGCTTCTCCAGTCTGGAGGTGGCCTGGTGCAGCCTGGAGGATCCC TGAAAGTCTCCTGTGCAGCCTCAGGATTCGATTTTAGTAGATACTGGATGAGTT GGGTTTCGGCGGGCTCCAGGAAAAGGACTAGAGTGGATTGGAGAAATTAATCC AGATGGCAATGCAATAAACTATGCACCATCTCTAAAGGATAAATTCATCGTCTC CAGAGACAACGCCAAAAATACGCTGTACCTGCAAATGAGCAATGTGAGATCTG AGGACACAGCCCTTTATTACTGTGCACGACCTTTCCCAGCGTCTGGGGCACA GGGACCACGGTCACCGTCTCCTCA	Mouse mAb008 heavy chain DNA sequence
29	CAGGTGCAGCTGAAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCC TGTCATCACATGCACCGTCTCAGGGTTCTATTAACCGGCTATGGTGTAAACT GGGTTCCGACAGCCTCCAGGAAAGGGTCTGGAGTGGCTGGGAATGATATGGGG TGATGGAAGCACAGACTATAATTCAGCTCTCAAATCCAGACTGAGCATCAGCA AGGACAACCTCAAGAGCCAAGTTTTCTTAAAAATGAATAGTCTGCAAACCTGAT GACACAGCCAGGTACTACTGTGCCAACTGGGCCTTTGCTTACTGGGGCCAAGG GACTCTGGTCACTGTCTCTGCA	Mouse mAb010 heavy chain DNA sequence
30	CAGGTGCAACTGCAGCAGTCTGGGCCTCAGCTGGTTAGGCCTGGGGCTTCAGT GAAGATATCCTGCAAGGCTTCTGGTACTCATTACCCAGCTACTGGATGCACTG GCTGAAGCAGAGGCCTGGACAAGGTCTTGAGTGGATTGGCATGATTGATCCTT CCGATAGTGAAACTAGGTTAAATCAGAAGTTCAAGGACAAGGCCACATTGACT GTAGACAAATCCTCCAGTACAGTCTACATGCACCTCAGCAGCCCGACATCTGA GGACTCTGCGGTCTATTACTGTGTAAGGCCGTATGGTGACCTTGACTACTGGG GCCAAGGCACCACTCTCACAGTCTCCTCA	Mouse mAb011 heavy chain DNA sequence

31	GAGGTCCAGCTGCAACAGTCTGGACCTGAGCTGGTGAAGCCTGGGGCTTCAG TGAAGATGTCCTGCAAGGCTTCTGGATACACCTTCACTGACTTCTACATGAAGT GGGTGAAGCAGAGCCATGGAAAGAGCTTTGAGTGGATTGGAGATATTGATCC TAACAATGGTGATACTTTCTACAACCAGAAGTTCAAGGGCAAGGCCACATTGA CTGTAGACAAATCCTCCAGCACAGCCTACATGCAGCTCAACAGCCTGACATCTG AGGACTCTGCAGTCTATTACTGTGCAAGGGATCTCTACTGGGGCCAAGGCACC ACTCTCACAGTCTCCTCA	Mouse mAb013 heavy chain DNA sequence
32	CAGGTGCAGCTGAAGCAGTCAGGACCTGGCCTAGTGCAGCCCTCACAGAGCCT GTCCATCACCTGCACAGTCTCTGTTTTCTATTAAGTATGCTGTACACTGG GTTCCGAGTCTCCAGGAAAGGGTCTGGAGTGGCTGGGAGTGATGTGGAGTG GTGGAAGCACAGACTATAATGCAGCTTTCATATCCAGACTGAGCATCAGCAAG GACAATTCCAAGAGCCAAGTTTTCTTAAAATGAACAGTCTGCAAGCTGATGAC ACAGCCATATATTACTGTGCCAGAATGGGTGATTACGACGGGGTGGCCTGGTT TGCTTACTGGGGCCAAGGGACTCTGGTCACTGTCTCTGCA	Mouse mAb020 heavy chain DNA sequence
33	CAGATCCAGTTGGTACAGTCTGGACCTGAGCTGAAGAAGCCTGGAGAGACAG TCAAGATCTCCTGCAAGGCTTCTGGGTATACCTTTACAACCCATGGAATGAGCT GGGTGAAACAGGCTCCAGGAAAGGGTTTAAAGTGGATGGGCTGGATAAACAC CTACTCTGGAGTGCCAACATATACTGATGACTTCAAGGGACGTTTTGCCTTCTC TTTGAAACCTCTGCCAGCACTGCCTATTTGCAGATCAACAACCTCAAAAATGA GGACACGGCTACATATTTCTGTGCAAGATCAGAAGTCTGCTGGTTTGCTTACTG GGGCCAAGGGACTCTGGTCACTGTCTCTGCA	Mouse mAb025 heavy chain DNA sequence
34	CAGGTTCACTGCAGCAGTCTGGGGCTGAGCTGGTGAAGCCTGGGGCCTCAG TGAAGATTTCTGCAAAGCTTCTGGCTACGCATTAGTACTGATGAACT GGGTGAAGCAGAGGCTGGAAAGGGTCTTGAGTGGATTGGACAGATTTATCC TGGAGATGGTGATACTGATTACAACGGAAAGTTCAAGGGCAAGGCCACTG ACTGCAGACACATCCTCCAGCACAGCCTACATGCAGCTCAGCAGCCTGACCTCT GAGGACTCTGCGGTCTATTTCTGTGCAAGCCGATCCCCTTACTGGGGCCAAGG GACTCTGGTCACTGTCTCTGCA	Mouse mAb032 heavy chain DNA sequence
35	CAGGTTACTCTGAAAGAGTCTGGCCCTGGGATATTGCAGCCCTCCAGACCT CAGTCTGACTTGTCTTTCTCTGGGTTTTCACTGAGCACTTTTGGTATGGGTGTA GGCTGGTTTCGTAGCCTCAGGGAAGGGTCTGGAGTGGCTGGCACACATTTG GTGGGATGATGATAAGTACTATAACCCAGCCCTGAAGAGTGGCTCACAATCT CCAAGGATACCTCCAAAACCAGGTTTTCTCAAGATCGCCAATGTGGACT GCAGATACTGCCACATACTACTGTGCTCGAAGGGTAGTAATGCTCTGGACTA CTGGGGTCAAGGAACCTCAGTACCCTCTCCTCA	Mouse mAb033 heavy chain DNA sequence
36	GAGGTCCAGCTGCAACAGTCTGGACCTGAGCTGGTGAAGCCTGGGGCTTCAG TGAAGATACCCTGCAAGGCTTCTGGATACACATTCACTGACTACAACATGGACT GGGTGAAGCAGAGCCATGGAAAGAGCCTTGAGTGGATTGGAGATATTAATCC TAACACTGGTGGTACTATCTACAACCAGAAGTTCAAGGGCAAGGCCACATTGA CTGTAGACAAGTCTCCAGCACAGCCTACATGGAGCTCCGCAGCCTGACATCT GAGGACTGCACTATTACTGTGCAAGGAGGGCCCTTATTACTACGGTAC TACCCACCCTTTTGTACTGGGGCCAAGGGACTCTGGTCACTGTCTCTGCA	Mouse mAb037 heavy chain DNA sequence

108	CAAGTGCAGCTGGTCCAGAGCGGCGCCGAGGTGAAAAAGCCCGGCGCCAGC GTGAAGGTGTCTTGTAAGCCTCTGGCTACACCTTACCGACTACAACATGGA CTGGGTGCGGCAGGCCACGGCCAGGGCCTGGAATGGATCGGCGACATCAAC CCCAACACCGGCGGAACAATCTACAACCAGAAGTTCAAGGGCAGAGCCACCCT GACAGTGGACACCAGCATCAGCACCGCCTACATGGAAGTGGAGACTGAGA AGCGACGACACAGCCGTGTACTACTGCGCCGCGAGGGCCCTTACTACTACGG CACGACCCACCCCTTCGCCTACTGGGGCCAGGGCACACTGGTGACCGTGTCCA GC	Humanized mAb037 heavy chain DNA sequence
37	GATGTTTTGATGACCCAAACTCCA CTCTCCCTGCCTGTCAGTCTTGGAGATCAA GCCTCCATCTCTTG CAGATCTAGTCAGACCATTGTACATAGTAATGGAAACACC TATTTAGAA TGGTACCTGCAGAAACCAGGCCAGTCTCAAAGCTCCTGATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTCA GTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTACTGCTTTCAAGGTTCACTTGTTCCGTGGACGTTCGGTGGAGGCACC CAGCTGGAAATCAGG	Mouse mAb004 light chain DNA sequence
38	GATATTGTGATGACCCAAATTCCA CTCTCCCTGCCTGTCAGTCTTGGAGATCAA GCCTCCATCTCTTG CAGATCTAGTCAGAGCCTTGACACAGTAATGGAAACACC TATTTACATTGGTACCTGCAGAAAGCCAGGCCAGTCTCAAAGCTCCTAATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTCA GTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTCTGCTTTCAAAGTACACATGTTCTCCGACGTTCGGTGGAGGCACC AAGCTGGAAATCAAA	Mouse mAb005 light chain DNA sequence
39	GACGTGGTCATGACACAGAGCCCTCTGAGCCTGCCTGTGACACTGGGACAGCC TGCCAGCATCAGCTGTAGAAGCAGCCAGAGCCTGGTGCACAGCAACGGCAAT ACCTACCTGCACTGGTATCTGCAGAGGCCCGGACAGTCTCCAGACTGCTGAT CTACAAGGTGTCCAACCGGTTCA GCGGCGTGCCCGATAGATTTTCTGGCAGCG GCTCTGGCACCGACTTCACCCTGAAGATCTCCAGAGTGGAAAGCCGAGGACGTG GGCGTGTACTTCTGCTTCAAAGCACCCACGTGCCACCTACCTTTGGCCAGGGC ACCAAGCTGGAAATCAAG	Humanized mAb005 light chain DNA sequence
40	GATGTTTTGATGACCCAAACTCCA CTCTCCCTGCCTGTCAGTCTTGGAGATCAA GCCTCCATCTCTTG CAGATCTAGTCAGAGTCTTGACGTAGTAATGGAAACACC TATTTAGAA TGGTACCTGCAGAAACCAGGCCAGTCTCAAAGCTCCTGATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTCA GTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTACTGCTTTCAAGGTTCA CATGTTCCGTACACGTTCCGAGGGGGGACC AAGCTGGAAATAAAA	Mouse mAb008 light chain DNA sequence
41	GATGTTGTGATGACCCAGACTCCA CTCACTTTGTCGGTTACCATTGGACAACCA GCCTCCATCTCTTG TAAAGTCAAGTCAGAGCCTCTTAGATAGTGGTGGAAAGAC ATATTTGAATTGGTTGTTACAGAGGCCAGGCCAGTCTCAAAGCGCCTAATCTA TCAGGTGTCTAAACTGGACTCTGGAGTCCCTGACAGGTTCA CTGGCAGTGGAT CAGGGACAGATTTCACTGAAAATCAGCAGAGTGGAGGCTGAGGATTTGGG AGTTTATTATTGCTGGCAAGGTACACATTTCCGCTCACGTTCCGTGCTGGGAC CAAGCTGGAGCTGAAA	Mouse mAb010 light chain DNA sequence
42	GATGTTGTGATGACCCAGACTCCA CTCACTTTGTCGGTTACCATTGGACAACCA GCCTCCATCTCTTG CAAAGTCAAGTCAGAGCCTCTTAGATAGTGGAAAGAC	Mouse mAb011 light chain DNA sequence

	ATATTTGAATTGGTTGTTACAGAGGCCAGGCCAGTCTCCAAAGCGCCTAATCTA TCTGGTGTCTAACTGGACTCTGGAGTCCCTGACAGTTCACTGGCAGTGGAT CAGGGACAGATTTCACTGAAAATCAGCAGAGTGGAGGCTGAGGATTTGGG AGTTTATTATTGCTGGCAAGGTACACATTTTCCATTACGTTTCGGCTCGGGGAC AAAGTTGGAAATAAAA	
43	GATGTTGTGATGACCCAGACTCCACTCACTTTGTCGGTTACCATTGGACAACCA GCCTCTATCTCTTGCAAGTCAAGTCAGAGCCTTATATAGTAATGGAAAAACC TATTTGAATTGGTTATTACAGAGGCCAGGCCAGTCTCCAAAGCGCCTAATCTAT CTGGTGTCTAACTGGACTCTGGAGTCCCTGACAGGTTCACTGGCAGTGGATC AGGAACAGATTTTACACTGAAAATCAGCAGAGTGGAGGCTGAGGATTTGGGG GTTTATTACTGCGTGCAAGGTACACATTTTCTCACACGTTTCGGAGGGGGGAC CAAGCTGGAAATAAAA	Mouse mAb013 light chain DNA sequence
44	GATGTTGTGATGACCCAACTCCACTCTCCCTGCCTGTCAGTCTTGGAGATCAA GCCTCCATCTCTTGCAAGTCAAGTCAGAGCCTTGTACACAGTAATGGAAACACC TATTTACATTGGTACCTGCAGAAGCCAGGCCAGTCTCCAAAGCTCCTGATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTCACTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTCTGCTCTCAAAGTACACATGTTCTCCGTGGACGTTTCGGTGGAGGC ACCAAGCTGGAAATCAAA	Mouse mAb020 light chain DNA sequence
45	GACATTGTGATGACTCAGTCTCCAGCCACCCTGTCTGTGACTCCAGGAGATAG AGTCTCTCTTCTGTCAGGGCCAGCCAGAGTATTAGCGACTACTTACACTGGTA TCAACAAAATCACATGAGTCTCCAAGGCTTTCATCAAATATGCTTCCCAATC CATCTCTGGGATCCCCTCCAGGTTCACTGGCAGTGGATCAGGGTCAGATTTCA CTCTCAGTATCAACAGTGTGGAACCTGAAGATGTTGGAGTGTATTACTGTCAA AATGGTCACAGCTTTCGTACACGTTTCGGAGGGGGGACCAAGCTGGAAATAA AA	Mouse mAb025 light chain DNA sequence
46	GATATTTTGTGATGACCCAACTCCACTCTCCCTGCCTGTCAGTCTTGGAGATCAA GCCTCCATCTCTTGCAAGTCAAGTCAGAGCATTGTACATAGTAATGGAAACACC TATTTAGAATGGTACCTGCAGAAACCAGGCCAGTCTCCAAAGCTCCTGATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTCACTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTACTGCTTTCAGGTTTACATGTTCCGTACACGTTTCGGAGGGGGGACC AAGCTGGAAATAAAA	Mouse mAb032 light chain DNA sequence
47	GATGTTGTGGTACTCAAACCTCCACTCTCCCTGCCTGTCAGTCTTGGAGATCAA GTTTCTATCTCTTGCAAGTCAAGTCAGAGCCTTATATAGTAATGGAAAAACC TATTTGTCTTGGTACCTGCACAAGCCTGGCCAGTCTCCACAGCTCCTCATCTATG GGATTTCCAACAGATTTTCTGGGGTGCCAGACAGGTTCACTGGCAGTGGTTCA GGGACAGATTTCACTCAAGATCAGCACAATAAAGCCTGAGGACTTGGGAAT GTATTACTGCTTACAAGGTACACATCAGCCGTGGACGTTTCGGTGGAGGCACCA AGCTGGAAATCAAA	Mouse mAb033 light chain DNA sequence
48	GATGTTGTGATGACCCAGACTCCACTCACTTTGTCGGTTACCATTGGACAACCA GCCTCTATCTCTTGCAAGTCAAGTCAGAGCCTTATATAGTAATGGAAAAACC TATTTGAATTGGTTATTACAGAGGCCAGGCCAGTCTCCAAAGCGCCTAATCTAT CTGGTGTCTAACTGGACTCTGGAGTCCCTGACAGGTTCACTGGCAGTGGATC AGGAACAGATTTTACACTGAAAATCAGCAGAGTGGAGGCTGAGGATTTGGGA GTTTATTACTGCGTGCAAGGTACACATTTTCTCAGACGTTTCGGTGGAGGCACC AAGCTGGAAATCAAA	Mouse mAb037 light chain DNA sequence



109	GATGTGGTGATGACCCAGTCTCCACTGAGCCTGCCTGTGACCCTGGGCCAACC TGCCAGCATCAGCTGTAAAAGCAGCCAGAGCCTGCTGTACAGCAACGGCAAG ACCTACCTGAACTGGCTGCTGCAGAGACCTGGCCAGAGCCCTAGACGGCTGAT CTACCTGGTGTCCAAGCTGGACAGCGCGTCCCCGATAGATTCAGCGGATCTG GCAGCGGCACCGACTTCACCCTGAAGATCAGTAGAGTGGAAGCCGAGGACGT GGGCGTGTACTACTGCGTGCAGGGCACACACTTCCCCAGACCTTCGGCGGCG GAACAAAGCTGGAAATCAAG	Humarized mAb037 light chain DNA sequence
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**[0203]** In some embodiments, according to any nucleic acid encoding an anti-pTau antibody or antigen-binding moiety described herein, the nucleic acid is a vector. In some embodiments, the vector is an expression vector for expression of the anti-pTau antibody or antigen-binding moiety in a host cell. Expression vectors contemplated include, but are not limited to, viral vectors based on vaccinia virus, poliovirus, adenovirus, AAV, SV40, herpes simplex virus, human immunodeficiency virus, retrovirus (e.g., Murine Leukemia Virus, spleen necrosis virus, and vectors derived from retroviruses such as Rous Sarcoma Virus, Harvey Sarcoma Virus, avian leukosis virus, a lentivirus, human immunodeficiency virus, myeloproliferative sarcoma virus, and mammary tumor virus) and other recombinant vectors. Other vectors can be used so long as they are compatible with the host cell.

**[0204]** In some embodiments, a vector according to any of the embodiments described herein comprises one or more transcription and/or translation control elements. Depending on the host/vector system utilized, any of a number of suitable transcription and translation control elements, including constitutive and inducible promoters, transcription enhancer elements, transcription terminators, etc. can be used in the expression vector.

**[0205]** In some embodiments, a vector according to any of the embodiments described herein comprises a ribosome binding site for translation initiation and a transcription terminator. In some embodiments, the vector comprises appropriate sequences for amplifying expression. In some embodiments, the vector comprises nucleotide sequences encoding non-native tags (e.g., histidine tags, hemagglutinin tags, green fluorescent proteins, etc.) that are fused to nucleotide sequences encoding a polypeptide of interest (e.g., an antigen-binding construct), thus allowing for expression of fusion proteins comprising the tags.

**[0206]** In some embodiments, according to any of the vectors described herein comprising a promoter, the promoter is an inducible promoter (e.g., a heat shock promoter, tetracycline-regulated promoter, steroid-regulated promoter, metal-regulated promoter, estrogen receptor-

regulated promoter, etc.) or a constitutive promoter (e.g., CMV promoter, UBC promoter, etc.). In some embodiments, the promoter is a spatially restricted and/or temporally restricted promoter (e.g., a tissue specific promoter, a cell type specific promoter, etc.).

### Codon-optimization

[0207] In some embodiments, nucleic acid encoding an anti-pTau antibody or antigen-binding moiety as described herein is codon-optimized, e.g., codon-optimized based on specific host cells in which the anti-pTau antibody or antigen-binding moiety is to be expressed. It will be appreciated by the skilled artisan that any nucleotide sequence of the present disclosure can be codon optimized for expression in any species of interest. Codon optimization is well known in the art and involves modification of a nucleotide sequence for codon usage bias using species-specific codon usage tables. Codon usage tables can be generated based on a sequence analysis of the most highly expressed genes for the species of interest. The modifications of the nucleotide sequences can be determined by comparing a species specific codon usage table with the codons present in the native polynucleotide sequences.

[0208] Strategies and methodologies for codon optimization are known in the art and are available for various systems. In some embodiments, a nucleic acid described herein is codon-optimized for increased expression in a host cell.

[0209] As is well understood in the art, codon optimization of a nucleotide sequence results in a nucleotide sequence having less than 100% identity (e.g., less than 70%, 71 %, 72%, 73%, 74%, 75%, 76%, 77%, 78%, 79%, 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99%) to the native nucleotide sequence, but which still encodes a polypeptide having the same function as that encoded by the original, native nucleotide sequence.

### Host Cells

[0210] In another aspect, provided herein is a host cell comprising or capable of expressing an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein. In some embodiments, the host cell comprises nucleic acid (e.g., a vector) encoding an anti-pTau antibody or antigen-binding moiety as described herein, such as heterologous nucleic acid. In some embodiments, the host cell is eukaryotic, e.g., a Chinese Hamster Ovary (CHO) cell or lymphoid cell (e.g., Y0, NS0, Sp20 cell).

[0211] Suitable host cells for cloning or expression of vectors encoding an anti-pTau antibody or antigen-binding moiety include prokaryotic and eukaryotic cells. For example, antibodies or antigen-binding moieties thereof 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, see, e.g., U.S. Patent Nos. 5,648,237, 5,789,199, and 5,840,523. (See also Charlton, *Methods in Molecular Biology*, Vol. 248 (B.K.C. Lo, ed., Humana Press, Totowa, NJ, 2003), pp. 245-254, describing expression of antibody fragments in *E. coli*). After expression, the antibody or antigen-binding moiety may be isolated from the bacterial cell paste in a soluble fraction and can be further purified.

[0212] In addition to prokaryotes, eukaryotic microbes such as filamentous fungi or yeast are 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. See Gemgross, *Nat. Biotech.* 22: 1409-1414 (2004), and Li et al., *Nat. Biotech.* 24:210-215 (2006).

[0213] Suitable host cells for the expression of glycosylated antibody may also be derived from multicellular organisms. Numerous baculoviral strains have been identified which may be used in conjunction with insect cells, particularly for transfection of *Spodoptera frugiperda* cells.

[0214] Plant cell cultures can also be utilized as hosts. See, e.g., U.S. Patent Nos. 5,959,177, 6,040,498, 6,420,548, 7,125,978, and 6,417,429 (describing PLANTIBODIES™ technology for producing antibodies in transgenic plants).

[0215] Vertebrate cells may also be used as hosts. For example, mammalian cell lines that are adapted to grow in suspension may be useful. Examples of useful mammalian host cell lines include 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 (MDCK); buffalo rat liver cells (BRL 3 A); 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<sup>r</sup> CHO cells (Urlaub et al., *Proc. Natl. Acad. Sci. USA* 77:4216

(1980)); and myeloma cell lines such as Y0, NSO and Sp2/0. For a review of certain mammalian host cell lines suitable for antibody production, see, e.g., Yazaki and Wu, *Methods in Molecular Biology*, Vol. 248 (B.K.C. Lo, ed., Humana Press, Totowa, NJ), pp. 255-268 (2003).

**[0216]** In some embodiments, provided herein is a host cell comprising nucleic acid encoding an anti-pTau antibody or antigen-binding moiety, wherein the anti-pTau antibody or antigen-binding moiety comprises a) a heavy chain variable region comprising i) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 49-59 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 49-59; ii) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 60-70 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 60-70; and/or iii) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 71-81 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 71-81; and/or b) a light chain variable region comprising iv) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 82-90 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 82-90; v) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 91-95 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 91-95; and/or vi) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 96-105 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 96-105. In some embodiments, the heavy chain and/or light chain CDR sequences are as indicated for a given antibody clone shown in Tables 1 and 2.

**[0217]** In some embodiments, provided herein is a host cell comprising nucleic acid encoding an anti-pTau antibody or antigen-binding moiety, wherein the anti-pTau antibody or antigen-binding moiety comprises a heavy chain variable region comprising the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106; and/or a light chain variable region comprising the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107. In some embodiments, the heavy chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106; and/or the light chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107. In some

embodiments, the heavy chain and light chain variable regions are as indicated for a given antibody clone shown in Table 3.

**[0218]** In some embodiments, provided herein is a host cell comprising nucleic acid encoding an anti-pTau antibody or antigen-binding moiety, wherein the nucleic acid comprises a first coding sequence encoding a heavy chain variable region, wherein the first coding sequence comprises the nucleotide sequence of any one of SEQ ID NOs: 25-36 and 108 or a variant thereof having at least 80% sequence identity to the nucleotide sequence of any one of SEQ ID NOs: 25-36 and 108; and/or a second coding sequence encoding a light chain variable region, wherein the second coding sequence comprises the nucleotide sequence of any one of SEQ ID NOs: 37-48 and 109 or a variant thereof having at least 80% sequence identity to the nucleotide sequence of any one of SEQ ID NOs: 37-48 and 109. In some embodiments, the first coding sequence comprises the nucleotide sequence of any one of SEQ ID NOs: 25-36 and 108; and/or the second coding sequence comprises the nucleotide sequence of any one of SEQ ID NOs: 37-48 and 109.

**[0219]** Nucleic acids and vectors as described herein may be provided to the cells using well-developed transfection techniques; see, e.g., Angel, M. et al. (2010). *PLoS ONE*, 5(7):e11756, and the commercially available TransMessenger® reagents from Qiagen, Stemfect™ RNA Transfection Kit from Stemgent, and TransIT®-mRNA Transfection Kit from Mims Bio. See also Beumer, K. J. et al. (2008). *Proc. Natl. Acad. Sci. USA*, 105(50):19821-19826. Many vectors, e.g., plasmids, cosmids, minicircles, phage, viruses, etc., useful for transferring nucleic acids into host cells are available. The vectors comprising the nucleic acid(s) may be maintained episomally, e.g., as plasmids, minicircle DNAs, viruses such as cytomegalovirus, adenovirus, etc., or they may be integrated into the host cell genome, through homologous recombination or random integration, e.g., retrovirus-derived vectors such as MMLV, HIV-1, ALV, etc.

**[0220]** Vectors may be provided directly to the cells. In other words, the cells are contacted with vectors such that the vectors are taken up by the cells. Methods for contacting cells with nucleic acid vectors that are plasmids, including electroporation, calcium chloride transfection, microinjection, and lipofection are well known in the art. For viral vector delivery, the cells are contacted with viral particles comprising nucleic acid as described herein. Retroviruses, for example, lentiviruses, are particularly suitable to the method of the present disclosure. Commonly used retroviral vectors are “defective”, e.g., unable to produce viral proteins required for productive infection. Rather, replication of the vector requires growth in a packaging cell line. To

generate viral particles comprising nucleic acids of interest, the retroviral nucleic acids comprising the nucleic acid are packaged into viral capsids by a packaging cell line. Different packaging cell lines provide a different envelope protein (ecotropic, amphotropic or xenotropic) to be incorporated into the capsid, this envelope protein determining the specificity of the viral particle for the cells (ecotropic for murine and rat; amphotropic for most mammalian cell types including human, dog and mouse; and xenotropic for most mammalian cell types except murine cells). The appropriate packaging cell line may be used to ensure that the cells are targeted by the packaged viral particles. Methods of introducing the retroviral vectors comprising the nucleic acid encoding the reprogramming factors into packaging cell lines and of collecting the viral particles that are generated by the packaging lines are well known in the art. Nucleic acids can also be introduced by direct micro-injection (e.g., injection of RNA into a zebrafish embryo).

[0221] Vectors will generally comprise suitable promoters for driving the expression, that is, transcriptional activation, of the nucleic acid of interest. In other words, the nucleic acid of interest will be operably linked to a promoter. This may include ubiquitously active promoters, for example, the CMV-13-actin promoter, or inducible promoters, such as promoters that are active in particular cell populations or that respond to the presence of drugs such as tetracycline. By transcriptional activation, it is intended that transcription will be increased above basal levels in the host cell by at least about 10-fold (such as by at least about any of 100-fold, 1000-fold, or greater). In addition, vectors may include nucleic acid sequences that code for selectable markers in the host cells.

### **Methods of the Disclosure**

#### *Methods of Preparing an Anti-pTau Antibody or Antigen-Binding Moiety*

[0222] Antibodies and antigen-binding moieties thereof as described herein may be produced using recombinant methods and compositions, e.g., as described in U.S. Patent No. 4,816,567. In some embodiments, the methods employ nucleic acid encoding an anti-pTau antibody or antigen-binding moiety described herein. In some embodiments, the nucleic acid is one or more vectors (e.g., expression vectors). In some embodiments, a host cell comprising such nucleic acid is employed. In one such embodiment, the host cell comprises (e.g., has been transformed with): (1) a vector comprising nucleic acid encoding an amino acid sequence comprising a light chain variable region of the anti-pTau antibody or antigen-binding moiety and an amino acid sequence

comprising the heavy chain variable region of the anti-pTau antibody or antigen-binding moiety, or (2) a first vector comprising nucleic acid encoding an amino acid sequence comprising the light chain variable region of the anti-pTau antibody or antigen-binding moiety and a second vector comprising nucleic acid encoding an amino acid sequence comprising the heavy chain variable region of the anti-pTau antibody or antigen-binding moiety. In some embodiments, the host cell is eukaryotic, e.g. a Chinese Hamster Ovary (CHO) cell or lymphoid cell (e.g., Y0, NS0, Sp20 cell). In some embodiments, a method of preparing an anti-pTau antibody or antigen-binding moiety is provided, wherein the method comprises culturing a host cell comprising nucleic acid encoding the anti-pTau antibody or antigen-binding moiety, as provided herein, under conditions suitable for expression of the anti-pTau antibody or antigen-binding moiety, and optionally recovering the anti-pTau antibody or antigen-binding moiety from the host cell (or host cell culture medium).

**[0223]** For recombinant production of an anti-pTau antibody or antigen-binding moiety, nucleic acid encoding the anti-pTau antibody or antigen-binding moiety, e.g., as described herein, 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).

**[0224]** In another aspect, provided herein are anti-pTau antibodies or antigen-binding moieties prepared according to any of the methods described herein.

#### Methods of Detecting Pathological Tau

**[0225]** In certain embodiments, any of the anti-pTau antibodies provided herein is useful for detecting the presence of one or more pathological Tau species in a biological sample. The term “detecting” as used herein encompasses quantitative or qualitative detection. In certain embodiments, a biological sample comprises a cell or tissue, such as cerebrospinal fluid, a cell or tissue of the brain (e.g., brain cortex or hippocampus), or blood. In some embodiments, a biological sample is cerebrospinal fluid.

**[0226]** In some embodiments, an anti-pTau antibody for use in a method of diagnosis or detection is provided. In a further aspect, a method of detecting the presence of one or more pathological Tau species in a biological sample is provided. In certain embodiments, the method comprises contacting the biological sample with an anti-pTau antibody as described herein under conditions

permissive for binding of the anti-pTau antibody to the one or more pathological Tau species, and detecting whether a complex is formed between the anti-pTau antibody and the one or more pathological Tau species. Such method may be an *in vitro* or *in vivo* method. Further, the complex formed between the anti-pTau antibody and the one or more pathological Tau species in a test biological sample can be compared to the complex formed in a control biological sample (e.g., a biological sample from a healthy subject or subjects). The amount of the complex formed between the anti-pTau antibody and the one or more pathological Tau species in a test biological sample can also be quantified and compared to the amount of the complex formed in a control biological sample (e.g., a biological sample from a healthy subject or subjects) or to the average amount of the complex known to be formed in healthy subjects.

[0227] In some embodiments, an anti-pTau antibody is used to select subjects eligible for therapy with an anti-pTau antibody, e.g. where one or more pathological Tau species is a biomarker for selection of patients. For example, in some embodiments, an anti-pTau antibody is used to detect whether the subject has a Tau protein disease or disorder, or whether the subject is at high risk (or predisposed to) a Tau protein disease or disorder.

[0228] In some embodiments, the one or more pathological Tau species are selected from Tau Type 1A, IB, 11 A, and MB; misordered Tau; mis-disordered Tau; sarkosyl-insoluble Tau; an extracellular Tau deposit; a Tau aggregate; paired helical filaments; a neurofibrillary pathology; and a hyperphosphorylated form of truncated Tau or full-length Tau. In some embodiments, the one or more pathological Tau species includes hyperphosphorylated and sarkosyl-insoluble Tau.

[0229] Exemplary diseases or disorders that may be diagnosed using an antibody of the invention include Tau protein-associated diseases or disorders, and diseases or disorders caused by or associated with the formation of one or more pathological Tau species. In some embodiments, diseases or disorders that may be diagnosed using an antibody of the invention include Tau protein associated diseases or disorders that are manifested in an impairment or loss of cognitive functions including reasoning, situational judgement, memory capacity, learning, and/or special navigation. In particular, diseases or disorders that may be diagnosed using an antibody of the invention include tauopathies such as neurodegenerative tauopathies. Exemplary diseases or disorders that may be diagnosed using an antibody of the invention include, but are not limited to, Alzheimer's Disease (AD), amyotrophic lateral sclerosis (ALS), Huntington's disease (HD), Parkinson's disease (PD), Creutzfeldt-Jacob disease, Dementia pugilistica, Down's Syndrome, Gerstmann-Straussler-



Scheinker disease, British dementia, Danish dementia, inclusion-body myositis, prion protein cerebral amyloid angiopathy, traumatic brain injury, Guam Parkinsonism-dementia complex, Non-Guamanian motor neuron disease with neurofibrillary tangles, argyrophilic grain dementia, corticobasal degeneration, diffuse neurofibrillary tangles with calcification, frontotemporal dementia, frontotemporal dementia with parkinsonism linked to chromosome 17, Hallevorden-Spatz disease, multiple system atrophy, Niemann-Pick disease type C, Pallido-ponto-nigral degeneration, Pick's disease, progressive subcortical gliosis, progressive supranuclear palsy, Subacute sclerosing panencephalitis, Tangle-only dementia, White matter tauopathy with globular glial inclusions, Frontotemporal dementia, Postencephalitic Parkinsonism, Parkinsonism linked to chromosome 17, and Myotonic dystrophy. In some embodiments, a disorder that may be diagnosed using an antibody of the invention is Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), or Pick's disease (PiD).

**[0230]** In certain embodiments, labeled anti-pTau antibodies are provided. Labels include, but are not limited to, labels or moieties that are detected directly (such as fluorescent, chromophoric, electron-dense, chemiluminescent, and radioactive labels), as well as moieties, such as enzymes or ligands, that are detected indirectly, e.g., through an enzymatic reaction or molecular interaction. Exemplary labels include, but are not limited to, the radioisotopes  $^{252}\text{P}$ ,  $^{14}\text{C}$ ,  $^{125}\text{I}$ , H, and  $^m\text{I}$ , fluorophores such as rare earth chelates or fluorescein and its derivatives, rhodamine and its derivatives, dansyl, umbelliferone, luciferases, e.g., firefly luciferase and bacterial luciferase (U.S. Patent No. 4,737,456), luciferin, 2,3- dihydrophthalazinediones, horseradish peroxidase (HRP), alkaline phosphatase,  $\beta$ - galactosidase, glucoamylase, lysozyme, saccharide oxidases, e.g., glucose oxidase, galactose oxidase, and glucose-6-phosphate dehydrogenase, heterocyclic oxidases such as uricase and xanthine oxidase, coupled with an enzyme that employs hydrogen peroxide to oxidize a dye precursor such as HRP, lactoperoxidase, or microperoxidase, biotin/avidin, spin labels, bacteriophage labels, stable free radicals, and the like.

#### Methods of Treating Tau Protein-Associated Disease

**[0231]** In some aspects of the disclosure, an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein is employed for purposes of treating or preventing a Tau protein-associated disease in a subject. In some embodiments, the disease is a tauopathy. In some embodiments, the tauopathy is a neurodegenerative tauopathy. In some embodiments, the tauopathy is selected from the group consisting of Alzheimer's Disease (AD),

amyotrophic lateral sclerosis (ALS), Huntington's disease (HD), Parkinson's disease (PD), Creutzfeldt-Jacob disease, Dementia pugilistica, Down's Syndrome, Gerstmann-Straussler-Scheinker disease, British dementia, Danish dementia, inclusion-body myositis, prion protein cerebral amyloid angiopathy, traumatic brain injury, Guam Parkinsonism-dementia complex, Non-Guamanian motor neuron disease with neurofibrillary tangles, argyrophilic grain dementia, corticobasal degeneration, diffuse neurofibrillary tangles with calcification, frontotemporal dementia, frontotemporal dementia with parkinsonism linked to chromosome 17, Hallevorden-Spatz disease, multiple system atrophy, Niemann-Pick disease type C, Pallido-ponto-nigral degeneration, Pick's disease, progressive subcortical gliosis, progressive supranuclear palsy, Subacute sclerosing panencephalitis, Tangle-only dementia, White matter tauopathy with globular glial inclusions, Frontotemporal dementia, Postencephalitic Parkinsonism, Parkinsonism linked to chromosome 17, and Myotonic dystrophy. The anti-pTau antibody or antigen-binding moiety can be incorporated into a variety of formulations, including those comprising the anti-pTau antibody or antigen-binding moiety, nucleic acid encoding the anti-pTau antibody or antigen-binding moiety, and/or host cells capable of expressing the anti-pTau antibody or antigen-binding moiety. More particularly, the anti-pTau antibody or antigen-binding moiety can be formulated into pharmaceutical compositions by combination with appropriate pharmaceutically acceptable carriers or diluents. In some embodiments, administration of the anti-pTau antibody or antigen-binding moiety to the subject has one or more of the following effects: retention or increase of cognitive memory capacity, slowing of memory loss, reduction in the level of Tau protein, inhibition and/or reversal of the propagation of Tau aggregation, and inhibition and/or reversal of Tau seeding. In some embodiments, administration of the anti-pTau antibody or antigen-binding moiety to the subject has one or more of the following effects: retention or increase of cognitive memory capacity, slowing of memory loss, reduction in the level of Tau protein, inhibition of the propagation of Tau aggregation, and inhibition of Tau seeding. In some embodiments, the change in effect after administration is at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90% lower than before administration of the anti-pTau antibody or antigen-binding moiety, as measured by assays known in the art. In some embodiments, the change in effect after administration is at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90% higher than before administration of the anti-pTau antibody or antigen-binding moiety, as measured by assays known in the art.

**[0232]** In some embodiments, provided herein is a method of treating or preventing a tauopathy

in a subject in need thereof, the method comprising administering to the subject an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein. In some embodiments, administration of the anti-pTau antibody or antigen-binding moiety to the subject has one or more of the following effects: retention or increase of cognitive memory capacity, slowing of memory loss, reduction in the level of Tau protein, inhibition and/or reversal of the propagation of Tau aggregation, and inhibition and/or reversal of Tau seeding. In some embodiments, administration of the anti-pTau antibody or antigen-binding moiety to the subject has one or more of the following effects: retention or increase of cognitive memory capacity, slowing of memory loss, reduction in the level of Tau protein aggregates, inhibition of the propagation of Tau aggregation, and inhibition of Tau seeding. In some embodiments, the change in effect after administration is at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90% lower than before administration of the anti-pTau antibody or antigen-binding moiety, as measured by assays known in the art. In some embodiments, the change in effect after administration is at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90% higher than before administration of the anti-pTau antibody or antigen-binding moiety, as measured by assays known in the art.

**[0233]** In some embodiments, provided herein is a method of retaining or increasing cognitive memory capacity or slowing memory loss in a subject having or at risk of developing a Tau protein-associated disease, the method comprising administering to the subject an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein.

**[0234]** In some embodiments, provided herein is a method of reducing the level of Tau protein in a subject having or at risk of developing a Tau protein-associated disease, the method comprising administering to the subject an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein. In some embodiments, provided herein is a method of reducing the level of Tau protein aggregates in a subject having or at risk of developing a Tau protein-associated disease, the method comprising administering to the subject an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein. In some embodiments, the level of non-phosphorylated Tau protein, phosphorylated Tau protein, and/or hyperphosphorylated Tau protein is reduced in the subject as compared to their levels in the subject prior to administration of the antibody or antigen-binding moiety. In some embodiments, the Tau aggregates and/or abnormally phosphorylated Tau proteins are accumulated at synapses of brain. In some embodiments, the Tau aggregates and/or abnormally phosphorylated Tau proteins are

accumulated at synapses of tauopathy brain. In some embodiments, the level of a pathological Tau species is reduced in the subject as compared to its level in the subject prior to administration of the antibody or antigen-binding moiety. In some embodiments, the change in effect after administration is at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90% lower than before administration of the anti-pTau antibody or antigen-binding moiety, as measured by assays known in the art.

**[0235]** In some embodiments, provided herein is a method of inhibiting and/or reversing the propagation of Tau aggregation in a subject having or at risk of developing a Tau protein-associated disease, the method comprising administering to the subject an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein. In some embodiments, provided herein is a method of inhibiting the propagation of Tau aggregation in a subject having or at risk of developing a Tau protein-associated disease, the method comprising administering to the subject an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein. In some embodiments, the change in effect after administration is at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90% lower than before administration of the anti-pTau antibody or antigen-binding moiety, as measured by assays known in the art.

**[0236]** In some embodiments, provided herein is a method of inhibiting and/or reversing Tau seeding in a subject having or at risk of developing a Tau protein-associated disease, the method comprising administering to the subject an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein. In some embodiments, provided herein is a method of inhibiting Tau seeding in a subject having or at risk of developing a Tau protein-associated disease, the method comprising administering to the subject an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein. In some embodiments, the change in effect after administration is at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90% lower than before administration of the anti-pTau antibody or antigen-binding moiety, as measured by assays known in the art.

**[0237]** In some embodiments, according to any of the methods comprising administration of an anti-pTau antibody or antigen-binding moiety to a subject, the Tau protein-associated disease is a tauopathy. In some embodiments, the tauopathy is a neurodegenerative tauopathy. In some embodiments, the tauopathy is selected from the group consisting of Alzheimer's Disease (AD), amyotrophic lateral sclerosis (ALS), Huntington's disease (HD), Parkinson's disease (PD),

Creutzfeldt-Jacob disease, Dementia pugilistica, Down's Syndrome, Gerstmann-Straussler-Scheinker disease, British dementia, Danish dementia, inclusion-body myositis, prion protein cerebral amyloid angiopathy, traumatic brain injury, Guam Parkinsonism-dementia complex, Non-Guamanian motor neuron disease with neurofibrillary tangles, argyrophilic grain dementia, corticobasal degeneration, diffuse neurofibrillary tangles with calcification, frontotemporal dementia, frontotemporal dementia with parkinsonism linked to chromosome 17, Hallevorden-Spatz disease, multiple system atrophy, Niemann-Pick disease type C, Pallido-ponto-nigral degeneration, Pick's disease, progressive subcortical gliosis, progressive supranuclear palsy, Subacute sclerosing panencephalitis, Tangle-only dementia, White matter tauopathy with globular glial inclusions, Frontotemporal dementia, Postencephalitic Parkinsonism, Parkinsonism linked to chromosome 17, and Myotonic dystrophy.

[0238] In some embodiments, according to any of the methods comprising administration of an anti-pTau antibody or antigen-binding moiety to a subject, the anti-pTau antibody or antigen-binding moiety is incorporated into a formulation comprising the anti-pTau antibody or antigen-binding moiety, nucleic acid encoding the anti-pTau antibody or antigen-binding moiety, and/or host cells capable of expressing the anti-pTau antibody or antigen-binding moiety. In some embodiments, the anti-pTau antibody or antigen-binding moiety is formulated into a pharmaceutical composition by combination with appropriate pharmaceutically acceptable carriers or diluents.

[0239] In some embodiments, according to any of the methods comprising administration of an anti-pTau antibody or antigen-binding moiety to a subject, the method further comprises administering to the subject at least one additional therapeutic agent, such as a biologically active substance or compound including, for example, a known compound used in the medication of tauopathies and/or of amyloidoses, a group of diseases and disorders associated with amyloid or amyloid-like protein such as the amyloid  $\beta$  protein involved in Alzheimer's Disease. In some embodiments, the at least one additional therapeutic agent is selected from neurological drugs, corticosteroids, antibiotics, antiviral agents, anti-pTau antibodies, Tau inhibitors, anti-amyloid beta antibodies, beta-amyloid aggregation inhibitors, anti-BACE1 antibodies, and BACE1 inhibitors. In some embodiments, the at least one additional therapeutic agent is selected from neuron-transmission enhancers, psychotherapeutic drugs, acetylcholine esterase inhibitors, calcium-channel blockers, biogenic amines, benzodiazepine tranquilizers, acetylcholine

synthesis, storage or release enhancers, acetylcholine postsynaptic receptor agonists, monoamine oxidase-A or -B inhibitors, N-methyl-D-aspartate glutamate receptor antagonists, nonsteroidal anti-inflammatory drugs, antioxidants, serotonergic receptor antagonists, or other therapeutic agents. In particular, the biologically active agent or compound may comprise at least one compound selected from compounds against oxidative stress, anti-apoptotic compounds, metal chelators, inhibitors of DNA repair such as pirenzepine and metabolites, 3-amino-1-propanesulfonic acid (3 APS), 1,3-propanedisulfonate (1,3PDS), secretase activators, beta- and gamma-secretase inhibitors, tau proteins, anti-Tau antibodies (including, but not limited to, antibodies disclosed in WO 2012049570, WO 2014028777, WO 2014165271, WO 2014100600, WO 2015200806, U.S. Patent Nos. 8,980,270 and 8,980,271), neurotransmitter, beta-sheet breakers, antiinflammatory molecules, “atypical antipsychotics” such as, for example clozapine, ziprasidone, risperidone, aripiprazole or olanzapine or cholinesterase inhibitors (ChEIs) such as tacrine, rivastigmine, donepezil, and/or galantamine and other drugs and nutritive supplements such as, for example, vitamin B 12, cysteine, a precursor of acetylcholine, lecithin, choline, Ginkgo biloba, acetyl-L-carnitine, idebenone, propentofylline, or a xanthine derivative.

**[0240]** Such combination therapies noted above encompass combined administration (where two or more therapeutic agents are included in the same or separate formulations), and separate administration, in which case, administration of the antibody of the invention can occur prior to, simultaneously, and/or following, administration of the additional therapeutic agent or agents. In some embodiments, administration of the anti-pTau antibody and administration of an additional therapeutic agent occur within about one month, or within about one, two or three weeks, or within about one, two, three, four, five, or six days, of each other.

**[0241]** In some embodiments, according to any of the methods comprising administration of an anti-pTau antibody or antigen-binding moiety to a subject, the subject is diagnosed as having or being at risk of developing a Tau protein-associated disease, such as a tauopathy, including those described herein. In some embodiments, the subject is diagnosed as having or being at risk of developing a tauopathy selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD).

**[0242]** In some embodiments, according to any of the methods comprising administration of an anti-pTau antibody or antigen-binding moiety to a subject, the anti-pTau antibody or antigen-binding moiety comprises a) a heavy chain variable region comprising i) a CDR1 comprising the

amino acid sequence of any one of SEQ ID NOS: 49-59 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 49-59; ii) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOS: 60-70 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 60-70; and/or iii) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOS: 71-81 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 71-81; and/or b) a light chain variable region comprising iv) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOS: 82-90 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 82-90; v) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOS: 91-95 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 91-95; and/or vi) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOS: 96-105 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 96-105. In some embodiments, the heavy chain and/or light chain CDR sequences are as indicated for a given antibody clone shown in Tables 1 and 2.

**[0243]** In some embodiments, according to any of the methods comprising administration of an anti-pTau antibody or antigen-binding moiety to a subject, the anti-pTau antibody or antigen-binding moiety thereof comprises a heavy chain variable region comprising the amino acid sequence of any one of SEQ ID NOS: 1-12 and 106 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 1-12 and 106; and/or a light chain variable region comprising the amino acid sequence of any one of SEQ ID NOS: 13-24 and 107 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOS: 13-24 and 107. In some embodiments, the heavy chain variable region comprises the amino acid sequence of any one of SEQ ID NOS: 1-12 and 106; and/or the light chain variable region comprises the amino acid sequence of any one of SEQ ID NOS: 13-24 and 107. In some embodiments, the heavy chain and light chain variable regions are as indicated for a given antibody clone shown in Table 3.

**[0244]** An antibody of the invention (and any additional therapeutic agent) can be administered by any suitable means, including parenteral, intrapulmonary, and intranasal, and, if desired for local treatment, intralesional administration. Parenteral infusions include intramuscular, intravenous, intraarterial, intraperitoneal, or subcutaneous administration. 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. In some embodiments, the administration of an anti-pTau antibody or antigen-binding moiety to a subject is intravenous. In some embodiments, the administration of an anti-pTau antibody or antigen-binding moiety to a subject is subcutaneous. Various dosing schedules including but not limited to single or multiple administrations over various time- points, bolus administration, and pulse infusion are contemplated herein.

**[0245]** Antibodies of the invention may 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.

**[0246]** 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. Depending on the type and severity of the disease, about 1  $\mu\text{g}/\text{kg}$  to 15  $\text{mg}/\text{kg}$  (e.g. 0.1  $\text{mg}/\text{kg}$  to 10  $\text{mg}/\text{kg}$ ) 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  $\mu\text{g}/\text{kg}$  to 100  $\text{mg}/\text{kg}$  or more, depending on the factors mentioned above. For repeated administrations over several days or longer, depending on the condition, the treatment may 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  $\text{mg}/\text{kg}$  to about 10  $\text{mg}/\text{kg}$ . Thus, one or more doses of about 0.5  $\text{mg}/\text{kg}$ , 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). 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 can be monitored by conventional techniques and assays.

[0247] It is understood that any of the above formulations or therapeutic methods may be carried out using an immunoconjugate of the invention in place of or in addition to an anti-pTau antibody.

[0248] In some embodiments, provided herein is an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein, nucleic acid encoding the anti-pTau antibody or antigen-binding moiety, and/or host cells capable of expressing the anti-pTau antibody or antigen-binding moiety for use in the treatment of a Tau protein-associated disease in a subject, such as for use in the manufacture of a medicament for the treatment of a Tau protein-associated disease. In some embodiments, the disease is a tauopathy, including any of the tauopathies described herein.

### **Compositions**

[0249] In another aspect, provided herein is a composition comprising one or more of: an anti-pTau antibody or antigen-binding moiety as described herein; nucleic acid encoding an anti-pTau antibody or antigen-binding moiety as described herein; and a host cell capable of expressing an anti-pTau antibody or antigen-binding moiety as described herein. In some embodiments, the composition is a pharmaceutical composition and further comprises a pharmaceutically acceptable excipient and/or carrier.

[0250] In some embodiments, provided herein are pharmaceutical preparations or compositions comprising an anti-pTau antibody or antigen-binding moiety according to any of the embodiments described herein, nucleic acid encoding the anti-pTau antibody or antigen-binding moiety, and/or host cells capable of expressing the anti-pTau antibody or antigen-binding moiety present in a pharmaceutically acceptable vehicle. "Pharmaceutically acceptable vehicles" may be vehicles approved by a regulatory agency of the Federal or a state government or listed in the US Pharmacopeia or other generally recognized pharmacopeia for use in mammals, such as humans. The term "vehicle" refers to a diluent, adjuvant, excipient, or carrier with which a compound of

the disclosure is formulated for administration to a mammal. Such pharmaceutical vehicles can be lipids, e.g., liposomes, e.g., liposome dendrimers; liquids, such as water and oils, including those of petroleum, animal, vegetable or synthetic origin, such as peanut oil, soybean oil, mineral oil, sesame oil and the like, saline; gum acacia, gelatin, starch paste, talc, keratin, colloidal silica, urea, and the like. In addition, auxiliary, stabilizing, thickening, lubricating and coloring agents may be used. Pharmaceutical compositions may be formulated into preparations in solid, semisolid, liquid or gaseous forms, such as tablets, capsules, powders, granules, ointments, solutions, suppositories, injections, inhalants, gels, microspheres, and aerosols. As such, administration of the anti-pTau antibody or antigen-binding moiety, nucleic acid encoding the anti-pTau antibody or antigen-binding moiety, and/or host cells capable of expressing the anti-pTau antibody or antigen-binding moiety can be achieved in various ways, including by intravenous, oral, buccal, rectal, parenteral, intraperitoneal, intradermal, transdermal, intra-tracheal, intraocular, etc., administration. For example, administration of the anti-pTau antibody or antigen-binding moiety, nucleic acid encoding the anti-pTau antibody or antigen-binding moiety, and/or host cells capable of expressing the anti-pTau antibody or antigen-binding moiety can be achieved by intravenous or subcutaneous administration. In some embodiments, the composition of an anti-pTau antibody or antigen-binding moiety is suitable for intravenous administration to a subject. In some embodiments, the composition of an anti-pTau antibody or antigen-binding moiety is suitable for subcutaneous administration to a subject. The active agent may be systemic after administration or may be localized by the use of regional administration, intramural administration, or use of an implant that acts to retain the active dose at the site of implantation. The active agent may be formulated for immediate activity or it may be formulated for sustained release.

[0251] Pharmaceutical compositions can include, depending on the formulation desired, pharmaceutically acceptable, non-toxic carriers or diluents, which are defined as vehicles commonly used to formulate pharmaceutical compositions for animal or human administration. The diluent is selected so as not to affect the biological activity of the combination. Examples of such diluents are distilled water, buffered water, physiological saline, PBS, Ringer's solution, dextrose solution, and Hank's solution. In addition, the pharmaceutical composition or formulation can include other carriers, adjuvants, or non-toxic, nontherapeutic, non-immunogenic stabilizers, excipients and the like. The compositions can also include additional substances to approximate physiological conditions, such as pH adjusting and buffering agents, toxicity adjusting agents,

wetting agents and detergents.

[0252] The composition can also include any of a variety of stabilizing agents, such as an antioxidant for example. When the pharmaceutical composition includes a polypeptide, the polypeptide can be complexed with various well-known compounds that enhance the *in vivo* stability of the polypeptide, or otherwise enhance its pharmacological properties (e.g., increase the half-life of the polypeptide, reduce its toxicity, and/or enhance solubility or uptake). Examples of such modifications or complexing agents include sulfate, gluconate, citrate and phosphate. The nucleic acids or polypeptides of a composition can also be complexed with molecules that enhance their *in vivo* attributes. Such molecules include, for example, carbohydrates, polyamines, amino acids, other peptides, ions (e.g., sodium, potassium, calcium, magnesium, manganese), and lipids.

### **Kits**

[0253] In another aspect, provided herein are kits for carrying out a method described herein. A kit can include one or more of: an anti-pTau antibody or antigen-binding moiety as described herein; nucleic acid encoding an anti-pTau antibody or antigen-binding moiety as described herein; and a host cell capable of expressing an anti-pTau antibody or antigen-binding moiety as described herein. In some embodiments, the kit further comprises a reagent for reconstituting and/or diluting one or more of the kits components.

[0254] A kit as described herein can further include one or more additional reagents, where such additional reagents can be selected from: a dilution buffer; a reconstitution solution; a wash buffer; a control reagent; a control expression vector or polyribonucleotide; a reagent for *in vitro* production of the anti-pTau antibody or antigen-binding moiety from DNA, and the like.

[0255] Components of a kit can be in separate containers; or can be combined in a single container.

[0256] In addition to the above-mentioned components, a kit can further include instructions for using the components of the kit to practice the methods. For instance, in some embodiments, the kit includes directions for intravenous administration of an anti-pTau antibody or antigen-binding moiety to a subject. In some embodiments, the kit includes directions for subcutaneous administration of an anti-pTau antibody or antigen-binding moiety to a subject. The instructions for practicing the methods are generally recorded on a suitable recording medium. For example, the instructions may be printed on a substrate, such as paper or plastic, etc. As such, the instructions may be present in the kits as a package insert, in the labeling of the container of the kit or

components thereof (e.g., associated with the packaging or sub-packaging) etc. In some embodiments, the instructions are present as an electronic storage data file present on a suitable computer readable storage medium, e.g., CD-ROM, diskette, flash drive, etc. In yet other embodiments, the actual instructions are not present in the kit, but means for obtaining the instructions from a remote source, e.g., via the internet, are provided. An example of this embodiment is a kit that includes a web address where the instructions can be viewed and/or from which the instructions can be downloaded. As with the instructions, this means for obtaining the instructions is recorded on a suitable substrate.

### EXAMPLES

[0257] The practice of the present invention will employ, unless otherwise indicated, conventional techniques of molecular biology, microbiology, cell biology, biochemistry, nucleic acid chemistry, and immunology, which are well known to those skilled in the art. Such techniques are explained fully in the literature, such as Sambrook, J., & Russell, D. W. (2012). *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory and Sambrook, J., & Russel, D. W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory (jointly referred to herein as “Sambrook”); Ausubel, F. M. (1987). *Current Protocols in Molecular Biology*. New York, NY: Wiley (including supplements through 2014); Bollag, D. M. et al. (1996). *Protein Methods*. New York, NY: Wiley-Liss; Huang, L. et al. (2005). *Nonviral Vectors for Gene Therapy*. San Diego: Academic Press; Kaplitt, M. G. et al. (1995). *Viral Vectors: Gene Therapy and Neuroscience Applications*. San Diego, CA: Academic Press; Lefkovits, I. (1997). *The Immunology Methods Manual: The Comprehensive Sourcebook of Techniques*. San Diego, CA: Academic Press; Doyle, A. et al. (1998). *Cell and Tissue Culture: Laboratory Procedures in Biotechnology*. New York, NY: Wiley; Mullis, K. B., Ferré, F. & Gibbs, R. (1994). *PCR: The Polymerase Chain Reaction*. Boston: Birkhauser Publisher; Greenfield, E. A. (2014). *Antibodies: A Laboratory Manual* (2nd ed.). New York, NY: Cold Spring Harbor Laboratory Press; Beaucage, S. L. et al. (2000). *Current Protocols in Nucleic Acid Chemistry*. New York, NY: Wiley, (including supplements through 2014); and Makrides, S. C. (2003). *Gene Transfer and Expression in Mammalian Cells*. Amsterdam, NL: Elsevier Sciences B.V., the disclosures of which are incorporated herein by reference.

[0258] Additional embodiments are disclosed in further detail in the following examples, which

are provided by way of illustration and are not in any way intended to limit the scope of this disclosure or the claims.

## Materials and Methods

### *Human brain lysate preparation*

[0259] Brain tissues as indicated were purchased from Banner Health Institute (AZ, USA). Brain homogenate were prepared from frontal cortexes of 3 AD (Alzheimer's Disease, Braak Stage V & VI) patients and 3 ND (non-demented, Braak Stage III) individuals. Lysis buffer (50 mM Tris pH 8.0, 274 mM NaCl, 5 mM KCl, 2 mM EGTA, 2 mM EDTA, protease and phosphatase inhibitor (Pierce, 88668)) was added to the brain tissue at ~5 ml/g. ZrO<sub>2</sub> beads were then added and Bullet Blender (Next Advance) was set at level 9 for 2 min to generate homogenate. Homogenate was spun at 13,000 xg for 15 min at 4°C. Supernatant was collected as total lysate. Protein concentration was determined by Bradford Protein Assay.

### *Sarkosyl extraction to generate S1 and P2 fractions*

[0260] 1 mg total lysate in 0.9 ml lysis buffer was incubated with 0.1ml 10% N-laurylsarcosine (dissolved in lysis buffer) for 1 hr at room temperature. Mixture was spun at 150,000 xg for 20 min at 4°C. Supernatant was collected as S1 fraction, whereas the pellet was resuspended in 500 µl PBS and spun at 150,000 xg for 20 min at 4°C. 100 µl PBS was used to resuspend the pellet as P2.

### *Western Blot*

[0261] Frozen brain lysates were thawed on ice and 15 µg was aliquoted and PBS was added to 15 µL. Five µL of NuPAGE® LDS sample buffer (Invitrogen) and 2 µL of NuPAGE® Sample Reducing Agent (Invitrogen) were then added and the tube was boiled at 100°C for 5 min. Boiled samples were loaded into the wells of a Bolt™ 4-12% Bis-Tris Plus Gels in a Mini Gel Tank (Invitrogen). PageRuler prestained protein ladder (Invitrogen) was loaded as the molecular weight marker to visualize the progression of protein migration at a constant voltage set at 150V. After the dye front was migrated out of the gel, gel running was stopped, followed by protein band transfer onto a precut PVDF membrane using a preset P0 program (20V, 1min; 23V, 4 mins; 25V, 2 mins) of a iBlot 2 Dry Blotting System (Invitrogen). Membrane was then blocked by blocking buffer (LI-COR) for 30 min at room temperature. 0.2 µg/mL of the first antibodies (prepared in blocking buffer) were incubated with membrane for 1 hr at room temperature. Membrane were

washed with PBS for 5 min at room temperature 3 times. Secondary antibody (LI-COR, diluted at 1:10,000 by blocking buffer) was incubated with membrane for 1hr at room temperature. Membrane were washed again with PBS for 5 min at room temperature 3 times. Odyssey Imaging Systems scanning was performed to visualize proteins on the membrane.

#### *S1 and P2 Tau quantification by western blot*

[0262] Briefly, recombinant full-length Tau (1.25 to 40 ng Tau, 2-fold increment), S1 and P2 are mixed with reducing agent (Invitrogen, NP009), LDS sample buffer (Invitrogen, NP007) and boiled at 100 °C for 5 min. Samples were separated by Bolt™ 4-12% Bis-Tris Plus Gels (Invitrogen, NW04125BOX) and transferred to PVDF membrane by iBlot 2 Dry Blotting System (Invitrogen). Intensities of serially diluted recombinant full-length Tau protein were used to plot calibration curve, and the equation of linear regression was used to determine Tau concentrations in the samples.

#### *Synaptoneurosome and cytosol preparation*

[0263] Brain piece was transferred into a cold 2 mL glass homogenizer with cold buffer A ((25 mM HEPES, pH7.5. 120 mM NaCl, 5 mM KCl, 1 mM MgCl<sub>2</sub>, 2 mM CaCl<sub>2</sub>, protease and phosphatase inhibitor (Thermo, 88668) were added freshly)). Teflon pestle was attached to the stirring motor and set the speed at 170 rpm. First, short strokes were applied to disrupt the tissue completely until no large pieces left, and then apply 7 up-and-down strokes to homogenize. Homogenate was added into the 3 mL syringe with 80 µm filters (Millipore, #NY8002500) and filtrate the homogenate by pushing gently through the 80 µm filter. The filtrated homogenate was load onto a syringe with 5 µm filter gently. Filtrate was spun at 1000 g for 10 mins, pellet and supernatant is collected as P1 and S1. P1 was wash by buffer A and spun at 1000 g for 10 mins. Pellet was collected as synaptoneurosome fraction. S1 was centrifuged at 100,000 g for 30 mins to remove all organelles and collect supernatant as the cytosol fraction.

#### **Example 1: Selection of antibodies that bind pathological Tau species**

[0264] Antibodies that bind pathological Tau species were generated by employing conventional hybridoma techniques. Antibodies were identified as described in Tables 1-3.

**Table 1: Antibody heavy chain CDRs**

Antibody clone	Heavy chain CDR1	Heavy chain CDR2	Heavy chain CDR3
mAb004	SYGMS (SEQ ID NO: 49)	TISSSGSYTYYPDSVKG (SEQ ID NO: 60)	TYYGAMDY (SEQ ID NO: 71)
mAb005	DYGMH (SEQ ID NO: 50)	YSNSDSTTIYYADTVKG (SEQ ID NO: 61)	SYYSNYVDY (SEQ ID NO: 72)
mAb008	RYWMS (SEQ ID NO: 51)	EINPDGNAINYAPSLKD (SEQ ID NO: 62)	PFPSV (SEQ ID NO: 73)
mAb010	GYGVN (SEQ ID NO: 52)	MIWGDGSTDYNSALKS (SEQ ID NO: 63)	WAFAY (SEQ ID NO: 74)
mAb011	SYWMH (SEQ ID NO: 53)	MIDPSDSETRLNQKFKD (SEQ ID NO: 64)	PYGDLDY (SEQ ID NO: 75)
mAb013	DFYMK (SEQ ID NO: 54)	DIDPNNGDTFYNQKFKG (SEQ ID NO: 65)	DLY (SEQ ID NO: 76)
mAb020	SYAVH (SEQ ID NO: 55)	VMWSGGSTDYNAAFIS (SEQ ID NO: 66)	MGDYDGVAVFAY (SEQ ID NO: 77)
mAb025	THGMS (SEQ ID NO: 56)	TYSGVPTYTDDFKG (SEQ ID NO: 67)	SELSWFAY (SEQ ID NO: 78)
mAb032	SYWMN (SEQ ID NO: 57)	QIYPGDGDTDYNGKFKG (SEQ ID NO: 68)	RSPY (SEQ ID NO: 79)
mAb033	TFGMGVG (SEQ ID NO: 58)	HIWWDKDYYPALKS (SEQ ID NO: 69)	RGSNALDY (SEQ ID NO: 80)
mAb037	DYNMD (SEQ ID NO: 59)	DINPNTGGTIYNQKFKG (SEQ ID NO: 70)	EGPYYYGTTHPFAY (SEQ ID NO: 81)

**Table 2: Antibody light chain CDRs**

Antibody clone	Light chain CDR1	Light chain CDR2	Light chain CDR3
mAb004	RSSQTIVHSNGNTYLE (SEQ ID NO: 82)	KVSNRFS (SEQ ID NO: 91)	FQGS LVPWT (SEQ ID NO: 96)
mAb005	RSSQLVHSNGNTYLH (SEQ ID NO: 83)	KVSNRFS (SEQ ID NO: 91)	FQSTHVPPT (SEQ ID NO: 97)
mAb008	RSSQLVRSNGNTYLE (SEQ ID NO: 84)	KVSNRFS (SEQ ID NO: 91)	FQGSHPYPT (SEQ ID NO: 98)
mAb010	KSSQSLDSDGKTYLN (SEQ ID NO: 85)	QVSKLDSGVPD (SEQ ID NO: 92)	WQGTHFPLT (SEQ ID NO: 99)
mAb011	KSSQSLDSDGKTYLN (SEQ ID NO: 86)	LVSKLDS (SEQ ID NO: 93)	WQGTHFPPT (SEQ ID NO: 100)
mAb013	KSSQSLYSNGKTYLN (SEQ ID NO: 87)	LVSKLDS (SEQ ID NO: 93)	VQGTHFPHT (SEQ ID NO: 101)
mAb020	RSSQLVHSNGNTYLH (SEQ ID NO: 83)	KVSNRFS (SEQ ID NO: 91)	SQSTHVPPT (SEQ ID NO: 102)
mAb025	RASQISDYLH (SEQ ID NO: 88)	YASQIS (SEQ ID NO: 94)	QNGHSFPYPT (SEQ ID NO: 103)
mAb032	RSSQIVHSNGNTYLE (SEQ ID NO: 89)	KVSNRFS (SEQ ID NO: 91)	FQGSHPYPT (SEQ ID NO: 98)

Antibody clone	Light chain CDR1	Light chain CDR2	Light chain CDR3
mAb033	RSSQLSANSYGNTYLS (SEQ ID NO: 90)	GISNRFS (SEQ ID NO: 95)	LQGTHQPWT (SEQ ID NO: 104)
mAb037	KSSQSLLYSNGKTYLN (SEQ ID NO: 87)	LVSKLDS (SEQ ID NO: 93)	VQGTHFPQT (SEQ ID NO: 105)

**Table 3: Antibody variable regions**

Antibody clone (variable region)	Sequence
mAb004 (V <sub>H</sub> )	EVQLVESGGDLVESGGSLKLSCAASGFTFSSYGMSWVRQTPDKRLEWVATISSS GSYTYYPDSVKGRFTISRDNKNTLYLQMSSLNSEDAMYYCADTYYGAMDY WGQTSVTVSS (SEQ ID NO: 1)
mAb004 (V <sub>L</sub> )	DVLMTQTPLSLPVS LGDQASISCRSSQTIVHSNGNTYLEWYLQKPGQSPKLLIYK VSNRFGVPDRFSGSGSGTDFTLKISRVEAEDLGVYYCFQGS LVPWTFGGGTQLE IR (SEQ ID NO: 13)
mAb005 (V <sub>H</sub> )	EVQLVESGGGLVKPGGSLKLSCAASGFTFSDYGMHWVRQAPEKGLEWVAYSN SDSTTIYYADTVKGRFTISRDNKSTLFLQMTSLRSEDAMYYCGRSYYSNYVD YWGQGTTLTVSS (SEQ ID NO: 2)
mAb005 (V <sub>L</sub> )	DIVMTQIPLSLPVS LGDQASISCRSSQSLVHSNGNTYLHWYLQKPGQSPKLLIYK VSNRFGVPDRFSGSGSGTDFTLKISRVEAEDLGVYFCFQSTHVPPTFGGGTKLEI K (SEQ ID NO: 14)
Humanized mAb005, (V <sub>H</sub> )	EVQLVESGGGLVQPGGSLRLS CAASGFTFSDYGMHWVRQAPGKGLEWVAYSN SDSTTIYYADTVKGRFTISRDNKNSLYLQMNSLRAEDTAVYYCGRSYYSNYVD YWGQGTTLTVSS (SEQ ID NO: 3)
Humanized mAb005, (V <sub>L</sub> )	DVVMTQSPLSLPVT LGQPASISCRSSQSLVHSNGNTYLHWYLQRPQGSPRLLIYK VSNRFGVPDRFSGSGSGTDFTLKISRVEAEDVGVYFCFQSTHVPPTFGQGTKLEI K (SEQ ID NO: 15)
mAb008 (V <sub>H</sub> )	EVKLLQSGGGLVQPGGSLKVS CAASGFDFSRYWMSWVRRAPGKGLEWIGEINP DGNAINYAPSLKDKFIVSRDNKNTLYLQMSNVRSEDTALYYCARPFPSVWGT GTTVTVSS (SEQ ID NO: 4)
mAb008 (V <sub>L</sub> )	DVLMTQTPLSLPVS LGDQASISCRSSQSLVRSNGNTYLEWYLQNPQGSPKLLIYK VSNRFGVPDRFSGSGSGTDFTLKISRVEAEDLGVYYCFQGSHPVPTFGGGTKLE IK (SEQ ID NO: 16)
mAb010 (V <sub>H</sub> )	QVQLKESGPGLVAPSQLSITCTVSGFSLTGYGVNWVRQPPGKGLEWLGMIWG DGSTDYNSALKSRLSISKDNSKSVFLKMNSLQTDDTARYYCANWAFAYWGQ GTLVTVSA (SEQ ID NO: 5)
mAb010 (V <sub>L</sub> )	DVVMTQTPLTSLVTIGQPASISCKSSQSLDSDGKTYLNWLLQRPGQSPKRLIYQ VSKLDSGVPDRFTGSGSGTDFTLKISRVEAEDLGVYYCWQGHFPLTFGAGTKL ELK (SEQ ID NO: 17)
mAb011 (V <sub>H</sub> )	QVQLQQSGPQLVRPGASVKISCKASGYSFTSYWMHWLQRPQGQGLEWIGMIDP SDSETRLNQKFKDKATLTVDKSSSTVYMHLSPTSSEDSAVYYCVRPYGDLDYW GQGTTLTVSS (SEQ ID NO: 6)
mAb011 (V <sub>L</sub> )	DVVMTQTPLTSLVTIGQPASISCKSSQSLDSDGKTYLNWLLQRPGQSPKRLIYL VSKLDSGVPDRFTGSGSGTDFTLKISRVEAEDLGVYYCWQGHFPTFGSGTKLE IK (SEQ ID NO: 18)



Antibody clone (variable region)	Sequence
mAb013 (V <sub>H</sub> )	EVQLQQSGPELVKPGASVKMSCKASGYTFTDFYMKWVVKQSHGKSFEWIGDIDP NNGDTFYNQKFKGKATLTVDKSSSTAYMQLNSLTSEDSAVYYCARDLYWGQG TTLTVSS (SEQ ID NO: 7)
mAb013 (V <sub>L</sub> )	DVVMQTPLTLSVTIGQPASISCKSSQSLLYSNGKTYLNWLLQRPGQSPKRLIYL VSKLDSGVPDRFTGSGSGTDFTLKISRVEAEDLGVYYCVQGTTHPHTFGGGTKL EIK (SEQ ID NO: 19)
mAb020 (V <sub>H</sub> )	QVQLKQSGPGLVQPSQSLSTCTVSGFSLTSYAVHWVRQSPGKGLEWLGVMWS GGSTDYNAAFISRLSISKDNSKSVFFKMNSLQADDTAIYYCARMGDYDGVAV FAYWGQGTTLTVSA (SEQ ID NO: 8)
mAb020 (V <sub>L</sub> )	DVVMQTPLSLPVS LGDQASISCRSSQSLVHSNGNTYLHWYLQKPGQSPKLLIY KVSNRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYFCSQSTHVPWTFGGGK LEIK (SEQ ID NO: 20)
mAb025 (V <sub>H</sub> )	QIQLVQSGPELKKPGETVKISCKASGYTFTTHGMSWVKQAPGKGLKWMGWINT YSGVPTYTDDFKGRFAFSLETSASTAYLQINNLNEDTATYFCARSELWFAFW GQGTTLTVSA (SEQ ID NO: 9)
mAb025 (V <sub>L</sub> )	DIVMTQSPATLSVTPGDRVLS CRASQSISDYLHWYQKSHESPRLLIKYASQIS GIPSRFSGSGSGSDFTLINSVEPEDVGVYYCQNGHSFPYTFGGGKLEIK (SEQ ID NO: 21)
mAb032 (V <sub>H</sub> )	QVQLQQSGAELVKPGASVKISCKASGYAFSSYWMNWVKQRPKGLEWIGQIYP GDGDDYNGKFKGKATLTADTSSSTAYMQLSSLTSEDSAVYFCASRSPYWGQG TLTVSA (SEQ ID NO: 10)
mAb032 (V <sub>L</sub> )	DILMTQTPLSLPVS LGDQASISCRSSQSIVHSNGNTYLEWYLQKPGQSPKLLIYK VSNRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYYCFQGSHPYTFGGGKLEI K (SEQ ID NO: 22)
mAb033 (V <sub>H</sub> )	QVTLKESGPGILQPSQTLSTCSFSGFSLSTFGMGVGVWFRQPSGKGLEWLAHIW WDDDKYYNPALKSRLTISKDTSKNQVFLKIANVDTADTATYYCARRGNSALDY WGQTSVTVSS (SEQ ID NO: 11)
mAb033 (V <sub>L</sub> )	DVVVTQTPLSLPVSFGDQVSISCRSSQSLANSYGNTYLSWYLHKPGQSPQLLIYGI SNRFSGVPDRFSGSGSGTDFTLKISTIKPEDLGMYYCLQGTHQPWTFGGGKLEI K (SEQ ID NO: 23)
mAb037 (V <sub>H</sub> )	EVQLQQSGPELVKPGASVKIPCKASGYTFTDYNMDWVKQSHGKSLEWIGDINP NTGGTIYNQKFKGKATLTVDKSSSTAYMELRSLTSED TAVYYCAGEGPIYYGT THPFAYWGQGTTLTVSA (SEQ ID NO: 12)
mAb037 (V <sub>L</sub> )	DVVMQTPLTLSVTIGQPASISCKSSQSLLYSNGKTYLNWLLQRPGQSPKRLIYL VSKLDSGVPDRFTGSGSGTDFTLKISRVEAEDLGVYYCVQGTTHPQTFGGGKLEI EIK (SEQ ID NO: 24)
Humanized mAb037 (V <sub>H</sub> )	QVQLVQSGAEVKKPGASVKVSCASGYTFTDYNMDWVRQAHGQGLEWIGDIN PNTGGTIYNQKFKGRATLTVDTISISTAYMELSRSLRSDDTAVYYCAGEGPIYYGT THPFAYWGQGTTLTVSS (SEQ ID NO: 106)
Humanized mAb037 (V <sub>L</sub> )	DVVMQTSPSLPVTLGPASISCKSSQSLLYSNGKTYLNWLLQRPGQSPRRLIYL VSKLDSGVPDRFSGSGSGTDFTLKISRVEAEDVGVYYCVQGTTHPQTFGGGKLEI EIK (SEQ ID NO: 107)

**Example 2: Antibody binding profile in the brain of Tau transgenic mouse rTg4510**

[0265] To evaluate the binding profile of mAb005 to Tau protein in tauopathy brain, brain lysate from transgenic mouse rTg4510 (a mouse model expressing a repressible form of human Tau containing the P301L mutation that phenocopies the Tau pathology and pronounced neurodegeneration observed in human tauopathies) and control wild-type brain lysate were analyzed by western blot. **FIG. 1** shows western blots of rTg4510 and WT brain lysate stained by HT7 (an anti-human Tau antibody, ThermoFisher) or mAb005. Six-month-old rTg4510 (Tg) and age-matched wild-type (WT) brains were homogenized in Tris buffer and processed for western blot analysis against HT7 (left panel) and mAb005 (right panel). Over-exposed images were included to illuminate the specificity of mAb005 for human Tau species in the Tg sample.

[0266] The results show that mAb005 recognized only 43, 55, and 64 kD Tau species (FIGS. 1A-1B, mAb005 panel), whereas HT7 (epitope: human Tau 159-163 a.a., PPGQK) recognized all 43, 55, and 64 kD Tau species as well as some high molecular weight species (140/170 kD) (FIGS. 1A-1B, HT7 panel). The western blot analysis for mAb037 showed that comparable profile to mAb005. In conclusion, mAb005 specifically recognized human Tau species, including the hyperphosphorylated 64 kD forms in the rTg4510 mouse brain, but not WT mouse Tau species. Moreover, the 140/170 kD Tau species were not recognized by mAb005.

**Example 3: Antibody binding profile in AD brains in comparison with ND brains**

[0267] To further characterize the human Tau species recognized by mAb005 and mAb037 in healthy and diseased human brain tissues, western blot assays were performed using AD brain lysates and non-demented (ND) brain samples with HT7, mAb005 and mAb037 staining. **FIGS. 2A-2B** show western blots of AD and ND brain lysates stained by HT7, mAb005 and mAb037. Three ND (Non-demented; Braak Stage III) and three AD (Alzheimer's Disease, Braak Stage V-VI) frozen frontal cortices were obtained from Banner Sun Health Research Institute (AZ, USA) and equal amounts of tissues were dissected out for homogenization in Tris buffer and then combined for subsequent protein quantification. Fifteen  $\mu$ g of total lysates were resolved by SDS-PAGE and western blot analysis was conducted for HT7 (left panel), mAb005 (middle panel) and mAb037 (right panel) (FIG. 2B). Asterisk denotes 64 kD Tau species, and bracket denotes 140/170 kD Tau species. Over-exposed images are shown to illuminate weak signals.

[0268] In ND brain sample, a few Tau species (MW between 45 kD to 62 kD) were recognized by

mAb005 and mAb037 whereas more Tau species (MW between 30 kD to 68 kD) were recognized by HT7. In AD brain lysates, mAb005 and mAb037 further recognized two Tau species (MW: 64 and 68 kD). In particular, the 64 kD species (**FIGS. 2A-2B**, asterisk-marked band) is known to correspond to a hyperphosphorylated and sarkosyl-insoluble pathological Tau species. In addition, the HT7-positive 140/170 kD Tau species in the AD sample were not detected by mAb005, but detected by mAb037 (**FIG. 2B**, “037”). In conclusion, the mAb005 and mAb037 recognize a sub-population of pathological Tau species (MW between 45 to 68 kD), including the 64 kD pathology-related species in AD brain.

**Example 4: Antibody Binding Profile in sarkosyl-soluble and -insoluble fractions of AD human brains**

[0269] Since mAb005 and mAb037 bind to a 64 kD Tau species in AD diseased brain, corresponding to a sarkosyl-insoluble hyperphosphorylated form of Tau, western blot analysis was conducted on 10% sarkosyl-extracted AD brain lysate prepared by fractionation using high-speed centrifugation. **FIGS. 3A-3B** show western blots of sarkosyl-soluble and -insoluble AD brain fractions. AD brain lysate described in Example 3 was subjected to 10% sarkosyl extraction followed by a 150k x g centrifugation to obtain supernatant 1 (S1) and pellet 1 (P1). P1 was resuspended in PBS and spun again to obtain pellet 2 (P2). S1 denotes the sarkosyl-soluble fraction and P2 denotes the sarkosyl-insoluble fraction. Both S1 and P2 were loaded after being normalized to 10 ng of Tau for the western blot. Tau level measurements in these fractions were obtained by a separate western blot of these fractions together with a purified monomeric Tau protein in two-fold serial dilutions from 2.5 to 40 ng. Quantification was performed by Odyssey Imaging Systems (LI-COR). Asterisk denotes 64 kD Tau species and bracket denotes 140/170 kD Tau species. Over-exposed images are shown to confirm the lack of binding of mAb005 and mAb037 (**FIG. 3B**, “037”) to certain Tau species. Other than mAb005 binding to the 64 kD Tau species (**FIGS. 3A-3B**, asterisk) in the sarkosyl-insoluble fraction (P2), two major Tau species at 68 and 58 kD were also detected. Only a small number of sarkosyl-soluble (S1) Tau species were recognized by mAb005, and their molecular weights, identified as 45, 57 and 59 kD, are different than the Tau species recognized in the P2 fraction. Unlike mAb005, HT7 and mAb037 did not show a preference for Tau species present in either S1 or P2 fractions, recognizing a larger number of Tau species in the S1 fraction. In summary, mAb005 preferentially recognized three major Tau species,

58, 64, and 68 kD, in sarkosyl-insoluble fractions of AD brains, whereas HT7 and mAb037 showed no such preference.

**Example 5: Antibody Binding Profile in cytosol and synaptoneurosome fractions of ND and AD human brain lysates**

[0270] Pathological Tau is known to accumulate at the synapses in AD brains (Tai, H. C., et al. (2012). *The American journal of pathology*, 181(4), 1426-1435). Dot-blot analysis was performed to address whether mAb005-recognized Tau species are enriched at synapses and whether mAb005-recognized Tau species identified by western blot can be detected by Dot-blot under non-denaturing conditions.

[0271] FIG. 4 shows a schematic of the subcellular fractionation protocol and results for the dot-blot analysis. AD and ND brain lysates described in Example 3 were subjected to subcellular fractionation as depicted in FIG. 4A. Separation of cytosol and synaptoneurosome was carried out by two filtrations and several centrifugations. The protein level in each fraction was measured by Bradford Protein Assay (Bio-Rad), and equal amounts of protein (0.4 µg) were spotted onto a piece of nitrocellulose membrane and immunoblotting was performed after a brief air-dry period for the membrane. Enrichment of a synaptic marker, synaptophysin, and a cytosolic marker, GAPDH, was observed in synaptoneurosomal and cytosolic fractions, respectively (FIG. 4B). Abbreviations: Cy: cytosol; Cy adj.: reduced amount of cytosol loaded to facilitate side-by-side comparison; Sy: synaptoneurosome. Two reference anti-Tau antibodies, C2N-8E12 (ABBV-8E12, AbbVie) (“Reference AbbVie” in FIG. 4B) and BIIB092 (formerly BMS-986168/IPN007, Biogen) (“Reference Biogen” in FIG. 4B), were included for side-by-side comparison. As shown in FIG. 4B, mAb005 showed preferential binding to Tau species localized at the synapses of AD brains but not of ND brains, whereas both reference antibodies showed preferential binding to cytosolic Tau species irrespective of ND or AD. Further, mAb005 showed preferential binding to Tau species in AD total brain lysate, in agreement with the previous finding, whereas both reference antibodies showed preferential binding to Tau species in ND total brain lysate. Sarkosyl-insoluble fractions (P2) and sarkosyl-soluble fractions (S1) were prepared from AD brain as described in Example 4 and similarly analyzed by dot-blot (FIG. 4B, right panels). mAb005 showed preferential binding to Tau species in the AD the sarkosyl-insoluble fraction (P2), whereas both reference antibodies showed preferential binding to Tau species in the AD sarkosyl-soluble

fraction (S1).

[0272] FIG. 4C showed that mAb005 (“005”), mAb008 (“008”), mAb010 (“010”), mAb011 (“011”), mAb013 (“013”), mAb020 (“020”), mAb025 (“025”), mAb032 (“032”), and mAb037 (“037”), exhibit preferential binding to Tau species localized at the synapses of AD brains but not of ND brains. Ratio of Sy to Cy was measured from 3 independent experiments shown by mean value for each antibody from top to bottom to demonstrate the synaptic preferences. Further, the antibodies described herein showed preferential binding to Tau species in AD total brain lysate, in agreement with the previous finding, whereas both reference antibodies showed preferential binding to Tau species in ND total brain lysate.

#### **Example 6: Antibody Binding Profile in tauopathy human brain lysates**

[0273] Pathological Tau species have been shown in the literature to accumulate in several tauopathies, including AD, progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick’s disease (PiD). To examine whether mAb005 recognizes Tau species in tauopathies other than AD, frozen brain tissues from PSP, CBD, and PiD brains were obtained from Banner Sun Health Research Institute (AZ, USA) for Dot-blot analysis. The presence of pathological Tau species in the brain lysates of these various tissues was first validated by Dot-blot assay using the AT8 antibody. All diseased brain lysates showed prominent AT8 signals relative to ND control of the respective brain region (FIG. 5A, top two rows), confirming the presence of pathological Tau in these samples, whereas HT7 signals did not show such differences. Next, binding of mAb005 and reference antibodies C2N-8E12 and BIIB092 was analyzed by Dot-blot assay. mAb005 showed higher signals in all diseased brain lysates relative to the corresponding control ND brain lysate, whereas HT7 and the two reference antibodies showed no such discrimination (FIG. 5B).

[0274] The levels of pathological Tau varied across different brain regions as indicated by the AT8 signals in FIG. 5A, and mAb005 signals in FIG. 5B showed similar variations. However, mAb005 recognizes a different epitope than AT8, as demonstrated by the detection of substantial signal in PSP thalamus and putamen samples. FIG. 5C shows dot-blot assay on mAb005 (“005”), mAb011 (“011”), mAb013 (“013”), mAb010 (“010”), mAb032 (“032”), mAb037 (“037”), mAb020 (“020”), mAb008 (“008”), mAb025 (“025”), mAb033 (“033”), and mAb004 (“004”). In conclusion, mAb005, mAb011, mAb013, mAb010, mAb032, mAb037, mAb020, mAb008,

mAb025, mAb033, and mAb004 recognized pathological Tau species well in all tauopathies tested, namely AD, PSP, CBD and PiD. Notably, mAb005, mAb011, mAb013, mAb010, mAb032, mAb037, mAb020, and mAb008 showed stronger signals in the AD and PiD samples relative to samples from the other diseases, suggesting the mAb005, mAb011, mAb013, mAb010, mAb032, mAb037, mAb020, and mAb008-positive Tau species are more abundant in AD and PiD than the other tauopathies.

**Example 7: Antibody Binding Profile in sucrose-gradient fractionated AD and ND brain lysates**

[0275] Seed-competent forms of pathological Tau species have been found in the high-density fraction of sucrose gradient fractionated Tau transgenic mouse brain lysates (Jackson et al., 2016 JN). Sucrose gradient analysis was performed to evaluate the densities of mAb005-positive Tau species in human brain lysates. FIG. 6A shows the distribution of both HT7- and AT8-positive Tau species from low to high density of the sucrose-gradient fractionated ND and AD brain lysates. High-density Tau species were noted for both antibodies in AD samples, being consistent with published results. Dot-blot assay of the sucrose-gradient fractionated brain lysates under non-denaturing conditions was then performed with antibodies including: HT7, AT8, synaptophysin, GAPDH, and mAb005 (FIG. 6B).

[0276] FIG. 6A shows the Sucrose-Gradient-Centrifugation (SGC) and western blot analysis of ND and AD brain lysate. SGC was performed by loading 3 mL of 2 mg/mL ND and AD brain lysate (prepared by combining samples from three subjects as described in Example 3) onto a freshly prepared SW41 centrifuge tube containing 7.5 mL of sucrose solution (10-50%, 1.5 mL per layer). The tube was then spun at 250k x g at 4°C for 4 hours, and each fraction was collected by pipetting from top to bottom. Western blot analysis of each fractionated ND and AD sample after heat-denaturation was then performed using HT7 and AT8.

[0277] FIG. 6B shows SGC and dot-blot analysis of ND and AD brain lysate. Dot-blot analysis was performed for SGC-fractionated samples without heat-denaturation, probing with HT7, AT8, synaptophysin, GAPDH, and mAb005. HT7 had a similar fluctuation pattern of signals to AT8 across all fractions in western blot (FIG. 6A), whereas AT8's signals in both Top and 10% fractions were absent in Dot-blot. Synaptophysin, a synaptic marker, was mostly present in the 20-50%, whereas the cytosolic marker GAPDH was more enriched in the low-density fractions from top to

20%.

[0278] In summary, mAb005-positive Tau species were observed to be present in all fractions in AD with an increased signal at the highest density fraction (50%), suggesting the mAb005-positive Tau species were incorporated into multiple complexes with a widely diverse nature, more so than HT7 and AT8.

#### **Example 8: Antibody Binding Profile in SEC fractionated AD and ND brain lysates**

[0279] To gain insight into the complex nature of mAb005-positive Tau species, SEC analysis of ND and AD brain lysates was performed to separate different Tau species according to their molecular weights.

[0280] **FIG. 7A** shows the size exclusion chromatography (SEC) and western blot analysis of ND and AD brain lysates. Western blot analysis of HT7 was performed after heat-denature of samples to reveal the sizes of various Tau fragments in each fraction. Calibration by molecular size marker revealed that fraction 11, 15 and 17 correspond to 769kD, 158 kD and approximately 66kD, respectively. Note that very-large aggregates were excluded due to a required pre-filter step before SEC to prevent column clogging. Western blot analysis by HT7 (**FIG. 7A**) was performed for the collected fractions. HT7 signals in 8-10 fractions (> 670 kD) were prominent only in the AD samples. Notably, these heat-denature-stable Tau species of 64 and 140/170 kD were only present in 8-10 fractions, indicating these fractions derived from AD brain contain the pathological Tau species which are beyond 670 kD in non-denatured conditions and are highly-stable with MW of 64 and 140/170kD even after heat-denature.

[0281] Next, we performed Dot-blot analysis of the SEC fractions for HT7, AT8, synaptophysin (Synapt), GAPDH, mAb005, C2N-8E12 (Ref. AbbVie) and BIIB092 (Ref. Biogen). **FIG. 7B** shows the SEC and dot-blot analysis of ND and AD brain lysates. Equal volume of each fraction without heat denature was spotted on the NC membrane for all dot-blot analysis, probed with HT7, AT8, synaptophysin (Synapt), GAPDH, mAb005, C2N-8E12 (Ref. AbbVie) and BIIB092 (Ref. Biogen).

[0282] Both mAb005 and AT8 showed the most prominent signals in 8-10 fractions across all fractions among Tau-antibodies tested, demonstrating the mAb005-positive Tau species are specific to AD Tau in larger complexes of molecular weight (>679 kD) containing the mis-folded Tau and other proteins. Notably, Synaptophysin signals were also prominent in 8-10 fractions

corresponding to those of the mAb005-positives, suggesting that many mAb005-positive Tau species in the large complexes are present in the synapse, in agreement with the results of FIG. 4. Moreover, the cytosolic marker GAPDH signals were most prominent in 16-21 fractions. Finally, both reference antibodies from AbbVie and Biogen bound to Tau species between 13-22 fractions in both AD and ND samples, demonstrating their binding species are found in both AD and ND in smaller complexes.

**Example 9: Antibody Binding Profile in SEC fractionated Tau transgenic mouse rTg4510 brain lysate**

[0283] In Tau transgenic animals, pathological Tau species evolved into more aggregated forms with age (Berger et al., 2007 JN). To determine whether the mAb005-positive Tau species also incorporated into larger protein complexes with age in rTg4510 mouse brains, we performed SEC analysis for brain lysates extracted from 2.5- and 6-month-old WT and Tg animals. Prior to this analysis, we examined the age-dependency on pathological Tau protein levels for mAb005-positive species in dot blot analysis, in comparison with other Tau-antibodies of HT7, AT8, C2N-8E12 and BIIB092.

[0284] FIG. 8A shows the dot-blot analysis of 1- to 6-month-old rTg4510 (Tg) and wild type (WT) mouse brain lysates. Equal amount of protein was spotted on the NC membrane, probed with mAb005, HT7, AT8, C2N-8E12 and BIIB092 antibodies. We found an age-dependent increase in signals for mAb005 and AT8 using rTg4510 from 1 to 6-month-old (FIG. 8A). However, HT7, C2N-8E12 and BIIB092 antibodies exhibited an equal level of signals across all ages.

[0285] Next, we performed SEC analysis of the brain lysates on 2.5- and 6-month-old Tg animals in combination with dot-blot study probed with mAb005. FIG. 8B shows SEC and dot-blot analysis of 2.5- and 6-month-old Tg brain lysate, probed with mAb005. Over-exposed image was included to highlight the peak distribution. Control dot probed with only mouse secondary antibody showed some non-specific signals in 16-19 fractions.

[0286] A peak shift of mAb005-positive Tau signal towards much higher molecular weight fractions beyond 670 kD was observed from fraction 10 in 2.5-mo to fraction 9 in 6-mo (FIG. 8B). Moreover, mAb005-positive Tau signal between 14-19 fractions became more restricted to fewer fractions at 6-mo Tg mouse, being almost background level, suggesting a change in Tau complex formation during the aging process in Tg animals.



**Example 10: Immunohistochemical Analysis of PSP and AD brains**

[0287] To determine whether mAb005 and mAb037 could bind to pathological Tau in diseased brains in regional-specific and Braak stage-specific manners, an immunohistochemical analysis was performed in AD and PSP brain slices through a contract with an experienced neuropathologist Dr. Thomas Beach from Banner Sun Health Research Institute (AZ, USA).

[0288] **FIG. 9A** shows the schematic representation of Tau spreading through synaptically connected brain areas (modified from Brettschneider et al., 2015 Nat Rev Neurosci). **FIG. 9B-9C** show enlarged photos of indicated brain areas of human brain slices with their disease status (ND vs. AD), Braak Stage (I-VI) and ID labelled on top. Outlined photos show positive signals for mAb005 (a.k.a. RAA7) labelled Tau tangles. mAb005 and mAb037 labelled Tau tangles as shown by punctate and diffused signals in all Braak Stages including ND individuals, indicating the ability of mAb005 and mAb037 in binding to pathological tau species prior to disease onset. **FIG. 9D** indicated PSP brain tissues were all positive for mAb005 signals. **FIG. 9E** indicated PSP brain tissues from four patients were all positive for mAb005 and mAb037 signals. Three brain regions include putamen, globus pallidus and nucleus basalis of Meynert were stained to show astrocytes and neurons with tau tangles recognized by mAb005 and mAb037.

[0289] Since mAb005 antibody is enriched at the synapse (**FIG. 4B**) in AD brain lysates, it is possible that mAb005-positive Tau tangles might appear in connected brain area as depicted in **FIG. 9A** from entorhinal to Isocortical area during disease progression. Consistent with this notion, mAb005-positive Tau deposits were observed as early as Braak Stage III in two clinically ND individuals' entorhinal cortical area, whereas more intense mAb005 signals were found in clinically AD brains (**FIG. 9B**, blue-bracketed images). In the hippocampus CA1 area, synaptically connected with entorhinal cortex, mAb005 signals appeared at similar Braak stage as early as III in ND brains. However, in prefrontal cortex, mAb005 signals were weak and did not last to late Braak stage, suggesting its Tau species were less abundant in this brain area. In PSP brains, on the other hand, mAb005 recognized Tau tangles in tufted astrocytes, oligodendrocytes and neurons in putamen, globus pallidus and nucleus basalis, respectively (**FIG. 9C**). Taken together, we conclude that mAb005 recognizes Tau tangles in AD with a preference in early Braak stage III in entorhinal cortex-hippocampus connected area as well as in PSP.

**Example 11: Immunohistochemical Analysis of rTg4510 brain**

[0290] Next, we examined the localization of mAb005-positive Tau species in rTg4510 brain slices at 3- and 6-mo to reveal: (1) age-dependent changes in mAb005-staining- patterns; (2) relative signals in soma versus in axodendritic compartments in hippocampal formation. mAb005-specific signals were shown in FIG. 10 after a threshold applied to both WT and Tg brain slices so that there were little-to-no signals in WT images.

[0291] **FIGS. 10A-10B** show the immunohistochemical staining of rTg4510 brain by mAb005. FIG. 10A shows staining at 3 months. FIG. 10B shows staining at 6 months. Frozen brain slices in 30- $\mu$ m thickness were incubated with mAb005 antibody using a similar free-floating section immunostaining procedure as described (Evilsizor et al., 2015 J Vis Exp). Images were acquired by ImageXpress Micro XLS (Molecular Device). Abbreviations: WT: wild type, Tg: rTg4510, sub: subiculum, SO: Stratum Oriens, SP: Stratum Pyramidale, SR: Stratum Lucidum, SL-M: Stratum Lacunosum Moleculare, CA: Cornus Ammonis.

[0292] Prominent mAb005 signals were observed in the hippocampal-cortical areas, consistent with the reported Tau overexpression patterns in rTg4510 mouse brain (SantaCruz et al., 2005 Science). Within the hippocampal formation, weak mAb005 signals were observed in the soma (stratum pyramidale, SP) whereas uniformly strong signals in axodendritic compartments were observed in 3-mo image, demonstrating the mAb005-positive Tau species preferentially localized in neurites. In addition, mAb005 signals intensely marked the Tau tangle structures throughout the hippocampal-cortical region in 6-mo brain slices, indicating mAb005-positive Tau species are present in the neurofibrillary tangles.

**Example 12: Surrogate-response study using Plasma Tau level**

[0293] One unique in-vivo response in Tau antibody-treated-animals and human is a rapid increase in plasma Tau level at 48 hours after intraperitoneal injection of antibody (Yanamandra et al., 2017 Sci Trans Med). To explore whether mAb005 is capable of elicit such response in rTg4510 Tau transgenic animals, we performed intraperitoneal injections of C2N-8E12 and mAb005 in 3-mo animals and quantified plasma Tau level by the Human Total Tau kit with Simoa HD-1 Analyzer (Quanterix).

[0294] **FIGS. 11A-11B** show the summary graphs of C2N-8E12 and mAb005 after the intraperitoneal injection (i.p.) into 3-mo rTg4510 animals (n = 4-5 animals; mean  $\pm$ SD). **A**,

Changes in Tau levels at 2, 4 and 8 days after injection of 10 and 50 mg/kg C2N-8E12. **B**, Changes in Tau levels at 2, 4, 6 and 8 days after injection of 10 and 25 mg/kg mAb005. Graphs in left column: absolute amount of plasma Tau in pg/mL, graphs in right column: relative folds increase of Tau level compared with pre-injection. Color-coded dots denote each data point for respective animal.

[0295] In agreement with the literature, C2N-8E12 increased plasma Tau level with approximately 20- and 40-fold differences in animals injected at the dose of 10 and 50 mg/kg antibody on day 2, respectively (FIG. 11A). However, no obvious increase of plasma Tau level was observed in mAb005-injected animals at doses of 10 and 25 mg/kg (FIG. 11B). The inability of detecting plasma Tau level in mAb005-injected animals may be due to several reasons, such as the amount of mAb005-positive Tau species present in plasma being below the detection limit in plasma, the Tau antibody in the Human Total Tau kit being unable to detect the mAb005-positive Tau species, or epitope masking by mAb005-binding that prohibited the detection by Quanterix Tau antibody.

### **Example 13: Selection and characterization of humanized mAb005 and mAb037**

[0296] To facilitate the therapeutic usage of mAb005, we performed humanization of mAb005 and mAb037 by grafting the complementary determining regions (CDRs) of Variable Heavy chain ( $V_H$ ) and Variable Light chain ( $V_L$ ) into a human IgG4 S228P backbone (no Fab-arm exchange mutant, Silva et al., 2015 JBC). Four point-mutations were introduced in the nearby residues surrounding the CDRs to conserve the functionality of the resulting variants. We then performed dot-blot analysis to determine the  $EC_{50}$  of each variant, compared with the original mouse/chimeric clones as well as to visualize the specificity to AD Tau protein compared with ND Tau protein.

**FIGS. 12A-12B** show the binding affinity of mouse mAb005 and mAb037, and humanized variants of mAb005 and mAb037 (as shown in Tables 1-3) to AD and ND brain homogenate. Dot-blot experiments were performed by spotting of ND and AD total brain lysates in triplicate, and antibody solutions were diluted serially by a dilution factor of 2 from a maximum concentration of  $6 \times 10^{-8}$  M. Summary graphs denote Mean  $\pm$  SD of 3 independent experiments.

[0297] The results showed that the humanized mAb005 exhibited a binding affinity with an  $EC_{50}$  value of  $4.3 \times 10^{-10}$  M to AD, which is close to the original mouse clone's  $EC_{50}$  value of  $4.0 \times 10^{-10}$  M, indicating that the humanized mAb005 variant maintained the binding affinity and binding specificity in a similar manner to the original mouse clone. The humanized mAb037 exhibited a

binding affinity with an EC<sub>50</sub> value of  $9.5 \times 10^{-10}$  M to AD, which is close to the original mouse clone's EC<sub>50</sub> value of  $5.4 \times 10^{-10}$  M, indicating that the humanized mAb037 maintained the binding affinity and binding specificity in a similar manner to the original mouse clone.

**Example 14: mAb005 and mAb037 blocked Tau seeding ability**

[0298] Because the antibodies described herein, such as mAb005, 008, 010, 011, 013, 020, 025, 032 and 037 preferentially recognized synaptic Tau, which is highly associated with Tau-spreading (DeVos et al., 2018 Front Neurosci), Tau seeding assays were performed to determine the effect of mAb005 and mAb037 on Tau seeding propagation.

[0299] In order to study whether mAb005 and mAb037 can inhibit Tau-propagation, we established a reporter system by stably expressing a 4R repeat domain of mutant Tau ( $\Delta$ K280/P301L/V337M) tagged with GFP at its N-terminus in HEK293 cells (Tau-LM cell) (Najla., 2012 J Biol Chem). Two-fold serially diluted from 133.3 nM of isotype control mouse IgG, mAb005 or mAb037 were first mixed with 6-month-old rTg4510 brain lysate. Antibody-lysate mixture was incubated with Tau-LM cells for 24 hours. Imaging of Tau-spot formation was performed after lysate was incubated with cells for 48 hours, and cells were fixed and stained with DAPI. The number of Tau spots (represented by GFP-positive signals) and cell number (represented by DAPI-positive spots) were examined by ImageXpress Micro Confocal. The number of Tau spots was normalized by cell number and adjusted by subtracting the value for the "No lysate" condition (N = 3, mean  $\pm$  SD). The number of Tau spots was normalized by cell number and adjusted by subtracting the value for the "No lysate" condition (N = 3, mean  $\pm$  SD). An EC<sub>50</sub> value of  $72.2 \times 10^{-9}$  M for mAb005 and an EC<sub>50</sub> value of  $22.91 \times 10^{-9}$  M for mAb037 were obtained to quantify the potency of inhibition relative to control IgG sample. These results suggest that mAb005-recognized Tau and mAb037-recognized Tau are highly associated with Tau-propagation. (FIGS. 13A-13B).

[0300] 6 month old rTg4510 brain lysate was immunodepleted by protein G beads conjugated with mAb005 and isotype control mouse IgG, with concentrations of antibody 2-fold serially diluted from 133.3 nM. After immunodepletion, lysate was incubated with Tau-LM cells for 24hr. After another 24 hours, cells were fixed and stained with DAPI. Imaging of Tau-spot formation was performed after lysate was incubated with cells for 48 hours. FIG. 13C. The number of Tau spots and cell number (DAPI) was examined by ImageXpress Micro Confocal. The number of Tau spots

was normalized by cell number and adjusted by subtracting the value for the “No lysate” condition (N=3: mean  $\pm$ SD). FIG. 13D. The level of aggregated Tau in immunodepleted lysate was measured by Tau HTRF aggregation assay (N=3: mean  $\pm$ SD). FIG. 13E. Immunoprecipitated beads were analyzed by western blot assay. The membrane was blotted with HT7 antibody (pan-Tau antibody) and scanned by Odyssey infrared Imaging System (LI-COR). FIGS. 13B and 13C summarize the results for three independent experiments.

When we applied mAb005-immunodepleted lysate to Tau-LM cells, the number of Tau spots decreased in a concentration-dependent manner with an EC<sub>50</sub> value of  $0.62 \pm 0.76$  nM (FIG. 13C). We also used Tau aggregation HTRF assay (Cisbio) to double confirm the level of aggregated Tau in mAb005-immunodepleted lysate (FIG. 13D). When mAb005 was compared with isotype control mouse IgG, mAb005 almost abolished aggregated Tau in brain lysate with an EC<sub>50</sub> value of  $1.12 \pm 0.18$  nM. Finally, we used western blot assay to confirm that mAb005 can capture Tau in rTg4510 brain lysate (FIG. 13E). Interestingly, mAb005 not only captured Tau but also preferentially enriched 64 kD Tau as compared to 55 kD Tau. According to previous studies, 64 kD Tau contains phosphorylated Tau and pre-dominantly exists in high molecular weight fractions (Zdenek., 2007 J Neurosci) which contain strong Tau-propagation activity (Shuko., 2015 Nature Communications). These results suggest that mAb005-recognized Tau is highly associated with Tau-propagation.

#### **Example 15: Characterization of mAb005 and mAb037 by Conformational Epitope Mapping using Crosslinking Coupled Mass Spectrometry**

[0301] To get an in-depth view for conformational binding motif of mAb005 and mAb037, conformational epitope mapping using crosslinking coupled mass spectrometry was applied to identify conformational epitopes recognized by these anti-Tau antibodies (FIG. 14).

[0302] Crosslinking coupled mass spectrometry, performed by CovalX Instrument Incorporated, was applied in the study. Detergent-insoluble Tau aggregates isolated from Alzheimer’s patients were used as antigen in the study. Antibodies, mAb005 and mAb037, respectively, and Tau aggregates were incubated with deuterated cross-linker. Since after crosslinking chemistry the antibody/antigen complex was extremely stable, multiple enzymes (five utilized in parallel) and digestion conditions were applied to the complex to provide many different overlapping peptides. Identification of the peptides was performed using high-resolution Orbitrap™ mass spectrometry and MS/MS techniques. The identification of the crosslinked peptides was determined using mass

tags linked to the crosslinking reagents. After MS/MS fragmentation, data generated were analyzed using XQuest and Stavros softwares.

**[0303]** Results showed that mAb005 and mAb037 bind to a region of polypeptides located the mid-region and microtubule binding domain of Tau. Specifically, mAb005 binds to a domain comprising the amino acids S131, K132, T135, S137 and R155 in a human 2N4R Tau isoform, and mAb037 binds to a domain comprising the amino acids R230, T231, S237, T245, K281 and S289 in a human 2N4R Tau isoform.

**[0304]** While particular alternatives of the present disclosure have been disclosed, it is to be understood that various modifications and combinations are possible and are contemplated within the true spirit and scope of the appended claims. There is no intention, therefore, of limitations to the exact abstract and disclosure herein presented.

SEQUENCE LISTING

SEQ ID NO	Sequence	Description
1	EVQLVESGGDLVESGGSLKLSAASGFTFSSYGMSWVRQTPDKRLEWVATISSG SYTYPDSVKGRFTISRDNANTLYLQMSLSNSEDAMYYCADTYYGAMDYWGQ GTSVTVSS	Mouse mAb004 heavy chain AA sequence
2	EVQLVESGGGLVKPGGSLKLSAASGFTFSDYGMHWVRQAPEKGLEWVAYSNSD STTIYYADTVKGRFTISRDNASTLFLQMTSLRSEDAMYYCGRSYYSNYVDYWGQ GTTLVSS	Mouse mAb005 heavy chain AA sequence
3	EVQLVESGGGLVQPGGSLRLS AASGFTFSDYGMHWVRQAPGKGLEWVAYSNS DSTTIYYADTVKGRFTISRDNAKNSLYLQMNSLRAEDTAVYYCGRSYYSNYVDYW GQGLTVTVSS	Humanized mAb005 heavy chain AA sequence
4	EVKLLQSGGGLVQPGGSLKLSAASGFD FSRYWMSWVRRAPGKLEWIGEINPD GNAINYAPSLKDKFIVSRDNANTLYLQMSNVRESDALYYCARPFPVWGTGTT VTVSS	Mouse mAb008 heavy chain AA sequence
5	QVQLKESGPGLVAPSQSL SITCTVSGFSLTGYGVNWVRQPPGKLEWLGMIWGD GSTDYNSALKSRLSISKDNSK SQVFLKMNSLQTDDTARYCANWAFAYWGQGT LTVSA	Mouse mAb010 heavy chain AA sequence
6	QVQLQSQGPQLVRPGASVKISCKASGYFTSYWMHWLQKRPQGLEWIGMIDP SDSETRLNPKFKDKATLTVDKSSSTVYMHLSPTSSEDSAVYYCVRPYGDL DYWGQ GTTLVSS	Mouse mAb011 heavy chain AA sequence
7	EVQLQSQGPELVKPGASVKMSCKASGYFTDFYMKWVKQSHGKSEWIGDIDPN NGDTFYNQKFKGKATLTVDKSSSTAYMQLNSLTSEDSAVYYCARDLYWGQGT LTVSS	Mouse mAb013 heavy chain AA sequence
8	QVQLKQSGPGLVQPSQSL SITCTVSGFSLTSYAVHWVRQSPGKLEWLGVMWS GGSTDYNAAFISRLSISKDNSK SQVFFKMNSLQADDTAIYYCARMGDYDGVAF AYWGQGT LTVSA	Mouse mAb020 heavy chain AA sequence
9	QIQLVQSGPELKKPGETVKISCKASGYFTTHGMSWVKQAPGKGLKWMGWINT YSGVPTYTDDFKGRFAFSLETSASTAYLQINNLK NEDTATYFCARSEL SWFAYWGQ GTLTVSA	Mouse mAb025 heavy chain AA sequence
10	QVQLQSQGAELVKPGASVKISCKASGYAFSSYWMNWVKQRPKGLEWIGQIYP GDGDTDYNKFKGKATLTADTSSSTAYMQLSLSSEDSAVYFCASRSPYWGQGT LTVSA	Mouse mAb032 heavy chain AA sequence
11	QVTLKESGPGILQPSQTL SLTCSFSGFSLTFGMGVGWRQPSGKLEWLAHIW WDDDKYYNPALKSRLTISKDTSKNQVFLKIANVDTADTATYYCARRGSNALDYWG QGTSVTVSS	Mouse mAb033 heavy chain AA sequence
12	EVQLQSQGPELVKPGASVKIPCKASGYFTDYNMDWVKQSHGKSLEWIGDINPN TGGTIYNQKFKGKATLTVDKSSSTAYMELRSLTSEDTAVYYCAGEGPIYYGTT HPFAYWGQGT LTVSA	Mouse mAb037 heavy chain AA sequence
106	QVQLVQSGAEVKKPGASVKVSKASGYFTDYNMDWVRQAHGQGLEWIGDIN PNTGGTIYNQKFKGRATLTVDTSISTAYMELSRSDDTAVYYCAGEGPIYYGTT HPFAYWGQGT LTVSS	Humanized mAb037 heavy chain AA sequence
13	DVLMTQTPLSLPVS LGDQASISCRSSQTIVHSNGNTYLEWYLQKPGQSPKLLIYKVS NRFSGVPDRFSGSGSDFTFLKISRVEAEDLG VYFCFQGS LVPWTFGGGTQLEIR	Mouse mAb004 light chain AA sequence
14	DIVMTQIPLSLPVS LGDQASISCRSSQSLVHSNGNTYLHWYLQKPGQSPKLLIYKVS NRFSGVPDRFSGSGSDFTFLKISRVEAEDLG VYFCFQSTHVPPTFGGGTKLEIK	Mouse mAb005 light chain AA sequence

SEQ ID NO	Sequence	Description
15	DVVMTQSPVSLPVTLGQPASISCRSSQSLVHNSGNTYLHWYLQRPQGQSPRLIYKV SNRFSGVPDRFSGSGSGTDFTLKISRVEAEDVGVYFCFQSTHVPPTFGGQGTKLEIK	Humanized mAb005 light chain AA sequence
16	DVLMTQTPLSLPVS LGDQASISCRSSQSLVRSNGNTYLEWYLNQNPQGQSPKLLIYKV SNRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYFCFQGSHPVPTFGGGTKLEIK	Mouse mAb008 light chain AA sequence
17	DVVMTQTPLTSLVTIGQPASISCKSSQSLDSDGKTYLNWLLQRPQGQSPKRLIYQVS KLDGVPDRFTGSGSGTDFTLKISRVEAEDLGVYFCWQGHFPLTFGAGTKLELK	Mouse mAb010 light chain AA sequence
18	DVVMTQTPLTSLVTIGQPASISCKSSQSLDSDGKTYLNWLLQRPQGQSPKRLIYLV KLDGVPDRFTGSGSGTDFTLKISRVEAEDLGVYFCWQGHFPTFGSGTKLEIK	Mouse mAb011 light chain AA sequence
19	DVVMTQTPLTSLVTIGQPASISCKSSQSLLYSNGKTYLNWLLQRPQGQSPKRLIYLV KLDGVPDRFTGSGSGTDFTLKISRVEAEDLGVYFCWQGHFPTFGGGTKLEIK	Mouse mAb013 light chain AA sequence
20	DVVMTQTPLSLPVS LGDQASISCRSSQSLVHNSGNTYLHWYLQKPGQSPKLLIYKV SNRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYFCQSTHVPPTFGGGTKLEIK	Mouse mAb020 light chain AA sequence
21	DIVMTQSPATLSVTPGDRVSLSCRASQSIDYLNHWYQKSHESPRLIKIYASQISIGI PSRFSGSGSGSDFTLSINSVEPEDVGVYFCQNGHSFPYTFGGGKLEIK	Mouse mAb025 light chain AA sequence
22	DILMTQTPLSLPVS LGDQASISCRSSQSLVHNSGNTYLEWYLQKPGQSPKLLIYKVS NRFSGVPDRFSGSGSGTDFTLKISRVEAEDLGVYFCFQGSHPVPTFGGGTKLEIK	Mouse mAb032 light chain AA sequence
23	DVVVTQTPLSLPVSFGDQVVISCRSSQSLANSYGNTYLSWYLNHKGQSPQLLIYGIS NRFSGVPDRFSGSGSGTDFTLKISTIKPEDLGMYYCLQGHQPWTFGGGKLEIK	Mouse mAb033 light chain AA sequence
24	DVVMTQTPLTSLVTIGQPASISCKSSQSLLYSNGKTYLNWLLQRPQGQSPKRLIYLV KLDGVPDRFTGSGSGTDFTLKISRVEAEDLGVYFCWQGHFPTFGGGTKLEIK	Mouse mAb037 light chain AA sequence
107	DVVMTQSPVSLPVTLGQPASISCKSSQSLLYSNGKTYLNWLLQRPQGQSPRLIYLV KLDGVPDRFSGSGSGTDFTLKISRVEAEDVGVYFCWQGHFPTFGGGTKLEIK	Humanized mAb037 light chain AA sequence
25	GAGGTGCAGCTGGTGGAGTCTGGGGGAGACTTAGTGGAGTCTGGAGGGTCC CTAAACTCTCCTGTGCAGCCTCTGGATTCACTTTAGTAGCTATGGCATGTCTT GGGTTCCGACAGCTCCAGACAAGAGGCTGGAGTGGGTCGCAACCATTAGTAG TAGTGGTAGTTACACCTACTATCCAGACAGTGTGAAGGGGCGATTACCATCT CCAGAGACAATGCCAAGAACCCTGTACCTGCAAATGAGCAGTCTGAACTCT GAGGACACAGCCATGTATTACTGTGCTGATACTTACTACGGAGCTATGGACTA CTGGGGTCAAGGAACCTCAGTACCGTCTCCTCA	Mouse mAb004 heavy chain DNA sequence
26	GAGGTGCAGCTGGTGGAGTCTGGGGGAGGCTTAGTGAAGCCTGGAGGGTCC CTGAAACTCTCCTGTGCAGCCTCTGGATTCACTTTAGTAGCTATGGAATGCAC TGGGTTCCGTCAGGCTCCAGAGAAGGGGCTGGAGTGGGTTGCATACAGCAATA GTGACAGTACTACCATCTACTATGCAGACACAGTGAAGGGCCGATTACCATC TCCAGAGACAATGCCAAGAGCACCTGTTCTGCAAATGACCAGTCTGAGGTC TGAGGACACGGCCATGTATTATTGTGGAAGGAGCTACTATAGTAACTACGTTG ACTACTGGGGCCAAGGCACCACTCTCACAGTCTCCTCA	Mouse mAb005 heavy chain DNA sequence
27	GAGGTGCAGCTGGTGAATCTGGCGGAGGACTGGTTCAGCCTGGCGGATCTC TGAGACTGTCTTGTGCCCGCAGCGGCTTACCTTCAGCGATTATGGCATGCACT GGGTTCCGACAGGCCCTGGCAAAGGACTTAGTGGGTCGCTACAGCAACAG CGACAGCACCACCTACTACGCCGACACCGTGAAGGGCAGATTACCATCA GCCGGGACAACGCCAAGAAGCAGCCTGTACCTGCAGATGAACTCCCTGAGAGC CGAGGACACCGCGTGTACTACTGTGGCAGAAGCTACTACTCCAACCTACGTTG ACTACTGGGGCCAGGGCACACTGGTCCAGTGTCTAGC	Humanized mAb005 heavy chain DNA sequence



SEQ ID NO	Sequence	Description
28	GAGGTGAAGCTTCTCCAGTCTGGAGGTGGCCTGGTGCAGCCTGGAGGATCCC TGAAAGTCTCCTGTGCAGCCTCAGGATTCGATTTTAGTAGATACTGGATGAGTT GGGTTGCGCGGGCTCCAGGAAAAGGACTAGAGTGGATTGGAGAAATTAATCC AGATGGCAATGCAATAAACTATGCACCATCTCTAAAGGATAAATTCATCGTCTC CAGAGACAACGCCAAAAATACGCTGTACCTGCAAATGAGCAATGTGAGATCTG AGGACACAGCCCTTTATTACTGTGCACGACCTTCCCCAGCGTCTGGGGCACA GGGACCACGGTCACCGTCTCCTCA	Mouse mAb008 heavy chain DNA sequence
29	CAGGTGCAGCTGAAGGAGTCAGGACCTGGCCTGGTGGCGCCCTCACAGAGCC TGCCATCACATGCACCGTCTCAGGGTTCTATTAACCGGCTATGGTGTAAACT GGGTTGCGCAGCCTCCAGGAAAAGGTCTGGAGTGGCTGGGAATGATATGGGG TGATGGAAGCACAGACTATAATTCAGCTCTCAAATCCAGACTGAGCATCAGCA AGGACAACCTCCAAGAGCCAAGTTTTCTTAAAAATGAATAGTCTGCAAACCTGAT GACACAGCCAGGTACTACTGTGCCAACTGGGCCTTGTACTGGGGCCAAGG GACTCTGGTCACTGTCTCTGCA	Mouse mAb010 heavy chain DNA sequence
30	CAGGTGCAACTGCAGCAGTCTGGGCCTCAGCTGGTTAGGCCTGGGGCTTCAGT GAAGATATCCTGCAAGGCTTCTGGTTACTCATTACCAGCTACTGGATGCACTG GCTGAAGCAGAGGCCTGGACAAGGTCTTGAGTGGATTGGCATGATTGATCCTT CCGATAGTGAACTAGGTTAAATCAGAAGTTCAAGGACAAGGCCACATTGACT GTAGACAAATCCTCCAGTACAGTCTACATGCACCTCAGCAGCCCGACATCTGA GGACTCTGCGGTCTATTACTGTGTAAGGCCGTATGGTGACCTTGACTACTGGG GCCAAGGCACCACTCTCACAGTCTCCTCA	Mouse mAb011 heavy chain DNA sequence
31	GAGGTCCAGCTGCAACAGTCTGGACCTGAGCTGGTGAAGCCTGGGGCTTCAG TGAAGATGTCCTGCAAGGCTTCTGGATACACCTTCACTGACTTCTACATGAAGT GGGTGAAGCAGAGCCATGGAAAGAGCTTTGAGTGGATTGGAGATATTGATCC TAACAATGGTGATACTTTCTACAACCAGAAGTTCAAGGGCAAGGCCACATTGA CTGTAGACAAATCCTCCAGCACAGCCTACATGCAGCTCAACAGCCTGACATCTG AGGACTCTGCAGTCTATTACTGTGCAAGGGATCTCTACTGGGGCCAAGGCACC ACTCTCACAGTCTCCTCA	Mouse mAb013 heavy chain DNA sequence
32	CAGGTGCAGCTGAAGCAGTCAGGACCTGGCCTAGTGCAGCCCTCACAGAGCCT GTCCATCACCTGCACAGTCTCTGGTTTCTCATTAACTAGTTATGCTGTACTCTGG GTTGCGCAGTCTCCAGGAAAAGGGTCTGGAGTGGCTGGGAGTGATGTGGAGTG GTGGAAGCACAGACTATAATGCAGCTTTCATATCCAGACTGAGCATCAGCAAG GACAATTCCAAGAGCCAAGTTTTCTTAAAAATGAACAGTCTGCAAGCTGATGAC ACAGCCATATATTACTGTGCCAGAATGGGTGATTACGACGGGGTGGCCTGGTT TGCTTACTGGGGCCAAGGGACTCTGGTCACTGTCTCTGCA	Mouse mAb020 heavy chain DNA sequence
33	CAGATCCAGTTGGTACAGTCTGGACCTGAGCTGAAGAAGCCTGGAGAGACAG TCAAGATCTCCTGCAAGGCTTCTGGGTATACCTTTACAACCCATGGAATGAGCT GGGTGAAACAGGCTCCAGGAAAAGGGTTTAAAGTGGATGGGCTGGATAAACAC CTACTCTGGAGTGCCAACATATACTGATGACTTCAAGGGACGTTTTGCCTTCTC TTTGAAACCTCTGCCAGCACTGCCTATTTGCAGATCAACAACCTCAAAAATGA GGACACGGCTACATATTTCTGTGCAAGATCAGAAGTGTCTCTGGTTTGTACTG GGGCAAGGGACTCTGGTCACTGTCTCTGCA	Mouse mAb025 heavy chain DNA sequence
34	CAGGTTCACTGCAGCAGTCTGGGGCTGAGCTGGTGAAGCCTGGGGCCTCAG TGAAGATTTCTGCAAAGCTTCTGGCTACGCATTCAGTAGCTACTGGATGAACT GGGTGAAGCAGAGGCCTGGAAAGGGTCTTGAGTGGATTGGACAGATTTATCC	Mouse mAb032 heavy chain DNA sequence

SEQ ID NO	Sequence	Description
	TGGAGATGGTGATACTGATTACAACGGAAAAGTTCAAGGGCAAGGCCACACTGACTGCAGACACATCCTCCAGCACAGCCTACATGCAGCTCAGCAGCCTGACCTCTGAGGACTCTGCGGTCTATTTCTGTGCAAGCCGATCCCCTTACTGGGGCCAAGG GACTCTGGTCACTGTCTCTGCA	
35	CAGGTTACTCTGAAAGAGTCTGGCCCTGGGATATTGCAGCCCTCCAGACCCTCAGTCTGACTTGTCTTTCTCTGGGTTTTCACTGAGCACTTTTGGTATGGGTGTA GGCTGGTTTTCGTCAGCCTTCAGGGAAGGGTCTGGAGTGGCTGGCACACATTTG GTGGGATGATGATAAGTACTATAACCCAGCCCTGAAGAGTCGGCTCACAATCT CCAAGGATACCTCCAAAACCAGGTTTTCTCAAGATCGCCAATGTGGACACT GCAGATACTGCCACATACTACTGTGCTCGAAGGGGTAGTAATGCTCTGGACTA CTGGGGTCAAGGAACCTCAGTCACCGTCTCCTCA	Mouse mAb033 heavy chain DNA sequence
36	GAGGTCCAGCTGCAACAGTCTGGACCTGAGCTGGTGAAGCCTGGGGCTTCAG TGAAGATACCCTGCAAGGCTTCTGGATACACATTCAGTACTACAACATGGACT GGGTGAAGCAGAGCCATGGAAAGAGCCTTGAGTGGATTGGAGATATTAATCC TAACACTGGTGGTACTATCTACAACCAGAAGTTCAAGGGCAAGGCCACATTGA CTGTAGACAAGTCTCCAGCACAGCCTACATGGAGCTCCGCAGCCTGACATCT GAGGACACTGCAGTCTATTACTGTGCAGGAGAGGGCCCTTATTACTACGGTAC TACCACCCTTTTCTTACTGGGGCCAAGGGACTCTGGTCACTGTCTCTGCA	Mouse mAb037 heavy chain DNA sequence
108	CAAGTGCAGCTGGTCCAGAGCGGCCGAGGTGAAAAAGCCCGCGCCAGC GTGAAGGTGTCTTGAAAGCCTCTGGCTACACCTTACCAGACTACAACATGGA CTGGGTGCGGCAGGCCACGGCCAGGGCCTGGAATGGATCGGCGACATCAAC CCCAACACCGGCGGAACAATCTACAACCAGAAGTTCAAGGGCAGAGCCACCCT GACAGTGGACACCAGCATCAGCACCGCCTACATGGAAGTGGAGACTGAGA AGCGACGACACAGCCGTGTACTACTGCGCCGCGAGGGCCCTTACTACTACGG CACGACCCACCCCTTCGCCTACTGGGGCCAGGGCACACTGGTGACCGTGTCCA GC	Humanized mAb037 heavy chain DNA sequence
37	GATGTTTTGATGACCCAAACTCCACTCTCCCTGCCTGTCAGTCTTGGAGATCAA GCCTCCATCTCTTGCAGATCTAGTCAGACCATTGTACATAGTAATGGAAACACC TATTTAGAATGGTACCTGCAGAAACCAGGCCAGTCTCAAAGCTCCTGATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTCAAGTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTACTGCTTTCAAGGTTCACTTGTTCCTGGACGTTCCGGTGGAGGCACC CAGCTGGAAATCAGG	Mouse mAb004 light chain DNA sequence
38	GATATTGTGATGACCCAAATTCCACTCTCCCTGCCTGTCAGTCTTGGAGATCAA GCCTCCATCTCTTGCAGATCTAGTCAGAGCCTTGTACACAGTAATGGAAACACC TATTTACATTGGTACCTGCAGAAGCCAGGCCAGTCTCAAAGCTCCTAATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTCAAGTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTTCTGCTTTCAAAGTACACATGTTCTCCGACGTTCCGGTGGAGGCACC AAGCTGGAAATCAAA	Mouse mAb005 light chain DNA sequence
39	GACGTGGTCATGACACAGAGCCCTCTGAGCCTGCCTGTGACACTGGGACAGCC TGCCAGCATCAGCTGTAGAAGCAGCCAGAGCCTGGTGCACAGCAACGGCAAT ACCTACCTGCACTGGTATCTGCAGAGGCCCGGACAGTCTCCAGACTGCTGAT CTACAAGGTGTCCAACCGGTTCAAGCGGCTGCCGATAGATTTTCTGGCAGCG GCTCTGGCACCGACTTCACCCTGAAGATCTCCAGAGTGAAGCCGAGGACGTG	Humanized mAb005 light chain DNA sequence

SEQ ID NO	Sequence	Description
	GGCGTGTACTTCTGCTTCCAAAGCACCCACGTGCCACCTACCTTTGCCAGGGC ACCAAGCTGGAAATCAAG	
40	GATGTTTTGATGACCCAACTCCACTCTCCCTGCCTGTCAGTCTTGGAGATCAA GCCTCCATCTCTTGCAGATCTAGTCAGAGTCTTGTACGTAGTAATGGAAACACC TATTTAGAATGGTACCTGCAGAACCCAGGCCAGTCTCCAAAGCTCCTGATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTCAAGTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTACTGCTTTCAAGGTTACATGTTCCGTACACGTTCCGAGGGGGGACC AAGCTGGAAATAAAA	Mouse mAb008 light chain DNA sequence
41	GATGTTGTGATGACCCAGACTCCACTCACTTTGTCGGTTACCATTGGACAACCA GCCTCCATCTCTTGTAAAGTCAAGTCAGAGCCTCTTAGATAGTGGTGGAAAGAC ATATTTGAATTGGTTGTTACAGAGGCCAGGCCAGTCTCCAAAGCGCCTAATCTA TCAGGTGTCTAAACTGGACTCTGGAGTCCCTGACAGGTTCACTGGCAGTGGAT CAGGGACAGATTTCACTGAAAATCAGCAGAGTGGAGGCTGAGGATTTGGG AGTTTATTATTGCTGGCAAGGTACACATTTTCCGCTCACGTTCCGGTCTGGGAC CAAGCTGGAGCTGAAA	Mouse mAb010 light chain DNA sequence
42	GATGTTGTGATGACCCAGACTCCACTCACTTTGTCGGTTACCATTGGACAACCA GCCTCCATCTCTTGAAGTCAAGTCAGAGCCTCTTAGATAGTGGTGGAAAGAC ATATTTGAATTGGTTGTTACAGAGGCCAGGCCAGTCTCCAAAGCGCCTAATCTA TCTGGTGTCTAAACTGGACTCTGGAGTCCCTGACAGGTTCACTGGCAGTGGAT CAGGGACAGATTTCACTGAAAATCAGCAGAGTGGAGGCTGAGGATTTGGG AGTTTATTATTGCTGGCAAGGTACACATTTTCCATTACGTTCCGGTCTGGGGAC AAAGTTGGAAATAAAA	Mouse mAb011 light chain DNA sequence
43	GATGTTGTGATGACCCAGACTCCACTCACTTTGTCGGTTACCATTGGACAACCA GCCTCTATCTCTTGAAGTCAAGTCAGAGCCTCTATATAGTAATGGAAAAACC TATTTGAATTGGTTATTACAGAGGCCAGGCCAGTCTCCAAAGCGCCTAATCTAT CTGGTGTCTAAACTGGACTCTGGAGTCCCTGACAGGTTCACTGGCAGTGGATC AGGAACAGATTTTCACTGAAAATCAGCAGAGTGGAGGCTGAGGATTTGGGG GTTTATTACTGCGTGCAAGGTACACATTTTCTCACACGTTCCGAGGGGGGAC CAAGCTGGAAATAAAA	Mouse mAb013 light chain DNA sequence
44	GATGTTGTGATGACCCAACTCCACTCTCCCTGCCTGTCAGTCTTGGAGATCAA GCCTCCATCTCTTGCAGATCTAGTCAGAGCCTGTACACAGTAATGGAAACACC TATTTACATTGGTACCTGCAGAAGCCAGGCCAGTCTCCAAAGCTCCTGATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTCAAGTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTTCTGCTCTCAAAGTACACATGTTTCTCCGTGGACGTTCCGGTGGAGGC ACCAAGCTGGAAATCAAA	Mouse mAb020 light chain DNA sequence
45	GACATTGTGATGACTCAGTCTCCAGCCACCCTGTCTGTGACTCCAGGAGATAG AGTCTCTCTTTCTGCAGGGCCAGCCAGAGTATTAGCGACTACTTACACTGGTA TCAACAAAAATCACATGAGTCTCCAAGGCTTCTCATCAAATATGCTTCCCAATC CATCTCTGGGATCCCCTCCAGGTTCAAGTGGCAGTGGATCAGGGTCAGATTTCA CTCTCAGTATCAACAGTGTGGAACCTGAAGATGTTGGAGTGTATTACTGTCAA AATGGTCACAGCTTTCCGTACACGTTCCGAGGGGGGACCAAGCTGGAAATAA AA	Mouse mAb025 light chain DNA sequence
46	GATATTTTGTGATGACCCAACTCCACTCTCCCTGCCTGTCAGTCTTGGAGATCAA	Mouse mAb032 light

SEQ ID NO	Sequence	Description
	GCCTCCATCTCTTGCAGATCTAGTCAGAGCATTGTACATAGTAATGGAAACACC TATTTAGAATGGTACCTGCAGAAACCAGGCCAGTCTCCAAAGCTCCTGATCTAC AAAGTTTCCAACCGATTTTCTGGGGTCCCAGACAGGTTTCAGTGGCAGTGGATC AGGGACAGATTTCACTCAAGATCAGCAGAGTGGAGGCTGAGGATCTGGGA GTTTATTACTGCTTTCAAGGTTACATGTTCCGTACACGTTTCGGAGGGGGGACC AAGCTGGAAATAAAA	chain DNA sequence
47	GATGTTGTGGTGACTCAAACCTCCACTCTCCCTGCCTGTCAGCTTTGGAGATCAA GTTTCTATCTCTTGCAGGTCTAGTCAGAGTCTTGCAAACAGTTATGGGAACACC TATTTGTCTTGGTACCTGCACAAGCCTGGCCAGTCTCCACAGCTCCTCATCTATG GGATTTCCAACAGATTTTCTGGGGTGCCAGACAGGTTTCAGTGGCAGTGGTTCA GGGACAGATTTCACTCAAGATCAGCACAATAAAGCCTGAGGACTTGGGAAT GTATTACTGCTTACAAGGTACACATCAGCCGTGGACGTTTCGGTGGAGGCACCA AGCTGGAAATCAAA	Mouse mAb033 light chain DNA sequence
48	GATGTTGTGATGACCCAGACTCCACTCACTTTGTCGGTTACCATTGGACAACCA GCCTCTATCTCTTGAAGTCAAGTCAGAGCCTTATATAGTAATGGAAAAACC TATTTGAATTGGTTATTACAGAGGCCAGGCCAGTCTCCAAAGCGCTAATCTAT CTGGTGTCTAAACTGGACTCTGGAGTCCCTGACAGGTTCACTGGCAGTGGATC AGGAACAGATTTTCACTGAAAATCAGCAGAGTGGAGGCTGAGGATTTGGGA GTTTATTACTGCGTGCAAGGTACACATTTTCTCAGACGTTTCGGTGGAGGCACC AAGCTGGAAATCAAA	Mouse mAb037 light chain DNA sequence
109	GATGTGGTGATGACCCAGTCTCCACTGAGCCTGCCTGTGACCCTGGGCCAACC TGCCAGCATCAGCTGTAAAAGCAGCCAGAGCCTGCTGTACAGCAACGGCAAG ACCTACCTGAACTGGCTGCTGCAGAGACCTGGCCAGAGCCCTAGACGGCTGAT CTACCTGGTGTCCAAGCTGGACAGCGCGTCCCCGATAGATTCAGCGGATCTG GCAGCGGCACCGACTTCACCCTGAAGATCAGTAGAGTGAAGCCGAGGACGT GGGCGTGTACTACTGCGTGCAGGGCACACACTTCCCCCAGACCTTCGGCGGGC GAACAAAGCTGGAAATCAAG	Humanized mAb037 light chain DNA sequence
49	SYGMS	Mouse mAb004 heavy chain CDR1
50	DYGMH	Mouse mAb005 heavy chain CDR1
51	RYWMS	Mouse mAb008 heavy chain CDR1
52	GYGVN	Mouse mAb010 heavy chain CDR1
53	SYWMH	Mouse mAb011 heavy chain CDR1
54	DFYMK	Mouse mAb013 heavy chain CDR1
55	SYAVH	Mouse mAb020 heavy chain CDR1
56	THGMS	Mouse mAb025 heavy chain CDR1
57	SYWMN	Mouse mAb032 heavy chain CDR1

SEQ ID NO	Sequence	Description
58	TFGMGVG	Mouse mAb033 heavy chain CDR1
59	DYNMD	Mouse mAb037 heavy chain CDR1
60	TISSGSYTYYPDSVKG	Mouse mAb004 heavy chain CDR2
61	YSNSDSTTIYADTVKG	Mouse mAb005 heavy chain CDR2
62	EINPDGNAINYAPSLKD	Mouse mAb008 heavy chain CDR2
63	MIWGDGSTDYNSALKS	Mouse mAb010 heavy chain CDR2
64	MIDPSDSETRLNQQFKD	Mouse mAb011 heavy chain CDR2
65	DIDPNNGDTFYNQKFKG	Mouse mAb013 heavy chain CDR2
66	VMWSGGSTDYNAAFIS	Mouse mAb020 heavy chain CDR2
67	TYSGVPTYTDDFKG	Mouse mAb025 heavy chain CDR2
68	QIYPGDGDTDYNGKFKG	Mouse mAb032 heavy chain CDR2
69	HIWWDDDKYYNPALKS	Mouse mAb033 heavy chain CDR2
70	DINPNTGGTIYNQKFKG	Mouse mAb037 heavy chain CDR2
71	TYYGAMDY	Mouse mAb004 heavy chain CDR3
72	SYYSNYVDY	Mouse mAb005 heavy chain CDR3
73	PFPSV	Mouse mAb008 heavy chain CDR3
74	WAFAY	Mouse mAb010 heavy chain CDR3
75	PYGDLDY	Mouse mAb011 heavy chain CDR3
76	DLY	Mouse mAb013 heavy chain CDR3
77	MGDYDGVAVFAY	Mouse mAb020 heavy chain CDR3
78	SELSWFAY	Mouse mAb025 heavy chain CDR3
79	RSPY	Mouse mAb032 heavy chain CDR3

SEQ ID NO	Sequence	Description
80	RGSNALDY	Mouse mAb033 heavy chain CDR3
81	EGPYYYGTTHPFAY	Mouse mAb037 heavy chain CDR3
82	RSSQTIVHSNGNTYLE	Mouse mAb004 light chain CDR1
83	RSSQSLVHSNGNTYLH	Mouse mAb005 light chain CDR1
84	RSSQSLVRSNGNTYLE	Mouse mAb008 light chain CDR1
85	KSSQSLLDSDGKTYLN	Mouse mAb010 light chain CDR1
86	KSSQSLLDSDGKTYLN	Mouse mAb011 light chain CDR1
87	KSSQSLLYSNGKTYLN	Mouse mAb013 light chain CDR1
88	RASQISDYLH	Mouse mAb025 light chain CDR1
89	RSSQSIVHSNGNTYLE	Mouse mAb032 light chain CDR1
90	RSSQSLANSYGNTYLS	Mouse mAb033 light chain CDR1
91	KVSNRFS	Mouse mAb004 light chain CDR2
92	QVSKLDGVPD	Mouse mAb010 light chain CDR2
93	LVSKLDS	Mouse mAb011 light chain CDR2
94	YASQIS	Mouse mAb025 light chain CDR2
95	GISNRFS	Mouse mAb033 light chain CDR2
96	FQGSLVPWT	Mouse mAb004 light chain CDR3
97	FQSTHVPPT	Mouse mAb005 light chain CDR3
98	FQGSHVPYT	Mouse mAb008 light chain CDR3
99	WQGTHFPLT	Mouse mAb010 light chain CDR3
100	WQGTHFPFT	Mouse mAb011 light chain CDR3
101	VQGTHFPHT	Mouse mAb013 light chain CDR3

<b>SEQ ID NO</b>	<b>Sequence</b>	<b>Description</b>
102	SQSTHVPPWT	Mouse mAb020 light chain CDR3
103	QNGHSFPYT	Mouse mAb025 light chain CDR3
104	LQGTHQPWT	Mouse mAb033 light chain CDR3
105	VQGTHFPQT	Mouse mAb037 light chain CDR3

## CLAIMS

### WHAT IS CLAIMED IS:

1. An isolated anti-Tau antibody or antigen-binding moiety thereof comprising:

a) a heavy chain variable region comprising i) a complementary determining region (CDR) 1 comprising the amino acid sequence of any one of SEQ ID NOs: 49-59 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 49-59; ii) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 60-70 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 60-70; and/or iii) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 71-81 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 71-81; and/or

b) a light chain variable region comprising iv) a CDR1 comprising the amino acid sequence of any one of SEQ ID NOs: 82-90 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 82-90; v) a CDR2 comprising the amino acid sequence of any one of SEQ ID NOs: 91-95 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 91-95; and/or vi) a CDR3 comprising the amino acid sequence of any one of SEQ ID NOs: 96-105 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 96-105.

2. The antibody or antigen-binding moiety of claim 1, wherein

1) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively;

2) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 49, 60, and 71, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 49, 60, and 71, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 82, 91, and 96, respectively, or variants thereof having at least 80% sequence identity



to the amino acid sequences of SEQ ID NOs: 82, 91, and 96, respectively;

3) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 51, 62, and 73, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 51, 62, and 73, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 84, 91, and 98, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 84, 91, and 98, respectively;

4) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 52, 63, and 74, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 52, 63, and 74, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 85, 92, and 99, respectively, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 85, 92, and 99, respectively;

5) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 53, 64, and 75, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 53, 64, and 75, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 86, 93, and 100, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 86, 93, and 100, respectively;

6) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 54, 65, and 76, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 54, 65, and 76, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 101, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 87, 93, and 101, respectively;

7) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 55, 66, and 77, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 55, 66, and 77, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 102, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 83, 91, and 102, respectively;

8) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 56, 67, and 78, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 56, 67, and 78, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 88, 94, and 103, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 88, 94, and 103, respectively;

9) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 57, 68, and 79, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 57, 68, and 79, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 89, 91, and 98, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 89, 91, and 98, respectively;

10) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 58, 69, and 80, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 58, 69, and 80, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 90, 95, and 104, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 90, 95, and 104, respectively; or

11) the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 59, 70, and 81, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 87, 93, and 105, respectively.

3. The antibody or antigen-binding moiety of claim 2, wherein the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively, or variants thereof having at least 80% sequence identity to the amino acid sequences of SEQ ID

NOs: 83, 91, and 97, respectively.

4. The antibody or antigen-binding moiety of claim 2, wherein the heavy chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 50, 61, and 72, respectively; and the light chain variable region CDR1, CDR2, and CDR3 comprise the amino acid sequences of SEQ ID NOs: 83, 91, and 97, respectively.

5. The antibody or antigen-binding moiety of any one of claims 1-4, wherein the heavy chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106 or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 1-12 and 106; and/or the light chain variable region comprises the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107, or a variant thereof having at least 80% sequence identity to the amino acid sequence of any one of SEQ ID NOs: 13-24 and 107.

6. The antibody or antigen-binding moiety of claim 5, wherein

1) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 3 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 3; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 15 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 15;

2) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 2 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 2; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 14 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 14;

3) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 1 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 1; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 13 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 13;

4) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 4 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO:

4; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 16 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 16;

5) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 5 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 5; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 17 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 17;

6) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 6 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 6; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 18 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 18;

7) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 7 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 7; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 19 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 19;

8) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 8 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 8; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 20 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 20;

9) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 9 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 9; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 21 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 21;

10) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 10 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 10; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 22

or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 22;

11) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 11 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 11; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 23 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 23;

12) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 12 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 12; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 24 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 24; or

13) the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 106 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 106; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 107 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NOs: 107.

7. The antibody or antigen-binding moiety of claim 6, wherein the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 3 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 3; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 15 or a variant thereof having at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 15.

8. The antibody or antigen-binding moiety of claim 6, wherein the heavy chain variable region comprises the amino acid sequence of SEQ ID NO: 3; and the light chain variable region comprises the amino acid sequence of SEQ ID NO: 15.

9. The antibody or antigen-binding moiety of any one of claims 1-8, wherein the antibody or antigen-binding moiety is a monoclonal antibody.

10. The antibody or antigen-binding moiety of any one of claims 1-9, wherein the antibody or

antigen-binding moiety is a human, humanized, or chimeric antibody.

11. The antibody or antigen-binding moiety of any one of claims 1-10, wherein the antibody or antigen-binding moiety specifically binds to pathological human Tau species relative to normal human Tau species.

12. The antibody or antigen-binding moiety of claim 11, wherein the pathological human Tau species is from a tauopathy selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD).

13. The antibody or antigen-binding moiety of claim 11, wherein the pathological human Tau species is from a tauopathy brain selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD).

14. The antibody or antigen-binding moiety of claim 11 or 12, wherein the pathological human Tau species is Tau Type 1A, IB, 11 A, or MB; misordered Tau; mis-disordered Tau; sarkosyl-insoluble Tau; an extracellular Tau deposit; a Tau aggregate; paired helical filaments; a neurofibrillary pathology; or a hyperphosphorylated form of truncated Tau or full-length Tau.

15. The antibody or antigen-binding moiety of claim 14, wherein the pathological human Tau species is a hyperphosphorylated and sarkosyl-insoluble Tau species.

16. The antibody or antigen-binding moiety of claim 14, wherein the pathological human Tau species is Tau aggregates and/or abnormally phosphorylated accumulated at synapses of brain.

17. The antibody or antigen-binding moiety of any one of claims 1-15, wherein the antibody or antigen-binding moiety binds to a hyperphosphorylated and sarkosyl-insoluble 64 kD Tau species from a human Alzheimer's Disease (AD) brain lysate.

18. The antibody or antigen-binding moiety of claim 14, wherein the pathological human Tau species is Tau aggregates and/or abnormally phosphorylated accumulated at synapses of tauopathy brain.

19. The antibody or antigen-binding moiety of claim 17, wherein the antibody or antigen-binding

moiety i) further binds to sarkosyl-insoluble 58 kD and/or 68 kD Tau species from the human AD brain lysate; and/or ii) does not bind to 140 kD and/or 170 kD Tau species from the human AD brain lysate.

20. The antibody or antigen-binding moiety of any one of claims 1-19, wherein the antibody or antigen-binding moiety is an IgG1 or an IgG4 antibody.

21. An isolated nucleic acid encoding the antibody or antigen-binding moiety of any one of claims 1-20.

22. A host cell comprising the nucleic acid of claim 21.

23. A method of producing an antibody or antigen-binding moiety comprising culturing the host cell of claim 22 under conditions suitable for producing the antibody or antigen-binding moiety.

24. An immunoconjugate comprising the antibody or antigen-binding moiety of any one of claims 1-20 and a second therapeutic agent.

25. A labeled antibody comprising the antibody or antigen-binding moiety of any one of claims 1-20 and a detectable label.

26. A pharmaceutical composition comprising the antibody or antigen-binding moiety of any one of claims 1-20 and a pharmaceutically acceptable carrier.

27. A method of treating or preventing a Tau protein-associated disease in a subject, comprising administering to the subject the antibody or antigen-binding moiety of any one of claims 1-20 or the pharmaceutical composition of claim 26.

28. A method of retaining or increasing cognitive memory capacity or slowing memory loss in a subject having or at risk of developing a Tau protein-associated disease, comprising administering to the subject the antibody or antigen-binding moiety of any one of claims 1-20 or the pharmaceutical composition of claim 26.

29. A method of reducing the level of Tau protein in a subject having or at risk of developing a Tau protein-associated disease, comprising administering to the subject the antibody or antigen-

binding moiety of any one of claims 1-20 or the pharmaceutical composition of claim 26, wherein

i) the level of non-phosphorylated Tau protein, phosphorylated Tau protein, and/or hyperphosphorylated Tau protein is reduced in the subject as compared to their levels in the subject prior to administration of the antibody or antigen-binding moiety; and/or

ii) the level of a pathological Tau species is reduced in the subject as compared to its level in the subject prior to administration of the antibody or antigen-binding moiety.

30. A method of reducing the level of Tau protein aggregates in a subject having or at risk of developing a Tau protein-associated disease, comprising administering to the subject the antibody or antigen-binding moiety of any one of claims 1-20 or the pharmaceutical composition of claim 26, wherein

i) the level of non-phosphorylated Tau protein, phosphorylated Tau protein, and/or hyperphosphorylated Tau protein is reduced in the subject as compared to their levels in the subject prior to administration of the antibody or antigen-binding moiety; and/or

ii) the level of a pathological Tau species is reduced in the subject as compared to its level in the subject prior to administration of the antibody or antigen-binding moiety.

31. A method of inhibiting and/or reversing the propagation of Tau aggregation in a subject having or at risk of developing a Tau protein-associated disease, comprising administering to the subject the antibody or antigen-binding moiety of any one of claims 1-20 or the pharmaceutical composition of claim 26.

32. A method of inhibiting and/or reversing Tau seeding in a subject having or at risk of developing a Tau protein-associated disease, comprising administering to the subject the antibody or antigen-binding moiety of any one of claims 1-20 or the pharmaceutical composition of claim 26.

33. The method of any one of claims 27-32, wherein the Tau protein-associated disease is a tauopathy.

34. The method of claim 33, wherein the tauopathy is a neurodegenerative tauopathy.

35. The method of claim 33 or 34, wherein the tauopathy is selected from the group consisting of Alzheimer's Disease (AD), amyotrophic lateral sclerosis (ALS), Huntington's disease (HD),



Parkinson's disease (PD), Creutzfeldt-Jacob disease, Dementia pugilistica, Down's Syndrome, Gerstmann-Straussler-Scheinker disease, British dementia, Danish dementia, inclusion-body myositis, prion protein cerebral amyloid angiopathy, traumatic brain injury, Guam Parkinsonism-dementia complex, Non-Guamanian motor neuron disease with neurofibrillary tangles, argyrophilic grain dementia, corticobasal degeneration, diffuse neurofibrillary tangles with calcification, frontotemporal dementia, frontotemporal dementia with parkinsonism linked to chromosome 17, Hallevorden-Spatz disease, multiple system atrophy, Niemann-Pick disease type C, Pallido-ponto-nigral degeneration, Pick's disease, progressive subcortical gliosis, progressive supranuclear palsy, Subacute sclerosing panencephalitis, Tangle-only dementia, White matter tauopathy with globular glial inclusions, Frontotemporal dementia, Postencephalitic Parkinsonism, Parkinsonism linked to chromosome 17, and Myotonic dystrophy.

36. The method of any one of claims 33-35, wherein the tauopathy is Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), or Pick's disease (PiD).

37. The method of any one of claims 27-36, wherein the method further comprises administering to the subject at least one additional therapy.

38. The method of claim 37, wherein the at least one additional therapy is selected from neurological drugs, corticosteroids, antibiotics, antiviral agents, anti-Tau antibodies, Tau inhibitors, anti-amyloid beta antibodies, beta-amyloid aggregation inhibitors, anti-BACE1 antibodies, and BACE1 inhibitors.

39. The method of any one of claims 27-38, wherein the subject is diagnosed as having or being at risk of developing a Tau protein-associated disease.

40. The method of claim 39, wherein the subject is diagnosed as having or being at risk of developing a tauopathy selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD).

41. A method of detecting pathological human Tau in a sample comprising i) contacting the sample with the antibody or antigen-binding moiety of any one of claims 1-20 and detecting, directly or indirectly, the antibody or antigen-binding moiety; or ii) contacting the sample with the antibody

or antigen-binding moiety of claim 25 and detecting the label.

42. The method of claim 41, wherein the pathological human Tau is from a tauopathy selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD).

43. The method of claim 41, wherein the pathological human Tau is from a tauopathy brain sample selected from the group consisting of Alzheimer's disease (AD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), and Pick's disease (PiD).

44. The method of claim 41 or 42, wherein the pathological human Tau is Tau Type 1A, IB, 11 A, or MB; misordered Tau; mis-disordered Tau; sarkosyl-insoluble Tau; an extracellular Tau deposit; a Tau aggregate; paired helical filaments; a neurofibrillary pathology; or a hyperphosphorylated form of truncated Tau or full-length Tau.

45. The method of claim 44, wherein the pathological human Tau is hyperphosphorylated and sarkosyl-insoluble Tau.

46. The method of claim 44, wherein the pathological human Tau is accumulated at synapses of brain.

47. The method of any one of claims 41-45, wherein the sample is a brain sample, a cerebrospinal fluid sample, or a blood sample.

48. The method of any one of claims 41-47, wherein the detecting comprising producing a readout comprising information about the presence of pathological human Tau in the sample.

49. The method of claim 48, wherein the sample is from a subject and the method further comprises diagnosing whether the subject has a tauopathy or is likely to develop a tauopathy based on the readout.

FIG. 1A

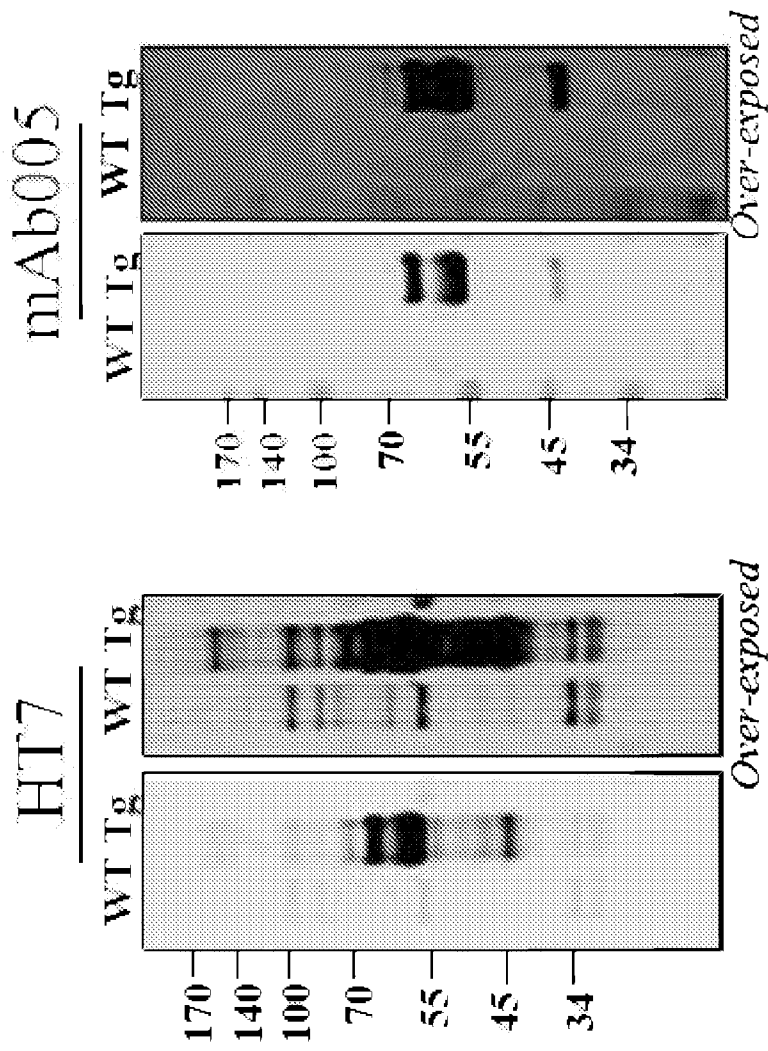


FIG. 1B

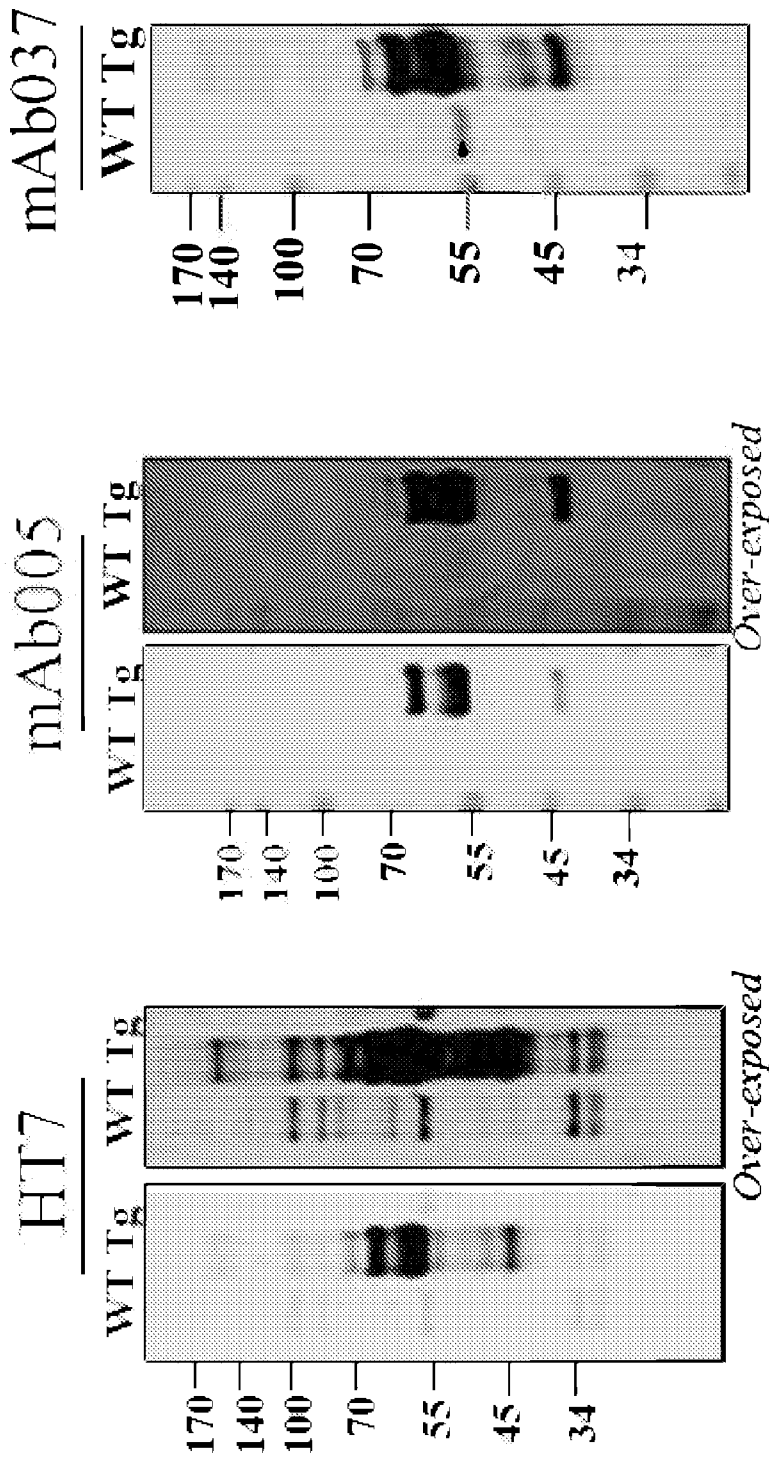


FIG. 2A

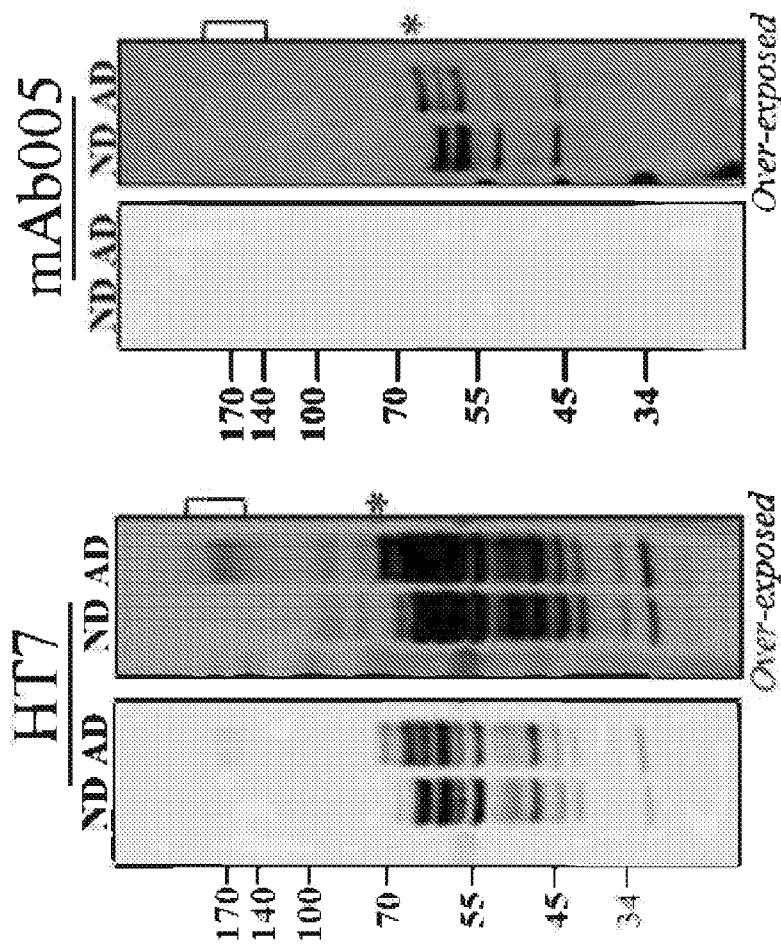


FIG. 2B

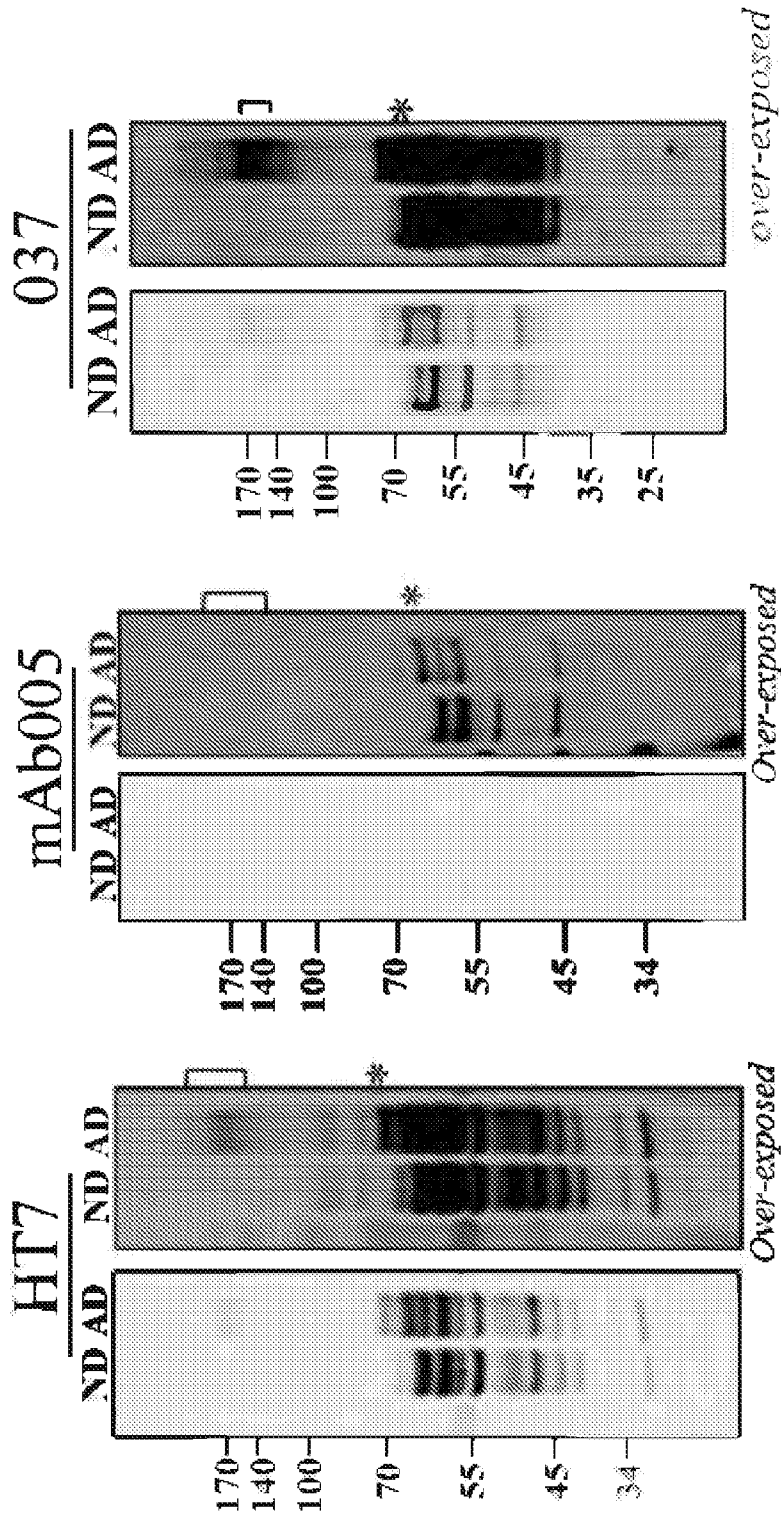


FIG. 3A

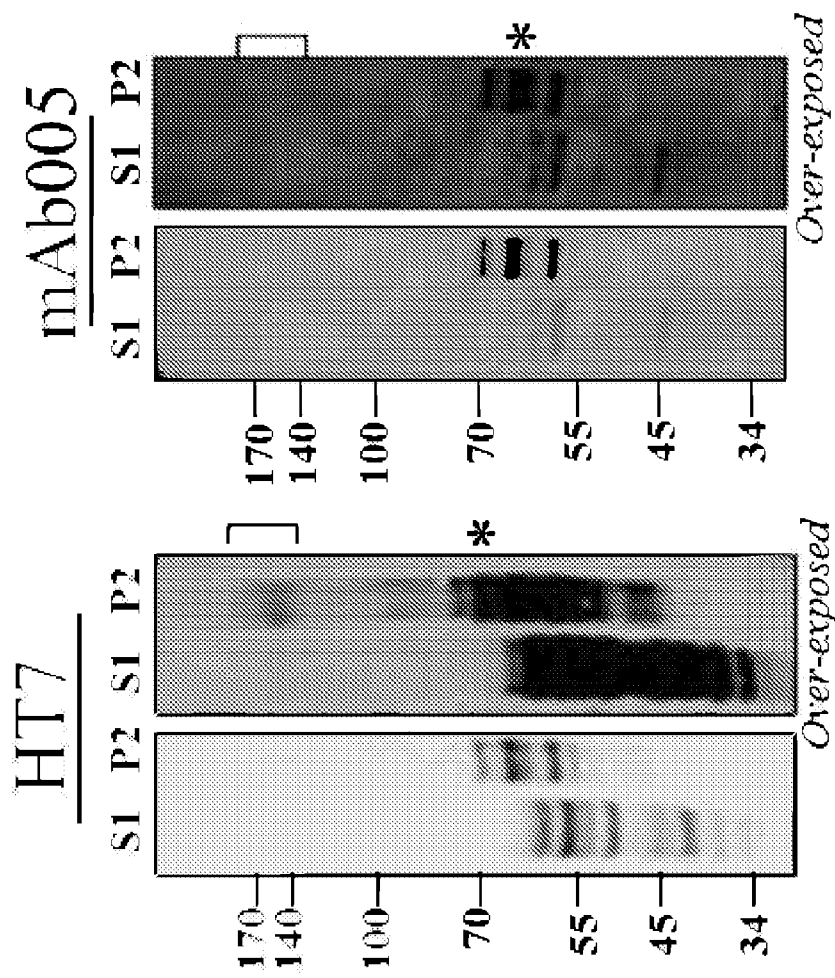
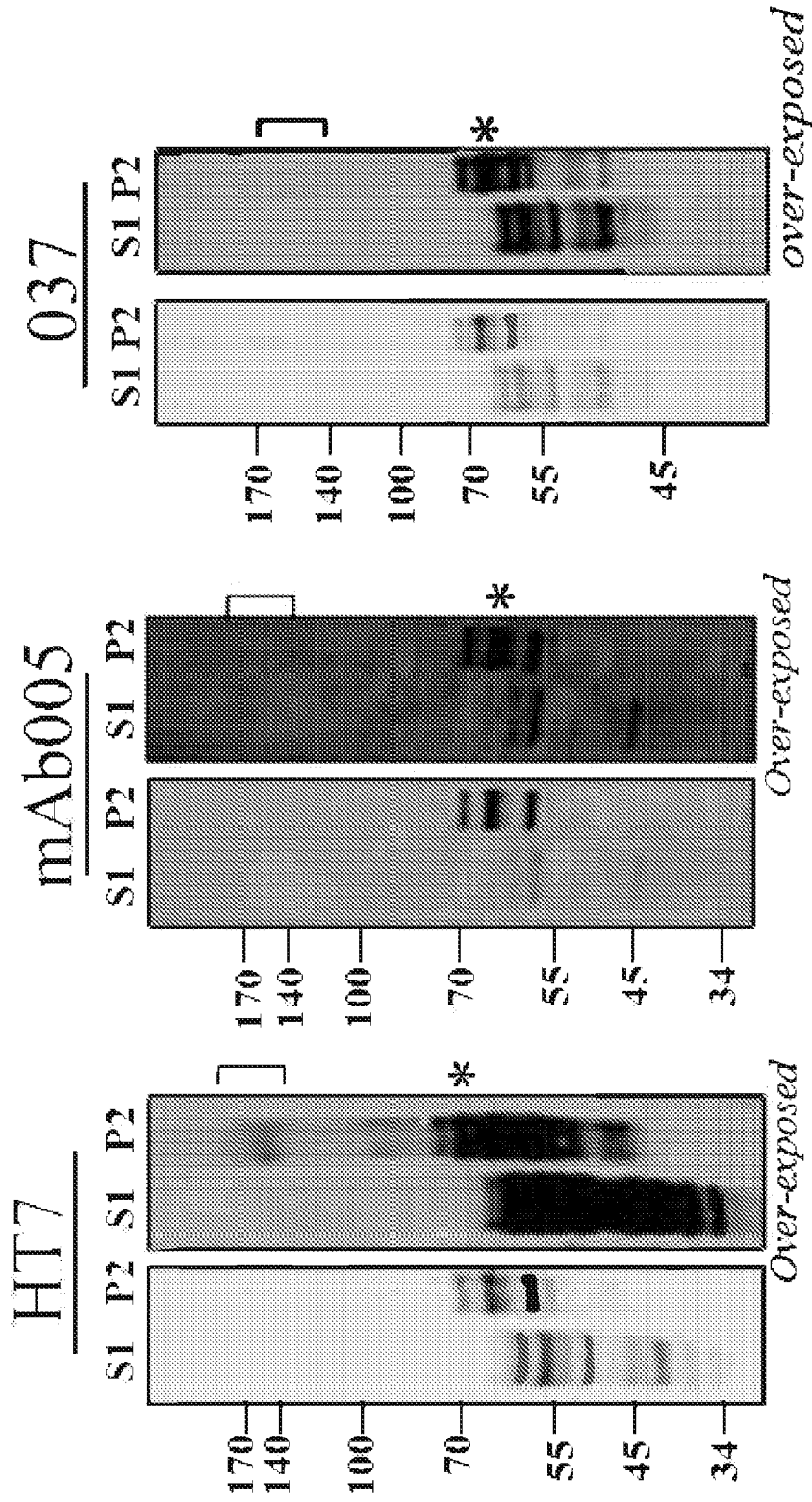
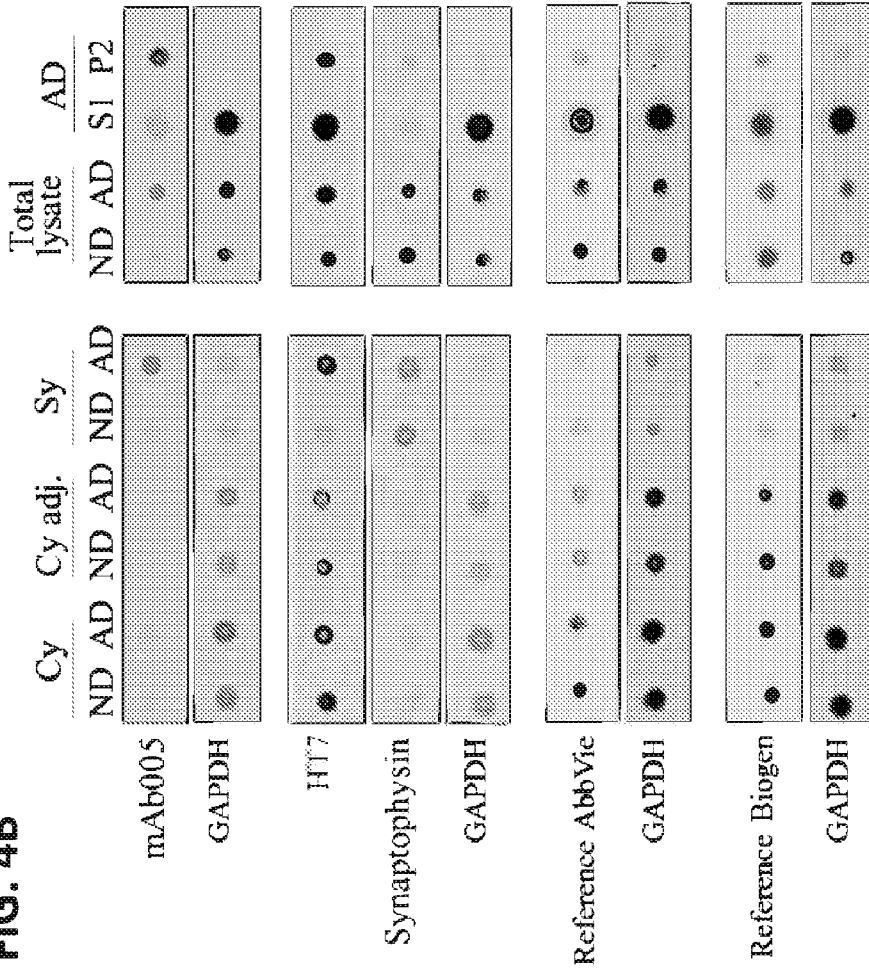


FIG. 3B





**FIG. 4B**



**FIG. 4A**

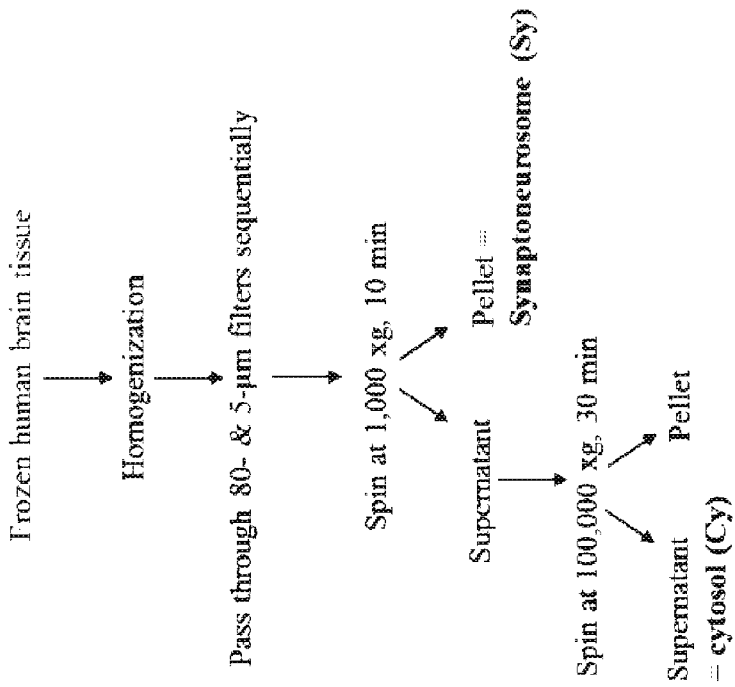
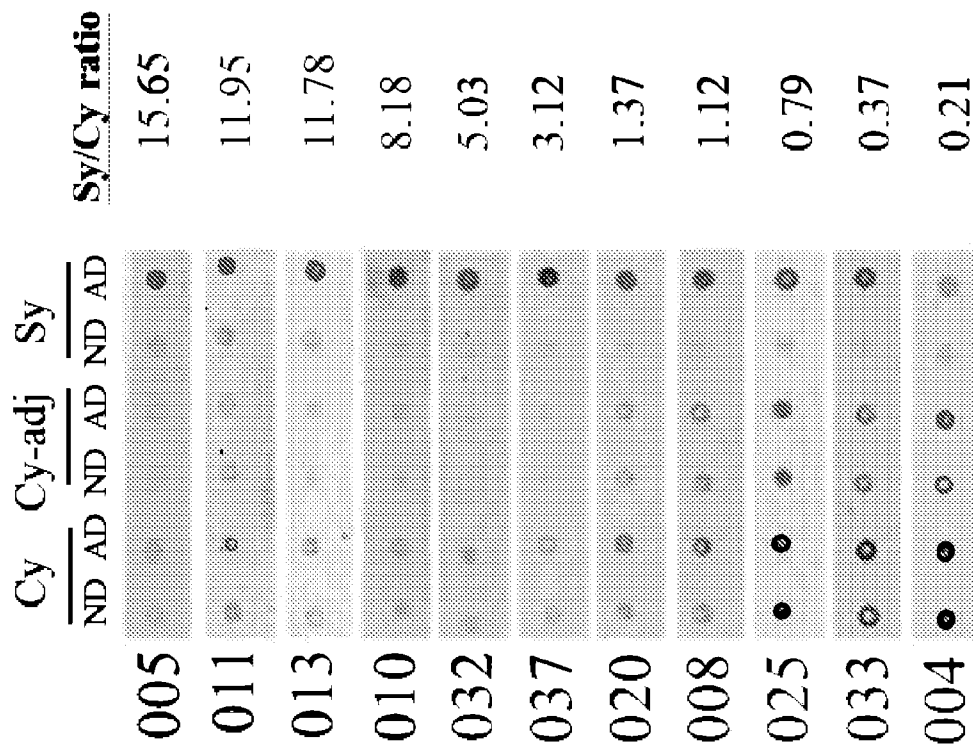


FIG. 4C



*Cy: cytosolic fraction*

*Cy-adj: adjusted cytosolic fraction*

*Sy: synaptoneurosome fraction*

FIG. 5A

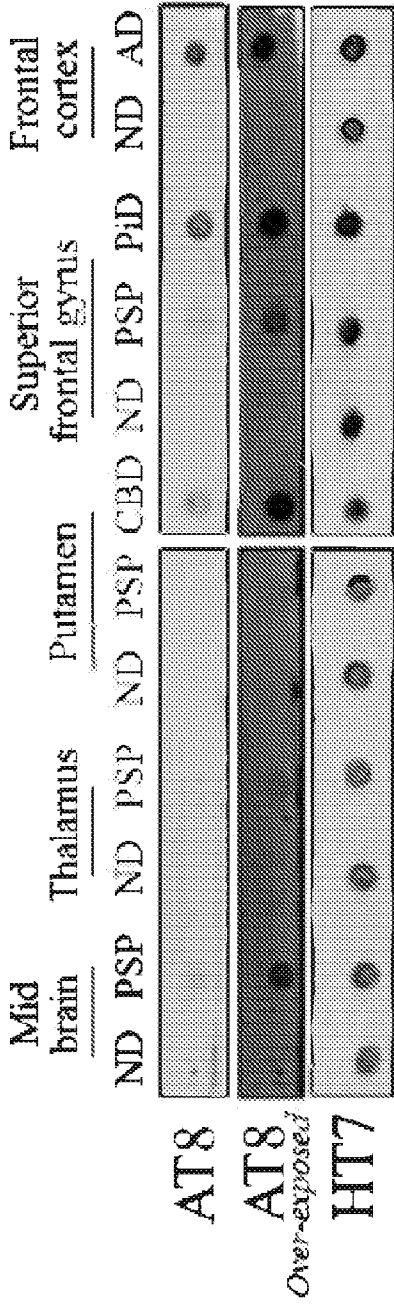
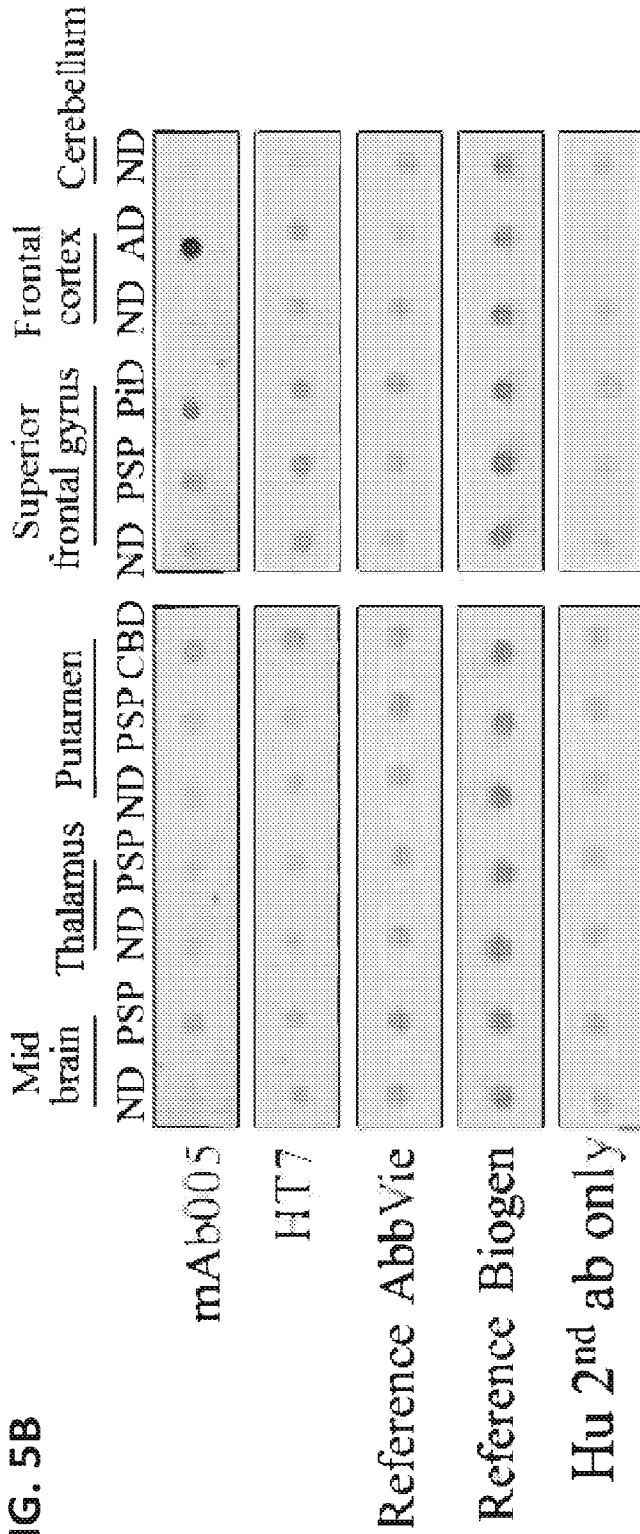


FIG. 5B



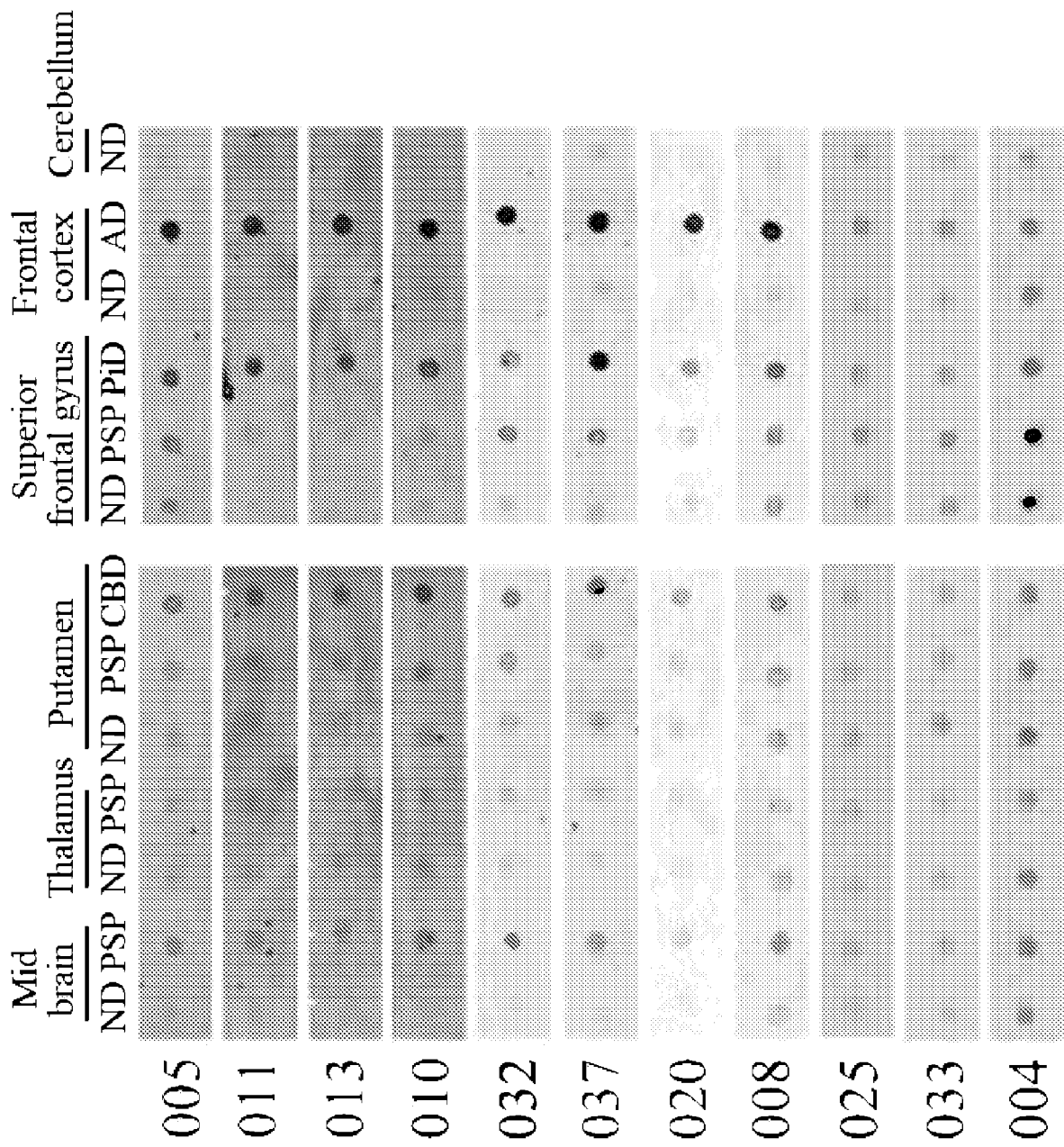
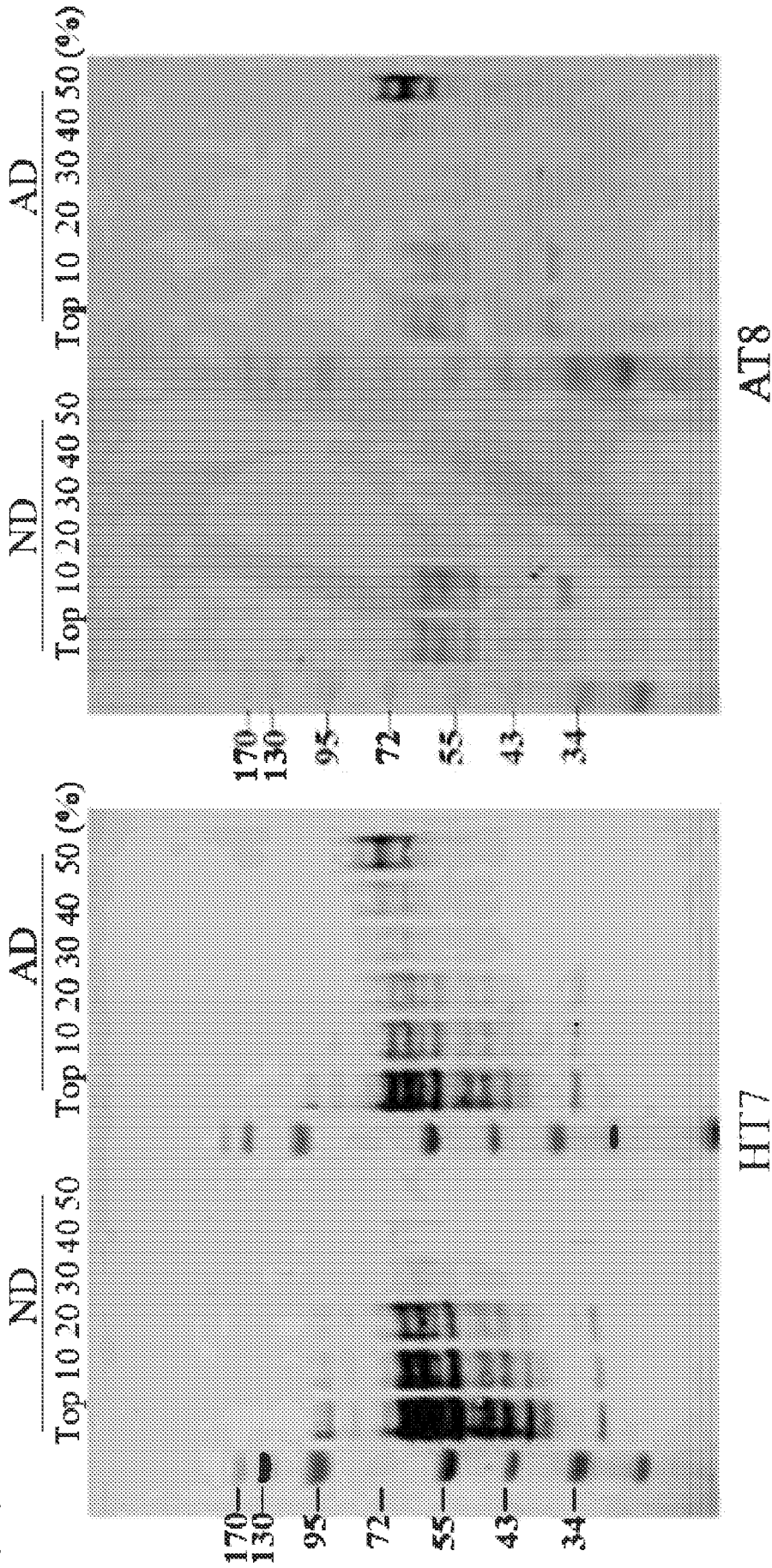
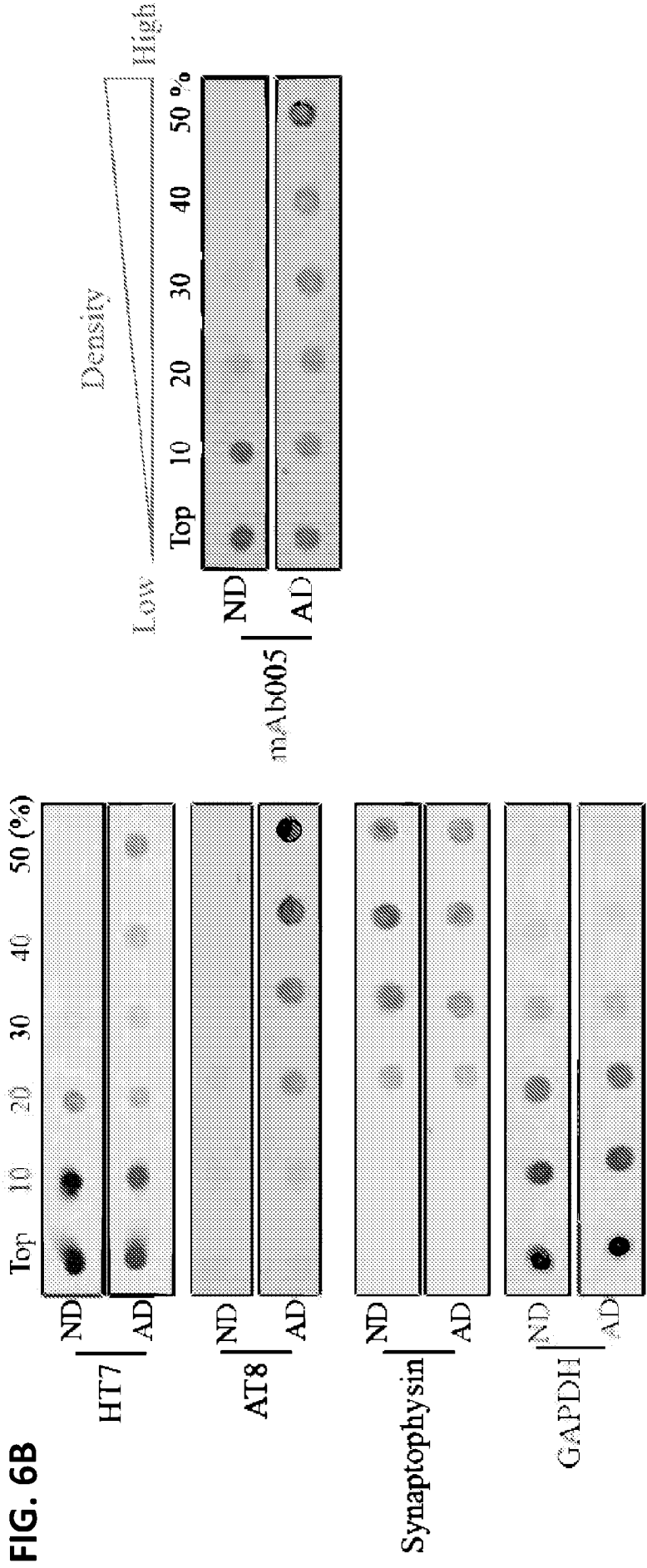


FIG. 5C

FIG. 6A





**FIG. 7A**

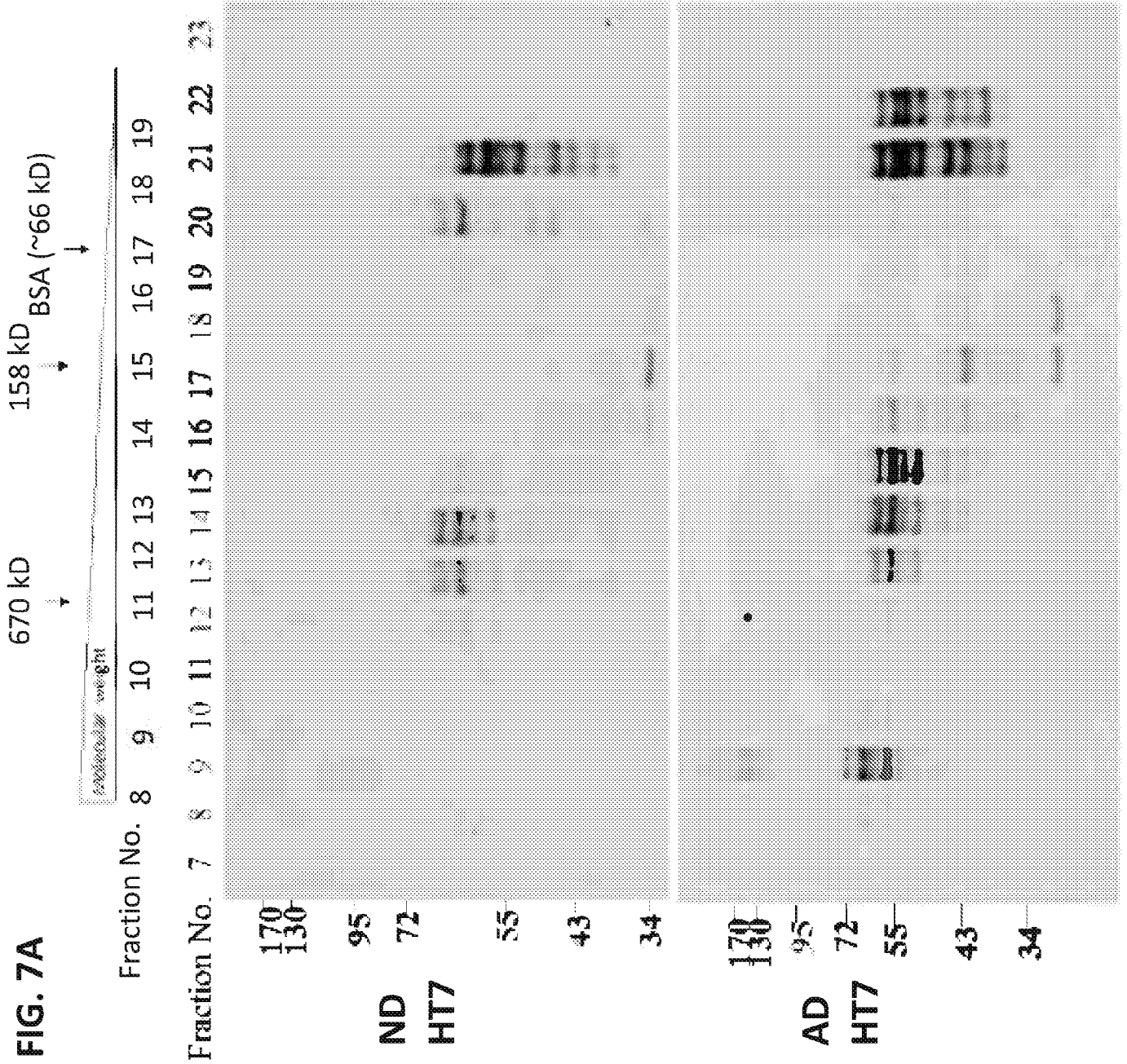
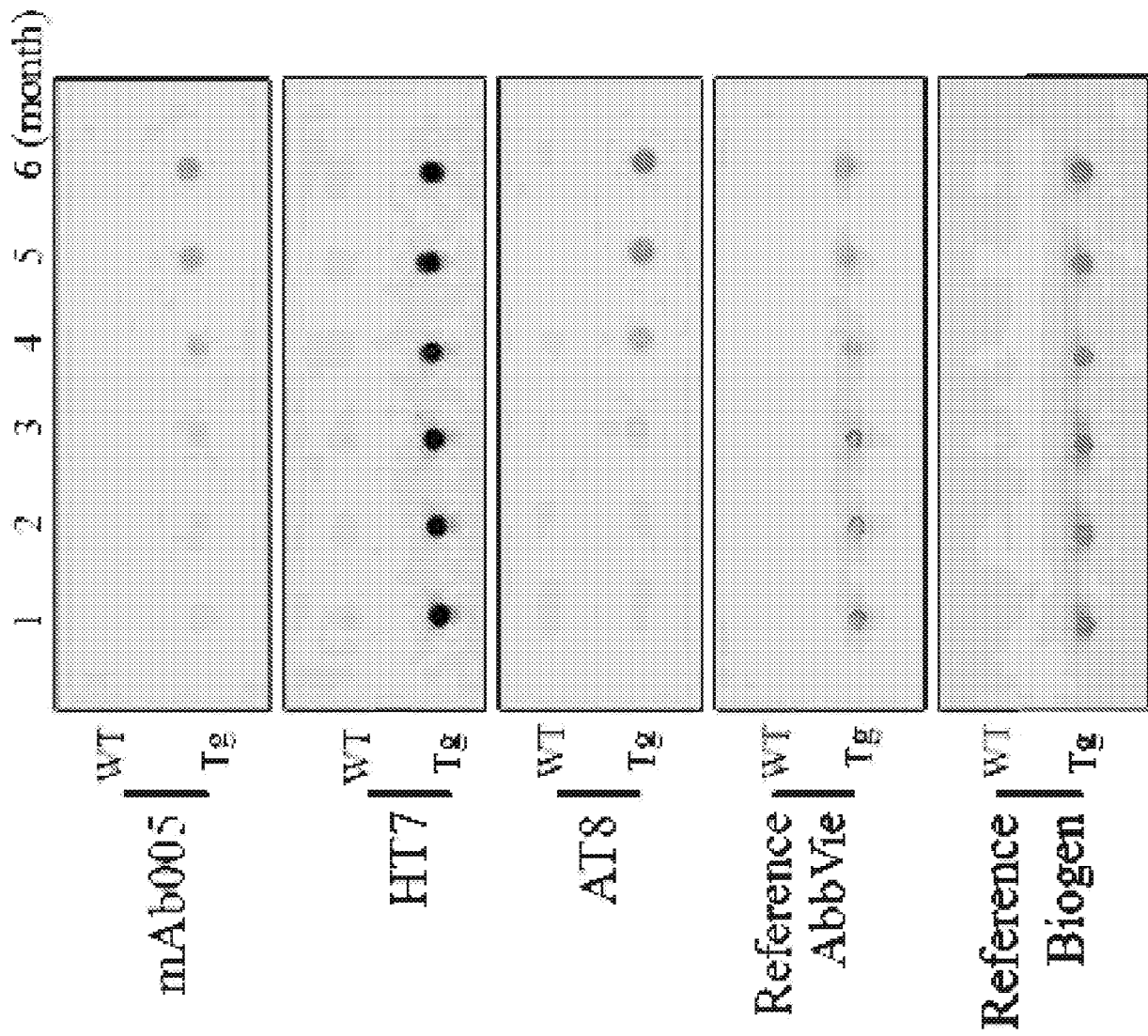


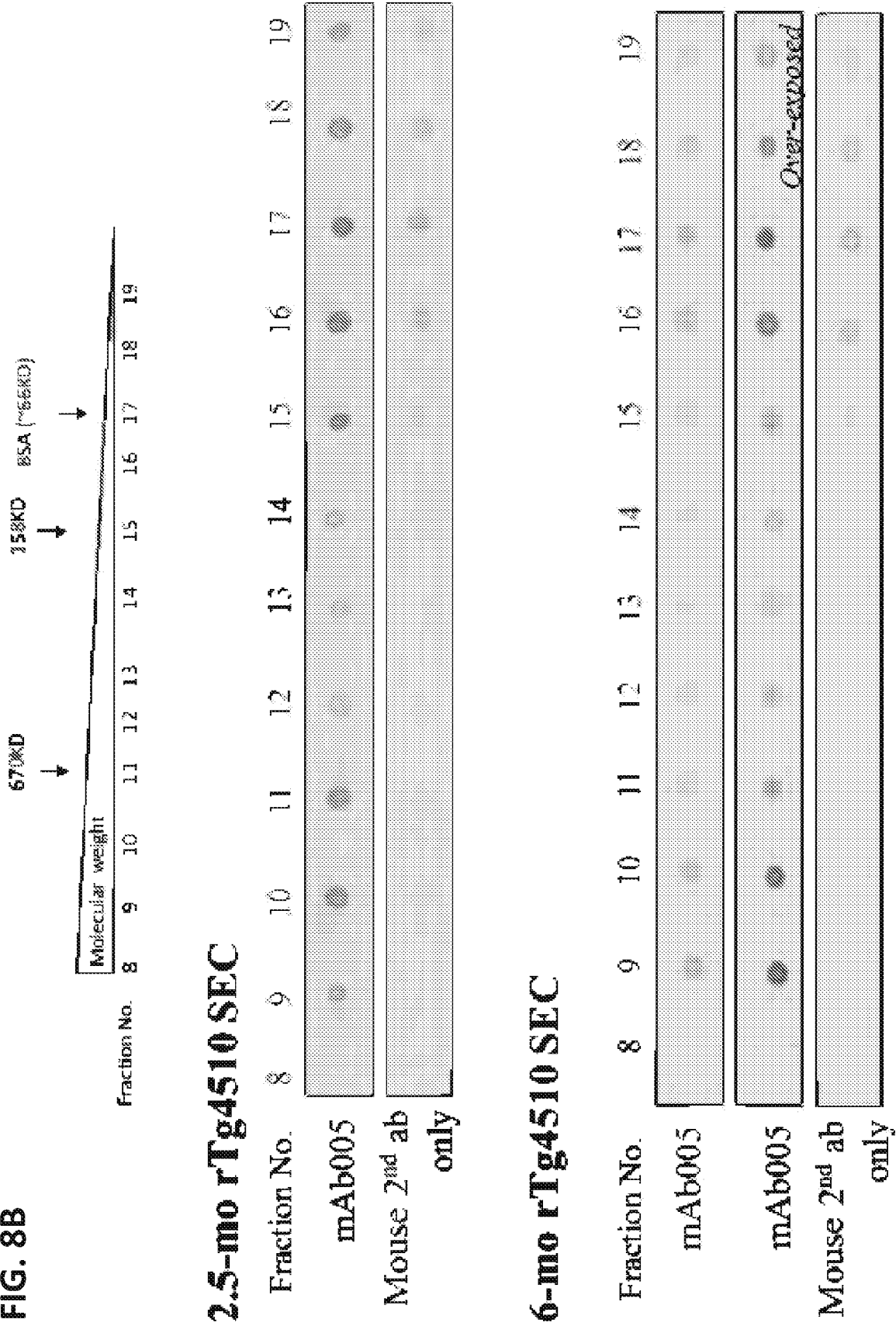




FIG. 8A



**FIG. 8B**



**FIG. 9A**

**Pathological Tau spreading via  
synaptically connected brain area**

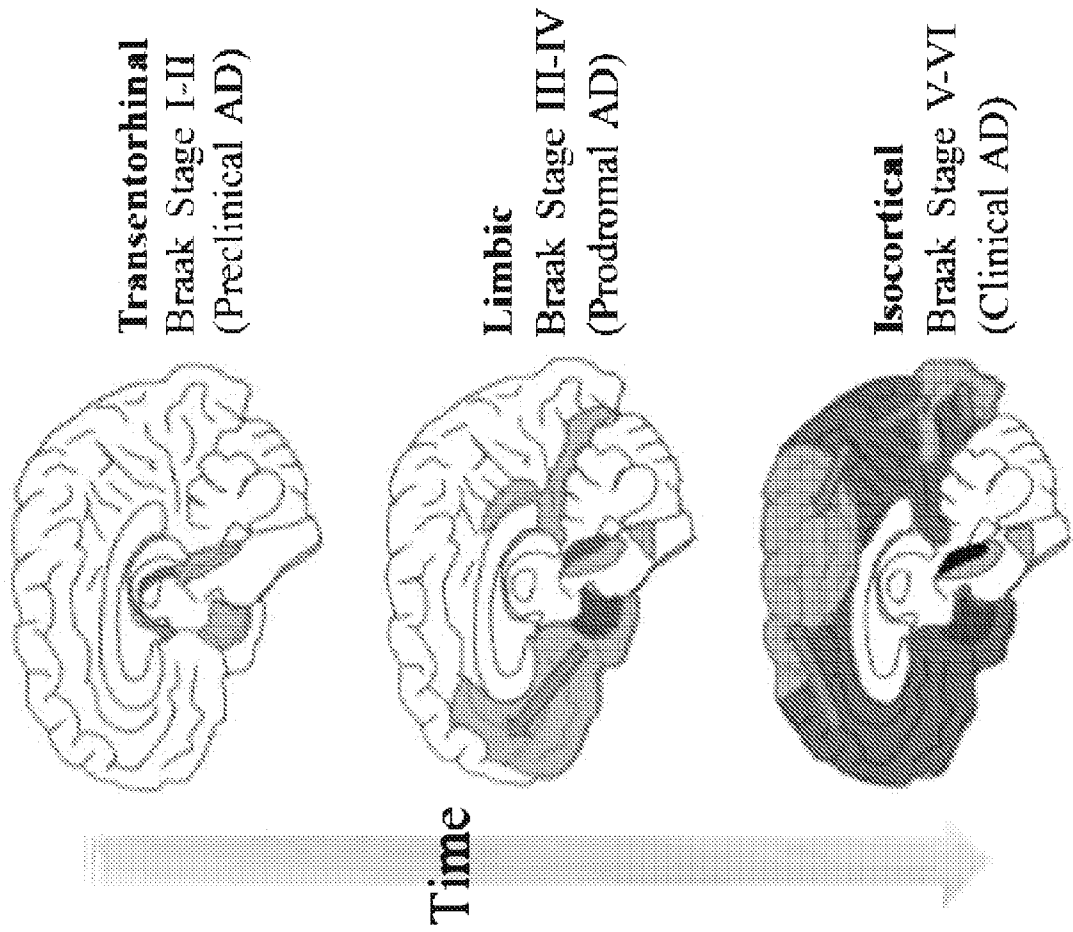
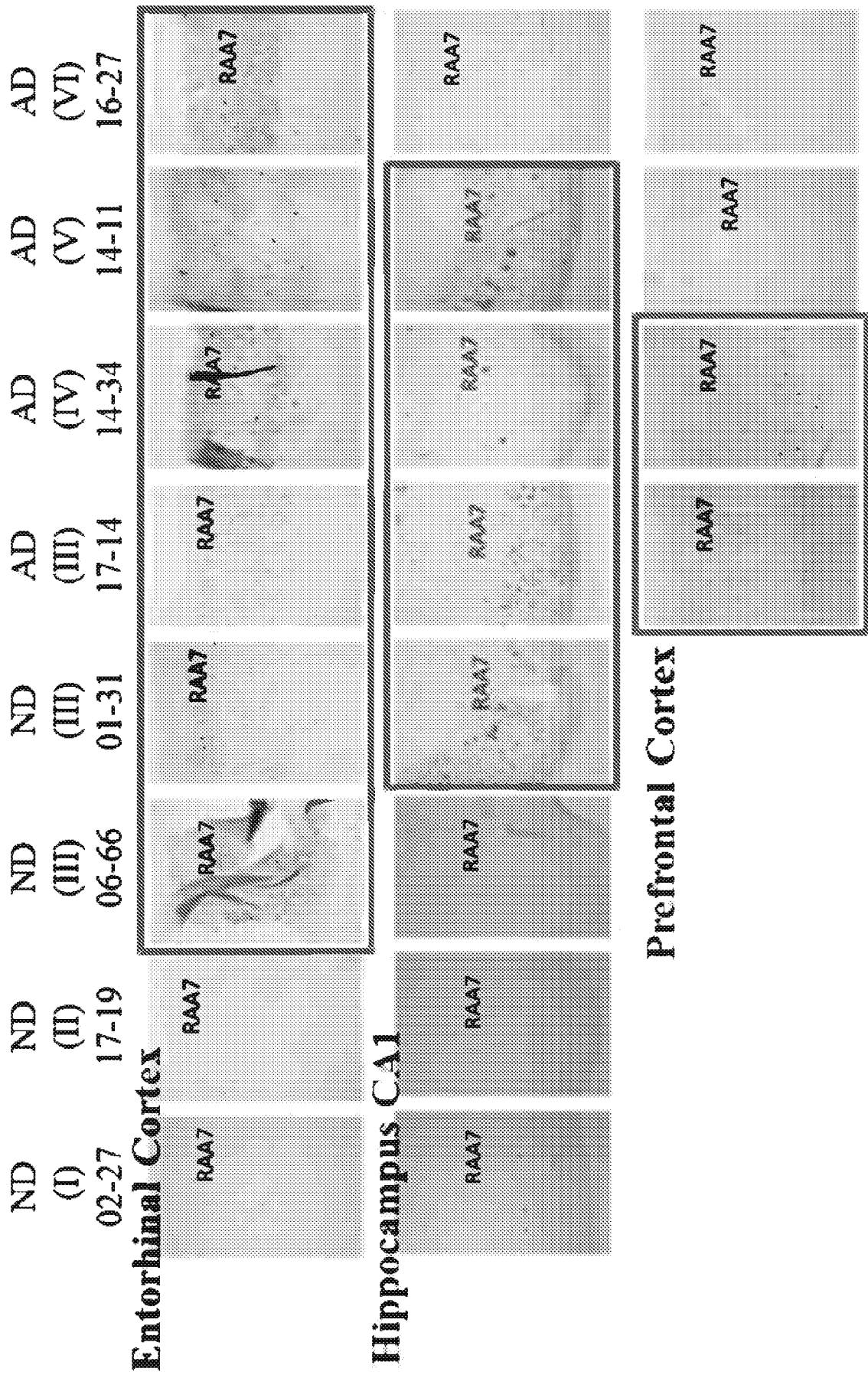


FIG. 9B



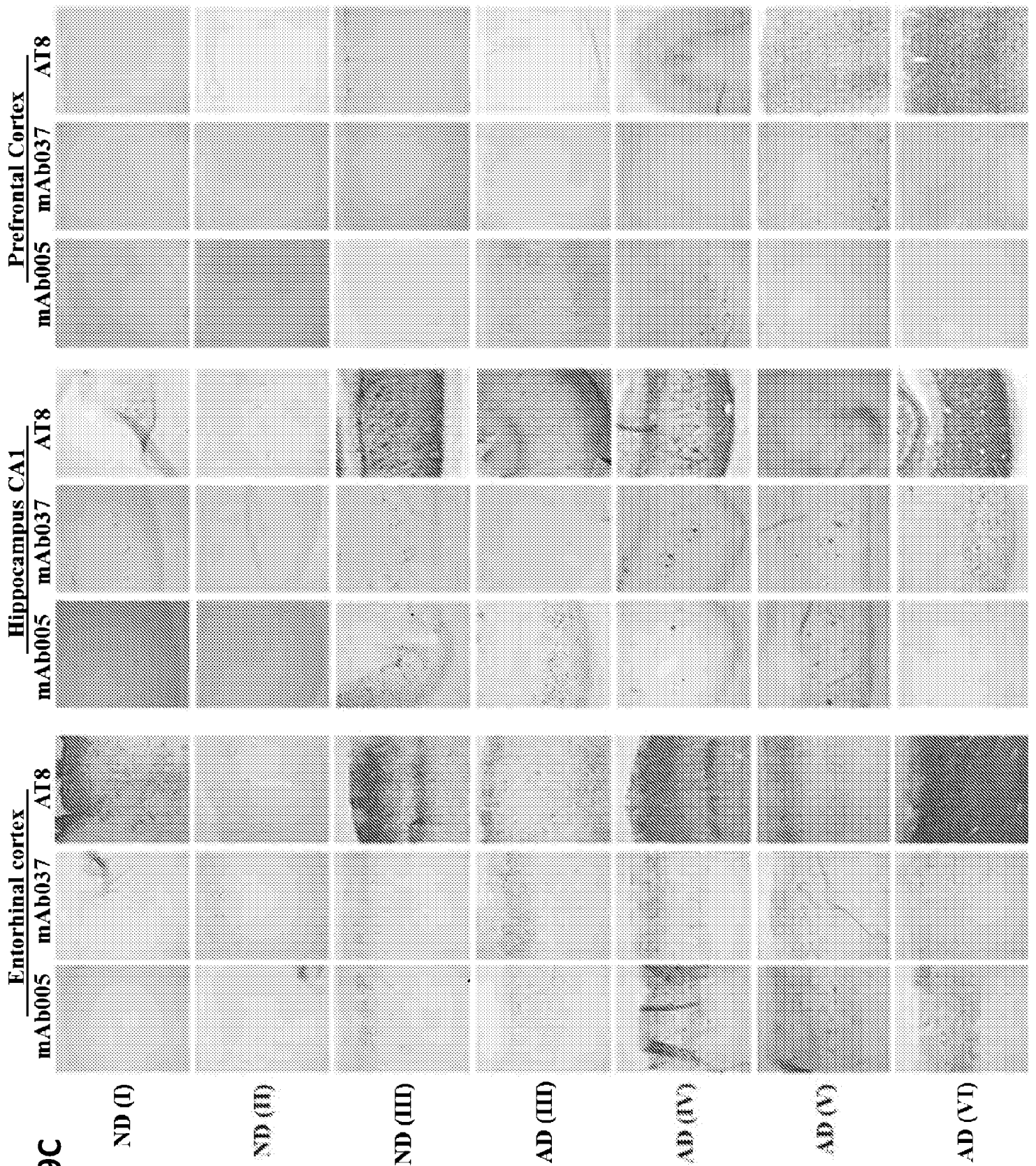


FIG. 9C

FIG. 9D

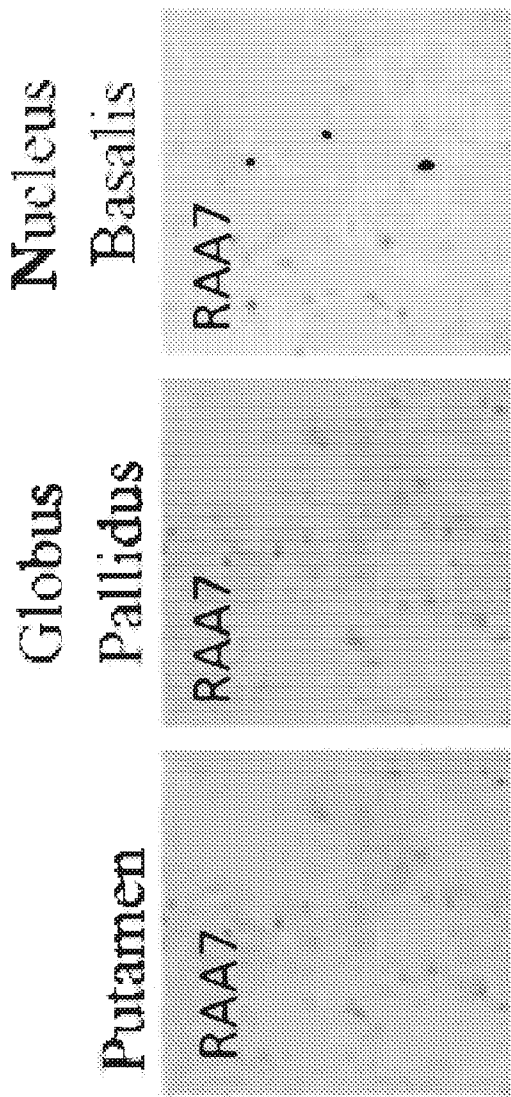


FIG. 9E

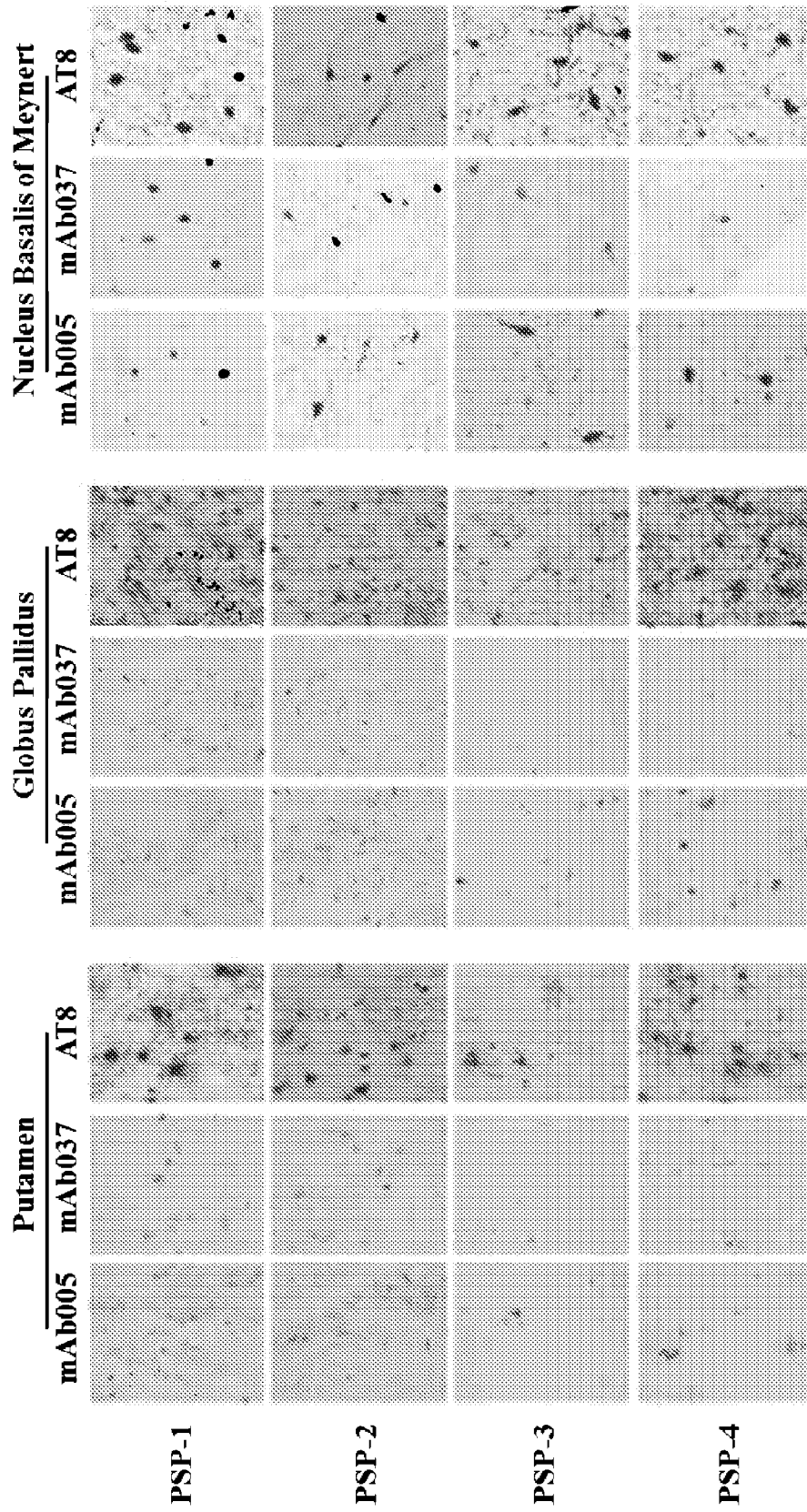


FIG. 10A 3-mo

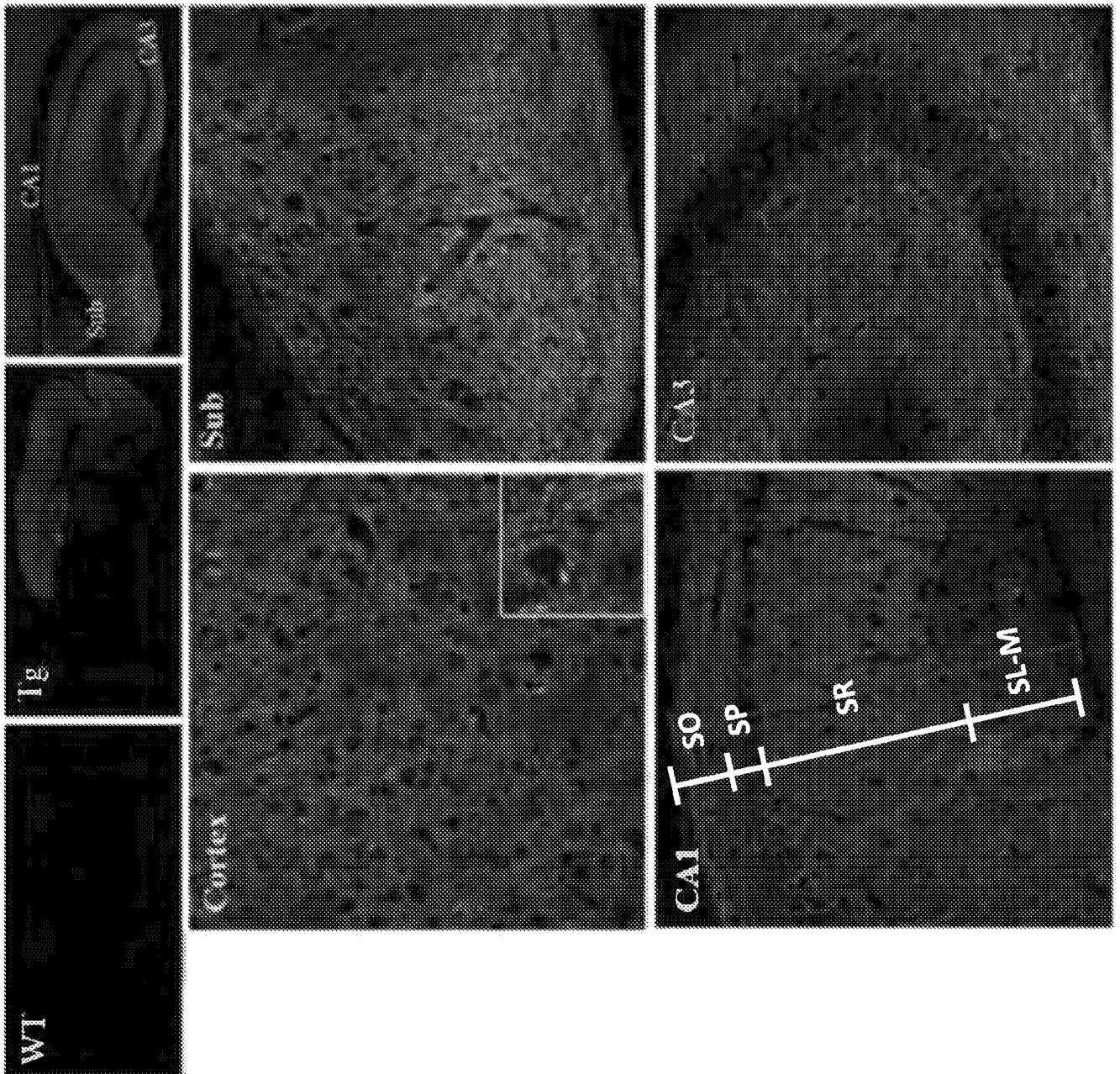




FIG. 10B

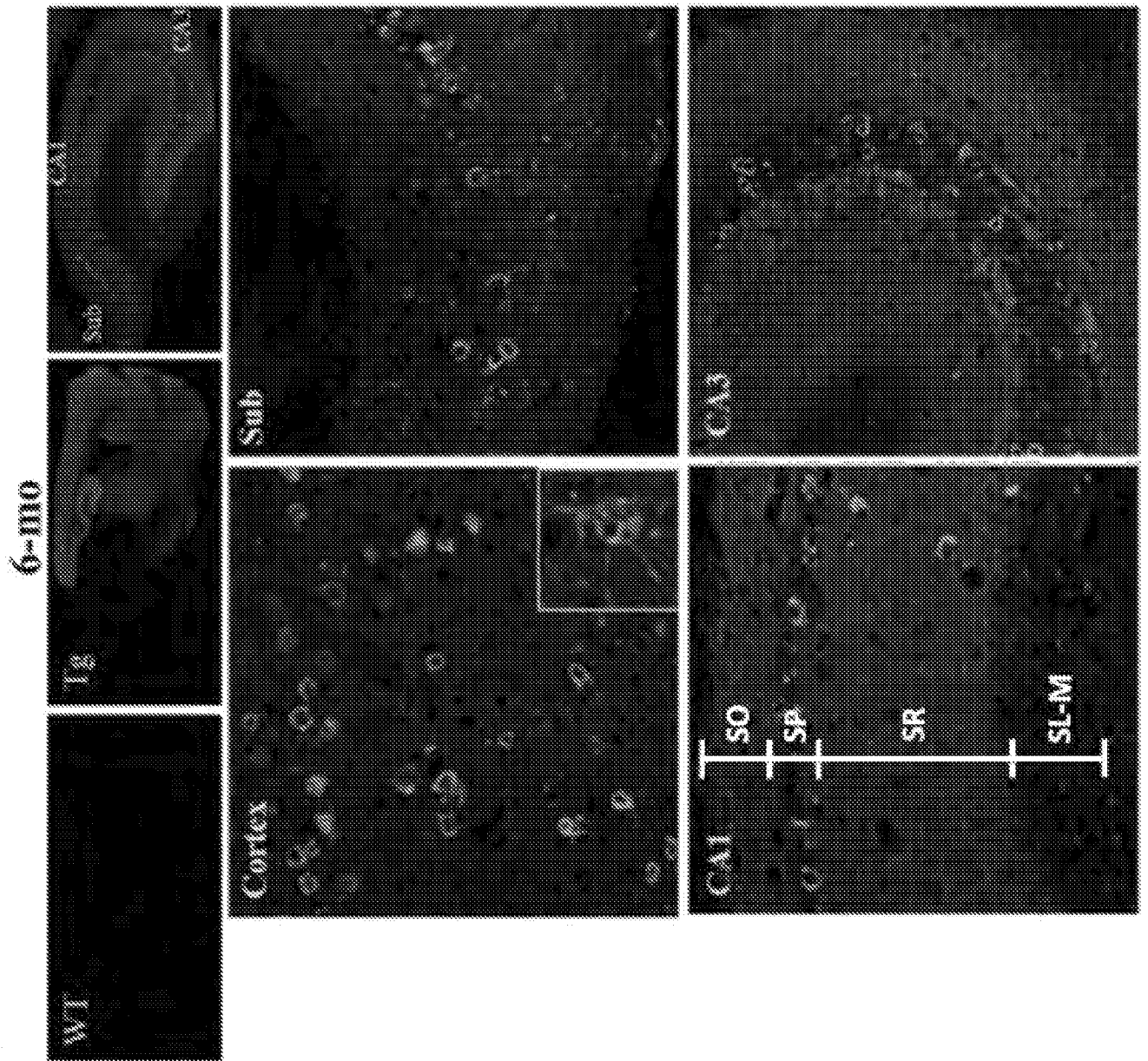
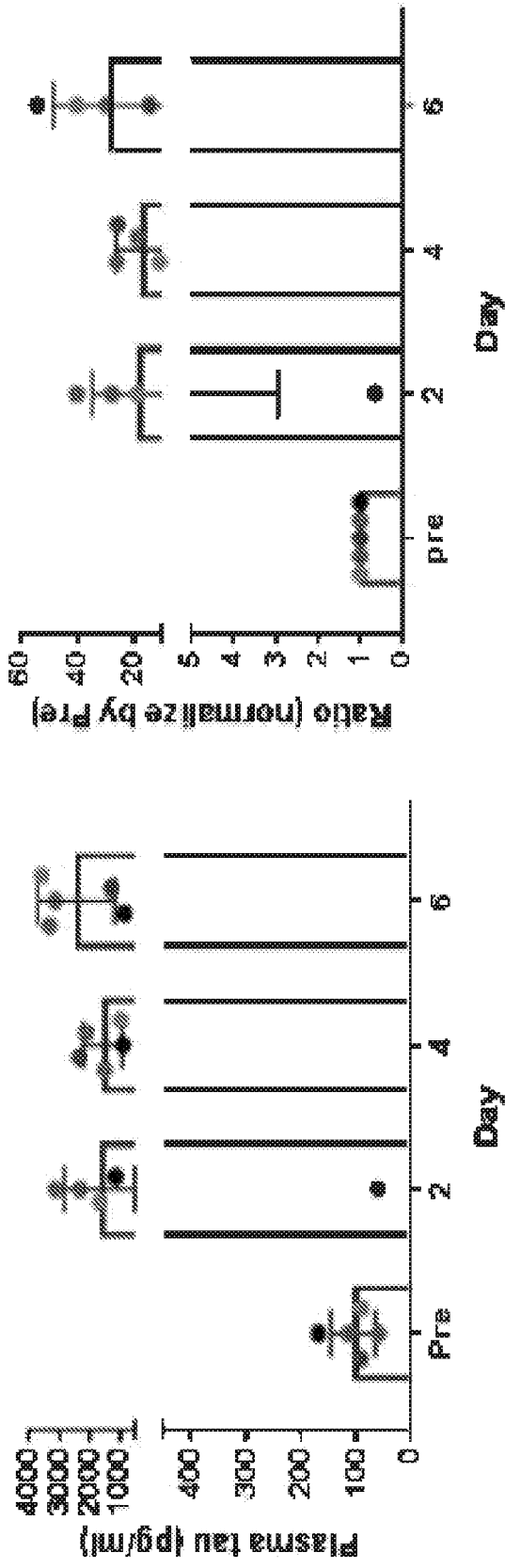
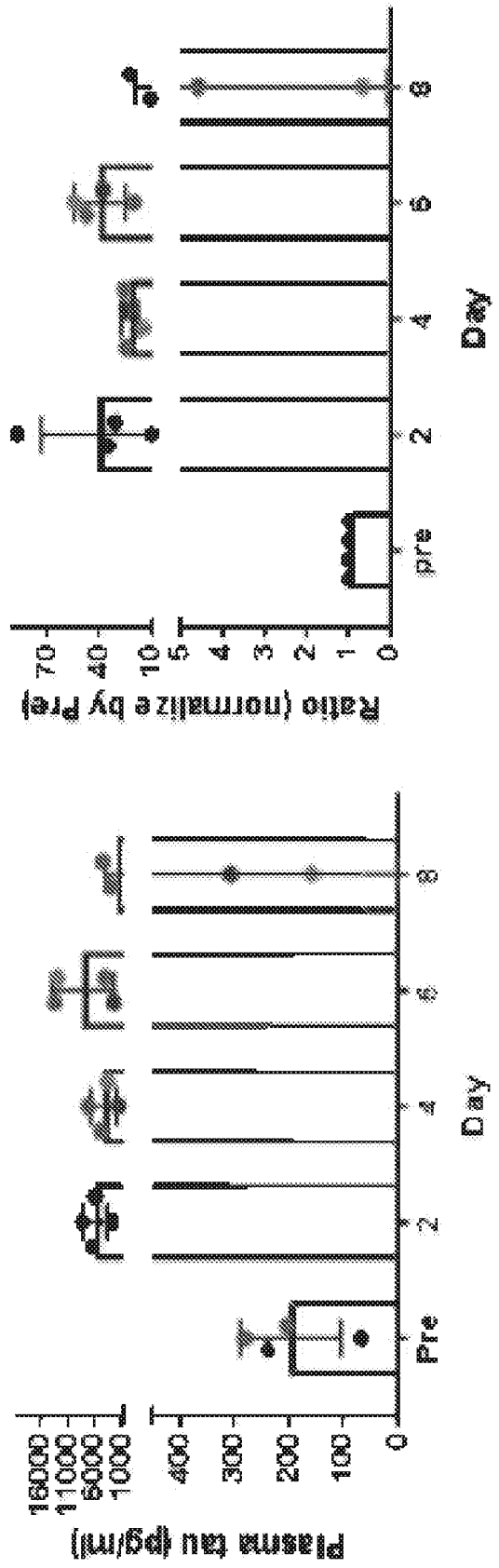


FIG. 11A

Reference AbbVie 10 mg/kg i.p.

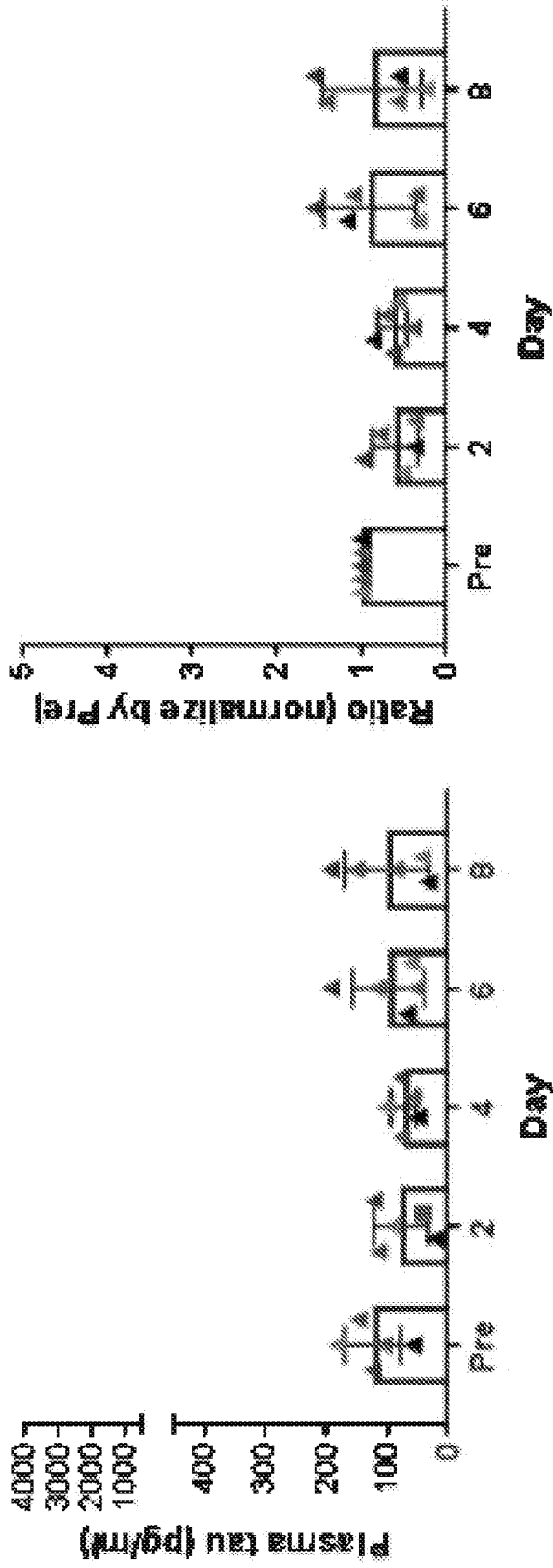


Reference AbbVie 50 mg/kg i.p.

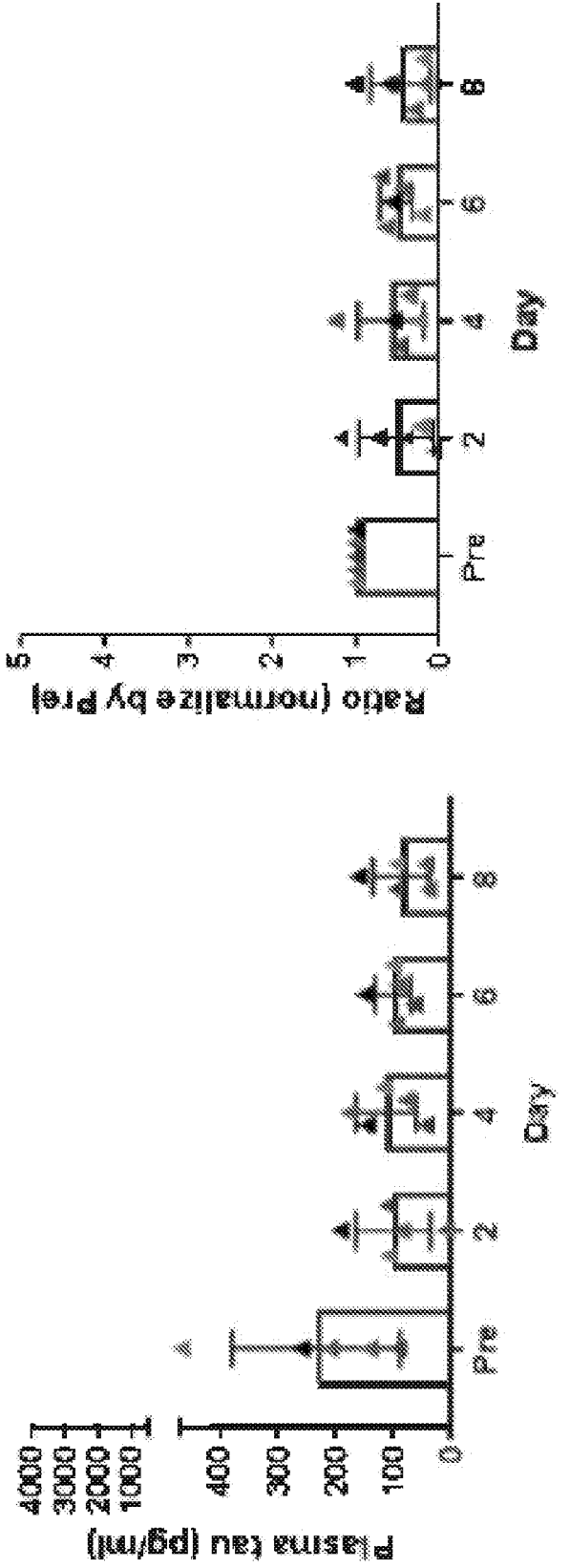


**mAb005 10 mg/kg i.p.**

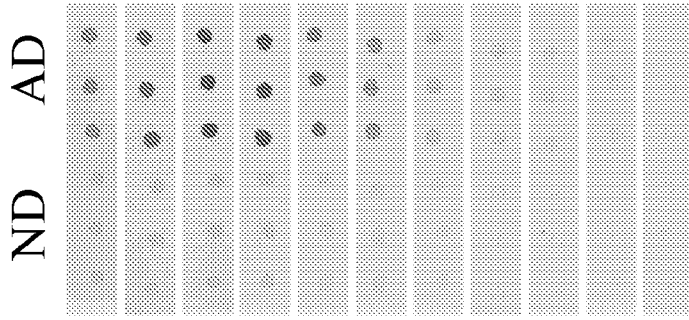
**FIG. 11B**



**mAb005 25 mg/kg i.p.**



**Humanized mAb005**



**FIG. 12A Mouse mAb005**

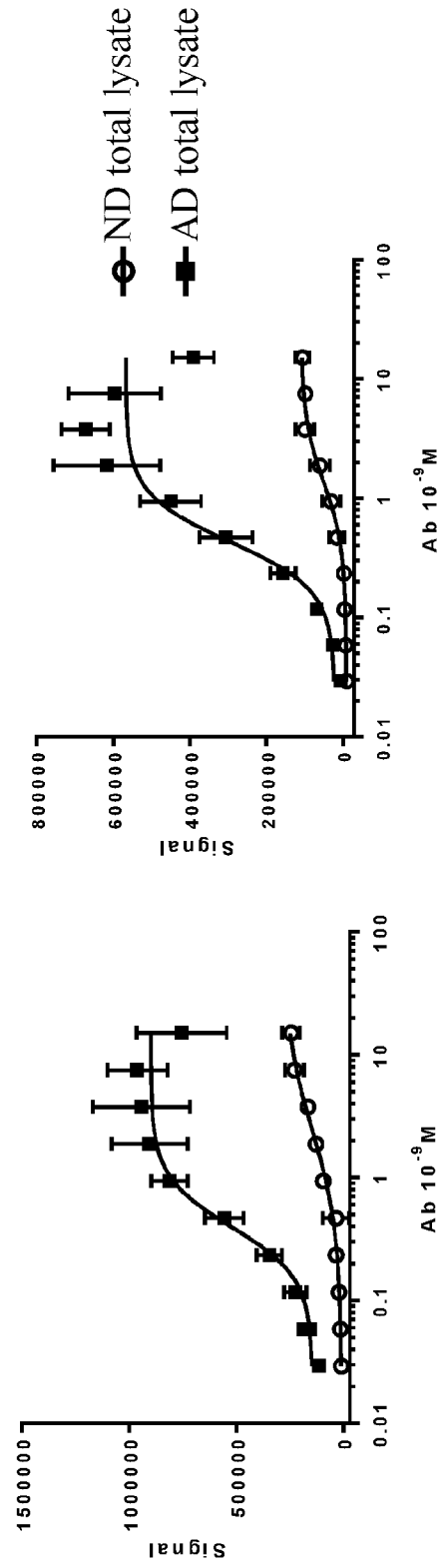
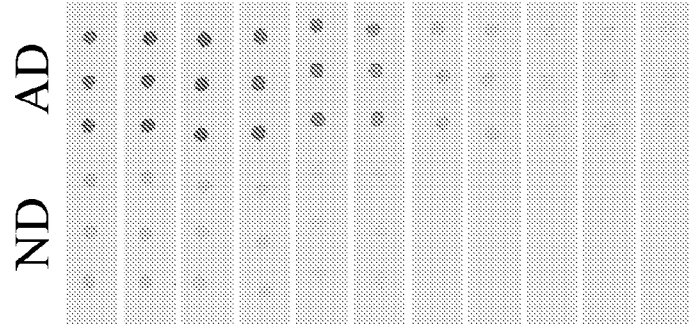
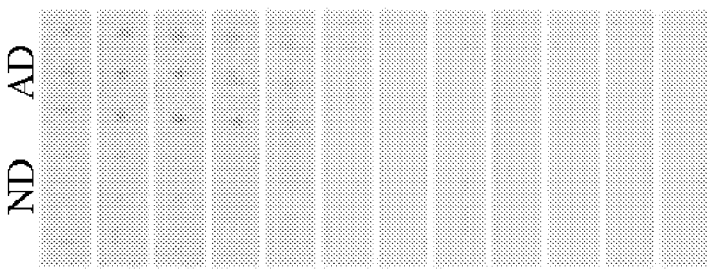
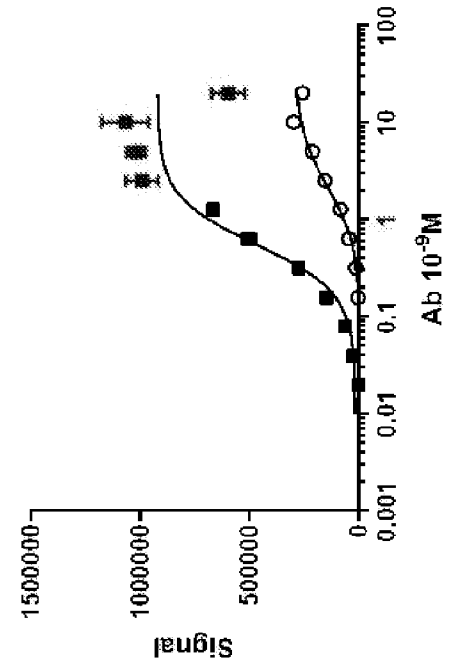
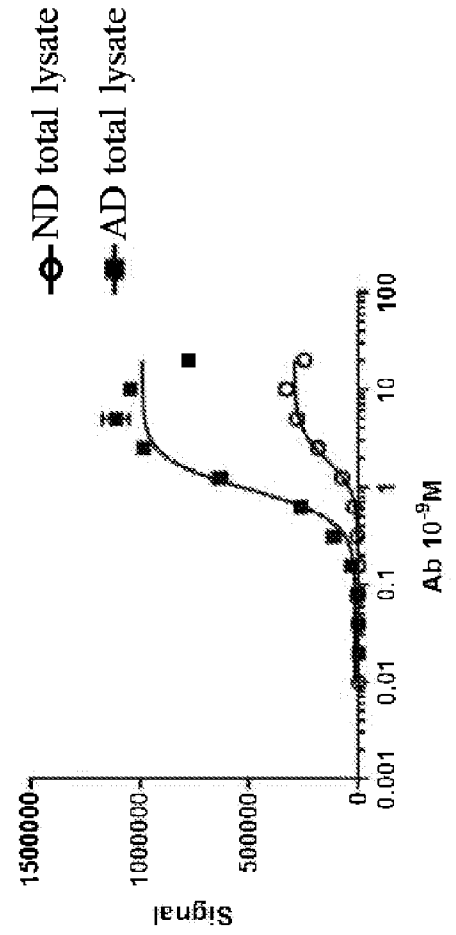
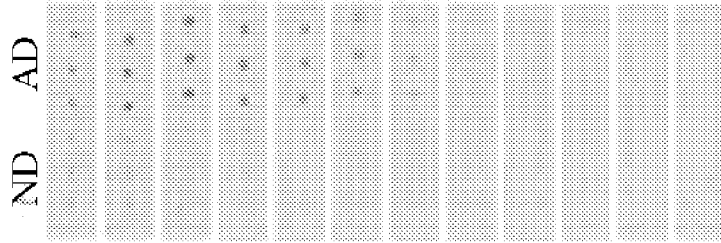


FIG. 12B

Humanized mAb037



Mouse mAb037



**FIG. 13A**

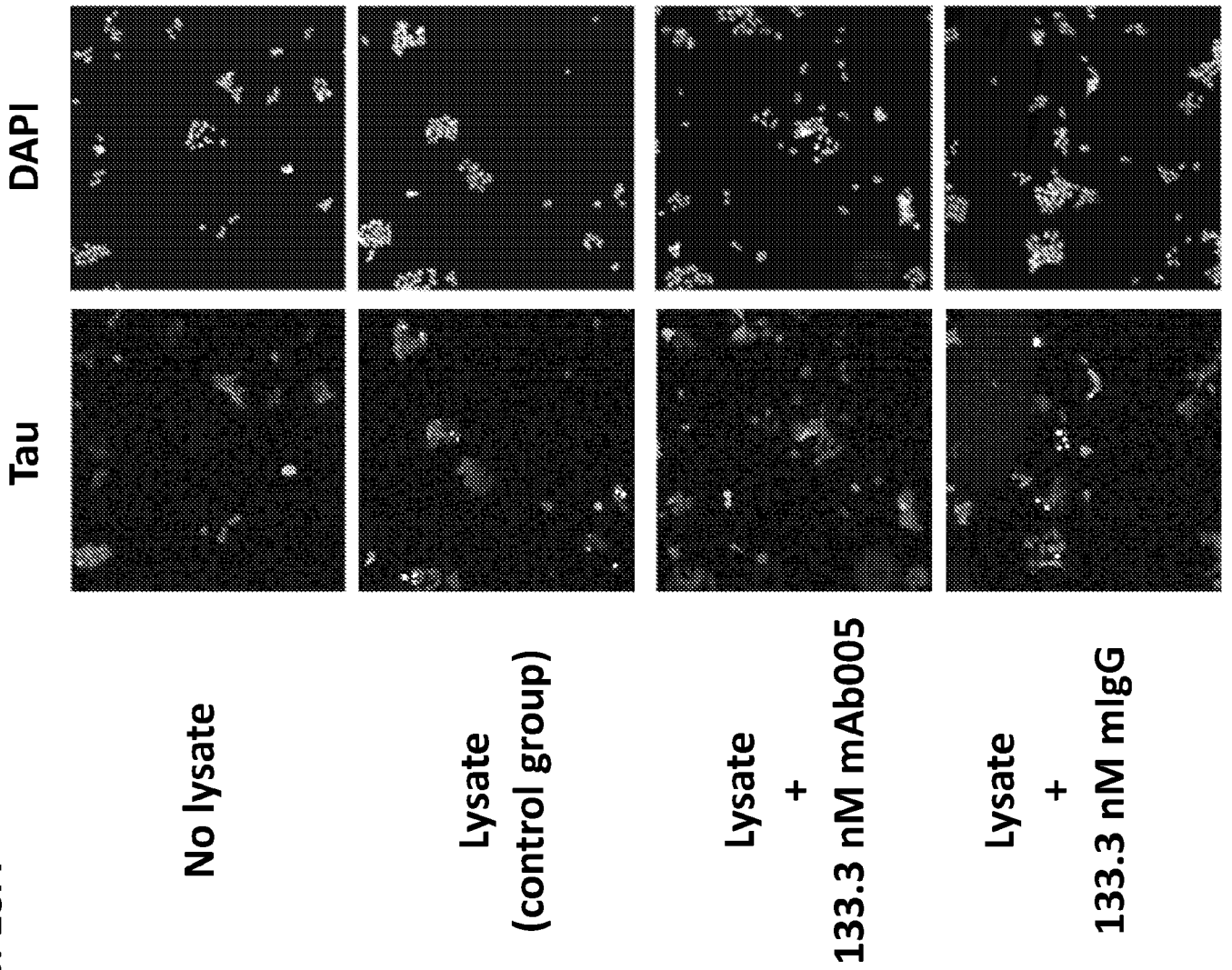


FIG. 13B

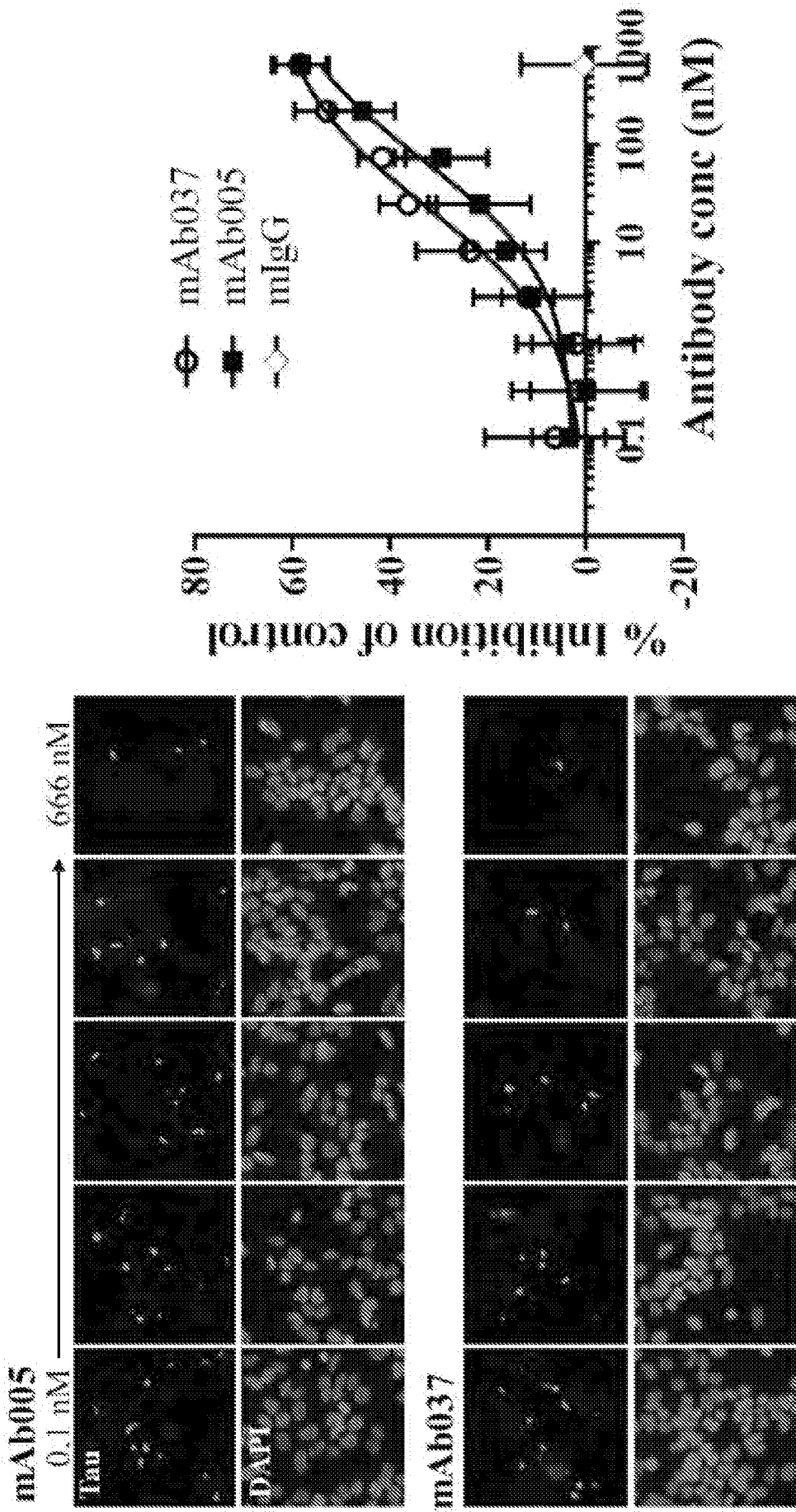


FIG. 13C

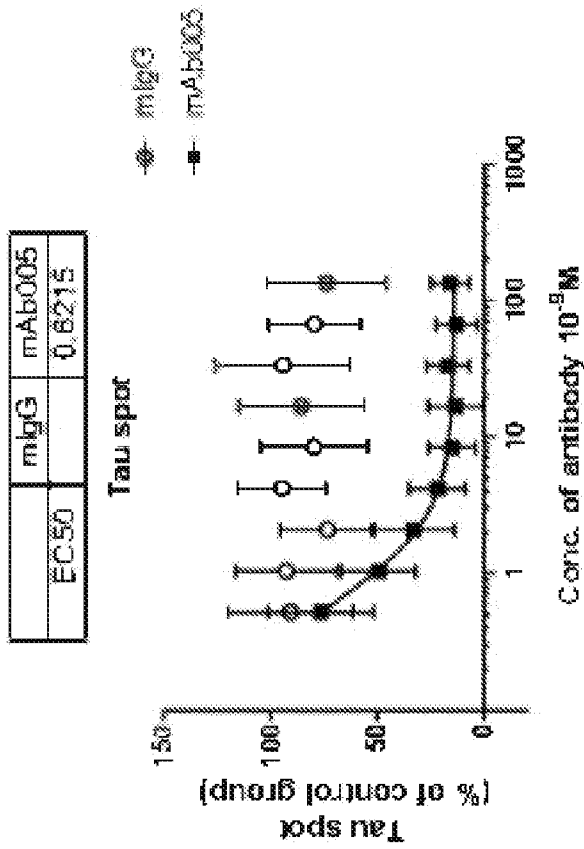


FIG. 13E

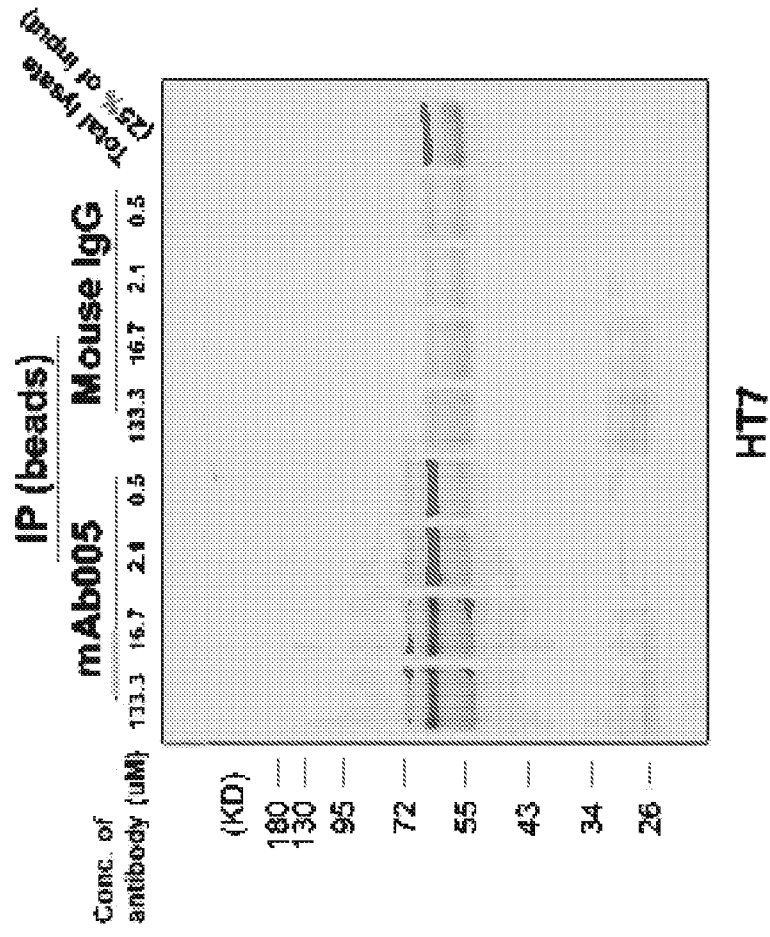


FIG. 13D

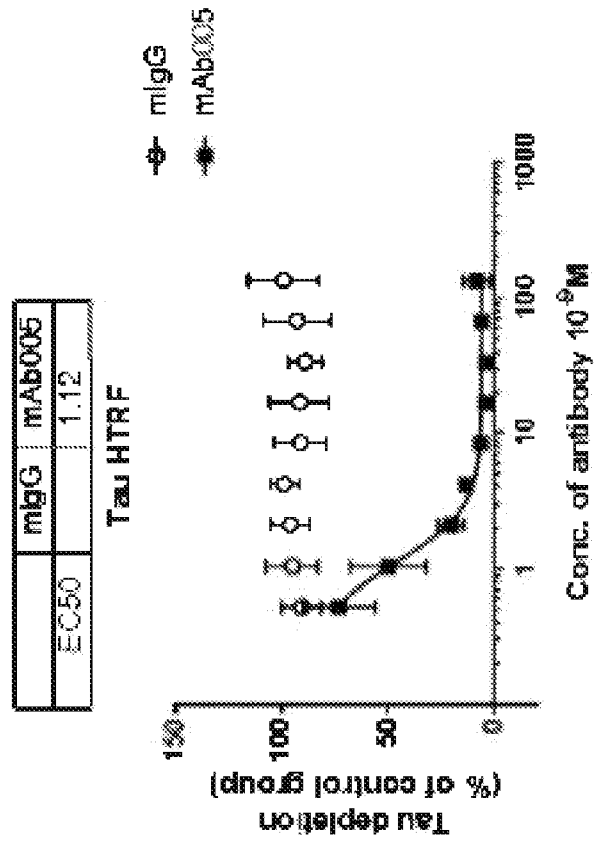




FIG. 14

