Claims

1. A peptide ~~comprising an~~ consisting of the amino acid sequence ~~selected from the group consisting~~ of SEQ ID NO: 87 ~~and SEQ ID NOs: 1 to 86 and 88 to 398~~, or a pharmaceutically acceptable salt thereof~~,, wherein said peptide has a maximal length of 12 amino acids~~.

2. The peptide or the salt thereof according to claim 1, wherein said peptide has the ability to bind to a major histocompatibility complex (MHC) class-I ~~or –II~~ molecule, and wherein said peptide, when bound to said MHC, is capable of being recognized by ~~CD4 and/or~~ CD8 T cells.

~~**3.** The peptide or the salt thereof according to claim 1 or 2, wherein the peptide consists of an amino acid sequence according to any one of SEQ ID NOs: 87, 1 to 86 and 88 to 398.~~

~~4.~~3. The peptide or the salt thereof according to any of claims 1 to ~~3~~2, wherein said peptide ~~comprises one or more chemically modified amino acids and/or~~ includes non-peptide bonds.

~~5.~~4. A fusion protein, comprising ~~a~~the peptide according to any of claim 1 to 3~~of maximally 12 amino acids in length, the peptide comprising an amino acid sequence selected from the group consisting of any of SEQ ID NOs: 87, 1 to 86 and 88 to 398, and~~ in particular comprising the N-terminal amino acids of the HLA-DR antigen-associated invariant chain (Ii).

~~6.~~5. A binding molecule that specifically recognizes the peptide according to any one of claims 1 to ~~4~~3, or the peptide according to any one of claims 1 to ~~4~~3 when bound to an MHC molecule, the binding molecule being

~~**7.** The binding molecule of claim 6, being~~

(i) an antibody, soluble or membrane-bound, or a functional fragment thereof, or

(ii) a T-cell receptor (TCR), or a functional fragment thereof, that is reactive with an HLA ligand, the HLA ligand being the peptide ~~or variant thereof~~ according to any one of claims 1 to ~~4~~3, or the peptide according to any one of claims 1 to ~~4~~3 when bound to an MHC molecule.

~~8.~~6. The binding molecule of claim ~~7~~5, wherein (i) the antibody is a monoclonal antibody, a chimeric antibody and/or a humanized antibody, or a functional fragment thereof, (ii) the antibody binds to said peptide when bound to an MHC molecule and is a bi-specific antibody or a functional fragment thereof and/or (iii) wherein the T-cell receptor is soluble or membrane-bound.

~~9.~~**7.** The binding molecule of claim ~~7~~5 or ~~8~~6, being an antibody or a soluble TCR, or a functional fragment thereof, which carries a further effector function such as an immune stimulating domain or toxin.

~~10.~~**8.** A nucleic acid, encoding the peptide of any one of claims 1 to 3~~4 claim 1 or 3~~, or the binding molecule according to any one of claims ~~7~~5 to ~~9~~7, optionally linked to a heterologous promoter sequence, or an expression vector expressing said nucleic acid.

~~11. An expression vector comprising the nucleic acid of claim 10.~~

~~12.~~**9.** A recombinant host cell comprising the peptide of any one of claims claim 1 to ~~4~~3, the binding molecule of any one of claims ~~7~~ 5 to ~~9~~7, ~~the~~ the nucleic acid ~~according to claim 10~~ or the expression vector according to claim ~~11~~8~~.~~,

~~13. The recombinant host cell according to claim 12,~~ wherein said host cell is (i) an antigen presenting cell, such as a dendritic cell, (ii) a T cell or (iii) an NK cell.

~~14.~~**10.** An *in vitro* method for producing activated T lymphocytes, the method comprising contacting *in vitro* T cells with antigen loaded human class I ~~or II~~ MHC molecules expressed on the surface of a suitable antigen-presenting cell or an artificial construct mimicking an antigen-presenting cell for a period of time sufficient to activate said T cells in an antigen specific manner, wherein said antigen is a peptide according to any one of claims 1 to ~~3~~2.

~~15.~~**11.** An activated T lymphocyte, produced by the method of claim ~~14~~10, that selectively recognizes a cell which presents a polypeptide comprising an amino acid sequence given in any one of claims 1 to~~3~~ 2.

~~16.~~**12.** A pharmaceutical composition comprising at least one active ingredient selected from the group consisting of the peptide or the salt thereof according to any one of claims 1 to ~~4~~3, the fusion protein according to claim ~~5~~4, the binding molecule according to any one of claims ~~6~~5 to ~~9~~7, the nucleic acid ~~according to claim 10,~~or the expression vector according to claim ~~11~~8, the recombinant host cell according to claim~~ 12 or 13~~9, or the activated T lymphocyte according to claim ~~15~~11, ~~or a conjugated or labelled active ingredient,~~ and a pharmaceutically acceptable carrier, and/or a pharmaceutically acceptable excipient.

13. The pharmaceutical composition according to claim ~~16~~12, wherein (i) the pharmaceutical composition further comprises an immunogenicity enhancing amount of an adjuvant, and/or (ii) wherein the pharmaceutical composition is a vaccine or a cellular therapy.

~~17.~~14. The pharmaceutical composition according to claim 13, wherein the adjuvant is an interleukin, including IL-2, IL-15 or a combination thereof.

~~18.~~15. A method for producing the peptide according to any one of claims 1 to ~~4~~3, or the binding molecule according to any one of claims ~~7~~ 5 to ~~9~~7, the method comprising culturing the recombinant host cell according to claim ~~12 or 13~~ 9, and isolating the peptide or the binding molecule from said host cell and/or its culture medium.

~~19.~~16. The peptide or salt thereof according to any one of claims 1 to ~~4~~3, the fusion protein according to claim ~~5~~4, binding molecule according to any one of claims ~~7~~5 to ~~9~~7, the nucleic acid ~~according to claim 10,~~ or the expression vector according to claim ~~11~~8, the recombinant host cell according to claim ~~12 or 13~~ 9, or the activated T lymphocyte according to claim ~~15~~ 11 for ~~use in medicine.~~

~~**20.** The peptide or variant or salt thereof, fusion protein, binding molecule, nucleic acid, expression vector, recombinant host cell, activated T lymphocyte or pharmaceutical composition for use of claim 19, wherein the use is~~ in the treatment and/or diagnosis of cancer or for use in the manufacture of a medicament for treating cancer, wherein said cancer shows an overpresentation of a peptide of SEQ ID No. 87.

~~**21.** Use of the peptide or salt thereof according to any one of claims 1 to 4, the fusion protein according to claim 5, the binding molecule according to any one of claims 6 to 9, the nucleic acid according to claim 10, the expression vector according to claim 11, the recombinant host cell according to claim 12 or 13, or the activated T lymphocyte according to claim 15 in the manufacture of a medicament for treating cancer.~~

~~22.~~17. The peptide or salt thereof, fusion protein, binding molecule, nucleic acid, expression vector, recombinant host cell, activated T lymphocyte or pharmaceutical composition for use of claim ~~20 or the use according to claim 21~~16, wherein said cancer is selected from acute myeloid leukemia, breast cancer, cholangiocellular carcinoma, chronic lymphocytic leukemia, colorectal

cancer, gallbladder cancer, glioblastoma, gastric cancer, hepatocellular carcinoma, head and neck squamous cell carcinoma, melanoma, non-Hodgkin lymphoma, lung cancer (including non-small cell lung cancer adenocarcinoma, squamous cell non-small cell lung cancer, and small cell lung cancer), ovarian cancer, esophageal cancer, pancreatic cancer, prostate cancer, renal cell carcinoma, urinary bladder carcinoma, uterine and endometrial cancer. ~~and other tumors that show an overexpression of a protein from which a peptide having a sequence of one of SEQ ID NOs: 87, 1 to 86 and 88 to 398 is derived.~~

18. An effective number of activated T cells as defined in claim 11 for use in killing target cancer cells in a patient, which target cancer cells present a peptide according to any one of claims 1 to 3.

~~23.~~**19.** A kit comprising

(a) a container comprising a pharmaceutical composition containing the peptide or the salt thereof according to any one of claims 1 to ~~4~~3, the fusion protein according to claim ~~5~~4, the binding molecule according to any one of claims ~~6~~ 5 to ~~9~~7, ~~the~~ nucleic acid ~~according to claim 10,~~ or the expression vector according to claim ~~11~~8, the recombinant host cell according to claim ~~12 or 13~~9, or the activated T lymphocyte according to claim ~~15~~11, in solution or in lyophilized form; and

(b) optionally, a second container containing a diluent or reconstituting solution for the lyophilized formulation;

(c) optionally, at least one more peptide selected from the group consisting of SEQ ID NO: 1 to SEQ ID NO: 432.

~~24.~~**20.** The kit according to claim ~~23~~19, further comprising one or more of (i) a buffer, (ii) a diluent, (iii) a filter, (iv) a needle, ~~or~~ (vii) a syringe, or (viii) an adjuvant.

~~25.~~**21.** A method for producing a personalized anti-cancer vaccine or a compound-based and/or cellular therapy for an individual patient, said method comprising:

a) identifying a tumor-associated peptide (TUMAP) presented by a tumor sample of said individual patient;

b) comparing the peptides as identified in a) with a warehouse of peptides that have been pre-screened for immunogenicity and/or over-presentation in tumors as compared to normal tissues;

c) selecting at least one peptide from the warehouse that matches the TUMAP identified in the sample of the patient; and

d) manufacturing and/or formulating the personalized vaccine or compound-based or cellular therapy based on step c);
wherein said warehouse comprises a peptide having a sequence according to ~~any of~~ SEQ ID NOs: 87~~, 1 to 86 and 88 to 398~~.

~~26.~~**22.** The method according to claim ~~25~~21, wherein said TUMAP is identified by:
a1) comparing expression data from the tumor sample to expression data from a sample of normal tissue corresponding to the tissue type of the tumor sample to identify proteins that are over-expressed or aberrantly expressed in the tumor sample; and
a2) correlating the expression data with sequences of MHC ligands bound to MHC class I and/or class II molecules in the tumor sample to identify MHC ligands derived from proteins over-expressed or aberrantly expressed by the tumor.

~~27.~~**23.** The method of claim ~~25~~ 21 or ~~26~~22, wherein the sequences of MHC ligands are identified by eluting bound peptides from MHC molecules isolated from the tumor sample and sequencing the eluted ligands.

~~28.~~**24.** The method of any one of claims ~~25~~ 21 to ~~27~~23, wherein the normal tissue corresponding to the tissue type of the tumor sample has been obtained from the same patient.

~~29.~~**25.** The method of any one of claims ~~25~~ 21 to ~~28~~24, wherein the immunogenicity of the peptides included in the warehouse is determined by a method comprising *in vitro* immunogenicity assays, MHC multimer staining, ELISPOT assays and/or intracellular cytokine staining.

~~30.~~**26.** The method of any one of claims ~~25~~ 21 to ~~29~~25, further comprising identifying at least one mutation that is unique to the tumor sample relative to normal corresponding tissue from the individual patient and selecting a peptide that correlates with the mutation for inclusion in the vaccine or for the generation of cellular therapies.

~~31.~~**27.** The method of claim ~~30~~26, wherein said at least one mutation is identified by whole genome sequencing.

~~32. A composition comprising a population of activated T cells that kill cancer cells in the patient that express the peptide of any one of claims 1 to 3 for use in a method of treating a patient~~

who has cancer, wherein said cancer is selected from acute myeloid leukemia, breast cancer, cholangiocellular carcinoma, chronic lymphocytic leukemia, colorectal cancer, gallbladder cancer, glioblastoma, gastric cancer, hepatocellular carcinoma, head and neck squamous cell carcinoma, melanoma, non-Hodgkin lymphoma, non-small cell lung cancer adenocarcinoma, squamous cell non-small cell lung cancer, small cell lung cancer, ovarian cancer, esophageal cancer, pancreatic cancer, prostate cancer, renal cell carcinoma, urinary bladder carcinoma, uterine and endometrial cancer.

33. A population of activated T cells that kill cancer cells of a patient that aberrantly express the peptide of any one of claims 1 to 3 for use in a method of eliciting an immune response in the patient who has cancer, wherein said cancer is selected from acute myeloid leukemia, breast cancer, cholangiocellular carcinoma, chronic lymphocytic leukemia, colorectal cancer, gallbladder cancer, glioblastoma, gastric cancer, hepatocellular carcinoma, head and neck squamous cell carcinoma, melanoma, non-Hodgkin lymphoma, lung cancer, ovarian cancer, esophageal cancer, pancreatic cancer, prostate cancer, renal cell carcinoma, urinary bladder carcinoma, uterine and endometrial cancer.

34. The composition for use according to claim 32 or the population of activated T cells for use according to 33, wherein the T cells are autologous to the patient.

35. The composition for use according to claim 32 or the population of activated T cells for use according to 33, wherein the T cells are obtained from a healthy donor.

36. The composition for use according to claim 32 or the population of activated T cells for use according to 33, wherein the T cells are derived from tumor infiltrating lymphocytes or peripheral blood mononuclear cells.

39. The composition or population of activated T cells for use according to any one of claims 32 to 36, wherein the activated T cells are produced by contacting T cells, *in vitro*, with an antigen presenting cell that expresses the peptide in a complex with an MHC class I molecule on the surface of the antigen presenting cell, for a period of time sufficient to activate said T cell.