

Claims

1. A recombinant binding protein comprising a first ankyrin repeat domain, wherein said first ankyrin repeat domain comprises an amino acid sequence that has at least about 90% sequence identity with an ankyrin repeat domain selected from the group consisting of SEQ ID NOs 1 to 11, 76, 77 and 85.
2. The recombinant binding protein according to claim 1, wherein said first ankyrin repeat domain comprises an amino acid sequence that has at least about 95% sequence identity with an ankyrin repeat domain selected from the group consisting of SEQ ID NOs 1 to 11, 76, 77 and 85.
3. The recombinant binding protein according to claim 1, wherein said first ankyrin repeat domain is selected from the group consisting of SEQ ID NOs 1 to 11, 76, 77 and 85.
4. The recombinant binding protein according to any one of claims 1 to 3 further comprising a second ankyrin repeat domain, wherein said second ankyrin repeat domain comprises an amino acid sequence that has at least about 90% sequence identity with an ankyrin repeat domain selected from the group consisting of SEQ ID NOs 1 to 11, 76, 77 and 85.
5. The recombinant binding protein according to claim 4, wherein said second ankyrin repeat domain comprises an amino acid sequence that has at least about 95% sequence identity with an ankyrin repeat domain selected from the group consisting of SEQ ID NOs 1 to 11, 76, 77 and 85.
6. The recombinant binding protein according to claim 4, wherein said second ankyrin repeat domain is selected from the group consisting of SEQ ID NOs 1 to 11, 76, 77 and 85.
7. The recombinant binding protein according to any one of claims 4 to 6 further comprising a third ankyrin repeat domain, wherein said third ankyrin repeat domain comprises an amino acid sequence that has at least about 90% sequence identity with an ankyrin repeat domain selected from the group consisting of SEQ ID NOs 1 to 11, 76, 77 and 85.
8. The recombinant binding protein according to claim 7, wherein said third ankyrin repeat domain comprises an amino acid sequence that has at least about 95% sequence identity with an ankyrin repeat domain selected from the group consisting of SEQ ID NOs 1 to 11, 76, 77 and 85.
9. The recombinant binding protein according to claim 7, wherein said third ankyrin repeat domain is selected from the group consisting of SEQ ID NOs 1 to 11, 76, 77 and 85.

10. The recombinant binding protein according to claim 7, wherein said first, second and third ankyrin repeat domains comprise amino acid sequences and are arranged, from the N-terminus to C-terminus, as follows:

- (i) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 6, 1 and 3;
- 5 (ii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 4, 2 and 1;
- (iii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 4, 6 and 3;
- (iv) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 6, 3 and 6;
- (v) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 7, 3 and 6;
- (vi) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 8, 4 and 1;
- 10 (vii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 3, 6 and 7;
- (viii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 4, 1 and 8;
- (ix) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 3, 6 and 9;
- (x) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 9, 3 and 6;
- (xi) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 1, 6 and 9;
- 15 (xii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 9, 6 and 1;
- (xiii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 6, 9 and 10;
- (xiv) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 3, 9 and 11;
- (xv) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 10, 9 and 6;
- (xvi) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 11, 9 and 3;
- 20 (xvii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 5, 1 and 3;
- (xviii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 1, 2 and 5;
- (xix) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 3, 5 and 6;
- (xx) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 6, 3 and 5;
- (xxi) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 7, 3 and 5;
- 25 (xxii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 8, 5 and 6;
- (xxiii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 6, 10 and 11;
- (xxiv) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 3, 10 and 10;
- (xxv) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 5, 6 and 9;
- (xxvi) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 9, 3 and 5;
- 30 (xxvii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 9, 6 and 5;
- (xxviii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 5, 9 and 10;
- (xxix) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 6, 9 and 11;
- (xxx) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 10, 9 and 5;
- (xxxi) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 11, 9 and 6;
- 35 (xxxii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 3, 76 and 77;
- or (xxxiii) amino acid sequences having at least about 90% sequence identity with SEQ ID NOs 3, 85 and 77.

11. The recombinant binding protein according to any one of claims 7 to 10, wherein said binding protein comprises a polypeptide, wherein said polypeptide has an amino acid sequence that has at least about 90% sequence identity with a sequence selected from the group consisting of SEQ ID NOs: 68, 69,
5 79, and 89 to 91.
12. The recombinant binding protein according to any one of claims 1 to 11, wherein said binding protein binds to a coronavirus spike protein.
- 10 13. The recombinant binding protein according to claim 12, wherein said spike protein is SARS-CoV-2 spike protein.
14. The recombinant binding protein according to claim 12 or 13, wherein said first, second and/or third ankyrin repeat domain binds said coronavirus spike protein with a dissociation constant (K_D) of or below
15 about 100 nM.
15. A recombinant binding protein comprising at least one ankyrin repeat domain, wherein said ankyrin repeat domain binds a coronavirus spike protein with a dissociation constant (K_D) of or below about 100 nM.
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16. The recombinant binding protein according to any preceding claim further comprising at least one serum albumin binding domain.
17. The recombinant binding protein according to claim 16, wherein said serum albumin binding
25 domain comprises an amino acid sequence that has at least about 90% sequence identity with a sequence selected from the group consisting of SEQ ID NOs: 47-49.
18. A recombinant binding protein comprising a polypeptide, wherein said polypeptide has an amino acid sequence that has at least about 90% sequence identity with a sequence selected from the group
30 consisting of SEQ ID NOs: 12-42, 75, 84, 87 and 88.
19. The recombinant binding protein according to claim 18, wherein said polypeptide has an amino acid sequence that has at least about 90% sequence identity with SEQ ID NO: 31.
- 35 20. The recombinant binding protein according to claim 18, wherein said polypeptide has an amino acid sequence that has at least about 90% sequence identity with SEQ ID NO: 39.

21. The recombinant binding protein according to claim 18, wherein said polypeptide has an amino acid sequence that has at least about 90% sequence identity with SEQ ID NO: 75.
22. The recombinant binding protein according to claim 18, wherein said polypeptide has an amino acid sequence that has at least about 90% sequence identity with SEQ ID NO: 84.
23. The recombinant binding protein according to claim 18, wherein said polypeptide has an amino acid sequence that has at least about 90% sequence identity with SEQ ID NO: 87.
24. The recombinant binding protein according to claim 18, wherein said polypeptide has an amino acid sequence that has at least about 90% sequence identity with SEQ ID NO: 88.
25. The recombinant binding protein according to claim 18, wherein said polypeptide has an amino acid sequence that has at least about 95% sequence identity with a sequence selected from the group consisting of SEQ ID NOs: 12-42, 75, 84, 87 and 88.
26. The recombinant binding protein according to claim 18, wherein said polypeptide has an amino acid sequence that is selected from the group consisting of SEQ ID NOs: 12-42, 75, 84, 87 and 88.
27. A recombinant binding protein comprising a polypeptide, wherein said polypeptide has the amino acid sequence of SEQ ID NO: 31, SEQ ID NO: 39, SEQ ID NO: 75, SEQ ID NO: 84, SEQ ID NO: 87, or SEQ ID NO: 88.
28. The recombinant binding protein according to any one of claims 18 to 27, wherein said binding protein binds to a coronavirus spike protein.
29. The recombinant binding protein according to claim 28, wherein said spike protein is SARS-CoV-2 spike protein.
30. The recombinant binding protein according to claims 28 or 29, wherein said binding protein binds said coronavirus spike protein with a dissociation constant (K_D) of or below about 100 nM.
31. The recombinant binding protein according to any one of claims 1 to 30, wherein said binding protein is capable of inhibiting infection of cells by a coronavirus.
32. The recombinant binding protein according to any one of claims 1 to 30, wherein said binding protein is capable of inhibiting infection of cells by SARS-CoV-2.

33. A nucleic acid encoding a recombinant binding protein according to any one of claims 1 to 32.
34. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
5 NO 70 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 70.
35. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
NO 71 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 71.
- 10 36. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
NO 72 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 72.
37. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
15 NO 73 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 73.
38. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
NO 74 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 74.
39. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
20 NO 80 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 80.
40. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
NO 81 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 81.
- 25 41. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
NO 82 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 82.
42. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
30 NO 83 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 83.
43. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
NO 78 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 78.
44. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID
35 NO 86 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 86.

45. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID NO 92 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 92.
46. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID NO 93 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 93.
47. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID NO 94 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 94.
48. The nucleic acid according to claim 33, wherein said nucleic acid comprises or consists of SEQ ID NO 95 or of a variant thereof encoding the same amino acid sequence as SEQ ID NO 95.
49. A host cell comprising the nucleic acid molecule of any one of claims 33 to 48.
50. A method of making the recombinant binding protein according to any one of claims 1 to 32, comprising culturing the host cell of claim 49 under conditions wherein said recombinant binding protein is expressed.
51. A pharmaceutical composition comprising the binding protein of any one of claims 1 to 32 or the nucleic acid of any one of claims 33 to 48, and a pharmaceutically acceptable carrier or excipient.
52. A method of treating a coronavirus infection in a subject, the method comprising the step of administering an effective amount of at least one binding protein according to any one of claims 1 to 32, or the nucleic acid of any one of claims 33 to 48, or of the pharmaceutical composition according to claim 51, to a subject in need thereof.
53. A method of preventing a coronavirus infection in a subject, the method comprising the step of administering an effective amount of at least one binding protein according to any one of claims 1 to 32, or of the nucleic acid of any one of claims 33 to 48, or of the pharmaceutical composition according to claim 51, to a subject in need thereof.
54. A method of detecting a coronavirus infection in a subject, said method comprising:
- a) obtaining a sample from a subject;
 - b) contacting said sample with at least one binding protein according to any one of claims 1 to 32; and
 - c) detecting the presence of a coronavirus infection.

55. The method according to any one of claims 52 to 54, wherein the coronavirus infection is caused by SARS-CoV-2.

56. The method according to any one of claims 52 to 55 wherein said subject is a human.

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