CLAIMS

1. A chimeric antigen receptor (CAR) comprising an antigen specific binding domain, a hinge domain, a transmembrane domain, co-stimulatory domain, and a CD3ζ signaling domain, wherein the antigen specific binding domain specifically binds to antigens comprising vimentin polypeptides or peptides thereof.

2. The chimeric antigen receptor of claim 1, wherein:
(a) the vimentin polypeptides or peptides thereof are posttranslationally modified, comprising citrullinated- vimentin (CV) polypeptides or peptides thereof;
(b) the antigen specific binding domain comprises an antibody, antibody fragment, a camelid nanobody or aptamer, optionally wherein the antibody fragment is a single chain fragment, further optionally wherein the single chain fragment is a single chain variable fragment (scFv); and/or
(c) the co-stimulatory domain comprises a CD28 or a 41BB polypeptide.

3. The chimeric antigen receptor of claim 1 or 2, wherein:
(a) (i) the CD28 or the 41BB co-stimulatory domain is encoded by a nucleic acid sequence having at least 50% sequence identity to SEQ ID NO: 11 or SEQ ID NO: 12 respectively;
(ii) the hinge domain is encoded by a nucleic acid sequence having at least 50% sequence identity to SEQ ID NO: 8;
(iii) the transmembrane domain is encoded by a nucleic acid sequence having at least 50% sequence identity to SEQ ID NO: 9; and/or
(iv) the CD3ζ signaling domain is encoded by a nucleic acid sequence having at least 50% sequence identity to SEQ ID NO: 10;
(b) (i) the CD28 or the 41BB co-stimulatory domain is encoded by a nucleic acid sequence having at least 75% sequence identity to SEQ ID NO: 11 or SEQ ID NO: 12 respectively;
(ii) the hinge domain is encoded by a nucleic acid sequence having at least 75% sequence identity to SEQ ID NO: 8;
(iii) the transmembrane domain is encoded by a nucleic acid sequence having at least 75% sequence identity to SEQ ID NO: 9; and/or

(iv) the CD3ζ signaling domain is encoded by a nucleic acid sequence having at least 75% sequence identity to SEQ ID NO: 10;

(c) (i) the CD28 or the 41BB co-stimulatory domain is encoded by a nucleic acid sequence having at least 95% sequence identity to SEQ ID NO: 11 or SEQ ID NO: 12 respectively;

(ii) the hinge domain is encoded by a nucleic acid sequence having at least 95% sequence identity to SEQ ID NO: 8;

(iii) the transmembrane domain is encoded by a nucleic acid sequence having at least 95% sequence identity to SEQ ID NO: 9; and/or

(iv) the CD3ζ signaling domain is encoded by a nucleic acid sequence having at least 95% sequence identity to SEQ ID NO: 10; or

(d) (i) the CD28 or the 41BB co-stimulatory domain is encoded by the nucleic acid sequence of SEQ ID NO: 11 or SEQ ID NO: 12 respectively;

(ii) the hinge domain is encoded by the nucleic acid sequence of SEQ ID NO: 8;

(iii) the transmembrane domain is encoded by the nucleic acid sequence of SEQ ID NO: 9; and/or

(iv) the CD3ζ signaling domain is encoded by the nucleic acid sequence of SEQ ID NO: 10.

4. The chimeric antigen receptor of any one of claims 1-3, wherein:

(a) the CV-CAR specifically binds to a CV peptide having at least a 50%, at least a 75%, or at least a 95% sequence identity to SEQ ID NO: 21 or 22; or

(b) the CV-CAR specifically binds to a CV peptide comprising SEQ ID NO: 21 or 22.

5. An isolated T cell that is modified to express: a chimeric antigen receptor (CAR) comprising an antigen binding domain linked to at least one co-stimulatory domain and a CD3ζ signaling domain, wherein the antigen binding domain comprises a single chain variable fragment (scFv) which specifically binds to citrullinated-vimentin (CV).

6. An expression vector encoding a chimeric antigen receptor (CAR) which specifically binds to a citrullinated-vimentin (CV) antigen for use in a method of treating a subject diagnosed with rheumatoid arthritis, wherein the method of treatment comprises:
isolating T lymphocytes from a biological sample obtained from the subject;
separating $CD4^+$ T regulatory Cells (Treg) from conventional T cells (Tconv), wherein the Treg cells are $CD4^+CD25^+CD127^-$ and the Tconv are $CD4^+CD25^-CD127^+$;
transducing the Treg cells with said expression vector;
expanding the transduced Treg with anti-CD3/CD28 beads at least once *ex vivo* to obtain expanded Treg cells specific for the CV antigen; and
reinfusing the Treg into the subject, thereby treating the subject.

7. The expression vector for the use of claim 6, wherein the Treg cells are autologous cells.

8. The isolated T cell of claim 5 or the expression vector for the use of claim 6 or 7, wherein the CAR is as defined in any one of claims 1-4.

9. The isolated T cell of claim 5 or 8, wherein the T cell is a mammalian regulatory T cell (Treg); optionally wherein the Treg cell is $CD4^+CD25^+$ $CD127^-$ $FOXP3^+$.

10. An expression vector encoding the chimeric antigen receptor (CAR) of any one of claims 1-4.

11. A host cell comprising the expression vector of claim 10.

12. The expression vector for the use of claims 6-8, further comprising administering to the subject one or more anti-inflammatory agents and/or therapeutic agents; optionally wherein the anti-inflammatory agents comprise one or more antibodies which specifically bind to pro-inflammatory cytokines; further optionally wherein the antibodies are anti-TNFα, anti-IL-6 or combinations thereof.

13. A chimeric antigen receptor (CAR) comprising an antigen binding domain, a hinge domain, a transmembrane domain, co-stimulatory domain, and a CD3ζ signaling domain,

wherein the antigen specific domain comprises an antibody or antibody fragment, optionally wherein:
(a) the antibody fragment is a single chain variable fragment (scFv) which specifically binds to post-translationally modified antigens; and/or(b) the co-stimulatory domain comprises a CD28 or a 41BB polypeptide.

14. A pharmaceutical composition comprising the chimeric antigen receptor (CAR) of any one of claims 1-4 and 13, the isolated T cell of any one of claims 5 and 8-9, the expression vector of claim 10, or the host cell of claim 11.

15. The chimeric antigen receptor of any one of claims 2(b)-4 and 13, the isolated T cell of any one of claims 5 and 8-9, the expression vector for the use of claim 8, the expression vector of claim 10, or the host cell of claim 11, wherein the scFv comprises the complementarity determining region (CDR) sequences of SEQ ID NO: 15.

16. The chimeric antigen receptor of any one of claims 2(b)-4 and 13, the isolated T cell of any one of claims 5 and 8-9, the expression vector for the use of claim 8, the expression vector of claim 10, or the host cell of claim 11, wherein the scFv has the amino acid sequence of SEQ ID NO: 15.