CLAIMS

1. A method of inactivating a lipid-coat containing virus, the method comprising the steps of: a) providing a fluid comprising a protein having an activity; b) mixing an organic solvent and a surfactant with the fluid, thereby creating a mixture; and c) incubating the mixture for no more than about 120 minutes; wherein both steps (b) and (c) are performed at a temperature of no higher than about 20°C; wherein the mixture after incubation is essentially free of a viable lipid-coat containing virus; and wherein the protein after incubation has an activity of at least 25%, at least 50% or at least 75% of the activity provided in step (a).

2. The method of claim 1, wherein the fluid is a cell lysate, a cell supernatant, an elution from a previous purification step, or a biological fluid.

3. The method of claim 1, wherein the protein is recombinant Factor VIII.

4. The method of claim 1, wherein the protein is ADAMTS-13, α1-antiplasmin, α2-antiplasmin, antithrombin, antithrombin III, cancer procoagulant, erythropoietin, Factor II, Factor V, Factor VI, Factor VII, Factor VIII, Factor IX, Factor X, Factor XI, Factor XII, Factor XIII, fibronectin, fibrinogen, heparin cofactor II, high-molecular-weight kininogen, intramuscular immunoglobulin, intravenous immunoglobulin, plasminogen, plasminogen activator inhibitor-1, plasminogen activator inhibitor-2, prekallikrein, protein C, protein S, protein Z, protein Z-related protease inhibitor, tissue factor, tissue plasminogen activator, urokinase, or Von Willebrand Factor.

5. The method of claim 1, wherein the organic solvent is (i) an ether selected from dimethyl ether, diethyl ether, ethyl propyl ether, methyl-butyl ether, methyl isopropyl ether, or methyl isobutyl ether; (ii) an alcohol selected from methanol, ethanol, propanol, isopropanol, n-butanol, isobutanol, n-pentanol, or isopentanol; (iii) a dialkylphosphate selected from di-(n-butyl)phosphate, di-(t-butyl)phosphate, di-(n-hexyl)phosphate, di-(2-ethylhexyl)phosphate, di-(n-decyl)phosphate, or ethyl di(n-butyl) phosphate or (iv) a trialkylphosphate selected from tri-(n-butyl)phosphate, tri-(t-butyl)phosphate, tri-(n-hexyl)phosphate, tri-(2-ethylhexyl)phosphate, or tri-(n-decyl)phosphate.

6. The method of claim 1, wherein the final concentration of the organic solvent is from about 0.1% (v/v) to about 5.0% (v/v), from about 0.1% (v/v) to about 1.0% (v/v), from about 0.2% (v/v) to about 0.5% (v/v), or from about 0.2% (v/v) to about 0.4% (v/v), or about 0.3% (v/v).

7. The method of claim 1, wherein the surfactant is an (i) ionic surfactant selected from an anionic surfactant or a cationic surfactant, (ii) a zwitterionic (amphoteric) surfactant, or (iii) a non-ionic surfactant.

8. The method of claim 7, wherein the anionic surfactant is (i) an alkyl sulfate selected from ammonium lauryl sulfate or sodium lauryl sulfate (SDS), (ii) an alkyl ether sulfate selected from sodium laureth sulfate or sodium myreth sulfate, (iii) a docusate selected from dioctyl sodium sulfosuccinate, (iv) a sulfonate fluorosurfactant selected from perfluorooctanesulfonate (PFOS) or perfluorobutanesulfonate, (v) an alkyl benzene sulfonate, (vi) an alkyl aryl ether phosphate, (vii) an alkyl ether phosphate, (viii) an alkyl carboxylate selected from a fatty acid salt or sodium stearate, (ix) a sodium lauroyl sarcosinate, or (x) a carboxylate fluorosurfactant selected from perfluorononanoate or perfluorooctanoate; wherein the cationic surfactant is (i) an alkyltrimethylammonium salt selected from cetyl trimethylammonium bromide (CTAB) or cetyl trimethylammonium chloride (CTAC), (ii) cetylpyridinium chloride (CPC), (iii) polyethoxylated tallow amine (POEA), (iv) benzalkonium chloride (BAC), (v) benzethonium chloride (BZT), (vi) 5-bromo-5-nitro-1,3-dioxane, (vii) dimethyldioctadecylammonium chloride, (viii) dioctadecyldimethylammonium bromide (DODAB), (ix) a pH-dependent primary amine, (x) a pH-dependent secondary amine, (xi) a pH-dependent tertiary amine or (xii) octenidine dihydrochloride; wherein the zwitterionic surfactant is (i) 3-[(3-cholamidopropyl) dimethylammonio]-1-propanesulfonate (CHAPS), (ii) a sultaine (iii) a betaine or (iv) a lecithin; and wherein the non-ionic surfactant is (i) a polyoxyethylene glycol sorbitan alkyl ester selected from polysorbate 20 sorbitan monooleate (TWEEN® 20), polysorbate 40 sorbitan monooleate (TWEEN® 40), polysorbate 60 sorbitan monooleate (TWEEN® 60), polysorbate 61 sorbitan monooleate (TWEEN® 61), polysorbate 65 sorbitan monooleate (TWEEN® 65), polysorbate 80 sorbitan monooleate (TWEEN® 80), or polysorbate 81 sorbitan monooleate (TWEEN® 81), (ii) a poloxamer selected from Poloxamer 124 (PLURONIC® L44), Poloxamer 181 (PLURONIC® L61), Poloxamer 182 (PLURONIC® L62), Poloxamer 184 (PLURONIC® L64), Poloxamer 188 (PLURONIC® F68), Poloxamer 237 (PLURONIC® F87), Poloxamer 338 (PLURONIC® L108), or Poloxamer 407 (PLURONIC® F127), (iii) an alkyl phenol polyglycol ether, (iv) a polyethylene glycol alkyl aryl ether, (v) a polyoxyethylene glycol alkyl ether selected from octaethylene glycol monododecyl ether, pentaethylene glycol monododecyl ether, BRIJ® 30, or BRIJ® 35, (vi) 2-dodecoxyethanol (LUBROL®-PX), (vii) a polyoxyethylene glycol octylphenol ether selected from polyoxyethylene (4-5) p-t-octyl phenol (TRITON® X-45) or polyoxyethylene octyl phenyl ether (TRITON® X-100), (viii) a polyoxyethylene glycol alkylphenol ether, (ix) a phenoxypolyethoxylethanol selected from nonyl phenoxypolyethoxylethanol or octyl phenoxypolyethoxylethanol, (x) a glucoside alkyl ether, (xi) a maltoside alkyl ether, (xii) a thioglucoside alkyl ether, (xiii) a digitonin, (xiv) a glycerol alkyl ester, (xv) an alkyl aryl polyether sulfate, (xvi) an alcohol sulfonate, (xvii) a sorbitan alkyl ester, (xviii) a cocamide

ethanolamine selected from cocamide monoethanolamine or cocamide diethanolamine, (xix) sucrose monolaurate, (xx) dodecyl dimethylamine oxide, or (xxi) sodium cholate.

9. The method of claim 8, wherein the primary amine becomes positively charged at pH < 10 or the secondary amine becomes charged at pH < 4.

10. The method of claim 8, wherein the polyoxyethylene glycol alkylphenol ether is nonoxynol-9; the glucoside alkyl ether is octyl glucopyranoside; the maltoside alkyl ether is dodecyl maltopyranoside; the thioglucoside alkyl ether is heptyl thioglucopyranoside; and/or the glycerol alkyl ester is glyceryl laurate.

11. The method of claim 1, wherein the final concentration of the surfactant is from about 0.1% (v/v) to about 10.0% (v/v), or from about 0.5% (v/v) to about 5.0% (v/v).

12. The method of claim 1, wherein the surfactant is a plurality of surfactants.

13. The method of claim 12, wherein the final concentration of the one surfactant is from about 0.1% (v/v) to about 10.0% (v/v), from about 0.5% (v/v) to about 5.0% (v/v), or from about 0.5% (v/v) to about 1.0% (v/v), and the final concentration of the remainder of surfactants is from about 0.1% (v/v) to about 5% (v/v), from about 0.1% (v/v) to about 1.0% (v/v), or from about 0.2% (v/v) to about 4% (v/v).

14. The method of claim 1, wherein in step (c) the mixture is incubated between about 10 minutes and about 90 minutes; or between about 30 minutes and about 60 minutes.

15. The method of claim 1, wherein both steps (b) and (c) are performed at a temperature from between about 0°C and about 16°C; at a temperature from between about 2°C and about 12°C; at a temperature from between about 2°C and about 8°C; or at a temperature from between about 2°C and about 4°C.

16. The method of claim 1, wherein the mixture after incubation comprises an ID_{50} of at least 100-fold less for a viable lipid-coat containing virus than before incubation; less than 1×10^1 PFU/mL of a viable lipid-coat containing virus; is essentially free of a viable lipid-coat containing virus; and/or is entirely free of a viable lipid-coat containing virus.

17. The method of claim 1, wherein the lipid-coat containing virus is a DNA virus, a RNA virus, a reverse transcribing virus, a human immunodeficiency virus, a sindbis virus, a herpes simplex virus, a pseudorabies virus, a sendai virus, a vesicular stomatitis virus, a West Nile virus, a bovine viral

diarrhea virus, a corona virus, an equine arthritis virus, a severe acute respiratory syndrome virus, Moloney murine leukemia virus, a vaccinia virus, a herpesviridae virus, a poxviridae virus, a hepadnaviridae virus; a flaviviridae virus, a togaviridae virus, a coronaviridae virus, a deltavirus virus, an orthomyxoviridae virus, a paramyxoviridae virus, a rhabdoviridae virus, a bunyaviridae virus, a filoviridae virus, a retroviridae virus and/or a hepadnaviridae virus.

18. The method of claim 1, wherein the method further comprises one or more steps after step (c) including removing the solvent from the mixture; removing the non-ionic surfactant from the mixture; and/or removing the non-viable virus from the mixture.

19. A method of inactivating a lipid-coat containing virus, the method comprising the steps of: a) providing a fluid comprising a Factor VIII having an activity; b) mixing tri(n-butyl) phosphate, polyoxyethylene octyl phenyl, and polysorbate 80 sorbitan with the fluid, thereby creating a mixture wherein the concentration of tri(n-butyl) phosphate is about 0.3% (v/v), the concentration of polyoxyethylene octyl phenyl is about 1.0% (v/v), and the concentration of polysorbate 80 sorbitan is about 0.3% (v/v) and c) incubating the mixture for no more than about 120 minutes; wherein both steps (b) and (c) are performed at a temperature of no higher than about 20°C; wherein the mixture after incubation is essentially free of a viable lipid-coat containing virus; and wherein the Factor VIII after incubation has an activity of at least 25% of the activity provided in step (a).

CLAIMS

1. A method of inactivating a lipid-coat containing virus, the method comprising the steps of: a) providing a fluid comprising a Factor VIII having an activity; b) mixing tri(n-butyl) phosphate, polyoxyethylene octyl phenyl ether, and polysorbate 80 sorbitan monooleate with the fluid, thereby creating a mixture; wherein the final concentration of the tri(n-butyl) phosphate is from about 0.1% (v/v) to about 5.0% (v/v), the final concentration of the polyoxyethylene octyl phenyl ether is from about 0.5% (v/v) to about 10.0% (v/v), and the final concentration of the polysorbate 80 sorbitan monooleate is from about 0.1% (v/v) to about 5.0% (v/v)and c) incubating the mixture for no more than 120 minutes; wherein both steps (b) and (c) are performed at a temperature from between 2°C and 8°C; and wherein the protein after incubation has an activity of at least 25%, at least 50% or at least 75% of the activity provided in step (a).

2. The method of claim 1, wherein the fluid is a cell lysate, a cell supernatant, an elution from a previous purification step, or a biological fluid.

3. The method of claim 1, wherein the Factor VIII is recombinant Factor VIII.

4. The method of claim 1, wherein in step (c) the mixture is incubated between 10 minutes and 90 minutes; or between 30 minutes and 60 minutes.

5. The method of claim 1, wherein both steps (b) and (c) are performed at a temperature from between 2°C and 4°C.

6. The method of claim 1, wherein the mixture after incubation comprises an ID_{50} of at least 100-fold less for a viable lipid-coat containing virus than before incubation; and/or less than 1×10^1 PFU/mL of a viable lipid-coat containing virus.

7. The method of claim 1, wherein the lipid-coat containing virus is a DNA virus, a RNA virus, a reverse transcribing virus, a human immunodeficiency virus, a sindbis virus, a herpes simplex virus, a pseudorabies virus, a sendai virus, a vesicular stomatitis virus, a West Nile virus, a bovine viral diarrhea virus, a corona virus, an equine arthritis virus, a severe acute respiratory syndrome virus, Moloney murine leukemia virus, a vaccinia virus, a herpesviridae virus, a poxviridae virus, a hepadnaviridae virus; a flaviviridae virus, a togaviridae virus, a coronaviridae virus, a deltavirus virus, an orthomyxoviridae virus, a paramyxoviridae virus, a rhabdoviridae virus, a bunyaviridae virus, a filoviridae virus, a retroviridae virus and/or a hepadnaviridae virus.

8. The method of claim 1, wherein the method further comprises one or more steps after step (c) including removing the tri(n-butyl) phosphate from the mixture; removing the polyoxyethylene octyl phenyl ether and the polysorbate 80 sorbitan monooleate from the mixture; and/or removing the non-viable virus from the mixture.

9. A method of inactivating a lipid-coat containing virus, the method comprising the steps of: a) providing a fluid comprising a Factor VIII having an activity; b) mixing tri(n-butyl) phosphate, polyoxyethylene octyl phenyl ether, and polysorbate 80 sorbitan monooleate with the fluid, thereby creating a mixture wherein the concentration of tri(n-butyl) phosphate is 0.3% (v/v), the concentration of polyoxyethylene octyl phenyl ether is 1.0% (v/v), and the concentration of polysorbate 80 sorbitan monooleate is 0.3% (v/v) and c) incubating the mixture for no more than 120 minutes; wherein both steps (b) and (c) are performed at a temperature from between 2 °C and 8 °C; and wherein the Factor VIII after incubation has an activity of at least 25% of the activity provided in step (a).