SUMMARY OF THE INVENTION

[0003a] In one aspect, provided herein is a polypeptide comprising an antigen binding variable region comprising a CDR3 comprising:

(A) the amino acid sequence of SEQ ID NO:7 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:7; or

(B) the amino acid sequence of SEQ ID NO:14 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:14; or

(C) the amino acid sequence of SEQ ID NO:21 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:21; or

(D) the amino acid sequence of SEQ ID NO:28 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:28; or

(E) the amino acid sequence of SEQ ID NO:35 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:35; or

(F) the amino acid sequence of SEQ ID NO:42 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:42

(a) the variable region comprises a CDR1, CDR2, and/or CDR3; optionally wherein the variable region:

i) of (A) comprising a CDR1 and/or CDR2 with the amino acid sequence of SEQ ID NO:5 and 6, respectively, or with an amino acid sequence that is at least 80% sequence identity to SEQ ID NO:5 and SEQ ID NO:6, respectively; or

ii) of (B) comprising a CDR1 and/or CDR2 with the amino acid sequence of SEQ ID NO:12 and SEQ ID NO:13, respectively, or with at least 80% sequence identity to SEQ ID NO:12 and SEQ ID NO:13, respectively; or

iii) of (C) comprising a CDR1 and/or CDR2 with the amino acid sequence of SEQ ID NO:19 and 20, respectively, or with an amino acid sequence that is at least 80% sequence identity to SEQ ID NO:19 and SEQ ID NO:20, respectively; or

iv) of (D) comprising a CDR1 and/or CDR2 with the amino acid sequence of SEQ ID NO:26 and 27, respectively, or with an amino acid sequence that is at least 80% sequence identity to SEQ ID NO:26 and SEQ ID NO:27, respectively; or

v) of (E) comprising a CDR1 and/or CDR2 with the amino acid sequence of SEQ ID NO:33 and 34, respectively, or with an amino acid sequence that is at least 80% sequence identity to SEQ ID NO:33 and SEQ ID NO:34, respectively; or

vi) of (F) comprising a CDR1 and/or CDR2 with the amino acid sequence of SEQ ID NO:40 and 41, respectively, or with an amino acid sequence that is at least 80% sequence identity to SEQ ID NO:40 and SEQ ID NO:41, respectively; and/or

(b) the variable region:

i) of (A) comprises an amino acid sequence or SEQ ID NO:3 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:3; or

ii) of (B) comprises an amino acid sequence of SEQ ID NO:10 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:10; or

iii) of (C) comprises an amino acid sequence or SEQ ID NO:17 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:17; or

iv) of (D) comprises an amino acid sequence or SEQ ID NO:24 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:24; or

v) of (E) comprises an amino acid sequence or SEQ ID NO:31 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:31; or

vi) of (F) comprises an amino acid sequence or SEQ ID NO:38 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:38.

(c) The polypeptide:

(i) of (A), (C), or (E) comprises a T cell receptor alpha (TCR-a) variable region and/or a TCR-a variable and constant region; or

(ii) of (B), (D), or (F) comprises a T cell receptor beta (TCR-b) variable region and/or comprises a TCR-b variable and constant region;

(d) the polypeptide is recombinant.

[0003b] In another aspect, provided herein is an engineered T-cell Receptor (TCR) comprising a TCR-a polypeptide and a TCR-b polypeptide, wherein:

(A) the TCR-a polypeptide comprises a CDR3 with the amino acid sequence of SEQ ID NO:7 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:7; and the TCR-b polypeptide comprises a CDR3 with the amino acid sequence of SEQ ID NO:14 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:14;

(B) the TCR-a polypeptide comprises a CDR3 with the amino acid sequence of SEQ ID NO:21 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:21; and the TCR-b polypeptide comprises a CDR3 with the amino acid sequence of SEQ ID NO:28 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:28; or

(C) the TCR-a polypeptide comprises a CDR3 with the amino acid sequence of SEQ ID NO:35 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:35; and the TCR-b polypeptide comprises a CDR3 with the amino acid sequence of SEQ ID NO:42 or an amino acid sequence with at least 80% sequence identity to SEQ ID NO:42

Optionally wherein:

(a) the TCR-a polypeptide comprising a variable region comprising CDR1, CDR2, and CDR3 and a TCR-b polypeptide comprising a variable region comprising CDR1, CDR2, and CDR3;

(i) the TCR-a region:

(I) of (A) comprises a CDR1 having the amino acid sequence of SEQ ID NO:5 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:5; and/or the TCR-b polypeptide comprises a CDR1 having the amino acid sequence of SEQ ID NO:12 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:12; or

(II) of (B) comprises a CDR1 having the amino acid sequence of SEQ ID NO:19 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:19; and/or the TCR-b polypeptide comprises a CDR1 having the amino acid sequence of SEQ ID NO:26 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:26; or

(III) of (C) comprises a CDR1 having the amino acid sequence of SEQ ID NO:33 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:33; and/or the TCR-b polypeptide comprises a CDR1 having the amino acid sequence of SEQ ID NO:40 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:40

(ii)The TCR-a region:

(I) of (A) comprises a CDR2 having the amino acid sequence of SEQ ID NO:6 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:6; and/or the TCR-b polypeptide comprises a CDR2 having the amino acid sequence of SEQ ID NO:13 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:13; or

(II) of (B) comprises a CDR2 having the amino acid sequence of SEQ ID NO:20 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:20; and/or the TCR-b polypeptide comprises a CDR2 having the amino

acid sequence of SEQ ID NO:27 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:27; or

(III) of (C) comprises a CDR2 having the amino acid sequence of SEQ ID NO:34 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:34; and/or the TCR-b polypeptide comprises a CDR2 having the amino acid sequence of SEQ ID NO:41 or having an amino acid sequence with at least 80% sequence identity to SEQ ID NO:41.

(b) the CDR1, CDR2, and CDR3 of the TCR-a region:

(i) of (A) comprise the amino acid sequence of SEQ ID NOS:5, 6, and 7, respectively; and wherein the CDR1, CDR3, and CDR3 of the TCR-b polypeptide comprise the amino acid sequence of SEQ ID NO:12, 13, and 14, respectively; or

(ii) of (B) comprise the amino acid sequence of SEQ ID NOS:19, 20, and 21, respectively; and wherein the CDR1, CDR3, and CDR3 of the TCR-b polypeptide comprise the amino acid sequence of SEQ ID NO:26, 27, and 28, respectively; or

(iii) of (C) comprise the amino acid sequence of SEQ ID NOS:33, 34, and 35, respectively; and wherein the CDR1, CDR3, and CDR3 of the TCR-b polypeptide comprise the amino acid sequence of SEQ ID NO:40, 41, and 42, respectively.

(c) The TCR-a region:

(i) of (A) comprises the amino acid sequence of SEQ ID NO:3 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:3; and the TCR-b polypeptide comprises the amino acid sequence of SEQ ID NO:10 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:10; or

(ii) of (B) comprises the amino acid sequence of SEQ ID NO:17 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:17; and the TCR-b polypeptide comprises the amino acid sequence of SEQ ID NO:24 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:24; or

(iii) of (C) comprises the amino acid sequence of SEQ ID NO:31 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:31; and the TCR-b polypeptide comprises the amino acid sequence of SEQ ID NO:38 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:38

(d) The TCR-a region:

(i) of (A) comprises the amino acid sequence of SEQ ID NO:2 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:2 and/or the TCR-b polypeptide comprises the amino acid sequence of SEQ ID NO:9 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:9; or

(ii) of (B) comprises the amino acid sequence of SEQ ID NO:16 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:16 and/or the TCR-b polypeptide comprises the amino acid sequence of SEQ ID NO:23 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:23; or

(iii) of (C) comprises the amino acid sequence of SEQ ID NO:30 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:30 and/or the TCR-b polypeptide comprises the amino acid sequence of SEQ ID NO:37 or an amino acid sequence with at least 70% sequence identity to SEQ ID NO:37.

[0003c] In another aspect, provided herein is a peptide comprising at least 55% sequence identity to a peptide of one of SEQ ID NOS:43-45

(a) the peptide:

(i) comprises at least 6 contiguous amino acids of one of SEQ ID NO:43-45; or

(ii) consists of 9 or 10 amino acids, or

(iii) consist of a peptide of one of SEQ ID NOS:43-45.

(b) the peptide is immunogenic; and/or

(c) the peptide modified, optionally wherein:

(i) the modification comprises conjugation to a molecule; and/or

ii) the molecule comprises an antibody, a lipid, an adjuvant, or a detection moiety; and/or

iii) the peptide comprises 1, 2 or 3 substitutions relative to a peptide of one of SEQ ID NOS:43-45.

[0003d] In another aspect, provided herein is a polypeptide comprising the peptide as described herein and at least one MHC polypeptide, optionally wherein:

(i) the MHC polypeptide and peptide are operatively linked through a peptide bond or van der Waals forces; or

(ii) the MHC polypeptide is conjugated to a detection tag; or

(iii) the peptide is bound to a peptide specific binding molecule.

[0003e] In another aspect, provided herein is a method of producing peptide-specific immune effector cells comprising:

(a) contacting a starting population of immune effector cells with a peptide or polypeptide as described herein, thereby generating peptide-specific immune effector cells,

(b) purifying immune effector cells specific to the peptide,

(c) isolating a TCR sequence from the purified immune effector cells,

optionally wherein:

(i) contacting comprises co-culturing the starting population of immune effector cells with antigen presenting cells (APCs), artificial antigen presenting cells (aAPCs), or an artificial antigen presenting surface (aAPSs); wherein the APCs, aAPCs, or the aAPSs present the peptide on their surface; and/or

(ii) purifying comprises a population of CD8-positive and peptide MHC tetramer-positive T cells from the immune effector cells following the co-culturing, wherein the population of CD8-positive and peptide MHC tetramer-positive T cells are purified by fluorescence activated cell sorting (FACS), wherein purifying further comprises generation of a clonal population of peptide-specific immune effector cells by limiting or serial dilution of sorted cells followed by expansion of individual clones by a rapid expansion protocol, and/or wherein the method further comprises cloning of a T cell receptor (TCR) from the clonal population of peptide-specific immune effector cells.

[0003f] In another aspect, provided herein is a peptide-specific engineered T cell or TCR produced according to the method as described herein.

[0003g] In another aspect, provided herein is a fusion protein comprising the TCR as described herein and a CD3 binding region and optionally wherein the CD3 binding region comprises a CD3-specific fragment antigen binding (Fab), single chain variable fragment (scFv), single domain antibody, or single chain antibody.

[0003h] In another aspect, provided herein is a nucleic acid or expression vector encoding the polypeptide as described herein, the TCR as described herein or the peptide as described herein.

[0003i] In another aspect, provided herein is a cell comprising the polypeptide as described herein, the TCR as described herein, or the nucleic acid(s) or expression vector as described herein.

[0003j] In another aspect, provided herein is an *in vitro* isolated dendritic cell comprising the nucleic acid or expression vector as described herein; and optionally wherein the dendritic cell is a mature dendritic cell and/or wherein the cell is a cell with an HLA-A, HLA-B, or HLA-C type.

[0003k] In another aspect, provided herein is a composition comprising the cell as described herein.

[0003l] In another aspect, provided herein is a method of making an engineered cell comprising transferring the nucleic acid(s) as described herein into a cell and optionally wherein the method further comprises culturing the cell in media, incubating the cell at conditions that allow for the division of the cell, screening the cell, and/or freezing the cell.

[0003m] In another aspect, provided herein is use of the composition as described herein in the manufacture of a medicament for treating or preventing cancer or for stimulating an immune response in a subject.

[0003n] In another aspect, provided herein is a method for prognosing a patient or for detecting T cell responses in a patient, the method comprising: contacting a biological sample obtained from the patient with the peptide, polypeptide, composition, or molecular complex as described herein.

[0003o] In another aspect, provided herein a kit comprising the peptide or polypeptide as described herein in a container**.**

[0003p] In another aspect, provided herein is the composition as described herein for use in therapy.

[0004] This disclosure provides for peptides useful for vaccination and other applications, engineered T cell Receptors (TCRs), cells comprising the peptides and TCRs, and methods of making and using the peptides and TCRs. The current disclosure relates to TCRs that specifically recognize a cancer testis antigen such as Fanci, RAD51, or PBK, or peptide therefrom, such as a peptide having the amino acid sequence of KLQEFLQTL (SEQ ID NO:43), RLADEFGVAV (SEQ ID NO:44), or SYQKVIELF (SEQ ID NO:45).

[0005] Accordingly, aspects of the disclosure relate to a polypeptide comprising an antigen binding variable region comprising a CDR3 comprising an amino acid sequence with at least 80% sequence identity to SEQ ID NO:7. Other aspects relate to a polypeptide comprising an antigen binding variable region comprising a CDR3 comprising an amino acid sequence with at least 80% sequence identity to SEQ ID NO:14. Further aspects of the disclosure relate to a polypeptide comprising an antigen binding variable region comprising a CDR3 comprising an amino acid sequence with at least 80% sequence identity to SEQ ID NO:21. Aspects relate to a polypeptide comprising an antigen binding variable region comprising a CDR3 comprising an amino acid sequence with at least 80% sequence identity to SEQ ID NO:28. Further aspects of the disclosure relate to a polypeptide comprising an antigen binding variable region comprising a CDR3 comprising an amino acid sequence with at least 80% sequence identity to

SEQ ID NO:35. Aspects relate to a polypeptide comprising an antigen binding variable region comprising a CDR3 comprising an amino acid sequence with at least 80% sequence identity to SEQ ID NO:42.

[0006] The disclosure also provides for T-cell receptors (TCR) and engineered TCRs, such as a TCR comprising a TCR-a polypeptide and a TCR-b polypeptide, wherein the TCR-a polypeptide comprises a CDR3 comprising an amino acid sequence with at least 80% sequence identity to SEQ ID NO:7 and the TCR-b polypeptide comprises a CDR3 comprising an amino acid sequence with at least 80% sequence identity to SEQ ID NO:14. The TCR-a polypeptide may comprise a CDR3 comprising an amino acid sequence having or having at least 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, or 100% (or any derivable range therein) sequence identity to SEQ ID NO:7 and the TCR-b polypeptide may comprise a CDR3 comprising an amino acid sequence having or having at least 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, or 100% (or any derivable range therein) sequence identity to SEQ ID