neuronal dysfunction and loss. Alpha-synuclein (SNCA) misfolding and aggregation can often be accompanied by β-amyloid deposition in some neurodegenerative diseases, and alpha-synuclein and tau aggregates coexist in several neurodegenerative disorders, including Alzheimer's disease and Parkinson's disease.

[0008] Accordingly, there exists the need for new therapies and reagents for the prevention or treatment of Alzheimer's disease, in particular, therapies and reagents capable of causing an immune response to the Aβ, Tau and alpha-synuclein present in patients.

SUMMARY

[0009] In some embodiments, disclosure is directed to a polypeptide including a first peptide comprising 3-10 amino acids from residues 1-10 or 12-25 of SEQ ID NO:01, a second peptide including 3-13 amino acids from residues 244-400 of SEQ ID NO:02, and a third peptide comprising 3-10 amino acids from residues 81-140 of SEQ ID NO:58. In certain embodiments, the polypeptide further comprises a fourth peptide selected from one of: (a) a peptide comprising 3-10 amino acids from residues 1-10 or 12-25 of SEQ ID NO:01; (b) a peptide comprising 3-13 amino acids from residues 244-400 of SEQ ID NO:02; and (c) a peptide comprising 3-10 amino acids from residues 81-140 of SEQ ID NO:58. In some embodiments, the first peptide, second peptide, third peptide, and fourth peptide are arranged in any order in the polypeptide. For example, the second peptide may be from the microtubule binding region (MTBR) of tau (residues 244-372 of SEQ ID NO:02). In addition, the first peptide may include an amino acid sequence of one of SEQ ID NOS: 3 to 38 or 1002-1057, the second peptide may include an amino acid sequence of one of SEQ ID NOS: 39 to 57, or 142 to 1000, the third peptide may include an amino acid sequence of one of SEQ ID NOS: 59-129, and the fourth peptide, if present, is one of any one of the amino acid sequences of SEQ ID NO: 3-38, 1002-1057, 39-57, 142 to 1000, and 59-129. For example, the first polypeptide may be DAEFRHD (SEQ ID NO:06), or EFRHDSG (SEQ ID NO:19), the second polypeptide may be 5-10 amino acids, for example QIVYKPV (SEQ ID NO:39), or NIKHVPG (SEQ ID NO:57), the third polypeptide may be PDNEAYE (SEQ ID NO:75), or DPDNEAY (SEQ ID NO:69), and the fourth polypeptide, if present, may be NIKHVP (SEQ ID NO:48), or QIVYKPV (SEQ ID NO:39).

[0009a] In another aspect, the present disclosure refers to a polypeptide comprising: (a) a first peptide comprising 3-10 amino acids from residues 1-10 or 12-25 of SEQ ID NO:01; (b) a second peptide comprising 3-13 amino acids from residues 244-400 of SEQ ID NO:02; and (c) a third peptide comprising 3-10 amino acids from residues 81-140 of SEQ ID NO:58; wherein the first peptide, second peptide and third peptide are arranged in any order in the polypeptide.

[0009b] In another aspect, the present disclosure refers to an immunotherapy composition, comprising the polypeptide of any of claims 1 to 24, wherein the polypeptide is linked to a carrier. Also disclosed herein is an immunotherapy composition, comprising:(a) a first peptide sequence comprising 3-10 amino acid residues from the first ten or 12 to 25 N-terminal residues of SEQ ID NO:01; (b) a second peptide sequence comprising 3-13 amino acids from residues 244-400 of SEQ ID NO:02; and (c) a third peptide sequence comprising 3-10 amino acids from residues 81-140 of SEQ ID NO:58.

[0009c] In another embodiment, the present disclosure refers to a pharmaceutical composition comprising the immunotherapy composition of any of claims 38 to 49 and at least one adjuvant. In another aspect, the present disclosure refers to a nucleic acid comprising a nucleic acid sequence encoding a polypeptide of any one of claims 1 to 24 of the immunotherapy composition of claims 38 to 55. Also disclosed herein is a nucleic acid immunotherapy composition comprising the nucleic acid of claim 55 and at least one adjuvant.

[0009d] In another aspect, the present disclosure refers to the use of the immunotherapy composition of any of claims 25 to 28 and 38 to 49 or the pharmaceutical formulations of any of claims 31 to 37 and 50 to 54 in the manufacture of a medicament for inhibiting or reducing aggregation of at least one of Aβ, tau, and alpha-synuclein in a subject having or at risk of developing Alzheimer’s disease, wherein the medicament is to be administered to the subject.

[0009e] In another aspect, the present disclosure is directed to the use of the nucleic acid immunotherapy composition of claim 56 in the manufacture of a medicament for treating or effecting prophylaxis of Alzheimer's disease in a subject, wherein the medicament is to be administered to the subject. Also disclosed herein is the use of the nucleic acid immunotherapy composition of claim 56 in the

manufacture of a medicament for inhibiting or reducing aggregation of at least one of Aβ, tau, and alpha-synuclein in a subject having or at risk of developing Alzheimer's disease, wherein the medicament is to be administered to the subject.

[0009f] In yet another aspect, the present disclosure refers to the use of any one of the polypeptides of claims 1 to 21, the immunotherapy composition of any one of claims 25 to 28 and 38 to 49, the pharmaceutical formulations of any one of claims 25 to 37 and 50 to 54 or the nucleic acid immunotherapy composition of claim 62, in the manufacture of medicament for inducing an immune response in an animal, wherein the medicament is to be administered to the animal in a regimen effective to generate an immune response comprising antibodies that specifically bind to Aβ, tau, and/or alpha-synuclein.

[0009g] In another embodiment, the present disclosure is directed to an immunization kit comprising the immunotherapy composition of any of claims 25 to 28 and 38 to 49. Also disclosed herein is a kit comprising the nucleic acid immunotherapy composition of claim 56.

[0009h] In another embodiment, the present disclosure refers to the polypeptides of any one of claims 1 to 21, the immunotherapy composition of any one of claims 25 to 28 and 38 to 49, the pharmaceutical formulations of any one of claims 25 to 37 and 50 to 54 or the nucleic acid immunotherapy composition of claim 56 for use in therapy.