Claims

1. An individualized therapeutic anticancer vaccine comprising an immunologically effective amount of:

(i) a polynucleotide comprising a nucleotide sequence encoding a targeting unit, a dimerization unit and an antigenic unit, wherein said antigenic unit comprises at least one patient-present shared antigen sequence or one or more parts thereof; or

(ii) a polypeptide encoded by the polynucleotide as defined in (i); or

(iii) a dimeric protein consisting of two polypeptides encoded by the polynucleotide as defined in (i); and

a pharmaceutically acceptable carrier.

2. The vaccine according to claim 1, wherein said antigenic unit further comprises one or more patient-specific antigen sequences or one or more parts thereof.

3. The vaccine according to any of claims 1 or 2, wherein said at least one patient-present shared antigen sequence is a sequence of a shared antigen selected from the group consisting of overexpressed cellular proteins, aberrantly expressed cellular proteins, cancer testis antigens, viral antigens, differentiation antigens, mutated oncogenes, mutated tumor suppressor genes, oncofetal antigens, shared fusion antigens, shared intron retention antigens, dark matter antigens, shared antigens caused by spliceosome mutations and shared antigens caused by frameshift mutations.

4. The vaccine according to any of claims 1 to 3, wherein said at least one patient-present shared antigen sequence is a sequence of a shared antigen that is a human cellular protein.

5. The vaccine according to any of claims 1 to 4, wherein said at least one patient-present shared antigen sequence or one or more parts thereof are known to be immunogenic or are predicted to bind to the patient's HLA class I and/or HLA class II alleles.

6. The vaccine according to any of claims 1 to 5, wherein said at least one patient-present shared antigen sequence or the one or more parts thereof have a length suitable for presentation by the patient's HLA alleles, preferably have a length of from 7 to 30 amino acids.

7. The vaccine according to any of claims 1 to 6, wherein the antigenic unit comprises sequences of several patient-present shared antigens or one or more parts thereof.

8. The vaccine according to claim 7, wherein the antigenic unit comprises several parts of sequences of several patient-present shared antigens.

9. The vaccine according to claim 8, wherein the antigenic unit comprises several epitopes of several patient-present shared antigens, which epitopes are known to be immunogenic or are predicted to bind to the patient's HLA class I and/or HLA class II alleles.

10. The vaccine according to any of claims 1 to 9, wherein the antigenic unit comprises one or more patient-present shared antigen sequences in full length.

11. The vaccine according to any of claims 1 to 10, wherein the antigenic unit comprises 1 to 30 parts of at least one patient-present shared antigen sequence.

12. The vaccine according to claim 11, wherein the parts include multiple epitopes that are predicted to bind to the patient's HLA class I and/or HLA class II alleles.

13. The vaccine according to any of claims 1 to 12, wherein the antigenic unit comprises 1 to 50 patient-present shared antigen sequences in the form of epitopes.

14. The vaccine according to claim 13, wherein the epitopes are predicted to bind to the patient's HLA class I and/or HLA class II alleles.

15. The vaccine according to any of claims 13 to 14, wherein the epitopes have a length of from 7 to 30 amino acids.

16. The vaccine according to any of claims 2 to 15, wherein the antigenic unit comprises several patient-specific antigen sequences or one or more parts thereof.

17. The vaccine according to any of claims 2 to 16, wherein the antigenic unit comprises one or more patient-specific epitopes.

18. The vaccine according to claim 17, wherein the one or more patient-specific epitopes have a length of from 7 to 30 amino acids.

19. The vaccine according to any of claims 17 to 18, wherein antigenic unit comprises at least 5 patient-specific epitopes.

20. The vaccine according to any of the preceding claims, wherein the antigenic unit comprises from 7 to 2000 amino acids.

21. The vaccine according to any of the preceding claims, wherein the antigenic unit comprises one or more linkers, preferably one or more linkers which separate the antigen sequences from each other.

22. The vaccine according to any of the preceding claims, wherein the dimerization unit comprises a hinge region, preferably a hinge region which is Ig derived.

23 The vaccine according to claim 22, wherein the dimerization unit further comprises another domain that facilitates dimerization, preferably an immunoglobulin domain and more preferably an immunoglobulin constant domain.

24. The vaccine according to any of claims 22 or 23, wherein the other domain is a carboxyterminal C domain derived from IgG, preferably derived from IgG3.

25. The vaccine according to any of claims 22 to 24, wherein the dimerization unit further comprises a linker, preferably a linker that connects the hinge region and the other domain that facilitates dimerization.

26. The vaccine according to any of claims 22 to 25, wherein the dimerization unit comprises hinge exons h1 and h4 connected through a linker to a CH3 domain of human IgG3.

27. The vaccine according to any of the preceding claims, wherein the antigenic unit and the dimerization unit are connected through a linker, preferably a linker that comprises a restriction site.

28. The vaccine according to any of the preceding claims, wherein the targeting unit targets antigen presenting cells, preferably wherein the targeting unit is or comprises a moiety that interacts with surface molecules on the antigen presenting cells, preferably surface molecules selected from the group consisting of HLA, CD14, CD40, chemokine receptors and Toll-like receptors.

29. The vaccine according to claim 28, wherein the targeting unit comprises or consists of soluble CD40 ligand, RANTES, MIP-1α, XCL1, XCL2, flagellin, anti-HLA-DP, anti-HLA-DR, anti-pan HLA class II or an antibody variable domain with specificity for anti-CD40, anti-TLR-2, anti-TLR-4 or anti-TLR-5, preferably comprises or consists of MIP-1α.

30. The vaccine according to any of the preceding claims, wherein said vaccine comprises a polynucleotide, preferably an RNA or DNA.

31. The vaccine according to claim 30, wherein the polynucleotide further comprises a nucleotide sequence encoding a signal peptide.

32. The vaccine according to any of the preceding claims, wherein said targeting unit, dimerization unit and antigenic unit in said polypeptide are in the N-terminal to C-terminal order of targeting unit, dimerization unit and antigenic unit or wherein said targeting unit, dimerization unit and antigenic unit in said polynucleotide are in the 5' to 3' order of targeting unit, dimerization unit and antigenic unit.

33. The vaccine according to any of the preceding claims, wherein the pharmaceutically acceptable carrier is selected from the group consisting of saline, buffered saline, PBS, dextrose, water, glycerol, ethanol, sterile isotonic aqueous buffers, and combinations thereof.

34. A method for preparing the individualized therapeutic anticancer vaccine of claim 1, said method comprises the steps of:

a) identifying at least one patient-present shared antigen in the tumor tissue or body fluid of a patient
b) determining the patient's HLA class I and/or class II alleles
c) predicting the immunogenicity of the identified at least one antigen or one or more parts thereof by their predicted binding to the patient's HLA class I and/or II alleles
d) selecting at least one antigen or one or more parts thereof based on their immunogenicity predicted in step c);
e) preparing a polynucleotide sequence comprising an antigenic unit comprising a nucleotide sequence encoding the at least one antigen or one or more parts thereof selected in step d);
f) cloning the polynucleotide sequence into an expression vector comprising nucleotide sequences encoding a targeting unit and a dimerization unit; and
g) mixing the expression vector obtained in step f with a pharmaceutically acceptable carrier.

35. The method according to claim 34 for preparing the individualized anticancer vaccine of claim 2, wherein said method further comprises:
in step a) identifying one or more patient-specific antigens in the tumor tissue of the patient
in step c) predicting the immunogenicity of the identified one or more patient-specific antigens or one or more parts thereof by their predicted binding to the patient's HLA class I and/or II alleles
in step d) selecting one or more patient-specific antigens or one or more parts thereof based on their immunogenicity predicted in step c);

and wherein the polynucleotide sequence of step e) further comprises nucleotide sequences encoding the one or more patient-specific antigens or one or more parts thereof selected in step d).

36. A polynucleotide as defined in any of the claims 1 to 32.

37. A vector comprising the polynucleotide according to claim 36.

38. A host cell comprising the polynucleotide as defined in any of the claims 1 to 32 or comprising the vector according to claim 37.

39. A polypeptide encoded by the polynucleotide sequence as defined in any of the claims 1 to 32.

40. A dimeric protein consisting of two polypeptides as defined in claim 39.

41. The dimeric protein according to claim 40, being a homodimeric protein.

42. The polynucleotide according to claim 36 or the polypeptide according to claim 39 or the dimeric protein according to any of claims 40 or 41 for use as a medicament.

43. A method of treating a patient having cancer, the method comprising administering to the patient the vaccine according to any of claims 1 to 33, which has been prepared specifically for the patient.

44. The method according to claim 43, wherein the vaccine comprises a polynucleotide and is administered intradermally or intramuscularly.