

WHAT IS CLAIMED IS:

1. A CAR polypeptide comprising:
 - a) at least one intracytoplasmic/costimulatory region comprising a cluster of differentiation 28 zeta (CD28/ ζ) domain,
 - b) at least one intracytoplasmic signaling region comprising a cluster of differentiation 3 zeta (CD3/ ζ) domain, and
 - c) an antigen binding domain specific for a peptide in groove cancer antigen.
2. The CAR polypeptide of claim 1, wherein the intracytoplasmic/costimulatory region of the CAR polypeptide further comprises a 4-1BB domain.
3. The CAR polypeptide of claim 1 or claim 2, wherein the hinge/spacer region of the CAR comprises at least one cluster of differentiation 28 zeta (CD28/ ζ) domain.
4. The CAR polypeptide of any one of claims 1 to 3, wherein the transmembrane region of the CAR comprises at least one cluster of differentiation 28 zeta (CD28/ ζ) domain.
5. A CAR polypeptide having antigenic specificity for a peptide in groove cancer antigen, wherein the CAR comprises at least one cluster of differentiation 28 zeta (CD28/ ζ) amino acid sequence selected from the amino acid sequences set forth in SEQ ID NOs. 1 to 3.
6. The CAR polypeptide of claim 5, wherein at least one cluster of differentiation 28 (CD28) amino acid sequence is part of the intracytoplasmic/costimulatory region of the CAR.
7. The CAR polypeptide of claim 5, wherein at least one cluster of differentiation 28 (CD28) amino acid sequence is part of the transmembrane region of the CAR.
8. The CAR polypeptide of claim 5, wherein at least one cluster of differentiation 28 (CD28) amino acid sequence is part of the hinge/spacer region of the CAR.

9. The CAR polypeptide of any one of claims 1 to 8, wherein the cancer antigen is a MAGEA4, Tyrosinase, HPV16 E7, or a NY-ESO peptide.
10. The CAR polypeptide of claim 9, wherein the CAR is specific for an antigen comprising at least one epitope selected from MAGEA4₂₃₀₋₂₃₉, MAGEA4₂₈₆₋₂₉₄, TyT₃₆₉₋₃₇₇, HPV16E7₁₁₋₁₉ or NY-ESO-1₁₅₇₋₁₆₅.
11. A CAR polypeptide having antigenic specificity for a peptide in groove cancer antigen and the CAR comprises an amino acid sequence set forth in SEQ ID NOs: 7, 9, 11, 13, 30, or 34.
12. The CAR polypeptide of any one of claims 1 to 11, wherein the CAR polypeptide comprises a variable light chain comprising any one of the amino acid sequences set forth in SEQ ID NOs: 16 to 19, 31, or 37.
13. The CAR polypeptide of any one of claims 1 to 12, wherein the CAR polypeptide comprises a variable heavy chain comprising any one of the amino acid sequences set forth in SEQ ID NOs: 20 to 23, 32, or 38.
14. A composition comprising immune cells expressing the CAR of any one of claims 1 to 13.
15. A nucleic acid encoding the CAR polypeptide of any one of claims 1 to 14.
16. The nucleic acid of claims 15, wherein the nucleic acid is an expression vector.
17. The nucleic acid of claim 15 or 16, wherein the nucleic acid has a sequence set forth in SEQ ID NOs: 14, 15, 35 or 36.
18. The nucleic acid of claim 17, wherein the expression vector is a viral vector.
19. The nucleic acid of claim 18, wherein the viral vector is lentiviral expression vector.

20. An immune cell comprising the nucleic acid of any one of claims 15 to 19.
21. An immune cell expressing the CAR polypeptide of any one of claims 1 to 20.
22. The immune cell of claim 20 or 21, wherein the immune cell is a leukocyte.
23. The immune cell of claim 21 or 22 wherein the immune cell is a lymphocyte, a monocyte, a macrophage, a dendritic cell, a mast cell, a neutrophil, a basophil, or an eosinophil.
24. The immune cell of any one of claims 21 to 23 wherein the immune cell is a lymphocyte selected from an $\alpha\beta$ T cell, $\gamma\delta$ T cell, a Natural Killer (NK) cell, a Natural Killer T (NKT) cell, an innate lymphoid cell (ILC), a cytokine induced killer (CIK) cell, a cytotoxic T lymphocyte (CTL), a lymphokine activated killer (LAK) cell, a regulatory T cell, or any combination thereof.
25. The immune cell of claim 24, wherein the immune cell is a cytotoxic T lymphocyte (CTL).
26. A method of treating a tumor in a subject, the method comprising administering a composition comprising cells expressing a CAR polypeptide comprising:
- a) at least one intracytoplasmic/costimulatory region comprising a cluster of differentiation 28 zeta (CD28/ ζ) domain,
 - b) at least one intracytoplasmic signaling region comprising a cluster of differentiation 3 zeta (CD3/ ζ) domain, and
 - c) an antigen binding domain specific for a peptide in groove antigen.
27. The method of claim 26, wherein the CAR comprises at least one CD28/ ζ domain in the hinge/spacer region of the CAR.
28. The method of claim 27, wherein the CAR comprises at least one CD28/ ζ domain in the transmembrane region of the CAR.

29. The method of any one of claims 26 to 28, wherein at least one cluster of differentiation 28 zeta (CD28/ ζ) amino acid sequence selected from the amino acid sequences set forth in SEQ ID NOs. 1 to 3.
30. The method of any one of claims 26 to 29, wherein the method further comprises conjointly administering to the subject a second CAR polypeptide comprising:
- a) a 4-1BB domain in the costimulatory region of the CAR polypeptide,
 - b) at least one intracytoplasmic signaling region comprising a cluster of differentiation 3 zeta (CD3/ ζ) domain, and
 - c) an extracellular domain specific for a peptide in groove cancer antigen.
31. The method of claim 30, wherein the second CAR polypeptide comprises a cluster of differentiation 8 alpha (CD8/ α) peptide in the hinge/transmembrane region.
32. A cell bank comprising cells for adoptive immunotherapy, wherein the cells express the CAR of any one of claims 1 to 13.