

WHAT IS CLAIMED:

1. A recombinant vector comprising a polycistronic expression cassette, wherein the polycistronic expression cassette comprises a transcriptional regulatory element operably linked to a polycistronic polynucleotide that comprises:
 - a. a first polynucleotide sequence that encodes a T cell receptor (TCR) alpha chain comprising an alpha chain variable ($V\alpha$) region and an alpha chain constant ($C\alpha$) region;
 - b. a second polynucleotide sequence that comprises a first 2A element;
 - c. a third polynucleotide sequence that encodes a TCR beta chain comprising a beta chain variable ($V\beta$) region and a beta chain constant ($C\beta$) region;
 - d. a fourth polynucleotide sequence that comprises a second 2A element; and
 - e. a fifth polynucleotide sequence that encodes a fusion protein that comprises IL-15, or a functional fragment or functional variant thereof, and IL-15R α , or a functional fragment or functional variant thereof.
2. The recombinant vector of claim 1, wherein either or both of the first 2A element and the second 2A element, independently, is a P2A element, a T2A element, an F2A element, or an E2A element.
- ~~3. The recombinant vector of claim 1, wherein the first 2A element is a P2A element.~~
- ~~4.3.~~ The recombinant vector of claim 2 ~~or 3~~, wherein the P2A element comprises (a) a polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 18 or 20, or the amino acid sequence of SEQ ID NO: 18 or 20 comprising 1, 2, or 3 amino acid modifications; or (b) a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 19 or 21.
- ~~5. The recombinant vector of claim 2 or 3, wherein the P2A element comprises a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 19 or 21.~~
- ~~6. The recombinant vector of any one of claims 1 or 3-5, wherein the second 2A element is a T2A element.~~

- ~~7.4.~~ The recombinant vector of claim 2 ~~or 6~~, wherein the T2A element comprises (a) a polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 22 or 24, or the amino acid sequence of SEQ ID NO: 22 or 24 comprising 1, 2, or 3 amino acid modifications; or a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 23 or 25.
- ~~8.~~ ~~The recombinant vector of claim 2 or 6, wherein the T2A element comprises a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 23 or 25.~~
- ~~9.5.~~ The recombinant vector of any one of claims 1-~~48~~, wherein either or both of the second polynucleotide sequence and the fourth polynucleotide sequence, independently, encode a furin recognition site, wherein optionally, the furin recognition site comprises (a) the amino acid sequence of SEQ ID NO: 2 or 4, or the amino acid sequence of SEQ ID NO: 2 or 4 comprising 1, 2, or 3 amino acid modifications; or (b) an amino acid encoded by the polynucleotide sequence of SEQ ID NO: 3 or 5 or the polynucleotide sequence of SEQ ID NO: 3 or 5 comprising 1, 2, or 3 nucleotide modifications.
- ~~10.~~ ~~The recombinant vector of claim 9, wherein the furin recognition site comprises the amino acid sequence of SEQ ID NO: 2 or 4, or the amino acid sequence of SEQ ID NO: 2 or 4 comprising 1, 2, or 3 amino acid modifications.~~
- ~~11.~~ ~~The recombinant vector of claim 9, wherein the furin recognition site is encoded by the polynucleotide sequence of SEQ ID NO: 3 or 5 or the polynucleotide sequence of SEQ ID NO: 3 or 5 comprising 1, 2, or 3 nucleotide modifications.~~
- ~~12.6.~~ The recombinant vector of any one of claims 1-~~115~~, wherein the second polynucleotide sequence comprises (a) a polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 10, or the amino acid sequence of SEQ ID NO: 10 comprising 1, 2, or 3 amino acid modifications; or (b) a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 11.
- ~~13.~~ ~~The recombinant vector of any one of claims 1-11, wherein the second polynucleotide sequence comprises a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 11.~~

- ~~14.7.~~ The recombinant vector of any one of claims 1-~~136~~, wherein the fourth polynucleotide sequence comprises (a) a polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 12, or the amino acid sequence of SEQ ID NO: 12 comprising 1, 2, or 3 amino acid modifications; or (b) a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 13.
- ~~15.~~ ~~The recombinant vector of any one of claims 1-13, wherein the fourth polynucleotide sequence comprises a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 13.~~
- ~~16.8.~~ The recombinant vector of any one of claims 1-~~157~~, wherein the IL-15, or functional fragment or functional variant thereof, comprises (a) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 76; or (b) an amino acid sequence encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 77.
- ~~17.~~ ~~The recombinant vector of any one of claims 1-15, wherein the IL-15, or functional fragment or functional variant thereof, is encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 77.~~
- ~~18.9.~~ The recombinant vector of any one of claims 1-~~158~~, wherein the IL-15R α , or functional fragment or functional variant thereof, comprises (a) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 78; or (b) an amino acid sequence encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 79.
- ~~19.~~ ~~The recombinant vector of any one of claims 1-15, wherein the IL-15R α , or functional fragment or functional variant thereof, is encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 79.~~

- ~~20. The recombinant vector of any one of claims 1-19, wherein the IL-15, or functional fragment or functional variant thereof, is operably linked to the IL-15R α , or functional fragment or functional variant thereof, via a peptide linker.~~
- ~~21. The recombinant vector of claim 20, wherein the peptide linker comprises the amino acid sequence of SEQ ID NO: 81, or the amino acid sequence of SEQ ID NO: 81 comprising 1, 2, or 3 amino acid modifications.~~
- ~~22. The recombinant vector of claim 20, wherein the peptide linker is encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 82.~~
- ~~23. The recombinant vector of any one of claims 1-22, wherein the fusion protein is membrane bound.~~
- ~~24. The recombinant vector of any one of claims 1-23, wherein the fusion protein comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 70 or 73.~~
- ~~25. The recombinant vector of any one of claims 1-22, wherein the fusion protein is encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 71 or 74.~~
- 26.10. The recombinant vector of any one of claims 1-249, wherein the C α region comprises (a) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 40-49; or (b) an amino acid sequence encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 55, 57, or 58.
- ~~27. The recombinant vector of any one of claims 1-24, wherein the C α region is encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 55, 57, or 58.~~
- 28.11. The recombinant vector of any one of claims 1-2610, wherein the C β region comprises (a) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 50-54 or 60; or (b) an amino acid sequence encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 56 or 59.

~~29. The recombinant vector of any one of claims 1-26, wherein the C β region is encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 56 or 59.~~

30:12. The recombinant vector of any one of claims 1-2911, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': (a) the first polynucleotide sequence, the second polynucleotide sequence, the third polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence; (b) the first polynucleotide sequence, the fourth polynucleotide sequence, the third polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence; (c) the first polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, the fourth polynucleotide sequence, and the third polynucleotide sequence; (d) the first polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, the second polynucleotide sequence, and the third polynucleotide sequence; (e) the third polynucleotide sequence, the second polynucleotide sequence, the first polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence; (f) the third polynucleotide sequence, the fourth polynucleotide sequence, the first polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence; (g) the third polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, the fourth polynucleotide sequence, and the first polynucleotide sequence; (h) the third polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, the second polynucleotide sequence, and the first polynucleotide sequence; (i) the fifth polynucleotide sequence, the second polynucleotide sequence, the first polynucleotide sequence, the fourth polynucleotide sequence, and the third polynucleotide sequence; (j) the fifth polynucleotide sequence, the fourth polynucleotide sequence, the first polynucleotide sequence, the second polynucleotide sequence, and the third polynucleotide sequence; (k) the fifth polynucleotide sequence, the second polynucleotide sequence, the third polynucleotide sequence, the fourth polynucleotide sequence, and the first polynucleotide sequence; or (l) the fifth polynucleotide sequence, the fourth polynucleotide sequence, the third polynucleotide sequence, the second polynucleotide sequence, and the first polynucleotide sequence.

31. ~~The recombinant vector of claim 30, wherein the first polynucleotide sequence and the second polynucleotide sequence together comprise a first combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 160; the third polynucleotide sequence and the fourth polynucleotide sequence together comprise a second combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 168; or the third polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence together comprise a third combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 161.~~
32. ~~The recombinant vector of claim 31, wherein the first combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 230; the second combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 231; or the third combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 232.~~
33. ~~The recombinant vector of claim 30, wherein the first polynucleotide sequence and the second polynucleotide sequence together comprise a first combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 160; and the third polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence together comprise a third combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 161.~~
34. ~~The recombinant vector of claim 30, wherein the first polynucleotide sequence and the second polynucleotide sequence together comprise a first combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 180 or 210; and the third polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence together comprise a third combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 181.~~
35. ~~The recombinant vector of claim 33, wherein the first combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 230; and the third combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 232.~~
36. ~~The recombinant vector of claim 35, wherein the first combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 250 or 270; and the~~

~~third combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 252.~~

- ~~37. The recombinant vector of any one of claims 1-29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the first polynucleotide sequence, the fourth polynucleotide sequence, the third polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence.~~
- ~~38. The recombinant vector of claim 37, wherein the first polynucleotide sequence and the fourth polynucleotide sequence together comprise a fourth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 162; the third polynucleotide sequence and the second polynucleotide sequence together comprise a fifth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 166; or the third polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence together comprise a sixth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 163.~~
- ~~39. The recombinant vector of claim 38, wherein the fourth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 233; the fifth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 234; or the sixth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 235.~~
- ~~40. The recombinant vector of claim 37, wherein the first polynucleotide sequence and the fourth polynucleotide sequence together comprise a fourth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 162; and the third polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence together comprise a sixth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 163.~~
- ~~41. The recombinant vector of claim 37, wherein the first polynucleotide sequence and the fourth polynucleotide sequence together comprise a fourth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 182 or 212; and the third polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence together comprise a sixth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 183.~~

42. ~~The recombinant vector of claim 40, wherein the fourth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 233; and the sixth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 235.~~
43. ~~The recombinant vector of claim 41, wherein the fourth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 253 or 273; and the sixth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 255.~~
44. ~~The recombinant vector of any one of claims 1-29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the first polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, the fourth polynucleotide sequence, and the third polynucleotide sequence.~~
45. ~~The recombinant vector of claim 44, wherein the first polynucleotide sequence and the second polynucleotide sequence together comprise a first combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 160; the first polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence together comprise a seventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 169; the fifth polynucleotide sequence and the fourth polynucleotide sequence together comprise an eighth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 173; or the first polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, and the fourth polynucleotide sequence together comprise a ninth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 164.~~
46. ~~The recombinant vector of claim 45, wherein the first combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 230; the seventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 236; the eighth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 237; or the ninth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 238.~~

47. — The recombinant vector of claim 44, wherein the first polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, and the fourth polynucleotide sequence together comprise a ninth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 164; and the third polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 50.
48. — The recombinant vector of claim 44, wherein the first polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, and the fourth polynucleotide sequence together comprise a ninth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 184 or 214; and the third polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 51.
49. — The recombinant vector of claim 47, wherein the ninth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 238; and the third polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 59.
50. — The recombinant vector of claim 48, wherein the ninth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 258 or 278; and the third polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 56.
51. — The recombinant vector of any one of claims 1–29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the first polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, the second polynucleotide sequence, and the third polynucleotide sequence.
52. — The recombinant vector of claim 51, wherein the first polynucleotide sequence and the fourth polynucleotide sequence together comprise a fourth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 162; the first polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence together comprise a tenth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 167; the fifth polynucleotide sequence and the second polynucleotide sequence together comprise an eleventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 172; or the first polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, and the second polynucleotide sequence together comprise a

- ~~twelfth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 165.~~
53. ~~The recombinant vector of claim 52, wherein the fourth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 233; the tenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 239; the eleventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 240; or the twelfth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 241.~~
54. ~~The recombinant vector of claim 51, wherein the first polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, and the second polynucleotide sequence together comprise a twelfth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 165; and the third polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 50.~~
55. ~~The recombinant vector of claim 51, wherein the first polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, and the second polynucleotide sequence together comprise a twelfth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 185 or 215; and the third polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 51.~~
56. ~~The recombinant vector of claim 54, wherein the twelfth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 241; and the third polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 59.~~
57. ~~The recombinant vector of claim 55, wherein the twelfth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 261 or 281; and the third polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 56.~~
58. ~~The recombinant vector of any one of claims 1-29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the third polynucleotide sequence, the second polynucleotide sequence, the first polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence.~~
59. ~~The recombinant vector of claim 58, wherein the first polynucleotide sequence and the fourth polynucleotide sequence together comprise a fourth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 162; the third~~

- ~~polynucleotide sequence and the second polynucleotide sequence together comprise a fifth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 166; or the first polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence together comprise a tenth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 167.~~
60. ~~The recombinant vector of claim 59, wherein the fourth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 233; the fifth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 234; or the tenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 239.~~
61. ~~The recombinant vector of claim 58, wherein the third polynucleotide sequence and the second polynucleotide sequence together comprise a fifth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 166; and the first polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence together comprise a tenth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 167.~~
62. ~~The recombinant vector of claim 58, wherein the third polynucleotide sequence and the second polynucleotide sequence together comprise a fifth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 186; and the first polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence together comprise a tenth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 187 or 217.~~
63. ~~The recombinant vector of claim 61, wherein the fifth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 234; and the tenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 239.~~
64. ~~The recombinant vector of claim 62, wherein the fifth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 254; and the tenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 259 or 279.~~

65. — ~~The recombinant vector of any one of claims 1-29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the third polynucleotide sequence, the fourth polynucleotide sequence, the first polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence.~~
66. — ~~The recombinant vector of claim 65, wherein the first polynucleotide sequence and the second polynucleotide sequence together comprise a first combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 160; the third polynucleotide sequence, and the fourth polynucleotide sequence together comprise a second combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 168; or the first polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence together comprise a seventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 169.~~
67. — ~~The recombinant vector of claim 66, wherein the first combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 230; the second combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 231; or the seventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 236.~~
68. — ~~The recombinant vector of claim 65, wherein the third polynucleotide sequence, and the fourth polynucleotide sequence together comprise a second combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 168; and the first polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence together comprise a seventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 169.~~
69. — ~~The recombinant vector of claim 65, wherein the third polynucleotide sequence, and the fourth polynucleotide sequence together comprise a second combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 188; and the first polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence together comprise a seventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 189 or 219.~~
70. — ~~The recombinant vector of claim 68, wherein the second combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 231; and the seventh~~

- combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 236.
71. — ~~The recombinant vector of claim 69, wherein the second combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 251; and the seventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 256 or 276.~~
72. — ~~The recombinant vector of any one of claims 1–29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the third polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, the fourth polynucleotide sequence, and the first polynucleotide sequence.~~
73. — ~~The recombinant vector of claim 72, wherein the third polynucleotide sequence and the second polynucleotide sequence together comprise a fifth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 166; the third polynucleotide sequence, the second polynucleotide sequence, and the fifth polynucleotide sequence together comprise a sixth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 163; the fifth polynucleotide sequence and the fourth polynucleotide sequence together comprise an eighth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 173; or the third polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, and the fourth polynucleotide sequence together comprise a thirteenth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 170.~~
74. — ~~The recombinant vector of claim 73, wherein the fifth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 234; the sixth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 235; the eighth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 237; or the thirteenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 242.~~
75. — ~~The recombinant vector of claim 72, wherein the third polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, and the fourth polynucleotide sequence together comprise a thirteenth combination polynucleotide~~

- sequence that encodes the amino acid sequence of SEQ ID NO: 170; and the first polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 40.
76. — The recombinant vector of claim 72, wherein the third polynucleotide sequence, the second polynucleotide sequence, the fifth polynucleotide sequence, and the fourth polynucleotide sequence together comprise a thirteenth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 190; and the first polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 41 or 42.
77. — The recombinant vector of claim 75, wherein the thirteenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 242; and the first polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 57.
78. — The recombinant vector of claim 76, wherein the thirteenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 262; and the first polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 55 or 58.
79. — The recombinant vector of any one of claims 1–29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the third polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, the second polynucleotide sequence, and the first polynucleotide sequence.
80. — The recombinant vector of claim 79, wherein the third polynucleotide sequence and the fourth polynucleotide sequence together comprise a second combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 168; the third polynucleotide sequence, the fourth polynucleotide sequence, and the fifth polynucleotide sequence together comprise a third combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 161; the fifth polynucleotide sequence and the second polynucleotide sequence together comprise an eleventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 172; or the third polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, and the second polynucleotide sequence together comprise a fourteenth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 171.

81. ~~The recombinant vector of claim 80, wherein the second combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 231; the third combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 232; the eleventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 240; or the fourteenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 243.~~
82. ~~The recombinant vector of claim 79, wherein the third polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, and the second polynucleotide sequence together comprise a fourteenth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 171; and the first polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 40.~~
83. ~~The recombinant vector of claim 79, wherein the third polynucleotide sequence, the fourth polynucleotide sequence, the fifth polynucleotide sequence, and the second polynucleotide sequence together comprise a fourteenth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 191; and the first polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 41 or 42.~~
84. ~~The recombinant vector of claim 82, wherein the fourteenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 243; and the first polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 57.~~
85. ~~The recombinant vector of claim 83, wherein the fourteenth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 263; and the first polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 55 or 58.~~
86. ~~The recombinant vector of any one of claims 1-29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the fifth polynucleotide sequence, the second polynucleotide sequence, the first polynucleotide sequence, the fourth polynucleotide sequence, and the third polynucleotide sequence.~~
87. ~~The recombinant vector of claim 86, wherein the first polynucleotide sequence and the fourth polynucleotide sequence together comprise a fourth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 162; or the fifth polynucleotide sequence and the second polynucleotide sequence together comprise an~~

- ~~eleventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 172.~~
88. ~~The recombinant vector of claim 87, wherein the fourth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 233; or the eleventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 240.~~
89. ~~The recombinant vector of claim 86, wherein the first polynucleotide sequence and the fourth polynucleotide sequence together comprise a fourth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 162; the fifth polynucleotide sequence and the second polynucleotide sequence together comprise an eleventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 172; and the third polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 50.~~
90. ~~The recombinant vector of claim 86, wherein the first polynucleotide sequence and the fourth polynucleotide sequence together comprise a fourth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 182 or 212; the fifth polynucleotide sequence and the second polynucleotide sequence together comprise an eleventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 172; and the third polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 51.~~
91. ~~The recombinant vector of claim 89, wherein the fourth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 233; and the eleventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 240; and the third polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 59.~~
92. ~~The recombinant vector of claim 90, wherein the fourth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 253 or 273; the eleventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 240; and the third polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 56.~~

93. — ~~The recombinant vector of any one of claims 1-29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the fifth polynucleotide sequence, the fourth polynucleotide sequence, the first polynucleotide sequence, the second polynucleotide sequence, and the third polynucleotide sequence.~~
94. — ~~The recombinant vector of claim 93, wherein the first polynucleotide sequence and the second polynucleotide sequence together comprise a first combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 160; or the fifth polynucleotide sequence and the fourth polynucleotide sequence together comprise an eighth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 173.~~
95. — ~~The recombinant vector of claim 94, wherein the first combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 230; or the eighth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 237.~~
96. — ~~The recombinant vector of claim 93, wherein the first polynucleotide sequence and the second polynucleotide sequence together comprise a first combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 160; the fifth polynucleotide sequence and the fourth polynucleotide sequence together comprise an eighth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 173; and the third polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 50.~~
97. — ~~The recombinant vector of claim 93, wherein the first polynucleotide sequence and the second polynucleotide sequence together comprise a first combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 180 or 210; the fifth polynucleotide sequence and the fourth polynucleotide sequence together comprise an eighth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 173; and the third polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 51.~~
98. — ~~The recombinant vector of claim 96, wherein the first combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 230; the eighth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID~~

- NO: 237; and the third polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 59.
99. The recombinant vector of claim 97, wherein the first combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 250 or 270; the eighth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 237; and the third polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 56.
100. The recombinant vector of any one of claims 1-29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the fifth polynucleotide sequence, the second polynucleotide sequence, the third polynucleotide sequence, the fourth polynucleotide sequence, and the first polynucleotide sequence.
101. The recombinant vector of claim 100, wherein the third polynucleotide sequence and the fourth polynucleotide sequence together comprise a second combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 168; or the fifth polynucleotide sequence and the second polynucleotide sequence together comprise an eleventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 172.
102. The recombinant vector of claim 101, wherein the second combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 231; or the eleventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 240.
103. The recombinant vector of claim 100, wherein the third polynucleotide sequence and the fourth polynucleotide sequence together comprise a second combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 168; the fifth polynucleotide sequence and the second polynucleotide sequence together comprise an eleventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 172; and the first polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 40.
104. The recombinant vector of claim 100, wherein the third polynucleotide sequence and the fourth polynucleotide sequence together comprise a second combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 188; the fifth

- polynucleotide sequence and the second polynucleotide sequence together comprise an eleventh combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 172; and the first polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 41 or 42.
105. — The recombinant vector of claim 103, wherein the second combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 231; the eleventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 240; and the first polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 57.
106. — The recombinant vector of claim 104, wherein the second combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 251; the eleventh combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 240; and the first polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 55 or 58.
107. — The recombinant vector of any one of claims 1–29, wherein the polycistronic polynucleotide comprises, in order from 5' to 3': the fifth polynucleotide sequence, the fourth polynucleotide sequence, the third polynucleotide sequence, the second polynucleotide sequence, and the first polynucleotide sequence.
108. — The recombinant vector of claim 107, wherein the third polynucleotide sequence and the second polynucleotide sequence together comprise a fifth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 166; or the fifth polynucleotide sequence and the fourth polynucleotide sequence together comprise an eighth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 173.
109. — The recombinant vector of claim 108, wherein the fifth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 234; or the eighth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 237.
110. — The recombinant vector of claim 107, wherein the third polynucleotide sequence and the second polynucleotide sequence together comprise a fifth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 166; the fifth

polynucleotide sequence and the fourth polynucleotide sequence together comprise an eighth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 173; and the first polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 40.

~~111. The recombinant vector of claim 107, wherein the third polynucleotide sequence and the second polynucleotide sequence together comprise a fifth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 186; the fifth polynucleotide sequence and the fourth polynucleotide sequence together comprise an eighth combination polynucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 173; and the first polynucleotide sequence encodes the amino acid sequence of SEQ ID NO: 41 or 42.~~

~~112. The recombinant vector of claim 110, wherein the fifth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 234; the eighth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 237; and the first polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 57.~~

~~113. The recombinant vector of claim 111, wherein the fifth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 254; the eighth combination polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 237; and the first polynucleotide sequence comprises the polynucleotide sequence of SEQ ID NO: 55 or 58.~~

~~114.~~ 13. The recombinant vector of any one of claims 1-~~113~~ 12, wherein the polycistronic polynucleotide further comprises

f. (a) a sixth polynucleotide sequence that comprises a third 2A element; and

g. (b) a seventh polynucleotide sequence that comprises a marker protein.

~~115. The recombinant vector of claim 114, wherein the third 2A element is a P2A element, a T2A element, an F2A element, or an E2A element.~~

~~116. The recombinant vector of any one of claims 114 or 115, wherein the marker protein comprises: domain III of HER1, or a functional fragment or functional variant thereof; an N-terminal portion of domain IV of HER1; and a transmembrane domain of CD28, or a functional fragment or functional variant thereof.~~

- ~~117. The recombinant vector of claim 116, wherein the domain III of HER1, or a functional fragment or functional variant thereof, comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 104.~~
- ~~118. The recombinant vector of claim 116, wherein the N terminal portion of domain IV of HER1 comprises amino acids 1 40, 1 39, 1 38, 1 37, 1 36, 1 35, 1 34, 1 33, 1 32, 1 31, 1 30, 1 29, 1 28, 1 27, 1 26, 1 25, 1 24, 1 23, 1 22, 1 21, 1 20, 1 19, 1 18, 1 17, 1 16, 1 15, 1 14, 1 13, 1 12, 1 11, or 1 10 of SEQ ID NO: 105.~~
- ~~119. The recombinant vector of claim 116, wherein the N terminal portion of domain IV of HER1 comprises amino acids 1 21 of SEQ ID NO: 105.~~
- ~~120. The recombinant vector of claim 116, wherein the N terminal portion of domain IV of HER1 comprises the amino acid sequence of SEQ ID NO: 106, or the amino acid sequence of SEQ ID NO: 106, comprising 1, 2, or 3 amino acid modifications.~~
- ~~121. The recombinant vector of any one of claims 114-120, wherein the transmembrane region of CD28 comprises the amino acid sequence of SEQ ID NO: 107, or the amino acid sequence of SEQ ID NO: 107, comprising 1, 2, or 3 amino acid modifications.~~
- ~~122. The recombinant vector of any one of claims 114-121, wherein the marker protein comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 100, 103, or 112.~~
- ~~123.~~ 14. The recombinant vector of any one of claims 1-~~122~~13, wherein the V α region comprises (a) complementarity determining region 1 α (CDR1 α), CDR2 α , and CDR3 α , comprising the amino acid sequences of SEQ ID NO: 1001 + 10n, 1002 + 10n, and 1003 + 10n, respectively, wherein n is an integer from 0 to 79; (b) the CDR1 α , CDR2 α , and CDR3 α from a V α region comprising the amino acid sequence of SEQ ID NO: 1004 + 10n, 1005 + 10n, 1006 + 10n, or 1007 + 10n, wherein n is an integer from 0 to 79; (c) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1004 + 10n, 1005 + 10n, 1006 + 10n, or 1007 + 10n, wherein n is an integer from 0 to 79; or (d) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1004 + 10n, wherein the V β region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID

NO: 2004 + 10n, and wherein n is an integer from 0 to 79; wherein the V α region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1005 + 10n, wherein the V β region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2005 + 10n, and wherein n is an integer from 0 to 79; wherein the V α region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1006 + 10n, wherein the V β region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2006 + 10n, and wherein n is an integer from 0 to 79; or wherein the V α region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1007 + 10n, wherein the V β region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2007 + 10n, and wherein n is an integer from 0 to 79.

- ~~124.~~ 15. The recombinant vector of any one of claims 1-~~123~~14, wherein the V β region comprises (a) CDR1 β , CDR2 β , and CDR3 β , comprising the amino acid sequences of SEQ ID NO: 2001 + 10n, 2002 + 10n, and 2003 + 10n, respectively, wherein n is an integer from 0 to 79; (b) the CDR1 β , CDR2 β , and CDR3 β from a V β region comprising the amino acid sequence of SEQ ID NO: 2004 + 10n, 2005 + 10n, 2006 + 10n, or 2007 + 10n, wherein n is an integer from 0 to 79; or (c) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2004 + 10n, 2005 + 10n, 2006 + 10n, or 2007 + 10n, wherein n is an integer from 0 to 79.
- ~~125.~~ The recombinant vector of any one of claims 1-124, wherein the V α region comprises the CDR1 α , CDR2 α , and CDR3 α from a V α region comprising the amino acid sequence of SEQ ID NO: 1004 + 10n, 1005 + 10n, 1006 + 10n, or 1007 + 10n, wherein n is an integer from 0 to 79.
- ~~126.~~ The recombinant vector of any one of claims 1-125, wherein the V β region comprises the CDR1 β , CDR2 β , and CDR3 β from a V β region comprising the amino acid sequence of

SEQ ID NO: 2004 + 10n, 2005 + 10n, 2006 + 10n, or 2007 + 10n, wherein n is an integer from 0 to 79.

- ~~127.~~ The recombinant vector of any one of claims 1-126, wherein the V α region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1004 + 10n, 1005 + 10n, 1006 + 10n, or 1007 + 10n, wherein n is an integer from 0 to 79.
- ~~128.~~ The recombinant vector of any one of claims 1-127, wherein the V β region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2004 + 10n, 2005 + 10n, 2006 + 10n, or 2007 + 10n, wherein n is an integer from 0 to 79.
- ~~129.~~ The recombinant vector of any one of claims 1-128, wherein the V α region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1004 + 10n, wherein the V β region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2004 + 10n, and wherein n is an integer from 0 to 79; wherein the V α region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1005 + 10n, wherein the V β region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2005 + 10n, and wherein n is an integer from 0 to 79; wherein the V α region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1006 + 10n, wherein the V β region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2006 + 10n, and wherein n is an integer from 0 to 79; or wherein the V α region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1007 + 10n, wherein the V β region comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2007 + 10n, and wherein n is an integer from 0 to 79.
- ~~130.~~ 16. The recombinant vector of any one of claims 1-~~129~~15, wherein the TCR alpha chain comprises (a) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100%

identical to the amino acid sequence of SEQ ID NO: 1008 + 10n, wherein n is an integer from 0 to 79; (b) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1009 + 10n, wherein n is an integer from 0 to 79; or (c) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1010 + 10n, wherein n is an integer from 0 to 79.

~~131. The recombinant vector of any one of claims 1-129, wherein the TCR alpha chain comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1009 + 10n, wherein n is an integer from 0 to 79.~~

~~132. The recombinant vector of any one of claims 1-129, wherein the TCR alpha chain comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 1010 + 10n, wherein n is an integer from 0 to 79.~~

~~133. 17. The recombinant vector of any one of claims 1-132~~16, wherein the TCR beta chain comprises (a) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2008 + 10n, wherein n is an integer from 0 to 79; (b) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2009 + 10n, wherein n is an integer from 0 to 79; or (c) an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2010 + 10n, wherein n is an integer from 0 to 79.

~~134. The recombinant vector of any one of claims 1-132, wherein the TCR beta chain comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2009 + 10n, wherein n is an integer from 0 to 79.~~

~~135. The recombinant vector of any one of claims 1-132, wherein the TCR beta chain comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 2010 + 10n, wherein n is an integer from 0 to 79.~~

- ~~136. The recombinant vector of any one of claims 1-135, wherein the transcriptional regulatory element comprises a promoter.~~
- ~~137. The recombinant vector of claim 136, wherein the promoter is a human elongation factor 1-alpha (hEF-1 α) hybrid promoter.~~
- ~~138. The recombinant vector of claim 136 or 137, wherein the promoter comprises a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO:150.~~
- ~~139. The recombinant vector of any one of claims 1-138, further comprising a polyA sequence at the 3' end of the polycistronic expression cassette.~~
- ~~140. The recombinant vector of claim 139, wherein the polyA sequence comprises a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO:151.~~
- ~~141. The recombinant vector of any one of claims 1-140, further comprising a Left inverted terminal repeat (ITR) and a Right ITR, wherein the Left ITR and the Right ITR flank the polycistronic expression cassette.~~
- ~~142. The recombinant vector of claim 141, which comprises, in order from 5' to 3':~~
- ~~i. the Left ITR;~~
 - ~~ii. the transcriptional regulatory element;~~
 - ~~iii. the first polynucleotide sequence;~~
 - ~~iv. the second polynucleotide sequence;~~
 - ~~v. the third polynucleotide sequence;~~
 - ~~vi. the fourth polynucleotide sequence;~~
 - ~~vii. the fifth polynucleotide sequence; and~~
 - ~~viii. the Right ITR.~~
- ~~143. The recombinant vector of any one of claims 1-142, wherein the recombinant vector is a non-viral vector.~~
- ~~144. The recombinant vector of claim 143, wherein the non-viral vector is a plasmid.~~
- ~~145. The recombinant vector of any one of claims 1-142, wherein the recombinant vector is a viral vector.~~
- ~~146. The recombinant vector of any one of claims 1-145, wherein the recombinant vector is a polynucleotide.~~

147. 18. A polynucleotide, wherein the polynucleotide encoding encodes an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to an amino acid sequence selected from the group consisting of SEQ ID NOs: 161, 163, 164, 165, 167, 169, 170, and 171; or wherein the polynucleotide comprises a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to a polynucleotide sequence selected from the group consisting of SEQ ID NOs: 232, 235, 236, 238, 239, 241, 242, and 243.
148. ~~A polynucleotide comprising a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to a polynucleotide sequence selected from the group consisting of SEQ ID NOs: 232, 235, 236, 238, 239, 241, 242, and 243.~~
149. ~~A population of cells that comprise the recombinant vector of any one of claims 1-146 or the polynucleotide of claim 147 or 148.~~
150. ~~The population of cells of claim 149, wherein the recombinant vector or the polynucleotide is integrated into the genome of the population of cells.~~
151. ~~The population of cells of claims 149 or 150, wherein the cells are immune effector cells.~~
152. ~~The population of cells of claim 151, wherein the immune effector cells are selected from the group consisting of T cells, natural killer (NK) cells, B cells, mast cells, and myeloid-derived phagocytes.~~
153. ~~The population of cells of claim 152, wherein the immune effector cells are one or more T cells selected from the group consisting of naïve T cells (CD4⁺ or CD8⁺); killer CD8⁺ T cells; cytotoxic CD4⁺ T cells; helper CD4⁺ T cells; CD4⁺ T cells corresponding to Th1, Th2, Th9, Th17, Th22, follicular helper (T_{fh}), regulatory (T_{reg}) lineages; tumor infiltrating lymphocytes (TILs); and memory T cells (central memory, effector memory, stem cell memory, stem cell like memory).~~
154. ~~The population of cells of claim 152, comprising alpha/beta T cells, gamma/delta T cells, or natural killer T (NKT) cells.~~
155. ~~The population of cells of claim 152, comprising CD4⁺ T cells, CD8⁺ T cells, or both CD4⁺ T cells and CD8⁺ T cells.~~
156. ~~The population of cells of any one of claims 149-155, wherein the cells are *ex vivo*.~~
157. ~~The population of cells of any one of claims 149-156, wherein the cells are human.~~

- ~~158. The population of cells of any one of claims 149-157, wherein the population of cells are T cells that comprise more than 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45% or 50% CD45RA+CD45RO-CD62L+CD95+ cells.~~
- ~~159. The population of cells of any one of claims 149-157, wherein the population of cells are T cells that comprise more than 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45% or 50% CD45RA+CD45RO+CD62L+CD95+ cells.~~
- ~~160. 19. A population of cells comprising a polycistronic expression cassette comprising~~
a. a first cistron comprising a polynucleotide sequence that encodes a fusion protein that comprises IL-15, or a functional fragment or functional variant thereof, and IL-15R α , or a functional fragment or functional variant thereof;
b. a second cistron comprising a polynucleotide sequence that encodes a TCR beta chain comprising a V β region and a C β region; and
c. a third cistron comprising a polynucleotide sequence that encodes a TCR alpha chain comprising a V α region and a C α region,
wherein the population of cells are T cells that comprise i) more than 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45% or 50% CD45RA+CD45RO-CD62L+CD95+ cells, or ii) more than 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45% or 50% CD45RA+CD45RO+CD62L+CD95+ cells.
- ~~161. A population of cells comprising a polycistronic expression cassette comprising~~
a. ~~a first cistron comprising a polynucleotide sequence that encodes a fusion protein that comprises IL-15, or a functional fragment or functional variant thereof, and IL-15R α , or a functional fragment or functional variant thereof;~~
b. ~~a second cistron comprising a polynucleotide sequence that encodes a TCR beta chain comprising a V β region and a C β region; and~~
c. ~~a third cistron comprising a polynucleotide sequence that encodes a TCR alpha chain comprising a V α region and a C α region;~~
~~wherein the population of cells are T cells that comprise more than 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45% or 50% CD45RA+CD45RO+CD62L+CD95+ cells.~~
- ~~162. A method of producing a population of engineered cells, comprising:~~
~~introducing into a population of cells the recombinant vector of claim 141 or 142, and a DNA transposase or a polynucleotide encoding a DNA transposase; and~~

- culturing the population of cells under conditions wherein the transposase integrates the polycistronic expression cassette into the genome of the population of cells, thereby producing the population of engineered cells.
163. ~~The method of claim 162, wherein the Left ITR and the Right ITR are ITRs of a DNA transposon selected from the group consisting of a *Sleeping Beauty* transposon, a piggyBac transposon, a TeBuster transposon, and a Tol2 transposon.~~
164. ~~The method of claim 163, wherein the DNA transposon is the *Sleeping Beauty* transposon.~~
165. ~~The method of any one of claims 162-164, wherein the transposase is a *Sleeping Beauty* transposase.~~
166. ~~The method of claim 165, wherein the *Sleeping Beauty* transposase is selected from the group consisting of SB11, SB10, SB100X, hSB110, and hSB81.~~
167. ~~The method of claim 166, wherein the *Sleeping Beauty* transposase is SB11.~~
168. ~~The method of claim 167, wherein the SB11 comprises an amino acid sequence at least 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the amino acid sequence of SEQ ID NO: 300.~~
169. ~~The method of claim 167, wherein the SB11 is encoded by a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 301.~~
170. ~~The method of any one of claims 162-169, wherein the polynucleotide encoding the DNA transposase is a DNA vector or an RNA vector.~~
171. ~~The method of any one of claims 162-170, wherein the Left ITR comprises a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 290 or 291; and the Right ITR comprises a polynucleotide sequence at least 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the polynucleotide sequence of SEQ ID NO: 292, 293 or 294.~~
172. ~~The method of any one of claims 162-171, wherein the recombinant vector, and the DNA transposase or polynucleotide encoding the DNA transposase, are introduced to the population of cells using electroporation, sonication, calcium phosphate precipitation,~~

- lipofection, particle bombardment, microinjection, mechanical deformation by passage through a microfluidic device, or a colloidal dispersion system.
- ~~173. The method of claim 172, wherein the recombinant vector, and the DNA transposase or polynucleotide encoding the DNA transposase, are introduced to the population of cells using electroporation.~~
- ~~174. The method of any one of claims 162-173, wherein the method is completed within 30 days, 25 days, 20 days, 15 days, 14 days, 10 days, 7 days, 6 days, 5 days, 4 days, 3 days, 2 days, or 1 day.~~
- ~~175. The method of any one of claims 162-173, wherein the method is completed in less than 30 days, 25 days, 20 days, 15 days, 14 days, 10 days, 7 days, 6 days, 5 days, 4 days, 3 days, 2 days, or 1 day.~~
- ~~176. The method of any one of claims 162-175, wherein the population of cells is cryopreserved and thawed before introduction of the recombinant vector and the DNA transposase or polynucleotide encoding the DNA transposase.~~
- ~~177. The method of any one of claims 162-176, wherein the population of cells is rested before introduction of the recombinant vector and the DNA transposase or polynucleotide encoding the DNA transposase.~~
- ~~178. The method of any one of claims 162-177, wherein the population of cells is not rested before introduction of the recombinant vector and the DNA transposase or polynucleotide encoding the DNA transposase.~~
- ~~179. The method of any one of claims 162-178, wherein the population of cells comprises expanded human *ex vivo* cells.~~
- ~~180. The method of any one of claims 162-179, wherein the population of cells is not activated *ex vivo*.~~
- ~~181. The method of any one of claims 162-180, wherein the population of cells comprises T cells.~~
- ~~182. 20. Use of a population of cells comprising the recombinant vector of any one of claims 1-17, or a population of cells comprising the polynucleotide of claim 18, or the population of cells of claim 19 in the manufacture of a medicament A method of treating cancer in a subject in need thereof comprising administering to the subject a therapeutically effective amount of the population of cells of any one of claims 149-161,~~

thereby for treating the cancer or an autoimmune disease or disorder in a subject in need thereof.

~~183. The method of claim 182, wherein the cancer is selected from lung, cholangiocarcinoma, pancreatic, colorectal, gynecological and ovarian cancer.~~

~~184. A method of treating an autoimmune disease or disorder in a subject in need thereof comprising administering to the subject a therapeutically effective amount of the population of cells of any one of claims 149-161, thereby treating the autoimmune disease or disorder.~~