CLAIMS

1. A fusion protein comprising an ectodomain of a viral fusion protein linked to a heptad repeat (HR) from a SARS-COV-2 spike (S) protein and/or a HR from respiratory syncytial virus (RSV) F protein.

2. The fusion protein of claim 1, wherein one or more of the following apply:

(i) the HR from respiratory syncytial virus (RSV) F protein is HR1 from RSV F protein;

(ii) the HR from a SARS-COV-2 spike (S) protein is HR1 from SARS-COV-2 S protein;

(iii) the HR(s) are additional to any HRs in the ectodomain; and

(iv) the fusion protein comprises a linker positioned between the ectodomain and the HR, and/or between two HRs.

3. The fusion protein of claim 1 or 2 comprising the ectodomain linked to two HRs from a RSV F protein, or to two HRs from a SARS-COV-2 S protein.

4. The fusion protein of claim 3, comprising a HR1 and HR2 from the RSV F protein or HR1 and HR2 from the SARS-COV-2 S protein.

5. The fusion protein of any one of claims 1 to 4, wherein the ectodomain lacks a signal peptide and/or lacks all or a portion of a p27 sequence.

6. The fusion protein of any one of claims 1 to 5, wherein the ectodomain is a respiratory syncytial virus F protein ectodomain, and/or wherein the ectodomain comprises one or more mutations to stabilize the ectodomain in a prefusion conformation.

7. The fusion protein of claim 6, wherein the mutation(s) introduce one or more cysteine residues that form a disulfide bond that is not present in the native ectodomain, and/or wherein the mutation(s) introduce an amino acid that fills a hydrophobic cavity that is present in the native ectodomain.

8. The fusion protein of claim 6 or 7, comprising one or more of the following groups of mutations that stabilize respiratory syncytial virus the F protein ectodomain in a prefusion conformation:

(i) S155C, S290C, S190F and V207L relative to SEQ ID NO: 3;

(ii) N67I and S215P relative to SEQ ID NO: 3;

(iii) N67I, S215P and E487Q relative to SEQ ID NO: 3; and

(iv) D486H, E487Q, F488W and D489H relative to SEQ ID NO: 3.

9. The fusion protein of claim 8 wherein the fusion protein comprises a respiratory syncytial virus F protein ectodomain comprising the following mutations S155C, S290C, S190F and V207L relative to SEQ ID NO: 3 or comprises or consists of a sequence set forth in SEQ ID NO: 18.

10. The fusion protein of claim 9 comprising in amino to carboxy order:

(i) respiratory syncytial virus F protein ectodomain comprising the following mutations S155C, S290C, S190F and V207L relative to SEQ ID NO: 3, HR1 from RSV and HR2 from RSV;

(ii) respiratory syncytial virus F protein ectodomain comprising the following mutations S155C, S290C, S190F and V207L relative to SEQ ID NO: 3, HR2 from RSV and HR1 from RSV;

(iii) respiratory syncytial virus F protein ectodomain comprising the following mutations S155C, S290C, S190F and V207L relative to SEQ ID NO: 3, HR1 from SARS-COV-2 spike (S) protein and HR2 from SARS-COV-2 spike (S) protein; or

(iv) respiratory syncytial virus F protein ectodomain comprising the following mutations S155C, S290C, S190F and V207L relative to SEQ ID NO: 3, HR2 from SARS-COV-2 spike (S) protein and HR1 from SARS-COV-2 spike (S) protein.

11. The fusion protein of claim 10, wherein the linker:

(i) comprises glycine and/or serine; and/or

(ii) is selected from a sequence set forth in any one of SEQ ID NOs: 10 to 13.

12. The fusion protein of any one of any one of claims 1 to 11 comprising in amino to carboxy order respiratory syncytial virus F protein ectodomain comprising the following mutations S155C, S290C, S190F and V207L relative to SEQ ID NO: 3 or comprising or consisting of the sequence set forth in SEQ ID NO: 18; HR1 from SARS-COV-2 spike (S) protein; a linker; and HR2 from SARS-COV-2 spike (S) protein.

13. The fusion protein of any one of any one of claims 1 to 11 comprising in amino to carboxy order respiratory syncytial virus F protein ectodomain comprising the following mutations S155C, S290C, S190F and V207L relative to SEQ ID NO: 3 or comprising or consisting of the sequence set forth in SEQ ID NO: 18; HR1 from SARS-COV-2 spike (S) protein; a linker; and HR2 from SARS-COV-2 spike (S) protein.

14. A nucleic acid encoding the fusion protein of any one of claims 1 to 13.

15. The nucleic acid of claim 14, wherein one or more of the following apply:

(i) the HR from respiratory syncytial virus (RSV) F protein is HR1 or HR2 from RSV F protein;

(ii) the HR from a SARS-COV-2 spike (S) protein is HR1 or HR2 from SARS-COV-2 S protein;

(iii) the HR(s) are additional to any HRs in the ectodomain; and

(iv) the fusion protein comprises a linker positioned between the ectodomain and the HR, and/or between two HRs

16. The nucleic acid of claim 14 or 15, which is a RNA, and/or which is within a mRNA or sa-mRNA vaccine.

17. A nanoparticle comprising the nucleic acid of any one of claims 14 to 16.

18. The nanoparticle of claim 17, wherein the nucleic is a RNA, and/or is within a mRNA or sa-mRNA vaccine

19. A composition comprising the fusion protein of any one of claims 1 to 13, the nucleic acid of any one of claims 14 to 16 or the nanoparticle of claim 17 or 18.

20. The composition of claim 19, wherein one or more of the following apply:

(i) the HR from respiratory syncytial virus (RSV) F protein is HR1 or HR2 from RSV F protein;

(ii) the HR from a SARS-COV-2 spike (S) protein is HR1 or HR2 from SARS-COV-2 S protein;

(iii) the HR(s) are additional to any HRs in the ectodomain; and

(iv) the fusion protein comprises a linker positioned between the ectodomain and the HR, and/or between two HRs

21. The composition of claim 20 comprising one or more of the following features:
(i) wherein the fusion protein is encoded by a nucleic acid molecule;
(ii) wherein the composition further comprises an adjuvant;
(iii) wherein the composition further comprises a PIV3 vaccine; and
(iv) wherein the composition further comprises a hMPV vaccine.

22. The composition of claim 21, wherein the adjuvant comprises MF59 and/or a nanoparticle.

23. Use of the fusion protein of any one of claims 1 to 13, the nucleic acid of any one of claims 14 to 16 or the nanoparticle of claim 17 or 18 or the composition of any one of claims 19 to 22 in the manufacture of a medicament for treating or preventing an infection by a virus in a subject.