Claims

1. A recombinant pre-fusion respiratory syncytial virus (RSV) Fusion (F) polypeptide, comprising at least one epitope that is specific to the pre-fusion conformation F protein, wherein the at least one epitope is recognized by a pre-fusion specific monoclonal antibody, comprising a heavy chain CDR1 region of SEQ ID NO: 54, a heavy chain CDR2 region of SEQ ID NO: 55, a heavy chain CDR3 region of SEQ ID NO: 56 and a light chain CDR1 region of SEQ ID NO: 62, a light chain CDR2 region of SEQ ID NO: 63, and a light chain CDR3 region of SEQ ID NO: 64 and/or a pre-fusion specific monoclonal antibody, comprising a heavy chain CDR1 region of SEQ ID NO: 58, a heavy chain CDR2 region of SEQ ID NO: 59, a heavy chain CDR3 region of SEQ ID NO: 60 and a light chain CDR1 region of SEQ ID NO: 66, a light chain CDR2 region of SEQ ID NO: 67, and a light chain CDR3 region of SEQ ID NO: 68, wherein the polypeptide comprises an F1 domain and an F2 domain, and wherein the polypeptides comprise at least one mutation, as compared to wild-type F1 and F2 domains, wherein the least one mutation is selected from the group consisting of:
   (a) a mutation of the amino acid residue E on position 161 into P, Q or G (E161P, E161Q or E161G);
   (b) a mutation of the amino acid residue S on position 182 into P (S182P);
   (c) a mutation of the amino acid residue S, T or N on position 173 into P; and
   (d) a mutation of the amino acid residue D on position 486 into C (D486C) in combination with a mutation of the amino acid residue D on position 489 into C

(D489C) or a mutation of the amino acid residue E on position 487 into C (E487C), and wherein

the amino acid positions are given in reference to the sequence of RSV F protein from the A2 strain (SEQ ID NO: 1).

2. Pre-fusion RSV F polypeptide according to claim 1, wherein the polypeptide is trimeric.

3. Pre-fusion RSV F polypeptide according to claim 1 or 2, wherein the polypeptide further comprises a mutation of the amino acid residue on position 67 and/or a mutation of the amino acid residue on position 215.

4. Pre-fusion RSV F polypeptide according to claim 3, wherein the polypeptide comprise a mutation of the amino acid residue N or T on position 67 and/or a mutation of amino acid residue S on position 215.

5. Pre-fusion RSV F polypeptide according to anyone of the preceding claims, wherein the polypeptide comprises a linking sequence comprising from 1 to 10 amino acids, linking the F1 domain and F2 domain.

6. Pre-fusion RSV F polypeptide according to anyone of the preceding claims, wherein the polypeptide comprises a truncated F1 domain.

7. Pre-fusion RSV F polypeptide according to claim 6, wherein the polypeptide comprises a heterologous trimerization domain linked to said truncated F1 domain.

8. Pre-fusion RSV F polypeptide according to claim 7, wherein the heterologous trimerization domain comprises the amino acid sequence GYIPEAPRDGQAYVRKDGEWVLLSTFL (SEQ ID NO: 4).

9. Pre-fusion RSV F polypeptide according to claim 8, wherein the trimerization domain is linked to amino acid residue 513 of the RSV F protein.

10. Pre-fusion RSV F polypeptide according to any of the preceding claims, wherein the F1 domain and/or the F2 domain are from an RSV A strain.

11. Pre-fusion RSV F polypeptide according to any of the preceding claims 1-10, wherein the F1 domain and/or the F2 domain are from an RSV B strain.

12. Pre-fusion RSV F polypeptide according to any one of the preceding claims, wherein the polypeptide comprises an amino acid sequence selected from the group consisting of SEQ ID NO: 90 – SEQ ID NO: 94.

13. Nucleic acid molecule encoding a pre-fusion RSV F polypeptide according to any one of the preceding claims 1-12.

14. Nucleic acid molecule according to claim 13, wherein the nucleic acid molecule has been codon-optimized for expression in mammalian cells.

15. Vector comprising a nucleic acid molecule according to claim 13 or claim 14.

16. Composition comprising a pre-fusion RSV F polypeptide according to any of the claims 1-12, a nucleic acid molecule according to claim 13 or claim 14 and/or a vector according to claim 15.

17. Pre-fusion RSV F polypeptide according to any of the claims 1-12, a nucleic acid molecule according to claim 13 or claim 14 and/or a vector according to claim 15 for use in inducing an immune response against RSV F protein.

18. Pre-fusion RSV F polypeptide according to any of the claims 1-12, a nucleic acid molecule according to claim 13 or claim 14 and/or a vector according to claim 15 for use as a vaccine.

19. Pre-fusion RSV F polypeptide according to any of the claims 1-12, a nucleic acid molecule according to claim 13 or claim 14 and/or a vector according to claim 15 for use in the prophylaxis and/or treatment of RSV infection.