We claim:

1. An influenza vaccine comprising a hemagglutinin containing one or more alkylated cysteine residues, such as 1-5, 1-4, 1-3 or 1-2 alkylated cysteine residues, such as 1, 2, 3, 4, or 5 alkylated cysteine residues, optionally wherein the one or more alkylated cysteine residues constitute about 1-50%, 1-40%, 1-30%, 1-20% or 1-10% of total cysteine residues present in the hemagglutinin, such as about 10%, 20%, 30%, 40% or 50% of total cysteine residues present in the hemagglutinin, such as substantially all free cysteine residues are alkylated.

2. The influenza vaccine of any one of the preceding claims, wherein the alkylated cysteine residues comprise methylated cysteine residues, and/or wherein the hemagglutinin does not have non-specific alkylation and/or ubiquitous methylation.

3. The influenza vaccine of any one of the preceding claims, wherein the number of alkylated cysteine residues is determined by mass spectrometry.

4. An influenza vaccine comprising a hemagglutinin treated with an alkylating agent, such as an alkylating agent selected from the group consisting of 2-iodoacetamide (IOAM), iodoacetic acid, 2-bromoacetamide, glutathione bromoacetamide, bromoacetic acid, 1,3-propane sultone, methyl methanethiosulfonate, methoxycarbonylmethyl disulfide, maleamide, maleimide-PEG, vinylpyridine, N-ethylmaleimide, tosylacetamide, and combination thereof, optionally the alkylating agent is 2-iodoacetamide (IOAM),

optionally, wherein :

(a) the hemagglutinin is an H1 protein present in a California or Solomon strain, a B protein present in a Brisbane, Florida, Ohio, Jiangsu or Hong Kong strain, and/or or a H3 protein present in a Victoria, Perth, Bristane or Wisconsin strain, and/or

(b) the vaccine is a split influenza virus vaccine or a recombinant influenza vaccine, and/or

(c) the influenza vaccine is an egg based influenza vaccine or the influenza vaccine is produced in insect cells, mammalian cells, yeast cells, viral cells, fungus or algae, and/or

(d) the influenza vaccine is a monovalent, divalent, trivalent or quadrivalent influenza vaccine.

5. The influenza vaccine of any one of the preceding claims, wherein the influenza vaccine retains at least about 90% potency as determined by Single Radial Immunodiffusion (SRID) assay upon storage of about 6 month at a temperature ranging from 1-30 $^{\circ}$C and/or wherein the influenza vaccine is substantially free of the alkylating agent.

6. A method of alkylating a hemagglutinin comprising a step of treating a purified hemagglutinin antigen or a hemagglutinin-containing viral particle with an alkylating agent, optionally wherein:
(a) the hemagglutinin-containing viral particle is a split virus, or
(b) the purified hemagglutinin antigen is a purified surface antigen or a purified recombinant hemagglutinin protein, and/or
(c) the hemagglutinin is selected from an H1 protein present in a California or Solomon strain, a B protein present in a Brisbane, Florida, Ohio, Jiangsu or Hong Kong strain, or a H3 protein present in a Victoria, Perth, Bristane or Wisconsin strain.

7. A method of manufacturing an influenza vaccine comprising a step of treating a viral particle obtained from an influenza virus produced from an egg based or cell culture based production system with an alkylating agent, wherein the viral particle is optionally obtained by splitting the influenza virus.

8. A method of manufacturing an influenza vaccine, comprising

harvesting influenza virus from an egg based or cell culture based production system;

splitting the influenza virus, optionally by treating the influenza virus with a detergent, such as Triton®, sodium taurodeoxycholate, nonylphenol ethoxylate, cetyltrimethylammonium bromide (CTAB), and/or sodium deoxycholate;

treating the split influenza virus with an alkylating agent selected from the group consisting of 2-iodoacetamide (IOAM), iodoacetic acid, 2-bromoacetamide, glutathione bromoacetamide, bromoacetic acid, 1,3-propane sultone, methyl methanethiosulfonate, methoxycarbonylmethyl disulfide, maleamide, maleimide-PEG, vinylpyridine, N-ethylmaleimide, tosylacetamide, and combination thereof, most preferably the alkylating agent is 2-iodoacetamide (IOAM); and

inactivating the treated split influenza virus.

9. The method of any one of claims 7-8, wherein the influenza virus is produced in the egg based production system or in animal cells such as insect cells, mammalian cells and/or avian cells, or in plant cells, yeast cells, viral cells, fungus or algae, or synthetic cells.

10. The method of any one of claims 7-9, wherein
(a) the step of treating comprises incubating the purified hemagglutinin antigen, the hemagglutinin-containing viral particle, the viral particle, or the split influenza virus with the alkylating agent at a

temperature ranging between 1-30 °C, such as room temperature, such as a temperature ranging between 1-5 °C, 2-8 °C, 5-10 °C, 10-15 °C, 15-20 °C, 20-25 °C, or 25-30 °C, and/or

(b) the step of treating comprises incubating the purified hemagglutinin antigen, the hemagglutinin-containing viral particle, the viral particle, or the split influenza virus with the alkylating agent for up to about 24, 20, 18, 16, 14, 12, 10, 8, 6, 4, 2, 1.5 hours, 1 hour, 50 minutes, 40 minutes, 30 minutes, 20 minutes, or 10 minutes, and/or

(c) the alkylating agent is present at a concentration of more than 1X molar excess to hemagglutinin (HA)-cysteine concentration, such as a concentration ranging from 1X to 100X, from 5X to 85X, from 1X to 50X, or from 5X to 50X molar excess to hemagglutinin (HA)-cysteine concentration, such as a concentration ranging from 1 mM – 1 M, 1 mM – 500 mM, 1 mM – 400 mM, 1 mM – 300 mM, 1 mM – 200 mM, or 1 mM – 100 mM, such as a concentration of about 1 mM, 10 mM, 20 mM, 30 mM, 40 mM, 50 mM, 100 mM, 200 mM, 300 mM, 400 mM, or 500 mM, such as a concentration ranging from 1 μg/ml – 1,000 μg/ml, 1 μg/ml – 500 μg/ml, 1 μg/ml – 400 μg/ml, 1 μg/ml – 300 μg/ml, 1 μg/ml – 200 μg/ml, or 1 μg/ml – 100 μg/ml, such as a concentration of about 1 μg/ml, 10 μg/ml, 20 μg/ml, 30 μg/ml, 40 μg/ml, 50 μg/ml, 60 μg/ml, 70 μg/ml, 80 μg/ml, 90 μg/ml, 100 μg/ml, 200 μg/ml, 300 μg/ml, 400 μg/ml, or 500 μg/ml.

11. The method of any one of claims 7-10, wherein the step of treating with the alkylating agent results in alkylation of one of more cysteine residues of hemagglutinin, such as 1-5, 1-4, 1-3 or 1-2 cysteine residues, such as 1, 2, 3, 4, or 5 cysteine residues, such as about 1-50%, 1-40%, 1-30%, or 1-20% total cysteine residues present, such as about 10%, 20%, 30%, 40% or 50% total cysteine residues present, such as substantially all free cysteine residues, and/or

wherein treatment with the alkylating agent does not result in non-specific alkylation, and/or

wherein treatment with the alkylating agent does not result in ubiquitous methylation.

12. The method of any one of claims 7-11, wherein

(a) the step of treatment with the alkylating agent results in reduced potency loss of the influenza vaccine determined by Single Radial Immunodiffusion (SRID) as compared to an otherwise identical influenza vaccine without the treatment of the alkylating agent, such as no more than 50% potency loss determined by SRID when the influenza vaccine is stored at 1-30 °C for 30 days, such as no more than 30% potency loss determined by SRID when the influenza vaccine is stored at 1-30

°C for 30 days, such as no more than 10% potency loss determined by SRID when the influenza vaccine is stored at 1-30 °C for 30 days, and/or

(b) the step of treating with the alkylating agent is performed prior to or concurrently with a step of inactivating the influenza virus, and/or

(c) the inactivating step comprises treating the influenza virus with ultraviolet light or a chemical inactivating agent such as beta-propiolactone, sodium deoxycholate, and/or formalin, for example with formalin.

13. The method of any one of claims 7-12, wherein the method further comprises a step of removing the alkylating agent, for example by diafiltration, and/or the alkylating agent is removed together with the chemical inactivating agent.

14. The method of any one of claims 7-13, wherein the influenza vaccine is a monovalent, divalent, trivalent or quadrivalent influenza vaccine.

15. An influenza vaccine manufactured according to a method of any one of claims 7-14.