CLAIMS:

1. A pharmaceutical composition comprising an aqueous formulation comprising an insoluble vitamin at least partially solubilized with a surfactant wherein the pharmaceutical composition is in liquid aerosol form.

2. The pharmaceutical composition according to claim 1, wherein the insoluble vitamin comprises at least one of vitamin A, all-trans retinol, 13-cis-retinol, the palmitate ester of all-trans retinol, the acetate ester of all-trans retinol, the maleate ester of all-trans retinol, 9-cis-retinol, 9,13-dicis-retinol, 3,4-didehydroretinol, CD437, CD1530, and an intrinsically fluorescent retinoid analog.

3. The pharmaceutical composition according to claim 1, wherein the insoluble vitamin comprises at least one of all-trans retinol, the palmitate ester of all-trans retinol, the acetate ester of all-trans retinol, the maleate ester of all-trans retinol, wherein the surfactant comprises polysorbate 80, and wherein the pH of the pharmaceutical composition is 7.0 to 7.5.

4. The pharmaceutical composition according to claim 3, comprising up to 6.0% (w/w) of the all-trans retinol, the palmitate ester of all-trans retinol, the acetate ester of all-trans retinol, the maleate ester of all-trans retinol, and/or a mixture thereof.

5. The pharmaceutical composition according to claim 1, wherein a weight of the surfactant is at least 3.0 times the weight of the insoluble vitamin.

6. The pharmaceutical composition according to claim 1, wherein the insoluble vitamin comprises at least one selected from the group consisting of all-trans retinol, 13-cis-retinol, 9-cis-retinol, 9,13-dicis-retinol, 3,4-didehydroretinol, the palmitate ester of all-trans-retinol, the acetate ester of all-trans-retinol, the maleate ester of all-trans-retinol, CD437, CD1530, an intrinsically fluorescent retinoid analog and/or a mixture thereof, wherein a weight of the surfactant is 3.0 times and 8.5 times the weight of the all-trans-retinol, 13-cis-retinol, 9-cis-retinol, 9,13-dicis-retinol, 3,4-didehydroretinol, the maleate ester of all-trans-retinol, 3,4-didehydroretinol, CD437, CD-1530, an intrinsically fluorescent retinoid analog, and mixtures thereof, and,

optionally, wherein the pharmaceutical composition further comprises a conjugate base of a pharmaceutically acceptable acid and/or a conjugate acid of a pharmaceutically acceptable base.

7. The pharmaceutical composition according to claim 1, wherein the surfactant comprises polysorbate 20, polysorbate 60, polysorbate 80, stearyl alcohol, sorbitan monolaurate, sorbitan monopalmitate, sorbitan monostearate, polyoxyethylene (20) oleyl ether, polyoxyethylene (20) cetyl ether, polyoxyethylene (10) cetyl ether, polyoxyethylene (10) oleyl ether, polyoxyethylene (100) stearyl ether, polyoxyethylene (10) stearyl ether, polyoxyethylene (20) stearyl ether, polyoxyethylene (4) lauryl ether, polyoxyethylene (20) cetyl ether, polyoxyethylene (2) cetyl ether, caprylocaproyl polyoxyl-8 glyceride, polyethylene glycol (20) stearate, polyethylene glycol (40) stearate, polyethylene glycol, polyethylene glycol (8) stearate, polyoxyl 40 stearate, poloxamer 188, polaxamer 312, or mixtures thereof.

8. The pharmaceutical composition according to claim 1, wherein the surfactant comprises polysorbate 80.

9. The pharmaceutical composition according to claim 1, wherein the surfactant comprises polysorbate 80 and the fatty acid content of the polysorbate 80 is between 85% and 100% oleic acid.

10. The pharmaceutical composition according to claim 1, wherein the pharmaceutical composition further comprises:

at least one antibiotic compound comprising at least one penicillin, at least one tetracycline, at least one cephalosporin, at least one quinolone, at least one lincomycin, at least one macrolide, at least one sulfonamide, at least one glycopeptide, at least one amino glycoside, a carbapenem, and/or a mixture thereof;

at least one insoluble vitamin comprising Vitamin D, an analog of Vitamin D, a derivative of Vitamin D, Vitamin E, an analog of Vitamin D, a derivative of Vitamin D, Vitamin K, an analog of Vitamin K, a derivative of Vitamin K, Vitamin B6, niacinamide, Vitamin B2, Vitamin B1. dexpanthenol, biotin, folic acid, vitamin B12, and/or a mixture thereof;

an anti-viral compound comprising oseltamivir, zanamivir, peramivir, ribavirin, remdesivir, at least one nucleoside analog, at least one interferon, at least one protease inhibitor, at least one reverse transcriptase inhibitor, at least one neuramidinidase inhibitor, and/or a mixture thereof; and/or

a sugar comprising glucose, arabinose, maltose, sucrose, dextrose, lactose, and/or a mixture thereof; and/or

caffeine, epinephrine, and/or a mixture thereof.

11. The pharmaceutical composition according to claim 1, wherein the pharmaceutical composition does not comprise a preservative.

12. A pharmaceutical composition comprising an aqueously insoluble vitamin that has been at least partially solubilized with a surfactant wherein the pharmaceutical composition is in liquid aerosol form.

13. A pharmaceutical composition comprising:

i) vitamin A, or a pharmaceutically acceptable isomer, analog, and/or derivative thereof, or a mixture thereof;

ii) a surfactant, and

wherein the pharmaceutical composition is in aerosol form.

14. The pharmaceutical composition according to claim 13. wherein the surfactant comprises a non-natural surfactant.

15. The pharmaceutical composition according to claim 13, wherein the pharmaceutical composition is a liquid and wherein the vitamin A, or a pharmaceutically acceptable isomer, analog, and/or derivative thereof, or a mixture thereof, is disposed within a micelle.

16. A pharmaceutical composition according to claim 13, wherein the pharmaceutical composition consisting essentially of vitamin A, or a pharmaceutically acceptable isomer, analog, and/or derivative thereof, or a mixture thereof, and a surfactant therein.

17. A system for use in the prophylaxis or treatment of a vitamin deficiency disorder, hyperoxia damage, oxidative lung injury (lung damage), lung damage caused by chemical or environmental exposure, lung damage caused by a biological/infectious agent, lung damage caused by a chemical, biological, or radio-nuclear (CBRN) agent, and lung damage caused by radio-nuclear exposure, wherein the system comprises a therapeutically effective dose of a pharmaceutical composition according to claim 1, and a device suitable for generating the liquid aerosol form thereby forming a plurality of liquid droplets wherein the liquid droplets produced by the system have a mass median aerodynamic diameter of less than 15 microns.

18. The system according to claim 17, wherein the liquid droplets have a mass median aerodynamic diameter of less than 5 microns.

19. Use of the pharmaceutical composition according to claim 1 in the preparation of a medicament for treatment or prophylaxis of a vitamin deficiency disorder, hyperoxia damage, lung damage caused by oxidative lung injury, lung damage caused by chemical or environmental exposure, lung damage caused by a biological/infectious agent, lung damage caused by a chemical, biological, or radio-nuclear (CBRN) agent, lung damage caused by radio-nuclear bronchopulmonary dysplasia, retinopathy of prematurity, neonatal sepsis, hypovitaminosis A, hospital-acquired sepsis, sepsis from premature rupture of membranes, meningitis, pneumonia, necrotizing enterocolitis, radiation-induced pneumonitis, a viral infection, and/or a bacterial infection.

20. Use of the pharmaceutical composition according to claim 1 in the preparation of a medicament for supporting a patient’s immune response in improving the efficacy of a vaccine against an infectious agent in a patient.