CLAIMS

What is claimed is:

1. A multivalent HPV immunogenic composition suitable for preventing HPV-related diseases or infections, comprising:

HPV virus-like particles assembled from the L1 protein of HPV Types 6, 11, 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, ~~and~~ 58 and 59; wherein at least one of said HPV virus-like particles is assembled from chimeric HPV L1 protein which comprises, from its N-terminus to C-terminus orientation:

a. an N-terminal fragment derived from L1 protein of a first papilloma virus type and obtained by truncating the C-terminus of the natural sequence of said L1 protein of the first papilloma virus type at any amino acid position within its α5 region, or a fragment having at least 98% identity therewith, wherein said N-terminal fragment maintains the immunogenicity of the L1 protein of the first papilloma virus type, wherein said L1 protein of the first papilloma virus type is selected from HPV Types 6, 11, 16, 18, 31, 35, 39, 45, 51, 52, 56, 58; and

b. a C-terminal fragment derived from L1 protein of a second papilloma virus type and obtained by truncating the N-terminus of the natural sequence of said L1 protein of the second papilloma virus type at any amino acid position within its α5 region or functional variants resulting from further mutations, deletions and/or additions to the fragment, wherein said L1 protein of the second papilloma virus type has a better expression level and solubility compared to L1 proteins of other types, and wherein said L1 protein of the second papilloma virus

type is selected from L1 proteins of HPV Types 16, 28, 33, 59, or 68;

wherein the chimeric HPV L1 protein has the immunogenicity of the L1 protein of the first papilloma virus type. ~~One or more HPV virus-like particles assembled from L1 proteins of other pathogenic HPV types.~~

~~2. The multivalent HPV immunogenic composition according to claim 1, wherein said one or more other pathogenic HPV types are selected from HPV Types 35, 39, 51, 56 and 59.~~

~~3. The multivalent HPV immunogenic composition according to claims 1 or 2, wherein at least one of said HPV virus-like particles is a chimeric HPV virus-like particle, said chimeric HPV L1 protein comprises, from its N-terminus to C-terminus orientation:~~

~~a. an N-terminal fragment derived from L1 protein of the first papilloma virus type, said N-terminal fragment maintains the immunogenicity of the L1 protein of the first papilloma virus type, wherein said L1 protein of the first papilloma virus type is selected from HPV Types 6, 11, 16, 18, 31, 35, 39, 45, 51, 52, 56, 58, and one or more other pathogenic HPV types; and~~

~~b. a C-terminal fragment derived from L1 protein of the second papilloma virus type, said L1 protein of the second papilloma virus type has a better expression level and solubility compared to L1 proteins of other types;~~

~~Wherein the chimeric HPV L1 protein has the immunogenicity of the L1 protein of the first papilloma virus type.~~

~~4. The multivalent HPV immunogenic composition according to~~

~~claim 3, wherein~~

~~Said N-terminal fragment is a fragment obtained by truncating the C-terminus of the natural sequence of said L1 protein of the first papilloma virus type at any amino acid position within its α5 region, and a fragment having at least 98% identity therewith; and~~

~~Said C-terminal fragment is a fragment obtained by truncating the N-terminus of the natural sequence of said L1 protein of the second papilloma virus type at any amino acid position within its α5 region and functional variants resulting from further mutations, deletions and/or additions to the fragment.~~

~~5~~2. The multivalent HPV immunogenic composition according to claim ~~4~~1, wherein said C-terminal fragment contains one or more nuclear localization sequences.

~~6~~3. The multivalent HPV immunogenic composition according to claim ~~3~~1,

~~Wherein~~ wherein said L1 protein of the first papilloma virus type is selected from L1 proteins of HPV Types 6, 11, 16, 18, 31, 35, 39, 45, 51, 52, 56 or 58;

preferably, selected from

HPV type 6 L1 protein encoded by the gene thereof shown in SEQ ID No: 5,

HPV type 11 L1 protein encoded by the gene thereof shown in SEQ ID No: 18,

HPV type 16 L1 protein encoded by the gene thereof shown in SEQ ID No: 31,

HPV type 18 L1 protein encoded by the gene thereof shown in SEQ ID

No: 44,

HPV type 31 L1 protein encoded by the gene thereof shown in SEQ ID No: 57,

HPV type 35 L1 protein encoded by the gene thereof shown in SEQ ID No: 73,

HPV type 39 L1 protein encoded by the gene thereof shown in SEQ ID No: 86,

HPV type 45 L1 protein encoded by the gene thereof shown in SEQ ID No: 99,

HPV type 51 L1 protein encoded by the gene thereof shown in SEQ ID No: 112,

HPV type 52 L1 protein encoded by the gene thereof shown in SEQ ID No: 125,

HPV type 56 L1 protein encoded by the gene thereof shown in SEQ ID No: 138, or

HPV type 58 L1 protein encoded by the gene thereof shown in SEQ ID No: 151;

~~Wherein~~ wherein said L1 protein of the second papilloma virus type is selected from L1 proteins of HPV Types 1, 2, 3, 4, 6, 7, 10, 11, 13, 16, 18, 22, 26, 28, 31, 32, 33, 35, 39, 42, 44, 45, 51, 52, 53, 56, 58, 59, 60, 63, 66, 68, 73 or 82;

~~Preferably~~preferably, said L1 protein of the second papilloma virus type is selected from L1 proteins of HPV Types 16, 28, 33, 59, or 68;

~~More~~ more preferably, said L1 protein of the second papilloma virus type is selected from L1 proteins of HPV Type 33 or HPV Type 59.

~~7~~4. The multivalent HPV immunogenic composition according to claim ~~6~~3, wherein said C-terminal fragment is SEQ ID No: 2; or a fragment having a length of m1 amino acids, preferably a fragment covering amino acids 1-m1 position of SEQ ID No: 2; wherein m1 is an integer of 8-26; or said C-terminal fragment is SEQ ID No: 135; or a fragment having a length of m2 amino acids, preferably a fragment covering amino acids 1-m2 position of SEQ ID No: 135; wherein m2 is an integer of 13-31.

~~8~~5. The multivalent HPV immunogenic composition according to claim ~~6~~3, wherein said C-terminal fragment is SEQ ID No: 13; or a fragment having a length of n amino acids, preferably covering amino acids 1-n position of SEQ ID No: 13; wherein n is an integer of 16-38.

~~9~~6. The multivalent HPV immunogenic composition according to claim ~~3~~1, wherein

~~Said~~ said N-terminal fragment of said HPV Type 6 L1 protein has 98%, 98.5%, 99%, 99.5%, 99%, or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 1 at any amino acid site within its alpha 5 region;

~~Said~~ said N-terminal fragment of said HPV Type 11 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 14 at any amino acid site within its alpha 5 region;

~~Said~~ said N-terminal fragment of said HPV Type 16 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 27 at any amino acid site within its alpha 5 region;

~~S~~s~~s~~aid N-terminal fragment of said HPV Type 18 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 40 at any amino acid site within its alpha 5 region;

~~S~~s~~s~~aid N-terminal fragment of said HPV Type 31 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 53 at any amino acid site within its alpha 5 region;

~~Said~~ said N-terminal fragment of said HPV Type 35 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 69 at any amino acid site within its alpha 5 region;

~~Said~~ said N-terminal fragment of said HPV Type 39 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 82 at any amino acid site within its alpha 5 region;

~~Said~~ said N-terminal fragment of said HPV Type 45 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 95 at any amino acid site within its alpha 5 region;

~~Said~~ said N-terminal fragment of said HPV Type 51 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 108 at any amino acid site within its alpha 5 region;

~~Said~~ said N-terminal fragment of said HPV Type 52 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 121 at any amino acid site within its alpha 5 region;

~~Said~~ said N-terminal fragment of said HPV Type 56 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 134 at any amino acid site within its alpha 5 region; and

~~Said~~ said N-terminal fragment of said HPV Type 58 L1 protein has 98%, 98.5%, 99%, 99.5%, 99% or 100% identity to the fragment obtained by truncating the C-terminus of the sequence shown in SEQ ID No: 147 at any amino acid site within its alpha 5 region.

~~10~~7. The multivalent HPV immunogenic composition according to claim ~~3~~1, wherein the C-terminus of said N-terminal fragment is connected to the N-terminus of said C-terminal fragment directly or via a linker.

~~11~~8. The multivalent HPV immunogenic composition according to claim ~~3~~1, wherein when the C-terminus of said N-terminal fragment is connected to the N-terminus of said C-terminal fragment, the continuous amino acid sequence RKFL is present within a range of plus or minus 4 amino acid positions of the connection point,

~~Preferably~~preferably, the continuous amino acid sequence LGRKFL is present within a range of plus or minus 6 amino acid positions of the connection point.

~~12~~9. The multivalent HPV immunogenic composition according to claim ~~3~~1, wherein

~~Said~~ said chimeric HPV L1 protein of HPV Types 6, 11, 16, 18, 31, 35, 39, 45, 51, 52, 56, and 58 has 98%, 98.5%, 99%, 99.5% or 100% identity to SEQ ID No: 3, SEQ ID No: 16, SEQ ID No: 29, SEQ ID No:

42, SEQ ID No: 55, SEQ ID No: 71, SEQ ID No: 84, SEQ ID No: 97, SEQ ID No: 110, SEQ ID No: 123, SEQ ID No: 136 and SEQ ID No: 149, respectively; and

~~The~~ the HPV Type 33 L1 protein and the HPV Type 59 L1 protein has 98%, 98.5%, 99%, 99.5%, or 100% identity to SEQ ID No: 66 and SEQ ID No: 160, respectively;

~~Preferably~~preferably, comprising

~~Chimeric~~ chimeric HPV L1 protein of HPV types 6, 11, 16, 18, 31, 35, 39, 45, 51, 52 , 56 and 58, HPV Type 33 L1 protein and HPV Type 59 L1 protein,

w~~W~~herein said chimeric HPV L1 protein of HPV Types 6, 11, 16, 18, 31, 35, 39, 45, 51, 52, 56 and 58 is shown in SEQ ID No: 3, SEQ ID No: 16, SEQ ID No: 29, SEQ ID No: 42, SEQ ID No: 55, SEQ ID No: 71, SEQ ID No: 84, SEQ ID No: 97, SEQ ID No: 110, SEQ ID No: 123, SEQ ID No: 136 and SEQ ID No: 149, respectively; and

~~The~~ the HPV Type 33 L1 protein and the HPV Type 59 L1 protein is shown in SEQ ID No: 66 and SEQ ID No: 160, respectively.

~~13~~10. The multivalent HPV immunogenic composition according to claim ~~3~~1, wherein at least one of said HPV virus-like particles is composed of a single type of chimeric HPV L1 protein, preferably is composed of said single type of chimeric HPV L1 protein having the same amino acid sequence.

~~14~~11. The multivalent HPV immunogenic composition according to any one of claims 1-~~13~~10, wherein said multivalent HPV immunogenic composition further comprises a physiologically acceptable carrier and, optionally, an adjuvant.

~~15~~12. The multivalent HPV immunogenic composition according to claim ~~14~~11, wherein said adjuvant is an aluminum phosphate adjuvant.

~~16. A method of preventing HPV- related disease or infection comprising.~~

~~Administering to a subject the multivalent HPV immunogenic composition of any one of claims 1-15.~~

~~17~~13. The use of the multivalent HPV immunogenic composition of any one of claims 1-~~15~~ 12 in the preparation of vaccines or drugs for preventing HPV-related diseases or infections.