SOLID DOSAGE FORMS OF BACTERIA

Cross-Reference to Related Applications

[1] This application claims the benefit of the following U.S. Provisional Application serial numbers 63/080,263, filed September 18, 2020, 63/089,799, filed October 9, 2020, 63/157,153, filed March 5, 2021, 63/145,786, filed February 4, 2021, 63/161,617, filed March 16, 2021, 63/234,483, filed August 18, 2021, and 63/110,090, filed November 5, 2020, the entire contents of each of which are incorporated herein by reference.

Background

[2] The formulation of the solid dosage form of a pharmaceutical product can have a significant impact on the bioavailability of its active pharmaceutical ingredients.

Summary

[3] In certain aspects provided herein are solid dosage forms of pharmaceutical compositions. The pharmaceutical composition is also referred to as drug product. In certain embodiments, the solid dosage form comprises a pharmaceutical agent, wherein the pharmaceutical agent comprises bacteria and/or an agent of bacterial origin, such as mEVs, or a powder comprising bacteria and/or an agent of bacterial origin, such as mEVs and a diluent.

[4] In certain aspects, provided herein is a solid dosage form of a pharmaceutical composition comprising a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 95% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises bacteria, a diluent having a total mass that is at least 1% and no more than 95% of the total mass of the pharmaceutical composition, a lubricant having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition, and a glidant having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition. In some embodiments, the solid dosage form is a capsule.

[5] In certain aspects, provided herein is a solid dosage form of a pharmaceutical composition comprising a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 95% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises *Prevotella histicola* bacteria, a diluent having a total mass that is at least 1% and no more than 95% of the total mass of the pharmaceutical composition, a lubricant having a total mass that is at least 0.1% and no more than 5% of the

total mass of the pharmaceutical composition, and a glidant having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition. In some embodiments, the solid dosage form is a capsule.

[6] In some aspects, provided herein is a solid dosage form of a pharmaceutical composition comprising a pharmaceutical agent having a total pharmaceutical agent mass that is at least 2.5% and no more than 70% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises bacteria, a diluent having a total mass that is at least 30% and no more than 98% of the total mass of the pharmaceutical composition, a lubricant having a total mass that is at least 0.5% and no more than 2.5% of the total mass of the pharmaceutical composition, and a glidant having a total mass that is at least 0.1% and no more than 1% of the total mass of the pharmaceutical composition. In some embodiments, the solid dosage form is a capsule.

[7] In some aspects, provided herein is a solid dosage form of a pharmaceutical composition comprising a pharmaceutical agent having a total pharmaceutical agent mass that is at least 2.5% and no more than 70% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises *Veillonella parvula* bacteria, a diluent having a total mass that is at least 30% and no more than 98% of the total mass of the pharmaceutical composition, a lubricant having a total mass that is at least 0.5% and no more than 2.5% of the total mass of the pharmaceutical composition, and a glidant having a total mass that is at least 0.1% and no more than 1% of the total mass of the pharmaceutical composition. In some embodiments, the solid dosage form is a capsule.

[8] In certain aspects, provided herein is a solid dosage form of a pharmaceutical composition comprising a pharmaceutical agent having a total pharmaceutical agent mass that is at least 10% and no more than 90% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises microbial extracellular vesicles (mEVs), a diluent having a total mass that is at least 7.5% and no more than 87.5% of the total mass of the pharmaceutical composition, a lubricant having a total mass that is about 1.5% of the total mass of the pharmaceutical composition, and a glidant having a total mass that is about 1% of the total mass of the pharmaceutical composition. In some embodiments, the solid dosage form is a capsule.

[9] In certain aspects, provided herein is a solid dosage form of a pharmaceutical composition comprising a pharmaceutical agent having a total pharmaceutical agent mass that is at least 10% and no more than 90% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises *Prevotella histicola* microbial

extracellular vesicles (mEVs), a diluent having a total mass that is at least 7.5% and no more than 87.5% of the total mass of the pharmaceutical composition, a lubricant having a total mass that is about 1.5% of the total mass of the pharmaceutical composition, and a glidant having a total mass that is about 1% of the total mass of the pharmaceutical composition. In some embodiments, the solid dosage form is a capsule.

[10] In certain embodiments, the total pharmaceutical agent mass is at least 2.5%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, or 95% of the total mass of the pharmaceutical composition. In some embodiments, the total pharmaceutical agent mass is no more than 95%, 90%, 85%, 80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, or 2.5% of the total mass of the pharmaceutical composition. In some embodiments, the pharmaceutical agent has a total pharmaceutical agent mass that is at least 2.5% and no more than 95% of the total mass of the pharmaceutical composition. In some embodiments, the total pharmaceutical agent mass is about 5% to about 90% of the total mass of the pharmaceutical composition.

[11] In some embodiments, the total mass of the diluent is at least 1%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, or 98% of the total mass of the pharmaceutical composition. In some embodiments, the total mass of the diluent is no more than 98%, 95%, 90%, 85%, 80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, or 1%. In some embodiments, the diluent has a total mass that is at least 1% and no more than 98% of the total mass of the pharmaceutical composition. In some embodiments, the diluent has a total mass that is at least 35% and no more than 95% of the total mass of the pharmaceutical composition. In some embodiments, the diluent has a total mass that is about 38% to 93% of the total mass of the pharmaceutical composition. In some embodiments, the diluent comprises mannitol. In some embodiments, the diluent comprises microcrystalline cellulose.

[12] In certain embodiments, the solid dosage form provided herein comprises a lubricant. In certain embodiments, the total lubricant mass is at least 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is no more than 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 0.5% to about 1.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 1% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant

mass is about 1% to about 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 1.5% of the total mass of the pharmaceutical composition. In some embodiments, the lubricant comprises magnesium stearate.

[13] In certain embodiments, the solid dosage forms provided herein comprise a glidant. In some embodiments, the glidant is colloidal silicon dioxide. In certain embodiments, the total glidant mass is at least 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is no more than 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.25% to about 0.75% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.5% to about 1.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 1% of the total mass of the pharmaceutical composition.

[14] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 4% and no more than 65% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 35% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[15] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 60% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 38% and no more than 93% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[16] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 20% and no more than 55% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 45% and no more than 80% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[17] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 20% to about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 50% to 80% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[18] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 20% to about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 50% to 80% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[19] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 95% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 1% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[20] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 8% to about 92%

the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 5% to 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[21] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10% to about 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 7% to about 88% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 1% of the total mass of the pharmaceutical composition.

[22] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 30% and no more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 45% and no more than 70% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[23] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 30% to about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 45% to 70% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[24] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 48.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the

pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[25] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 92% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 5% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[26] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 10% and no more than 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 8.5% and no more than 88.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[27] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 13.5% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 85.% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[28] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 90.2% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 8.3% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[29] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no

more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 50% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[30] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 45% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 55% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[31] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 40% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 58% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[32] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10.6% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 87.4% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[33] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 30% and no more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 50% and no more than 70% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant

(e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[34] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 30% and no more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 45% and no more than 70% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[35] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 48.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[36] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 10% and no more than 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 8.5% and no more than 88.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[37] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 13.51% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 84.99% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[38] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 90.22% of the

total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 8.28% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[39] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 48.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[40] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 5% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 93% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[41] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 60% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 38% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[42] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10.6% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 87.4% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[43] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 40% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 58% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[44] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 98.5% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 0% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[45] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 25.1% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., microcrystalline cellulose) having a total mass that is about 73.4% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[46] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 87.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 1% of the total mass of the pharmaceutical composition.

[47] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 7.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the

pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 1% of the total mass of the pharmaceutical composition.

[48] In certain embodiments, the solid dosage forms of a pharmaceutical agent as described herein comprise capsules. In some embodiments, the capsule is a size 00, size 0, size 1, size 2, size 3, size 4, or size 5 capsule. In some embodiments, the capsule is a size 0 capsule. In some embodiments, the capsule comprises HPMC (hydroxyl propyl methyl cellulose) or gelatin. In some embodiments, the capsule comprises HPMC (hydroxyl propyl methyl cellulose). In some embodiments, the capsule is banded. In some embodiments, the capsule is banded with an HPMC-based banding solution.

[49] In some embodiments, the solid dosage form is enterically coated (e.g., comprises an enteric coating; e.g., is coated with an enteric coating).

[50] In some embodiments, the solid dosage form is enteric coated to dissolve at pH 5.5.

[51] In some embodiments, the enteric coating comprises a polymethacrylate-based copolymer. In some embodiments, the enteric coating comprises poly(methacrylic acid-co-ethyl acrylate).

[52] In some embodiments, the enteric coating comprises a methacrylic acid ethyl acrylate (MAE) copolymer (1:1).

[53] In some embodiments, the enteric coating comprises methacrylic acid ethyl acrylate (MAE) copolymer (1:1) (such as Kollicoat MAE 100P).

[54] In some embodiments, the enteric coating comprises a Eudragit copolymer, e.g., a Eudragit L (e.g., Eudragit L 100-55; Eudragit L 30 D-55), a Eudragit S, a Eudragit RL, a Eudragit RS, a Eudragit E, or a Eudragit FS (e.g., Eudragit FS 30 D).

[55] In some embodiments, the enteric coating comprises cellulose acetate phthalate (CAP), cellulose acetate trimellitate (CAT), poly(vinyl acetate phthalate) (PVAP), hydroxypropyl methylcellulose phthalate (HPMCP), a fatty acid, a wax, shellac (esters of aleurtic acid), a plastic, a plant fiber, zein, Aqua-Zein (an aqueous zein formulation containing no alcohol), amylose starch, a starch derivative, a dextrin, a methyl acrylate-methacrylic acid copolymer, cellulose acetate succinate, hydroxypropyl methyl cellulose acetate succinate (hypromellose acetate succinate), a methyl methacrylate-methacrylic acid copolymer, or sodium alginate.

[56] In some embodiments, the enteric coating comprises an anionic polymeric material.

[57] The pharmaceutical agent can be of bacterial origin (e.g., mixture of selected strains or agents (e.g., components) thereof, such as microbial extracellular vesicles (mEVs) of the mixture of selected strains). The pharmaceutical agent can be of bacterial origin (e.g., a

single selected strain and/or agents (e.g., components) thereof, such as microbial extracellular vesicles (mEVs) of that single selected strain). The pharmaceutical agent can be a powder that comprises the bacteria and/or components thereof, and, can comprise additional agents such as, e.g., cryoprotectant. For example, in some embodiments, the pharmaceutical agent is a lyophilized powder of bacteria and/or components thereof (e.g., mEVs) that optionally, further comprise additional agents, such as a cryoprotectant. In some embodiments, the pharmaceutical agent has one or more beneficial immune effects outside the gastrointestinal tract, e.g., when the solid dosage form is orally administered.

[58] In some embodiments, the pharmaceutical agent modulates immune effects outside the gastrointestinal tract in the subject, e.g., when the solid dosage form is orally administered.

[59] In some embodiments, the pharmaceutical agent causes a systemic effect (e.g., an effect outside of the gastrointestinal tract), e.g., when the solid dosage form is orally administered.

[60] In some embodiments, the pharmaceutical agent acts on immune cells and/or epithelial cells in the small intestine (e.g., causing a systemic effect (e.g., an effect outside of the gastrointestinal tract), e.g., when the solid dosage form is orally administered.

[61] In some embodiments, the pharmaceutical agent comprises isolated bacteria (e.g., from one or more strains of bacteria (e.g., bacteria of interest) (e.g., a therapeutically effective amount thereof)). E.g., wherein at least 50%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% of the content of the pharmaceutical agent is the isolated bacteria (e.g., bacteria of interest).

[62] In some embodiments, the pharmaceutical agent comprises bacteria.

[63] In some embodiments, the pharmaceutical agent comprises microbial extracellular vesicles (mEV).

[64] In some embodiments, the pharmaceutical agent comprises bacteria and microbial extracellular vesicles (mEV).

[65] In some embodiments, the pharmaceutical agent has one or more beneficial immune effects outside the gastrointestinal tract, e.g., when the solid dosage form is orally administered.

[66] In some embodiments, the pharmaceutical agent modulates immune effects outside the gastrointestinal tract in the subject, e.g., when the solid dosage form is orally administered.

[67] In some embodiments, the pharmaceutical agent causes a systemic effect (e.g., an effect outside of the gastrointestinal tract), e.g., when the solid dosage form is orally administered.

[68] In some embodiments, the pharmaceutical agent acts on immune cells and/or epithelial cells in the small intestine (e.g., causing a systemic effect (e.g., an effect outside of the gastrointestinal tract), e.g., when the solid dosage form is orally administered.

[69] In some embodiments, the pharmaceutical agent comprises isolated bacteria (e.g., from one or more strains of bacteria (e.g., bacteria of interest) (e.g., a therapeutically effective amount thereof)). E.g., wherein at least 50%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% of the content of the pharmaceutical agent is the isolated bacteria (e.g., bacteria of interest).

[70] In some embodiments, the pharmaceutical agent comprises bacteria that have been gamma irradiated, UV irradiated, heat inactivated, acid treated, or oxygen sparged.

[71] In some embodiments, the pharmaceutical agent comprises live bacteria.

[72] In some embodiments, the pharmaceutical agent comprises dead bacteria.

[73] In some embodiments, the pharmaceutical agent comprises non-replicating bacteria.

[74] In some embodiments, the pharmaceutical agent comprises bacteria from one strain of bacteria.

[75] In some embodiments, the bacteria are lyophilized (e.g., the lyophilized product further comprises a pharmaceutically acceptable excipient) (e.g., a powder form).

[76] In some embodiments, the bacteria are gamma irradiated.

[77] In some embodiments, the bacteria are UV irradiated.

[78] In some embodiments, the bacteria are heat inactivated (e.g., at 50°C for two hours or at 90°C for two hours).

[79] In some embodiments, the bacteria are acid treated.

[80] In some embodiments, the bacteria are oxygen sparged (e.g., at 0.1 vvm for two hours).

[81] In some embodiments, the bacteria are Gram positive bacteria.

[82] In some embodiments, the bacteria are Gram negative bacteria.

[83] In some embodiments, the bacteria are aerobic bacteria.

[84] In some embodiments, the bacteria are anaerobic bacteria. In some embodiments, the anaerobic bacteria comprise obligate anaerobes. In some embodiments, the anaerobic bacteria comprise facultative anaerobes.

[85] In some embodiments, the bacteria are acidophile bacteria.

[86] In some embodiments, the bacteria are alkaliphile bacteria.

[87] In some embodiments, the bacteria are neutralophile bacteria.

[88] In some embodiments, the bacteria are fastidious bacteria.

[89] In some embodiments, the bacteria are nonfastidious bacteria.

[90] In some embodiments, the bacteria are of a taxonomic group (e.g., class, order, family, genus, species or strain) listed in Table 1, Table 2, or Table 3.

[91] In some embodiments, the bacteria are of a taxonomic group (e.g., class, order, family, genus, species or strain) listed in Table 4.

[92] In some embodiments, the bacteria are a bacterial strain listed in Table 1, Table 2, or Table 3.

[93] In some embodiments, the bacteria are a bacterial strain listed in Table 4.

[94] In some embodiments, the bacteria are of a taxonomic group (e.g., class, order, family, genus, species or strain) listed in Table J.

[95] In some embodiments, the bacteria are a bacterial strain listed in Table J.

[96] In some embodiments, the Gram negative bacteria belong to class *Negativicutes*.

[97] In some embodiments, the Gram negative bacteria belong to family *Veillonellaceae, Selenomonadaceae, Acidaminococcaceae*, or *Sporomusaceae*.

[98] In some embodiments, the bacteria of the genus Megasphaera, Selenomonas, Propionospora, or Acidaminococcus.

[99] In some embodiments, the bacteria are Megasphaera sp., Selenomonas felix, Acidaminococcus intestine, or Propionospora sp. bacteria.

[100] In some embodiments, the bacteria are of the genus *Lactococcus, Prevotella, Bifidobacterium,* or *Veillonell*a.

[101] In some embodiments, the bacteria are *Lactococcus lactis cremoris* bacteria.

[102] In some embodiments, the bacteria are *Prevotella histicola* bacteria.

[103] In some embodiments, the bacteria are *Bifidobacterium animalis* bacteria.

[104] In some embodiments, the bacteria are *Veillonella parvula* bacteria.

[105] In some embodiments, the bacteria are *Lactococcus lactis cremoris* bacteria. In some embodiments, the *Lactococcus lactis cremoris* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Lactococcus lactis cremoris* Strain A (ATCC designation number PTA-125368). In some embodiments, the *Lactococcus* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the

Lactococcus lactis cremoris Strain A (ATCC designation number PTA-125368). In some embodiments, the *Lactococcus* bacteria are *Lactococcus lactis cremoris* Strain A (ATCC designation number PTA-125368).

[106] In some embodiments, the bacteria are *Prevotella* bacteria. In some embodiments, the *Prevotella* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Prevotella* Strain B 50329 (NRRL accession number B 50329). In some embodiments, the *Prevotella* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Prevotella* Strain B 50329 (NRRL accession number B 50329). In some embodiments, the *Prevotella* bacteria are *Prevotella* Strain B 50329 (NRRL accession number B 50329).

[107] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Prevotella* bacteria, e.g., a strain comprising at least 90% or at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Prevotella* Strain C (ATCC Accession Number PTA-126140). In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Prevotella* bacteria, e.g., Prevotella Strain C (ATCC Accession Number PTA-126140).

[108] In some embodiments, the bacteria are *Bifidobacterium* bacteria. In some embodiments, the *Bifidobacterium* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Bifidobacterium* bacteria deposited as ATCC designation number PTA-125097. In some embodiments, the *Bifidobacterium* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Bifidobacterium* bacteria deposited as ATCC designation number PTA-125097. In some embodiments, the *Bifidobacterium* bacteria are *Bifidobacterium* bacteria deposited as ATCC designation number PTA-125097.

[109] In some embodiments, the bacteria are *Veillonella* bacteria. In some embodiments, the *Veillonella* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Veillonella* bacteria deposited as ATCC designation number PTA-125691. In some embodiments, the *Veillonella* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Veillonella* bacteria deposited as ATCC designation number

PTA-125691. In some embodiments, the *Veillonella* bacteria are *Veillonella* bacteria deposited as ATCC designation number PTA-125691.

[110] In some embodiments, the bacteria are from *Ruminococcus gnavus* bacteria. In some embodiments, the *Ruminococcus gnavus* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Ruminococcus gnavus* bacteria deposited as ATCC designation number PTA-126695. In some embodiments, the *Ruminococcus gnavus* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Ruminococcus gnavus* bacteria deposited as ATCC designation number PTA-126695. In some embodiments, the *Ruminococcus gnavus* bacteria are *Ruminococcus gnavus* bacteria deposited as ATCC designation number PTA-126695.

[111] In some embodiments, the bacteria are *Megasphaera sp.* bacteria. In some embodiments, the *Megasphaera sp.* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Megasphaera sp.* bacteria deposited as ATCC designation number PTA-126770. In some embodiments, the *Megasphaera sp.* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Megasphaera sp.* bacteria deposited as ATCC designation number PTA-126770. In some embodiments, the *Megasphaera sp.* bacteria are *Megasphaera sp.* bacteria deposited as ATCC designation number PTA-126770.

[112] In some embodiments, the bacteria are *Fournierella massiliensis* bacteria. In some embodiments, the *Fournierella massiliensis* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Fournierella massiliensis* bacteria deposited as ATCC designation number PTA-126696. In some embodiments, the *Fournierella massiliensis* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Fournierella massiliensis* bacteria deposited as ATCC designation number PTA-126696. In some embodiments, the *Fournierella massiliensis* bacteria are *Fournierella massiliensis* bacteria deposited as ATCC designation number PTA-126696.

[113] In some embodiments, the bacteria are *Harryflintia acetispora* bacteria. In some embodiments, the *Harryflintia acetispora* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Harryflintia acetispora* bacteria deposited as ATCC designation number PTA-126694. In some embodiments, the *Harryflintia acetispora* bacteria are a strain comprising at least 99%

genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Harryflintia acetispora* bacteria deposited as ATCC designation number PTA-126694. In some embodiments, the *Harryflintia acetispora* bacteria are *Harryflintia acetispora* bacteria deposited as ATCC designation number PTA-126694.

[114] In some embodiments, the bacteria are of the family Acidaminococcaceae, Alcaligenaceae, Akkermansiaceae, Bacteriodaceae, Bifidobacteriaceae, Burkholderiaceae, Catabacteriaceae, Clostridiaceae, Coriobacteriaceae, Enterobacteriaceae, Enterococcaceae, Fusobacteriaceae, Lachnospiraceae, Listeraceae, Mycobacteriaceae, Neisseriaceae, Odoribacteraceae, Oscillospiraceae, Peptococcaceae, Peptostreptococcaceae, Porphyromonadaceae, Prevotellaceae, Propionibacteraceae, Rikenellaceae, Ruminococcaceae, Selenomonadaceae, Sporomusaceae, Streptococcaceae, Streptomycetaceae, Sutterellaceae, Synergistaceae, or Veillonellaceae.

[115] In some embodiments, the bacteria are of the genus Akkermansia, Christensenella, Blautia, Enterococcus, Eubacterium, Roseburia, Bacteroides, Parabacteroides, or Erysipelatoclostridium.

[116] In some embodiments, the bacteria are Blautia hydrogenotrophica, Blautia stercoris, Blautia wexlerae, Eubacterium faecium, Eubacterium contortum, Eubacterium rectale, Enterococcus faecalis, Enterococcus durans, Enterococcus villorum, Enterococcus gallinarum; Bifidobacterium lactis, Bifidobacterium bifidium, Bifidobacterium longum, Bifidobacterium animalis, or Bifidobacterium breve bacteria.

[117] In some embodiments, the bacteria are BCG (bacillus Calmette-Guerin), Parabacteroides, Blautia, Veillonella, Lactobacillus salivarius, Agathobaculum, Ruminococcus gnavus, Paraclostridium benzoelyticum, Turicibacter sanguinus, Burkholderia, Klebsiella quasipneumoniae ssp similpneumoniae, Klebsiella oxytoca, Tyzzerela nexilis, or Neisseria bacteria.

[118] In some embodiments, the bacteria are *Blautia hydrogenotrophica* bacteria.

[119] In some embodiments, the bacteria are *Blautia stercoris* bacteria.

[120] In some embodiments, the bacteria are *Blautia wexlerae* bacteria.

[121] In some embodiments, the bacteria are *Enterococcus gallinarum* bacteria.

[122] In some embodiments, the bacteria are *Enterococcus faecium* bacteria.

[123] In some embodiments, the bacteria are *Bifidobacterium bifidium* bacteria.

[124] In some embodiments, the bacteria are *Bifidobacterium breve* bacteria.

[125] In some embodiments, the bacteria are *Bifidobacterium longum* bacteria.

[126] In some embodiments, the bacteria are *Roseburia hominis* bacteria.

[127] In some embodiments, the bacteria are *Bacteroides thetaiotaomicron* bacteria.

[128] In some embodiments, the bacteria are *Bacteroides coprocola* bacteria.

[129] In some embodiments, the bacteria are *Erysipelatoclostridium ramosum* bacteria.

[130] In some embodiments, the bacteria are *Megasphera massiliensis* bacteria.

[131] In some embodiments, the bacteria are *Eubacterium* bacteria.

[132] In some embodiments, the bacteria are *Parabacteroides distasonis* bacteria.

[133] In some embodiments, the bacteria are *Lactobacillus plantarum* bacteria.

[134] In some embodiments, the bacteria are bacteria of the *Negativicutes* class.

[135] In some embodiments, the bacteria are of the *Veillonellaceae* family.

[136] In some embodiments, the bacteria are of the *Selenomonadaceae* family.

[137] In some embodiments, the bacteria are of the *Acidaminococcaceae* family.

[138] In some embodiments, the bacteria are of the *Sporomusaceae* family.

[139] In some embodiments, the bacteria are of the *Megasphaera* genus.

[140] In some embodiments, the bacteria are of the *Selenomonas* genus.

[141] In some embodiments, the bacteria are of the *Propionospora* genus.

[142] In some embodiments, the bacteria are of the *Acidaminococcus* genus.

[143] In some embodiments, the bacteria are *Megasphaera sp.* bacteria.

[144] In some embodiments, the bacteria are *Selenomonas felix* bacteria.

[145] In some embodiments, the bacteria are *Acidaminococcus intestini* bacteria.

[146] In some embodiments, the bacteria are *Propionospora sp.* bacteria.

[147] In some embodiments, the bacteria are bacteria of the *Clostridia* class.

[148] In some embodiments, the bacteria are of the *Oscillospriraceae* family.

[149] In some embodiments, the bacteria are of the *Faecalibacterium* genus.

[150] In some embodiments, the bacteria are of the *Fournierella* genus.

[151] In some embodiments, the bacteria are of the *Harryflintia* genus.

[152] In some embodiments, the bacteria are of the *Agathobaculum* genus.

[153] In some embodiments, the bacteria are *Faecalibacterium prausnitzii* (e.g., *Faecalibacterium prausnitzii* Strain A) bacteria.

[154] In some embodiments, the bacteria are *Fournierella massiliensis* (e.g., *Fournierella massiliensis* Strain A) bacteria.

[155] In some embodiments, the bacteria are *Harryflintia acetispora* (e.g., *Harryflintia acetispora* Strain A) bacteria.

[156] In some embodiments, the bacteria are *Agathobaculum sp.* (e.g., *Agathobaculum sp.* Strain A) bacteria.

[157] In some embodiments, the bacteria are a strain of *Agathobaculum sp.* In some embodiments, the *Agathobaculum sp.* strain is a strain comprising at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, CRISPR sequence) of the *Agathobaculum sp.* Strain A (ATCC Deposit Number PTA-125892). In some embodiments, the *Agathobaculum sp.* strain is the Agathobaculum sp. Strain A (ATCC Deposit Number PTA- 125892).

[158] In some embodiments, the bacteria are of the class *Bacteroidia* [phylum *Bacteroidota*]. In some embodiments, the bacteria are of order *Bacteroidales*. In some embodiments, the bacteria are of the family *Porphyromonoadaceae*. In some embodiments, the bacteria are of the family *Prevotellaceae*. In some embodiments, the bacteria are of the class *Bacteroidia* wherein the cell envelope structure of the bacteria is diderm. In some embodiments, the bacteria are of the class *Bacteroidia* that stain Gram negative. In some embodiments, the bacteria are of the class *Bacteroidia* wherein the bacteria is diderm and the bacteria stain Gram negative.

[159] In some embodiments, the bacteria are of the class *Clostridia* [phylum *Firmicutes*]. In some embodiments, the bacteria are of the order *Eubacteriales*. In some embodiments, the bacteria are of the family *Oscillispiraceae*. In some embodiments, the bacteria are of the family *Lachnospiraceae*. In some embodiments, the bacteria are of the family *Peptostreptococcaceae*. In some embodiments, the bacteria are of the family *Clostridiales family XIII/ Incertae sedis 41*. In some embodiments, the bacteria are of the class *Clostridia* wherein the cell envelope structure of the bacteria is monoderm. In some embodiments, the bacteria are of the class *Clostridia* that stain Gram negative. In some embodiments, the bacteria are of the class *Clostridia* that stain Gram positive. In some embodiments, the bacteria are of the class *Clostridia* wherein the cell envelope structure of the bacteria is monoderm and the bacteria stain Gram negative. In some embodiments, the bacteria are of the class *Clostridia* wherein the cell envelope structure of the bacteria is monoderm and the bacteria stain Gram positive.

[160] In some embodiments, the bacteria are of the class *Negativicutes* [phylum *Firmicutes*]. In some embodiments, the bacteria are of the order *Veillonellales*. In some embodiments, the bacteria are of the family *Veillonelloceae*. In some embodiments, the bacteria are of the order *Selenomonadales*. In some embodiments, the bacteria are of the family *Selenomonadaceae*. In some embodiments, the bacteria are of the family

Sporomusaceae. In some embodiments, the bacteria are of the class *Negativicutes* wherein the cell envelope structure of the bacteria is diderm. In some embodiments, the bacteria are of the class *Negativicutes* that stain Gram negative. In some embodiments, the bacteria are of the class *Negativicutes* wherein the cell envelope structure of the bacteria is diderm and the bacteria stain Gram negative.

[161] In some embodiments, the bacteria are of the class *Synergistia* [phylum *Synergistota*]. In some embodiments, the bacteria are of the order *Synergistales*. In some embodiments, the bacteria are of the family *Synergistaceae*. In some embodiments, the bacteria are of the class *Synergistia* wherein the cell envelope structure of the bacteria is diderm. In some embodiments, the bacteria are of the class *Synergistia* that stain Gram negative. In some embodiments, the bacteria are of the class *Synergistia* wherein the cell envelope structure of the bacteria is diderm and the bacteria stain Gram negative.

[162] In some embodiments, the bacteria are bacteria that produce metabolites, e.g., the bacteria produce butyrate, iosine, proprionate, or tryptophan metabolites.

[163] In some embodiments, the bacteria produce butyrate. In some embodiments, the bacteria are from the genus *Blautia; Christensella; Copracoccus; Eubacterium; Lachnosperacea; Megasphaera;* or *Roseburia*.

[164] In some embodiments, the bacteria produce iosine. In some embodiments, the bacteria are from the genus *Bifidobacterium; Lactobacillus;* or *Olsenella*.

[165] In some embodiments, the bacteria produce proprionate. In some embodiments, the bacteria are from the genus Akkermansia; Bacteriodes; Dialister; Eubacterium; Megasphaera; Parabacteriodes; Prevotella; Ruminococcus; or Veillonella.

[166] In some embodiments, the bacteria produce tryptophan metabolites. In some embodiments, the bacteria are from the genus *Lactobacillus* or *Peptostreptococcus*.

[167] In some embodiments, the bacteria are bacteria that produce inhibitors of histone deacetylase 3 (HDAC3). In some embodiments, the bacteria are from the species *Bariatricus massiliensis, Faecalibacterium prausnitzii, Megasphaera massiliensis* or *Roseburia intestinalis*.

[168] In some embodiments, the bacteria are from the genus *Alloiococcus; Bacillus; Catenibacterium; Corynebacterium; Cupriavidus; Enhydrobacter; Exiguobacterium; Faecalibacterium; Geobacillus; Methylobacterium; Micrococcus; Morganella; Proteus; Pseudomonas; Rhizobium;* or *Sphingomonas*.

[169] In some embodiments, the bacteria are from the genus *Cutibacterium*.

[170] In some embodiments, the bacteria are from the species *Cutibacterium avidum*.

[171] In some embodiments, the bacteria are from the genus *Lactobacillus*.

[172] In some embodiments, the bacteria are from the species *Lactobacillus gasseri*.

[173] In some embodiments, the bacteria are from the genus *Dysosmobacter*.

[174] In some embodiments, the bacteria are from the species *Dysosmobacter welbionis*.

[175] In some embodiments, the bacteria of the genus *Leuconostoc*.

[176] In some embodiments, the bacteria of the genus *Lactobacillus*.

[177] In some embodiments, the bacteria are of the genus *Akkermansia muciniphila; Bacillus; Blautia; Cupriavidus; Enhydrobacter; Faecalibacterium; Lactobacillus; Lactococcus; Micrococcus; Morganella; Propionibacterium; Proteus; Rhizobium;* or *Streptococcus*.

[178] In some embodiments, the bacteria are *Leuconostoc holzapfelii* bacteria.

[179] In some embodiments, the bacteria are *Akkermansia muciniphila; Cupriavidus metallidurans; Faecalibacterium prausnitzii; Lactobacillus casei; Lactobacillus plantarum; Lactobacillus paracasei; Lactobacillus plantarum; Lactobacillus rhamnosus; Lactobacillus sakei;* or *Streptococcus pyogenes* bacteria.

[180] In some embodiments, the bacteria are *Lactobacillus casei; Lactobacillus plantarum; Lactobacillus paracasei; Lactobacillus plantarum; Lactobacillus rhamnosus;* or *Lactobacillus sakei* bacteria.

[181] In some embodiments, the bacteria are *Megasphaera sp.* bacteria (e.g., from the strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387).

[182] In some embodiments, the bacteria are *Megasphaera massiliensis* bacteria (e.g., from the strain with accession number NCIMB 42787, NCIMB 43388 or NCIMB 43389).

[183] In some embodiments, the bacteria are *Megasphaera massiliensis* bacteria (e.g., from the strain with accession number DSM 26228).

[184] In some embodiments, the bacteria are *Parabacteroides distasonis* bacteria (e.g., from the strain with accession number NCIMB 42382).

[185] In some embodiments, the bacteria are *Megasphaera massiliensis* bacteria (e.g., from the strain with accession number NCIMB 43388 or NCIMB 43389), or a derivative thereof. See, e.g., WO 2020/120714. In some embodiments, the *Megasphaera massiliensis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least

99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of *Megasphaera massiliensis* bacteria from the strain with accession number NCIMB 43388 or NCIMB 43389. In some embodiments, the *Megasphaera massiliensis* bacteria is the strain with accession number NCIMB 43388 or NCIMB 43389.

[186] In some embodiments, the bacteria are *Megasphaera massiliensis* bacteria strain deposited under accession number NCIMB 42787, or a derivative thereof. See, e.g., WO 2018/229216. In some embodiments, the *Megasphaera massiliensis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of the *Megasphaera massiliensis* bacteria strain deposited under accession number NCIMB 42787. In some embodiments, the *Megasphaera massiliensis* bacteria is the strain deposited under accession number NCIMB 42787.

[187] In some embodiments, the bacteria are *Megasphaera spp.* bacteria from the strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387, or a derivative thereof. See, e.g., WO 2020/120714. In some embodiments, the *Megasphaera sp.* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of the *Megasphaera sp.* from a strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387. In some embodiments, the *Megasphaera sp.* bacteria is the strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387.

[188] In some embodiments, the bacteria are *Parabacteroides distasonis* bacteria deposited under accession number NCIMB 42382, or a derivative thereof. See, e.g., WO 2018/229216. In some embodiments, the *Parabacteroides distasonis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S

sequence, and/or CRISPR sequence) of the *Parabacteroides distasonis* bacteria deposited under accession number NCIMB 42382. In some embodiments, the *Parabacteroides distasonis* bacteria is the strain deposited under accession number NCIMB 42382.

[189] In some embodiments, the bacteria are *Megasphaera massiliensis* bacteria deposited under accession number DSM 26228, or a derivative thereof. See, e.g., WO 2018/229216. In some embodiments, the *Megasphaera massiliensis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of *Megasphaera massiliensis* bacteria deposited under accession number DSM 26228. In some embodiments, the *Megasphaera massiliensis* bacteria is the strain deposited under accession number DSM 26228.

[190] In some embodiments, the pharmaceutical agent comprises isolated mEVs (e.g., from one or more strains of bacteria (e.g., bacteria of interest)) (e.g., a therapeutically effective amount thereof). E.g., wherein at least 50%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% of the content of the pharmaceutical agent is isolated mEV of bacteria (e.g., bacteria of interest).

[191] In some embodiments, the pharmaceutical agent comprises mEVs and the mEVs comprise secreted mEVs (smEVs).

[192] In some embodiments, the pharmaceutical agent comprises mEVs and the mEVs comprise processed mEVs (pmEVs).

[193] In some embodiments, the pharmaceutical agent comprises pmEVs and the pmEVs are produced from bacteria that have been gamma irradiated, UV irradiated, heat inactivated, acid treated, or oxygen sparged.

[194] In some embodiments, the pharmaceutical agent comprises pmEVs and the pmEVs are produced from live bacteria.

[195] In some embodiments, the pharmaceutical agent comprises pmEVs and the pmEVs are produced from dead bacteria.

[196] In some embodiments, the pharmaceutical agent comprises pmEVs and the pmEVs are produced from non-replicating bacteria.

[197] In some embodiments, the pharmaceutical agent comprises mEVs and the mEVs are from one strain of bacteria.

[198] In some embodiments, the mEVs are lyophilized (e.g., the lyophilized product further comprises a pharmaceutically acceptable excipient).

[199] In some embodiments, the mEVs are gamma irradiated.

[200] In some embodiments, the mEVs are UV irradiated.

[201] In some embodiments, the mEVs are heat inactivated (e.g., at 50°C for two hours or at 90°C for two hours).

[202] In some embodiments, the mEVs are acid treated.

[203] In some embodiments, the mEVs are oxygen sparged (e.g., at 0.1 vvm for two hours).

[204] In some embodiments, the mEVs are from Gram positive bacteria.

[205] In some embodiments, the mEVs are from Gram negative bacteria.

[206] In some embodiments, the mEVs are from aerobic bacteria.

[207] In some embodiments, the mEVs are from anaerobic bacteria. In some embodiments, the anaerobic bacteria comprise obligate anaerobes. In some embodiments, the anaerobic bacteria comprise facultative anaerobes.

[208] In some embodiments, the mEVs are from acidophile bacteria.

[209] In some embodiments, the mEVs are from alkaliphile bacteria.

[210] In some embodiments, the mEVs are from neutralophile bacteria.

[211] In some embodiments, the mEVs are from fastidious bacteria.

[212] In some embodiments, the mEVs are from nonfastidious bacteria.

[213] In some embodiments, the mEVs are from bacteria of a taxonomic group (e.g., class, order, family, genus, species or strain) listed in Table 1, Table 2, or Table 3.

[214] In some embodiments, the mEVs are from a bacterial strain listed in Table 1, Table 2, or Table 3.

[215] In some embodiments, the mEVs are from bacteria of a taxonomic group (e.g., class, order, family, genus, species or strain) listed in Table J.

[216] In some embodiments, the mEVs are from a bacterial strain listed in Table J.

[217] In some embodiments, the Gram negative bacteria belong to class *Negativicutes*.

[218] In some embodiments, the Gram negative bacteria belong to family *Veillonellaceae, Selenomonadaceae, Acidaminococcaceae,* or *Sporomusaceae*.

[219] In some embodiments, the mEVs are from bacteria of the genus *Megasphaera, Selenomonas, Propionospora,* or *Acidaminococcus*.

[220] In some embodiments, the mEVs are Megasphaera sp., Selenomonas felix, Acidaminococcus intestine, or Propionospora sp. bacteria.

[221] In some embodiments, the mEVs are from bacteria of the genus *Lactococcus, Prevotella, Bifidobacterium,* or *Veillonell*a.

[222] In some embodiments, the mEVs are from *Lactococcus lactis cremoris* bacteria.

[223] In some embodiments, the mEVs are from *Prevotella histicola* bacteria.

[224] In some embodiments, the mEVs are from *Bifidobacterium animalis* bacteria.

[225] In some embodiments, the mEVs are from *Veillonella parvula* bacteria.

[226] In some embodiments, the mEVs are from *Lactococcus lactis cremoris* bacteria. In some embodiments, the *Lactococcus lactis cremoris* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Lactococcus lactis cremoris* Strain A (ATCC designation number PTA-125368). In some embodiments, the *Lactococcus* bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Lactococcus lactis cremoris* Strain A (ATCC designation number PTA-125368). In some embodiments, the *Lactococcus* bacteria are from *Lactococcus lactis cremoris* Strain A (ATCC designation number PTA-125368).

[227] In some embodiments, the mEVs are from *Prevotella* bacteria. In some embodiments, the *Prevotella* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Prevotella* Strain B 50329 (NRRL accession number B 50329). In some embodiments, the *Prevotella* bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Prevotella* Strain B 50329 (NRRL accession number B 50329). In some embodiments, the *Prevotella* bacteria are from *Prevotella* Strain B 50329 (NRRL accession number B 50329).

[228] In some embodiments, the mEVs are from *Bifidobacterium* bacteria. In some embodiments, the *Bifidobacterium* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Bifidobacterium* bacteria deposited as ATCC designation number PTA-125097. In some embodiments, the *Bifidobacterium* bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Bifidobacterium* bacteria deposited as ATCC designation number PTA-125097. In some embodiments, the *Bifidobacterium* bacteria are from *Bifidobacterium* bacteria deposited as ATCC designation number PTA-125097.

[229] In some embodiments, the mEVs are from *Veillonella* bacteria. In some embodiments, the *Veillonella* bacteria are from a strain comprising at least 90% (or at least

97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Veillonell*a bacteria deposited as ATCC designation number PTA-125691. In some embodiments, the *Veillonella* bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Veillonella* bacteria deposited as ATCC designation number PTA-125691. In some embodiments, the *Veillonella* bacteria are from *Veillonella* bacteria deposited as ATCC designation number PTA-125691.

[230] In some embodiments, the mEVs are from *Ruminococcus gnavus* bacteria. In some embodiments, the *Ruminococcus gnavus* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Ruminococcus gnavus* bacteria deposited as ATCC designation number PTA-126695. In some embodiments, the *Ruminococcus gnavus* bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Ruminococcus gnavus* bacteria deposited as ATCC designation number PTA-126695. In some embodiments, the *Ruminococcus gnavus* bacteria are from *Ruminococcus gnavus* bacteria deposited as ATCC designation number PTA-126695.

[231] In some embodiments, the mEVs are from *Megasphaera sp.* bacteria. In some embodiments, the *Megasphaera sp.* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Megasphaera sp.* bacteria deposited as ATCC designation number PTA-126770. In some embodiments, the *Megasphaera sp.*bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Megasphaera sp.*bacteria deposited as ATCC designation number PTA-126770. In some embodiments, the *Megasphaera sp.* bacteria are from *Megasphaera sp.* bacteria deposited as ATCC designation number PTA-126770.

[232] In some embodiments, the mEVs are from *Fournierella massiliensis* bacteria. In some embodiments, the *Fournierella massiliensis* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Fournierella massiliensis* bacteria deposited as ATCC designation number PTA-126696. In some embodiments, the *Fournierella massiliensis* bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Fournierella massiliensis* bacteria deposited as ATCC designation number PTA-126696. In some embodiments, the *Fournierella massiliensis* bacteria are from *Fournierella massiliensis* bacteria deposited as ATCC designation number PTA-126696.

[233] In some embodiments, the mEVs are from *Harryflintia acetispora* bacteria. In some embodiments, the *Harryflintia acetispora* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Harryflintia acetispora* bacteria deposited as ATCC designation number PTA-126694. In some embodiments, the *Harryflintia acetispora* bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Harryflintia acetispora* bacteria deposited as ATCC designation number PTA-126694. In some embodiments, the *Harryflintia acetispora* bacteria are from *Harryflintia acetispora* bacteria deposited as ATCC designation number PTA-126694.

[234] In some embodiments, the mEVs are from bacteria of the family Acidaminococcaceae, Alcaligenaceae, Akkermansiaceae, Bacteriodaceae, Bifidobacteriaceae, Burkholderiaceae, Catabacteriaceae, Clostridiaceae, Coriobacteriaceae, Enterobacteriaceae, Enterococcaceae, Fusobacteriaceae, Lachnospiraceae, Listeraceae, Mycobacteriaceae, Neisseriaceae, Odoribacteraceae, Oscillospiraceae, Peptococcaceae, Peptostreptococcaceae, Porphyromonadaceae, Prevotellaceae, Propionibacteraceae, Rikenellaceae, Ruminococcaceae, Selenomonadaceae, Sporomusaceae, Streptococcaceae, Streptomycetaceae, Sutterellaceae, Synergistaceae, or Veillonellaceae.

[235] In some embodiments, the mEVs are from bacteria of the genus Akkermansia, Christensenella, Blautia, Enterococcus, Eubacterium, Roseburia, Bacteroides, Parabacteroides, or Erysipelatoclostridium.

[236] In some embodiments, the mEVs are from Blautia hydrogenotrophica, Blautia stercoris, Blautia wexlerae, Eubacterium faecium, Eubacterium contortum, Eubacterium rectale, Enterococcus faecalis, Enterococcus durans, Enterococcus villorum, Enterococcus gallinarum; Bifidobacterium lactis, Bifidobacterium bifidium, Bifidobacterium longum, Bifidobacterium animalis, or Bifidobacterium breve bacteria.

[237] In some embodiments, the mEVs are from BCG (bacillus Calmette-Guerin), Parabacteroides, Blautia, Veillonella, Lactobacillus salivarius, Agathobaculum, Ruminococcus gnavus, Paraclostridium benzoelyticum, Turicibacter sanguinus, Burkholderia, Klebsiella quasipneumoniae ssp similpneumoniae, Klebsiella oxytoca, Tyzzerela nexilis, or Neisseria bacteria.

[238] In some embodiments, the mEVs are from *Blautia hydrogenotrophica* bacteria.

[239] In some embodiments, the mEVs are from *Blautia stercoris* bacteria.

[240] In some embodiments, the mEVs are from *Blautia wexlerae* bacteria.

[241] In some embodiments, the mEVs are from *Enterococcus gallinarum* bacteria.

[242] In some embodiments, the mEVs are from *Enterococcus faecium* bacteria.

[243] In some embodiments, the mEVs are from *Bifidobacterium bifidium* bacteria.

[244] In some embodiments, the mEVs are from *Bifidobacterium breve* bacteria.

[245] In some embodiments, the mEVs are from *Bifidobacterium longum* bacteria.

[246] In some embodiments, the mEVs are from *Roseburia hominis* bacteria.

[247] In some embodiments, the mEVs are from *Bacteroides thetaiotaomicron* bacteria.

[248] In some embodiments, the mEVs are from *Bacteroides coprocola* bacteria.

[249] In some embodiments, the mEVs are from *Erysipelatoclostridium ramosum* bacteria.

[250] In some embodiments, the mEVs are from *Megasphera massiliensis* bacteria.

[251] In some embodiments, the mEVs are from *Eubacterium* bacteria.

[252] In some embodiments, the mEVs are from *Parabacteroides distasonis* bacteria.

[253] In some embodiments, the mEVs are from *Lactobacillus plantarum* bacteria.

[254] In some embodiments, the mEVs are from bacteria of the *Negativicutes* class.

[255] In some embodiments, the mEVs are from bacteria of the *Veillonellaceae* family.

[256] In some embodiments, the mEVs are from bacteria of the *Selenomonadaceae* family.

[257] In some embodiments, the mEVs are from bacteria of the *Acidaminococcaceae* family.

[258] In some embodiments, the mEVs are from bacteria of the *Sporomusaceae* family.

[259] In some embodiments, the mEVs are from bacteria of the *Megasphaera* genus.

[260] In some embodiments, the mEVs are from bacteria of the *Selenomonas* genus.

[261] In some embodiments, the mEVs are from bacteria of the *Propionospora* genus.

[262] In some embodiments, the mEVs are from bacteria of the *Acidaminococcus* genus.

[263] In some embodiments, the mEVs are from *Megasphaera sp.* bacteria.

[264] In some embodiments, the mEVs are from *Selenomonas felix* bacteria.

[265] In some embodiments, the mEVs are from *Acidaminococcus intestini* bacteria.

[266] In some embodiments, the mEVs are from *Propionospora sp.* bacteria.

[267] In some embodiments, the mEVs are from bacteria of the *Clostridia* class.

[268] In some embodiments, the mEVs are from bacteria of the *Oscillospriraceae* family.

[269] In some embodiments, the mEVs are from bacteria of the *Faecalibacterium* genus.

[270] In some embodiments, the mEVs are from bacteria of the *Fournierella* genus.

[271] In some embodiments, the mEVs are from bacteria of the *Harryflintia* genus.

[272] In some embodiments, the mEVs are from bacteria of the *Agathobaculum* genus.

[273] In some embodiments, the mEVs are from *Faecalibacterium prausnitzii* (e.g., *Faecalibacterium prausnitzii* Strain A) bacteria.

[274] In some embodiments, the mEVs are from *Fournierella massiliensis* (e.g., *Fournierella massiliensis* Strain A) bacteria.

[275] In some embodiments, the mEVs are from *Harryflintia acetispora* (e.g., *Harryflintia acetispora* Strain A) bacteria.

[276] In some embodiments, the mEVs are from *Agathobaculum sp.* (e.g., *Agathobaculum sp.* Strain A) bacteria.

[277] In some embodiments, the mEVs are from a strain of *Agathobaculum sp.* In some embodiments, the *Agathobaculum sp.* strain is a strain comprising at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, CRISPR sequence) of the *Agathobaculum sp.* Strain A (ATCC Deposit Number PTA-125892). In some embodiments, the *Agathobaculum sp.* strain is the Agathobaculum sp. Strain A (ATCC Deposit Number PTA- 125892).

[278] In some embodiments, the mEVs are from bacteria of the class *Bacteroidia* [phylum *Bacteroidota*]. In some embodiments, the mEVs are from bacteria of order *Bacteroidales*. In some embodiments, the mEVs are from bacteria of the family *Porphyromonoadaceae*. In some embodiments, the mEVs are from bacteria of the family *Prevotellaceae*. In some embodiments, the mEVs are from bacteria of the class *Bacteroidia* wherein the cell envelope structure of the bacteria is diderm. In some embodiments, the mEVs are from bacteria of the class *Bacteroidia* that stain Gram negative. In some embodiments, the mEVs are from bacteria of the class *Bacteroidia* wherein the bacteria is diderm and the bacteria stain Gram negative.

[279] In some embodiments, the mEVs are from bacteria of the class *Clostridia* [phylum *Firmicutes*]. In some embodiments, the mEVs are from bacteria of the order *Eubacteriales*. In some embodiments, the mEVs are from bacteria of the family *Oscillispiraceae*. In some embodiments, the mEVs are from bacteria of the family *Lachnospiraceae*. In some embodiments, the mEVs are from bacteria of the family *Peptostreptococcaceae*. In some embodiments, the mEVs are from bacteria of the family *Clostridiales family XIII/ Incertae sedis 41*. In some embodiments, the mEVs are from bacteria of the class *Clostridia* wherein

the cell envelope structure of the bacteria is monoderm. In some embodiments, the mEVs are from bacteria of the class *Clostridia* that stain Gram negative. In some embodiments, the mEVs are from bacteria of the class *Clostridia* that stain Gram positive. In some embodiments, the mEVs are from bacteria of the class *Clostridia* wherein the cell envelope structure of the bacteria is monoderm and the bacteria stain Gram negative. In some embodiments, the mEVs are from bacteria of the class *Clostridia* wherein the cell envelope structure of the bacteria is monoderm and the bacteria stain Gram positive.

[280] In some embodiments, the mEVs are from bacteria of the class *Negativicutes* [phylum *Firmicutes*]. In some embodiments, the mEVs are from bacteria of the order *Veillonellales*. In some embodiments, the mEVs are from bacteria of the family *Veillonelloceae*. In some embodiments, the mEVs are from bacteria of the order *Selenomonadales*. In some embodiments, the mEVs are from bacteria of the family *Selenomonadaceae*. In some embodiments, the mEVs are from bacteria of the family *Sporomusaceae*. In some embodiments, the mEVs are from bacteria of the class *Negativicutes* wherein the cell envelope structure of the bacteria is diderm. In some embodiments, the mEVs are from bacteria of the class *Negativicutes* that stain Gram negative. In some embodiments, the mEVs are from bacteria of the class *Negativicutes* wherein the cell envelope structure of the bacteria is diderm and the bacteria stain Gram negative.

[281] In some embodiments, the mEVs are from bacteria of the class *Synergistia* [phylum *Synergistota*]. In some embodiments, the mEVs are from bacteria of the order *Synergistales*. In some embodiments, the mEVs are from bacteria of the family *Synergistaceae*. In some embodiments, the mEVs are from bacteria of the class *Synergistia* wherein the cell envelope structure of the bacteria is diderm. In some embodiments, the mEVs are from bacteria of the class *Synergistia* that stain Gram negative. In some embodiments, the mEVs are from bacteria of the class *Synergistia* wherein the cell envelope structure of the bacteria is diderm and the bacteria stain Gram negative.

[282] In some embodiments, the mEVs are from bacteria that produce metabolites, e.g., the bacteria produce butyrate, iosine, proprionate, or tryptophan metabolites.

[283] In some embodiments, the mEVs are from bacteria that produce butyrate. In some embodiments, the bacteria are from the genus *Blautia; Christensella; Copracoccus; Eubacterium; Lachnosperacea; Megasphaera;* or *Roseburia*.

[284] In some embodiments, the mEVs are from bacteria that produce iosine. In some embodiments, the bacteria are from the genus *Bifidobacterium; Lactobacillus;* or *Olsenella*.

[285] In some embodiments, the mEVs are from bacteria that produce proprionate. In some embodiments, the mEVs are from bacteria from the genus Akkermansia; Bacteriodes; Dialister; Eubacterium; Megasphaera; Parabacteriodes; Prevotella; Ruminococcus; or Veillonella.

[286] In some embodiments, the mEVs are from bacteria that produce tryptophan metabolites. In some embodiments, the mEVs are from bacteria from the genus *Lactobacillus* or *Peptostreptococcus*.

[287] In some embodiments, the mEVs are from bacteria that produce inhibitors of histone deacetylase 3 (HDAC3). In some embodiments, the mEVs are from bacteria from the species *Bariatricus massiliensis, Faecalibacterium prausnitzii, Megasphaera massiliensis* or *Roseburia intestinalis*.

[288] In some embodiments, the mEVs are from bacteria of the genus *Alloiococcus; Bacillus; Catenibacterium; Corynebacterium; Cupriavidus; Enhydrobacter; Exiguobacterium; Faecalibacterium; Geobacillus; Methylobacterium; Micrococcus; Morganella; Proteus; Pseudomonas; Rhizobium;* or *Sphingomonas*.

[289] In some embodiments, the mEVs are from bacteria of the genus *Cutibacterium*.

[290] In some embodiments, the mEVs are from bacteria of the species *Cutibacterium avidum*.

[291] In some embodiments, the mEVs are from bacteria of the genus *Lactobacillus*.

[292] In some embodiments, the mEVs are from bacteria of the species *Lactobacillus gasseri*.

[293] In some embodiments, the mEVs are from bacteria of the genus *Dysosmobacter*.

[294] In some embodiments, the mEVs are from bacteria of the species *Dysosmobacter welbionis*.

[295] In some embodiments, the mEVs are from bacteria of the genus *Leuconostoc*.

[296] In some embodiments, the mEVs are from bacteria of the genus *Lactobacillus*.

[297] In some embodiments, the mEVs are from bacteria of the genus *Akkermansia muciniphila; Bacillus; Blautia; Cupriavidus; Enhydrobacter; Faecalibacterium; Lactobacillus; Lactococcus; Micrococcus; Morganella; Propionibacterium; Proteus; Rhizobium;* or *Streptococcus*.

[298] In some embodiments, the mEVs are from *Leuconostoc holzapfelii* bacteria.

[299] In some embodiments, the mEVs are from *Akkermansia muciniphila; Cupriavidus metallidurans; Faecalibacterium prausnitzii; Lactobacillus casei; Lactobacillus plantarum; Lactobacillus paracasei; Lactobacillus plantarum; Lactobacillus rhamnosus; Lactobacillus sakei;* or *Streptococcus pyogenes* bacteria.

[300] In some embodiments, the mEVs are from *Lactobacillus casei; Lactobacillus plantarum; Lactobacillus paracasei; Lactobacillus plantarum; Lactobacillus rhamnosus;* or *Lactobacillus sakei* bacteria.

[301] In some embodiments, the mEVs are from *Megasphaera sp.* bacteria (e.g., from the strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387).

[302] In some embodiments, the mEVs are from *Megasphaera massiliensis* bacteria (e.g., from the strain with accession number NCIMB 42787, NCIMB 43388 or NCIMB 43389).

[303] In some embodiments, the mEVs are from *Megasphaera massiliensis* bacteria (e.g., from the strain with accession number DSM 26228).

[304] In some embodiments, the mEVs are from *Parabacteroides distasonis* bacteria (e.g., from the strain with accession number NCIMB 42382).

[305] In some embodiments, the mEVs are from *Megasphaera massiliensis* bacteria (e.g., from the strain with accession number NCIMB 43388 or NCIMB 43389), or a derivative thereof. See, e.g., WO 2020/120714. In some embodiments, the *Megasphaera massiliensis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of *Megasphaera massiliensis* bacteria from the strain with accession number NCIMB 43388 or NCIMB 43389. In some embodiments, the *Megasphaera massiliensis* bacteria is the strain with accession number NCIMB 43388 or NCIMB 43389.

[306] In some embodiments, the mEVs are from *Megasphaera massiliensis* bacteria strain deposited under accession number NCIMB 42787, or a derivative thereof. See, e.g., WO 2018/229216. In some embodiments, the *Megasphaera massiliensis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity,

at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of the *Megasphaera massiliensis* bacteria strain deposited under accession number NCIMB 42787. In some embodiments, the *Megasphaera massiliensis* bacteria is the strain deposited under accession number NCIMB 42787.

[307] In some embodiments, the mEVs are from *Megasphaera spp.* bacteria from the strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387, or a derivative thereof. See, e.g., WO 2020/120714. In some embodiments, the *Megasphaera sp.* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of the *Megasphaera sp.* from a strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387. In some embodiments, the *Megasphaera sp.* bacteria is the strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387.

[308] In some embodiments, the mEVs are from *Parabacteroides distasonis* bacteria deposited under accession number NCIMB 42382, or a derivative thereof. See, e.g., WO 2018/229216. In some embodiments, the *Parabacteroides distasonis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of the *Parabacteroides distasonis* bacteria deposited under accession number NCIMB 42382. In some embodiments, the *Parabacteroides distasonis* bacteria is the strain deposited under accession number NCIMB 42382.

[309] In some embodiments, the mEVs are from *Megasphaera massiliensis* bacteria deposited under accession number DSM 26228, or a derivative thereof. See, e.g., WO 2018/229216. In some embodiments, the *Megasphaera massiliensis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of *Megasphaera massiliensis* bacteria deposited under

accession number DSM 26228. In some embodiments, the *Megasphaera massiliensis* bacteria is the strain deposited under accession number DSM 26228.

[310] In some embodiments, the pharmaceutical agent comprises *Prevotella histicola* bacteria and the dose of bacteria is about 1 x 10^7 to about 2 x 10^{12} (e.g., about 3 x 10^{10} or about 1.5 x 10^{11}) cells (e.g., wherein cell number is determined by total cell count, which is determined by Coulter counter), wherein the dose is per capsule. In some embodiments, the pharmaceutical agent comprises about 1 x 10^7 to about 2 x 10^{12} cells of *Prevotella histicola* bacteria. In some embodiments, the pharmaceutical agent comprises about 1.6 x 10^{10} cells of *Prevotella histicola* bacteria. In some embodiments, the pharmaceutical agent comprises about 8.0 x 10^{10} cells of *Prevotella histicola* bacteria. In some embodiments, the pharmaceutical agent comprises about 1.6 x 10^{11} cells of *Prevotella histicola* bacteria. In some embodiments, the pharmaceutical agent comprises about 3.2 x 10^{11} cells of *Prevotella histicola* bacteria.

[311] In some embodiments, the pharmaceutical agent comprises *Prevotella histicola* bacteria and the dose of bacteria is about 1 x 10^9, about 3 x 10^9, about 5 x 10^9, about 1.5 x 10^{10}, or about 5 x 10^{10} cells (e.g., TCC (total cell count)), wherein the dose is per capsule. In some embodiments, the pharmaceutical agent comprises bacteria and the dose of bacteria is about 8 x 10^{10} cells, wherein the dose is per capsule. In some embodiments, the pharmaceutical agent comprises bacteria and the dose of bacteria is about 1.6 x 10^{11} cells, wherein the dose is per capsule. In some embodiments, the pharmaceutical agent comprises bacteria and the dose of bacteria is about 3.2 x 10^{11} cells, wherein the dose is per capsule.

[312] In some embodiments, the pharmaceutical agent comprises a powder comprising bacteria and the dose of the pharmaceutical agent (e.g., a powder comprising bacteria) is about 10 mg to about 3500 mg, wherein the dose is per capsule.

[313] In some embodiments, the pharmaceutical agent comprises a powder comprising bacteria and/ and the dose of the pharmaceutical agent (e.g., a powder comprising bacteria) is about 30 mg to about 1300 mg (by weight of bacteria powder) (about 25, about 30, about 35, about 50, about 75, about 100, about 120, about 150, about 250, about 300, about 350, about 400, about 500, about 600, about 700, about 750, about 800, about 900, about 1000, about 1100, about 1200, about 1250, about 1300, about 2000, about 2500, about 3000, or about 3500 mg wherein the dose is per capsule.

[314] In some embodiments, the pharmaceutical agent comprises bacteria and the dose of pharmaceutical agent (e.g., bacteria) is about 2x10^6 to about 2x10^{16} particles (e.g.,

wherein particle count is determined by NTA (nanoparticle tracking analysis)), wherein the dose is per capsule.

[315] In some embodiments, the pharmaceutical agent comprises bacteria and the dose of pharmaceutical agent (e.g., bacteria) is about 5 mg to about 900 mg total protein (e.g., wherein total protein is determined by Bradford assay or BCA), wherein the dose is per capsule.

[316] In some embodiments, the solid dosage form further comprises one or more additional therapeutic agents.

[317] In some aspects, the disclosure provides a method of treating a subject (e.g., human) (e.g., a subject in need of treatment), the method comprising administering to the subject a solid dosage form provided herein.

[318] In some aspects, the disclosure provides use of a solid dosage form provided herein for the preparation of a medicament for treating a subject (e.g., human) (e.g., a subject in need of treatment).

[319] In some embodiments, the solid dosage form is orally administered (e.g., is for oral administration).

[320] In some embodiments, the solid dosage form is administered to a subject that is in a fed or fasting state. In some embodiments, the solid dosage form is administered to a subject on an empty stomach (e.g., one hour before eating or two hours after eating). In some embodiments, the solid dosage form is administered to a subject one hour before eating. In some embodiments, the solid dosage form is administered to a subject two hours after eating.

[321] In some embodiments, the solid dosage form is administered (e.g., is for administration) 1, 2, 3, or 4 times a day. In some embodiments, 1, 2, 3, or 4 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1, 2, 3, or 4 times a day. In some embodiments, 2, 4, 6, 8, or 10 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1, 2, 3, or 4 times a day.

[322] In some embodiments, the solid dosage form provides release of the pharmaceutical agent in the small intestine, e.g., in the upper small intestine, of the pharmaceutical agent contained in the solid dosage form.

[323] In some embodiments, the solid dosage form delivers the pharmaceutical agent to the small intestine, wherein the pharmaceutical agent can act on immune cells and/or epithelial cells in the small intestine, e.g., in the upper small intestine, e.g., to cause effects throughout the body (e.g., systemic effect).

[324] In some embodiments, the pharmaceutical agent provides one or more beneficial immune effects outside the gastrointestinal tract, e.g., when orally administered.

[325] In some embodiments, the pharmaceutical agent modulates immune effects outside the gastrointestinal tract in the subject, e.g., when orally administered.

[326] In some embodiments, the pharmaceutical agent causes a systemic effect (e.g., an effect outside of the gastrointestinal tract), e.g., when orally administered.

[327] In some embodiments, the pharmaceutical agent acts on immune cells and/or epithelial cells in the small intestine (e.g., upper small intestine) (e.g., causing a systemic effect (e.g., an effect outside of the gastrointestinal tract), e.g., when orally administered.

[328] In some embodiments, the solid dosage form is administered orally and has one or more beneficial immune effects outside the gastrointestinal tract (e.g., interaction between the agent and cells in the small intestine modulates a systemic immune response).

[329] In some embodiments, the solid dosage form is administered orally and modulates immune effects outside the gastrointestinal tract (e.g., interaction between agent and cells in the small intestine (e.g., upper small intestine) modulates a systemic immune response).

[330] In some embodiments, the solid dosage form is administered orally and activates innate antigen presenting cells (e.g., in the small intestine, e.g., upper small intestine).

[331] In some embodiments, the subject is in need of treatment (and/or prevention) of a cancer.

[332] In some embodiments, the subject is in need of treatment (and/or prevention) of an autoimmune disease.

[333] In some embodiments, the subject is in need of treatment (and/or prevention) of an inflammatory disease.

[334] In some embodiments, the subject is in need of treatment (and/or prevention) of a metabolic disease.

[335] In some embodiments, the subject is in need of treatment (and/or prevention) of a dysbiosis.

[336] In some embodiments, the subject is in need of decreased inflammatory cytokine expression (e.g., decreased IL-8, IL-6, IL-1β, and/or TNFα expression levels).

[337] In some embodiments, the subject is in need of treatment (and/or prevention) of bacterial septic shock, cytokine storm and/or viral infection.

[338] In some embodiments, the subject is in need of treatment (and/or prevention) of a viral infection.

[339] In some embodiments, the viral infection is a coronavirus infection, an influenza infection, and/or a respiratory syncytial virus infection.

[340] In some embodiments the viral infection is a SARS-CoV-2 infection.

[341] In some embodiments, the solid dosage form is administered in combination with a therapeutic agent (e.g., additional therapeutic agent).

[342] In certain aspects, provided herein are methods of preparing a solid dosage form of a pharmaceutical composition, the method comprising combining into a pharmaceutical composition a pharmaceutical agent (*e.g., Prevotella histicola or Veillonella parvula* bacteria disclosed herein or a powder comprising the bacteria) and a diluent.

[343] In certain embodiments, the total pharmaceutical agent mass is at least 2.5%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, or 95% of the total mass of the pharmaceutical composition. In some embodiments the total pharmaceutical agent mass is no more than 95%, 90%, 85%, 80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, or 2.5% of the total mass of the pharmaceutical composition. In some embodiments, the pharmaceutical agent has a total pharmaceutical agent mass that is at least 2.5% and no more than 95% of the total mass of the pharmaceutical composition.

[344] In some embodiments, the total mass of the diluent is at least 1%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, or 98% of the total mass of the pharmaceutical composition. In some embodiments, the total mass of the diluent is no more than 98%, 95%, 90%, 85%, 80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, or 1% of the total mass of the pharmaceutical composition. In some embodiments, the diluent has a total mass that is at least 1% and no more than 98% of the total mass of the pharmaceutical composition. In some embodiments, the diluent comprises mannitol.

[345] In certain embodiments, the method further comprises combining a lubricant. In certain embodiments, the total lubricant mass is at least 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is no more than 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 0.5% to about 1.5% of the total mass of the

pharmaceutical composition. In certain embodiments, the total lubricant mass is about 1% of the total mass of the pharmaceutical composition. In some embodiments, the lubricant comprises magnesium stearate.

[346] In certain embodiments, the method further comprises combining a glidant. In some embodiments, the glidant is colloidal silicon dioxide. In certain embodiments, the total glidant mass is at least 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is no more than 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.25% to about 0.75% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.5% to about 1.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 1% of the total mass of the pharmaceutical composition.

[347] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 4% and no more than 65% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 35% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[348] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 60% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 38% and no more than 93% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[349] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 20% and no more than 55% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 45% and no more than 80% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[350] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 92% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 5% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[351] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 20% to about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 50% to 80% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[352] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 30% and no more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 45% and no more than 70% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[353] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 50% of the

total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 48.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[354] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 92% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 5% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[355] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10% to about 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 7% to about 88% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 1% of the total mass of the pharmaceutical composition.

[356] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 10% and no more than 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 8.5% and no more than 88.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[357] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 13.51% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 84.99% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of

the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[358] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 90.22% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 8.28% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[359] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 50% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[360] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 50% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[361] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 45% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 55% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[362] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 40% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 58% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[363] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10.6% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 87.4% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[364] In some embodiments, the method further comprises loading the pharmaceutical composition into a capsule. In some embodiments, the capsule comprises HPMC.

[365] In some embodiments, the method further comprises banding the capsule. In some embodiments, the capsule is banded with an HPMC-based banding solution.

[366] In some embodiments, the method further comprises enterically coating the capsule, thereby preparing an enterically coated capsule.

[367] In certain embodiments, the method comprises performing wet granulation on a pharmaceutical agent prior to combining the pharmaceutical agent (e.g., bacteria (e.g., bacteria disclosed herein) and/or an agent of bacterial origin, such as mEVs (e.g., mEVs disclosed herein)) and one or more (e.g., one, two or three) excipients into a pharmaceutical composition. In some embodiments, the wet granulation comprises (i) mixing the pharmaceutical agent with a granulating fluid (e.g., water, ethanol, or isopropanol, alone or in combination). In some embodiments, the wet granulation comprises mixing the pharmaceutical agent with water. In some embodiments, the wet granulation comprises (ii) drying mixed pharmaceutical agent and granulating fluid (e.g., drying on a fluid bed dryer). In some embodiments, the wet granulation comprises (iii) milling the dried pharmaceutical agent and granulating fluid. The milled pharmaceutical agent and granulating fluid are then combined with the one or more (e.g., one, two or three) excipients to prepare a pharmaceutical composition.

[368] As used herein, the percent of mass of a solid dosage form is on a percent weight:weight basis (% w:w).

Brief Description of the Drawings

[369] **Figure 1** is a graph showing a Total Cells/Capsule Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH) storage conditions for Batch A. The trace ending at 6 months (diamonds) in the graph provides values for accelerated (25˚C / 60% RH) storage conditions. The trace ending at 18 months (circles) in the graph provides values for long-term (2-8˚C) storage conditions. Total Cell Count (TCC) was determined by Coulter counter.

[370] **Figure 2** is a graph showing a Water Content Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH) storage conditions for Batch A. The trace ending at 6 months (diamonds) in the graph provides values for accelerated (25˚C / 60% RH) storage conditions. The trace ending at 18 months (circles) in the graph provides values for long-term (2-8˚C) storage conditions. Water content was determined by the Karl Fisher method.

[371] **Figure 3** is a graph showing Total Cells/ Capsule Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH) storage conditions for Batch B. The lower trace (diamonds) in the graph provides values for accelerated (25˚C / 60% RH) storage conditions. The upper trace (circles) in the graph provides values for long-term (2-8˚C) storage conditions. Total Cell Count (TCC) was determined by Coulter counter.

[372] **Figure 4** is a graph showing a Water Content Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH) storage conditions for Batch B. The upper trace (diamonds) in the graph provides values for accelerated (25˚C / 60% RH) storage conditions. The lower trace (circles) in the graph provides values for long-term (2-8˚C) storage conditions. Water content was determined by the Karl Fisher method.

[373] **Figure 5** is a graph showing a Total Cells/ Capsule Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH) storage conditions for Batch C. The trace ending at 6 months (diamonds) in the graph provides values for accelerated (25˚C / 60% RH) storage conditions. The trace ending at 18 months (circles) in the graph provides values for long-term (2-8˚C) storage conditions. Total Cell Count (TCC) was determined by Coulter counter.

[374] **Figure 6** is a graph showing a Water Content Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH) storage conditions for Batch C. The trace ending at 6 months (diamonds) in the graph provides values for accelerated (25˚C / 60% RH) storage

conditions. The trace ending at 18 months (circles) in the graph provides values for long-term (2-8°C) storage conditions. Water content was determined by the Karl Fisher method.

[375] **Figure 7** is a graph showing a Total Cells/Capsule Stability Profile over time long-term (2-8°C) and accelerated (25°C / 60% RH) storage conditions for Batch F. The lower trace (diamonds) in the graph provides values for accelerated (25°C / 60% RH) storage conditions. The upper trace (circles) in the graph provides values for long-term (2-8°C) storage conditions. Total Cell Count (TCC) was determined by Coulter counter.

[376] **Figure 8** is a graph showing a Water Content Stability Profile over time long-term (2-8°C) and accelerated (25°C / 60% RH) storage conditions for Batch F. The trace that ends in the lower position (diamonds) in the graph provides values for accelerated (25°C / 60% RH) storage conditions. The trace that ends in the upper position (circles) in the graph provides values for long-term (2-8°C) storage conditions. Water content was determined by the Karl Fisher method.

[377] **Figure 9** is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8°C (abbreviation: 5°C)) storage conditions for the low dose batch. Total Cell Count (TCC) was determined by Coulter counter.

[378] **Figure 10** is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8°C (abbreviation: 5°C)) storage conditions for the high dose batch. Total Cell Count (TCC) was determined by Coulter counter.

[379] **Figure 11** is a graph showing Water Content Stability Profile over time long-term (2-8°C (abbreviation: 5°C)) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the low dose batch. The traces for the two conditions overlap. Water content was determined by the Karl Fisher method.

[380] **Figure 12** is a graph showing Water Content Stability Profile over time long-term (2-8°C (abbreviation: 5°C)) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the high dose batch. The traces for the two conditions largely overlap until the 3-month time point. The upper trace at the 3-month time point in the graph provides values for long-term (2-8°C) storage conditions. The lower trace at the 3-month time point in the graph provides values for accelerated (25°C / 60% RH) storage conditions. Water content was determined by the Karl Fisher method.

[381] **Figures 13A and B** are graphs showing 6-month Stability Profiles for the high dose batch. Figure 13A is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8°C (abbreviation: 5°C)) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the high dose batch. Total Cell Count (TCC) was determined by

Coulter counter. Figure 13B is a graph showing Moisture Content Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH (abbreviation: 25˚C)) storage conditions for the high dose batch. Water content was determined by the Karl Fisher method.

[382] **Figures 14A and B** are graphs showing 6-month Stability Profiles for the low dose batch. Figure 14A is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8˚C (abbreviation: 5˚C)) and accelerated (25˚C / 60% RH (abbreviation: 25˚C)) storage conditions for the low dose batch. Total Cell Count (TCC) was determined by Coulter counter. Figure 14B is a graph showing Moisture Content Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH (abbreviation: 25˚C)) storage conditions for the low dose batch. Water content was determined by the Karl Fisher method.

[383] **Figures 15A and B** are graphs showing 6-month Stability Profiles for a second high dose batch. Figure 15A is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8˚C (abbreviation: 5˚C)) and accelerated (25˚C / 60% RH (abbreviation: 25˚C)) storage conditions for the second high dose batch. Total Cell Count (TCC) was determined by Coulter counter. Figure 15B is a graph showing Moisture Content Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH (abbreviation: 25˚C)) storage conditions for the second high dose batch. Water content was determined by the Karl Fisher method.

Figures 16A and B are graphs showing 6-month Stability Profiles for a second low dose batch. Figure 8A is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8˚C (abbreviation: 5˚C)) and accelerated (25˚C / 60% RH (abbreviation: 25˚C)) storage conditions for the second dose batch. Total Cell Count (TCC) was determined by Coulter counter. Figure 8B is a graph showing Moisture Content Stability Profile over time long-term (2-8˚C) and accelerated (25˚C / 60% RH (abbreviation: 25˚C)) storage conditions for the second low dose batch. Water content was determined by the Karl Fisher method.

Detailed Description

[384] This disclosure is based, in part, on the discovery that a solid dosage form is prepared with or without a diluent (e.g., mannitol or microcrystalline cellulose). For example, for a solid dosage form to contain a given amount (e.g., dose) of active ingredient (e.g., bacteria and agents (e.g., components) of bacterial origin (e.g., microbial extracellular vesicles, or mEVs)), the amount of pharmaceutical agent (that contains the active ingredient) incorporated into a solid dosage form may be adjusted depending on the amount of active ingredient contained in a given preparation (e.g., batch) of pharmaceutical agent. The

amount of diluent (such as mannitol or microcrystalline cellulose) is then adjusted accordingly. For example, if the amount of pharmaceutical agent is increased, the amount of diluent is decreased; and vice versa. As described herein, adjustments can be made to the amounts of pharmaceutical agent and diluent, yet the amount of one or more excipients (e.g., one, two or three excipients) remains constant, e.g., batch to batch for a given solid dosage form recipe. Similarly, the amounts of magnesium stearate and colloidal silica can also remain constant, e.g., batch to batch for a given solid dosage form recipe.

[385] The disclosure provides solid dosage forms that comprise bacteria (e.g., powder comprising bacteria) that maintain their stability, e.g., for three, six, twelve, eighteen and/or twenty-four months under long-term (2-8˚C) and/or accelerated (25˚C / 60% RH) storage conditions, e.g., as determined by total cell count (TCC), e.g., as determined by Coulter counter and described herein. For example, as described herein, stability is maintained wherein the TCC range is set at 50% to 150% of the target amount, e.g., at a given time point (e.g., at a three, six, twelve, eighteen and/or twenty-four month time point under long-term (2-8˚C) and/or accelerated (25˚C / 60% RH) storage conditions), and the solid dosage form comprises a TCC within the set TCC range.

[386] The disclosure provides solid dosage forms that comprise *Prevotella histicola* (e.g., *Prevotella histicola* powder) that maintain their stability, e.g., for three, six, twelve, eighteen and/or twenty-four months under long-term (2-8˚C) and/or accelerated (25˚C / 60% RH) storage conditions, e.g., as determined by total cell count (TCC), e.g., as determined by Coulter counter and described herein. For example, as described herein, stability is maintained wherein the TCC range is set at 50% to 150% of the target amount, e.g., at a given time point (e.g., at a three, six, twelve, eighteen and/or twenty-four month time point under long-term (2-8˚C) and/or accelerated (25˚C / 60% RH) storage conditions), and the solid dosage form comprises a TCC within the set TCC range. For example, for a target amount of $1.6x10^{10}$ TCC/capsule, the acceptable TCC range is set at $0.8x10^{10}$ to $2.4x10^{10}$ and stability is maintained wherein the solid dosage form comprises a TCC within the set TCC range; for a target amount of $8x10^{10}$ TCC/capsule, the acceptable TCC range is set at $4x10^{10}$ to $1.2x10^{11}$ and stability is maintained wherein the solid dosage form comprises a TCC within the set TCC range; for a target amount of $3.2x10^{11}$ TCC/capsule, the acceptable TCC range is set at $1.6x10^{11}$ to $4.8x10^{11}$ and stability is maintained wherein the solid dosage form comprises a TCC within the set TCC range.

[387] The disclosure provides solid dosage forms that comprise *Prevotella histicola* (e.g., *Prevotella histicola* powder) that have the water content between about 0.5% and about 8.3% (e.g., about 1% to about 6%, e.g., about 3.5%, e.g., about 5.2%, e.g., about 3.4%, e.g., about 4.0%, e.g., about 1.9%, e.g., about 5.9%, or e.g., about 0.99%), e.g., as determined by the Karl-Fischer method for water content analysis provided in Ph. Eur. method 2.5.32, and as described herein. In some embodiments, the solid dosage forms maintain their water content, e.g., for three, six, twelve, eighteen and/or twenty-four months under long-term (2-8°C) and/or accelerated (25°C / 60% RH) storage conditions.

[388] The disclosure provides solid dosage forms that comprise *Veillonella parvula* (e.g., *Veillonella parvula* powder) that maintain their stability, e.g., for three, six, twelve, eighteen and/or twenty-four months under long-term (2-8°C) and/or accelerated (25°C / 60% RH) storage conditions, e.g., as determined by total cell count (TCC), e.g., as determined by Coulter counter and described herein. For example, as described herein, stability is maintained wherein the TCC range is set at 50% to 150% of the target amount, e.g., at a given time point (e.g., at a three, six, twelve, eighteen and/or twenty-four month time point under long-term (2-8°C) and/or accelerated (25°C / 60% RH) storage conditions), and the solid dosage form comprises a TCC within the set TCC range. For example, for a target amount of $4.5x10^{10}$ TCC/capsule, the acceptable TCC range is set at $2.25x10^{10}$ to $6.75x10^{10}$ and stability is maintained wherein the solid dosage form comprises a TCC within the set TCC range; for a target amount of $1.5x10^{11}$ TCC/capsule, the acceptable TCC range is set at $7.5x10^{10}$ to $2.25x10^{11}$ and stability is maintained wherein the solid dosage form comprises a TCC within the set TCC range.

[389] The disclosure provides solid dosage forms that comprise *Veillonella parvula* (e.g., *Veillonella parvula* powder) that have the water content between about 0.5% and about 13%, between about 0.5% and about 6%, between about 1.5% and about 12%, (e.g., about 0.5% to about 5%, e.g., about 0.7%, e.g., about 4.3%, e.g., about 1.1%, or e.g., about 3.6%), e.g., as determined by the Karl-Fischer method for water content analysis provided in Ph. Eur. method 2.5.32, and as described herein. In some embodiments, the solid dosage forms maintain their water content, e.g., for three, five, six, twelve, eighteen and/or twenty-four months under long-term (2-8°C) and/or accelerated (25°C / 60% RH) storage conditions.

[390] As described herein, for a solid dosage form to contain a given amount (e.g., dose) of active ingredient (e.g., pharmaceutical agent, e.g, *Veillonella parvula* bacteria (e.g., bacteria and/or a powder comprising bacteria), the amount of pharmaceutical agent (that

contains the active ingredient) incorporated into a solid dosage form may be adjusted depending on the amount of active ingredient contained in a given preparation (e.g., batch) of pharmaceutical agent. The amount of diluent (such as mannitol) is then adjusted accordingly. For example, if the amount of pharmaceutical agent is increased, the amount of diluent is decreased; and vice versa. As described herein, adjustments can be made to the amounts of pharmaceutical agent and diluent, yet the amount of one or more excipients (e.g., one, two or three excipients) remains constant, e.g., batch to batch for a given solid dosage form recipe. Similarly, the amounts of magnesium stearate and colloidal silica can also remain constant, e.g., batch to batch for a given solid dosage form recipe.

[391] For example, in the working examples provided herein, pharmaceutical agent containing *Veillonella parvula* powder was used to prepare two capsule solid dosage forms. Both preparations contained 1.5% magnesium stearate and 0.5% colloidal silica. Yet in one preparation, the pharmaceutical agent was used at 60%. In the other, it was used at 5%. To adjust for the differing amounts of pharmaceutical agent, the amount of mannitol was differed: 38% mannitol when 60% pharmaceutical agent was used; 93% mannitol when 5% pharmaceutical agent was used.

[392] For example, in the working examples provided herein, pharmaceutical agent containing *Lactococcus lactis ssp. cremoris* powder was used to prepare a capsule solid dosage form. In the preparation, the active ingredient totaled at 98.5% (w:w) and the magnesium stearate and colloidal silica were each 1% and 0.5%, respectively. No diluent was used.

[393] For example, in the working examples provided herein, pharmaceutical agent containing *Lactococcus lactis ssp. cremoris* powder was used to prepare a capsule solid dosage form. In the preparation, the active ingredient totaled at 25.1% (w:w), microcrystalline cellulose was used as the diluent and totaled at 73.4%, and the magnesium stearate and colloidal silica were each 1% and 0.5%, respectively.

[394] For example, in the working examples provided herein, pharmaceutical agent containing *Prevotella histicola* powder was used to prepare two capsule solid dosage forms. Both preparations contained 1.0% magnesium stearate and 0.5% colloidal silica. Yet in one preparation, the pharmaceutical agent was used at 90.22%. In the other, it was used at 50%. To adjust for the differing amounts of pharmaceutical agent, the amount of mannitol was differed: 8.28% mannitol when 90.22% pharmaceutical agent was used; 48.5% mannitol when 50% pharmaceutical agent was used.

[395] For example, in the working examples provided herein, pharmaceutical agent containing *Veillonella parvula* powder (e.g., in which the *Veillonella parvula* bacteria were gamma irradiated) was used to prepare two capsule solid dosage forms. Both preparations contained 1.5% magnesium stearate and 0.5% colloidal silica. Yet in one preparation, the pharmaceutical agent was used at 60%. In the other, it was used at 5%. To adjust for the differing amounts of pharmaceutical agent, the amount of mannitol was differed: 38% mannitol when 60% pharmaceutical agent was used; 93% mannitol when 5% pharmaceutical agent was used.

Definitions

[396] The term "about" when used before a numerical value indicates that the value may vary within a reasonable range, such as within ±10%, ±5% or ±1% of the stated value.

[397] "Adjuvant" or "Adjuvant therapy" broadly refers to an agent that affects an immunological or physiological response in a subject (e.g., human). For example, an adjuvant might help absorb an antigen presenting cell antigen, activate macrophages and lymphocytes and support the production of cytokines. By changing an immune response, an adjuvant might permit a smaller dose of an immune interacting agent to increase the effectiveness or safety of a particular dose of the immune interacting agent. For example, an adjuvant might prevent T cell exhaustion and thus increase the effectiveness or safety of a particular immune interacting agent.

[398] "Administration" broadly refers to a route of administration of a composition (e.g., a pharmaceutical composition such as a solid dosage form of a pharmaceutical agent as described herein) to a subject. Examples of routes of administration include oral administration, rectal administration, topical administration, inhalation (nasal) or injection. Administration by injection includes intravenous (IV), intramuscular (IM), and subcutaneous (SC) administration. A pharmaceutical composition described herein can be administered in any form by any effective route, including but not limited to oral, parenteral, enteral, intravenous, intraperitoneal, topical, transdermal (e.g., using any standard patch), intradermal, ophthalmic, (intra)nasally, local, non-oral, such as aerosol, inhalation, subcutaneous, intramuscular, buccal, sublingual, (trans)rectal, vaginal, intra-arterial, and intrathecal, transmucosal (e.g., sublingual, lingual, (trans)buccal, (trans)urethral, vaginal (e.g., trans- and perivaginally), implanted, intravesical, intrapulmonary, intraduodenal, intragastrical, and intrabronchial. In preferred embodiments, a pharmaceutical composition described herein is administered orally, rectally, topically, intravesically, by injection into or adjacent to a

draining lymph node, intravenously, by inhalation or aerosol, or subcutaneously. In another preferred embodiment, a pharmaceutical composition described herein is administered orally, or intravenously. In another embodiment, a pharmaceutical composition described herein is administered orally.

[399] "Cancer" broadly refers to an uncontrolled, abnormal growth of a host's own cells leading to invasion of surrounding tissue and potentially tissue distal to the initial site of abnormal cell growth in the host. Major classes include carcinomas which are cancers of the epithelial tissue (e.g., skin, squamous cells); sarcomas which are cancers of the connective tissue (e.g., bone, cartilage, fat, muscle, blood vessels, etc.); leukemias which are cancers of blood forming tissue (e.g., bone marrow tissue); lymphomas and myelomas which are cancers of immune cells; and central nervous system cancers which include cancers from brain and spinal tissue. "Cancer(s) and" "neoplasm(s)"" are used herein interchangeably. As used herein, "cancer" refers to all types of cancer or neoplasm or malignant tumors including leukemias, carcinomas and sarcomas, whether new or recurring. Specific examples of cancers are: carcinomas, sarcomas, myelomas, leukemias, lymphomas and mixed type tumors. Non-limiting examples of cancers are new or recurring cancers of the brain, melanoma, bladder, breast, cervix, colon, head and neck, kidney, lung, non-small cell lung, mesothelioma, ovary, prostate, sarcoma, stomach, uterus and medulloblastoma. In some embodiments, the cancer comprises a solid tumor. In some embodiments, the cancer comprises a metastasis.

[400] A "carbohydrate" refers to a sugar or polymer of sugars. The terms "saccharide," "polysaccharide," "carbohydrate," and "oligosaccharide" may be used interchangeably. Most carbohydrates are aldehydes or ketones with many hydroxyl groups, usually one on each carbon atom of the molecule. Carbohydrates generally have the molecular formula CnH2nOn. A carbohydrate may be a monosaccharide, a disaccharide, trisaccharide, oligosaccharide, or polysaccharide. The most basic carbohydrate is a monosaccharide, such as glucose, sucrose, galactose, mannose, ribose, arabinose, xylose, and fructose. Disaccharides are two joined monosaccharides. Exemplary disaccharides include sucrose, maltose, cellobiose, and lactose. Typically, an oligosaccharide includes between three and six monosaccharide units (e.g., raffinose, stachyose), and polysaccharides include six or more monosaccharide units. Exemplary polysaccharides include starch, glycogen, and cellulose. Carbohydrates may contain modified saccharide units such as 2'-deoxyribose wherein a hydroxyl group is removed, 2'-fluororibose wherein a hydroxyl group is replaced with a fluorine, or N-acetylglucosamine, a nitrogen-containing form of glucose (e.g., 2'-fluororibose, deoxyribose, and hexose). Carbohydrates may exist in many different forms, for

example, conformers, cyclic forms, acyclic forms, stereoisomers, tautomers, anomers, and isomers.

[401] "Cellular augmentation" broadly refers to the influx of cells or expansion of cells in an environment that are not substantially present in the environment prior to administration of a composition and not present in the composition itself. Cells that augment the environment include immune cells, stromal cells, bacterial and fungal cells.

[402] "Clade" refers to the OTUs or members of a phylogenetic tree that are downstream of a statistically valid node in a phylogenetic tree. The clade comprises a set of terminal leaves in the phylogenetic tree that is a distinct monophyletic evolutionary unit and that share some extent of sequence similarity.

[403] A "combination" of bacteria from two or more strains includes the physical co-existence of the bacteria, either in the same material or product or in physically connected products, as well as the temporal co-administration or co-localization of the bacteria from the two or more strains.

[404] A "combination" of mEVs (such as smEVs and/or pmEVs) from two or more microbial (such as bacteria) strains includes the physical co-existence of the microbes from which the mEVs (such as smEVs and/or pmEVs) are obtained, either in the same material or product or in physically connected products, as well as the temporal co-administration or co-localization of the mEVs (such as smEVs and/or pmEVs) from the two or more strains.

[405] The term "decrease" or "deplete" means a change, such that the difference is, depending on circumstances, at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 1/100, 1/1000, 1/10,000, 1/100,000, 1/1,000,000 or undetectable after treatment when compared to a pre-treatment state. Properties that may be decreased include the number of immune cells, bacterial cells, stromal cells, myeloid derived suppressor cells, fibroblasts, metabolites; the level of a cytokine; or another physical parameter (such as ear thickness (e.g., in a DTH animal model) or tumor size).

[406] "Dysbiosis" refers to a state of the microbiota or microbiome of the gut or other body area, including, e.g., mucosal or skin surfaces (or any other microbiome niche) in which the normal diversity and/or function of the host gut microbiome ecological networks "microbiome") are disrupted. A state of dysbiosis may result in a diseased state, or it may be unhealthy under only certain conditions or only if present for a prolonged period. Dysbiosis may be due to a variety of factors, including, environmental factors, infectious agents, host genotype, host diet and/or stress. A dysbiosis may result in: a change (e.g., increase or decrease) in the prevalence of one or more bacteria types (e.g., anaerobic), species and/or

strains, change (e.g., increase or decrease) in diversity of the host microbiome population composition; a change (e.g., increase or reduction) of one or more populations of symbiont organisms resulting in a reduction or loss of one or more beneficial effects; overgrowth of one or more populations of pathogens (e.g., pathogenic bacteria); and/or the presence of, and/or overgrowth of, symbiotic organisms that cause disease only when certain conditions are present.

[407] The term "ecological consortium" is a group of bacteria which trades metabolites and positively co-regulates one another, in contrast to two bacteria which induce host synergy through activating complementary host pathways for improved efficacy.

[408] As used herein, "engineered bacteria" are any bacteria that have been genetically altered from their natural state by human activities, and the progeny of any such bacteria. Engineered bacteria include, for example, the products of targeted genetic modification, the products of random mutagenesis screens and the products of directed evolution.

[409] The term "gene" is used broadly to refer to any nucleic acid associated with a biological function. The term "gene" applies to a specific genomic sequence, as well as to a cDNA or an mRNA encoded by that genomic sequence.

[410] "Identity" as between nucleic acid sequences of two nucleic acid molecules can be determined as a percentage of identity using known computer algorithms such as the "FASTA" program, using for example, the default parameters as in Pearson et al. (1988) Proc. Natl. Acad. Sci. USA 85:2444 (other programs include the GCG program package (Devereux, J., et al., Nucleic Acids Research 12(I):387 (1984)), BLASTP, BLASTN, FASTA Atschul, S. F., et al., J Molec Biol 215:403 (1990); Guide to Huge Computers, Mrtin J. Bishop, ed., Academic Press, San Diego, 1994, and Carillo et al. (1988) SIAM J Applied Math 48:1073). For example, the BLAST function of the National Center for Biotechnology Information database can be used to determine identity. Other commercially or publicly available programs include, DNAStar "MegAlign" program (Madison, Wis.) and the University of Wisconsin Genetics Computer Group (UWG) "Gap" program (Madison Wis.)).

[411] As used herein, the term "immune disorder" refers to any disease, disorder or disease symptom caused by an activity of the immune system, including autoimmune diseases, inflammatory diseases and allergies. Immune disorders include, but are not limited to, autoimmune diseases (e.g., psoriasis, atopic dermatitis, lupus, scleroderma, hemolytic anemia, vasculitis, type one diabetes, Grave's disease, rheumatoid arthritis, multiple sclerosis, Goodpasture's syndrome, pernicious anemia and/or myopathy), inflammatory diseases (e.g.,

acne vulgaris, asthma, celiac disease, chronic prostatitis, glomerulonephritis, inflammatory bowel disease, pelvic inflammatory disease, reperfusion injury, rheumatoid arthritis, sarcoidosis, transplant rejection, vasculitis and/or interstitial cystitis), and/or an allergies (e.g., food allergies, drug allergies and/or environmental allergies).

[412] "Immunotherapy" is treatment that uses a subject's immune system to treat disease (e.g., immune disease, inflammatory disease, metabolic disease) and includes, for example, cytokines, cell therapy, CAR-T cells, and dendritic cell therapy.

[413] The term "increase" means a change, such that the difference is, depending on circumstances, at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 2-fold, 4-fold, 10-fold, 100-fold, 10^3 fold, 10^4 fold, 10^5 fold, 10^6 fold, and/or 10^7 fold greater after treatment when compared to a pre-treatment state. Properties that may be increased include the number of immune cells, bacterial cells, stromal cells, myeloid derived suppressor cells, fibroblasts, metabolites; the level of a cytokine; or another physical parameter (such as ear thickness (e.g., in a DTH animal model) or tumor size).

[414] "Innate immune agonists" or "immuno-adjuvants" are small molecules, proteins, or other agents that specifically target innate immune receptors including Toll-Like Receptors (TLR), NOD receptors, RLRs, C-type lectin receptors, STING-cGAS Pathway components, inflammasome complexes. For example, LPS is a TLR-4 agonist that is bacterially derived or synthesized and aluminum can be used as an immune stimulating adjuvant. immuno-adjuvants are a specific class of broader adjuvant or adjuvant therapy. Examples of STING agonists include, but are not limited to, 2'3'- cGAMP, 3'3'-cGAMP, c-di-AMP, c-di-GMP, 2'2'-cGAMP, and 2'3'-cGAM(PS)2 (Rp/Sp) (Rp, Sp-isomers of the bis-phosphorothioate analog of 2'3'-cGAMP). Examples of TLR agonists include, but are not limited to, TLRl, TLR2, TLR3, TLR4, TLR5, TLR6, TLR7, TLR8, TLR9, TLRlO and TLRl l. Examples of NOD agonists include, but are not limited to, N-acetylmuramyl-L-alanyl-D-isoglutamine (muramyldipeptide (MDP)), gamma-D-glutamyl-meso-diaminopimelic acid (iE-DAP), and desmuramylpeptides (DMP).

[415] The "internal transcribed spacer" or "ITS" is a piece of non-functional RNA located between structural ribosomal RNAs (rRNA) on a common precursor transcript often used for identification of eukaryotic species in particular fungi. The rRNA of fungi that forms the core of the ribosome is transcribed as a signal gene and consists of the 8S, 5.8S and 28S regions with ITS4 and 5 between the 8S and 5.8S and 5.8S and 28S regions, respectively. These two intercistronic segments between the 18S and 5.8S and 5.8S and 28S regions are removed by splicing and contain significant variation between species for barcoding purposes

as previously described (Schoch et al Nuclear ribosomal internal transcribed spacer (ITS) region as a universal DNA barcode marker for Fungi. PNAS 109:6241-6246. 2012). 18S rDNA is traditionally used for phylogenetic reconstruction however the ITS can serve this function as it is generally highly conserved but contains hypervariable regions that harbor sufficient nucleotide diversity to differentiate genera and species of most fungus.

[416] The term "isolated" or "enriched" encompasses a microbe (such as a bacterium), an mEV (such as an smEV and/or pmEV) or other entity or substance that has been (1) separated from at least some of the components with which it was associated when initially produced (whether in nature or in an experimental setting), and/or (2) produced, prepared, purified, and/or manufactured by the hand of man. Isolated microbes or mEVs may be separated from at least about 10%, about 20%, about 30%, about 40%, about 50%, about 60%, about 70%, about 80%, about 90%, or more of the other components with which they were initially associated. In some embodiments, isolated microbes or mEVs are more than about 80%, about 85%, about 90%, about 91%, about 92%, about 93%, about 94%, about 95%, about 96%, about 97%, about 98%, about 99%, or more than about 99% pure. As used herein, a substance is "pure" if it is substantially free of other components. The terms "purify," "purifying" and "purified" refer to a microbe or mEV or other material that has been separated from at least some of the components with which it was associated either when initially produced or generated (*e.g.*, whether in nature or in an experimental setting), or during any time after its initial production. A microbe or a microbial population or mEVs may be considered purified if it is isolated at or after production, such as from a material or environment containing the microbe or microbial population, and a purified microbe or microbial population or mEVs may contain other materials up to about 10%, about 20%, about 30%, about 40%, about 50%, about 60%, about 70%, about 80%, about 90%, or above about 90% and still be considered "isolated." In some embodiments, purified microbes or microbial population or mEVs are more than about 80%, about 85%, about 90%, about 91%, about 92%, about 93%, about 94%, about 95%, about 96%, about 97%, about 98%, about 99%, or more than about 99% pure. In the instance of microbial compositions provided herein, the one or more microbial types present in the composition can be independently purified from one or more other microbes produced and/or present in the material or environment containing the microbial type. Microbial compositions and the microbial components (such as mEVs) thereof are generally purified from residual habitat products.

[417] As used herein a "lipid" includes fats, oils, triglycerides, cholesterol, phospholipids, fatty acids in any form including free fatty acids. Fats, oils and fatty acids can be saturated, unsaturated (cis or trans) or partially unsaturated (cis or trans).

[418] The term "LPS mutant or lipopolysaccharide mutant" broadly refers to selected bacteria that comprises loss of LPS. Loss of LPS might be due to mutations or disruption to genes involved in lipid A biosynthesis, such as *lpxA*, *lpxC*, and *lpxD*. Bacteria comprising LPS mutants can be resistant to aminoglycosides and polymyxins (polymyxin B and colistin).

[419] "Metabolite" as used herein refers to any and all molecular compounds, compositions, molecules, ions, co-factors, catalysts or nutrients used as substrates in any cellular or microbial metabolic reaction or resulting as product compounds, compositions, molecules, ions, co-factors, catalysts or nutrients from any cellular or microbial metabolic reaction.

[420] "Microbial extracellular vesicles" (mEVs) can be obtained from microbes such as bacteria, archaea, fungi, microscopic algae, protozoans, and parasites. In some embodiments, the mEVs are obtained from bacteria. mEVs include secreted microbial extracellular vesicles (smEVs) and processed microbial extracellular vesicles (pmEVs). "Secreted microbial extracellular vesicles" (smEVs) are naturally-produced vesicles derived from microbes. smEVs are comprised of microbial lipids and/or microbial proteins and/or microbial nucleic acids and/or microbial carbohydrate moieties, and are isolated from culture supernatant. The natural production of these vesicles can be artificially enhanced (e.g., increased) or decreased through manipulation of the environment in which the bacterial cells are being cultured (e.g., by media or temperature alterations). Further, smEV compositions may be modified to reduce, increase, add, or remove microbial components or foreign substances to alter efficacy, immune stimulation, stability, immune stimulatory capacity, stability, organ targeting (e.g., lymph node), absorption (e.g., gastrointestinal), and/or yield (e.g., thereby altering the efficacy). As used herein, the term "purified smEV composition" or "smEV composition" refers to a preparation of smEVs that have been separated from at least one associated substance found in a source material (e.g., separated from at least one other microbial component) or any material associated with the smEVs in any process used to produce the preparation. It can also refer to a composition that has been significantly enriched for specific components. "Processed microbial extracellular vesicles" (pmEVs) are a non-naturally-occurring collection of microbial membrane components that have been purified from artificially lysed microbes (e.g., bacteria) (e.g., microbial membrane components that

have been separated from other, intracellular microbial cell components), and which may comprise particles of a varied or a selected size range, depending on the method of purification. A pool of pmEVs is obtained by chemically disrupting (e.g., by lysozyme and/or lysostaphin) and/or physically disrupting (e.g., by mechanical force) microbial cells and separating the microbial membrane components from the intracellular components through centrifugation and/or ultracentrifugation, or other methods. The resulting pmEV mixture contains an enrichment of the microbial membranes and the components thereof (e.g., peripherally associated or integral membrane proteins, lipids, glycans, polysaccharides, carbohydrates, other polymers), such that there is an increased concentration of microbial membrane components, and a decreased concentration (e.g., dilution) of intracellular contents, relative to whole microbes. For gram-positive bacteria, pmEVs may include cell or cytoplasmic membranes. For gram-negative bacteria, a pmEV may include inner and outer membranes. pmEVs may be modified to increase purity, to adjust the size of particles in the composition, and/or modified to reduce, increase, add or remove, microbial components or foreign substances to alter efficacy, immune stimulation, stability, immune stimulatory capacity, stability, organ targeting (e.g., lymph node), absorption (e.g., gastrointestinal), and/or yield (e.g., thereby altering the efficacy). pmEVs can be modified by adding, removing, enriching for, or diluting specific components, including intracellular components from the same or other microbes. As used herein, the term "purified pmEV composition" or "pmEV composition" refers to a preparation of pmEVs that have been separated from at least one associated substance found in a source material (e.g., separated from at least one other microbial component) or any material associated with the pmEVs in any process used to produce the preparation. It can also refer to a composition that has been significantly enriched for specific components.

[421] "Microbe" refers to any natural or engineered organism characterized as a archaeaon, parasite, bacterium, fungus, microscopic alga, protozoan, and the stages of development or life cycle stages (*e.g.*, vegetative, spore (including sporulation, dormancy, and germination), latent, biofilm) associated with the organism. Examples of gut microbes include: *Actinomyces graevenitzii, Actinomyces odontolyticus, Akkermansia muciniphila, Bacteroides caccae, Bacteroides fragilis, Bacteroides putredinis, Bacteroides thetaiotaomicron, Bacteroides vultagus, Bifidobacterium adolescentis, Bifidobacterium bifidum, Bilophila wadsworthia, Blautia, Butyrivibrio, Campylobacter gracilis, Clostridia cluster III, Clostridia cluster IV, Clostridia cluster IX (Acidaminococcaceae group), Clostridia cluster XI, Clostridia cluster XIII (*Peptostreptococcus *group), Clostridia cluster*

XIV, Clostridia cluster XV, Collinsella aerofaciens, Coprococcus, Corynebacterium sunsvallense, Desulfomonas pigra, Dorea formicigenerans, Dorea longicatena, Escherichia coli, Eubacterium hadrum, Eubacterium rectale, Faecalibacteria prausnitzii, Gemella, Lactococcus, Lanchnospira, Mollicutes cluster XVI, Mollicutes cluster XVIII, Prevotella, Rothia mucilaginosa, Ruminococcus callidus, Ruminococcus gnavus, Ruminococcus torques, and *Streptococcus.*

[422] "Microbiome" broadly refers to the microbes residing on or in body site of a subject or patient. Microbes in a microbiome may include bacteria, viruses, eukaryotic microorganisms, and/or viruses. Individual microbes in a microbiome may be metabolically active, dormant, latent, or exist as spores, may exist planktonically or in biofilms, or may be present in the microbiome in sustainable or transient manner. The microbiome may be a commensal or healthy-state microbiome or a disease-state microbiome. The microbiome may be native to the subject or patient, or components of the microbiome may be modulated, introduced, or depleted due to changes in health state or treatment conditions (*e.g.*, antibiotic treatment, exposure to different microbes). In some aspects, the microbiome occurs at a mucosal surface. In some aspects, the microbiome is a gut microbiome.

[423] A "microbiome profile" or a "microbiome signature" of a tissue or sample refers to an at least partial characterization of the bacterial makeup of a microbiome. In some embodiments, a microbiome profile indicates whether at least 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100 or more bacterial strains are present or absent in a microbiome.

[424] "Modified" in reference to a bacteria broadly refers to a bacteria that has undergone a change from its wild-type form. Bacterial modification can result from engineering bacteria. Examples of bacterial modifications include genetic modification, gene expression modification, phenotype modification, formulation modification, chemical modification, and dose or concentration. Examples of improved properties are described throughout this specification and include, e.g., attenuation, auxotrophy, homing, or antigenicity. Phenotype modification might include, by way of example, bacteria growth in media that modify the phenotype of a bacterium such that it increases or decreases virulence.

[425] "Operational taxonomic units" and "OTU(s)" refer to a terminal leaf in a phylogenetic tree and is defined by a nucleic acid sequence, e.g., the entire genome, or a specific genetic sequence, and all sequences that share sequence identity to this nucleic acid sequence at the level of species. In some embodiments the specific genetic sequence may be the 16S sequence or a portion of the 16S sequence. In other embodiments, the entire genomes

of two entities are sequenced and compared. In another embodiment, select regions such as multilocus sequence tags (MLST), specific genes, or sets of genes may be genetically compared. For 16S, OTUs that share ≥ 97% average nucleotide identity across the entire 16S or some variable region of the 16S are considered the same OTU. See e.g., Claesson MJ, Wang Q, O'Sullivan O, Greene-Diniz R, Cole JR, Ross RP, and O'Toole PW. 2010. Comparison of two next-generation sequencing technologies for resolving highly complex microbiota composition using tandem variable 16S rRNA gene regions. Nucleic Acids Res 38: e200. Konstantinidis KT, Ramette A, and Tiedje JM. 2006. The bacterial species definition in the genomic era. Philos Trans R Soc Lond B Biol Sci 361: 1929–1940. For complete genomes, MLSTs, specific genes, other than 16S, or sets of genes OTUs that share ≥ 95% average nucleotide identity are considered the same OTU. See e.g., Achtman M, and Wagner M. 2008. Microbial diversity and the genetic nature of microbial species. Nat. Rev. Microbiol. 6: 431–440. Konstantinidis KT, Ramette A, and Tiedje JM. 2006. The bacterial species definition in the genomic era. Philos Trans R Soc Lond B Biol Sci 361: 1929–1940. OTUs are frequently defined by comparing sequences between organisms. Generally, sequences with no more than 95% sequence identity are not considered to form part of the same OTU. OTUs may also be characterized by any combination of nucleotide markers or genes, in particular highly conserved genes (e.g., "house-keeping" genes), or a combination thereof. Operational Taxonomic Units (OTUs) with taxonomic assignments made to, e.g., genus, species, and phylogenetic clade are provided herein.

[426] As used herein, a gene is "overexpressed" in a bacteria if it is expressed at a higher level in an engineered bacteria under at least some conditions than it is expressed by a wild-type bacteria of the same species under the same conditions. Similarly, a gene is "underexpressed" in a bacteria if it is expressed at a lower level in an engineered bacteria under at least some conditions than it is expressed by a wild-type bacteria of the same species under the same conditions.

[427] The terms "polynucleotide," and "nucleic acid" are used interchangeably. They refer to a polymeric form of nucleotides of any length, either deoxyribonucleotides or ribonucleotides, or analogs thereof. Polynucleotides may have any three-dimensional structure, and may perform any function. The following are non-limiting examples of polynucleotides: coding or non-coding regions of a gene or gene fragment, loci (locus) defined from linkage analysis, exons, introns, messenger RNA (mRNA), micro RNA (miRNA), silencing RNA (siRNA), transfer RNA, ribosomal RNA, ribozymes, cDNA, recombinant polynucleotides, branched polynucleotides, plasmids, vectors, isolated DNA of

any sequence, isolated RNA of any sequence, nucleic acid probes, and primers. A polynucleotide may comprise modified nucleotides, such as methylated nucleotides and nucleotide analogs. If present, modifications to the nucleotide structure may be imparted before or after assembly of the polymer. A polynucleotide may be further modified, such as by conjugation with a labeling component. In all nucleic acid sequences provided herein, U nucleotides are interchangeable with T nucleotides.

[428] As used herein, the term "preventing" a disease or condition in a subject refers to administering to the subject to a pharmaceutical treatment, e.g., the administration of one or more agents (e.g., pharmaceutical agent), such that onset of at least one symptom of the disease or condition is delayed or prevented.

[429] As used herein, a substance is "pure" if it is substantially free of other components. The terms "purify," "purifying" and "purified" refer to an mEV (such as an smEV and/or a pmEV) preparation or other material that has been separated from at least some of the components with which it was associated either when initially produced or generated (e.g., whether in nature or in an experimental setting), or during any time after its initial production. An mEV (such as an smEV and/or a pmEV) preparation or compositions may be considered purified if it is isolated at or after production, such as from one or more other bacterial components, and a purified microbe or microbial population may contain other materials up to about 10%, about 20%, about 30%, about 40%, about 50%, about 60%, about 70%, about 80%, about 90%, or above about 90% and still be considered "purified." In some embodiments, purified mEVs (such as smEVs and/or pmEVs) are more than about 80%, about 85%, about 90%, about 91%, about 92%, about 93%, about 94%, about 95%, about 96%, about 97%, about 98%, about 99%, or more than about 99% pure. mEV (such as a smEV and/or a pmEV) compositions (or preparations) are, e.g., purified from residual habitat products.

[430] As used herein, the term "purified mEV composition" or "mEV composition" refers to a preparation that includes mEVs (such as smEVs and/or pmEVs) that have been separated from at least one associated substance found in a source material (*e.g.*, separated from at least one other bacterial component) or any material associated with the mEVs (such as smEVs and/or pmEVs) in any process used to produce the preparation. It also refers to a composition that has been significantly enriched or concentrated. In some embodiments, the mEVs (such as smEVs and/or pmEVs) are concentrated by 2 fold, 3-fold, 4-fold, 5-fold, 10-fold, 100-fold, 1000-fold, 10,000-fold or more than 10,000 fold.

[431] "Residual habitat products" refers to material derived from the habitat for microbiota within or on a subject. For example, fermentation cultures of microbes can contain contaminants, e.g., other microbe strains or forms (e.g., bacteria, virus, mycoplasm, and/or fungus). For example, microbes live in feces in the gastrointestinal tract, on the skin itself, in saliva, mucus of the respiratory tract, or secretions of the genitourinary tract (i.e., biological matter associated with the microbial community). Substantially free of residual habitat products means that the microbial composition no longer contains the biological matter associated with the microbial environment on or in the culture or human or animal subject and is 100% free, 99% free, 98% free, 97% free, 96% free, or 95% free of any contaminating biological matter associated with the microbial community. Residual habitat products can include abiotic materials (including undigested food) or it can include unwanted microorganisms. Substantially free of residual habitat products may also mean that the microbial composition contains no detectable cells from a culture contaminant or a human or animal and that only microbial cells are detectable. In one embodiment, substantially free of residual habitat products may also mean that the microbial composition contains no detectable viral (including bacteria, viruses (e.g., phage)), fungal, mycoplasmal contaminants. In another embodiment, it means that fewer than $1x10^{-2}$%, $1x10^{-3}$%, $1x10^{-4}$%, $1x10^{-5}$%, $1x10^{-6}$%, $1x10^{-7}$%, $1x10^{-8}$% of the viable cells in the microbial composition are human or animal, as compared to microbial cells. There are multiple ways to accomplish this degree of purity, none of which are limiting. Thus, contamination may be reduced by isolating desired constituents through multiple steps of streaking to single colonies on solid media until replicate (such as, but not limited to, two) streaks from serial single colonies have shown only a single colony morphology. Alternatively, reduction of contamination can be accomplished by multiple rounds of serial dilutions to single desired cells (e.g., a dilution of 10^{-8} or 10^{-9}), such as through multiple 10-fold serial dilutions. This can further be confirmed by showing that multiple isolated colonies have similar cell shapes and Gram staining behavior. Other methods for confirming adequate purity include genetic analysis (e.g., PCR, DNA sequencing), serology and antigen analysis, enzymatic and metabolic analysis, and methods using instrumentation such as flow cytometry with reagents that distinguish desired constituents from contaminants.

[432] "Strain" refers to a member of a bacterial species with a genetic signature such that it may be differentiated from closely-related members of the same bacterial species. The genetic signature may be the absence of all or part of at least one gene, the absence of all or part of at least on regulatory region (e.g., a promoter, a terminator, a riboswitch, a ribosome

binding site), the absence ("curing") of at least one native plasmid, the presence of at least one recombinant gene, the presence of at least one mutated gene, the presence of at least one foreign gene (a gene derived from another species), the presence at least one mutated regulatory region (e.g., a promoter, a terminator, a riboswitch, a ribosome binding site), the presence of at least one non-native plasmid, the presence of at least one antibiotic resistance cassette, or a combination thereof. Genetic signatures between different strains may be identified by PCR amplification optionally followed by DNA sequencing of the genomic region(s) of interest or of the whole genome. In the case in which one strain (compared with another of the same species) has gained or lost antibiotic resistance or gained or lost a biosynthetic capability (such as an auxotrophic strain), strains may be differentiated by selection or counter-selection using an antibiotic or nutrient/metabolite, respectively.

[433] The terms "subject" or "patient" refers to any mammal. A subject or a patient described as "in need thereof" refers to one in need of a treatment (or prevention) for a disease. Mammals (i.e., mammalian animals) include humans, laboratory animals (e.g., primates, rats, mice), livestock (e.g., cows, sheep, goats, pigs), and household pets (e.g., dogs, cats, rodents). The subject may be a human. The subject may be a non-human mammal including but not limited to of a dog, a cat, a cow, a horse, a pig, a donkey, a goat, a camel, a mouse, a rat, a guinea pig, a sheep, a llama, a monkey, a gorilla or a chimpanzee. The subject may be healthy, or may be suffering from a cancer at any developmental stage, wherein any of the stages are either caused by or opportunistically supported of a cancer associated or causative pathogen, or may be at risk of developing a cancer, or transmitting to others a cancer associated or cancer causative pathogen. In some embodiments, a subject has lung cancer, bladder cancer, prostate cancer, plasmacytoma, colorectal cancer, rectal cancer, Merkel Cell carcinoma, salivary gland carcinoma, ovarian cancer, and/or melanoma. The subject may have a tumor. The subject may have a tumor that shows enhanced macropinocytosis with the underlying genomics of this process including Ras activation. In other embodiments, the subject has another cancer. In some embodiments, the subject has undergone a cancer therapy.

[434] As used herein, a "systemic effect" in a subject treated with a pharmaceutical composition containing bacteria or mEVs (e.g., a pharmaceutical agent comprising bacteria or mEVs) of the instant invention means a physiological effect occurring at one or more sites outside the gastrointestinal tract. Systemic effect(s) can result from immune modulation (e.g., via an increase and/or a reduction of one or more immune cell types or subtypes (e.g., CD8+ T cells) and/or one or more cytokines). Such systemic effect(s) may be the result of the

modulation by bacteria or mEVs of the instant invention on immune or other cells (such as epithelial cells) in the gastrointestinal tract which then, directly or indirectly, result in the alteration of activity (activation and/or deactivation) of one or more biochemical pathways outside the gastrointestinal tract. The systemic effect may include treating or preventing a disease or condition in a subject.

[435] As used herein, the term "treating" a disease in a subject or "treating" a subject having or suspected of having a disease refers to administering to the subject to a pharmaceutical treatment, *e.g.*, the administration of one or more agents, such that at least one symptom of the disease is decreased or prevented from worsening. Thus, in one embodiment, "treating" refers inter alia to delaying progression, expediting remission, inducing remission, augmenting remission, speeding recovery, increasing efficacy of or decreasing resistance to alternative therapeutics, or a combination thereof.

[436] As used herein, a value is "greater than" another value if it is higher by any amount (e.g., each of 100, 50, 20, 12, 11, 10.6, 10.1, 10.01, and 10.001 is at least 10). Similarly, as used herein, a value is "less than" another value if it is lower by any amount (e.g., each of 1, 2, 4, 6, 8, 9, 9.2, 9.4, 9.6, 9.8, 9.9, 9.99, 9.999 is no more than 10). In contrast, as used herein, a test value "is" an anchor value when the test value rounds to the anchor value (e.g., if "an ingredient mass is 10% of a total mass," in which case 10% is the anchor value, the test values of 9.5, 9.6, 9.7, 9.8, 9.9, 10, 10.1, 10.2, 10.3, and 10.4 would also meet the "ingredient mass is 10% of the total mass" feature).

Bacteria

[437] The pharmaceutical agent of the pharmaceutical compositions disclosed herein can comprise bacteria and/or microbial extracellular vesicles (mEVs) (such as smEVs and/or pmEVs). For example, the pharmaceutical agent of the pharmaceutical compositions disclosed herein can comprise a powder comprising bacteria and/or microbial extracellular vesicles (mEVs) (such as smEVs and/or pmEVs). Within a pharmaceutical agent that contains bacteria and mEVs, the mEVs can be from the same bacterial origin (e.g., same strain) as the bacteria of the pharmaceutical agent. The pharmaceutical agent can contain bacteria and/or mEVs from one or more strains.

[438] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are modified to reduce toxicity or other adverse effects, to enhance delivery) (e.g., oral delivery) (e.g., by improving acid resistance, muco-adherence and/or penetration and/or resistance to bile acids, digestive enzymes,

resistance to anti-microbial peptides and/or antibody neutralization), to target desired cell types (e.g., M-cells, goblet cells, enterocytes, dendritic cells, macrophages), to enhance their immunomodulatory and/or therapeutic effect of the bacteria and/or mEVs (e.g., either alone or in combination with another therapeutic agent), and/or to enhance immune activation or suppression by the bacteria and/or mEVs (such as smEVs and/or pmEVs) (e.g., through modified production of polysaccharides, pili, fimbriae, adhesins). In some embodiments, the engineered bacteria described herein are modified to improve bacteria and/or mEV (such as smEV and/or pmEV) manufacturing (e.g., higher oxygen tolerance, stability, improved freeze-thaw tolerance, shorter generation times). For example, in some embodiments, the engineered bacteria described include bacteria harboring one or more genetic changes, such change being an insertion, deletion, translocation, or substitution, or any combination thereof, of one or more nucleotides contained on the bacterial chromosome or endogenous plasmid and/or one or more foreign plasmids, wherein the genetic change may result in the overexpression and/or underexpression of one or more genes. The engineered bacteria may be produced using any technique known in the art, including but not limited to site-directed mutagenesis, transposon mutagenesis, knock-outs, knock-ins, polymerase chain reaction mutagenesis, chemical mutagenesis, ultraviolet light mutagenesis, transformation (chemically or by electroporation), phage transduction, directed evolution, or any combination thereof.

[439] Examples of taxonomic groups (e.g., class, order, family, genus, species or strain) of bacteria that can be used as a source of bacteria and/or mEVs (such as smEVs and/or pmEVs) for a pharmaceutical agent described herein are provided herein (e.g., listed in Table 1, Table 2, Table 3, and/or Table 4 and/or elsewhere in the specification (e.g., Table J)). In some embodiments, the bacterial strain is a bacterial strain having a genome that has at least 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, 99.1%, 99.2%, 99.3%, 99.4%, 99.5%, 99.6%, 99.7%, 99.8% or 99.9% sequence identity to a strain listed herein. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are oncotrophic bacteria. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are immunomodulatory bacteria. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are immunostimulatory bacteria. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are immunosuppressive bacteria. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are immunomodulatory

bacteria. In certain embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are generated from a combination of bacterial strains provided herein. In some embodiments, the combination is a combination of at least 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 25, 30, 35, 40, 45 or 50 bacterial strains. In some embodiments, the combination includes the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are from bacterial strains listed herein and/or bacterial strains having a genome that has at least 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, 99.1%, 99.2%, 99.3%, 99.4%, 99.5%, 99.6%, 99.7%, 99.8% or 99.9% sequence identity to a strain listed herein (e.g., listed in Table 1, Table 2, and/or Table 3 and/or elsewhere in the specification (e.g., Table J)). In certain embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are generated from a bacterial strain provided herein. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are from a bacterial strain listed herein (e.g., listed in Table 1, Table 2, and/or Table 3 and/or elsewhere in the specification (e.g., Table J))and/or a bacterial strain having a genome that has at least 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, 99.1%, 99.2%, 99.3%, 99.4%, 99.5%, 99.6%, 99.7%, 99.8% or 99.9% sequence identity to a strain listed herein (e.g., listed in Table 1, Table 2, Table 3, and/or Table 4 and/or elsewhere in the specification (e.g., Table J)).

[440] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are Gram negative bacteria.

[441] In some embodiments, the Gram negative bacteria belong to the class *Negativicutes*. The *Negativicutes* represent a unique class of microorganisms as they are the only diderm members of the *Firmicutes* phylum. These anaerobic organisms can be found in the environment and are normal commensals of the oral cavity and GI tract of humans. Because these organisms have an outer membrane, the yields of EVs from this class were investigated. It was found that on a per cell basis these bacteria produce a high number of vesicles (10-150 EVs/cell). The EVs from these organisms are broadly stimulatory and highly potent in *in vitro* assays. Investigations into their therapeutic applications in several oncology and inflammation *in vivo* models have shown their therapeutic potential. The *Negativicutes* class includes the families *Veillonellaceae, Selenomonadaceae, Acidaminococcaceae*, and *Sporomusaceae*. The *Negativicutes* class includes the genera *Megasphaera, Selenomonas, Propionospora,* and *Acidaminococcus*. Exemplary Negativicutes species include, but are not

limited to, *Megasphaera sp.*, *Selenomonas felix*, *Acidaminococcus intestine*, and *Propionospora sp.*

[442] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are Gram positive bacteria.

[443] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are aerobic bacteria.

[444] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are anaerobic bacteria. In some embodiments, the anaerobic bacteria comprise obligate anaerobes. In some embodiments, the anaerobic bacteria comprise facultative anaerobes.

[445] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are acidophile bacteria.

[446] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are alkaliphile bacteria.

[447] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are neutralophile bacteria.

[448] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are fastidious bacteria.

[449] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are nonfastidious bacteria.

[450] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained or the mEVs themselves are lyophilized.

[451] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained or the mEVs themselves are gamma irradiated (e.g., at 17.5 or 25 kGy).

[452] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained or the mEVs themselves are UV irradiated.

[453] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained or the mEVs themselves are heat inactivated (e.g., at 50°C for two hours or at 90°C for two hours).

[454] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained or the mEVs themselves are acid treated.

[455] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained or the mEVs themselves are oxygen sparged (e.g., at 0.1 vvm for two hours).

[456] The phase of growth can affect the amount or properties of bacteria and/or mEVs produced by bacteria. For example, in the methods of mEVs preparation provided herein, mEVs can be isolated, e.g., from a culture, at the start of the log phase of growth, midway through the log phase, and/or once stationary phase growth has been reached.

[457] In certain embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained from obligate anaerobic bacteria. Examples of obligate anaerobic bacteria include gram-negative rods (including the genera of *Bacteroides*, *Prevotella*, *Porphyromonas*, *Fusobacterium*, *Bilophila* and *Sutterella spp.*), gram-positive cocci (primarily *Peptostreptococcus spp.*), gram-positive spore-forming (*Clostridium spp.*), non-spore-forming bacilli (*Actinomyces*, *Propionibacterium*, *Eubacterium*, *Lactobacillus* and *Bifidobacterium spp.*), and gram-negative cocci (mainly *Veillonella spp.*). In some embodiments, the obligate anaerobic bacteria are of a genus selected from the group consisting of *Agathobaculum, Atopobium, Blautia, Burkholderia, Dielma, Longicatena, Paraclostridium, Turicibacter,* and *Tyzzerella*.

[458] The *Negativicutes* class includes the families *Veillonellaceae, Selenomonadaceae, Acidaminococcaceae,* and *Sporomusaceae*. The *Negativicutes* class includes the genera *Megasphaera, Selenomonas, Propionospora,* and *Acidaminococcus*. Exemplary *Negativicutes* species include, but are not limited to, *Megasphaera sp., Selenomonas felix, Acidaminococcus intestini,* and *Propionospora* sp.

[459] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Negativicutes* class.

[460] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Veillonellaceae* family.

[461] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Selenomonadaceae* family.

[462] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Acidaminococcaceae* family.

[463] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Sporomusaceae* family.

[464] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Megasphaera* genus.

[465] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Selenomonas* genus.

[466] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Propionospora* genus.

[467] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Acidaminococcus* genus.

[468] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera sp.* bacteria.

[469] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Selenomonas felix* bacteria.

[470] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Acidaminococcus intestini* bacteria.

[471] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Propionospora sp.* bacteria.

[472] The *Oscillospriraceae* family within the *Clostridia* class of microorganisms are common commensal organisms of vertebrates.

[473] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Clostridia* class.

[474] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Oscillospriraceae* family.

[475] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Faecalibacterium* genus.

[476] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Fournierella* genus.

[477] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Harryflintia* genus.

[478] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Agathobaculum* genus.

[479] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Faecalibacterium prausnitzii* (e.g., *Faecalibacterium prausnitzii* Strain A) bacteria.

[480] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Fournierella massiliensis* (e.g., *Fournierella massiliensis* Strain A) bacteria.

[481] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Harryflintia acetispora* (e.g., *Harryflintia acetispora* Strain A) bacteria.

[482] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Agathobaculum sp.* (e.g., *Agathobaculum sp.* Strain A) bacteria.

[483] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are bacteria of a genus selected from the group consisting of *Escherichia, Klebsiella, Lactobacillus, Shigella,* and *Staphylococcus*.

[484] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are a species selected from the group consisting of *Blautia massiliensis, Paraclostridium benzoelyticum, Dielma fastidiosa, Longicatena caecimuris, Lactococcus lactis cremoris, Tyzzerella nexilis, Hungatella effluvia, Klebsiella quasipneumoniae subsp. Similipneumoniae, Klebsiella oxytoca,* and *Veillonella tobetsuensis*.

[485] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are a *Prevotella* bacteria selected from the group consisting of *Prevotella albensis, Prevotella amnii, Prevotella bergensis, Prevotella bivia, Prevotella brevis, Prevotella bryantii, Prevotella buccae, Prevotella buccalis, Prevotella copri, Prevotella dentalis, Prevotella denticola, Prevotella disiens, Prevotella histicola, Prevotella intermedia, Prevotella maculosa,* Prevotella *marshii, Prevotella melaninogenica, Prevotella micans, Prevotella multiformis, Prevotella nigrescens, Prevotella oralis, Prevotella oris, Prevotella oulorum, Prevotella pallens, Prevotella salivae, Prevotella stercorea, Prevotella tannerae, Prevotella timonensis, Prevotella jejuni, Prevotella aurantiaca, Prevotella baroniae, Prevotella colorans, Prevotella corporis, Prevotella dentasini, Prevotella enoeca, Prevotella falsenii, Prevotella fusca, Prevotella heparinolytica, Prevotella loescheii, Prevotella multisaccharivorax, Prevotella nanceiensis, Prevotella oryzae, Prevotella paludivivens, Prevotella pleuritidis, Prevotella ruminicola, Prevotella saccharolytica, Prevotella scopos, Prevotella shahii, Prevotella zoogleoformans,* and *Prevotella veroralis*.

[486] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are a strain of bacteria comprising a genomic sequence that is at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least

99% sequence identity (*e.g.*, at least 99.1%, 99.2%, 99.3%, 99.4%, 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the genomic sequence of the strain of bacteria deposited with the ATCC Deposit number as provided in Table 3. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are a strain of bacteria comprising a 16S sequence that is at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the 16S sequence of the strain of bacteria deposited with the ATCC Deposit number as provided in Table 3.

[487] The *Negativicutes* class includes the families *Veillonellaceae, Selenomonadaceae, Acidaminococcaceae,* and *Sporomusaceae*. The *Negativicutes* class includes the genera *Megasphaera, Selenomonas, Propionospora,* and *Acidaminococcus*. Exemplary *Negativicutes* species include, but are not limited to, *Megasphaera sp., Selenomonas felix, Acidaminococcus intestini,* and *Propionospora* sp.

[488] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Negativicutes* class.

[489] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Veillonellaceae* family.

[490] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Selenomonadaceae* family.

[491] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Acidaminococcaceae* family.

[492] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Sporomusaceae* family.

[493] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Megasphaera* genus.

[494] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Selenomonas* genus.

[495] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Propionospora* genus.

[496] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Acidaminococcus* genus.

[497] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera sp.* bacteria.

[498] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Selenomonas felix* bacteria.

[499] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Acidaminococcus intestini* bacteria.

[500] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Propionospora sp.* bacteria.

[501] The *Oscillospriraceae* family within the *Clostridia* class of microorganisms are common commensal organisms of vertebrates.

[502] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Clostridia* class.

[503] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Oscillospriraceae* family.

[504] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Faecalibacterium* genus.

[505] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Fournierella* genus.

[506] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Harryflintia* genus.

[507] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Agathobaculum* genus.

[508] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Faecalibacterium prausnitzii* (e.g., *Faecalibacterium prausnitzii* Strain A) bacteria.

[509] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Fournierella massiliensis* (e.g., *Fournierella massiliensis* Strain A) bacteria.

[510] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Harryflintia acetispora* (e.g., *Harryflintia acetispora* Strain A) bacteria.

[511] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Agathobaculum sp.* (e.g., *Agathobaculum sp.* Strain A) bacteria.

[512] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are a strain of *Agathobaculum sp.* In some embodiments, the *Agathobaculum sp.* strain is a strain comprising at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, CRISPR sequence) of the *Agathobaculum sp.* Strain A (ATCC Deposit Number PTA-125892). In some embodiments, the *Agathobaculum sp.* strain is the Agathobaculum sp. Strain A (ATCC Deposit Number PTA- 125892).

[513] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Bacteroidia* [phylum *Bacteroidota*]. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are bacteria of order *Bacteroidales*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the family *Porphyromonoadaceae*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the family *Prevotellaceae*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are bacteria of the class *Bacteroidia* wherein the cell envelope structure of the bacteria is diderm. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are bacteria of the class *Bacteroidia* that stain Gram negative. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are bacteria of the class *Bacteroidia* wherein the bacteria is diderm and the bacteria stain Gram negative.

[514] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are bacteria of the class *Clostridia* [phylum *Firmicutes*]. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the order *Eubacteriales*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the family *Oscillispiraceae*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the family *Lachnospiraceae*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent

are obtained are of the family *Peptostreptococcaceae*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the family *Clostridiales family XIII/ Incertae sedis 41*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Clostridia* wherein the cell envelope structure of the bacteria is monoderm. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Clostridia* that stain Gram negative. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Clostridia* that stain Gram positive. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Clostridia* wherein the cell envelope structure of the bacteria is monoderm and the bacteria stain Gram negative. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Clostridia* wherein the cell envelope structure of the bacteria is monoderm and the bacteria stain Gram positive.

[515] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Negativicutes* [phylum *Firmicutes*]. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the order *Veillonellales*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the family *Veillonelloceae*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the order *Selenomonadales*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are bacteria of the family *Selenomonadaceae*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the family *Sporomusaceae*. In some embodiments, t the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Negativicutes* wherein the cell envelope structure of the bacteria is diderm. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are the EVs are from bacteria of the class *Negativicutes* wherein the cell envelope structure of the bacteria is diderm and the bacteria stain Gram negative.

[516] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Synergistia* [phylum *Synergistota*]. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the order *Synergistales*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the family *Synergistaceae*. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Synergistia* wherein the cell envelope structure of the bacteria is diderm. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Synergistia* that stain Gram negative. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the class *Synergistia* wherein the cell envelope structure of the bacteria is diderm and the bacteria stain Gram negative.

[517] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are from one strain of bacteria, e.g., a strain provided herein.

[518] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are from one strain of bacteria (e.g., a strain provided herein) or from more than one strain provided herein.

[519] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Lactococcus lactis cremoris* bacteria, e.g., a strain comprising at least 90% or at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Lactococcus lactis* cremoris Strain A (ATCC designation number PTA-125368). In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Lactococcus* bacteria, e.g., *Lactococcus lactis cremoris* Strain A (ATCC designation number PTA-125368).

[520] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Prevotella* bacteria, e.g., a strain comprising at least 90% or at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Prevotella* Strain B 50329 (NRRL accession number B 50329). In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Prevotella* bacteria, e.g., *Prevotella* Strain B 50329 (NRRL accession number B 50329).

[521] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Prevotella* bacteria, e.g., a strain comprising at least 90% or at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Prevotella* Strain C (ATCC Accession Number PTA-126140). In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Prevotella* bacteria, e.g., *Prevotella* Strain C (ATCC Accession Number PTA-126140).

[522] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Bifidobacterium* bacteria, e.g., a strain comprising at least 90% or at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Bifidobacterium* bacteria deposited as ATCC designation number PTA-125097. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Bifidobacterium* bacteria, e.g., *Bifidobacterium* bacteria deposited as ATCC designation number PTA-125097.

[523] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Veillonella* bacteria, e.g., a strain comprising at least 90% or at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Veillonella* bacteria deposited as ATCC designation number PTA-125691. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Veillonella* bacteria, e.g., *Veillonella* bacteria deposited as ATCC designation number PTA-125691.

[524] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Ruminococcus gnavus* bacteria. In some embodiments, the *Ruminococcus gnavus* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Ruminococcus gnavus* bacteria deposited as ATCC designation number PTA-126695. In some embodiments, the *Ruminococcus gnavus* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Ruminococcus gnavus* bacteria deposited as ATCC designation number PTA-126695. In some embodiments, the *Ruminococcus gnavus* bacteria are *Ruminococcus gnavus* bacteria deposited as ATCC designation number PTA-126695.

[525] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera sp.* bacteria. In some embodiments, the *Megasphaera sp.* bacteria are a strain comprising at least 90% (or at least

97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Megasphaera sp.* bacteria deposited as ATCC designation number PTA-126770. In some embodiments, the *Megasphaera sp.* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Megasphaera sp.*bacteria deposited as ATCC designation number PTA-126770. In some embodiments, the *Megasphaera sp.* bacteria are *Megasphaera sp.* bacteria deposited as ATCC designation number PTA-126770.

[526] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Fournierella massiliensis* bacteria. In some embodiments, the *Fournierella massiliensis* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Fournierella massiliensis* bacteria deposited as ATCC designation number PTA-126696. In some embodiments, the *Fournierella massiliensis* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Fournierella massiliensis* bacteria deposited as ATCC designation number PTA-126696. In some embodiments, the *Fournierella massiliensis* bacteria are *Fournierella massiliensis* bacteria deposited as ATCC designation number PTA-126696.

[527] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Harryflintia acetispora* bacteria. In some embodiments, the *Harryflintia acetispora* bacteria are a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Harryflintia acetispora* bacteria deposited as ATCC designation number PTA-126694. In some embodiments, the *Harryflintia acetispora* bacteria are a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Harryflintia acetispora* bacteria deposited as ATCC designation number PTA-126694. In some embodiments, the *Harryflintia acetispora* bacteria are *Harryflintia acetispora* bacteria deposited as ATCC designation number PTA-126694.

[528] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are bacteria that produce metabolites, e.g., the bacteria produce butyrate, iosine, proprionate, or tryptophan metabolites.

[529] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained produce butyrate. In some embodiments, the bacteria are from the genus *Blautia; Christensella;* Copracoccus; *Eubacterium; Lachnosperacea; Megasphaera;* or *Roseburia.*

[530] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained produce iosine. In some embodiments, the bacteria are from the genus *Bifidobacterium;* Lactobacillus; or *Olsenella*.

[531] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained produce proprionate. In some embodiments, the bacteria are from the genus *Akkermansia; Bacteriodes; Dialister; Eubacterium; Megasphaera; Parabacteriodes; Prevotella; Ruminococcus;* or *Veillonella*.

[532] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained produce tryptophan metabolites. In some embodiments, the bacteria are from the genus *Lactobacillus* or *Peptostreptococcus*.

[533] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are bacteria that produce inhibitors of histone deacetylase 3 (HDAC3). In some embodiments, the bacteria are from the species *Bariatricus massiliensis, Faecalibacterium prausnitzii, Megasphaera massiliensis* or *Roseburia intestinalis*. In some embodiments, the bacteria are from the genus *Alloiococcus; Bacillus; Catenibacterium; Corynebacterium; Cupriavidus; Enhydrobacter; Exiguobacterium; Faecalibacterium; Geobacillus; Methylobacterium; Micrococcus; Morganella; Proteus; Pseudomonas; Rhizobium;* or *Sphingomonas*. In some embodiments, the bacteria are from the genus *Cutibacterium*. In some embodiments, the bacteria are from the species *Cutibacterium avidum*. In some embodiments, the bacteria are from the genus *Lactobacillus*. In some embodiments, the bacteria are from the species *Lactobacillus gasseri*. In some embodiments, the bacteria are from the genus *Dysosmobacter*. In some embodiments, the bacteria are from the species *Dysosmobacter welbionis*.

[534] Applicant represents that the ATCC is a depository affording permanence of the deposit and ready accessibility thereto by the public if a patent is granted. All restrictions on the availability to the public of the material so deposited will be irrevocably removed upon the granting of a patent. The material will be available during the pendency of the patent application to one determined by the Commissioner to be entitled thereto under 37 CFR 1.14 and 35 U.S.C. 122. The deposited material will be maintained with all the care necessary to keep it viable and uncontaminated for a period of at least five years after the most recent request for the furnishing of a sample of the deposited plasmid, and in any case, for a period of at least thirty (30) years after the date of deposit or for the enforceable life of the patent,

whichever period is longer. Applicant acknowledges its duty to replace the deposit should the depository be unable to furnish a sample when requested due to the condition of the deposit.

[535] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the genus *Alloiococcus; Bacillus; Catenibacterium; Corynebacterium; Cupriavidus; Enhydrobacter; Exiguobacterium; Faecalibacterium; Geobacillus; Methylobacterium; Micrococcus; Morganella; Proteus; Pseudomonas; Rhizobium;* or *Sphingomonas.*

[536] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the *Cutibacterium* genus. In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Cutibacterium avidum* bacteria.

[537] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the genus *Leuconostoc.*

[538] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the genus *Lactobacillus.*

[539] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are of the genus *Akkermansia muciniphila; Bacillus; Blautia; Cupriavidus; Enhydrobacter; Faecalibacterium; Lactobacillus; Lactococcus; Micrococcus; Morganella; Propionibacterium; Proteus; Rhizobium;* or *Streptococcus.*

[540] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Leuconostoc holzapfelii* bacteria.

[541] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Akkermansia muciniphila; Cupriavidus metallidurans; Faecalibacterium prausnitzii; Lactobacillus casei; Lactobacillus plantarum; Lactobacillus paracasei; Lactobacillus plantarum; Lactobacillus rhamnosus; Lactobacillus sakei;* or *Streptococcus pyogenes* bacteria.

[542] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Lactobacillus casei; Lactobacillus plantarum; Lactobacillus paracasei; Lactobacillus plantarum; Lactobacillus rhamnosus;* or *Lactobacillus sakei* bacteria.

[543] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera sp.* bacteria (e.g., from the strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387).

[544] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera massiliensis* bacteria (e.g., from the strain with accession number NCIMB 42787, NCIMB 43388 or NCIMB 43389).

[545] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera massiliensis* bacteria (e.g., from the strain with accession number DSM 26228).

[546] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Parabacteroides distasonis* bacteria (e.g., from the strain with accession number NCIMB 42382).

[547] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera massiliensis* bacteria (e.g., from the strain with accession number NCIMB 43388 or NCIMB 43389), or a derivative thereof. See, e.g., WO 2020/120714. In some embodiments, the *Megasphaera massiliensis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of *Megasphaera massiliensis* bacteria from the strain with accession number NCIMB 43388 or NCIMB 43389. In some embodiments, the *Megasphaera massiliensis* bacteria is the strain with accession number NCIMB 43388 or NCIMB 43389.

[548] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera massiliensis* bacteria strain deposited under accession number NCIMB 42787, or a derivative thereof. See, e.g., WO 2018/229216. In some embodiments, the *Megasphaera massiliensis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of the *Megasphaera massiliensis* bacteria strain

deposited under accession number NCIMB 42787. In some embodiments, the *Megasphaera massiliensis* bacteria is the strain deposited under accession number NCIMB 42787.

[549] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera spp.* bacteria from the strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387, or a derivative thereof. See, e.g., WO 2020/120714. In some embodiments, the *Megasphaera sp.* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of the *Megasphaera sp.* from a strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387. In some embodiments, the *Megasphaera sp.* bacteria is the strain with accession number NCIMB 43385, NCIMB 43386 or NCIMB 43387.

[550] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Parabacteroides distasonis* bacteria deposited under accession number NCIMB 42382, or a derivative thereof. See, e.g., WO 2018/229216. In some embodiments, the *Parabacteroides distasonis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of the *Parabacteroides distasonis* bacteria deposited under accession number NCIMB 42382. In some embodiments, the *Parabacteroides distasonis* bacteria is the strain deposited under accession number NCIMB 42382.

[551] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Megasphaera massiliensis* bacteria deposited under accession number DSM 26228, or a derivative thereof. See, e.g., WO 2018/229216. In some embodiments, the *Megasphaera massiliensis* bacteria is a strain comprising at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% sequence identity (e.g., at least 99.5% sequence identity, at least 99.6% sequence identity, at least 99.7% sequence identity, at least 99.8% sequence identity, at least 99.9% sequence identity) to the nucleotide sequence (e.g., genomic sequence, 16S sequence, and/or CRISPR sequence) of *Megasphaera massiliensis* bacteria deposited under

accession number DSM 26228. In some embodiments, the *Megasphaera massiliensis* bacteria is the strain deposited under accession number DSM 26228.

Table 1: Bacteria by Class

Class	Order	Family	Genus	Species
Actinobacter	*Actinomycetales*	*Mycobacteriaceae*	*Mycobacterium*	
		Streptomycetaceae	*Streptomyces*	*Streptomyces lividans, Streptomyces coelicolor, Streptomyces sudanesis, Streptomyces somaliensis*
	Bifidobacteriales	*Bifidobacteriaceae*	*Bifidobacterium*	*Bifidobacterium adolescentis, Bifidobacterium animalis, Bifidobacterium bifidum, Bifidobacterium breve, Bifidobacterium lactis, Bifidobacterium longum, Bifidobacterium pseudocatenulatum*
	Coriobacteriales	*Coriobacteriaceae*	***Collinsella***	*Collinsella aerofaciens*
			Olsenella	*Olsenellafaecalis*
	Propionibacteriales	*Propionibacteraceae*	*Propionibacterium*	
Bacilli	*Bacillales*	*Bacillales incertae sedis family XI*	*Gemella*	*Gemella haemolysans, Gemella morbillorum*
		Listeraceae	*Listeria*	*Listeria monocytogenes, Listeria welshimeri*
	Lactobacillales	*Enterococcaceae*	*Enterococcus*	*Enterococcus durans, Enterococcus faecium, Enterococcus faecalis, Enterococcus gallinarum, Enterococcus villorum*
			Lactobacillus	*Lactobacillus casei, Lactobacillus fermentum, Lactococcus lactis cremoris, Lactobacillus mucosae, Lactobacillus plantarum, Lactobacillus reuteri, Lactobacillus rhamnosus, L. salvarius, L. gasseri*
		Streptococcaceae	*Lactococcus*	
			Staphylococcus	*Staphylococcus aureus*
			Streptococcus	*Streptococcus agalactiae, Streptococcus aureus, Streptococcus australi, Streptococcus mutans,*

				Streptococcus parasanguinis, Streptococcus pneumoniae, Streptococcus pyogenes, Streptococcus salivraius
Bacteriodes	*Bacteroidales*	*Bacteriodaceae*	*Bacteriodes*	*Bacteroides caccae, Bacteroides cellulosilyticus, Bacteroides coprocola, Bacteroides dorei, Bacteroides fragilis, Bacteroides ovatus, Bacteroides putredinis, Bacteroides salanitronis, Bacteroides thetaiotaomicron, Bacteroides vulgatus*
		Odoribacteraceae	*Odoribacter*	*Odoribacter splanchnicus*
		Porphyromonadaceae	*Parabacteriodes*	*Parabacteriodes distasonis, Parabacteroides goldsteinii, P Parabacteriodes merdae*
			Porphyromonas	*Porphyromonas gingivalis*
		Prevotellaceae	*Prevotella*	*Prevotella albensis, Prevotella amnii, Prevotella aurantiaca, Prevotella baroniae, Prevotella bergensis, Prevotella bivia, Prevotella brevis, Prevotella bryantii, Prevotella buccae, Prevotella buccalis, Prevotella colorans, Prevotella corporis, Prevotella copri, Prevotella dentalis, Prevotella dentasini, Prevotella denticola, Prevotella disiens,, Prevotella enoeca, Prevotella falsenii, Prevotella fusca, Prevotella heparinolytica, Prevotella histicola, Prevotella intermedia, Prevotella jejuni, , Prevotella loescheii, Prevotella maculosa,*

				Prevotella marshii, Prevotella melaninogenica, Prevotella micans, Prevotella multiformis, Prevotella multisaccharivorax, Prevotella nanceiensis, Prevotella nigrescens, Prevotella oralis, Prevotella oris, , Prevotella oryzae, Prevotella oulorum, Prevotella pallens, Prevotella paludivivens, Prevotella pleuritidis Prevotella ruminicola, Prevotella saccharolytica ,Prevotella salivae, Prevotella scopos, Prevotella shahii, Prevotella stercorea, Prevotella tannerae, Prevotella timonensis, Prevotella veroralis, Prevotella zoogleoformans
		Rikenellaceae	*Alstipes*	*Alistipes communis , Alistipes dispar, A. finegoldii, Alistipes indistinctus, Alistipes ihumii, Alistipes inops,, Alistipes massiliensis,, Alistipes megaguti, Alistipes obesi , Alistipes onderdonkii, Alistipes provencensis, Alistipes putredinis, Alistipes senegalensis, , Alistipes shahii, Alistipes timonensis*
Betaproteobacteria	*Burkholderiales*	*Alcaligenaceae*	*Paenalcaligenes*	*Paenalcaligenes hominis*
			Bordella	*Bordella pertussis*
		Burkholderiaceae	*Burkholderia*	*Burkholderia mallei, Burkholderia pseudomallei*
			Ralstonia	*Ralstonia solanacearum*
		Neisseriaceae	*Neisseria*	***Neisseria meningitidis***
		Sutterellaceae	*Sutterella*	*Sutterella parvirubra, Sutterella stercoricanis,*

				Sutterella wadsworthensis
Clostridia	*Clostridiales*	*Catabacteriaceae*	*Catabacter*	***Catabacter hongkongensis***
		Clostridiaceae	*Aminiphila*	***Anaerosphaera aminiphila***
			Christensenellaceae	*C. massiliensis,C. minuta, C.timonensis*
			Hungatella	*Hungatella effluvia*
		Eubacteriaceae	*Eubacterium*	*Eubacterium contortum, Enterococcus durans, Eubacterium eligens, Eubacterium faecium Enterococcus faecalis, Enterococcus gallinarum , Eubacterium hadrum, Eubacterium hallii, Eubacterium limosum, Eubacterium ramulus, Eubacterium rectale, Enterococcus villorum*
		Lachnospiraceae	*Anaerostipes*	*Anaerostipes caccae, Anaerostipes hadrus*
			Blautia	*Blautia hydrogenotrophica, Blautia massiliensis, Blautia stercoris, Blautia wexlerae*
			Catonella	*Catonella morbi*
			Coprococcus	*Coprococcus catus, Coprococcus comes, Coprococcus eutactus*
			Dialister	*Dialister invisus, Dialister micraeophilus , Dialister succinatiphilus*
			Dorea	*Dorea formicigenerans, Dorea longicatena,*
			Johnsonella	*Johnsonella ignava*
			Oribacterium	*Oribacterium parvum, Oribacterium sinus*
			Lachnobacterium	
			Lachnoclostridium	
			Lacrimispora	*Lacrimispora saccharolytica*
			Roseburia	*Roseburia hominis, seburia intestinalis*
			Tyzzerella	*Tyzzerella nexilis*
		Oscillospiraceae	*Oscillibacter*	*Oscillibacter valericigenes*
			Harryflintia	*Harryflinta acetispora*

		Peptococcaceae		
		Peptostreptococcaceae	*Paraclostridium*	*Paraclostridium benzoelyticum*
			Peptostreptococcus	*Peptostreptococcus russellii*
		Ruminococcaceae		*Agathobaculum sp.*
			Fournierella	*Fournierella masssiliensis*
			Ruminococcus	*Ruminococcus albus, Ruminococcus bromii,Ruminococcus callidus, Ruminococcus gnavus, Ruminococcus inulinivorans, Ruminococcus obeum, Ruminococcus torques*
			Faecalibacterium	*Faecalibacterium prasusnitzii*
		Clostridiales family XIII/ Incertae sedis		*Intestimonas butyriciproducens*
Fusobacteria	*Fusobacteriales*	*Fusobacteriaceae*	*Fusobacterium*	***Fusobacterium nucleatum, Fusobacterium naviforme***
		Leptotrichiaceae	*Leptotrichia*	
			Sneathia	
Gammaproteobacteria	*Enterobacterales*	*Enterobacteriaceae*	*Klebsiella*	*Klebsiella oxytoca,, Klebsiella pneumoniae, Klebsiella quasipneumoniae subsp. Similipneumoniae,*
			Escherichia	*Escherichia coli strain Nissle 1917 (EcN) Escherichia coli strain ECOR12 Escherichia coli strain ECOR63*
			Shigella	
Negativicutes		*Acidaminococcaceae*	*Acidaminococcus*	*Acidaminococcus fermentans, Acidaminococcus intestine*
			Phascolarctobacterium	*Phascolarctobacterium faecium, Phascolarctobacterium succinatutens*

		Selenomonadaceae	*Selenomonas*	*Selenomonas felix, Selemonadales incertae sedis, Selenomonas sputigena*
		Sporomusaceae	*Selenomonadales*	
		Veillonellaceae	*Allisonella*	
			Anaeroglobus	*Anaeroglobus germinatus*
			Caecibacter	
			Colibacter	
			Veillonella	*Veillonella parvula*
			Megasphaera	*Megasphera elsedenii, Megasphaera massiliensis, Megasphera micronuciformis Megasphaera sp*
			Massilibacillus	***Massilibacillus massiliensis***
			Propionispira	
			Negativicoccus	*Negativicoccus succinicivornas*
			Veillonella	*Veillonella dispar, Veillonella parvula, Veillonella ratti, Veillonella tobetsuensis*
	Synergistales	*Synergistaceae*	*Aminobacterium*	*Aminobacterium mobile*
			Cloacibacillus	*Cloacibacillus evryensis*
			Rarimicrobium	*Rarimicrobium hominis*
Verrucomicrobia	*Verrucomicrobiales*	*Akkermansiaceae*	*Akkermansia*	*Akkermansia mucinophila*

Table 2: Exemplary Bacterial Strains

OTU	Public DB Accession
Actinobacillus actinomycetemcomitans	AY362885
Actinobacillus minor	ACFT01000025
Actinobacillus pleuropneumoniae	NR_074857
Actinobacillus succinogenes	CP000746
Actinobacillus ureae	AEVG01000167
Actinobaculum massiliae	AF487679
Actinobaculum schaalii	AY957507
Actinobaculum sp. BM#101342	AY282578
Actinobaculum sp. P2P_19 P1	AY207066
Akkermansia muciniphila	CP001071
Alistipes finegoldii	NR_043064

Alistipes indistinctus	AB490804
Alistipes onderdonkii	NR_043318
Alistipes putredinis	ABFK02000017
Alistipes shahii	FP929032
Alistipes sp. HGB5	AENZ01000082
Alistipes sp. JC50	JF824804
Alistipes sp. RMA 9912	GQ140629
Anaerostipes caccae	ABAX03000023
Anaerostipes sp. 3_2_56FAA	ACWB01000002
Bacillus aeolius	NR_025557
Bacillus aerophilus	NR_042339
Bacillus aestuarii	GQ980243
Bacillus alcalophilus	X76436
Bacillus amyloliquefaciens	NR_075005
Bacillus anthracis	AAEN01000020
Bacillus atrophaeus	NR_075016
Bacillus badius	NR_036893
Bacillus cereus	ABDJ01000015
Bacillus circulans	AB271747
Bacillus clausii	FN397477
Bacillus coagulans	DQ297928
Bacillus firmus	NR_025842
Bacillus flexus	NR_024691
Bacillus fordii	NR_025786
Bacillus gelatini	NR_025595
Bacillus halmapalus	NR_026144
Bacillus halodurans	AY144582
Bacillus herbersteinensis	NR_042286
Bacillus horti	NR_036860
Bacillus idriensis	NR_043268
Bacillus lentus	NR_040792
Bacillus licheniformis	NC_006270

Bacillus megaterium	GU252124
Bacillus nealsonii	NR_044546
Bacillus niabensis	NR_043334
Bacillus niacini	NR_024695
Bacillus pocheonensis	NR_041377
Bacillus pumilus	NR_074977
Bacillus safensis	JQ624766
Bacillus simplex	NR_042136
Bacillus sonorensis	NR_025130
Bacillus sp. 10403023 MM10403188	CAET01000089
Bacillus sp. 2_A_57_CT2	ACWD01000095
Bacillus sp. 2008724126	GU252108
Bacillus sp. 2008724139	GU252111
Bacillus sp. 7_16AIA	FN397518
Bacillus sp. 9_3AIA	FN397519
Bacillus sp. AP8	JX101689
Bacillus sp. B27(2008)	EU362173
Bacillus sp. BT1B_CT2	ACWC01000034
Bacillus sp. GB1.1	FJ897765
Bacillus sp. GB9	FJ897766
Bacillus sp. HU19.1	FJ897769
Bacillus sp. HU29	FJ897771
Bacillus sp. HU33.1	FJ897772
Bacillus sp. JC6	JF824800
Bacillus sp. oral taxon F26	HM099642
Bacillus sp. oral taxon F28	HM099650
Bacillus sp. oral taxon F79	HM099654
Bacillus sp. SRC_DSF1	GU797283
Bacillus sp. SRC_DSF10	GU797292
Bacillus sp. SRC_DSF2	GU797284
Bacillus sp. SRC_DSF6	GU797288
Bacillus sp. tc09	HQ844242

Bacillus sp. zh168	FJ851424
Bacillus sphaericus	DQ286318
Bacillus sporothermodurans	NR_026010
Bacillus subtilis	EU627588
Bacillus thermoamylovorans	NR_029151
Bacillus weihenstephanensis	NR_074926
Bacteroidales bacterium ph8	JN837494
Bacteroidales genomosp. P1	AY341819
Bacteroidales genomosp. P2 oral clone MB1_G13	DQ003613
Bacteroidales genomosp. P3 oral clone MB1_G34	DQ003615
Bacteroidales genomosp. P4 oral clone MB2_G17	DQ003617
Bacteroidales genomosp. P5 oral clone MB2_P04	DQ003619
Bacteroidales genomosp. P6 oral clone MB3_C19	DQ003634
Bacteroidales genomosp. P7 oral clone MB3_P19	DQ003623
Bacteroidales genomosp. P8 oral clone MB4_G15	DQ003626
Bacteroides acidifaciens	NR_028607
Bacteroides barnesiae	NR_041446
Bacteroides caccae	EU136686
Bacteroides cellulosilyticus	ACCH01000108
Bacteroides clarus	AFBM01000011
Bacteroides coagulans	AB547639
Bacteroides coprocola	ABIY02000050
Bacteroides coprophilus	ACBW01000012
Bacteroides dorei	ABWZ01000093
Bacteroides eggerthii	ACWG01000065

Bacteroides faecis	GQ496624
Bacteroides finegoldii	AB222699
Bacteroides fluxus	AFBN01000029
Bacteroides fragilis	AP006841
Bacteroides galacturonicus	DQ497994
Bacteroides helcogenes	CP002352
Bacteroides heparinolyticus	JN867284
Bacteroides intestinalis	ABJL02000006
Bacteroides massiliensis	AB200226
Bacteroides nordii	NR_043017
Bacteroides oleiciplenus	AB547644
Bacteroides ovatus	ACWH01000036
Bacteroides pectinophilus	ABVQ01000036
Bacteroides plebeius	AB200218
Bacteroides pyogenes	NR_041280
Bacteroides salanitronis	CP002530
Bacteroides salyersiae	EU136690
Bacteroides sp. 1_1_14	ACRP01000155
Bacteroides sp. 1_1_30	ADCL01000128
Bacteroides sp. 1_1_6	ACIC01000215
Bacteroides sp. 2_1_22	ACPQ01000117
Bacteroides sp. 2_1_56FAA	ACWI01000065
Bacteroides sp. 2_2_4	ABZZ01000168
Bacteroides sp. 20_3	ACRQ01000064
Bacteroides sp. 3_1_19	ADCJ01000062
Bacteroides sp. 3_1_23	ACRS01000081
Bacteroides sp. 3_1_33FAA	ACPS01000085
Bacteroides sp. 3_1_40A	ACRT01000136
Bacteroides sp. 3_2_5	ACIB01000079
Bacteroides sp. 315_5	FJ848547
Bacteroides sp. 31SF15	AJ583248
Bacteroides sp. 31SF18	AJ583249

Bacteroides sp. 35AE31	AJ583244
Bacteroides sp. 35AE37	AJ583245
Bacteroides sp. 35BE34	AJ583246
Bacteroides sp. 35BE35	AJ583247
Bacteroides sp. 4_1_36	ACTC01000133
Bacteroides sp. 4_3_47FAA	ACDR02000029
Bacteroides sp. 9_1_42FAA	ACAA01000096
Bacteroides sp. AR20	AF139524
Bacteroides sp. AR29	AF139525
Bacteroides sp. B2	EU722733
Bacteroides sp. D1	ACAB02000030
Bacteroides sp. D2	ACGA01000077
Bacteroides sp. D20	ACPT01000052
Bacteroides sp. D22	ADCK01000151
Bacteroides sp. F_4	AB470322
Bacteroides sp. NB_8	AB117565
Bacteroides sp. WH2	AY895180
Bacteroides sp. XB12B	AM230648
Bacteroides sp. XB44A	AM230649
Bacteroides stercoris	ABFZ02000022
Bacteroides thetaiotaomicron	NR_074277
Bacteroides uniformis	AB050110
Bacteroides ureolyticus	GQ167666
Bacteroides vulgatus	CP000139
Bacteroides xylanisolvens	ADKP01000087
Bacteroidetes bacterium oral taxon D27	HM099638
Bacteroidetes bacterium oral taxon F31	HM099643
Bacteroidetes bacterium oral taxon F44	HM099649
Barnesiella intestinihominis	AB370251
Bifidobacteriaceae genomosp. C1	AY278612
Bifidobacterium adolescentis	AAXD02000018
Bifidobacterium angulatum	ABYS02000004

Bifidobacterium animalis	CP001606
Bifidobacterium bifidum	ABQP01000027
Bifidobacterium breve	CP002743
Bifidobacterium catenulatum	ABXY01000019
Bifidobacterium dentium	CP001750
Bifidobacterium gallicum	ABXB03000004
Bifidobacterium infantis	AY151398
Bifidobacterium kashiwanohense	AB491757
Bifidobacterium longum	ABQQ01000041
Bifidobacterium pseudocatenulatum	ABXX02000002
Bifidobacterium pseudolongum	NR_043442
Bifidobacterium scardovii	AJ307005
Bifidobacterium sp. HM2	AB425276
Bifidobacterium sp. HMLN12	JF519685
Bifidobacterium sp. M45	HM626176
Bifidobacterium sp. MSX5B	HQ616382
Bifidobacterium sp. TM_7	AB218972
Bifidobacterium thermophilum	DQ340557
Bifidobacterium urinalis	AJ278695
Blautia coccoides	AB571656
Blautia glucerasea	AB588023
Blautia glucerasei	AB439724
Blautia hansenii	ABYU02000037
Blautia hydrogenotrophica	ACBZ01000217
Blautia luti	AB691576
Blautia producta	AB600998
Blautia schinkii	NR_026312
Blautia sp. M25	HM626178
Blautia stercoris	HM626177
Blautia wexlerae	EF036467
Bordetella bronchiseptica	NR_025949
Bordetella holmesii	AB683187

Bordetella parapertussis	NR_025950
Bordetella pertussis	BX640418
Borrelia afzelii	ABCU01000001
Borrelia burgdorferi	ABGI01000001
Borrelia crocidurae	DQ057990
Borrelia duttonii	NC_011229
Borrelia garinii	ABJV01000001
Borrelia hermsii	AY597657
Borrelia hispanica	DQ057988
Borrelia persica	HM161645
Borrelia recurrentis	AF107367
Borrelia sp. NE49	AJ224142
Borrelia spielmanii	ABKB01000002
Borrelia turicatae	NC_008710
Borrelia valaisiana	ABCY01000002
Brucella ovis	NC_009504
Brucella sp. 83_13	ACBQ01000040
Brucella sp. BO1	EU053207
Brucella suis	ACBK01000034
Burkholderia ambifaria	AAUZ01000009
Burkholderia cenocepacia	AAHI01000060
Burkholderia cepacia	NR_041719
Burkholderia mallei	CP000547
Burkholderia multivorans	NC_010086
Burkholderia oklahomensis	DQ108388
Burkholderia pseudomallei	CP001408
Burkholderia rhizoxinica	HQ005410
Burkholderia sp. 383	CP000151
Burkholderia xenovorans	U86373
Burkholderiales bacterium 1_1_47	ADCQ01000066
Butyrivibrio crossotus	ABWN01000012
Butyrivibrio fibrisolvens	U41172

Chlamydia muridarum	AE002160
Chlamydia psittaci	NR_036864
Chlamydia trachomatis	U68443
Chlamydiales bacterium NS11	JN606074
Citrobacter amalonaticus	FR870441
Citrobacter braakii	NR_028687
Citrobacter farmeri	AF025371
Citrobacter freundii	NR_028894
Citrobacter gillenii	AF025367
Citrobacter koseri	NC_009792
Citrobacter murliniae	AF025369
Citrobacter rodentium	NR_074903
Citrobacter sedlakii	AF025364
Citrobacter sp. 30_2	ACDJ01000053
Citrobacter sp. KMSI_3	GQ468398
Citrobacter werkmanii	AF025373
Citrobacter youngae	ABWL02000011
Cloacibacillus evryensis	GQ258966
Clostridiaceae bacterium END_2	EF451053
Clostridiaceae bacterium JC13	JF824807
Clostridiales bacterium 1_7_47FAA	ABQR01000074
Clostridiales bacterium 9400853	HM587320
Clostridiales bacterium 9403326	HM587324
Clostridiales bacterium oral clone P4PA_66 P1	AY207065
Clostridiales bacterium oral taxon 093	GQ422712
Clostridiales bacterium oral taxon F32	HM099644
Clostridiales bacterium ph2	JN837487
Clostridiales bacterium SY8519	AB477431
Clostridiales genomosp. BVAB3	CP001850
Clostridiales sp. SM4_1	FP929060
Clostridiales sp. SS3_4	AY305316
Clostridiales sp. SSC_2	FP929061

Clostridium acetobutylicum	NR_074511
Clostridium aerotolerans	X76163
Clostridium aldenense	NR_043680
Clostridium aldrichii	NR_026099
Clostridium algidicarnis	NR_041746
Clostridium algidixylanolyticum	NR_028726
Clostridium aminovalericum	NR_029245
Clostridium amygdalinum	AY353957
Clostridium argentinense	NR_029232
Clostridium asparagiforme	ACCJ01000522
Clostridium baratii	NR_029229
Clostridium bartlettii	ABEZ02000012
Clostridium beijerinckii	NR_074434
Clostridium bifermentans	X73437
Clostridium bolteae	ABCC02000039
Clostridium botulinum	NC_010723
Clostridium butyricum	ABDT01000017
Clostridium cadaveris	AB542932
Clostridium carboxidivorans	FR733710
Clostridium carnis	NR_044716
Clostridium celatum	X77844
Clostridium celerecrescens	JQ246092
Clostridium cellulosi	NR_044624
Clostridium chauvoei	EU106372
Clostridium citroniae	ADLJ01000059
Clostridium clariflavum	NR_041235
Clostridium clostridiiformes	M59089
Clostridium clostridioforme	NR_044715
Clostridium coccoides	EF025906
Clostridium cochlearium	NR_044717
Clostridium cocleatum	NR_026495
Clostridium colicanis	FJ957863

Clostridium colinum	NR_026151
Clostridium difficile	NC_013315
Clostridium disporicum	NR_026491
Clostridium estertheticum	NR_042153
Clostridium fallax	NR_044714
Clostridium favososporum	X76749
Clostridium felsineum	AF270502
Clostridium frigidicarnis	NR_024919
Clostridium gasigenes	NR_024945
Clostridium ghonii	AB542933
Clostridium glycolicum	FJ384385
Clostridium glycyrrhizinilyticum	AB233029
Clostridium haemolyticum	NR_024749
Clostridium hathewayi	AY552788
Clostridium hiranonis	AB023970
Clostridium histolyticum	HF558362
Clostridium hylemonae	AB023973
Clostridium indolis	AF028351
Clostridium innocuum	M23732
Clostridium irregulare	NR_029249
Clostridium isatidis	NR_026347
Clostridium kluyveri	NR_074165
Clostridium lactatifermentans	NR_025651
Clostridium lavalense	EF564277
Clostridium leptum	AJ305238
Clostridium limosum	FR870444
Clostridium magnum	X77835
Clostridium malenominatum	FR749893
Clostridium mayombei	FR733682
Clostridium methylpentosum	ACEC01000059
Clostridium nexile	X73443
Clostridium novyi	NR_074343

Clostridium orbiscindens	Y18187
Clostridium oroticum	FR749922
Clostridium paraputrificum	AB536771
Clostridium perfringens	ABDW01000023
Clostridium phytofermentans	NR_074652
Clostridium piliforme	D14639
Clostridium putrefaciens	NR_024995
Clostridium quinii	NR_026149
Clostridium ramosum	M23731
Clostridium rectum	NR_029271
Clostridium saccharogumia	DQ100445
Clostridium saccharolyticum	CP002109
Clostridium sardiniense	NR_041006
Clostridium sartagoforme	NR_026490
Clostridium scindens	AF262238
Clostridium septicum	NR_026020
Clostridium sordellii	AB448946
Clostridium sp. 7_2_43FAA	ACDK01000101
Clostridium sp. D5	ADBG01000142
Clostridium sp. HGF2	AENW01000022
Clostridium sp. HPB_46	AY862516
Clostridium sp. JC122	CAEV01000127
Clostridium sp. L2_50	AAYW02000018
Clostridium sp. LMG 16094	X95274
Clostridium sp. M62_1	ACFX02000046
Clostridium sp. MLG055	AF304435
Clostridium sp. MT4 E	FJ159523
Clostridium sp. NMBHI_1	JN093130
Clostridium sp. NML 04A032	EU815224
Clostridium sp. SS2_1	ABGC03000041
Clostridium sp. SY8519	AP012212
Clostridium sp. TM_40	AB249652

Clostridium sp. YIT 12069	AB491207
Clostridium sp. YIT 12070	AB491208
Clostridium sphenoides	X73449
Clostridium spiroforme	X73441
Clostridium sporogenes	ABKW02000003
Clostridium sporosphaeroides	NR_044835
Clostridium stercorarium	NR_025100
Clostridium sticklandii	L04167
Clostridium straminisolvens	NR_024829
Clostridium subterminale	NR_041795
Clostridium sulfidigenes	NR_044161
Clostridium symbiosum	ADLQ01000114
Clostridium tertium	Y18174
Clostridium tetani	NC_004557
Clostridium thermocellum	NR_074629
Clostridium tyrobutyricum	NR_044718
Clostridium viride	NR_026204
Clostridium xylanolyticum	NR_037068
Collinsella aerofaciens	AAVN02000007
Collinsella intestinalis	ABXH02000037
Collinsella stercoris	ABXJ01000150
Collinsella tanakaei	AB490807
Coprobacillus cateniformis	AB030218
Coprobacillus sp. 29_1	ADKX01000057
Coprobacillus sp. D7	ACDT01000199
Coprococcus catus	EU266552
Coprococcus comes	ABVR01000038
Coprococcus eutactus	EF031543
Coprococcus sp. ART55_1	AY350746
Dialister invisus	ACIM02000001
Dialister micraerophilus	AFBB01000028
Dialister microaerophilus	AENT01000008

Dialister pneumosintes	HM596297
Dialister propionicifaciens	NR_043231
Dialister sp. oral taxon 502	GQ422739
Dialister succinatiphilus	AB370249
Dorea formicigenerans	AAXA02000006
Dorea longicatena	AJ132842
Enhydrobacter aerosaccus	ACYI01000081
Enterobacter aerogenes	AJ251468
Enterobacter asburiae	NR_024640
Enterobacter cancerogenus	Z96078
Enterobacter cloacae	FP929040
Enterobacter cowanii	NR_025566
Enterobacter hormaechei	AFHR01000079
Enterobacter sp. 247BMC	HQ122932
Enterobacter sp. 638	NR_074777
Enterobacter sp. JC163	JN657217
Enterobacter sp. SCSS	HM007811
Enterobacter sp. TSE38	HM156134
Enterobacteriaceae bacterium 9_2_54FAA	ADCU01000033
Enterobacteriaceae bacterium CF01Ent_1	AJ489826
Enterobacteriaceae bacterium Smarlab 3302238	AY538694
Enterococcus avium	AF133535
Enterococcus caccae	AY943820
Enterococcus casseliflavus	AEWT01000047
Enterococcus durans	AJ276354
Enterococcus faecalis	AE016830
Enterococcus faecium	AM157434
Enterococcus gallinarum	AB269767
Enterococcus gilvus	AY033814
Enterococcus hawaiiensis	AY321377
Enterococcus hirae	AF061011
Enterococcus italicus	AEPV01000109

Enterococcus mundtii	NR_024906
Enterococcus raffinosus	FN600541
Enterococcus sp. BV2CASA2	JN809766
Enterococcus sp. CCRI_16620	GU457263
Enterococcus sp. F95	FJ463817
Enterococcus sp. RfL6	AJ133478
Enterococcus thailandicus	AY321376
Erysipelotrichaceae bacterium 3_1_53	ACTJ01000113
Erysipelotrichaceae bacterium 5_2_54FAA	ACZW01000054
Escherichia albertii	ABKX01000012
Escherichia coli	NC_008563
Escherichia fergusonii	CU928158
Escherichia hermannii	HQ407266
Escherichia sp. 1_1_43	ACID01000033
Escherichia sp. 4_1_40B	ACDM02000056
Escherichia sp. B4	EU722735
Escherichia vulneris	NR_041927
Eubacteriaceae bacterium P4P_50 P4	AY207060
Eubacterium barkeri	NR_044661
Eubacterium biforme	ABYT01000002
Eubacterium brachy	U13038
Eubacterium budayi	NR_024682
Eubacterium callanderi	NR_026330
Eubacterium cellulosolvens	AY178842
Eubacterium contortum	FR749946
Eubacterium coprostanoligenes	HM037995
Eubacterium cylindroides	FP929041
Eubacterium desmolans	NR_044644
Eubacterium dolichum	L34682
Eubacterium eligens	CP001104
Eubacterium fissicatena	FR749935
Eubacterium hadrum	FR749933

Eubacterium hallii	L34621
Eubacterium infirmum	U13039
Eubacterium limosum	CP002273
Eubacterium moniliforme	HF558373
Eubacterium multiforme	NR_024683
Eubacterium nitritogenes	NR_024684
Eubacterium nodatum	U13041
Eubacterium ramulus	AJ011522
Eubacterium rectale	FP929042
Eubacterium ruminantium	NR_024661
Eubacterium saburreum	AB525414
Eubacterium saphenum	NR_026031
Eubacterium siraeum	ABCA03000054
Eubacterium sp. 3_1_31	ACTL01000045
Eubacterium sp. AS15b	HQ616364
Eubacterium sp. OBRC9	HQ616354
Eubacterium sp. oral clone GI038	AY349374
Eubacterium sp. oral clone IR009	AY349376
Eubacterium sp. oral clone JH012	AY349373
Eubacterium sp. oral clone JI012	AY349379
Eubacterium sp. oral clone JN088	AY349377
Eubacterium sp. oral clone JS001	AY349378
Eubacterium sp. oral clone OH3A	AY947497
Eubacterium sp. WAL 14571	FJ687606
Eubacterium tenue	M59118
Eubacterium tortuosum	NR_044648
Eubacterium ventriosum	L34421
Eubacterium xylanophilum	L34628
Eubacterium yurii	AEES01000073
Fusobacterium canifelinum	AY162222
Fusobacterium genomosp. C1	AY278616
Fusobacterium genomosp. C2	AY278617

Fusobacterium gonidiaformans	ACET01000043
Fusobacterium mortiferum	ACDB02000034
Fusobacterium naviforme	HQ223106
Fusobacterium necrogenes	X55408
Fusobacterium necrophorum	AM905356
Fusobacterium nucleatum	ADVK01000034
Fusobacterium periodonticum	ACJY01000002
Fusobacterium russii	NR_044687
Fusobacterium sp. 1_1_41FAA	ADGG01000053
Fusobacterium sp. 11_3_2	ACUO01000052
Fusobacterium sp. 12_1B	AGWJ01000070
Fusobacterium sp. 2_1_31	ACDC02000018
Fusobacterium sp. 3_1_27	ADGF01000045
Fusobacterium sp. 3_1_33	ACQE01000178
Fusobacterium sp. 3_1_36A2	ACPU01000044
Fusobacterium sp. 3_1_5R	ACDD01000078
Fusobacterium sp. AC18	HQ616357
Fusobacterium sp. ACB2	HQ616358
Fusobacterium sp. AS2	HQ616361
Fusobacterium sp. CM1	HQ616371
Fusobacterium sp. CM21	HQ616375
Fusobacterium sp. CM22	HQ616376
Fusobacterium sp. D12	ACDG02000036
Fusobacterium sp. oral clone ASCF06	AY923141
Fusobacterium sp. oral clone ASCF11	AY953256
Fusobacterium ulcerans	ACDH01000090
Fusobacterium varium	ACIE01000009
Gemella haemolysans	ACDZ02000012
Gemella morbillorum	NR_025904
Gemella morbillorum	ACRX01000010
Gemella sanguinis	ACRY01000057
Gemella sp. oral clone ASCE02	AY923133

Gemella sp. oral clone ASCF04	AY923139
Gemella sp. oral clone ASCF12	AY923143
Gemella sp. WAL 1945J	EU427463
Klebsiella oxytoca	AY292871
Klebsiella pneumoniae	CP000647
Klebsiella sp. AS10	HQ616362
Klebsiella sp. Co9935	DQ068764
Klebsiella sp. enrichment culture clone SRC_DSD25	HM195210
Klebsiella sp. OBRC7	HQ616353
Klebsiella sp. SP_BA	FJ999767
Klebsiella sp. SRC_DSD1	GU797254
Klebsiella sp. SRC_DSD11	GU797263
Klebsiella sp. SRC_DSD12	GU797264
Klebsiella sp. SRC_DSD15	GU797267
Klebsiella sp. SRC_DSD2	GU797253
Klebsiella sp. SRC_DSD6	GU797258
Klebsiella varicola	CP001891
Lachnobacterium bovis	GU324407
Lachnospira multipara	FR733699
Lachnospira pectinoschiza	L14675
Lachnospiraceae bacterium 1_1_57FAA	ACTM01000065
Lachnospiraceae bacterium 1_4_56FAA	ACTN01000028
Lachnospiraceae bacterium 2_1_46FAA	ADLB01000035
Lachnospiraceae bacterium 2_1_58FAA	ACTO01000052
Lachnospiraceae bacterium 3_1_57FAA_CT1	ACTP01000124
Lachnospiraceae bacterium 4_1_37FAA	ADCR01000030
Lachnospiraceae bacterium 5_1_57FAA	ACTR01000020
Lachnospiraceae bacterium 5_1_63FAA	ACTS01000081
Lachnospiraceae bacterium 6_1_63FAA	ACTV01000014
Lachnospiraceae bacterium 8_1_57FAA	ACWQ01000079
Lachnospiraceae bacterium 9_1_43BFAA	ACTX01000023

Lachnospiraceae bacterium A4	DQ789118
Lachnospiraceae bacterium DJF VP30	EU728771
Lachnospiraceae bacterium ICM62	HQ616401
Lachnospiraceae bacterium MSX33	HQ616384
Lachnospiraceae bacterium oral taxon 107	ADDS01000069
Lachnospiraceae bacterium oral taxon F15	HM099641
Lachnospiraceae genomosp. C1	AY278618
Lactobacillus acidipiscis	NR_024718
Lactobacillus acidophilus	CP000033
Lactobacillus alimentarius	NR_044701
Lactobacillus amylolyticus	ADNY01000006
Lactobacillus amylovorus	CP002338
Lactobacillus antri	ACLL01000037
Lactobacillus brevis	EU194349
Lactobacillus buchneri	ACGH01000101
Lactobacillus casei	CP000423
Lactobacillus catenaformis	M23729
Lactobacillus coleohominis	ACOH01000030
Lactobacillus coryniformis	NR_044705
Lactobacillus crispatus	ACOG01000151
Lactobacillus curvatus	NR_042437
Lactobacillus delbrueckii	CP002341
Lactobacillus dextrinicus	NR_036861
Lactobacillus farciminis	NR_044707
Lactobacillus fermentum	CP002033
Lactobacillus gasseri	ACOZ01000018
Lactobacillus gastricus	AICN01000060
Lactobacillus genomosp. C1	AY278619
Lactobacillus genomosp. C2	AY278620
Lactobacillus helveticus	ACLM01000202
Lactobacillus hilgardii	ACGP01000200
Lactobacillus hominis	FR681902

Lactobacillus iners	AEKJ01000002
Lactobacillus jensenii	ACQD01000066
Lactobacillus johnsonii	AE017198
Lactobacillus kalixensis	NR_029083
Lactobacillus kefiranofaciens	NR_042440
Lactobacillus kefiri	NR_042230
Lactobacillus kimchii	NR_025045
Lactobacillus leichmannii	JX986966
Lactobacillus mucosae	FR693800
Lactobacillus murinus	NR_042231
Lactobacillus nodensis	NR_041629
Lactobacillus oeni	NR_043095
Lactobacillus oris	AEKL01000077
Lactobacillus parabrevis	NR_042456
Lactobacillus parabuchneri	NR_041294
Lactobacillus paracasei	ABQV01000067
Lactobacillus parakefiri	NR_029039
Lactobacillus pentosus	JN813103
Lactobacillus perolens	NR_029360
Lactobacillus plantarum	ACGZ02000033
Lactobacillus pontis	HM218420
Lactobacillus reuteri	ACGW02000012
Lactobacillus rhamnosus	ABWJ01000068
Lactobacillus rogosae	GU269544
Lactobacillus ruminis	ACGS02000043
Lactobacillus sakei	DQ989236
Lactobacillus salivarius	AEBA01000145
Lactobacillus saniviri	AB602569
Lactobacillus senioris	AB602570
Lactobacillus sp. 66c	FR681900
Lactobacillus sp. BT6	HQ616370
Lactobacillus sp. KLDS 1.0701	EU600905

Lactobacillus sp. KLDS 1.0702	EU600906
Lactobacillus sp. KLDS 1.0703	EU600907
Lactobacillus sp. KLDS 1.0704	EU600908
Lactobacillus sp. KLDS 1.0705	EU600909
Lactobacillus sp. KLDS 1.0707	EU600911
Lactobacillus sp. KLDS 1.0709	EU600913
Lactobacillus sp. KLDS 1.0711	EU600915
Lactobacillus sp. KLDS 1.0712	EU600916
Lactobacillus sp. KLDS 1.0713	EU600917
Lactobacillus sp. KLDS 1.0716	EU600921
Lactobacillus sp. KLDS 1.0718	EU600922
Lactobacillus sp. KLDS 1.0719	EU600923
Lactobacillus sp. oral clone HT002	AY349382
Lactobacillus sp. oral clone HT070	AY349383
Lactobacillus sp. oral taxon 052	GQ422710
Lactobacillus tucceti	NR_042194
Lactobacillus ultunensis	ACGU01000081
Lactobacillus vaginalis	ACGV01000168
Lactobacillus vini	NR_042196
Lactobacillus vitulinus	NR_041305
Lactobacillus zeae	NR_037122
Lactococcus garvieae	AF061005
Lactococcus lactis	CP002365
Lactococcus raffinolactis	NR_044359
Listeria grayi	ACCR02000003
Listeria innocua	JF967625
Listeria ivanovii	X56151
Listeria monocytogenes	CP002003
Listeria welshimeri	AM263198
Megasphaera elsdenii	AY038996
Megasphaera genomosp. C1	AY278622
Megasphaera genomosp. type_1	ADGP01000010

Megasphaera micronuciformis	AECS01000020
Megasphaera sp. BLPYG_07	HM990964
Megasphaera sp. UPII 199_6	AFIJ01000040
Microbacterium gubbeenense	NR_025098
Microbacterium lacticum	EU714351
Mitsuokella jalaludinii	NR_028840
Mitsuokella multacida	ABWK02000005
Mitsuokella sp. oral taxon 521	GU413658
Mitsuokella sp. oral taxon G68	GU432166
Mycobacterium abscessus	AGQU01000002
Mycobacterium africanum	AF480605
Mycobacterium alsiensis	AJ938169
Mycobacterium avium	CP000479
Mycobacterium chelonae	AB548610
Mycobacterium colombiense	AM062764
Mycobacterium elephantis	AF385898
Mycobacterium gordonae	GU142930
Mycobacterium intracellulare	GQ153276
Mycobacterium kansasii	AF480601
Mycobacterium lacus	NR_025175
Mycobacterium leprae	FM211192
Mycobacterium lepromatosis	EU203590
Mycobacterium mageritense	FR798914
Mycobacterium mantenii	FJ042897
Mycobacterium marinum	NC_010612
Mycobacterium microti	NR_025234
Mycobacterium neoaurum	AF268445
Mycobacterium parascrofulaceum	ADNV01000350
Mycobacterium paraterrae	EU919229
Mycobacterium phlei	GU142920
Mycobacterium seoulense	DQ536403
Mycobacterium smegmatis	CP000480

Mycobacterium sp. 1761	EU703150
Mycobacterium sp. 1776	EU703152
Mycobacterium sp. 1781	EU703147
Mycobacterium sp. 1791	EU703148
Mycobacterium sp. 1797	EU703149
Mycobacterium sp. AQ1GA4	HM210417
Mycobacterium sp. B10_07.09.0206	HQ174245
Mycobacterium sp. GN_10546	FJ497243
Mycobacterium sp. GN_10827	FJ497247
Mycobacterium sp. GN_11124	FJ652846
Mycobacterium sp. GN_9188	FJ497240
Mycobacterium sp. GR_2007_210	FJ555538
Mycobacterium sp. HE5	AJ012738
Mycobacterium sp. NLA001000736	HM627011
Mycobacterium sp. W	DQ437715
Mycobacterium tuberculosis	CP001658
Mycobacterium ulcerans	AB548725
Mycobacterium vulneris	EU834055
Mycoplasma agalactiae	AF010477
Mycoplasma amphoriforme	AY531656
Mycoplasma arthritidis	NC_011025
Mycoplasma bovoculi	NR_025987
Mycoplasma faucium	NR_024983
Mycoplasma fermentans	CP002458
Mycoplasma flocculare	X62699
Mycoplasma genitalium	L43967
Mycoplasma hominis	AF443616
Mycoplasma orale	AY796060
Mycoplasma ovipneumoniae	NR_025989
Mycoplasma penetrans	NC_004432
Mycoplasma pneumoniae	NC_000912
Mycoplasma putrefaciens	U26055

Mycoplasma salivarium	M24661
Mycoplasmataceae genomosp. P1 oral clone MB1_G23	DQ003614
Neisseria bacilliformis	AFAY01000058
Neisseria cinerea	ACDY01000037
Neisseria elongata	ADBF01000003
Neisseria flavescens	ACQV01000025
Neisseria genomosp. P2 oral clone MB5_P15	DQ003630
Neisseria gonorrhoeae	CP002440
Neisseria lactamica	ACEQ01000095
Neisseria macacae	AFQE01000146
Neisseria meningitidis	NC_003112
Neisseria mucosa	ACDX01000110
Neisseria pharyngis	AJ239281
Neisseria polysaccharea	ADBE01000137
Neisseria sicca	ACKO02000016
Neisseria sp. KEM232	GQ203291
Neisseria sp. oral clone AP132	AY005027
Neisseria sp. oral clone JC012	AY349388
Neisseria sp. oral strain B33KA	AY005028
Neisseria sp. oral taxon 014	ADEA01000039
Neisseria sp. SMC_A9199	FJ763637
Neisseria sp. TM10_1	DQ279352
Neisseria subflava	ACEO01000067
Odoribacter laneus	AB490805
Odoribacter splanchnicus	CP002544
Oscillibacter sp. G2	HM626173
Oscillibacter valericigenes	NR_074793
Oscillospira guilliermondii	AB040495
Paenibacillus barcinonensis	NR_042272
Paenibacillus barengoltzii	NR_042756
Paenibacillus chibensis	NR_040885

Paenibacillus cookii	NR_025372
Paenibacillus durus	NR_037017
Paenibacillus glucanolyticus	D78470
Paenibacillus lactis	NR_025739
Paenibacillus lautus	NR_040882
Paenibacillus pabuli	NR_040853
Paenibacillus polymyxa	NR_037006
Paenibacillus popilliae	NR_040888
Paenibacillus sp. CIP 101062	HM212646
Parabacteroides distasonis	CP000140
Parabacteroides goldsteinii	AY974070
Parabacteroides gordonii	AB470344
Parabacteroides johnsonii	ABYH01000014
Parabacteroides merdae	EU136685
Parabacteroides sp. D13	ACPW01000017
Parabacteroides sp. NS31_3	JN029805
Peptococcus niger	NR_029221
Peptococcus sp. oral clone JM048	AY349389
Peptococcus sp. oral taxon 167	GQ422727
Peptoniphilus asaccharolyticus	D14145
Peptoniphilus duerdenii	EU526290
Peptoniphilus harei	NR_026358
Peptoniphilus indolicus	AY153431
Peptoniphilus ivorii	Y07840
Peptoniphilus lacrimalis	ADDO01000050
Peptoniphilus sp. gpac007	AM176517
Peptoniphilus sp. gpac018A	AM176519
Peptoniphilus sp. gpac077	AM176527
Peptoniphilus sp. gpac148	AM176535
Peptoniphilus sp. JC140	JF824803
Peptoniphilus sp. oral taxon 386	ADCS01000031
Peptoniphilus sp. oral taxon 836	AEAA01000090

Peptostreptococcaceae bacterium ph1	JN837495
Peptostreptococcus anaerobius	AY326462
Peptostreptococcus micros	AM176538
Peptostreptococcus sp. 9succ1	X90471
Peptostreptococcus sp. oral clone AP24	AB175072
Peptostreptococcus sp. oral clone FJ023	AY349390
Peptostreptococcus sp. P4P_31 P3	AY207059
Peptostreptococcus stomatis	ADGQ01000048
Porphyromonadaceae bacterium NML 060648	EF184292
Porphyromonas asaccharolytica	AENO01000048
Porphyromonas endodontalis	ACNN01000021
Porphyromonas gingivalis	AE015924
Porphyromonas levii	NR_025907
Porphyromonas macacae	NR_025908
Porphyromonas somerae	AB547667
Porphyromonas sp. oral clone BB134	AY005068
Porphyromonas sp. oral clone F016	AY005069
Porphyromonas sp. oral clone P2PB_52 P1	AY207054
Porphyromonas sp. oral clone P4GB_100 P2	AY207057
Porphyromonas sp. UQD 301	EU012301
Porphyromonas uenonis	ACLR01000152
Prevotella albensis	NR_025300
Prevotella amnii	AB547670
Prevotella bergensis	ACKS01000100
Prevotella bivia	ADFO01000096
Prevotella brevis	NR_041954
Prevotella buccae	ACRB01000001
Prevotella buccalis	JN867261
Prevotella copri	ACBX02000014
Prevotella corporis	L16465
Prevotella dentalis	AB547678
Prevotella denticola	CP002589

Prevotella disiens	AEDO01000026
Prevotella genomosp. C1	AY278624
Prevotella genomosp. C2	AY278625
Prevotella genomosp. P7 oral clone MB2_P31	DQ003620
Prevotella genomosp. P8 oral clone MB3_P13	DQ003622
Prevotella genomosp. P9 oral clone MB7_G16	DQ003633
Prevotella heparinolytica	GQ422742
Prevotella histicola	JN867315
Prevotella intermedia	AF414829
Prevotella loescheii	JN867231
Prevotella maculosa	AGEK01000035
Prevotella marshii	AEEI01000070
Prevotella melaninogenica	CP002122
Prevotella micans	AGWK01000061
Prevotella multiformis	AEWX01000054
Prevotella multisaccharivorax	AFJE01000016
Prevotella nanceiensis	JN867228
Prevotella nigrescens	AFPX01000069
Prevotella oralis	AEPE01000021
Prevotella oris	ADDV01000091
Prevotella oulorum	L16472
Prevotella pallens	AFPY01000135
Prevotella ruminicola	CP002006
Prevotella salivae	AB108826
Prevotella sp. BI_42	AJ581354
Prevotella sp. CM38	HQ610181
Prevotella sp. ICM1	HQ616385
Prevotella sp. ICM55	HQ616399
Prevotella sp. JCM 6330	AB547699
Prevotella sp. oral clone AA020	AY005057
Prevotella sp. oral clone ASCG10	AY923148
Prevotella sp. oral clone ASCG12	DQ272511

Prevotella sp. oral clone AU069	AY005062
Prevotella sp. oral clone CY006	AY005063
Prevotella sp. oral clone DA058	AY005065
Prevotella sp. oral clone FL019	AY349392
Prevotella sp. oral clone FU048	AY349393
Prevotella sp. oral clone FW035	AY349394
Prevotella sp. oral clone GI030	AY349395
Prevotella sp. oral clone GI032	AY349396
Prevotella sp. oral clone GI059	AY349397
Prevotella sp. oral clone GU027	AY349398
Prevotella sp. oral clone HF050	AY349399
Prevotella sp. oral clone ID019	AY349400
Prevotella sp. oral clone IDR_CEC_0055	AY550997
Prevotella sp. oral clone IK053	AY349401
Prevotella sp. oral clone IK062	AY349402
Prevotella sp. oral clone P4PB_83 P2	AY207050
Prevotella sp. oral taxon 292	GQ422735
Prevotella sp. oral taxon 299	ACWZ01000026
Prevotella sp. oral taxon 300	GU409549
Prevotella sp. oral taxon 302	ACZK01000043
Prevotella sp. oral taxon 310	GQ422737
Prevotella sp. oral taxon 317	ACQH01000158
Prevotella sp. oral taxon 472	ACZS01000106
Prevotella sp. oral taxon 781	GQ422744
Prevotella sp. oral taxon 782	GQ422745
Prevotella sp. oral taxon F68	HM099652
Prevotella sp. oral taxon G60	GU432133
Prevotella sp. oral taxon G70	GU432179
Prevotella sp. oral taxon G71	GU432180
Prevotella sp. SEQ053	JN867222
Prevotella sp. SEQ065	JN867234
Prevotella sp. SEQ072	JN867238

Prevotella sp. SEQ116	JN867246
Prevotella sp. SG12	GU561343
Prevotella sp. sp24	AB003384
Prevotella sp. sp34	AB003385
Prevotella stercorea	AB244774
Prevotella tannerae	ACIJ02000018
Prevotella timonensis	ADEF01000012
Prevotella veroralis	ACVA01000027
Prevotellaceae bacterium P4P_62 P1	AY207061
Propionibacteriaceae bacterium NML 02_0265	EF599122
Propionibacterium acidipropionici	NC_019395
Propionibacterium acnes	ADJM01000010
Propionibacterium avidum	AJ003055
Propionibacterium freudenreichii	NR_036972
Propionibacterium granulosum	FJ785716
Propionibacterium jensenii	NR_042269
Propionibacterium propionicum	NR_025277
Propionibacterium sp. 434_HC2	AFIL01000035
Propionibacterium sp. H456	AB177643
Propionibacterium sp. LG	AY354921
Propionibacterium sp. oral taxon 192	GQ422728
Propionibacterium sp. S555a	AB264622
Propionibacterium thoenii	NR_042270
Pseudomonas aeruginosa	AABQ07000001
Pseudomonas fluorescens	AY622220
Pseudomonas gessardii	FJ943496
Pseudomonas mendocina	AAUL01000021
Pseudomonas monteilii	NR_024910
Pseudomonas poae	GU188951
Pseudomonas pseudoalcaligenes	NR_037000
Pseudomonas putida	AF094741
Pseudomonas sp. 2_1_26	ACWU01000257

Pseudomonas sp. G1229	DQ910482
Pseudomonas sp. NP522b	EU723211
Pseudomonas stutzeri	AM905854
Pseudomonas tolaasii	AF320988
Pseudomonas viridiflava	NR_042764
Ralstonia pickettii	NC_010682
Ralstonia sp. 5_7_47FAA	ACUF01000076
Roseburia cecicola	GU233441
Roseburia faecalis	AY804149
Roseburia faecis	AY305310
Roseburia hominis	AJ270482
Roseburia intestinalis	FP929050
Roseburia inulinivorans	AJ270473
Roseburia sp. 11SE37	FM954975
Roseburia sp. 11SE38	FM954976
Rothia aeria	DQ673320
Rothia dentocariosa	ADDW01000024
Rothia mucilaginosa	ACVO01000020
Rothia nasimurium	NR_025310
Rothia sp. oral taxon 188	GU470892
Ruminobacter amylophilus	NR_026450
Ruminococcaceae bacterium D16	ADDX01000083
Ruminococcus albus	AY445600
Ruminococcus bromii	EU266549
Ruminococcus callidus	NR_029160
Ruminococcus champanellensis	FP929052
Ruminococcus flavefaciens	NR_025931
Ruminococcus gnavus	X94967
Ruminococcus hansenii	M59114
Ruminococcus lactaris	ABOU02000049
Ruminococcus obeum	AY169419
Ruminococcus sp. 18P13	AJ515913

Ruminococcus sp. 5_1_39BFAA	ACII01000172
Ruminococcus sp. 9SE51	FM954974
Ruminococcus sp. ID8	AY960564
Ruminococcus sp. K_1	AB222208
Ruminococcus torques	AAVP02000002
Salmonella bongori	NR_041699
Salmonella enterica	NC_011149
Salmonella enterica	NC_011205
Salmonella enterica	DQ344532
Salmonella enterica	ABEH02000004
Salmonella enterica	ABAK02000001
Salmonella enterica	NC_011080
Salmonella enterica	EU118094
Salmonella enterica	NC_011094
Salmonella enterica	AE014613
Salmonella enterica	ABFH02000001
Salmonella enterica	ABEM01000001
Salmonella enterica	ABAM02000001
Salmonella typhimurium	DQ344533
Salmonella typhimurium	AF170176
Selenomonas artemidis	HM596274
Selenomonas dianae	GQ422719
Selenomonas flueggei	AF287803
Selenomonas genomosp. C1	AY278627
Selenomonas genomosp. C2	AY278628
Selenomonas genomosp. P5	AY341820
Selenomonas genomosp. P6 oral clone MB3_C41	DQ003636
Selenomonas genomosp. P7 oral clone MB5_C08	DQ003627
Selenomonas genomosp. P8 oral clone MB5_P06	DQ003628

Selenomonas infelix	AF287802
Selenomonas noxia	GU470909
Selenomonas ruminantium	NR_075026
Selenomonas sp. FOBRC9	HQ616378
Selenomonas sp. oral clone FT050	AY349403
Selenomonas sp. oral clone GI064	AY349404
Selenomonas sp. oral clone GT010	AY349405
Selenomonas sp. oral clone HU051	AY349406
Selenomonas sp. oral clone IK004	AY349407
Selenomonas sp. oral clone IQ048	AY349408
Selenomonas sp. oral clone JI021	AY349409
Selenomonas sp. oral clone JS031	AY349410
Selenomonas sp. oral clone OH4A	AY947498
Selenomonas sp. oral clone P2PA_80 P4	AY207052
Selenomonas sp. oral taxon 137	AENV01000007
Selenomonas sp. oral taxon 149	AEEJ01000007
Selenomonas sputigena	ACKP02000033
Serratia fonticola	NR_025339
Serratia liquefaciens	NR_042062
Serratia marcescens	GU826157
Serratia odorifera	ADBY01000001
Serratia proteamaculans	AAUN01000015
Shigella boydii	AAKA01000007
Shigella dysenteriae	NC_007606
Shigella flexneri	AE005674
Shigella sonnei	NC_007384
Sphingobacterium faecium	NR_025537
Sphingobacterium mizutaii	JF708889
Sphingobacterium multivorum	NR_040953
Sphingobacterium spiritivorum	ACHA02000013
Sphingomonas echinoides	NR_024700
Sphingomonas sp. oral clone FI012	AY349411

Sphingomonas sp. oral clone FZ016	AY349412
Sphingomonas sp. oral taxon A09	HM099639
Sphingomonas sp. oral taxon F71	HM099645
Staphylococcaceae bacterium NML 92_0017	AY841362
Staphylococcus aureus	CP002643
Staphylococcus auricularis	JQ624774
Staphylococcus capitis	ACFR01000029
Staphylococcus caprae	ACRH01000033
Staphylococcus carnosus	NR_075003
Staphylococcus cohnii	JN175375
Staphylococcus condimenti	NR_029345
Staphylococcus epidermidis	ACHE01000056
Staphylococcus equorum	NR_027520
Staphylococcus fleurettii	NR_041326
Staphylococcus haemolyticus	NC_007168
Staphylococcus hominis	AM157418
Staphylococcus lugdunensis	AEQA01000024
Staphylococcus pasteuri	FJ189773
Staphylococcus pseudintermedius	CP002439
Staphylococcus saccharolyticus	NR_029158
Staphylococcus saprophyticus	NC_007350
Staphylococcus sciuri	NR_025520
Staphylococcus sp. clone bottae7	AF467424
Staphylococcus sp. H292	AB177642
Staphylococcus sp. H780	AB177644
Staphylococcus succinus	NR_028667
Staphylococcus vitulinus	NR_024670
Staphylococcus warneri	ACPZ01000009
Staphylococcus xylosus	AY395016
Streptobacillus moniliformis	NR_027615
Streptococcus agalactiae	AAJO01000130
Streptococcus alactolyticus	NR_041781

Streptococcus anginosus	AECT01000011
Streptococcus australis	AEQR01000024
Streptococcus bovis	AEEL01000030
Streptococcus canis	AJ413203
Streptococcus constellatus	AY277942
Streptococcus cristatus	AEVC01000028
Streptococcus downei	AEKN01000002
Streptococcus dysgalactiae	AP010935
Streptococcus equi	CP001129
Streptococcus equinus	AEVB01000043
Streptococcus gallolyticus	FR824043
Streptococcus genomosp. C1	AY278629
Streptococcus genomosp. C2	AY278630
Streptococcus genomosp. C3	AY278631
Streptococcus genomosp. C4	AY278632
Streptococcus genomosp. C5	AY278633
Streptococcus genomosp. C6	AY278634
Streptococcus genomosp. C7	AY278635
Streptococcus genomosp. C8	AY278609
Streptococcus gordonii	NC_009785
Streptococcus infantarius	ABJK02000017
Streptococcus infantis	AFNN01000024
Streptococcus intermedius	NR_028736
Streptococcus lutetiensis	NR_037096
Streptococcus massiliensis	AY769997
Streptococcus milleri	X81023
Streptococcus mitis	AM157420
Streptococcus mutans	AP010655
Streptococcus oligofermentans	AY099095
Streptococcus oralis	ADMV01000001
Streptococcus parasanguinis	AEKM01000012
Streptococcus pasteurianus	AP012054

Streptococcus peroris	AEVF01000016
Streptococcus pneumoniae	AE008537
Streptococcus porcinus	EF121439
Streptococcus pseudopneumoniae	FJ827123
Streptococcus pseudoporcinus	AENS01000003
Streptococcus pyogenes	AE006496
Streptococcus ratti	X58304
Streptococcus salivarius	AGBV01000001
Streptococcus sanguinis	NR_074974
Streptococcus sinensis	AF432857
Streptococcus sp. 16362	JN590019
Streptococcus sp. 2_1_36FAA	ACOI01000028
Streptococcus sp. 2285_97	AJ131965
Streptococcus sp. 69130	X78825
Streptococcus sp. AC15	HQ616356
Streptococcus sp. ACS2	HQ616360
Streptococcus sp. AS20	HQ616366
Streptococcus sp. BS35a	HQ616369
Streptococcus sp. C150	ACRI01000045
Streptococcus sp. CM6	HQ616372
Streptococcus sp. CM7	HQ616373
Streptococcus sp. ICM10	HQ616389
Streptococcus sp. ICM12	HQ616390
Streptococcus sp. ICM2	HQ616386
Streptococcus sp. ICM4	HQ616387
Streptococcus sp. ICM45	HQ616394
Streptococcus sp. M143	ACRK01000025
Streptococcus sp. M334	ACRL01000052
Streptococcus sp. OBRC6	HQ616352
Streptococcus sp. oral clone ASB02	AY923121
Streptococcus sp. oral clone ASCA03	DQ272504
Streptococcus sp. oral clone ASCA04	AY923116

Streptococcus sp. oral clone ASCA09	AY923119
Streptococcus sp. oral clone ASCB04	AY923123
Streptococcus sp. oral clone ASCB06	AY923124
Streptococcus sp. oral clone ASCC04	AY923127
Streptococcus sp. oral clone ASCC05	AY923128
Streptococcus sp. oral clone ASCC12	DQ272507
Streptococcus sp. oral clone ASCD01	AY923129
Streptococcus sp. oral clone ASCD09	AY923130
Streptococcus sp. oral clone ASCD10	DQ272509
Streptococcus sp. oral clone ASCE03	AY923134
Streptococcus sp. oral clone ASCE04	AY953253
Streptococcus sp. oral clone ASCE05	DQ272510
Streptococcus sp. oral clone ASCE06	AY923135
Streptococcus sp. oral clone ASCE09	AY923136
Streptococcus sp. oral clone ASCE10	AY923137
Streptococcus sp. oral clone ASCE12	AY923138
Streptococcus sp. oral clone ASCF05	AY923140
Streptococcus sp. oral clone ASCF07	AY953255
Streptococcus sp. oral clone ASCF09	AY923142
Streptococcus sp. oral clone ASCG04	AY923145
Streptococcus sp. oral clone BW009	AY005042
Streptococcus sp. oral clone CH016	AY005044
Streptococcus sp. oral clone GK051	AY349413
Streptococcus sp. oral clone GM006	AY349414
Streptococcus sp. oral clone P2PA_41 P2	AY207051
Streptococcus sp. oral clone P4PA_30 P4	AY207064
Streptococcus sp. oral taxon 071	AEEP01000019
Streptococcus sp. oral taxon G59	GU432132
Streptococcus sp. oral taxon G62	GU432146
Streptococcus sp. oral taxon G63	GU432150
Streptococcus sp. SHV515	Y07601
Streptococcus suis	FM252032

Streptococcus thermophilus	CP000419
Streptococcus uberis	HQ391900
Streptococcus urinalis	DQ303194
Streptococcus vestibularis	AEKO01000008
Streptococcus viridans	AF076036
Sutterella morbirenis	AJ832129
Sutterella parvirubra	AB300989
Sutterella sanguinus	AJ748647
Sutterella sp. YIT 12072	AB491210
Sutterella stercoricanis	NR_025600
Sutterella wadsworthensis	ADMF01000048
Synergistes genomosp. C1	AY278615
Synergistes sp. RMA 14551	DQ412722
Synergistetes bacterium ADV897	GQ258968
Synergistetes bacterium LBVCM1157	GQ258969
Synergistetes bacterium oral taxon 362	GU410752
Synergistetes bacterium oral taxon D48	GU430992
Turicibacter sanguinis	AF349724
Veillonella atypica	AEDS01000059
Veillonella dispar	ACIK02000021
Veillonella genomosp. P1 oral clone MB5_P17	DQ003631
Veillonella montpellierensis	AF473836
Veillonella parvula	ADFU01000009
Veillonella sp. 3_1_44	ADCV01000019
Veillonella sp. 6_1_27	ADCW01000016
Veillonella sp. ACP1	HQ616359
Veillonella sp. AS16	HQ616365
Veillonella sp. BS32b	HQ616368
Veillonella sp. ICM51a	HQ616396
Veillonella sp. MSA12	HQ616381
Veillonella sp. NVG 100cf	EF108443
Veillonella sp. OK11	JN695650

Veillonella sp. oral clone ASCA08	AY923118
Veillonella sp. oral clone ASCB03	AY923122
Veillonella sp. oral clone ASCG01	AY923144
Veillonella sp. oral clone ASCG02	AY953257
Veillonella sp. oral clone OH1A	AY947495
Veillonella sp. oral taxon 158	AENU01000007
Veillonellaceae bacterium oral taxon 131	GU402916
Veillonellaceae bacterium oral taxon 155	GU470897
Vibrio cholerae	AAUR01000095
Vibrio fluvialis	X76335
Vibrio furnissii	CP002377
Vibrio mimicus	ADAF01000001
Vibrio parahaemolyticus	AAWQ01000116
Vibrio sp. RC341	ACZT01000024
Vibrio vulnificus	AE016796
Yersinia aldovae	AJ871363
Yersinia aleksiciae	AJ627597
Yersinia bercovieri	AF366377
Yersinia enterocolitica	FR729477
Yersinia frederiksenii	AF366379
Yersinia intermedia	AF366380
Yersinia kristensenii	ACCA01000078
Yersinia mollaretii	NR_027546
Yersinia pestis	AE013632
Yersinia pseudotuberculosis	NC_009708
Yersinia rohdei	ACCD01000071

Table 3: Exemplary Bacterial Strains

Strain	**Deposit Number**
Parabacteroides goldsteinii	PTA-126574
Bifidobacterium animalis ssp. lactis Strain A	PTA-125097

Blautia Massiliensis Strain A	PTA-125134
Prevotella Strain B	NRRL accession Number B 50329
Prevotella Histicola	PTA-126140
Blautia Strain A	PTA-125346
Lactococcus lactis cremoris Strain A	PTA-125368
Lactobacillus salivarius	PTA-125893
Ruminococcus gnavus strain	PTA-125706
Tyzzerella nexilis strain	PTA-125707
Paraclostridium benzoelyticum	PTA-125894
Ruminococcus gnavus (also referred to as Mediterraneibacter gnavus)	PTA-126695
Veillonella parvula	PTA-125710
Veillonella atypica Strain A	PTA-125709
Veillonella atypica Strain B	PTA-125711
Veillonella parvula Strain A	PTA-125691
Veillonella parvula Strain B	PTA-125711
Veillonella tobetsuensis Strain A	PTA-125708
Agathobaculum sp.	PTA-125892
Turicibacter sanguinis	PTA-125889
Klebsiella quasipneumoniae subsp. similipneumoniae	PTA-125891
Klebsiella oxytoca	PTA-125890
Megasphaera Sp. Strain A	PTA-126770
Megasphaera Sp.	PTA-126837
Harryflintia acetispora	PTA-126694
Fournierella massiliensis	PTA-126696

Table 4. Exemplary Bacterial Strains

Escherichia coli	NCIMB 12210
Enterococcus faecalis	NCIMB 13280
Bacteroides fragilis	DSM 2151
Bacteroides vulgatus	DSM 1447
Bacteroides ovatus	DSM 1896

Megasphaera massiliensis	DSM 26228
Megasphaera elsdenii	NCIMB 8927
Megasphaera massiliensis	NCIMB 42787
Bifidobacterium breve	DSM 20213
Bifidobacterium longum subsp. longum	DSM 20219
Faecalibacterium prausnitzii	DSM17677
Anaerostipes hadrus	DSM 3319
Blautia coccoides	DSM 935
Dorea longicatena	DSM 13814
Parabacteroides distasonis	DSM 20701
Faecalicatena contorta	DSM3982
Ruminococcus gnavus	ATCC29149
Megasphaera massiliensis	NCIMB 43388
Megasphaera massiliensis	NCIMB 43389
Megasphaera spp.	NCIMB 43385
Megasphaera spp.	NCIMB 43386
Megasphaera spp.	NCIMB 43387
Parabacteroides distasonis (also referred to as "Parabacteroides sp 755")	NCIMB 42382

Modified Bacteria and mEVs

[552] In some aspects, the bacteria and/or mEVs (such as smEVs and/or pmEVs) described herein are modified such that they comprise, are linked to, and/or are bound by a therapeutic moiety.

[553] In some embodiments, the therapeutic moiety is a cancer-specific moiety. In some embodiments, the cancer-specific moiety has binding specificity for a cancer cell (e.g., has binding specificity for a cancer-specific antigen). In some embodiments, the cancer-specific moiety comprises an antibody or antigen binding fragment thereof. In some embodiments, the cancer-specific moiety comprises a T cell receptor or a chimeric antigen receptor (CAR). In some embodiments, the cancer-specific moiety comprises a ligand for a receptor expressed on the surface of a cancer cell or a receptor-binding fragment thereof. In some embodiments, the cancer-specific moiety is a bipartite fusion protein that has two parts: a first part that binds to and/or is linked to the bacterium and a second part that is capable of binding to a cancer cell (e.g., by having binding specificity for a cancer-specific antigen). In some embodiments, the first part is a fragment of or a full-length peptidoglycan recognition protein, such as PGRP. In some embodiments the first part has binding specificity for the mEV (e.g., by having binding specificity for a bacterial antigen). In some embodiments, the first and/or second part comprises an antibody or antigen binding fragment thereof. In some embodiments, the first and/or second part comprises a T cell receptor or a chimeric antigen

receptor (CAR). In some embodiments, the first and/or second part comprises a ligand for a receptor expressed on the surface of a cancer cell or a receptor-binding fragment thereof. In certain embodiments, co-administration of the cancer-specific moiety with the pharmaceutical agent (either in combination or in separate administrations) increases the targeting of the pharmaceutical agent to the cancer cells.

[554] In some embodiments, the bacteria and/or mEVs described herein can be modified such that they comprise, are linked to, and/or are bound by a magnetic and/or paramagnetic moiety (e.g., a magnetic bead). In some embodiments, the magnetic and/or paramagnetic moiety is comprised by and/or directly linked to the bacteria. In some embodiments, the magnetic and/or paramagnetic moiety is linked to and/or a part of a bacteria- or a mEV-binding moiety that binds to the bacteria or mEV. In some embodiments, the bacteria- or mEV-binding moiety is a fragment of or a full-length peptidoglycan recognition protein, such as PGRP. In some embodiments the bacteria- or mEV-binding moiety has binding specificity for the bacteria or mEV (e.g., by having binding specificity for a bacterial antigen). In some embodiments, the bacteria- or mEV-binding moiety comprises an antibody or antigen binding fragment thereof. In some embodiments, the bacteria- or mEV-binding moiety comprises a T cell receptor or a chimeric antigen receptor (CAR). In some embodiments, the bacteria- or mEV-binding moiety comprises a ligand for a receptor expressed on the surface of a cancer cell or a receptor-binding fragment thereof. In certain embodiments, co-administration of the magnetic and/or paramagnetic moiety with the bacteria or mEVs (either together or in separate administrations) can be used to increase the targeting of the mEVs (e.g., to cancer cells and/or a part of a subject where cancer cells are present.

Production of Processed Microbial Extracellular Vesicles (pmEVs)

[555] In certain aspects, the pmEVs described herein can be prepared using any method known in the art.

[556] In some embodiments, the pmEVs are prepared without a pmEV purification step. For example, in some embodiments, bacteria from which the pmEVs described herein are released are killed using a method that leaves the bacterial pmEVs intact, and the resulting bacterial components, including the pmEVs, are used in the methods and compositions described herein. In some embodiments, the bacteria are killed using an antibiotic (e.g., using an antibiotic described herein). In some embodiments, the bacteria are killed using UV irradiation.

[557] In some embodiments, the pmEVs described herein are purified from one or more other bacterial components. Methods for purifying pmEVs from bacteria (and optionally, other bacterial components) are known in the art. In some embodiments, pmEVs are prepared from bacterial cultures using methods described in Thein, *et al.* (*J. Proteome Res.* 9(12):6135-6147 (2010)) or Sandrini, *et al.* (*Bio-protocol* 4(21): e1287 (2014)), each of which is hereby incorporated by reference in its entirety. In some embodiments, the bacteria are cultured to high optical density and then centrifuged to pellet bacteria (*e.g.*, at 10,000-15,000 x g for 10- 15 min at room temperature or 4°C). In some embodiments, the supernatants are discarded and cell pellets are frozen at -80°C. In some embodiments, cell pellets are thawed on ice and resuspended in 100 mM Tris-HCl, pH 7.5 supplemented with 1 mg/mL DNase I. In some embodiments, cells are lysed using an Emulsiflex C-3 (Avestin, Inc.) under conditions recommended by the manufacturer. In some embodiments, debris and unlysed cells are pelleted by centrifugation at 10,000 x g for 15 min at 4°C. In some embodiments, supernatants are then centrifuged at 120,000 x g for 1 hour at 4°C. In some embodiments, pellets are resuspended in ice-cold 100 mM sodium carbonate, pH 11, incubated with agitation for 1 hr at 4°C, and then centrifuged at 120,000 x g for 1 hour at 4°C. In some embodiments, pellets are resuspended in 100 mM Tris-HCl, pH 7.5, re-centrifuged at 120,000 x g for 20 min at 4°C, and then resuspended in 0.1 M Tris-HCl, pH 7.5 or in PBS. In some embodiments, samples are stored at -20°C.

[558] In certain aspects, pmEVs are obtained by methods adapted from Sandrini et al, 2014. In some embodiments, bacterial cultures are centrifuged at 10,000-15,500 x g for 10-15 min at room temp or at 4°C. In some embodiments, cell pellets are frozen at -80°C and supernatants are discarded. In some embodiments, cell pellets are thawed on ice and resuspended in 10 mM Tris-HCl, pH 8.0, 1 mM EDTA supplemented with 0.1 mg/mL lysozyme. In some embodiments, samples are incubated with mixing at room temp or at 37°C for 30 min. In some embodiments, samples are re-frozen at -80°C and thawed again on ice. In some embodiments, DNase I is added to a final concentration of 1.6 mg/mL and MgCl2 to a final concentration of 100 mM. In some embodiments, samples are sonicated using a QSonica Q500 sonicator with 7 cycles of 30 sec on and 30 sec off. In some embodiments, debris and unlysed cells are pelleted by centrifugation at 10,000 x g for 15 min. at 4°C. In some embodiments, supernatants are then centrifuged at 110,000 x g for 15 min at 4°C. In some embodiments, pellets are resuspended in 10 mM Tris-HCl, pH 8.0, 2% Triton X-100 and incubated 30-60 min with mixing at room temperature. In some embodiments, samples

are centrifuged at 110,000 x g for 15 min at 4°C. In some embodiments, pellets are resuspended in PBS and stored at -20°C.

[559] In certain aspects, a method of forming (e.g., preparing) isolated bacterial pmEVs, described herein, comprises the steps of: (a) centrifuging a bacterial culture, thereby forming a first pellet and a first supernatant, wherein the first pellet comprises cells; (b) discarding the first supernatant;(c) resuspending the first pellet in a solution; (d) lysing the cells; (e) centrifuging the lysed cells, thereby forming a second pellet and a second supernatant; (f) discarding the second pellet and centrifuging the second supernatant, thereby forming a third pellet and a third supernatant; (g) discarding the third supernatant and resuspending the third pellet in a second solution, thereby forming the isolated bacterial pmEVs.

[560] In some embodiments, the method further comprises the steps of: (h) centrifuging the solution of step (g), thereby forming a fourth pellet and a fourth supernatant; (i) discarding the fourth supernatant and resuspending the fourth pellet in a third solution. In some embodiments, the method further comprises the steps of: (j) centrifuging the solution of step (i), thereby forming a fifth pellet and a fifth supernatant; and (k) discarding the fifth supernatant and resuspending the fifth pellet in a fourth solution.

[561] In some embodiments, the centrifugation of step (a) is at 10,000 x g. In some embodiments the centrifugation of step (a) is for 10-15 minutes. In some embodiments, the centrifugation of step (a) is at 4 °C or room temperature. In some embodiments, step (b) further comprises freezing the first pellet at -80 °C. In some embodiments, the solution in step (c) is 100mM Tris-HCl, pH 7.5 supplemented with 1mg/ml DNaseI. In some embodiments, the solution in step (c) is 10mM Tris-HCl, pH 8.0, 1mM EDTA, supplemented with 0.1 mg/ml lysozyme. In some embodiments, step (c) further comprises incubating for 30 minutes at 37 °C or room temperature. In some embodiments, step (c) further comprises freezing the first pellet at -80 °C. In some embodiments, step (c) further comprises adding DNase I to a final concentration of 1.6mg/ml. In some embodiments, step (c) further comprises adding $MgCl_2$ to a final concentration of 100mM. In some embodiments, the cells are lysed in step (d) via homogenization. In some embodiments, the cells are lysed in step (d) via emulsiflex C3. In some embodiments, the cells are lysed in step (d) via sonication. In some embodiments, the cells are sonicated in 7 cycles, wherein each cycle comprises 30 seconds of sonication and 30 seconds without sonication. In some embodiments, the centrifugation of step (e) is at 10,000 x g. In some embodiments, the centrifugation of step (e) is for 15 minutes. In some embodiments, the centrifugation of step (e) is at 4 °C or room temperature.

[562] In some embodiments, the centrifugation of step (f) is at 120,000 x g. In some embodiments, the centrifugation of step (f) is at 110,000 x g. In some embodiments, the centrifugation of step (f) is for 1 hour. In some embodiments, the centrifugation of step (f) is for 15 minutes. In some embodiments, the centrifugation of step (f) is at 4 °C or room temperature. In some embodiments, the second solution in step (g) is 100 mM sodium carbonate, pH 11. In some embodiments, the second solution in step (g) is 10mM Tris-HCl pH 8.0, 2% triton X-100. In some embodiments, step (g) further comprises incubating the solution for 1 hour at 4 °C. In some embodiments, step (g) further comprises incubating the solution for 30-60 minutes at room temperature. In some embodiments, the centrifugation of step (h) is at 120,000 x g. In some embodiments, the centrifugation of step (h) is at 110,000 x g. In some embodiments, the centrifugation of step (h) is for 1 hour. In some embodiments, the centrifugation of step (h) is for 15 minutes. In some embodiments, the centrifugation of step (h) is at 4 °C or room temperature. In some embodiments, the third solution in step (i) is 100mM Tris-HCl, pH 7.5. In some embodiments, the third solution in step (i) is PBS. In some embodiments, the centrifugation of step (j) is at 120,000 x g. In some embodiments, the centrifugation of step (j) is for 20 minutes. In some embodiments, the centrifugation of step (j) is at 4 °C or room temperature. In some embodiments, the fourth solution in step (k) is 100mM Tris-HCl, pH 7.5 or PBS.

[563] pmEVs obtained by methods provided herein may be further purified by size based column chromatography, by affinity chromatography, and by gradient ultracentrifugation, using methods that may include, but are not limited to, use of a sucrose gradient or Optiprep gradient. Briefly, using a sucrose gradient method, if ammonium sulfate precipitation or ultracentrifugation were used to concentrate the filtered supernatants, pellets are resuspended in 60% sucrose, 30 mM Tris, pH 8.0. If filtration was used to concentrate the filtered supernatant, the concentrate is buffer exchanged into 60% sucrose, 30 mM Tris, pH 8.0, using an Amicon Ultra column. Samples are applied to a 35-60% discontinuous sucrose gradient and centrifuged at 200,000 x g for 3-24 hours at 4°C. Briefly, using an Optiprep gradient method, if ammonium sulfate precipitation or ultracentrifugation were used to concentrate the filtered supernatants, pellets are resuspended in 35% Optiprep in PBS. In some embodiments, if filtration was used to concentrate the filtered supernatant, the concentrate is diluted using 60% Optiprep to a final concentration of 35% Optiprep. Samples are applied to a 35-60% discontinuous sucrose gradient and centrifuged at 200,000 x g for 3-24 hours at 4°C.

[564] In some embodiments, to confirm sterility and isolation of the pmEV preparations, pmEVs are serially diluted onto agar medium used for routine culture of the bacteria being tested, and incubated using routine conditions. Non-sterile preparations are passed through a 0.22 um filter to exclude intact cells. To further increase purity, isolated pmEVs may be DNase or proteinase K treated.

[565] In some embodiments, the sterility of the pmEV preparations can be confirmed by plating a portion of the pmEVs onto agar medium used for standard culture of the bacteria used in the generation of the pmEVs and incubating using standard conditions.

[566] In some embodiments select pmEVs are isolated and enriched by chromatography and binding surface moieties on pmEVs. In other embodiments, select pmEVs are isolated and/or enriched by fluorescent cell sorting by methods using affinity reagents, chemical dyes, recombinant proteins or other methods known to one skilled in the art.

[567] The pmEVs can be analyzed, e.g., as described in Jeppesen, et al. Cell 177:428 (2019).

[568] In some embodiments, pmEVs are lyophilized.

[569] In some embodiments, pmEVs are gamma irradiated (e.g., at 17.5 or 25 kGy).

[570] In some embodiments, pmEVs are UV irradiated.

[571] In some embodiments, pmEVs are heat inactivated (e.g., at 50°C for two hours or at 90°C for two hours).

[572] In some embodiments, pmEVs are acid treated.

[573] In some embodiments, pmEVs are oxygen sparged (e.g., at 0.1 vvm for two hours).

[574] The phase of growth can affect the amount or properties of bacteria. In the methods of pmEV preparation provided herein, pmEVs can be isolated, e.g., from a culture, at the start of the log phase of growth, midway through the log phase, and/or once stationary phase growth has been reached.

Production of Secreted Microbial Extracellular Vesicles (smEVs)

[575] In certain aspects, the smEVs described herein can be prepared using any method known in the art.

[576] In some embodiments, the smEVs are prepared without a smEV purification step. For example, in some embodiments, bacteria described herein are killed using a method that leaves the smEVs intact and the resulting bacterial components, including the smEVs,

are used in the methods and compositions described herein. In some embodiments, the bacteria are killed using an antibiotic (e.g., using an antibiotic described herein). In some embodiments, the bacteria are killed using UV irradiation. In some embodiments, the bacteria are heat-killed.

[577] In some embodiments, the smEVs described herein are purified from one or more other bacterial components. Methods for purifying smEVs from bacteria are known in the art. In some embodiments, smEVs are prepared from bacterial cultures using methods described in S. Bin Park, et al. PLoS ONE. 6(3):e17629 (2011) or G. Norheim, et al. PLoS ONE. 10(9): e0134353 (2015) or Jeppesen, et al. Cell 177:428 (2019), each of which is hereby incorporated by reference in its entirety. In some embodiments, the bacteria are cultured to high optical density and then centrifuged to pellet bacteria (e.g., at 10,000 x g for 30 min at 4°C, at 15,500 x g for 15 min at 4°C). In some embodiments, the culture supernatants are then passed through filters to exclude intact bacterial cells (e.g., a 0.22 μm filter). In some embodiments, the supernatants are then subjected to tangential flow filtration, during which the supernatant is concentrated, species smaller than 100 kDa are removed, and the media is partially exchanged with PBS. In some embodiments, filtered supernatants are centrifuged to pellet bacterial smEVs (e.g., at 100,000-150,000 x g for 1-3 hours at 4°C, at 200,000 x g for 1-3 hours at 4°C). In some embodiments, the smEVs are further purified by resuspending the resulting smEV pellets (e.g., in PBS), and applying the resuspended smEVs to an Optiprep (iodixanol) gradient or gradient (e.g., a 30-60% discontinuous gradient, a 0-45% discontinuous gradient), followed by centrifugation (e.g., at 200,000 x g for 4-20 hours at 4°C). smEV bands can be collected, diluted with PBS, and centrifuged to pellet the smEVs (e.g., at 150,000 x g for 3 hours at 4°C, at 200,000 x g for 1 hour at 4°C). The purified smEVs can be stored, for example, at -80°C or -20°C until use. In some embodiments, the smEVs are further purified by treatment with DNase and/or proteinase K.

[578] For example, in some embodiments, cultures of bacteria can be centrifuged at 11,000 x g for 20-40 min at 4°C to pellet bacteria. Culture supernatants may be passed through a 0.22 μm filter to exclude intact bacterial cells. Filtered supernatants may then be concentrated using methods that may include, but are not limited to, ammonium sulfate precipitation, ultracentrifugation, or filtration. For example, for ammonium sulfate precipitation, 1.5-3 M ammonium sulfate can be added to filtered supernatant slowly, while stirring at 4°C. Precipitations can be incubated at 4°C for 8-48 hours and then centrifuged at 11,000 x g for 20-40 min at 4°C. The resulting pellets contain bacteria smEVs and other debris. Using ultracentrifugation, filtered supernatants can be centrifuged at 100,000-200,000

x g for 1-16 hours at 4°C. The pellet of this centrifugation contains bacteria smEVs and other debris such as large protein complexes. In some embodiments, using a filtration technique, such as through the use of an Amicon Ultra spin filter or by tangential flow filtration, supernatants can be filtered so as to retain species of molecular weight > 50 or 100 kDa.

[579] Alternatively, smEVs can be obtained from bacteria cultures continuously during growth, or at selected time points during growth, for example, by connecting a bioreactor to an alternating tangential flow (ATF) system (e.g., XCell ATF from Repligen). The ATF system retains intact cells (>0.22 um) in the bioreactor, and allows smaller components (e.g., smEVs, free proteins) to pass through a filter for collection. For example, the system may be configured so that the <0.22 um filtrate is then passed through a second filter of 100 kDa, allowing species such as smEVs between 0.22 um and 100 kDa to be collected, and species smaller than 100 kDa to be pumped back into the bioreactor. Alternatively, the system may be configured to allow for medium in the bioreactor to be replenished and/or modified during growth of the culture. smEVs collected by this method may be further purified and/or concentrated by ultracentrifugation or filtration as described above for filtered supernatants.

[580] smEVs obtained by methods provided herein may be further purified by size-based column chromatography, by affinity chromatography, by ion-exchange chromatography, and by gradient ultracentrifugation, using methods that may include, but are not limited to, use of a sucrose gradient or Optiprep gradient. Briefly, using a sucrose gradient method, if ammonium sulfate precipitation or ultracentrifugation were used to concentrate the filtered supernatants, pellets are resuspended in 60% sucrose, 30 mM Tris, pH 8.0. If filtration was used to concentrate the filtered supernatant, the concentrate is buffer exchanged into 60% sucrose, 30 mM Tris, pH 8.0, using an Amicon Ultra column. Samples are applied to a 35-60% discontinuous sucrose gradient and centrifuged at 200,000 x g for 3-24 hours at 4°C. Briefly, using an Optiprep gradient method, if ammonium sulfate precipitation or ultracentrifugation were used to concentrate the filtered supernatants, pellets are resuspended in PBS and 3 volumes of 60% Optiprep are added to the sample. In some embodiments, if filtration was used to concentrate the filtered supernatant, the concentrate is diluted using 60% Optiprep to a final concentration of 35% Optiprep. Samples are applied to a 0-45% discontinuous Optiprep gradient and centrifuged at 200,000 x g for 3-24 hours at 4°C, e.g., 4-24 hours at 4°C.

[581] In some embodiments, to confirm sterility and isolation of the smEV preparations, smEVs are serially diluted onto agar medium used for routine culture of the

bacteria being tested, and incubated using routine conditions. Non-sterile preparations are passed through a 0.22 um filter to exclude intact cells. To further increase purity, isolated smEVs may be DNase or proteinase K treated.

[582] In some embodiments, for preparation of smEVs used for in vivo injections, purified smEVs are processed as described previously (G. Norheim, et al. PLoS ONE. 10(9): e0134353 (2015)). Briefly, after sucrose gradient centrifugation, bands containing smEVs are resuspended to a final concentration of 50 μg/mL in a solution containing 3% sucrose or other solution suitable for in vivo injection known to one skilled in the art. This solution may also contain adjuvant, for example aluminum hydroxide at a concentration of 0-0.5% (w/v). In some embodiments, for preparation of smEVs used for in vivo injections, smEVs in PBS are sterile-filtered to < 0.22 um.

[583] In certain embodiments, to make samples compatible with further testing (e.g., to remove sucrose prior to TEM imaging or in vitro assays), samples are buffer exchanged into PBS or 30 mM Tris, pH 8.0 using filtration (e.g., Amicon Ultra columns), dialysis, or ultracentrifugation (200,000 x g, ≥ 3 hours, 4°C) and resuspension.

[584] In some embodiments, the sterility of the smEV preparations can be confirmed by plating a portion of the smEVs onto agar medium used for standard culture of the bacteria used in the generation of the smEVs and incubating using standard conditions.

[585] In some embodiments, select smEVs are isolated and enriched by chromatography and binding surface moieties on smEVs. In other embodiments, select smEVs are isolated and/or enriched by fluorescent cell sorting by methods using affinity reagents, chemical dyes, recombinant proteins or other methods known to one skilled in the art.

[586] The smEVs can be analyzed, e.g., as described in Jeppesen, et al. Cell 177:428 (2019).

[587] In some embodiments, smEVs are lyophilized.

[588] In some embodiments, smEVs are gamma irradiated (e.g., at 17.5 or 25 kGy).

[589] In some embodiments, smEVs are UV irradiated.

[590] In some embodiments, smEVs are heat inactivated (e.g., at 50°C for two hours or at 90°C for two hours).

[591] In some embodiments, smEVs s are acid treated.

[592] In some embodiments, smEVs are oxygen sparged (e.g., at 0.1 vvm for two hours).

[593] The phase of growth can affect the amount or properties of bacteria and/or smEVs produced by bacteria. For example, in the methods of smEV preparation provided herein, smEVs can be isolated, e.g., from a culture, at the start of the log phase of growth, midway through the log phase, and/or once stationary phase growth has been reached.

[594] The growth environment (e.g., culture conditions) can affect the amount of smEVs produced by bacteria. For example, the yield of smEVs can be increased by an smEV inducer, as provided in Table 5.

Table 5: Culture Techniques to Increase smEV Production

smEV inducement	smEV inducer	Acts on
Temperature		
	Heat RT to 37 °C temp change 37 to 40 °C temp change	stress response simulates infection febrile infection
ROS		
	Plumbagin Cumene hydroperoxide Hydrogen Peroxide	oxidative stress response oxidative stress response oxidative stress response
Antibiotics		
	Ciprofloxacin Gentamycin Polymyxin B D-cycloserine	bacterial SOS response protein synthesis outer membrane cell wall
Osmolyte		
	NaCl	osmotic stress
Metal Ion Stress		
	Iron Chelation EDTA Low Hemin	iron levels removes divalent cations iron levels
Media additives or removal		
	Lactate Amino acid deprivation Hexadecane Glucose Sodium bicarbonate PQS Diamines+ DFMO High nutrients Low nutrients	growth stress stress growth ToxT induction vesiculator (from bacteria) membrane anchoring (negativicutes only) enhanced growth

Other mechanisms	Oxygen No Cysteine Inducing biofilm or floculation Diauxic Growth Phage Urea	oxygen stress in anaerobe oxygen stress in anaerobe

[595] In the methods of smEVs preparation provided herein, the method can optionally include exposing a culture of bacteria to a smEV inducer prior to isolating smEVs from the bacterial culture. The culture of bacteria can be exposed to a smEV inducer at the start of the log phase of growth, midway through the log phase, and/or once stationary phase growth has been reached.

Solid Dosage Form Compositions

[596] In certain embodiments, provided herein are solid dosage forms (*e.g.*, pharmaceutical products having a solid dosage form) comprising a pharmaceutical agent that contains bacteria and/or mEVs (such as smEVs and/or pmEVs). In some embodiments, the pharmaceutical agent can optionally contain one or more additional components, such as a cryoprotectant. The pharmaceutical agent can be lyophilized (e.g., resulting in a powder). The pharmaceutical agent can be combined with one or more excipients (e.g., pharmaceutically acceptable excipients) in the solid dose form. The pharmaceutical agent is also referred to as drug substance. The solid dosage form is also referred to as solid dose form.

[597] In certain aspects provided herein are solid dosage forms of pharmaceutical compositions. The pharmaceutical composition is also referred to as drug product. In certain embodiments, the solid dosage form comprises a a pharmaceutical agent (*e.g.*, bacteria and/or an agent (e.g., component) of bacterial origin, such as mEVs, a powder comprising bacteria and/or an agent (e.g., component) of bacterial origin, such as mEVs) and a diluent. In certain embodiments, the total pharmaceutical agent mass is at least 2.5%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, or 95% of the total mass of the pharmaceutical composition. In some embodiments, the total pharmaceutical agent mass is no more than 95%, 90%, 85%, 80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, or 2.5% of the total mass of the pharmaceutical composition.

[598] In some embodiments, the total mass of the diluent is at least 1%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, or 98% of the total mass of the pharmaceutical composition. In some embodiments, the total mass of the diluent is no more than 98%, 95%, 90%, 85%, 80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, or 1% of the total mass of the pharmaceutical composition. In some embodiments, the diluent comprises mannitol.

[599] In certain embodiments, the solid dosage form provided herein comprises a lubricant. In certain embodiments, the total lubricant mass is at least 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is no more than 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 0.5% to about 1.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 1% of the total mass of the pharmaceutical composition. In some embodiments, the lubricant comprises magnesium stearate.

[600] In certain embodiments, the solid dosage forms provided herein comprise a glidant. In some embodiments, the glidant is colloidal silicon dioxide. In certain embodiments, the total glidant mass is at least 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is no more than 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.25% to about 0.75% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.5% to about 1.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 1% of the total mass of the pharmaceutical composition.

[601] In some embodiments, the diluent is selected from the group consisting of lactose, sucrose, dextrose, dextrates, maltodextrin, mannitol, xylitol, sorbitol, cyclodextrins, calcium phosphate, calcium sulfate, starches, modified starches, microcrystalline cellulose, microcellulose, and talc. In some embodiments the diluent is microcrystalline cellulose. In

some embodiments, the disintegrating agent is selected from the group consisting of natural starch, a pregelatinized starch, a sodium starch, methylcrystalline cellulose, methylcellulose, croscarmellose, croscarmellose sodium, cross-linked sodium carboxymethylcellulose, crosslinked carboxymethylcellulose, cross-linked croscarmellose, cross-linked starch such as sodium starch glycolate, cross-linked polymer such as crospovidone, cross-linked polyvinylpyrrolidone, sodium alginate, a clay, or a gum. In some embodiments, the disintegrating agent is croscarmellose sodium. In some embodiments, the surfactant is selected from the group consisting of sodium lauryl sulfate, sorbitan monooleate, polyoxyethylene sorbitan monooleate, polysorbates, polaxomers, bile salts, glyceryl monostearate, copolymers of ethylene oxide and propylene oxide. In some embodiments, the surfactant is sodium lauryl sulfate. In some embodiments, the lubricant is selected from the group consisting of stearic acid, calcium hydroxide, talc, corn starch, sodium stearyl fumerate, stearic acid, sodium stearates, magnesium stearate, zinc stearate, and waxes. In some embodiments, the lubricant is magnesium stearate.

[602] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 4% and no more than 65% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 35% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[603] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 60% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 38% and no more than 93% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[604] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 20% and no more than 55% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 45% and no more than 80% of the total mass of

the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[605] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 20% to about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 50% to 80% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition. In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 30% and no more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 45% and no more than 70% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[606] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 48.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[607] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 92% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 5% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical

composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[608] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10% to about 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 7% to about 88% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 1% of the total mass of the pharmaceutical composition.

[609] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 10% and no more than 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 8.5% and no more than 88.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[610] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 13.51% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 84.99% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[611] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 90.22% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 8.28% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[612] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no

more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 50% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[613] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 45% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 55% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[614] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 40% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 58% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[615] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10.6% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 87.4% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[616] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 13.51% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 84.99% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of

the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[617] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 90.22% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 8.28% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[618] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 48.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[619] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 5% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 93% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[620] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 60% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 38% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[621] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 30% to about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent

having a total pharmaceutical agent mass that is about 10% to about 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 45% to 70% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 2.5% to about 70% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 30% to 98% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.5% and no more than 2.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.1% and no more than 1% of the total mass of the pharmaceutical composition.

[622] Thus, in certain embodiments, provided herein are solid dosage forms comprising a pharmaceutical agent that contains bacteria. The bacteria can be live bacteria (e.g., powder or biomass thereof); non-live (dead) bacteria (e.g., powder or biomass thereof); non replicating bacteria (e.g., powder or biomass thereof); gamma irradiated bacteria (e.g., powder or biomass thereof); and/or lyophilized bacteria (e.g., powder or biomass thereof).

[623] In certain embodiments, provided herein are solid dosage forms comprising a pharmaceutical agent that contains mEVs. The mEVs can be from culture media (e.g., culture supernatant). The mEVs can be from live bacteria (e.g., powder or biomass thereof); the mEVs can be from non-live (dead) bacteria (e.g., powder or biomass thereof); the mEVs can be from non-replicating bacteria (e.g., powder or biomass thereof); the mEVs can be from gamma irradiated bacteria (e.g., powder or biomass thereof); and/or the mEVs can be from lyophilized bacteria (e.g., powder or biomass thereof).

[624] In some embodiments, the pharmaceutical agent comprises mEVs substantially or entirely free of bacteria (e.g., whole bacteria), bacteria (e.g., live bacteria, dead (e.g., killed), non-replicating bacteria, attenuated bacteria. In some embodiments, the pharmaceutical compositions comprise both mEVs and bacteria (e.g., whole bacteria) (e.g., live bacteria, killed bacteria, attenuated bacteria). In some embodiments, the pharmaceutical agents comprise bacteria and/or mEVs from one or more (e.g., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or more) of the bacteria strains or species or taxonomic groups listed herein. In some embodiments, the pharmaceutical agents comprise bacteria and/or mEVs from one of the

bacteria strains or species or taxonomic groups listed herein. In some embodiments, the pharmaceutical agents comprise bacteria and/or mEVs from one of the bacteria strains or species described herein, e.g., *Lactococcus, Prevotella, Bifidobacterium, Veillonella, Fournierella, Harryflintia, Megasphaera; e.g., Lactococcus lactis cremoris; Prevotella histicola; Bifidobacterium animalis lactis; Veillonella parvula; Fournierella massiliensis; Harryflintia acetispora; or Megasphaera sp.*

[625] In some embodiments, the pharmaceutical agents comprise lyophilized *Prevotella histicola* bacteria.

[626] In some embodiments, the pharmaceutical agents comprise lyophilized bacteria and/or mEVs. In some embodiments, the pharmaceutical agent comprises gamma irradiated bacteria and/or mEVs. The mEVs (such as smEVs and/or pmEVs) can be gamma irradiated after the mEVs are isolated (e.g., prepared).

[627] In some embodiments, to quantify the numbers of mEVs (such as smEVs and/or pmEVs) and/or bacteria present in a sample, electron microscopy (e.g., EM of ultrathin frozen sections) can be used to visualize the mEVs (such as smEVs and/or pmEVs) and/or bacteria and count their relative numbers. Alternatively, nanoparticle tracking analysis (NTA), Coulter counting, or dynamic light scattering (DLS) or a combination of these techniques can be used. NTA and the Coulter counter count particles and show their sizes. DLS gives the size distribution of particles, but not the concentration. Bacteria frequently have diameters of 1-2 um (microns). The full range is 0.2-20 um. Combined results from Coulter counting and NTA can reveal the numbers of bacteria and/or mEVs (such as smEVs and/or pmEVs) in a given sample. Coulter counting reveals the numbers of particles with diameters of 0.7-10 um. For most bacterial and/or mEV (such as smEV and/or pmEV) samples, the Coulter counter alone can reveal the number of bacteria and/or mEVs (such as smEVs and/or pmEVs) in a sample. pmEVs are 20-600 nm in diameter. For NTA, a Nanosight instrument can be obtained from Malvern Pananlytical. For example, the NS300 can visualize and measure particles in suspension in the size range 10-2000nm. NTA allows for counting of the numbers of particles that are, for example, 50-1000 nm in diameter. DLS reveals the distribution of particles of different diameters within an approximate range of 1 nm – 3 um.

[628] mEVs can be characterized by analytical methods known in the art (e.g., Jeppesen, et al. Cell 177:428 (2019)).

[629] In some embodiments, the bacteria and/or mEVs may be quantified based on particle count. For example, total particle count of a bacteria and/or mEV preparation can be measured using NTA.

[630] In some embodiments, the bacteria and/or mEVs may be quantified based on the amount of protein, lipid, or carbohydrate. For example, total protein content of a bacteria and/or preparation can be measured using the Bradford assay or BCA.

[631] In some embodiments, mEVs are isolated away from one or more other bacterial components of the source bacteria or bacterial culture. In some embodiments, bacteria are isolated away from one or more other bacterial components of the source bacterial culture. In some embodiments, the pharmaceutical agent further comprises other bacterial components.

[632] In certain embodiments, the mEV preparation obtained from the source bacteria may be fractionated into subpopulations based on the physical properties (e.g., sized, density, protein content, binding affinity) of the subpopulations. One or more of the mEV subpopulations can then be incorporated into the pharmaceutical agents of the invention.

[633] In certain aspects, provided herein are solid dosage forms comprising pharmaceutical agents that comprise bacteria and/or mEVs (such as smEVs and/or pmEVs) useful for the treatment and/or prevention of disease (e.g., a cancer, an autoimmune disease, an inflammatory disease, a metabolic disease, or a dysbiosis); or treatment and/or prevention of bacterial septic shock, cytokine storm and/or viral infection (such as a coronavirus infection, an influenza infection, and/or a respiratory syncytial virus infection); or to decrease inflammatory cytokine expression (*e.g.,* decreased IL-8, IL-6, IL-1β, and/or TNFα expression levels), as well as methods of making and/or identifying such bacteria and/or mEVs, and methods of using pharmaceutical agents and solid dosage forms thereof (e.g., for the treatment of a cancer, an autoimmune disease, an inflammatory disease, or a metabolic disease dysbiosis, bacterial septic shock, cytokine storm and/or viral infection, or to decrease inflammatory cytokine expression), either alone or in combination with other therapeutics. In some embodiments, the pharmaceutical agents comprise both mEVs (such as smEVs and/or pmEVs) and bacteria (e.g., whole bacteria) (e.g., live bacteria, dead (e.g., killed) bacteria, non-replicating bacteria, attenuated bacteria). In some embodiments, the pharmaceutical agents comprise bacteria in the absence of mEVs (such as smEVs and/or pmEVs). In some embodiments, the pharmaceutical agents comprise mEVs (such as smEVs and/or pmEVs) in the absence of bacteria. In some embodiments, the pharmaceutical agents comprise mEVs (such as smEVs and/or pmEVs) and/or bacteria from one or more of the bacteria strains or

species listed in Table 1, Table 2, and/or Table 3. In some embodiments, the pharmaceutical compositions comprise mEVs (such as smEVs and/or pmEVs) and/or bacteria from one of the bacteria strains or species or taxonomic groups listed herein. In some embodiments, the pharmaceutical agents comprise bacteria and/or mEVs from one of the bacteria strains or species described herein, e.g., *Lactococcus, Prevotella, Bifidobacterium, Veillonella, Fournierella, Harryflintia, Megasphaera; e.g., Lactococcus lactis cremoris; Prevotella histicola; Bifidobacterium animalis lactis; Veillonella parvula; Fournierella massiliensis; Harryflintia acetispora; or Megasphaera sp.*

[634] In certain aspects, provided are pharmaceutical agents for administration to a subject (e.g., human subject). In some embodiments, the pharmaceutical agents are combined with additional active and/or inactive materials in order to produce a final product, which may be in single dosage unit or in a multi-dose format. In some embodiments, the pharmaceutical agent is combined with an adjuvant such as an immuno-adjuvant (e.g., a STING agonist, a TLR agonist, or a NOD agonist).

[635] In some embodiments, the solid dosage form comprises at least one carbohydrate.

[636] In some embodiments, the solid dosage form comprises at least one lipid. In some embodiments, the lipid comprises at least one fatty acid selected from lauric acid (12:0), myristic acid (14:0), palmitic acid (16:0), palmitoleic acid (16:1), margaric acid (17:0), heptadecenoic acid (17:1), stearic acid (18:0), oleic acid (18:1), linoleic acid (18:2), linolenic acid (18:3), octadecatetraenoic acid (18:4), arachidic acid (20:0), eicosenoic acid (20:1), eicosadienoic acid (20:2), eicosatetraenoic acid (20:4), eicosapentaenoic acid (20:5) (EPA), docosanoic acid (22:0), docosenoic acid (22:1), docosapentaenoic acid (22:5), docosahexaenoic acid (22:6) (DHA), and tetracosanoic acid (24:0).

[637] In some embodiments, the solid dosage form comprises at least one mineral or mineral source. Examples of minerals include, without limitation: chloride, sodium, calcium, iron, chromium, copper, iodine, zinc, magnesium, manganese, molybdenum, phosphorus, potassium, and selenium. Suitable forms of any of the foregoing minerals include soluble mineral salts, slightly soluble mineral salts, insoluble mineral salts, chelated minerals, mineral complexes, non-reactive minerals such as carbonyl minerals, and reduced minerals, and combinations thereof.

[638] In some embodiments, the solid dosage form comprises at least one vitamin. The at least one vitamin can be fat-soluble or water-soluble vitamins. Suitable vitamins include but are not limited to vitamin C, vitamin A, vitamin E, vitamin B12, vitamin K,

riboflavin, niacin, vitamin D, vitamin B6, folic acid, pyridoxine, thiamine, pantothenic acid, and biotin. Suitable forms of any of the foregoing are salts of the vitamin, derivatives of the vitamin, compounds having the same or similar activity of the vitamin, and metabolites of the vitamin.

[639] In some embodiments, the solid dosage form comprises an excipient. Non-limiting examples of suitable excipients include a buffering agent, a preservative, a stabilizer, a binder, a compaction agent, a lubricant, a dispersion enhancer, a disintegration agent, a flavoring agent, a sweetener, and a coloring agent.

[640] Suitable excipients that can be included in the solid dosage form can be one or more pharmaceutically acceptable excipients known in the art. For example, see Rowe, Sheskey, and Quinn, eds., *Handbook of Pharmaceutical Excipients*, sixth ed.; 2009; Pharmaceutical Press and American Pharmacists Association.

Solid Dosage Forms

[641] The solid dosage form described herein can be a capsule.

[642] The solid dosage forms of a pharmaceutical agent as described herein can comprise capsules. In some embodiments, the capsule is a size 00, size 0, size 1, size 2, size 3, size 4, or size 5 capsule. In some embodiments, the capsule comprises HPMC (hydroxyl propyl methyl cellulose) or gelatin. In some embodiments, the capsule comprises HPMC (hydroxyl propyl methyl cellulose). In some embodiments, the capsule is banded.

[643] In some embodiments, the solid dosage form is enterically coated (e.g., comprises an enteric coating; e.g., is coated with an enteric coating).

Coating

[644] The solid dosage form (e.g., capsule) described herein can be enterically coated. The enteric coating allows for release of the pharmaceutical agent, e.g., in the small intestine, e.g., upper small intestine, e.g., duodenum and/or jejunum. In some embodiments, the solid dosage form is enteric coated to dissolve at pH 5.5.

[645] Release of the pharmaceutical agent in the small intestine, e.g., in the upper small intestine, e.g., in the duodenum, or in the jejunum, allows the pharmaceutical agent to target and affect cells (e.g., epithelial cells and/or immune cells) located at these specific locations, e.g., which can cause a local effect in the small intestine and/or cause a systemic effect (e.g., an effect outside of the gastrointestinal tract).

[646] EUDRAGIT is the brand name for a diverse range of polymethacrylate-based copolymers. It includes anionic, cationic, and neutral copolymers based on methacrylic acid and methacrylic/acrylic esters or their derivatives.

[647] Examples of other materials that can be used in the enteric coating (e.g., the one enteric coating or the inner enteric coating and/or the outer enteric coating) include cellulose acetate phthalate (CAP), cellulose acetate trimellitate (CAT), poly(vinyl acetate phthalate) (PVAP), hydroxypropyl methylcellulose phthalate (HPMCP), fatty acids, waxes, shellac (esters of aleurtic acid), plastics, plant fibers, zein, AQUA-ZEIN® (an aqueous zein formulation containing no alcohol), amylose starch, starch derivatives, dextrins, methyl acrylate-methacrylic acid copolymers, cellulose acetate succinate, hydroxypropyl methyl cellulose acetate succinate (hypromellose acetate succinate), methyl methacrylate-methacrylic acid copolymers, and/or sodium alginate.

[648] The enteric coating can include a polymethacrylate-based copolymer.

[649] The enteric coating can include poly(methacrylic acid-co-ethyl acrylate).

[650] The enteric coating can include a methacrylic acid ethyl acrylate (MAE) copolymer (1:1).

[651] The enteric coating can include methacrylic acid ethyl acrylate (MAE) copolymer (1:1) (such as Kollicoat MAE 100P).

[652] The enteric coating can include a Eudragit copolymer, e.g., a Eudragit L (e.g., Eudragit L 100-55; Eudragit L 30 D-55), a Eudragit S, a Eudragit RL, a Eudragit RS, a Eudragit E, or a Eudragit FS (e.g., Eudragit FS 30 D).

[653] Other examples of materials that can be used in the enteric coating (e.g., the one enteric coating or the inner enteric coating and/or the outer enteric coating) include those described in, e.g., U.S. 6312728; U.S. 6623759; U.S. 4775536; U.S. 5047258; U.S. 5292522; U.S. 6555124; U.S. 6638534; U.S. 2006/0210631; U.S. 2008/200482; U.S. 2005/0271778; U.S. 2004/0028737; WO 2005/044240.

[654] See also, e.g., U.S. 9233074, which provides pH dependent, enteric polymers that can be used with the solid dosage forms provided herein, including methacrylic acid copolymers, polyvinylacetate phthalate, hydroxypropylmethyl cellulose acetate succinate, hydroxypropylmethyl cellulose phthalate and cellulose acetate phthalate; suitable methacrylic acid copolymers include: poly(methacrylic acid, methyl methacrylate) 1:1 sold, for example, under the Eudragit L100 trade name; poly(methacrylic acid, ethyl acrylate) 1:1 sold, for example, under the Eudragit L100-55 trade name; partially-neutralized poly(methacrylic acid, ethyl acrylate) 1:1 sold, for example, under the Kollicoat MAE-100P trade name; and

poly(methacrylic acid, methyl methacrylate) 1:2 sold, for example, under the Eudragit S100 trade name.

Dose

[655] The dose of the pharmaceutical agent (e.g., for human subjects) is the dose per capsule.

[656] In embodiments where dose is determined by total cell count (TCC), total cell count can be determined by Coulter counter.

[657] In some embodiments, the pharmaceutical agent comprises bacteria and the dose of bacteria is about 1×10^7 to about 2×10^{12} (e.g., about 3×10^{10} or about 1.5×10^{11} or about 1.5×10^{12}) cells (e.g., wherein cell number is determined by total cell count, which is determined by Coulter counter), wherein the dose is per capsule. In some embodiments, the pharmaceutical agent comprises bacteria and the dose of bacteria is about 1×10^{10} to about 2×10^{12} (e.g., about 1.6×10^{11} or about 8×10^{11} or about 9.6×10^{11} about 12.8×10^{11} or about 1.6×10^{12}) cells (e.g., wherein cell number is determined by total cell count, which is determined by Coulter counter), wherein the dose is per capsule.

[658] In some embodiments, the pharmaceutical agent comprises bacteria and the dose of bacteria is about 1×10^9, about 3×10^9, about 5×10^9, about 1.5×10^{10}, about 3×10^{10}, about 5×10^{10}, about 1.5×10^{11}, about 1.5×10^{12}, or about 2×10^{12} cells, wherein the dose is per capsule.

[659] In some embodiments, the pharmaceutical agent comprises mEVs and the dose of mEVs is about 1×10^5 to about 7×10^{13} particles (e.g., wherein particle count is determined by NTA (nanoparticle tracking analysis)), wherein the dose is per capsule. In some embodiments, the pharmaceutical agent comprises mEVs and the dose of mEVs is about 1×10^{10} to about 7×10^{13} particles (e.g., wherein particle count is determined by NTA (nanoparticle tracking analysis)), wherein the dose is per capsule.

[660] In some embodiments, wherein the pharmaceutical agent comprises mEVs, the dose of mEVs is about 2x106 to about 2x1016 particles (e.g., wherein particle count is determined by NTA (nanoparticle tracking analysis)), wherein the dose is per capsule.

[661] In some embodiments wherein the pharmaceutical agent comprises *Prevotella histicola* bacteria, the dose is total cell count of about 1×10^7 to about 1×10^{12} cells (e.g., wherein cell number is determined by total cell count, which is determined by Coulter counter) per capsule.

[662] In some embodiments, wherein the pharmaceutical agent comprises *Prevotella histicola* bacteria, the dose is about 3 x 10^{10} or about 1.5 x 10^{11} cells (e.g., wherein cell number is determined by total cell count, which is determined by Coulter counter) per capsule. In some embodiments, wherein the pharmaceutical agent comprises *Prevotella histicola* bacteria, the dose is about 8 x 10^{10} or about 1.6 x 10^{11} cells (e.g., wherein cell number is determined by total cell count, which is determined by Coulter counter) per capsule.

[663] In some aspects, the disclosure provides a method of treating a subject (e.g., human) (e.g., a subject in need of treatment), the method comprising administering to the subject a solid dosage form provided herein.

[664] In some aspects, the disclosure provides use of a solid dosage form provided herein for the preparation of a medicament for treating a subject (e.g., human) (e.g., a subject in need of treatment).

[665] In some embodiments, the solid dosage form is orally administered (e.g., is for oral administration).

[666] In some embodiments, the solid dosage form is administered (e.g., is for administration) 1, 2, 3, or 4 times a day. In some embodiments, 1, 2, 3, 4 or 5 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1, 2, 3, or 4 times a day. In some embodiments, 2, 4, 6, 8, or 10 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1, 2, 3, or 4 times a day. In some embodiments, 1 solid dosage form (e.g., capsule) is administered (e.g., is for administration) 1 or 2 times a day. In some embodiments, 2 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1 or 2 times a day. In some embodiments, 3 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1 or 2 times a day. In some embodiments, 4 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1 or 2 times a day. In some embodiments, 5 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1 or 2 times a day.

[667] In some embodiments, 1 solid dosage form (e.g., capsule) is administered (e.g., is for administration) 1 or 2 times a day, wherein the solid dosage form comprises a dose of bacteria of about 3.2 x 10^{11} cells. In some embodiments, 2 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1 or 2 times a day, wherein the solid dosage form comprises a dose of bacteria of about 3.2 x 10^{11} cells. In some embodiments, 3 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1 or 2 times a day, wherein the solid dosage form comprises a dose of bacteria of about 3.2 x 10^{11} cells. In

some embodiments, 4 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1 or 2 times a day, wherein the solid dosage form comprises a dose of bacteria of about 3.2×10^{11} cells. In some embodiments, 5 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) 1 or 2 times a day, wherein the solid dosage form comprises a dose of bacteria of about 3.2×10^{11} cells.

[668] In some embodiments, 1 solid dosage form (e.g., capsule) is administered (e.g., is for administration) per day, wherein the solid dosage form comprises a dose of bacteria of about 3.2×10^{11} cells (e.g., resulting in a total of about 3.2×10^{11} cells being administered). In some embodiments, 2 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) per day, wherein the solid dosage form comprises a dose of bacteria of about 3.2×10^{11} cells (e.g., resulting in a total of about 6.4×10^{11} cells being administered with the 2 tablets). In some embodiments, 3 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) per day, wherein the solid dosage form comprises a dose of bacteria of about 3.2×10^{11} cells (e.g., resulting in a total of about 9.6×10^{11} cells being administered with the 3 tablets). In some embodiments, 4 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) per a day, wherein the solid dosage form comprises a dose of bacteria of about 3.2×10^{11} cells (e.g., resulting in a total of about 12.8×10^{11} cells being administered with the 4 tablets). In some embodiments, 5 solid dosage forms (e.g., capsules) are administered (e.g., are for administration) per a day, wherein the solid dosage form comprises a dose of bacteria of about 3.2×10^{11} cells (e.g., resulting in a total of about 16×10^{11} cells being administered with the 5 capsules).

[669] In some embodiments, the pharmaceutical agent dose can be a milligram (mg) dose determined by weight the pharmaceutical agent (e.g., a powder comprising bacteria and/or an agent of bacterial origin, such as mEVs). The dose of the pharmaceutical agent is per capsule.

[670] For example, to administer a 1x dose of the pharmaceutical agent of about 400 mg, about 200 mg of the pharmaceutical agent is present per capsule and two capsules are administered, resulting in a dose of about 400 mg. The two capsules can be administered, for example, 1x or 2x daily.

[671] In some embodiments, the dose can be about 3 mg to about 125 mg of the pharmaceutical agent, per capsule.

[672] In some embodiments, the dose can be about 35 mg to about 1200 mg (e.g., about 35 mg, about 125 mg, about 350 mg, or about 1200 mg) of the pharmaceutical agent.

[673] In some embodiments, the pharmaceutical agent comprises a powder comprising bacteria and/or mEVs and the dose of the pharmaceutical agent (e.g., a powder comprising bacteria and/or mEVs) is about 10 mg to about 1500 mg, wherein the dose is per capsule.

[674] In some embodiments, the dose of the pharmaceutical agent can be about 30 mg to about 3500 mg (about 25, about 50, about 75, about 100, about 150, about 250, about 300, about 350, about 400, about 500, about 600, about 750, about 1000, about 1250, about 1300, about 2000, about 2500, about 3000, or about 3500 mg).

[675] A human dose can be calculated appropriately based on allometric scaling of a dose administered to a model organism (e.g., mouse).

[676] In some embodiments, one or two capsules can be administered one or two times a day.

[677] In some embodiments, one or two capsules can be administered daily.

[678] In some embodiments, 3, 4, or 5 capsules can be administered one or two times a day.

[679] In some embodiments, 3, 4, or 5 capsules can be administered daily.

[680] In some embodiments, 4 capsules can be administered one or two times a day.

[681] In some embodiments, 4 capsules can be administered daily.

[682] The pharmaceutical agent contains the bacteria and/or an agent of bacterial origin, such as mEVs, or contains a powder comprising bacteria and/or an agent of bacterial origin, such as mEVs, and can also contain one or more additional components, such as a cryoprotectant, etc.

[683] In some embodiments, the mg (by weight) dose of the pharmaceutical agent is, e.g., about 1 mg to about 500 mg per capsule, or per tablet, or per total number of minitablets, e.g., used in a capsule.

[684] The dose of the pharmaceutical agent (e.g., for human subjects) is the dose per capsule.

[685] In embodiments where dose is determined by total cell count (TCC), total cell count can be determined by Coulter counter.

[686] In some embodiments, the pharmaceutical agent comprises isolated *Veillonella parvula* bacteria (e.g., from one or more strains of bacteria (e.g., bacteria of interest) (e.g., a therapeutically effective amount thereof)). E.g., wherein at least 50%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% of the content of

the pharmaceutical agent is the isolated *Veillonella parvula* bacteria (e.g., bacteria of interest).

[687] In some embodiments, the pharmaceutical agent comprises isolated *Veillonella parvula* bacteria (e.g., from one or more strains of bacteria (e.g., bacteria of interest) (e.g., a therapeutically effective amount thereof)). E.g., wherein at least 50%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% of the content of the pharmaceutical agent is the isolated *Veillonella parvula* bacteria (e.g., bacteria of interest).

[688] In some embodiments, the *Veillonella parvula* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the Veillonella *parvula* Strain A (ATCC Deposit Number PTA-125691). In some embodiments, the *Veillonella parvula* bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Veillonella parvula* Strain A (ATCC Deposit Number PTA-125691). In some embodiments, the *Prevotella* bacteria are from *Veillonella parvula* Strain A (ATCC Deposit Number PTA-125691).

[689] In some embodiments, at least 50%, 60%, 70%, 80%, or 90% of the bacteria in the pharmaceutical composition are *Veillonella parvula* Strain A.

[690] In some embodiments, the pharmaceutical agent comprises at least 1×10^5, 5×10^5, 1×10^6, 2×10^6, 3×10^6, 4×10^6, 5×10^6, 6×10^6, 7×10^6, 8×10^6, 9×10^6, 1×10^7, 2×10^7, 3×10^7, 4×10^7, 5×10^7, 6×10^7, 7×10^7, 8×10^7, 9×10^7, 1×10^8, 2×10^8, 3×10^8, 4×10^8, 5×10^8, 6×10^8, 7×10^8, 8×10^8, 9×10^8 or 1×10^9 colony forming units of a *Veillonella* bacteria described herein (*e.g., Veillonella parvula bacteria strain A* (ATCC Deposit Number PTA-125691)).

[691] In some embodiments, the *Prevotella histicola* bacteria are from a strain comprising at least 90% (or at least 97%) genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Prevotella* Strain B 50329 (NRRL accession number B 50329). In some embodiments, the *Prevotella* bacteria are from a strain comprising at least 99% genomic, 16S and/or CRISPR sequence identity to the nucleotide sequence of the *Prevotella* Strain B 50329 (NRRL accession number B 50329). In some embodiments, the *Prevotella* bacteria are from *Prevotella* Strain B 50329 (NRRL accession number B 50329).

[692] In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Prevotella* bacteria, e.g., a strain comprising at least 90% or at least 99% genomic, 16S and/or CRISPR sequence identity to

the nucleotide sequence of the *Prevotella* Strain C (ATCC Accession Number PTA-126140). In some embodiments, the bacteria of the pharmaceutical agent or from which the mEVs of the pharmaceutical agent are obtained are *Prevotella* bacteria, e.g., Prevotella Strain C (ATCC Accession Number PTA-126140).

[693] In some embodiments, the pharmaceutical agent comprises *Prevotella histicola* bacteria and the dose of bacteria is about 1×10^7 to about 2×10^{12} (e.g., about 3×10^{10} or about 1.5×10^{11}) cells (e.g., wherein cell number is determined by total cell count, which is determined by Coulter counter), wherein the dose is per capsule. In some embodiments, the pharmaceutical agent comprises about 1×10^7 to about 2×10^{12} cells of *Prevotella histicola* bacteria. In some embodiments, the pharmaceutical agent comprises about 1.6×10^{10} cells of *Prevotella histicola* bacteria. In some embodiments, the pharmaceutical agent comprises about 8.0×10^{10} cells of *Prevotella histicola* bacteria. In some embodiments, the pharmaceutical agent comprises about 1.6×10^{11} cells of *Prevotella histicola* bacteria.

[694] In some embodiments, the pharmaceutical agent comprises *Prevotella histicola* bacteria and the dose of bacteria is about 1×10^9, about 3×10^9, about 5×10^9, about 1.5×10^{10}, or about 5×10^{10} cells (e.g., TCC (total cell count)), wherein the dose is per capsule. In some embodiments, the pharmaceutical agent comprises bacteria and the dose of bacteria is about 8×10^{10} cells, wherein the dose is per capsule. In some embodiments, the pharmaceutical agent comprises bacteria and the dose of bacteria is about 1.6×10^{11} cells, wherein the dose is per capsule.

[695] In some embodiments, the pharmaceutical agent dose can be a milligram (mg) dose determined by weight the pharmaceutical agent (e.g., a powder comprising bacteria). The dose of the pharmaceutical agent is per capsule.

[696] For example, to administer a 1x dose of the pharmaceutical agent of about 400 mg, about 200 mg of the pharmaceutical agent is present per capsule and two capsules are administered, resulting in a dose of about 400 mg. The two capsules can be administered, for example, 1x or 2x daily.

[697] In some embodiments, the dose can be about 3 mg to about 125 mg of the pharmaceutical agent per capsule.

[698] In some embodiments, the dose can be about 35 mg to about 1200 mg (e.g., about 35 mg, about 125 mg, about 350 mg, or about 1200 mg) of the pharmaceutical agent.

[699] In some embodiments, the dose of the pharmaceutical agent can be about 30 mg to about 3500 mg (about 25, about 50, about 75, about 100, about 150, about 250, about

300, about 350, about 400, about 500, about 600, about 750, about 1000, about 1250, about 1300, about 2000, about 2500, about 3000, or about 3500 mg).

[700] A human dose can be calculated appropriately based on allometric scaling of a dose administered to a model organism (e.g., mouse).

[701] In some embodiments, one or two capsules can be administered one or two times a day.

[702] In some embodiments, five or ten capsules can be administered daily.

[703] The pharmaceutical agent contains the bacteria or contains a powder comprising bacteria, and can also contain one or more additional components, such as a cryoprotectant.

[704] In some embodiments, the mg (by weight) dose of the pharmaceutical agent is, e.g., about 1 mg to about 500 mg per capsule.

Methods of Use

[705] The solid dosage forms described herein allow, e.g., for oral administration of a pharmaceutical agent contained therein.

[706] The solid dosage forms described herein can be used in the treatment and/or prevention of a cancer, inflammation, autoimmunity, a metabolic condition, or a dysbiosis.

[707] The solid dosage forms described herein can be used in the treatment and/or prevention of bacterial septic shock, cytokine storm and/or viral infection (such as a coronavirus infection, an influenza infection, and/or a respiratory syncytial virus infection).

[708] The solid dosage forms described herein can be used to decrease inflammatory cytokine expression (*e.g.*, decreased IL-8, IL-6, IL-1β, and/or TNFα expression levels).

[709] Methods of using a solid dosage form (e.g., for oral administration) (e.g., for pharmaceutical use) comprising a pharmaceutical agent (e.g., a therapeutically effective amount thereof), wherein the pharmaceutical agent comprises bacteria and/or microbial extracellular vesicles (mEVs), and wherein the solid dosage form further comprises the disclosed components are described herein.

[710] The methods and administered solid dosage forms described herein allow, e.g., for oral administration of a pharmaceutical agent contained therein. The solid dosage form can be administered to a subject is a fed or fasting state. The solid dosage form can be administered, e.g., on an empty stomach (e.g., one hour before eating or two hours after eating). The solid dosage form can be administered one hour before eating. The solid dosage form can be administered two hours after eating.

[711] A solid dosage form for use in the treatment and/or prevention of a cancer, inflammation, autoimmunity, a metabolic condition, or a dysbiosis is provided herein.

[712] A solid dosage form for use in the treatment and/or prevention of bacterial septic shock, cytokine storm and/or viral infection (such as a coronavirus infection, an influenza infection, and/or a respiratory syncytial virus infection) is provided herein.

[713] A solid dosage form for use in decrease inflammatory cytokine expression (*e.g.*, decreased IL-8, IL-6, IL-1β, and/or TNFα expression levels) is provided herein.

[714] Use of a solid dosage form for the preparation of a medicament for the treatment and/or prevention of a cancer, inflammation, autoimmunity, a metabolic condition, or a dysbiosis is provided herein.

[715] Use of a solid dosage form for the preparation of a medicament for the treatment and/or prevention of bacterial septic shock, cytokine storm and/or viral infection (such as a coronavirus infection, an influenza infection, and/or a respiratory syncytial virus infection) is provided herein.

[716] Use of a solid dosage form for the preparation of a medicament for decreasing inflammatory cytokine expression (*e.g.*, decreased IL-8, IL-6, IL-1β, and/or TNFα expression levels) is provided herein.

Method of Making Solid Dosage Forms

[717] The methods of preparing a solid dosage form of a pharmaceutical composition can comprise blending, encapsulation, banding, and coating of capsules.

[718] In certain aspects, provided herein are methods of preparing a solid dosage form of a pharmaceutical composition, the method comprising combining (e.g., blending) into a pharmaceutical composition a pharmaceutical agent (*e.g.*, bacteria disclosed herein and/or an agent of bacterial origin, such as mEVs (e.g., mEVs disclosed herein) or a powder comprising bacteria disclosed herein and/or an agent (e.g., component)) of bacterial origin, such as mEVs disclosed herein) and one or more additional components described herein. In certain aspects, provided herein are methods of preparing a solid dosage form of a pharmaceutical composition, the method comprising combining into a pharmaceutical composition a pharmaceutical agent (*e.g.*, bacteria disclosed herein or a powder comprising the bacteria) and a diluent. In certain embodiments, the total pharmaceutical agent mass is at least 2.5%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, or 75%, 80%, 85%, 90%, or 95% of the total mass of the pharmaceutical composition. In some embodiments the total pharmaceutical agent mass is no more than 95%, 90%, 85%,

80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, or 2.5%of the total mass of the pharmaceutical composition. In some embodiments, the pharmaceutical agent has a total pharmaceutical agent mass that is at least 2.5% and no more than 95% of the total mass of the pharmaceutical composition.

[719] In some embodiments, the total mass of the diluent is at least 1%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, or 98% of the total mass of the pharmaceutical composition. In some embodiments, the total mass of the diluent is no more than 98%, 95%, 90%, 85%, 80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, or 1% of the total mass of the pharmaceutical composition. In some embodiments, the diluent has a total mass that is at least 1% and no more than 98% of the total mass of the pharmaceutical composition. In some embodiments, the diluent comprises mannitol.

[720] In certain embodiments, the method further comprises combining a lubricant. In certain embodiments, the total lubricant mass is at least 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is no more than 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 0.1%, 0.5%, 1%, 2%, 3%, 4%, or 5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 0.5% to about 1.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total lubricant mass is about 1% of the total mass of the pharmaceutical composition. In some embodiments, the lubricant comprises magnesium stearate.

[721] In certain embodiments, the method further comprises combining a glidant. In some embodiments, the glidant is colloidal silicon dioxide. In certain embodiments, the total glidant mass is at least 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is no more than 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.01%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 1.5%, or 2% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.25% to about 0.75% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.5% to about 1.5% of the total mass of the pharmaceutical composition. In certain embodiments, the total glidant mass is about 0.5% of the total mass of the pharmaceutical

composition. In certain embodiments, the total glidant mass is about 1% of the total mass of the pharmaceutical composition.

[722] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 4% and no more than 65% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 35% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[723] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 60% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 38% and no more than 93% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[724] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 20% and no more than 55% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 45% and no more than 80% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[725] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 92% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 5% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[726] In certain embodiments, the solid dosage forms provided herein comprise: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10% to about 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 7% to about 88% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1.5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 1% of the total mass of the pharmaceutical composition.

[727] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 20% to about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 50% to 80% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[728] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 30% and no more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 45% and no more than 70% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[729] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 48.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[730] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 92% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g.,

mannitol) having a total mass that is at least 5% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[731] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 10% and no more than 90% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 8.5% and no more than 88.5% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[732] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 13.51% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 84.99% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[733] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 90.22% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 8.28% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[734] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 5% and no more than 50% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 50% and no more than 95% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical

composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[735] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 8% and no more than 45% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is at least 55% and no more than 90% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

[736] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 40% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 58% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[737] In certain embodiments, the method provided herein comprises combining: (i) a pharmaceutical agent having a total pharmaceutical agent mass that is about 10.6% of the total mass of the pharmaceutical composition; (ii) a diluent (e.g., mannitol) having a total mass that is about 87.4% of the total mass of the pharmaceutical composition; (iii) a lubricant (e.g., magnesium stearate) having a total mass that is about 1% of the total mass of the pharmaceutical composition; and (iv) a glidant (e.g., colloidal silicon dioxide) having a total mass that is about 0.5% of the total mass of the pharmaceutical composition.

[738] In some embodiments, the method further comprises loading the pharmaceutical composition into a capsule (e.g., encapsulation).

[739] In some embodiments, the method further comprises banding the capsule after loading.

[740] In some embodiments, the method further comprises enterically coating the capsule.

[741] In some embodiments, the method further comprises loading the pharmaceutical composition into a capsule. In some embodiments, the capsule comprises HPMC.

[742] In some embodiments, the method further comprises banding the capsule. In some embodiments, the capsule is banded with an HPMC-based banding solution.

[743] In some embodiments, the method further comprises enterically coating the capsule, thereby preparing an enterically coated capsule.

[744] As used herein, the percent of mass of a solid dosage form is on a percent weight:weight basis (% w:w).

[745] In certain embodiments, the method comprises performing wet granulation on a pharmaceutical agent prior to combining the pharmaceutical agent (e.g., bacteria (e.g., bacteria disclosed herein) and/or an agent of bacterial origin, such as mEVs (e.g., mEVs disclosed herein)) (e.g., the pharmaceutical agent can be a powder comprising bacteria and/or an agent of bacterial origin, such as mEVs) and one or more (e.g., one, two or three) excipients into a pharmaceutical composition. In some embodiments, the wet granulation comprises mixing the pharmaceutical agent with a granulating fluid (e.g., water, ethanol, or isopropanol, alone or in combination) to prepare a mixed composition. In some embodiments, the granulating fluid comprises water. In some embodiments, the granulating fluid consists of water. In some emodiments, the wet granulation further comprises drying the mixed composition (e.g., drying on a fluid bed dryer) to prepare a dried composition. In some emodiments, the wet granulation further comprises milling the dried composition to prepare a milled composition. The milled composition can optionally be combined with the one or more (e.g., one, two or three) excipients to prepare a pharmaceutical composition.

Granules and Wet Granulation

[746] In some aspects, provided herein are granules that comprise a pharmaceutical agent, e.g., wherein the pharmaceutical agent comprises bacteria (e.g., bacteria disclosed herein) and/or an agent of bacterial origin, such as mEVs (e.g., mEVs disclosed herein) (e.g., the pharmaceutical agent can be a powder comprising bacteria and/or an agent of bacterial origin, such as mEVs). The granules comprise agglomerations of pharmaceutical agent (e.g., larger particles than the pharmaceutical agent particles (e.g., than of a powder)). The diameter of the granules is greater (e.g., about 1.5-fold to over 4-fold greater) than the diameter (e.g., average diameter) of the pharmaceutical agent (e.g., powder, e.g., powder particles). The granules can be produced by wet granulation.

[747] For example, for *Prevotella histicola* Strain B smEVs, the diameter of granules after wet granulation is about 1.5-fold to over 4-fold larger than the diameter of the DS powder:

Prevotella histicola smEVs	D $_{10}$ (μm)	D $_{50}$ (μm)	D $_{90}$ (μm)
HS DS granules	8.22	110	386
HS DS powder	5.61	25.4	95.3

[748] Granulation is the process of particle enlargement by agglomeration. Granulation can transform fine powders into free-flowing, dust-free granules that are easier to compress. During the granulation process, small fine or coarse particles are converted into larger agglomerates called granules. See, e.g., Shanmugam, Bioimpacts 5:55-63 (2015). Wet granulation involves the production of a granule by the addition of a liquid binder (e.g., granulating fluid) to a powder (e.g., that comprises a pharmaceutical agent, e.g., comprises bacteria (e.g., bacteria disclosed herein) and/or an agent of bacterial origin, such as mEVs (e.g., mEVs disclosed herein)).

[749] Granulation, e.g., wet granulation, can allow for higher doses of bacteria (e.g., bacteria disclosed herein) and/or an agent of bacterial origin, such as mEVs (e.g., mEVs disclosed herein) to be formulated into a solid dose form (e.g., tablet, mini-tablet or capsule). For example, by performing wet granulation on a powder comprising mEVs, the dose of mEVs the dose of mEVs in a size 0 capsule is increased by 3 fold.

[750] In certain aspects, provided herein are methods of wet granulation of a pharmaceutical agent, e.g., wherein the pharmaceutical agent comprises bacteria (e.g., bacteria disclosed herein) and/or an agent of bacterial origin, such as mEVs (e.g., mEVs disclosed herein) (e.g., the pharmaceutical agent can be a powder comprising bacteria and/or an agent of bacterial origin, such as mEVs).

[751] In some embodiments, the wet granulation comprises mixing the pharmaceutical agent with a granulating fluid (e.g., water, ethanol, or isopropanol, alone or in combination) to prepare a mixed composition. In some embodiments, the granulating fluid comprises water. In some embodiments, the granulating fluid consists of water. In some emodiments, the wet granulation comprises drying the mixed composition (e.g., drying on a fluid bed dryer) to prepare a dried composition. In some embodiments, the wet granulation comprises milling the dried composition to prepare a milled composition. The milled composition can then optionally be combined with the one or more (e.g., one, two or three) excipients into a pharmaceutical composition. The wet granulation process can produce granules.

[752] In some embodiments, the wet granulation comprises (i) mixing the pharmaceutical agent with a granulating fluid (e.g., water, ethanol, or isopropanol, alone or in

combination) to prepare a mixed composition and (ii) drying the mixed composition (e.g., drying on a fluid bed dryer) to prepare a dried composition.

[753] In some embodiments, the wet granulation comprises (i) mixing the pharmaceutical agent with a granulating fluid (e.g., water, ethanol, or isopropanol, alone or in combination) to prepare a mixed composition; (ii) drying the mixed composition (e.g., drying on a fluid bed dryer) to prepare a dried composition; and (iii) milling the dried composition to prepare a milled composition.

[754] In some embodiments, the wet granulation comprises (i) mixing the pharmaceutical agent with a granulating fluid (e.g., water, ethanol, or isopropanol, alone or in combination) to prepare a mixed composition; (ii) drying the mixed composition (e.g., drying on a fluid bed dryer) to prepare a dried composition; (iii) milling the dried composition to prepare a milled composition; and (iv) combining the milled composition with the one or more (e.g., one, two or three) excipients into a pharmaceutical composition.

[755] In some embodiments, provided herein are granules produced by wet granulation.

[756] In some aspects, provided herein is a mixed composition, e.g., that comprises a pharmaceutical agent and a granulating fluid (e.g., water, ethanol, or isopropanol, alone or in combination).

[757] In certain aspects, provided herein is a dried composition, e.g., that comprises a mixed composition that has been dried.

[758] In certain aspects, provided herein is a milled composition, e.g., that comprises a dried composition that has been milled.

[759]

Additional Aspects of the Solid Dosage Forms

[760] The solid dosage forms, e.g., as described herein, comprising a pharmaceutical agent (e.g., a therapeutically effective amount thereof), wherein the pharmaceutical agent comprises bacteria and/or microbial extracellular vesicles (mEVs),and wherein the solid dosage form further comprises the described components, can provide a therapeutically effective amount of the pharmaceutical agent to a subject, e.g., a human.

[761] The solid dosage forms, e.g., as described herein, comprising a pharmaceutical agent (e.g., a therapeutically effective amount thereof), wherein the pharmaceutical agent comprises bacteria and/or microbial extracellular vesicles (mEVs), and wherein the solid dosage form further comprises the described components, can provide a non-natural amount

of the therapeutically effective components (e.g., present in the pharmaceutical agent) to a subject, e.g., a human.

[762] The solid dosage forms, e.g., as described herein, comprising a pharmaceutical agent (e.g., a therapeutically effective amount thereof), wherein the pharmaceutical agent comprises bacteria and/or microbial extracellular vesicles (mEVs), and wherein the solid dosage form further comprises the described components, can provide an unnatural quantity of the therapeutically effective components (e.g., present in the pharmaceutical agent) to a subject, e.g., a human.

[763] The solid dosage forms, e.g., as described herein, comprising a pharmaceutical agent (e.g., a therapeutically effective amount thereof), wherein the pharmaceutical agent comprises bacteria and/or microbial extracellular vesicles (mEVs), and wherein the solid dosage form further comprises the described components, can bring about one or more changes to a subject, e.g., human, e.g., to treat or prevent a disease or a health disorder.

[764] The solid dosage forms, e.g., as described herein, comprising a pharmaceutical agent (e.g., a therapeutically effective amount thereof), wherein the pharmaceutical agent comprises bacteria and/or microbial extracellular vesicles (mEVs), and wherein the solid dosage form further comprises the described components, has potential for significant utility, e.g., to affect a subject, e.g., a human, e.g., to treat or prevent a disease or a health disorder.

Additional Therapeutic Agents

[765] In certain aspects, the methods provided herein include the administration to a subject of a solid dosage form described herein either alone or in combination with an additional therapeutic agent. In some embodiments, the additional therapeutic agent is an immunosuppressant, an anti-inflammatory agent, a steroid, and/or a cancer therapeutic.

[766] In some embodiments, the solid dosage form is administered to the subject before the additional therapeutic agent is administered (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 or 24 hours before or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 days before). In some embodiments , the solid dosage form is administered to the subject after the additional therapeutic agent is administered (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 or 24 hours after or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 days after). In some embodiments, the solid dosage form and the additional therapeutic agent are

administered to the subject simultaneously or nearly simultaneously (e.g., administrations occur within an hour of each other).

[767] In some embodiments, the additional therapeutic agent is a cancer therapeutic. In some embodiments, the cancer therapeutic is a chemotherapeutic agent. Examples of such chemotherapeutic agents include, but are not limited to, alkylating agents such as thiotepa and cyclosphosphamide; alkyl sulfonates such as busulfan, improsulfan and piposulfan; aziridines such as benzodopa, carboquone, meturedopa, and uredopa; ethylenimines and methylamelamines including altretamine, triethylenemelamine, trietylenephosphoramide, triethiylenethiophosphoramide and trimethylolomelamine; acetogenins (especially bullatacin and bullatacinone); a camptothecin (including the synthetic analogue topotecan); bryostatin; callystatin; CC-1065 (including its adozelesin, carzelesin and bizelesin synthetic analogues); cryptophycins (particularly cryptophycin 1 and cryptophycin 8); dolastatin; duocarmycin (including the synthetic analogues, KW-2189 and CB1-TM1); eleutherobin; pancratistatin; a sarcodictyin; spongistatin; nitrogen mustards such as chlorambucil, chlornaphazine, cholophosphamide, estramustine, ifosfamide, mechlorethamine, mechlorethamine oxide hydrochloride, melphalan, novembichin, phenesterine, prednimustine, trofosfamide, uracil mustard; nitrosureas such as carmustine, chlorozotocin, fotemustine, lomustine, nimustine, and ranimnustine; antibiotics such as the enediyne antibiotics (e.g., calicheamicin, especially calicheamicin gammaII and calicheamicin omegaI1; dynemicin, including dynemicin A; bisphosphonates, such as clodronate; an esperamicin; as well as neocarzinostatin chromophore and related chromoprotein enediyne antibiotic chromophores, aclacinomysins, actinomycin, authramycin, azaserine, bleomycins, cactinomycin, carabicin, caminomycin, carzinophilin, chromomycinis, dactinomycin, daunorubicin, detorubicin, 6-diazo-5-oxo-L-norleucine, doxorubicin (including morpholino-doxorubicin, cyanomorpholino-doxorubicin, 2-pyrrolino-doxorubicin and deoxydoxorubicin), epirubicin, esorubicin, idarubicin, marcellomycin, mitomycins such as mitomycin C, mycophenolic acid, nogalamycin, olivomycins, peplomycin, potfiromycin, puromycin, quelamycin, rodorubicin, streptonigrin, streptozocin, tubercidin, ubenimex, zinostatin, zorubicin; anti-metabolites such as methotrexate and 5-fluorouracil (5-FU); folic acid analogues such as denopterin, methotrexate, pteropterin, trimetrexate; purine analogs such as fludarabine, 6-mercaptopurine, thiamiprine, thioguanine; pyrimidine analogs such as ancitabine, azacitidine, 6-azauridine, carmofur, cytarabine, dideoxyuridine, doxifluridine, enocitabine, floxuridine; androgens such as calusterone, dromostanolone propionate, epitiostanol, mepitiostane, testolactone; anti-adrenals such as aminoglutethimide, mitotane, trilostane; folic acid

replenisher such as frolinic acid; aceglatone; aldophosphamide glycoside; aminolevulinic acid; eniluracil; amsacrine; bestrabucil; bisantrene; edatraxate; defofamine; demecolcine; diaziquone; elformithine; elliptinium acetate; an epothilone; etoglucid; gallium nitrate; hydroxyurea; lentinan; lonidainine; maytansinoids such as maytansine and ansamitocins; mitoguazone; mitoxantrone; mopidanmol; nitraerine; pentostatin; phenamet; pirarubicin; losoxantrone; podophyllinic acid; 2-ethylhydrazide; procarbazine; PSK polysaccharide complex); razoxane; rhizoxin; sizofuran; spirogermanium; tenuazonic acid; triaziquone; 2,2',2''-trichlorotriethylamine; trichothecenes (especially T-2 toxin, verracurin A, roridin A and anguidine); urethan; vindesine; dacarbazine; mannomustine; mitobronitol; mitolactol; pipobroman; gacytosine; arabinoside ("Ara-C"); cyclophosphamide; thiotepa; taxoids, e.g., paclitaxel and doxetaxel; chlorambucil; gemcitabine; 6-thioguanine; mercaptopurine; methotrexate; platinum coordination complexes such as cisplatin, oxaliplatin and carboplatin; vinblastine; platinum; etoposide (VP-16); ifosfamide; mitoxantrone; vincristine; vinorelbine; novantrone; teniposide; edatrexate; daunomycin; aminopterin; xeloda; ibandronate; irinotecan (e.g., CPT-11); topoisomerase inhibitor RFS 2000; difluoromethylomithine (DMFO); retinoids such as retinoic acid; capecitabine; and pharmaceutically acceptable salts, acids or derivatives of any of the above.

[768] In some embodiments, the cancer therapeutic is a cancer immunotherapy agent. Immunotherapy refers to a treatment that uses a subject's immune system to treat cancer, e.g., checkpoint inhibitors, cancer vaccines, cytokines, cell therapy, CAR-T cells, and dendritic cell therapy. Non-limiting examples of immunotherapies are checkpoint inhibitors include Nivolumab (BMS, anti-PD-1), Pembrolizumab (Merck, anti-PD-1), Ipilimumab (BMS, anti-CTLA-4), MEDI4736 (AstraZeneca, anti-PD-L1), and MPDL3280A (Roche, anti-PD-L1). Other immunotherapies may be tumor vaccines, such as Gardail, Cervarix, BCG, sipulencel-T, Gp100:209-217, AGS-003, DCVax-L, Algenpantucel-L, Tergenpantucel-L, TG4010, ProstAtak, Prostvac-V/R-TRICOM, Rindopepimul, E75 peptide acetate, IMA901, POL-103A, Belagenpumatucel-L, GSK1572932A, MDX-1279, GV1001, and Tecemotide. The immunotherapy agent may be administered via injection (e.g., intravenously, intratumorally, subcutaneously, or into lymph nodes), but may also be administered orally, topically, or via aerosol. Immunotherapies may comprise adjuvants such as cytokines.

[769] In some embodiments, the immunotherapy agent is an immune checkpoint inhibitor. Immune checkpoint inhibition broadly refers to inhibiting the checkpoints that cancer cells can produce to prevent or downregulate an immune response. Examples of immune checkpoint proteins include, but are not limited to, CTLA4, PD-1, PD-L1, PD-L2,

A2AR, B7-H3, B7-H4, BTLA, KIR, LAG3, TIM-3 or VISTA. Immune checkpoint inhibitors can be antibodies or antigen binding fragments thereof that bind to and inhibit an immune checkpoint protein. Examples of immune checkpoint inhibitors include, but are not limited to, nivolumab, pembrolizumab, pidilizumab, AMP-224, AMP-514, STI-A1110, TSR-042, RG-7446, BMS-936559, MEDI-4736, MSB-0020718C, AUR-012 and STI-A1010.

[770] In some embodiments, the methods provided herein include the administration of a pharmaceutical composition described herein in combination with one or more additional therapeutic agents. In some embodiments, the methods disclosed herein include the administration of two immunotherapy agents (e.g., immune checkpoint inhibitor). For example, the methods provided herein include the administration of a pharmaceutical composition described herein in combination with a PD-1 inhibitor (such as pemrolizumab or nivolumab or pidilizumab) or a CLTA-4 inhibitor (such as ipilimumab) or a PD-L1 inhibitor.

[771] In some embodiments, the immunotherapy agent is an antibody or antigen binding fragment thereof that, for example, binds to a cancer-associated antigen. Examples of cancer-associated antigens include, but are not limited to, adipophilin, AIM-2, ALDH1A1, alpha-actinin-4, alpha-fetoprotein ("AFP"), ARTC1, B-RAF, BAGE-1, BCLX (L), BCR-ABL fusion protein b3a2, beta-catenin, BING-4, CA-125, CALCA, carcinoembryonic antigen ("CEA"), CASP-5, CASP-8, CD274, CD45, Cdc27, CDK12, CDK4, CDKN2A, CEA, CLPP, COA-1, CPSF, CSNK1A1, CTAG1, CTAG2, cyclin D1, Cyclin-A1, dek-can fusion protein, DKK1, EFTUD2, Elongation factor 2, ENAH (hMena), Ep-CAM, EpCAM, EphA3, epithelial tumor antigen ("ETA"), ETV6-AML1 fusion protein, EZH2, FGF5, FLT3-ITD, FN1, G250/MN/CAIX, GAGE-1,2,8, GAGE-3,4,5,6,7, GAS7, glypican-3, GnTV, gp100/Pmel17, GPNMB, HAUS3, Hepsin, HER-2/neu, HERV-K-MEL, HLA-A11, HLA-A2, HLA-DOB, hsp70-2, IDO1, IGF2B3, IL13Ralpha2, Intestinal carboxyl esterase, K-ras, Kallikrein 4, KIF20A, KK-LC-1, KKLC1, KM-HN-1, KMHN1 also known as CCDC110, LAGE-1, LDLR-fucosyltransferaseAS fusion protein, Lengsin, M-CSF, MAGE-A1, MAGE-A10, MAGE-A12, MAGE-A2, MAGE-A3, MAGE-A4, MAGE-A6, MAGE-A9, MAGE-C1, MAGE-C2, malic enzyme, mammaglobin-A, MART2, MATN, MC1R, MCSP, mdm-2, ME1, Melan-A/MART-1, Meloe, Midkine, MMP-2, MMP-7, MUC1, MUC5AC, mucin, MUM-1, MUM-2, MUM-3, Myosin, Myosin class I, N-raw, NA88-A, neo-PAP, NFYC, NY-BR-1, NY-ESO-1/LAGE-2, OA1, OGT, OS-9, P polypeptide, p53, PAP, PAX5, PBF, pml-RARalpha fusion protein, polymorphic epithelial mucin ("PEM"), PPP1R3B, PRAME, PRDX5, PSA, PSMA, PTPRK, RAB38/NY-MEL-1, RAGE-1, RBAF600, RGS5, RhoC, RNF43, RU2AS, SAGE, secernin 1, SIRT2, SNRPD1, SOX10, Sp17, SPA17, SSX-2, SSX-

4, STEAP1, survivin, SYT-SSX1 or -SSX2 fusion protein, TAG-1, TAG-2, Telomerase, TGF-betaRII, TPBG, TRAG-3, Triosephosphate isomerase, TRP-1/gp75, TRP-2, TRP2-INT2, tyrosinase, tyrosinase ("TYR"), VEGF, WT1, XAGE-1b/GAGED2a. In some embodiments, the antigen is a neo-antigen.

[772] In some embodiments, the immunotherapy agent is a cancer vaccine and/or a component of a cancer vaccine (e.g., an antigenic peptide and/or protein). The cancer vaccine can be a protein vaccine, a nucleic acid vaccine or a combination thereof. For example, in some embodiments, the cancer vaccine comprises a polypeptide comprising an epitope of a cancer-associated antigen. In some embodiments, the cancer vaccine comprises a nucleic acid (e.g., DNA or RNA, such as mRNA) that encodes an epitope of a cancer-associated antigen. Examples of cancer-associated antigens include, but are not limited to, adipophilin, AIM-2, ALDH1A1, alpha-actinin-4, alpha-fetoprotein ("AFP"), ARTC1, B-RAF, BAGE-1, BCLX (L), BCR-ABL fusion protein b3a2, beta-catenin, BING-4, CA-125, CALCA, carcinoembryonic antigen ("CEA"), CASP-5, CASP-8, CD274, CD45, Cdc27, CDK12, CDK4, CDKN2A, CEA, CLPP, COA-1, CPSF, CSNK1A1, CTAG1, CTAG2, cyclin D1, Cyclin-A1, dek-can fusion protein, DKK1, EFTUD2, Elongation factor 2, ENAH (hMena), Ep-CAM, EpCAM, EphA3, epithelial tumor antigen ("ETA"), ETV6-AML1 fusion protein, EZH2, FGF5, FLT3-ITD, FN1, G250/MN/CAIX, GAGE-1,2,8, GAGE-3,4,5,6,7, GAS7, glypican-3, GnTV, gp100/Pmel17, GPNMB, HAUS3, Hepsin, HER-2/neu, HERV-K-MEL, HLA-A11, HLA-A2, HLA-DOB, hsp70-2, IDO1, IGF2B3, IL13Ralpha2, Intestinal carboxyl esterase, K-ras, Kallikrein 4, KIF20A, KK-LC-1, KKLC1, KM-HN-1, KMHN1 also known as CCDC110, LAGE-1, LDLR-fucosyltransferaseAS fusion protein, Lengsin, M-CSF, MAGE-A1, MAGE-A10, MAGE-A12, MAGE-A2, MAGE-A3, MAGE-A4, MAGE-A6, MAGE-A9, MAGE-C1, MAGE-C2, malic enzyme, mammaglobin-A, MART2, MATN, MC1R, MCSP, mdm-2, ME1, Melan-A/MART-1, Meloe, Midkine, MMP-2, MMP-7, MUC1, MUC5AC, mucin, MUM-1, MUM-2, MUM-3, Myosin, Myosin class I, N-raw, NA88-A, neo-PAP, NFYC, NY-BR-1, NY-ESO-1/LAGE-2, OA1, OGT, OS-9, P polypeptide, p53, PAP, PAX5, PBF, pml-RARalpha fusion protein, polymorphic epithelial mucin ("PEM"), PPP1R3B, PRAME, PRDX5, PSA, PSMA, PTPRK, RAB38/NY-MEL-1, RAGE-1, RBAF600, RGS5, RhoC, RNF43, RU2AS, SAGE, secernin 1, SIRT2, SNRPD1, SOX10, Sp17, SPA17, SSX-2, SSX-4, STEAP1, survivin, SYT-SSX1 or -SSX2 fusion protein, TAG-1, TAG-2, Telomerase, TGF-betaRII, TPBG, TRAG-3, Triosephosphate isomerase, TRP-1/gp75, TRP-2, TRP2-INT2, tyrosinase, tyrosinase ("TYR"), VEGF, WT1, XAGE-1b/GAGED2a. In some embodiments, the antigen is a neo-antigen. In some

embodiments, the cancer vaccine is administered with an adjuvant. Examples of adjuvants include, but are not limited to, an immune modulatory protein, Adjuvant 65, α-GalCer, aluminum phosphate, aluminum hydroxide, calcium phosphate, β-Glucan Peptide, CpG ODN DNA, GPI-0100, lipid A, lipopolysaccharide, Lipovant, Montanide, N-acetyl-muramyl-L-alanyl-D-isoglutamine, Pam3CSK4, quil A , cholera toxin (CT) and heat-labile toxin from enterotoxigenic *Escherichia coli* (LT) including derivatives of these (CTB, mmCT, CTA1-DD, LTB, LTK63, LTR72, dmLT) and trehalose dimycolate.

[773] In some embodiments, the immunotherapy agent is an immune modulating protein to the subject. In some embodiments, the immune modulatory protein is a cytokine or chemokine. Examples of immune modulating proteins include, but are not limited to, B lymphocyte chemoattractant ("BLC"), C-C motif chemokine 11 ("Eotaxin-1"), Eosinophil chemotactic protein 2 ("Eotaxin-2"), Granulocyte colony-stimulating factor ("G-CSF"), Granulocyte macrophage colony-stimulating factor ("GM-CSF"), 1-309, Intercellular Adhesion Molecule 1 ("ICAM-1"), Interferon alpha ("IFN-alpha"), Interferon beta ("IFN-beta") Interferon gamma ("IFN-gamma"), Interlukin-1 alpha ("IL-1 alpha"), Interlukin-1 beta ("IL-1 beta"), Interleukin 1 receptor antagonist ("IL-1 ra"), Interleukin-2 ("IL-2"), Interleukin-4 ("IL-4"), Interleukin-5 ("IL-5"), Interleukin-6 ("IL-6"), Interleukin-6 soluble receptor ("IL-6 sR"), Interleukin-7 ("IL-7"), Interleukin-8 ("IL-8"), Interleukin- 10 ("IL-10"), Interleukin- 11 ("IL-11"), Subunit beta of Interleukin- 12 ("IL-12 p40" or "IL-12 p70"), Interleukin-13 ("IL-13"), Interleukin-15 ("IL-15"), Interleukin-16 ("IL-16"), Interleukin-17A-F ("IL-17A-F"), Interleukin-18 ("IL-18"), Interleukin-21 ("IL-21"), Interleukin-22 ("IL-22"), Interleukin-23 ("IL-23"), Interleukin-33 ("IL-33"), Chemokine (C-C motif) Ligand 2 ("MCP-1"), Macrophage colony-stimulating factor ("M-CSF"), Monokine induced by gamma interferon ("MIG"), Chemokine (C-C motif) ligand 2 ("MIP-1 alpha"), Chemokine (C-C motif) ligand 4 ("MIP-1 beta"), Macrophage inflammatory protein- 1 -delta ("MIP-1 delta"), Platelet-derived growth factor subunit B ("PDGF-BB"), Chemokine (C-C motif) ligand 5, Regulated on Activation, Normal T cell Expressed and Secreted ("RANTES"), TIMP metallopeptidase inhibitor 1 ("TIMP-1"), TIMP metallopeptidase inhibitor 2 ("TIMP-2"), Tumor necrosis factor, lymphotoxin-alpha ("TNF alpha"), Tumor necrosis factor, lymphotoxin-beta ("TNF beta"), Soluble TNF receptor type 1 ("sTNFRI"), sTNFRIIAR, Brain-derived neurotrophic factor ("BDNF"), Basic fibroblast growth factor ("bFGF"), Bone morphogenetic protein 4 ("BMP-4"), Bone morphogenetic protein 5 ("BMP-5"), Bone morphogenetic protein 7 ("BMP-7"), Nerve growth factor ("b-NGF"), Epidermal growth factor ("EGF"), Epidermal growth factor receptor ("EGFR"), Endocrine-gland-derived

vascular endothelial growth factor ("EG-VEGF"), Fibroblast growth factor 4 ("FGF-4"), Keratinocyte growth factor ("FGF-7"), Growth differentiation factor 15 ("GDF-15"), Glial cell-derived neurotrophic factor ("GDNF"), Growth Hormone, Heparin-binding EGF-like growth factor ("HB-EGF"), Hepatocyte growth factor ("HGF"), Insulin-like growth factor binding protein 1 ("IGFBP-1"), Insulin-like growth factor binding protein 2 ("IGFBP-2"), Insulin-like growth factor binding protein 3 (" IGFBP-3"), Insulin-like growth factor binding protein 4 ("IGFBP-4"), Insulin-like growth factor binding protein 6 ("IGFBP-6"), Insulin-like growth factor 1 ("IGF-1"), Insulin, Macrophage colony-stimulating factor ("M-CSF R"), Nerve growth factor receptor ("NGF R"), Neurotrophin-3 ("NT-3"), Neurotrophin-4 ("NT-4"), Osteoclastogenesis inhibitory factor ("Osteoprotegerin"), Platelet-derived growth factor receptors ("PDGF-AA"), Phosphatidylinositol-glycan biosynthesis ("PIGF"), Skp, Cullin, F-box containing comples ("SCF"), Stem cell factor receptor ("SCF R"), Transforming growth factor alpha ("TGFalpha"), Transforming growth factor beta-1 ("TGF beta 1"), Transforming growth factor beta-3 ("TGF beta 3"), Vascular endothelial growth factor ("VEGF"), Vascular endothelial growth factor receptor 2 ("VEGFR2"), Vascular endothelial growth factor receptor 3 ("VEGFR3"), VEGF-D 6Ckine, Tyrosine-protein kinase receptor UFO ("Axl"), Betacellulin ("BTC"), Mucosae-associated epithelial chemokine ("CCL28"), Chemokine (C-C motif) ligand 27 ("CTACK"), Chemokine (C-X-C motif) ligand 16 ("CXCL16"), C-X-C motif chemokine 5 ("ENA-78"), Chemokine (C-C motif) ligand 26 ("Eotaxin-3"), Granulocyte chemotactic protein 2 ("GCP-2"), GRO, Chemokine (C-C motif) ligand 14 ("HCC-l"), Chemokine (C-C motif) ligand 16 ("HCC-4"), Interleukin-9 ("IL-9"), Interleukin-17 F ("IL-17F"), Interleukin- 18-binding protein ("IL-18 BPa"), Interleukin-28 A ("IL-28A"), Interleukin 29 ("IL-29"), Interleukin 31 ("IL-31"), C-X-C motif chemokine 10 ("IP-10"), Chemokine receptor CXCR3 ("I-TAC"), Leukemia inhibitory factor ("LIF"), Light, Chemokine (C motif) ligand ("Lymphotactin"), Monocyte chemoattractant protein 2 ("MCP-2"), Monocyte chemoattractant protein 3 ("MCP-3"), Monocyte chemoattractant protein 4 ("MCP-4"), Macrophage-derived chemokine ("MDC"), Macrophage migration inhibitory factor ("MIF"), Chemokine (C-C motif) ligand 20 ("MIP-3 alpha"), C-C motif chemokine 19 ("MIP-3 beta"), Chemokine (C-C motif) ligand 23 ("MPIF-1"), Macrophage stimulating protein alpha chain ("MSPalpha"), Nucleosome assembly protein 1-like 4 ("NAP-2"), Secreted phosphoprotein 1 ("Osteopontin"), Pulmonary and activation-regulated cytokine ("PARC"), Platelet factor 4 ("PF4"), Stroma cell-derived factor- 1 alpha ("SDF-1 alpha"), Chemokine (C-C motif) ligand 17 ("TARC"), Thymus-expressed chemokine ("TECK"), Thymic stromal lymphopoietin ("TSLP 4- IBB"), CD 166 antigen ("ALCAM"), Cluster of

Differentiation 80 ("B7-1"), Tumor necrosis factor receptor superfamily member 17 ("BCMA"), Cluster of Differentiation 14 ("CD14"), Cluster of Differentiation 30 ("CD30"), Cluster of Differentiation 40 ("CD40 Ligand"), Carcinoembryonic antigen-related cell adhesion molecule 1 (biliary glycoprotein) ("CEACAM-1"), Death Receptor 6 ("DR6"), Deoxythymidine kinase ("Dtk"), Type 1 membrane glycoprotein ("Endoglin"), Receptor tyrosine-protein kinase erbB-3 ("ErbB3"), Endothelial-leukocyte adhesion molecule 1 ("E-Selectin"), Apoptosis antigen 1 ("Fas"), Fms-like tyrosine kinase 3 ("Flt-3L"), Tumor necrosis factor receptor superfamily member 1 ("GITR"), Tumor necrosis factor receptor superfamily member 14 ("HVEM"), Intercellular adhesion molecule 3 ("ICAM-3"), IL-1 R4, IL-1 RI, IL-10 Rbeta, IL-17R, IL-2Rgamma, IL-21R, Lysosome membrane protein 2 ("LIMPII"), Neutrophil gelatinase-associated lipocalin ("Lipocalin-2"), CD62L ("L-Selectin"), Lymphatic endothelium ("LYVE-1"), MHC class I polypeptide-related sequence A ("MICA"), MHC class I polypeptide-related sequence B ("MICB"), NRGl-betal, Beta-type platelet-derived growth factor receptor ("PDGF Rbeta"), Platelet endothelial cell adhesion molecule ("PECAM-1"), RAGE, Hepatitis A virus cellular receptor 1 ("TIM-1"), Tumor necrosis factor receptor superfamily member IOC ("TRAIL R3"), Trappin protein transglutaminase binding domain ("Trappin-2"), Urokinase receptor ("uPAR"), Vascular cell adhesion protein 1 ("VCAM-1"), XEDARActivin A, Agouti-related protein ("AgRP"), Ribonuclease 5 ("Angiogenin"), Angiopoietin 1, Angiostatin, Catheprin S, CD40, Cryptic family protein IB ("Cripto-1"), DAN, Dickkopf-related protein 1 ("DKK-1"), E-Cadherin, Epithelial cell adhesion molecule ("EpCAM"), Fas Ligand (FasL or CD95L), Fcg RIIB/C, FoUistatin, Galectin-7, Intercellular adhesion molecule 2 ("ICAM-2"), IL-13 Rl, IL-13R2, IL-17B, IL-2 Ra, IL-2 Rb, IL-23, LAP, Neuronal cell adhesion molecule ("NrCAM"), Plasminogen activator inhibitor- 1 ("PAI-1"), Platelet derived growth factor receptors ("PDGF-AB"), Resistin, stromal cell-derived factor 1 ("SDF-1 beta"), sgpl30, Secreted frizzled-related protein 2 ("ShhN"), Sialic acid-binding immunoglobulin-type lectins ("Siglec-5"), ST2, Transforming growth factor-beta 2 ("TGF beta 2"), Tie-2, Thrombopoietin ("TPO"), Tumor necrosis factor receptor superfamily member 10D ("TRAIL R4"), Triggering receptor expressed on myeloid cells 1 ("TREM-1"), Vascular endothelial growth factor C ("VEGF-C"), VEGFRlAdiponectin, Adipsin ("AND"), Alpha-fetoprotein ("AFP"), Angiopoietin-like 4 ("ANGPTL4"), Beta-2-microglobulin ("B2M"), Basal cell adhesion molecule ("BCAM"), Carbohydrate antigen 125 ("CA125"), Cancer Antigen 15-3 ("CA15-3"), Carcinoembryonic antigen ("CEA"), cAMP receptor protein ("CRP"), Human Epidermal Growth Factor Receptor 2 ("ErbB2"), Follistatin, Follicle-stimulating hormone ("FSH"),

Chemokine (C-X-C motif) ligand 1 ("GRO alpha"), human chorionic gonadotropin ("beta HCG"), Insulin-like growth factor 1 receptor ("IGF-1 sR"), IL-1 sRII, IL-3, IL-18 Rb, IL-21, Leptin, Matrix metalloproteinase-1 ("MMP-1"), Matrix metalloproteinase-2 ("MMP-2"), Matrix metalloproteinase-3 ("MMP-3"), Matrix metalloproteinase-8 ("MMP-8"), Matrix metalloproteinase-9 ("MMP-9"), Matrix metalloproteinase-10 ("MMP-10"), Matrix metalloproteinase-13 ("MMP-13"), Neural Cell Adhesion Molecule ("NCAM-1"), Entactin ("Nidogen-1"), Neuron specific enolase ("NSE"), Oncostatin M ("OSM"), Procalcitonin, Prolactin, Prostate specific antigen ("PSA"), Sialic acid-binding Ig-like lectin 9 ("Siglec-9"), ADAM 17 endopeptidase ("TACE"), Thyroglobulin, Metalloproteinase inhibitor 4 ("TIMP-4"), TSH2B4, Disintegrin and metalloproteinase domain-containing protein 9 ("ADAM-9"), Angiopoietin 2, Tumor necrosis factor ligand superfamily member 13/ Acidic leucine-rich nuclear phosphoprotein 32 family member B ("APRIL"), Bone morphogenetic protein 2 ("BMP-2"), Bone morphogenetic protein 9 ("BMP-9"), Complement component 5a ("C5a"), Cathepsin L, CD200, CD97, Chemerin, Tumor necrosis factor receptor superfamily member 6B ("DcR3"), Fatty acid-binding protein 2 ("FABP2"), Fibroblast activation protein, alpha ("FAP"), Fibroblast growth factor 19 ("FGF-19"), Galectin-3, Hepatocyte growth factor receptor ("HGF R"), IFN-gammalpha/beta R2, Insulin-like growth factor 2 ("IGF-2"), Insulin-like growth factor 2 receptor ("IGF-2 R"), Interleukin-1 receptor 6 ("IL-1R6"), Interleukin 24 ("IL-24"), Interleukin 33 ("IL-33", Kallikrein 14, Asparaginyl endopeptidase ("Legumain"), Oxidized low-density lipoprotein receptor 1 ("LOX-1"), Mannose-binding lectin ("MBL"), Neprilysin ("NEP"), Notch homolog 1, translocation-associated (Drosophila) ("Notch-1"), Nephroblastoma overexpressed ("NOV"), Osteoactivin, Programmed cell death protein 1 ("PD-1"), N-acetylmuramoyl-L-alanine amidase ("PGRP-5"), Serpin A4, Secreted frizzled related protein 3 ("sFRP-3"), Thrombomodulin, Tolllike receptor 2 ("TLR2"), Tumor necrosis factor receptor superfamily member 10A ("TRAIL Rl"), Transferrin ("TRF"), WIF-lACE-2, Albumin, AMICA, Angiopoietin 4, B-cell activating factor ("BAFF"), Carbohydrate antigen 19-9 ("CA19-9"), CD 163 , Clusterin, CRT AM, Chemokine (C-X-C motif) ligand 14 ("CXCL14"), Cystatin C, Decorin ("DCN"), Dickkopf-related protein 3 ("Dkk-3"), Delta-like protein 1 ("DLL1"), Fetuin A, Heparin-binding growth factor 1 ("aFGF"), Folate receptor alpha ("FOLR1"), Furin, GPCR-associated sorting protein 1 ("GASP-1"), GPCR-associated sorting protein 2 ("GASP-2"), Granulocyte colony-stimulating factor receptor ("GCSF R"), Serine protease hepsin ("HAI-2"), Interleukin-17B Receptor ("IL-17B R"), Interleukin 27 ("IL-27"), Lymphocyte-activation gene 3 ("LAG-3"), Apolipoprotein A-V ("LDL R"), Pepsinogen I, Retinol binding protein 4 ("RBP4"), SOST, Heparan sulfate proteoglycan

("Syndecan-1"), Tumor necrosis factor receptor superfamily member 13B ("TACI"), Tissue factor pathway inhibitor ("TFPI"), TSP-1, Tumor necrosis factor receptor superfamily, member 10b ("TRAIL R2"), TRANCE, Troponin I, Urokinase Plasminogen Activator ("uPA"), Cadherin 5, type 2 or VE-cadherin (vascular endothelial) also known as CD144 ("VE-Cadherin"), WNT1-inducible-signaling pathway protein 1 ("WISP-1"), and Receptor Activator of Nuclear Factor κ B ("RANK").

[774] In some embodiments, the cancer therapeutic is an anti-cancer compound. Exemplary anti-cancer compounds include, but are not limited to, Alemtuzumab (Campath®), Alitretinoin (Panretin®), Anastrozole (Arimidex®), Bevacizumab (Avastin®), Bexarotene (Targretin®), Bortezomib (Velcade®), Bosutinib (Bosulif®), Brentuximab vedotin (Adcetris®), Cabozantinib (Cometriq™), Carfilzomib (Kyprolis™), Cetuximab (Erbitux®), Crizotinib (Xalkori®), Dasatinib (Sprycel®), Denileukin diftitox (Ontak®), Erlotinib hydrochloride (Tarceva®), Everolimus (Afinitor®), Exemestane (Aromasin®), Fulvestrant (Faslodex®), Gefitinib (Iressa®), Ibritumomab tiuxetan (Zevalin®), Imatinib mesylate (Gleevec®), Ipilimumab (Yervoy™), Lapatinib ditosylate (Tykerb®), Letrozole (Femara®), Nilotinib (Tasigna®), Ofatumumab (Arzerra®), Panitumumab (Vectibix®), Pazopanib hydrochloride (Votrient®), Pertuzumab (Perjeta™), Pralatrexate (Folotyn®), Regorafenib (Stivarga®), Rituximab (Rituxan®), Romidepsin (Istodax®), Sorafenib tosylate (Nexavar®), Sunitinib malate (Sutent®), Tamoxifen, Temsirolimus (Torisel®), Toremifene (Fareston®), Tositumomab and 131I-tositumomab (Bexxar®), Trastuzumab (Herceptin®), Tretinoin (Vesanoid®), Vandetanib (Caprelsa®), Vemurafenib (Zelboraf®), Vorinostat (Zolinza®), and Ziv-aflibercept (Zaltrap®).

[775] Exemplary anti-cancer compounds that modify the function of proteins that regulate gene expression and other cellular functions (e.g., HDAC inhibitors, retinoid receptor ligants) are Vorinostat (Zolinza®), Bexarotene (Targretin®) and Romidepsin (Istodax®), Alitretinoin (Panretin®), and Tretinoin (Vesanoid®).

[776] Exemplary anti-cancer compounds that induce apoptosis (e.g., proteasome inhibitors, antifolates) are Bortezomib (Velcade®), Carfilzomib (Kyprolis™), and Pralatrexate (Folotyn®).

[777] Exemplary anti-cancer compounds that increase anti-tumor immune response (e.g., anti CD20, anti CD52; anti-cytotoxic T-lymphocyte-associated antigen-4) are Rituximab (Rituxan®), Alemtuzumab (Campath®), Ofatumumab (Arzerra®), and Ipilimumab (Yervoy™).

[778] Exemplary anti-cancer compounds that deliver toxic agents to cancer cells (e.g., anti-CD20-radionuclide fusions; IL-2-diphtheria toxin fusions; anti-CD30-monomethylauristatin E (MMAE)-fusions) are Tositumomab and 131I-tositumomab (Bexxar®)and Ibritumomab tiuxetan (Zevalin®), Denileukin diftitox (Ontak®), and Brentuximab vedotin (Adcetris®).

[779] Other exemplary anti-cancer compounds are small molecule inhibitors and conjugates thereof of, e.g., Janus kinase, ALK, Bcl-2, PARP, PI3K, VEGF receptor, Braf, MEK, CDK, and HSP90.

[780] Exemplary platinum-based anti-cancer compounds include, for example, cisplatin, carboplatin, oxaliplatin, satraplatin, picoplatin, Nedaplatin, Triplatin, and Lipoplatin. Other metal-based drugs suitable for treatment include, but are not limited to ruthenium-based compounds, ferrocene derivatives, titanium-based compounds, and gallium-based compounds.

[781] In some embodiments, the cancer therapeutic is a radioactive moiety that comprises a radionuclide. Exemplary radionuclides include, but are not limited to Cr-51, Cs-131, Ce-134, Se-75, Ru-97, I-125, Eu-149, Os-189m, Sb-119, I-123, Ho-161, Sb-117, Ce-139, In-111, Rh-103m, Ga-67, Tl-201, Pd-103, Au-195, Hg-197, Sr-87m, Pt-191, P-33, Er-169, Ru-103, Yb-169, Au-199, Sn-121, Tm-167, Yb-175, In-113m, Sn-113, Lu-177, Rh-105, Sn-117m, Cu-67, Sc-47, Pt-195m, Ce-141, I-131, Tb-161, As-77, Pt-197, Sm-153, Gd-159, Tm-173, Pr-143, Au-198, Tm-170, Re-186, Ag-111, Pd-109, Ga-73, Dy-165, Pm-149, Sn-123, Sr-89, Ho-166, P-32, Re-188, Pr-142, Ir-194, In-114m/In-114, and Y-90.

[782] In some embodiments, an antibiotic is administered to the subject before the solid dosage form is administered to the subject (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 or 24 hours before or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 days before). In some embodiments, an antibiotic is administered to the subject after the solid dosage form is administered to the subject (e.g., at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 or 24 hours before or at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 days after). In some embodiments, the solid dosage form and the antibiotic are administered to the subject simultaneously or nearly simultaneously (e.g., administrations occur within an hour of each other).

[783] In some embodiments, the additional therapeutic is an antibiotic. For example, if the presence of a disease-associated bacteria and/or a disease-associated microbiome

profile is detected, antibiotics can be administered, e.g., to eliminate the disease-associated bacteria from the subject. "Antibiotics" broadly refers to compounds capable of inhibiting or preventing a bacterial infection. Antibiotics can be classified in a number of ways, including their use for specific infections, their mechanism of action, their bioavailability, or their spectrum of target microbe (e.g., Gram-negative vs. Gram-positive bacteria, aerobic vs. anaerobic bacteria, etc.) and these may be used to kill specific bacteria in specific areas of the host ("niches") (Leekha, et al 2011. General Principles of Antimicrobial Therapy. Mayo Clin Proc. 86(2): 156-167). In certain embodiments, antibiotics can be used to selectively target bacteria of a specific niche. In some embodiments, antibiotics known to treat a particular infection that includes a disease niche may be used to target disease-associated microbes, including disease-associated bacteria in that niche. In other embodiments, antibiotics are administered after the solid dosage form. In some embodiments, antibiotics are administered before the solid dosage form.

[784] In some aspects, antibiotics can be selected based on their bactericidal or bacteriostatic properties. Bactericidal antibiotics include mechanisms of action that disrupt the cell wall (e.g., β-lactams), the cell membrane (e.g., daptomycin), or bacterial DNA (e.g., fluoroquinolones). Bacteriostatic agents inhibit bacterial replication and include sulfonamides, tetracyclines, and macrolides, and act by inhibiting protein synthesis. Furthermore, while some drugs can be bactericidal in certain organisms and bacteriostatic in others, knowing the target organism allows one skilled in the art to select an antibiotic with the appropriate properties. In certain treatment conditions, bacteriostatic antibiotics inhibit the activity of bactericidal antibiotics. Thus, in certain embodiments, bactericidal and bacteriostatic antibiotics are not combined.

[785] Antibiotics include, but are not limited to aminoglycosides, ansamycins, carbacephems, carbapenems, cephalosporins, glycopeptides, lincosamides, lipopeptides, macrolides, monobactams, nitrofurans, oxazolidonones, penicillins, polypeptide antibiotics, quinolones, fluoroquinolone, sulfonamides, tetracyclines, and anti-mycobacterial compounds, and combinations thereof.

[786] Aminoglycosides include, but are not limited to Amikacin, Gentamicin, Kanamycin, Neomycin, Netilmicin, Tobramycin, Paromomycin, and Spectinomycin. Aminoglycosides are effective, e.g., against Gram-negative bacteria, such as *Escherichia coli*, *Klebsiella*, *Pseudomonas aeruginosa*, and *Francisella tularensis*, and against certain aerobic bacteria but less effective against obligate/facultative anaerobes. Aminoglycosides are

believed to bind to the bacterial 30S or 50S ribosomal subunit thereby inhibiting bacterial protein synthesis.

[787] Ansamycins include, but are not limited to, Geldanamycin, Herbimycin, Rifamycin, and Streptovaricin. Geldanamycin and Herbimycin are believed to inhibit or alter the function of Heat Shock Protein 90.

[788] Carbacephems include, but are not limited to, Loracarbef. Carbacephems are believed to inhibit bacterial cell wall synthesis.

[789] Carbapenems include, but are not limited to, Ertapenem, Doripenem, Imipenem/Cilastatin, and Meropenem. Carbapenems are bactericidal for both Gram-positive and Gram-negative bacteria as broad-spectrum antibiotics. Carbapenems are believed to inhibit bacterial cell wall synthesis.

[790] Cephalosporins include, but are not limited to, Cefadroxil, Cefazolin, Cefalotin, Cefalothin, Cefalexin, Cefaclor, Cefamandole, Cefoxitin, Cefprozil, Cefuroxime, Cefixime, Cefdinir, Cefditoren, Cefoperazone, Cefotaxime, Cefpodoxime, Ceftazidime, Ceftibuten, Ceftizoxime, Ceftriaxone, Cefepime, Ceftaroline fosamil, and Ceftobiprole. Selected Cephalosporins are effective, e.g., against Gram-negative bacteria and against Gram-positive bacteria, including *Pseudomonas*, certain Cephalosporins are effective against methicillin-resistant *Staphylococcus aureus* (MRSA). Cephalosporins are believed to inhibit bacterial cell wall synthesis by disrupting synthesis of the peptidoglycan layer of bacterial cell walls.

[791] Glycopeptides include, but are not limited to, Teicoplanin, Vancomycin, and Telavancin. Glycopeptides are effective, e.g., against aerobic and anaerobic Gram-positive bacteria including MRSA and *Clostridium difficile*. Glycopeptides are believed to inhibit bacterial cell wall synthesis by disrupting synthesis of the peptidoglycan layer of bacterial cell walls.

[792] Lincosamides include, but are not limited to, Clindamycin and Lincomycin. Lincosamides are effective, e.g., against anaerobic bacteria, as well as Staphylococcus, and Streptococcus. Lincosamides are believed to bind to the bacterial 50S ribosomal subunit thereby inhibiting bacterial protein synthesis.

[793] Lipopeptides include, but are not limited to, Daptomycin. Lipopeptides are effective, e.g., against Gram-positive bacteria. Lipopeptides are believed to bind to the bacterial membrane and cause rapid depolarization.

[794] Macrolides include, but are not limited to, Azithromycin, Clarithromycin, Dirithromycin, Erythromycin, Roxithromycin, Troleandomycin, Telithromycin, and

Spiramycin. Macrolides are effective, e.g., against Streptococcus and Mycoplasma. Macrolides are believed to bind to the bacterial or 50S ribosomal subunit, thereby inhibiting bacterial protein synthesis.

[795] Monobactams include, but are not limited to, Aztreonam. Monobactams are effective, e.g., against Gram-negative bacteria. Monobactams are believed to inhibit bacterial cell wall synthesis by disrupting synthesis of the peptidoglycan layer of bacterial cell walls.

[796] Nitrofurans include, but are not limited to, Furazolidone and Nitrofurantoin.

[797] Oxazolidonones include, but are not limited to, Linezolid, Posizolid, Radezolid, and Torezolid. Oxazolidonones are believed to be protein synthesis inhibitors.

[798] Penicillins include, but are not limited to, Amoxicillin, Ampicillin, Azlocillin, Carbenicillin, Cloxacillin, Dicloxacillin, Flucloxacillin, Mezlocillin, Methicillin, Nafcillin, Oxacillin, Penicillin G, Penicillin V, Piperacillin, Temocillin and Ticarcillin. Penicillins are effective, e.g., against Gram-positive bacteria, facultative anaerobes, e.g., Streptococcus, Borrelia, and Treponema. Penicillins are believed to inhibit bacterial cell wall synthesis by disrupting synthesis of the peptidoglycan layer of bacterial cell walls.

[799] Penicillin combinations include, but are not limited to, Amoxicillin/clavulanate, Ampicillin/sulbactam, Piperacillin/tazobactam, and Ticarcillin/clavulanate.

[800] Polypeptide antibiotics include, but are not limited to, Bacitracin, Colistin, and Polymyxin B and E. Polypeptide Antibiotics are effective, e.g., against Gram-negative bacteria. Certain polypeptide antibiotics are believed to inhibit isoprenyl pyrophosphate involved in synthesis of the peptidoglycan layer of bacterial cell walls, while others destabilize the bacterial outer membrane by displacing bacterial counter-ions.

[801] Quinolones and Fluoroquinolone include, but are not limited to, Ciprofloxacin, Enoxacin, Gatifloxacin, Gemifloxacin, Levofloxacin, Lomefloxacin, Moxifloxacin, Nalidixic acid, Norfloxacin, Ofloxacin, Trovafloxacin, Grepafloxacin, Sparfloxacin, and Temafloxacin. Quinolones/Fluoroquinolone are effective, e.g., against *Streptococcus* and *Neisseria*. Quinolones/Fluoroquinolone are believed to inhibit the bacterial DNA gyrase or topoisomerase IV, thereby inhibiting DNA replication and transcription.

[802] Sulfonamides include, but are not limited to, Mafenide, Sulfacetamide, Sulfadiazine, Silver sulfadiazine, Sulfadimethoxine, Sulfamethizole, Sulfamethoxazole, Sulfanilimide, Sulfasalazine, Sulfisoxazole, Trimethoprim-Sulfamethoxazole (Co-trimoxazole), and Sulfonamidochrysoidine. Sulfonamides are believed to inhibit folate

synthesis by competitive inhibition of dihydropteroate synthetase, thereby inhibiting nucleic acid synthesis.

[803] Tetracyclines include, but are not limited to, Demeclocycline, Doxycycline, Minocycline, Oxytetracycline, and Tetracycline. Tetracyclines are effective, e.g., against Gram-negative bacteria. Tetracyclines are believed to bind to the bacterial 30S ribosomal subunit thereby inhibiting bacterial protein synthesis.

[804] Anti-mycobacterial compounds include, but are not limited to, Clofazimine, Dapsone, Capreomycin, Cycloserine, Ethambutol, Ethionamide, Isoniazid, Pyrazinamide, Rifampicin, Rifabutin, Rifapentine, and Streptomycin.

[805] Suitable antibiotics also include arsphenamine, chloramphenicol, fosfomycin, fusidic acid, metronidazole, mupirocin, platensimycin, quinupristin/dalfopristin, tigecycline, tinidazole, trimethoprim amoxicillin/clavulanate, ampicillin/sulbactam, amphomycin ristocetin, azithromycin, bacitracin, buforin II, carbomycin, cecropin PI, clarithromycin, erythromycins, furazolidone, fusidic acid, Na fusidate, gramicidin, imipenem, indolicidin, josamycin, magainan II, metronidazole, nitroimidazoles, mikamycin, mutacin B-Ny266, mutacin B-JHl 140, mutacin J-T8, nisin, nisin A, novobiocin, oleandomycin, ostreogrycin, piperacillin/tazobactam, pristinamycin, ramoplanin, ranalexin, reuterin, rifaximin, rosamicin, rosaramicin, spectinomycin, spiramycin, staphylomycin, streptogramin, streptogramin A, synergistin, taurolidine, teicoplanin, telithromycin, ticarcillin/clavulanic acid, triacetyloleandomycin, tylosin, tyrocidin, tyrothricin, vancomycin, vemamycin, and virginiamycin.

[806] In some embodiments, the additional therapeutic agent is an immunosuppressive agent, a DMARD, a pain-control drug, a steroid, a non-steroidal anti-inflammatory drug (NSAID), or a cytokine antagonist, and combinations thereof. Representative agents include, but are not limited to, cyclosporin, retinoids, corticosteroids, propionic acid derivative, acetic acid derivative, enolic acid derivatives, fenamic acid derivatives, Cox-2 inhibitors, lumiracoxib, ibuprophen, cholin magnesium salicylate, fenoprofen, salsalate, difunisal, tolmetin, ketoprofen, flurbiprofen, oxaprozin, indomethacin, sulindac, etodolac, ketorolac, nabumetone, naproxen, valdecoxib, etoricoxib, MK0966; rofecoxib, acetominophen, Celecoxib, Diclofenac, tramadol, piroxicam, meloxicam, tenoxicam, droxicam, lornoxicam, isoxicam, mefanamic acid, meclofenamic acid, flufenamic acid, tolfenamic, valdecoxib, parecoxib, etodolac, indomethacin, aspirin, ibuprophen, firocoxib, methotrexate (MTX), antimalarial drugs (e.g., hydroxychloroquine and chloroquine), sulfasalazine, Leflunomide, azathioprine, cyclosporin, gold salts, minocycline,

cyclophosphamide, D-penicillamine, minocycline, auranofin, tacrolimus, myocrisin, chlorambucil, TNF alpha antagonists (e.g., TNF alpha antagonists or TNF alpha receptor antagonists), e.g., ADALIMUMAB (Humira®), ETANERCEPT (Enbrel®), INFLIXIMAB (Remicade®; TA-650), CERTOLIZUMAB PEGOL (Cimzia®; CDP870), GOLIMUMAB (Simpom®; CNTO 148), ANAKINRA (Kineret®), RITUXIMAB (Rituxan®; MabThera®), ABATACEPT (Orencia®), TOCILIZUMAB (RoActemra /Actemra®), integrin antagonists (TYSABRI® (natalizumab)), IL-1 antagonists (ACZ885 (Ilaris)), Anakinra (Kineret®)), CD4 antagonists, IL-23 antagonists, IL-20 antagonists, IL-6 antagonists, BLyS antagonists (e.g., Atacicept, Benlysta®/ LymphoStat-B® (belimumab)), p38 Inhibitors, CD20 antagonists (Ocrelizumab, Ofatumumab (Arzerra®)), interferon gamma antagonists (Fontolizumab), prednisolone, Prednisone, dexamethasone, Cortisol, cortisone, hydrocortisone, methylprednisolone, betamethasone, triamcinolone, beclometasome, fludrocortisone, deoxycorticosterone, aldosterone, Doxycycline, vancomycin, pioglitazone, SBI-087, SCIO-469, Cura-100, Oncoxin + Viusid, TwHF, Methoxsalen, Vitamin D - ergocalciferol, Milnacipran, Paclitaxel, rosig tazone, Tacrolimus (Prograf®), RADOOl, rapamune, rapamycin, fostamatinib, Fentanyl, XOMA 052, Fostamatinib disodium,rosightazone, Curcumin (Longvida™), Rosuvastatin, Maraviroc, ramipnl, Milnacipran, Cobiprostone, somatropin, tgAAC94 gene therapy vector, MK0359, GW856553, esomeprazole, everolimus, trastuzumab, JAKl and JAK2 inhibitors, pan JAK inhibitors, e.g., tetracyclic pyridone 6 (P6), 325, PF-956980, denosumab, IL-6 antagonists, CD20 antagonistis, CTLA4 antagonists, IL-8 antagonists, IL-21 antagonists, IL-22 antagonist, integrin antagonists (Tysarbri® (natalizumab)), VGEF antagnosits, CXCL antagonists, MMP antagonists, defensin antagonists, IL-1 antagonists (including IL-1 beta antagonsits), and IL-23 antagonists (e.g., receptor decoys, antagonistic antibodies, etc.).

[807] In some embodiments, the additional therapy can comprise a JAK inhibitor such as baricitinib, ruxolitinib, tofacitinib, and/or pacritinib.

[808] In some embodiments, the additional therapeutic agent is an immunosuppressive agent. Examples of immunosuppressive agents include, but are not limited to, corticosteroids, mesalazine, mesalamine, sulfasalazine, sulfasalazine derivatives, immunosuppressive drugs, cyclosporin A, mercaptopurine, azathiopurine, prednisone, methotrexate, antihistamines, glucocorticoids, epinephrine, theophylline, cromolyn sodium, anti-leukotrienes, anti-cholinergic drugs for rhinitis, TLR antagonists, inflammasome inhibitors, anti-cholinergic decongestants, mast-cell stabilizers, monoclonal anti-IgE antibodies, vaccines (e.g., vaccines used for vaccination where the amount of an allergen is

gradually increased), cytokine inhibitors, such as anti-IL-6 antibodies, TNF inhibitors such as infliximab, adalimumab, certolizumab pegol, golimumab, or etanercept, and combinations thereof.

[809] In some embodiments, the additional therapeutic agent is an RNA molecule, such as a double stranded RNA.

[810] In some embodiments, the additional therapeutic agent is an anti-sense oligonucleotide.

Administration

[811] In certain aspects, provided herein is a method of delivering a solid dosage form described herein to a subject. In some embodiments of the methods provided herein, the solid dosage form is administered in conjunction with the administration of an additional therapeutic agent. In some embodiments, the solid dosage form comprises a pharmaceutical agent co-formulated with the additional therapeutic agent. In some embodiments, the solid dosage form is co-administered with the additional therapeutic agent. In some embodiments, the additional therapeutic agent is administered to the subject before administration of the solid dosage form (e.g., about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, 40, 45, 50 or 55 minutes before, about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 or 23 hours before, or about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 or 14 days before). In some embodiments, the additional therapeutic agent is administered to the subject after administration of the solid dosage form (e.g., about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, 40, 45, 50 or 55 minutes after, about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 or 23 hours after, or about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 or 14 days after). In some embodiments, the same mode of delivery is used to deliver both the solid dosage form and the additional therapeutic agent. In some embodiments, different modes of delivery are used to administer the solid dosage form and the additional therapeutic agent. For example, in some embodiments the solid dosage form is administered orally while the additional therapeutic agent is administered via injection (e.g., an intravenous and/or intramuscular).

[812] The dosage regimen can be any of a variety of methods and amounts, and can be determined by one skilled in the art according to known clinical factors. As is known in the medical arts, dosages for any one patient can depend on many factors, including the subject's species, size, body surface area, age, sex, immunocompetence, and general health, the particular microorganism to be administered, duration and route of administration, the

kind and stage of the disease, and other compounds such as drugs being administered concurrently or near-concurrently. In addition to the above factors, such levels can be affected by the infectivity of the microorganism, and the nature of the microorganism, as can be determined by one skilled in the art. In the present methods, appropriate minimum dosage levels of microorganisms can be levels sufficient for the microorganism to survive, grow and replicate. The dose of a pharmaceutical agent (e.g., in a solid dosage form) described herein may be appropriately set or adjusted in accordance with the dosage form, the route of administration, the degree or stage of a target disease, and the like. For example, the general effective dose of the agents may range between 0.01 mg/kg body weight/day and 1000 mg/kg body weight/day, between 0.1 mg/kg body weight/day and 1000 mg/kg body weight/day, 0.5 mg/kg body weight/day and 500 mg/kg body weight/day, 1 mg/kg body weight/day and 100 mg/kg body weight/day, or between 5 mg/kg body weight/day and 50 mg/kg body weight/day. The effective dose may be 0.01, 0.05, 0.1, 0.5, 1, 2, 3, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, 500, or 1000 mg/kg body weight/day or more, but the dose is not limited thereto.

[813] In some embodiments, the dose administered to a subject is sufficient to prevent disease (e.g., autoimmune disease, inflammatory disease, or metabolic disease), delay its onset, or slow or stop its progression, or relieve one or more symptoms of the disease. One skilled in the art will recognize that dosage will depend upon a variety of factors including the strength of the particular agent (e.g., pharmaceutical agent) employed, as well as the age, species, condition, and body weight of the subject. The size of the dose will also be determined by the route, timing, and frequency of administration as well as the existence, nature, and extent of any adverse side-effects that might accompany the administration of a particular pharmaceutical agent and the desired physiological effect.

[814] Suitable doses and dosage regimens can be determined by conventional range-finding techniques known to those of ordinary skill in the art. Generally, treatment is initiated with smaller dosages, which are no more than the optimum dose of the compound. Thereafter, the dosage is increased by small increments until the optimum effect under the circumstances is reached. An effective dosage and treatment protocol can be determined by routine and conventional means, starting e.g., with a low dose in laboratory animals and then increasing the dosage while monitoring the effects, and systematically varying the dosage regimen as well. Animal studies are commonly used to determine the maximal tolerable dose ("MTD") of bioactive agent per kilogram weight. Those skilled in the art regularly extrapolate doses for efficacy, while avoiding toxicity, in other species, including humans.

[815] In accordance with the above, in therapeutic applications, the dosages of the pharmaceutical agents used in accordance with the invention vary depending on the active agent, the age, weight, and clinical condition of the recipient patient, and the experience and judgment of the clinician or practitioner administering the therapy, among other factors affecting the selected dosage. As another example, the dose should be sufficient to result in slowing of progression of the disease for which the subject is being treated, and preferably amelioration of one or more symptoms of the disease for which the subject is being treated.

[816] Separate administrations can include any number of two or more administrations, including two, three, four, five or six administrations. One skilled in the art can readily determine the number of administrations to perform or the desirability of performing one or more additional administrations according to methods known in the art for monitoring therapeutic methods and other monitoring methods provided herein. Accordingly, the methods provided herein include methods of providing to the subject one or more administrations of a solid dosage form, where the number of administrations can be determined by monitoring the subject, and, based on the results of the monitoring, determining whether or not to provide one or more additional administrations. Deciding on whether or not to provide one or more additional administrations can be based on a variety of monitoring results.

[817] The time period between administrations can be any of a variety of time periods. The time period between administrations can be a function of any of a variety of factors, including monitoring steps, as described in relation to the number of administrations, the time period for a subject to mount an immune response. In one example, the time period can be a function of the time period for a subject to mount an immune response; for example, the time period can be more than the time period for a subject to mount an immune response, such as more than about one week, more than about ten days, more than about two weeks, or more than about a month; in another example, the time period can be no more than the time period for a subject to mount an immune response, such as no more than about one week, no more than about ten days, no more than about two weeks, or no more than about a month.

[818] In some embodiments, the delivery of an additional therapeutic agent in combination with the solid dosage form described herein reduces the adverse effects and/or improves the efficacy of the additional therapeutic agent.

[819] The effective dose of an additional therapeutic agent described herein is the amount of the additional therapeutic agent that is effective to achieve the desired therapeutic response for a particular subject, composition, and mode of administration, with the least

toxicity to the subject. The effective dosage level can be identified using the methods described herein and will depend upon a variety of pharmacokinetic factors including the activity of the particular compositions or agents administered, the route of administration, the time of administration, the rate of excretion of the particular compound being employed, the duration of the treatment, other drugs, compounds and/or materials used in combination with the particular compositions employed, the age, sex, weight, condition, general health and prior medical history of the subject being treated, and like factors well known in the medical arts. In general, an effective dose of an additional therapeutic agent will be the amount of the additional therapeutic agent which is the lowest dose effective to produce a therapeutic effect. Such an effective dose will generally depend upon the factors described above.

[820] The toxicity of an additional therapeutic agent is the level of adverse effects experienced by the subject during and following treatment. Adverse events associated with additional therapy toxicity can include, but are not limited to, abdominal pain, acid indigestion, acid reflux, allergic reactions, alopecia, anaphylaxis, anemia, anxiety, lack of appetite, arthralgias, asthenia, ataxia, azotemia, loss of balance, bone pain, bleeding, blood clots, low blood pressure, elevated blood pressure, difficulty breathing, bronchitis, bruising, low white blood cell count, low red blood cell count, low platelet count, cardiotoxicity, cystitis, hemorrhagic cystitis, arrhythmias, heart valve disease, cardiomyopathy, coronary artery disease, cataracts, central neurotoxicity, cognitive impairment, confusion, conjunctivitis, constipation, coughing, cramping, cystitis, deep vein thrombosis, dehydration, depression, diarrhea, dizziness, dry mouth, dry skin, dyspepsia, dyspnea, edema, electrolyte imbalance, esophagitis, fatigue, loss of fertility, fever, flatulence, flushing, gastric reflux, gastroesophageal reflux disease, genital pain, granulocytopenia, gynecomastia, glaucoma, hair loss, hand-foot syndrome, headache, hearing loss, heart failure, heart palpitations, heartburn, hematoma, hemorrhagic cystitis, hepatotoxicity, hyperamylasemia, hypercalcemia, hyperchloremia, hyperglycemia, hyperkalemia, hyperlipasemia, hypermagnesemia, hypernatremia, hyperphosphatemia, hyperpigmentation, hypertriglyceridemia, hyperuricemia, hypoalbuminemia, hypocalcemia, hypochloremia, hypoglycemia, hypokalemia, hypomagnesemia, hyponatremia, hypophosphatemia, impotence, infection, injection site reactions, insomnia, iron deficiency, itching, joint pain, kidney failure, leukopenia, liver dysfunction, memory loss, menopause, mouth sores, mucositis, muscle pain, myalgias, myelosuppression, myocarditis, neutropenic fever, nausea, nephrotoxicity, neutropenia, nosebleeds, numbness, ototoxicity, pain, palmar-plantar erythrodysesthesia, pancytopenia, pericarditis, peripheral neuropathy, pharyngitis, photophobia, photosensitivity, pneumonia,

pneumonitis, proteinuria, pulmonary embolus, pulmonary fibrosis, pulmonary toxicity, rash, rapid heart beat, rectal bleeding, restlessness, rhinitis, seizures, shortness of breath, sinusitis, thrombocytopenia, tinnitus, urinary tract infection, vaginal bleeding, vaginal dryness, vertigo, water retention, weakness, weight loss, weight gain, and xerostomia. In general, toxicity is acceptable if the benefits to the subject achieved through the therapy outweigh the adverse events experienced by the subject due to the therapy.

Immune Disorders

[821] In some embodiments, the methods and solid dosage forms described herein relate to the treatment or prevention of a disease or disorder associated a pathological immune response, such as an autoimmune disease, an allergic reaction and/or an inflammatory disease. In some embodiments, the disease or disorder is an inflammatory bowel disease (e.g., Crohn's disease or ulcerative colitis). In some embodiments, the disease or disorder is psoriasis. In some embodiments, the disease or disorder is atopic dermatitis. In some embodiments, the disease or disorder is asthma.

[822] The methods and solid dosage forms described herein can be used to treat any subject in need thereof. As used herein, a "subject in need thereof" includes any subject that has a disease or disorder associated with a pathological immune response (e.g., an inflammatory bowel disease), as well as any subject with an increased likelihood of acquiring a such a disease or disorder.

[823] The solid dosage forms described herein can be used, for example, as a pharmaceutical composition for preventing or treating (reducing, partially or completely, the adverse effects of) an autoimmune disease, such as chronic inflammatory bowel disease, systemic lupus erythematosus, psoriasis, muckle-wells syndrome, rheumatoid arthritis, multiple sclerosis, or Hashimoto's disease; an allergic disease, such as a food allergy, pollenosis, or asthma; an infectious disease, such as an infection with Clostridium difficile; an inflammatory disease such as a TNF-mediated inflammatory disease (e.g., an inflammatory disease of the gastrointestinal tract, such as pouchitis, a cardiovascular inflammatory condition, such as atherosclerosis, or an inflammatory lung disease, such as chronic obstructive pulmonary disease); a pharmaceutical composition for suppressing rejection in organ transplantation or other situations in which tissue rejection might occur; a supplement, food, or beverage for improving immune functions; or a reagent for suppressing the proliferation or function of immune cells.

[824] In some embodiments, the methods and solid dosage forms provided herein are useful for the treatment of inflammation. In certain embodiments, the inflammation of any tissue and organs of the body, including musculoskeletal inflammation, vascular inflammation, neural inflammation, digestive system inflammation, ocular inflammation, inflammation of the reproductive system, and other inflammation, as discussed below.

[825] Immune disorders of the musculoskeletal system include, but are not limited, to those conditions affecting skeletal joints, including joints of the hand, wrist, elbow, shoulder, jaw, spine, neck, hip, knew, ankle, and foot, and conditions affecting tissues connecting muscles to bones such as tendons. Examples of such immune disorders, which may be treated with the methods and compositions described herein include, but are not limited to, arthritis (including, for example, osteoarthritis, rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, acute and chronic infectious arthritis, arthritis associated with gout and pseudogout, and juvenile idiopathic arthritis), tendonitis, synovitis, tenosynovitis, bursitis, fibrositis (fibromyalgia), epicondylitis, myositis, and osteitis (including, for example, Paget's disease, osteitis pubis, and osteitis fibrosa cystic).

[826] Ocular immune disorders refers to a immune disorder that affects any structure of the eye, including the eye lids. Examples of ocular immune disorders which may be treated with the methods and compositions described herein include, but are not limited to, blepharitis, blepharochalasis, conjunctivitis, dacryoadenitis, keratitis, keratoconjunctivitis sicca (dry eye), scleritis, trichiasis, and uveitis.

[827] Examples of nervous system immune disorders which may be treated with the methods and solid dosage forms described herein include, but are not limited to, encephalitis, Guillain-Barre syndrome, meningitis, neuromyotonia, narcolepsy, multiple sclerosis, myelitis and schizophrenia. Examples of inflammation of the vasculature or lymphatic system which may be treated with the methods and compositions described herein include, but are not limited to, arthrosclerosis, arthritis, phlebitis, vasculitis, and lymphangitis.

[828] Examples of digestive system immune disorders which may be treated with the methods and solid dosage forms described herein include, but are not limited to, cholangitis, cholecystitis, enteritis, enterocolitis, gastritis, gastroenteritis, inflammatory bowel disease, ileitis, and proctitis. Inflammatory bowel diseases include, for example, certain art-recognized forms of a group of related conditions. Several major forms of inflammatory bowel diseases are known, with Crohn's disease (regional bowel disease, e.g., inactive and active forms) and ulcerative colitis (e.g., inactive and active forms) the most common of these disorders. In addition, the inflammatory bowel disease encompasses irritable bowel

syndrome, microscopic colitis, lymphocytic-plasmocytic enteritis, coeliac disease, collagenous colitis, lymphocytic colitis and eosinophilic enterocolitis. Other less common forms of IBD include indeterminate colitis, pseudomembranous colitis (necrotizing colitis), ischemic inflammatory bowel disease, Behcet's disease, sarcoidosis, scleroderma, IBD-associated dysplasia, dysplasia associated masses or lesions, and primary sclerosing cholangitis.

[829] Examples of reproductive system immune disorders which may be treated with the methods and solid dosage forms described herein include, but are not limited to, cervicitis, chorioamnionitis, endometritis, epididymitis, omphalitis, oophoritis, orchitis, salpingitis, tubo-ovarian abscess, urethritis, vaginitis, vulvitis, and vulvodynia.

[830] The methods and solid dosage forms described herein may be used to treat autoimmune conditions having an inflammatory component. Such conditions include, but are not limited to, acute disseminated alopecia universalise, Behcet's disease, Chagas' disease, chronic fatigue syndrome, dysautonomia, encephalomyelitis, ankylosing spondylitis, aplastic anemia, hidradenitis suppurativa, autoimmune hepatitis, autoimmune oophoritis, celiac disease, Crohn's disease, diabetes mellitus type 1, giant cell arteritis, Goodpasture's syndrome, Grave's disease, Guillain-Barre syndrome, Hashimoto's disease, Henoch-Schonlein purpura, Kawasaki's disease, lupus erythematosus, microscopic colitis, microscopic polyarteritis, mixed connective tissue disease, Muckle-Wells syndrome, multiple sclerosis, myasthenia gravis, opsoclonus myoclonus syndrome, optic neuritis, Ord's thyroiditis, pemphigus, polyarteritis nodosa, polymyalgia, rheumatoid arthritis, Reiter's syndrome, Sjogren's syndrome, temporal arteritis, Wegener's granulomatosis, warm autoimmune haemolytic anemia, interstitial cystitis, Lyme disease, morphea, psoriasis, sarcoidosis, scleroderma, ulcerative colitis, and vitiligo.

[831] The methods and solid dosage forms described herein may be used to treat T-cell mediated hypersensitivity diseases having an inflammatory component. Such conditions include, but are not limited to, contact hypersensitivity, contact dermatitis (including that due to poison ivy), uticaria, skin allergies, respiratory allergies (hay fever, allergic rhinitis, house dustmite allergy) and gluten-sensitive enteropathy (Celiac disease).

[832] Other immune disorders which may be treated with the methods and solid dosage forms include, for example, appendicitis, dermatitis, dermatomyositis, endocarditis, fibrositis, gingivitis, glossitis, hepatitis, hidradenitis suppurativa, iritis, laryngitis, mastitis, myocarditis, nephritis, otitis, pancreatitis, parotitis, percarditis, peritonoitis, pharyngitis, pleuritis, pneumonitis, prostatistis, pyelonephritis, and stomatisi, transplant rejection

(involving organs such as kidney, liver, heart, lung, pancreas (e.g., islet cells), bone marrow, cornea, small bowel, skin allografts, skin homografts, and heart valve xengrafts, sewrum sickness, and graft vs host disease), acute pancreatitis, chronic pancreatitis, acute respiratory distress syndrome, Sexary's syndrome, congenital adrenal hyperplasis, nonsuppurative thyroiditis, hypercalcemia associated with cancer, pemphigus, bullous dermatitis herpetiformis, severe erythema multiforme, exfoliative dermatitis, seborrheic dermatitis, seasonal or perennial allergic rhinitis, bronchial asthma, contact dermatitis, atopic dermatitis, drug hypersensistivity reactions, allergic conjunctivitis, keratitis, herpes zoster ophthalmicus, iritis and oiridocyclitis, chorioretinitis, optic neuritis, symptomatic sarcoidosis, fulminating or disseminated pulmonary tuberculosis chemotherapy, idiopathic thrombocytopenic purpura in adults, secondary thrombocytopenia in adults, acquired (autoimmune) haemolytic anemia, leukaemia and lymphomas in adults, acute leukaemia of childhood, regional enteritis, autoimmune vasculitis, multiple sclerosis, chronic obstructive pulmonary disease, solid organ transplant rejection, sepsis. Preferred treatments include treatment of transplant rejection, rheumatoid arthritis, psoriatic arthritis, multiple sclerosis, Type 1 diabetes, asthma, inflammatory bowel disease, systemic lupus erythematosus, psoriasis, chronic obstructive pulmonary disease, and inflammation accompanying infectious conditions (e.g., sepsis).

Metabolic Disorders

[833] In some embodiments, the methods and solid dosage forms described herein relate to the treatment or prevention of a metabolic disease or disorder a, such as type II diabetes, impaired glucose tolerance, insulin resistance, obesity, hyperglycemia, hyperinsulinemia, fatty liver, non-alcoholic steatohepatitis, hypercholesterolemia, hypertension, hyperlipoproteinemia, hyperlipidemia, hypertriglylceridemia, ketoacidosis, hypoglycemia, thrombotic disorders, dyslipidemia, non-alcoholic fatty liver disease (NAFLD), Nonalcoholic Steatohepatitis (NASH) or a related disease. In some embodiments, the related disease is cardiovascular disease, atherosclerosis, kidney disease, nephropathy, diabetic neuropathy, diabetic retinopathy, sexual dysfunction, dermatopathy, dyspepsia, or edema. In some embodiments, the methods and pharmaceutical compositions described herein relate to the treatment of Nonalcoholic Fatty Liver Disease (NAFLD) and Nonalcoholic Steatohepatitis (NASH).

[834] The methods and solid dosage forms described herein can be used to treat any subject in need thereof. As used herein, a "subject in need thereof" includes any subject that

has a metabolic disease or disorder, as well as any subject with an increased likelihood of acquiring a such a disease or disorder.

[835] The solid dosage forms described herein can be used, for example, for preventing or treating (reducing, partially or completely, the adverse effects of) a metabolic disease, such as type II diabetes, impaired glucose tolerance, insulin resistance, obesity, hyperglycemia, hyperinsulinemia, fatty liver, non-alcoholic steatohepatitis, hypercholesterolemia, hypertension, hyperlipoproteinemia, hyperlipidemia, hypertriglylceridemia, ketoacidosis, hypoglycemia, thrombotic disorders, dyslipidemia, non-alcoholic fatty liver disease (NAFLD), Nonalcoholic Steatohepatitis (NASH), or a related disease. In some embodiments, the related disease is cardiovascular disease, atherosclerosis, kidney disease, nephropathy, diabetic neuropathy, diabetic retinopathy, sexual dysfunction, dermatopathy, dyspepsia, or edema.

Cancer

[836] In some embodiments, the methods and solid dosage forms described herein relate to the treatment of cancer. In some embodiments, any cancer can be treated using the methods described herein. Examples of cancers that may treated by methods and solid dosage forms described herein include, but are not limited to, cancer cells from the bladder, blood, bone, bone marrow, brain, breast, colon, esophagus, gastrointestine, gum, head, kidney, liver, lung, nasopharynx, neck, ovary, prostate, skin, stomach, testis, tongue, or uterus. In addition, the cancer may specifically be of the following histological type, though it is not limited to these: neoplasm, malignant; carcinoma; carcinoma, undifferentiated; giant and spindle cell carcinoma; small cell carcinoma; papillary carcinoma; squamous cell carcinoma; lymphoepithelial carcinoma; basal cell carcinoma; pilomatrix carcinoma; transitional cell carcinoma; papillary transitional cell carcinoma; adenocarcinoma; gastrinoma, malignant; cholangiocarcinoma; hepatocellular carcinoma; combined hepatocellular carcinoma and cholangiocarcinoma; trabecular adenocarcinoma; adenoid cystic carcinoma; adenocarcinoma in adenomatous polyp; adenocarcinoma, familial polyposis coli; solid carcinoma; carcinoid tumor, malignant; branchiolo-alveolar adenocarcinoma; papillary adenocarcinoma; chromophobe carcinoma; acidophil carcinoma; oxyphilic adenocarcinoma; basophil carcinoma; clear cell adenocarcinoma; granular cell carcinoma; follicular adenocarcinoma; papillary and follicular adenocarcinoma; nonencapsulating sclerosing carcinoma; adrenal cortical carcinoma; endometroid carcinoma; skin appendage carcinoma; apocrine adenocarcinoma; sebaceous adenocarcinoma; ceruminous adenocarcinoma; mucoepidermoid

carcinoma; cystadenocarcinoma; papillary cystadenocarcinoma; papillary serous cystadenocarcinoma; mucinous cystadenocarcinoma; mucinous adenocarcinoma; signet ring cell carcinoma; infiltrating duct carcinoma; medullary carcinoma; lobular carcinoma; inflammatory carcinoma; paget's disease, mammary; acinar cell carcinoma; adenosquamous carcinoma; adenocarcinoma w/squamous metaplasia; thymoma, malignant; ovarian stromal tumor, malignant; thecoma, malignant; granulosa cell tumor, malignant; and roblastoma, malignant; sertoli cell carcinoma; leydig cell tumor, malignant; lipid cell tumor, malignant; paraganglioma, malignant; extra-mammary paraganglioma, malignant; pheochromocytoma; glomangiosarcoma; malignant melanoma; amelanotic melanoma; superficial spreading melanoma; malig melanoma in giant pigmented nevus; epithelioid cell melanoma; blue nevus, malignant; sarcoma; fibrosarcoma; fibrous histiocytoma, malignant; myxosarcoma; liposarcoma; leiomyosarcoma; rhabdomyosarcoma; embryonal rhabdomyosarcoma; alveolar rhabdomyosarcoma; stromal sarcoma; mixed tumor, malignant; mullerian mixed tumor; nephroblastoma; hepatoblastoma; carcinosarcoma; mesenchymoma, malignant; brenner tumor, malignant; phyllodes tumor, malignant; synovial sarcoma; mesothelioma, malignant; dysgerminoma; embryonal carcinoma; teratoma, malignant; struma ovarii, malignant; choriocarcinoma; mesonephroma, malignant; hemangiosarcoma; hemangioendothelioma, malignant; kaposi's sarcoma; hemangiopericytoma, malignant; lymphangiosarcoma; osteosarcoma; juxtacortical osteosarcoma; chondrosarcoma; chondroblastoma, malignant; mesenchymal chondrosarcoma; giant cell tumor of bone; ewing's sarcoma; odontogenic tumor, malignant; ameloblastic odontosarcoma; ameloblastoma, malignant; ameloblastic fibrosarcoma; pinealoma, malignant; chordoma; glioma, malignant; ependymoma; astrocytoma; protoplasmic astrocytoma; fibrillary astrocytoma; astroblastoma; glioblastoma; oligodendroglioma; oligodendroblastoma; primitive neuroectodermal; cerebellar sarcoma; ganglioneuroblastoma; neuroblastoma; retinoblastoma; olfactory neurogenic tumor; meningioma, malignant; neurofibrosarcoma; neurilemmoma, malignant; granular cell tumor, malignant; malignant lymphoma; Hodgkin's disease; Hodgkin's lymphoma; paragranuloma; malignant lymphoma, small lymphocytic; malignant lymphoma, large cell, diffuse; malignant lymphoma, follicular; mycosis fungoides; other specified non-Hodgkin's lymphomas; malignant histiocytosis; multiple myeloma; mast cell sarcoma; immunoproliferative small intestinal disease; leukemia; lymphoid leukemia; plasma cell leukemia; erythroleukemia; lymphosarcoma cell leukemia; myeloid leukemia; basophilic leukemia; eosinophilic leukemia; monocytic leukemia; mast cell leukemia; megakaryoblastic leukemia; myeloid sarcoma; and hairy cell leukemia.

[837] In some embodiments, the cancer comprises breast cancer (e.g., triple negative breast cancer).

[838] In some embodiments, the cancer comprises colorectal cancer (e.g., microsatellite stable (MSS) colorectal cancer).

[839] In some embodiments, the cancer comprises renal cell carcinoma.

[840] In some embodiments, the cancer comprises lung cancer (e.g., non small cell lung cancer).

[841] In some embodiments, the cancer comprises bladder cancer.

[842] In some embodiments, the cancer comprises gastroesophageal cancer.

[843] In some embodiments, the methods and solid dosage forms provided herein relate to the treatment of a leukemia. The term "leukemia" includes broadly progressive, malignant diseases of the hematopoietic organs/systems and is generally characterized by a distorted proliferation and development of leukocytes and their precursors in the blood and bone marrow. Non-limiting examples of leukemia diseases include, acute nonlymphocytic leukemia, chronic lymphocytic leukemia, acute granulocytic leukemia, chronic granulocytic leukemia, acute promyelocytic leukemia, adult T-cell leukemia, aleukemic leukemia, a leukocythemic leukemia, basophilic leukemia, blast cell leukemia, bovine leukemia, chronic myelocytic leukemia, leukemia cutis, embryonal leukemia, eosinophilic leukemia, Gross' leukemia, Rieder cell leukemia, Schilling's leukemia, stem cell leukemia, subleukemic leukemia, undifferentiated cell leukemia, hairy-cell leukemia, hemoblastic leukemia, hemocytoblastic leukemia, histiocytic leukemia, stem cell leukemia, acute monocytic leukemia, leukopenic leukemia, lymphatic leukemia, lymphoblastic leukemia, lymphocytic leukemia, lymphogenous leukemia, lymphoid leukemia, lymphosarcoma cell leukemia, mast cell leukemia, megakaryocytic leukemia, micromyeloblastic leukemia, monocytic leukemia, myeloblastic leukemia, myelocytic leukemia, myeloid granulocytic leukemia, myelomonocytic leukemia, Naegeli leukemia, plasma cell leukemia, plasmacytic leukemia, and promyelocytic leukemia.

[844] In some embodiments, the methods and solid dosage forms provided herein relate to the treatment of a carcinoma. The term "carcinoma" refers to a malignant growth made up of epithelial cells tending to infiltrate the surrounding tissues, and/or resist physiological and non-physiological cell death signals and gives rise to metastases. Non-limiting exemplary types of carcinomas include, acinar carcinoma, acinous carcinoma, adenocystic carcinoma, adenoid cystic carcinoma, carcinoma adenomatosum, carcinoma of adrenal cortex, alveolar carcinoma, alveolar cell carcinoma, basal cell carcinoma, carcinoma

basocellulare, basaloid carcinoma, basosquamous cell carcinoma, bronchioalveolar carcinoma, bronchiolar carcinoma, bronchogenic carcinoma, cerebriform carcinoma, cholangiocellular carcinoma, chorionic carcinoma, colloid carcinoma, comedo carcinoma, corpus carcinoma, cribriform carcinoma, carcinoma en cuirasse, carcinoma cutaneum, cylindrical carcinoma, cylindrical cell carcinoma, duct carcinoma, carcinoma durum, embryonal carcinoma, encephaloid carcinoma, epiennoid carcinoma, carcinoma epitheliale adenoides, exophytic carcinoma, carcinoma ex ulcere, carcinoma fibrosum, gelatiniform carcinoma, gelatinous carcinoma, giant cell carcinoma, signet-ring cell carcinoma, carcinoma simplex, small-cell carcinoma, solanoid carcinoma, spheroidal cell carcinoma, spindle cell carcinoma, carcinoma spongiosum, squamous carcinoma, squamous cell carcinoma, string carcinoma, carcinoma telangiectaticum, carcinoma telangiectodes, transitional cell carcinoma, carcinoma tuberosum, tuberous carcinoma, verrucous carcinoma, carcinoma villosum, carcinoma gigantocellulare, glandular carcinoma, granulosa cell carcinoma, hair-matrix carcinoma, hematoid carcinoma, hepatocellular carcinoma, Hurthle cell carcinoma, hyaline carcinoma, hypernephroid carcinoma, infantile embryonal carcinoma, carcinoma in situ, intraepidermal carcinoma, intraepithelial carcinoma, Krompecher's carcinoma, Kulchitzky-cell carcinoma, large-cell carcinoma, lenticular carcinoma, carcinoma lenticulare, lipomatous carcinoma, lymphoepithelial carcinoma, carcinoma medullare, medullary carcinoma, melanotic carcinoma, carcinoma molle, mucinous carcinoma, carcinoma muciparum, carcinoma mucocellulare, mucoepidermoid carcinoma, carcinoma mucosum, mucous carcinoma, carcinoma myxomatodes, naspharyngeal carcinoma, oat cell carcinoma, carcinoma ossificans, osteoid carcinoma, papillary carcinoma, periportal carcinoma, preinvasive carcinoma, prickle cell carcinoma, pultaceous carcinoma, renal cell carcinoma of kidney, reserve cell carcinoma, carcinoma sarcomatodes, schneiderian carcinoma, scirrhous carcinoma, and carcinoma scroti.

[845] In some embodiments, the methods and solid dosage forms provided herein relate to the treatment of a sarcoma. The term "sarcoma" generally refers to a tumor which is made up of a substance like the embryonic connective tissue and is generally composed of closely packed cells embedded in a fibrillar, heterogeneous, or homogeneous substance. Sarcomas include, but are not limited to, chondrosarcoma, fibrosarcoma, lymphosarcoma, melanosarcoma, myxosarcoma, osteosarcoma, endometrial sarcoma, stromal sarcoma, Ewing's sarcoma, fascial sarcoma, fibroblastic sarcoma, giant cell sarcoma, Abemethy's sarcoma, adipose sarcoma, liposarcoma, alveolar soft part sarcoma, ameloblastic sarcoma, botryoid sarcoma, chloroma sarcoma, chorio carcinoma, embryonal sarcoma, Wilms' tumor sarcoma,

granulocytic sarcoma, Hodgkin's sarcoma, idiopathic multiple pigmented hemorrhagic sarcoma, immunoblastic sarcoma of B cells, lymphoma, immunoblastic sarcoma of T-cells, Jensen's sarcoma, Kaposi's sarcoma, Kupffer cell sarcoma, angiosarcoma, leukosarcoma, malignant mesenchymoma sarcoma, parosteal sarcoma, reticulocytic sarcoma, Rous sarcoma, serocystic sarcoma, synovial sarcoma, and telangiectaltic sarcoma.

[846] Additional exemplary neoplasias that can be treated using the methods and solid dosage forms described herein include Hodgkin's Disease, Non-Hodgkin's Lymphoma, multiple myeloma, neuroblastoma, breast cancer, ovarian cancer, lung cancer, rhabdomyosarcoma, primary thrombocytosis, primary macroglobulinemia, small-cell lung tumors, primary brain tumors, stomach cancer, colon cancer, malignant pancreatic insulanoma, malignant carcinoid, premalignant skin lesions, testicular cancer, lymphomas, thyroid cancer, neuroblastoma, esophageal cancer, genitourinary tract cancer, malignant hypercalcemia, cervical cancer, endometrial cancer, plasmacytoma, colorectal cancer, rectal cancer, and adrenal cortical cancer.

[847] In some embodiments, the cancer treated is a melanoma. The term "melanoma" is taken to mean a tumor arising from the melanocytic system of the skin and other organs. Non-limiting examples of melanomas are Harding-Passey melanoma, juvenile melanoma, lentigo maligna melanoma, malignant melanoma, acral-lentiginous melanoma, amelanotic melanoma, benign juvenile melanoma, Cloudman's melanoma, S91 melanoma, nodular melanoma subungal melanoma, and superficial spreading melanoma.

[848] Particular categories of tumors that can be treated using methods and solid dosage forms described herein include lymphoproliferative disorders, breast cancer, ovarian cancer, prostate cancer, cervical cancer, endometrial cancer, bone cancer, liver cancer, stomach cancer, colon cancer, pancreatic cancer, cancer of the thyroid, head and neck cancer, cancer of the central nervous system, cancer of the peripheral nervous system, skin cancer, kidney cancer, as well as metastases of all the above. Particular types of tumors include hepatocellular carcinoma, hepatoma, hepatoblastoma, rhabdomyosarcoma, esophageal carcinoma, thyroid carcinoma, ganglioblastoma, fibrosarcoma, myxosarcoma, liposarcoma, chondrosarcoma, osteogenic sarcoma, chordoma, angiosarcoma, endotheliosarcoma, Ewing's tumor, leimyosarcoma, rhabdotheliosarcoma, invasive ductal carcinoma, papillary adenocarcinoma, melanoma, pulmonary squamous cell carcinoma, basal cell carcinoma, adenocarcinoma (well differentiated, moderately differentiated, poorly differentiated or undifferentiated), bronchioloalveolar carcinoma, renal cell carcinoma, hypernephroma, hypernephroid adenocarcinoma, bile duct carcinoma, choriocarcinoma, seminoma,

embryonal carcinoma, Wilms' tumor, testicular tumor, lung carcinoma including small cell, non-small and large cell lung carcinoma, bladder carcinoma, glioma, astrocyoma, medulloblastoma, craniopharyngioma, ependymoma, pinealoma, retinoblastoma, neuroblastoma, colon carcinoma, rectal carcinoma, hematopoietic malignancies including all types of leukemia and lymphoma including: acute myelogenous leukemia, acute myelocytic leukemia, acute lymphocytic leukemia, chronic myelogenous leukemia, chronic lymphocytic leukemia, mast cell leukemia, multiple myeloma, myeloid lymphoma, Hodgkin' s lymphoma, non-Hodgkin' s lymphoma, plasmacytoma, colorectal cancer, and rectal cancer.

[849] Cancers treated in certain embodiments also include precancerous lesions, e.g., actinic keratosis (solar keratosis), moles (dysplastic nevi), acitinic chelitis (farmer's lip), cutaneous horns, Barrett's esophagus, atrophic gastritis, dyskeratosis congenita, sideropenic dysphagia, lichen planus, oral submucous fibrosis, actinic (solar) elastosis and cervical dysplasia.

[850] Cancers treated in some embodiments include non-cancerous or benign tumors, *e.g.*, of endodermal, ectodermal or mesenchymal origin, including, but not limited to cholangioma, colonic polyp, adenoma, papilloma, cystadenoma, liver cell adenoma, hydatidiform mole, renal tubular adenoma, squamous cell papilloma, gastric polyp, hemangioma, osteoma, chondroma, lipoma, fibroma, lymphangioma, leiomyoma, rhabdomyoma, astrocytoma, nevus, meningioma, and ganglioneuroma.

Other Diseases and Disorders

[851] In some embodiments, the methods and solid dosage forms described herein relate to the treatment of liver diseases. Such diseases include, but are not limited to, Alagille Syndrome, Alcohol-Related Liver Disease, Alpha-1 Antitrypsin Deficiency, Autoimmune Hepatitis, Benign Liver Tumors, Biliary Atresia, Cirrhosis, Galactosemia, Gilbert Syndrome, Hemochromatosis, Hepatitis A, Hepatitis B, Hepatitis C, Hepatic Encephalopathy, Intrahepatic Cholestasis of Pregnancy (ICP), Lysosomal Acid Lipase Deficiency (LAL-D), Liver Cysts, Liver Cancer, Newborn Jaundice, Primary Biliary Cholangitis (PBC), Primary Sclerosing Cholangitis (PSC), Reye Syndrome, Type I Glycogen Storage Disease, and Wilson Disease.

[852] The methods and solid dosage forms described herein may be used to treat neurodegenerative and neurological diseases. In certain embodiments, the neurodegenerative and/or neurological disease is Parkinson's disease, Alzheimer's disease, prion disease,

Huntington's disease, motor neuron diseases (MND), spinocerebellar ataxia, spinal muscular atrophy, dystonia, idiopathicintracranial hypertension, epilepsy, nervous system disease, central nervous system disease, movement disorders, multiple sclerosis, encephalopathy, peripheral neuropathy or post-operative cognitive dysfunction.

Dysbiosis

[853] In recent years, it has become increasingly clear that the gut microbiome (also called the "gut microbiota") can have a significant impact on an individual's health through microbial activity and influence (local and/or distal) on immune and other cells of the host (Walker, W.A., Dysbiosis. The Microbiota in Gastrointestinal Pathophysiology. Chapter 25. 2017; Weiss and Thierry, Mechanisms and consequences of intestinal dysbiosis. *Cellular and Molecular Life Sciences*. (2017) 74(16):2959-2977. Zurich Open Repository and Archive, doi: https://doi.org/10.1007/s00018-017-2509-x)).

[854] A healthy host-gut microbiome homeostasis is sometimes referred to as a "eubiosis" or "normobiosis," whereas a detrimental change in the host microbiome composition and/or its diversity can lead to an unhealthy imbalance in the microbiome, or a "dysbiosis" (Hooks and O'Malley. *Dysbiosis* and *its discontents*. American Society for Microbiology. Oct 2017. Vol. 8. Issue 5. mBio 8:e01492-17. https://doi.org/10.1128/mBio.01492-17). Dysbiosis, and associated local or distal host inflammatory or immune effects, may occur where microbiome homeostasis is lost or diminished, resulting in: increased susceptibility to pathogens; altered host bacterial metabolic activity; induction of host proinflammatory activity and/or reduction of host anti-inflammatory activity. Such effects are mediated in part by interactions between host immune cells (e.g., T cells, dendritic cells, mast cells, NK cells, intestinal epithelial lymphocytes (IEC), macrophages and phagocytes) and cytokines, and other substances released by such cells and other host cells.

[855] A dysbiosis may occur within the gastrointestinal tract (a "gastrointestinal dysbiosis" or "gut dysbiosis") or may occur outside the lumen of the gastrointestinal tract (a "distal dysbiosis"). Gastrointestinal dysbiosis is often associated with a reduction in integrity of the intestinal epithelial barrier, reduced tight junction integrity and increased intestinal permeability. Citi, S. Intestinal Barriers protect against disease, *Science* 359:1098-99 (2018); Srinivasan et al., TEER measurement techniques for in vitro barrier model systems. *J. Lab. Autom.* 20:107-126 (2015). A gastrointestinal dysbiosis can have physiological and immune effects within and outside the gastrointestinal tract.

[856] The presence of a dysbiosis has been associated with a wide variety of diseases and conditions including: infection, cancer, autoimmune disorders (e.g., systemic lupus erythematosus (SLE)) or inflammatory disorders (e.g., functional gastrointestinal disorders such as inflammatory bowel disease (IBD), ulcerative colitis, and Crohn's disease), neuroinflammatory diseases (e.g., multiple sclerosis), transplant disorders (e.g., graft-versus-host disease), fatty liver disease, type I diabetes, rheumatoid arthritis, Sjögren's syndrome, celiac disease, cystic fibrosis, chronic obstructive pulmonary disorder (COPD), and other diseases and conditions associated with immune dysfunction. Lynch et al., The Human Microbiome in Health and Disease, *N. Engl. J. Med* .375:2369-79 (2016), Carding et al., Dysbiosis of the gut microbiota in disease. *Microb. Ecol. Health Dis.* (2015); 26: 10: 3402/mehd.v26.2619; Levy et al, Dysbiosis and the Immune System, *Nature Reviews Immunology* 17:219 (April 2017)

[857] Exemplary pharmaceutical compositions disclosed herein can treat a dysbiosis and its effects by modifying the immune activity present at the site of dysbiosis. As described herein, such compositions can modify a dysbiosis via effects on host immune cells, resulting in, e.g., an increase in secretion of anti-inflammatory cytokines and/or a decrease in secretion of pro-inflammatory cytokines, reducing inflammation in the subject recipient or via changes in metabolite production.

[858] Exemplary pharmaceutical compositions and/or solid dosage forms disclosed herein that are useful for treatment of disorders associated with a dysbiosis contain one or more types of immunomodulatory bacteria (*e.g.*, anti-inflammatory bacteria) and/or mEVs (microbial extracellular vesicles) derived from such bacteria. Such compositions are capable of affecting the recipient host's immune function, in the gastrointestinal tract, and/or a systemic effect at distal sites outside the subject's gastrointestinal tract.

[859] Exemplary pharmaceutical compositions and/or solid dosage forms disclosed herein that are useful for treatment of disorders associated with a dysbiosis contain a population of immunomodulatory bacteria of a single bacterial species (e.g., a single strain) (*e.g.*, anti-inflammatory bacteria) and/or mEVs derived from such bacteria. Such compositions are capable of affecting the recipient host's immune function, in the gastrointestinal tract, and /or a systemic effect at distal sites outside the subject's gastrointestinal tract.

[860] In one embodiment, pharmaceutical compositions and/or solid dosage forms containing an isolated population of immunomodulatory bacteria (*e.g.*, anti-inflammatory bacterial cells) and/or mEVs derived from such bacteria are administered (e.g., orally) to a

mammalian recipient in an amount effective to treat a dysbiosis and one or more of its effects in the recipient. The dysbiosis may be a gastrointestinal tract dysbiosis or a distal dysbiosis.

[861] In another embodiment, pharmaceutical compositions and/or solid dosage forms of the instant invention can treat a gastrointestinal dysbiosis and one or more of its effects on host immune cells, resulting in an increase in secretion of anti-inflammatory cytokines and/or a decrease in secretion of pro-inflammatory cytokines, reducing inflammation in the subject recipient.

[862] In another embodiment, the pharmaceutical compositions and/or solid dosage forms can treat a gastrointestinal dysbiosis and one or more of its effects by modulating the recipient immune response via cellular and cytokine modulation to reduce gut permeability by increasing the integrity of the intestinal epithelial barrier.

[863] In another embodiment, the pharmaceutical compositions and/or solid dosage forms can treat a distal dysbiosis and one or more of its effects by modulating the recipient immune response at the site of dysbiosis via modulation of host immune cells.

[864] Other exemplary pharmaceutical compositions and/or solid dosage forms are useful for treatment of disorders associated with a dysbiosis, which compositions contain one or more types of bacteria and/or mEVs capable of altering the relative proportions of host immune cell subpopulations, *e.g.*, subpopulations of T cells, immune lymphoid cells, dendritic cells, NK cells and other immune cells, or the function thereof, in the recipient.

[865] Other exemplary pharmaceutical compositions and/or solid dosage forms are useful for treatment of disorders associated with a dysbiosis, which compositions contain a population of immunomodulatory bacteria and/or mEVs of a single bacterial species e.g., a single strain) capable of altering the relative proportions of immune cell subpopulations, *e.g.*, T cell subpopulations, immune lymphoid cells, NK cells and other immune cells, or the function thereof, in the recipient subject.

[866] In one embodiment, the invention provides methods of treating a gastrointestinal dysbiosis and one or more of its effects by orally administering to a subject in need thereof a pharmaceutical composition and/or solid dosage form which alters the microbiome population existing at the site of the dysbiosis. The pharmaceutical composition and/or solid dosage form can contain one or more types of immunomodulatory bacteria or mEVs or a population of immunomodulatory bacteria and/or mEVs of a single bacterial species (e.g., a single strain).

[867] In one embodiment, the invention provides methods of treating a distal dysbiosis and one or more of its effects by orally administering to a subject in need thereof a

pharmaceutical composition and/or solid dosage form which alters the subject's immune response outside the gastrointestinal tract. The pharmaceutical composition and/or solid dosage form can contain one or more types of immunomodulatory bacteria or mEVs or a population of immunomodulatory bacteria and/or mEVs of a single bacterial species (e.g., a single strain).

[868] In exemplary embodiments, pharmaceutical compositions and/or solid dosage forms useful for treatment of disorders associated with a dysbiosis stimulate secretion of one or more anti-inflammatory cytokines by host immune cells. Anti-inflammatory cytokines include, but are not limited to, IL-10, IL-13, IL-9, IL-4, IL-5, TGFβ, and combinations thereof. In other exemplary embodiments, pharmaceutical compositions and/or solid dosage forms useful for treatment of disorders associated with a dysbiosis that decrease (e.g., inhibit) secretion of one or more pro-inflammatory cytokines by host immune cells. Pro-inflammatory cytokines include, but are not limited to, IFNγ, IL-12p70, IL-1α, IL-6, IL-8, MCP1, MIP1α, MIP1β, TNFα, and combinations thereof. Other exemplary cytokines are known in the art and are described herein.

[869] In another aspect, the invention provides a method of treating or preventing a disorder associated with a dysbiosis in a subject in need thereof, comprising administering (e.g., orally administering) to the subject a therapeutic composition in the form of a probiotic or medical food comprising bacteria and/or mEVs in an amount sufficient to alter the microbiome at a site of the dysbiosis, such that the disorder associated with the dysbiosis is treated.

[870] In another embodiment, a therapeutic composition of the instant invention in the form of a probiotic or medical food may be used to prevent or delay the onset of a dysbiosis in a subject at risk for developing a dysbiosis.

Infection

[871] Inflammation can be a protective response to harmful stimuli, such as invading pathogens, damaged cells, toxic compounds, or cancerous cells. However, excessive inflammatory responses to such stimuli can result in serious adverse effects, including tissue damage and even death. For example, production of pro-inflammatory cytokines such as interleukin-8 (IL-8), interleukin-6 (IL-6), interleukin-1 beta (IL-1β), and tumor necrosis factor alpha (TNFα) in response to many viral infections is one of the primary causes of the adverse symptoms associated with infection (including, in some cases, death). For example,

release of inflammatory cytokines has been associated with disease severity resulting from infection by a number of viruses, including infection by coronaviruses (*e.g.*, SARS-CoV-2, the virus that causes Coronavirus Disease 2019 (COVID-19)), influenza viruses, and respiratory syncytial viruses. For example, patients with severe COVID-19 often exhibit elevated levels of inflammatory cytokines in their lungs, which contributes to lung damage experienced by the COVID-19 patients.

[872] In some embodiments, the methods and solid dosage forms described herein relate to the treatment or prevention of bacterial septic shock, cytokine storm and/or viral infection.

[873] In some embodiments, the methods and solid dosage forms described herein relate to the treatment or prevention of a viral infection such as a respiratory viral infection, such as a coronavirus infection (e.g., a MERS (Middle East Respiratory Syndrome) infection, a severe acute respiratory syndrome (SARS) infection, such as a SARS-CoV-2 infection), an influenza infection, and/or a respiratory syncytial virus infection. In some embodiments, the methods and and solid dosage forms described herein provided herein are for the treatment of a coronavirus infection (e.g., a MERS infection, a severe acute respiratory syndrome (SARS) infection, such as a SARS-CoV-2 infection). In some embodiments, provided herein are methods and solid dosage forms for treating COVID-19.

[874] In some embodiments, the methods and solid dosage forms described herein relate to the treatment or prevention of a viral infection. In some embodiments, the infection is a coronavirus infection, an influenza infection, and/or a respiratory syncytial virus infection. In some embodiments the viral infection is a SARS-CoV-2 infection.

[875] In some embodiments, an additional therapy is administered to the subject. In some embodiments, the additional therapy comprises an antiviral medication. In some embodiments, the additional therapy comprises an antiviral medication such as ribavirin, neuraminidase inhibitor, protease inhibitor, recombinant interferons, antibodies, oseltamivir, zanamivir, peramivir or baloxavir marboxil. In some embodiments, the additional therapy comprises hydroxychloroquine and/or chloroquine. In some embodiments, the additional therapy comprises remdesivir. In some embodiments, the additional therapy comprises plasma from a subject who has recovered from infection by the same virus that is infecting the subject (e.g., plasma from a subject who has recovered from SARS-CoV-2 infection). In some embodiments, the additional therapy comprises an anti-inflammatory agent such as NSAIDs or anti-inflammatory steroids. In some embodiments, the additional therapy comprises dexamethasone.

[876] In some embodiments, the additional therapy comprises an antibody specific for IL-6 and/or the IL-6 receptor. In some embodiments, the additional therapy comprises tocilizumab (Actemra®). In some embodiments, the additional therapy comprises sarilumab (Kevzara®).

[877] In some embodiments, the additional therapy can comprise an anti-viral therapy. For example, the anti-viral therapy can comprise a nucleotide analog, such as remdesivir,galidesivir or clevudine; a viral RNA polymerase inhibitor such as favipiravir or galidesivir; a protease inhibitor such as ritonavir, darunavir, or danoprevir; an inhibitor of viral membrane fusion such as umifenovir; and/or anti-SARS-CoV-2 plasma.

[878] In some embodiments, the additional therapy can comprise an anti-inflammatory therapy. For example, the anti-inflammatory therapy can comprise a corticosteroid; sirolimus; anakinra; filamod; or an antibody. In some embodiments, the antibody can comprise a GMSF inhibitor, such as lenzilumab or gimsilumab; an anti-IL1 beta inhibitor such as canakinumab; an IL-6 inhibitor such as tocilizumab or siltuximab; an IL-6R inhibitor such as sarilumab; and/or a CCR5 antagonist such as leronlimab.

[879] In some embodiments, the additional therapy can comprise a JAK inhibitor such as baricitinib, ruxolitinib, tofacitinib, and/or pacritinib.

[880] In some embodiments, the additional therapy can comprise a TLR7 agonist such as imiquimod or reisquimod.

[881] In some embodiments, the additional therapy can comprise a cell based therapy. For example, the cell based therapy can comprise Remestemcel- L; bone marrow stem cell therapy, such as MultiStem or Bm-Allo-MSC; mesenchymal stromal cells; and/or adiopose derived mesenchymal stem cells such as AstroStem.

[882] In some embodiments, the additional therapy can comprise an ACE receptor inhibitor.

[883] In some embodiments, the additional therapy can comprise a regulator of the Sigma 1 and/or Sigma 2 receptor.

Methods of Making Enhanced Bacteria

[884] In certain aspects, provided herein are methods of making engineered bacteria for the production of the bacteria and/or mEVs (such as smEVs and/or pmEVs) described herein. In some embodiments, the engineered bacteria are modified to enhance certain desirable properties. For example, in some embodiments, the engineered bacteria are modified to enhance the immunomodulatory and/or therapeutic effect of the bacteria and/or

mEVs (such as smEVs and/or pmEVs) (e.g., either alone or in combination with another therapeutic agent), to reduce toxicity and/or to improve bacterial and/or mEV (such as smEV and/or pmEV) manufacturing (e.g., higher oxygen tolerance, improved freeze-thaw tolerance, shorter generation times). The engineered bacteria may be produced using any technique known in the art, including but not limited to site-directed mutagenesis, transposon mutagenesis, knock-outs, knock-ins, polymerase chain reaction mutagenesis, chemical mutagenesis, ultraviolet light mutagenesis, transformation (chemically or by electroporation), phage transduction, directed evolution, CRISPR/Cas9, or any combination thereof.

[885] In some embodiments of the methods provided herein, the bacterium is modified by directed evolution. In some embodiments, the directed evolution comprises exposure of the bacterium to an environmental condition and selection of bacterium with improved survival and/or growth under the environmental condition. In some embodiments, the method comprises a screen of mutagenized bacteria using an assay that identifies enhanced bacterium. In some embodiments, the method further comprises mutagenizing the bacteria (e.g., by exposure to chemical mutagens and/or UV radiation) or exposing them to a therapeutic agent (e.g., antibiotic) followed by an assay to detect bacteria having the desired phenotype (e.g., an *in vivo* assay, an *ex vivo* assay, or an *in vitro* assay).

Examples

Example 1: Powder Preparation Sample Protocol

[886] After desired level of bacterial culture growth is achieved, centrifuge cultures, discard the supernatant, leaving the pellet as dry as possible. Resuspend pellet in desired cryoprotectant solution to create a formulated cell paste. The cryoprotectant may contain, e.g., maltodextrin, sodium ascorbate, sodium glutamate, and/or calcium chloride. Load the formulated cell paste onto stainless steel trays and load into a freeze drier, e.g., operating in automated mode with defined cycle parameters. The freeze dried product is fed into a milling machine and the resulting powder is collected.

[887] Powders are stored (e.g., in vacuum sealed bags) at 2-8 degrees C (e.g., at 4 degrees C), e.g., in a desiccator.

Example 2: Gamma-Irradiation: Sample Protocol:

[888] Powders are gamma-irradiated at 17.5 kGy radiation unit at ambient temperature. Frozen biomasses are gamma-irradiated at 25 kGy radiation unit in the presence of dry ice.

Example 3: Preparation of a capsule comprising *Prevotella histicola*

[889] The following recipe in Table 6 is prepared.

Table 6: *Prevotella histicola* Capsule Composition

Name of ingredient(s)	**Function**	**Reference to standards**	**% w/w**
Prevotella histicola (lyophilized) powder	Active ingredient	NA	30-50%#
Mannitol	Diluent	USP / Ph. Eur.	50-70%#
Magnesium stearate	Lubricant	USP / Ph. Eur.	1.0
Colloidal silicon dioxide	Glidant	USP / Ph. Eur.	0.5
Total Fill Weight			100
Capsules, Size 0	Capsule Shell	1 unit	1 unit

Adjusted based on the potency of drug substance to ensure targeted strength.

[890] The capsule is enteric coated for release at pH 5.5.

[891] The *Prevotella* histicola strain referred to above has been deposited as *Prevotella histicola* Strain B (NRRL accession number B 50329).

Example 4: Preparation of a capsule comprising *Prevotella histicola*

[892] The following recipe in Table 7 is prepared.

Table 7: *Prevotella histicola* Capsule Composition

Name of ingredient(s)	**Function**	**Reference to standards**	**% w/w**
Prevotella histicola (lyophilized) powder	Active ingredient	NA	30-50%#
Mannitol	Diluent	USP / Ph. Eur.	45-70%#
Magnesium stearate	Lubricant	USP / Ph. Eur.	1.0
Colloidal silicon dioxide	Glidant	USP / Ph. Eur.	0.5
Total Fill Weight			100
Capsules, Size 0	Capsule Shell	1 unit	1 unit

Adjusted based on the potency of drug substance to ensure targeted strength.

[893] The capsule is enteric coated for release at pH 5.5.

[894] The *Prevotella histicola* strain referred to above has been deposited as *Prevotella histicola* Strain B (NRRL accession number B 50329).

[895] Batches of enteric coated capsules according to this recipe have been prepared.

Example 5: Preparation of a capsule comprising *Prevotella histicola*

[896] Capsules according to the following recipe in Table 8 were prepared:

Table 8: *Prevotella histicola* Capsule Composition

Name of ingredient(s)	**Function**	**% w/w**
Prevotella histicola (lyophilized) powder	Active ingredient	50
Mannitol	Diluent	48.5
Magnesium Stearate	Lubricant	1.0
Colloidal Silicon Dioxide	Glidant	0.5
Total Fill Weight		100
Capsules[a], Size 0	Capsule Shell	1 unit

[a] Composed of hydroxypropyl methylcellulose and titanium dioxide.

[897] This capsule contained $1.6x10^{11}$ cells.

[898] The Prevotella *histicola* strain referred to above has been deposited as *Prevotella histicola* Strain B (NRRL accession number B 50329).

[899] The capsule was banded with an HPMC-based banding solution.

[900] The banded capsule was enteric coated with a poly(methacrylic acid-co-ethyl acrylate copolymer.

Example 6: Preparation of a capsule comprising *Prevotella histicola*

[901] Capsules according to the recipe in Table 9 are prepared.

Table 9: *Prevotella histicola* Capsule Composition

Name of ingredient(s)	**Function**	**Reference to standards**	**% w/w**
Prevotella histicola (lyophilized) powder	Active ingredient	NA	10-90%#
Mannitol	Diluent	USP / Ph. Eur.	8.5-88.5%#
Magnesium stearate	Lubricant	USP / Ph. Eur.	1.0
Colloidal silicon dioxide	Glidant	USP / Ph. Eur.	0.5
Total Fill Weight			100
Capsules, Size 0	Capsule Shell	1 unit	1 unit

Adjusted based on the potency of drug substance to ensure targeted strength.

[902] The capsule is enteric coated for release at pH 5.5.

[903] The *Prevotella histicola* strain referred to above has been deposited as *Prevotella histicola* Strain B (NRRL accession number B 50329).

[904] Batches of enteric coated capsules according to this recipe have been prepared.

Example 7: Preparation of a capsule comprising *Prevotella histicola*

[905] Capsules according to the following recipe in Table 10 were prepared:

Table 10: *Prevotella histicola* Capsule Composition

Name of ingredient(s)	**Function**	**$1.6x10^{10}$ Cells**	**$8.0x10^{10}$ Cells**	**$1.6x10^{11}$ Cells**
		% w/w	**% w/w**	**% w/w**
Prevotella histicola (lyophilized) powder	Active ingredient	13.51 [b]	90.22 [b]	50
Mannitol	Diluent	84.99 [b]	8.28 [b]	48.5
Magnesium Stearate	Lubricant	1.0	1.0	1.0
Colloidal Silicon Dioxide	Glidant	0.5	0.5	0.5
Total Fill Weight		100	100	100
Capsules[a], Size 0	Capsule Shell	1 unit	1 unit	1 unit

[a] Composed of hydroxypropyl methylcellulose and titanium dioxide.

[b] Adjusted based on the potency of drug substance to ensure targeted strength.

[906] The capsule was banded with an HPMC-based banding solution.

[907] The banded capsule was enteric coated with a poly(methacrylic acid-co-ethyl acrylate copolymer.

Example 8: Preparation of a capsule comprising *Prevotella histicola*

[908] Capsules according to the following recipe in Table 11 were prepared:

Table 11: *Prevotella histicola* Capsule Composition

Name of ingredient(s)	Function	$3.35x10^{11}$ Cells
		% w/w
Prevotella histicola (lyophilized) powder	Active ingredient	50
Mannitol (Pearlitol SD200)	Diluent	48.5
Magnesium Stearate (Ligamed MF-2-V)	Lubricant	1.0
Colloidal Silicon Dioxide (Aerosil 200P)	Glidant	0.5
Total Fill Weight		100
Capsules[a], Size 0	Capsule Shell	1 unit

[a] Swedish orange Vcap capsules

[909] The *Prevotella histicola* strain referred to above has been deposited as *Prevotella histicola* Strain B (NRRL accession number B 50329).

[910] The capsule was banded with an HPMC-based banding solution.

[911] The banded capsule was enteric coated with Eudragit L30-D55, a poly(methacrylic acid-co-ethyl acrylate) copolymer.

[912] In disintegration tests, the enteric coated capsule did not disintegrate at 0.1N HCl media. In pH 6.8 buffer, the capsule disintegrated in less than 11 minutes.

Example 9: Preparation of a capsule comprising *Veillonella parvula*

[913] Capsules according to the following recipe in Table 12 were prepared:

Table 12: *Veillonella parvula* Capsule Composition

	Low Dose % w/w	High Dose % w/w
Veillonella Parvula Strain A powder	5.0	60.0
Mannitol	93.0	38.0
Silicon dioxide	0.5	0.5

Magnesium stearate	1.5	1.5
Total	**100.00**	**100.00**

[914] The *Veillonella parvula* Strain A bacteria in this capsule were gamma-irradiated.

[915] The capsule was banded with an HPMC-based banding solution. The banded capsule was enteric coated with a poly(methacrylic acid-co-ethyl acrylate copolymer.

Example 10: Preparation of a capsule comprising *Veillonella parvula*

[916] The following recipe in Table 13 is prepared:

Table 13: ***Veillonella parvula* Capsule Composition**

Name of ingredient(s)	**Function**	**$4.5x10^{10}$ Cells**	**$1.5x10^{11}$ Cells**
		% w/w	**% w/w**
Veillonella parvula strain A powder (lyophilized)	Active ingredient	10.6 [b]	40.0 [b]
Mannitol	Diluent	87.4 [b]	58.0 [b]
Magnesium Stearate	Lubricant	1.5	1.5
Colloidal Silicon Dioxide	Glidant	0.5	0.5
Total Fill Weight		100.0	100.0
Capsules[a], Size 0	Capsule Shell	1 unit	1 unit

[a] Composed of hydroxypropyl methylcellulose, titanium dioxide, and iron oxide.

[b] Adjusted based on the potency of drug substance to ensure targeted strength.

[917] The capsules are banded and enteric coated after encapsulation to prevent premature capsule disintegration in the stomach.

Example 11: *Lactococcus lactis* Capsule in the absence of Mannitol

[918] In some aspects, a solid dosage form, e.g., capsule, is prepared and no diluent is present. For example, the capsule comprises powder, lubricant and glidant. As one example, the following recipe in Table 14 is prepared:

Table 14: *Lactococcus lactis* Capsule Recipe

Name of ingredient(s)	Function	$1.5x10^{11}$ Cells[b,c]
		% w/w
Lactococcus lactis ssp. cremoris powder (lyophilized)	Active ingredient	98.5
Mannitol	Diluent	0.0
Magnesium Stearate	Lubricant	1.0
Colloidal Silicon Dioxide	Glidant	0.5
Total Fill Weight		100.0
Capsules[a], Size 0	Capsule Shell	1 unit

[a] Composed of hydroxypropyl methylcellulose, titanium dioxide, and iron oxide.

[b] TCC – Total cell count

[c] Total fill weight is adjusted based on the potency of drug substance to ensure 100% targeted strength

Example 12: *Lactococcus lactis* Capsule with microcrystalline cellulose

[919] In some aspects, microcrystalline cellulose can be used as a diluent (e.g., in place of mannitol) in the solid dose forms (such as capsules) provided herein. For example, the following recipe in Table 15 is prepared:

Table 15: Lactococcus lactis Capsule Recipe

Name of ingredient(s)	Function	$3x10^{10}$ Cells [b,c]
		% w/w
Lactococcus lactis ssp. cremoris powder (lyophilized)	Active ingredient	25.1
Microcrystalline cellulose[c]	Diluent	73.4
Magnesium Stearate	Lubricant	1.0
Colloidal Silicon Dioxide	Glidant	0.5
Total Fill Weight		100.0
Capsules[a], Size 0	Capsule Shell	1 unit

[a] Composed of hydroxypropyl methylcellulose and titanium dioxide.

[b] TCC – Total cell count

[c] Total fill weight is adjusted based on the potency of drug substance to ensure 100% targeted strength

Example 13: Representative Strains As Sources for EVs

[920] Secreted microbial extracellular vesicles (smEVs) were isolated from the strains listed in Table J. Information on the Gram staining, cell wall structure, and taxonomic classification for each strain is also provided in Table J.

[921] Bacteria of the taxonomic groups listed in Table J (e.g., class, order, family, genus, species or strain) can be used in the solid dosage forms described herein.

[922] mEVs of bacteria of the taxonomic groups listed in Table J (e.g., class, order, family, genus, species or strain) can be used in the solid dosage forms described herein.

Table J: Strains from which extracellular vesicles (EVs) were isolated

Strain	Gram-stain	Cell envelope structure	Phylum	Class	Order	Family
Parabacteroides distasonis DRLU022118 A ILEUM-6	*Gram-stain-negative*	*diderm*	Bacteroidota	Bacteroidia	Bacteroidales	*Porphyromonadaceae*
Parabacteroides goldsteinii S4	*Gram-stain-negative*	*diderm*	Bacteroidota	Bacteroidia	Bacteroidales	*Porphyromonadaceae*
Prevotella histicola	*Gram-stain-negative*	*diderm*	Bacteroidota	Bacteroidia	Bacteroidales	*Prevotellaceae*
Prevotella histicola	*Gram-stain-negative*	*diderm*	Bacteroidota	Bacteroidia	Bacteroidales	*Prevotellaceae*
Fournierella massiliensis S10 GIMucosa-297	*Gram-stain-negative*	*monoderm*	Firmicutes	Clostridia	Eubacteriales	*Oscillospiraceae (formely Ruminococcaceae)*
Harryflintia acetispora S4-M5	*Gram-stain-negative*	*monoderm*	Firmicutes	Clostridia	Eubacteriales	*Oscillospiraceae*
Blautia massiliensis S1046-4A5	*Gram-stain-negative*	*monoderm*	Firmicutes	Clostridia	Eubacteriales	*Lachnospiraceae*
Mediterraneibacter/[*Ruminococcus*] *gnavus* S10 GIMucosa-412	*Gram-stain-negative*	*monoderm*	Firmicutes	Clostridia	Eubacteriales	*Lachnospiraceae*
Clostridioides difficile S10 GImucosa-525	*Gram-stain-positive*	*monoderm*	Firmicutes	Clostridia	Eubacteriales	*Peptostreptococcaceae*
Aminipila sp. S16-M4	*Gram-stain-positive*	*monoderm*	Firmicutes	Clostridia	Eubacteriales	Clostridiales Family XIII/Incertae sedis

						41/[Eubacteriales, no family]
Megasphaera sp. S29-N3	*Gram-stain-negative*	*diderm*	Firmicutes	Negativicutes	Veillonellales	*Veillonellaceae*
Megasphaera sp. S1007	*Gram-stain-negative*	*diderm*	Firmicutes	Negativicutes	Veillonellales	*Veillonellaceae*
Selenomonas felix S34N-300R	*Gram-stain-negative*	*diderm*	Firmicutes	Negativicutes	Selenomonadales	*Selenomonadaceae*
Veillonella parvula S14Ileum-201	*Gram-stain-negative*	*diderm*	Firmicutes	Negativicutes	Veillonellales	*Veillonellaceae*
Propionispora sp. DSM100705-1A	*Gram-stain-negative*	*diderm*	Firmicutes	Negativicutes	Selenomonadales	*Sporomusaceae*
Rarimicrobium hominis S24RS2-T2-5	*Gram-stain-negative*	*diderm*	Synergistota	Synergistia	Synergistales	*Synergistaceae*
Cloacibacillus evryensis S29-M8	*Gram-stain-negative*	*diderm*	Synergistota	Synergistia	Synergistales	*Synergistaceae*
Veillonella parvula S14-205	*Gram-stain-negative*	*diderm*	Firmicutes	Negativicutes	Veillonellales	*Veillonellaceae*
Veillonella sp/*dispar* ECD01-DP-201	*Gram-stain-negative*	*diderm*	Firmicutes	Negativicutes	Veillonellales	*Veillonellaceae*
Veillonella parvula/dispar ECD01-DP-223	*Gram-stain-negative*	*diderm*	Firmicutes	Negativicutes	Veillonellales	*Veillonellaceae*
Veillonella parvula S16 GIMucosa-95	*Gram-stain-negative*	*diderm*	Firmicutes	Negativicutes	Veillonellales	*Veillonellaceae*

Example 14: Preparation of a Solid Dosage Form comprising *Prevotella histicola* smEVs

[923] Capsule of the recipes in Table 16 were prepared:

Table 16: Compositions of active capsules

Capsules	Low Strength	Medium Strength	High Strength
Prevotella histicola smEVs (drug substance/powder)	10% (LS DS)	10% (HS DS)	90% (HS DS)
Mannitol	87.5%	87.5%	7.5%
SiO2	1.0%	1.0%	1.0%
Magnesium stearate	1.5%	1.5%	1.5%
Capsule filled weight (mg)	360	360	360

[924] The *Prevotella histicola* smEVs in Table 16 are from strain *Prevotella histicola* Strain B 50329 (NRRL accession number B 50329).

[925] HS DS: high strength drug substance.

[926] LS DS: low strength drug substance.

[927] LS DS was prepared by diluting HS DS 10x (using lyophilization excipients) before lyophilization.

[928] To prepare the pharmaceutical composition capsules, wet granulation was performed on the drug substance (pharmaceutical agent) containing the smEVs. Drug substance was (i) mixed with water; (ii) dried on a fluid bed dryer; (iii) milled; (iv) then blended with the drug product excipients provided in Table 16.

[929] The capsules were size 0.

Example 15: Preparation of a capsule comprising *Prevotella histicola*

[930] Capsules according to the following recipe in Table 17 were prepared:

Table 17: Composition of *Prevotella histicola* Coated Capsules – $3.2x10^{11}$ cells/capsule

Name of ingredient(s)	% w/w
Prevotella histicola (lyophilized) powder	49.2[a]
Mannitol	49.3[a]
Magnesium stearate	1.0
Colloidal silicon dioxide	0.5
Total fill weight	100.0
Capsules, Size 0	1 unit

[a] Adjusted based on the potency of drug substance to ensure targeted strength.

[931] The *Prevotella histicola* strain referred to above has been deposited as *Prevotella histicola* Strain B (NRRL accession number B 50329).

[932] The capsule was banded with an HPMC-based banding solution.

[933] The banded capsule was enteric coated with Eudragit L30-D55, a poly(methacrylic acid-co-ethyl acrylate) copolymer.

Example 16: Properties of capsules comprising *Prevotella histicola*

[934] Batch A: A batch of capsules according to the recipe for $1.6x10^{10}$ TCC/capsule in Table 6 was prepared (Batch A). Upon evaluation, the capsules had a TCC of $1.7x\ 10^{10}$ as determined by Couter counter, and a water content of 0.99%, as determined by Karl Fisher (Ph. Eur. 2.5.32). The acceptable TCC range is set at $0.8x10^{10}$ to $2.4x10^{10}$.

[935] Batch B: A batch of capsules according to the recipe for $8x10^{10}$ TCC/capsule in Table 6 was prepared (Batch B). Upon evaluation, the capsules had a TCC of $6.9x\ 10^{10}$ as determined by Couter counter, and a water content of 4.0%, as determined by Karl Fisher (Ph. Eur. 2.5.32). The acceptable TCC range is set at $4x10^{10}$ to $1.2x10^{11}$.

[936] Batch C: A batch of capsules according to the recipe for $8x10^{10}$ TCC/capsule in Table 6 was prepared (Batch C). Upon evaluation, the capsules had a TCC of $7.7x\ 10^{10}$ as determined by Couter counter, and a water content of 5.9%, as determined by Karl Fisher (Ph. Eur. 2.5.32). The acceptable TCC range is set at $4x10^{10}$ to $1.2x10^{11}$.

[937] Batch D: A batch of capsules according to the recipe for $8x10^{10}$ TCC/capsule in Table 6 was prepared (Batch D). Upon evaluation, the capsules had a TCC of $7.6x\ 10^{10}$ as determined by Couter counter, and a water content of 3.4%, as determined by Karl Fisher (Ph. Eur. 2.5.32). The acceptable TCC range is set at $4x10^{10}$ to $1.2x10^{11}$.

[938] Batch E: A batch of capsules according to the recipe for $8x10^{10}$ TCC/capsule in Table 6 was prepared (Batch E). Upon evaluation, the capsules had a TCC of $9.4x\ 10^{10}$ as determined by Couter counter, and a water content of 1.9%, as determined by Karl Fisher (Ph. Eur. 2.5.32). The acceptable TCC range is set at $4x10^{10}$ to $1.2x10^{11}$.

[939] Batch F: A batch of capsules according to the recipe for $3.2x10^{11}$ TCC/capsule in Table 17 was prepared (Batch F). Upon evaluation, the capsules had a TCC of $3.2x\ 10^{11}$ as determined by Couter counter, and a water content of 5.2%, as determined by Karl Fisher (Ph. Eur. 2.5.32). The acceptable TCC range is set at $1.6x10^{11}$ to $4.8x10^{11}$.

[940] Batch G: A batch of capsules according to the recipe for $3.2x10^{11}$ TCC/capsule in Table 17 was prepared (Batch G). Upon evaluation, the capsules had a TCC of $2.9x\ 10^{11}$ as

determined by Couter counter, and a water content of 3.5%, as determined by Karl Fisher (Ph. Eur. 2.5.32). The acceptable TCC range is set at $1.6x10^{11}$ to $4.8x10^{11}$.

Example 17: Batch A Stability Data

[941] The stability of Batch A capsules was assessed.

[942] Capsule Content and Potency: Total Cells/Capsule:

[943] The total cells/capsule was determined for the batch for the durations shown at long-term (2-8°C) and accelerated (25°C / 60% RH (relative humidity)) storage conditions. TCC was determined by Coulter counter. The data are presented in Figure 1. The total cells/capsule for the batch were above 50% of the target value and within stability specifications for both long-term (5°C) and accelerated (25°C / 60% RH (relative humidity)) storage conditions all time points tested.

[944] Water Content:

[945] The water content was determined for the batch for the durations shown for both long-term (2-8°C) and accelerated (25°C / 60% RH) storage conditions for the durations shown. The results are shown in Figure 2. There are no apparent trends in water content on storage indicating that the capsule itself along with blister packaging configuration is providing adequate protection against water ingress.

Example 18: Batch B Stability Data

[946] The stability of Batch B capsules was assessed.

[947] Capsule Content and Potency: Total Cells/Capsule:

[948] The total cells/capsule was determined for the batch for the durations shown at long-term (2-8°C) and accelerated (25°C / 60% RH (relative humidity)) storage conditions. TCC was determined by Coulter counter. The data are presented in Figure 3. The total cells/capsule for the batch were above 50% of the target value and within stability specifications for both long-term (5°C) and accelerated (25°C / 60% RH (relative humidity)) storage conditions all time points tested.

[949] Water Content:

[950] The water content was determined for the batch for the durations shown for both long-term (2-8°C) and accelerated (25°C / 60% RH) storage conditions for the durations

shown. The results are shown in Figure 4. There are no apparent trends in water content on storage indicating that the capsule itself along with blister packaging configuration is providing adequate protection against water ingress.

Example 19: Batch C Stability Data

[951] The stability of Batch C capsules was assessed.

[952] Capsule Content and Potency: Total Cells/Capsule:

[953] The total cells/capsule was determined for the batch for the durations shown at long-term (2-8°C) and accelerated (25°C / 60% RH (relative humidity)) storage conditions. TCC was determined by Coulter counter. The data are presented in Figure 5. The total cells/capsule for the batch were above 50% of the target value and within stability specifications for both long-term (5°C) and accelerated (25°C / 60% RH (relative humidity)) storage conditions all time points tested.

[954] Water Content:

[955] The water content was determined for the batch for the durations shown for both long-term (2-8°C) and accelerated (25°C / 60% RH) storage conditions for the durations shown. The results are shown in Figure 6. There are no apparent trends in water content on storage indicating that the capsule itself along with blister packaging configuration is providing adequate protection against water ingress.

Example 20: Batch F Stability Data

[956] The stability of Batch F capsules was assessed.

[957] Capsule Content and Potency: Total Cells/Capsule:

[958] The total cells/capsule was determined for the batch for the durations shown at long-term (2-8°C) and accelerated (25°C / 60% RH (relative humidity)) storage conditions. TCC was determined by Coulter counter. The data are presented in Figure 7. The total cells/capsule for the batch were above 50% of the target value and within stability specifications for both long-term (5°C) and accelerated (25°C / 60% RH (relative humidity)) storage conditions all time points tested.

[959] Water Content:

[960] The water content was determined for the batch for the durations shown for both long-term (2-8°C) and accelerated (25°C / 60% RH) storage conditions for the durations shown. The results are shown in Figure 8. There are no apparent trends in water content on storage indicating that the capsule itself along with blister packaging configuration is providing adequate protection against water ingress.

Example 21: Preparation of a capsule comprising *Veillonella parvula*

[961] Capsules according to the following recipe in Table 18 were prepared:

Table 18: *Veillonella parvula* Capsule Composition

Name of ingredient(s)	**Function**	**$4.5x10^{10}$ Cells**	**$1.5x10^{11}$ Cells**
		% w/w	**% w/w**
Veillonella parvula strain A powder (lyophilized)	Active ingredient	10.6 [b]	40.0 [b]
Mannitol	Diluent	87.4 [b]	58.0 [b]
Magnesium Stearate	Lubricant	1.5	1.5
Colloidal Silicon Dioxide	Glidant	0.5	0.5
Total Fill Weight		100.0	100.0
Capsules[a], Size 0	Capsule Shell	1 unit	1 unit

[a] Composed of hydroxypropyl methylcellulose, titanium dioxide, and iron oxide.

[b] Adjusted based on the potency of drug substance to ensure targeted strength.

[962] The *Veillonella parvula* Strain A bacteria in these capsules were gamma-irradiated.

[963] The capsules were banded with an HPMC-based banding solution. The banded capsules were enteric coated with a poly(methacrylic acid-co-ethyl acrylate copolymer.

[964] The capsules were banded and enteric coated after encapsulation.

[965] Example 22: Properties of capsules comprising *Veillonella parvula*

[966] $4.5x10^{10}$ dose batch: A batch of capsules according to the recipe for $4.5x10^{10}$ TCC/capsule in Table 2 was prepared. Upon evaluation, the capsules had a TCC of $5x\ 10^{10}$ as determined by Couter counter, and a water content of 1.1%, as determined by Karl Fisher (Ph. Eur. 2.5.32). The acceptable TCC range is set at $2.25x10^{10}$ to $6.75x10^{10}$.

[967] $1.5x10^{11}$ dose batch: A batch of capsules according to the recipe for $1.5x10^{11}$ TCC/capsule in Table 2 was prepared. Upon evaluation, the capsules had a TCC of $1.62x\ 10^{11}$ as determined by Couter counter, and a water content of 3.6%, as determined by Karl Fisher (Ph. Eur. 2.5.32). The acceptable TCC range is set at $7.5x10^{10}$ to $2.25x10^{11}$.

[968] Example 23: Three-Month Stability Data for Low and High Dose Batches

[969] The stability of capsules from the low and high dose batches was assessed.

[970] Capsule Content and Potency: Total Cells/Capsule:

[971] The total cells/capsule was determined for the batches for the durations shown at long-term (2-8°C) (abbreviation: 5°C) storage conditions. TCC was determined by Coulter counter. The data are presented in Figure 9 (low dose batch) and Figure 10 (high dose batch). The total cells/capsule for both batches were within the set stability specification at long term storage for the time points tested to date. For the low dose batch, the acceptance criteria was $\geq 2.25x10^{10}$ cells/capsule, measured as TCC (determined by Coulter counter). For the high dose batch, the acceptance criteria was $\geq 7.5x10^{10}$ cells/capsule, measured as TCC (determined by Coulter counter).

[972] Water Content:

[973] The water content was determined for the batches for the durations shown for both long-term (2-8°C) (abbreviation: 5°C) and accelerated (25°C (± 2 °C) / 60% (±5%) RH (relative humidity)) (abbreviation: 25°C)) storage conditions for the durations shown. The results are shown in Figure 11 (low dose batch) and Figure 12 (high dose batch). There are no apparent trends in water content on storage for low dose or high dose batches indicating that the blister packaging configuration is providing adequate protection against water ingress. The low and high dose drug products are shown to be stable both at regular (5°C) and accelerated temperature (25°C) conditions for up to 3 months.

[974] Example 24: Six-Month Stability Data for Low and High Dose Batches

[975] Six-month stability data were obtained for the low and high dose batches described in Example 23.

[976] Figures 13A and B are graphs showing 6-month Stability Profiles for the high dose batch. Figure 13A is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8°C (abbreviation: 5°C)) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the high dose batch. Total Cell Count (TCC) was determined by Coulter counter. Figure 13B is a graph showing Moisture Content Stability Profile over time long-term (2-8°C) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the high dose batch. Moisture r content was determined by the Karl Fisher method.

[977] Figures 14A and B are graphs showing 6-month Stability Profiles for the low dose batch. Figure 14A is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8°C (abbreviation: 5°C)) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the low dose batch. Total Cell Count (TCC) was determined by Coulter counter. Figure 14B is a graph showing Moisture Content Stability Profile over time long-term (2-8°C) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the low dose batch. Moisture content was determined by the Karl Fisher method.

[978] Example 25: Six-Month Stability Data for Low and High Dose Batches

[979] Six-month stability data were obtained for second low and high dose batches.

[980] Figures 15A and B are graphs showing 6-month Stability Profiles for a second high dose batch. Figure 15A is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8°C (abbreviation: 5°C)) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the second high dose batch. Total Cell Count (TCC) was determined by Coulter counter. Figure 15B is a graph showing Moisture Content Stability Profile over time long-term (2-8°C) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the second high dose batch. Moisture content was determined by the Karl Fisher method.

[981] Figures 16A and B are graphs showing 6-month Stability Profiles for a second low dose batch. Figure 16A is a graph showing Total Cells/Capsule Stability Profile over time long-term (2-8°C (abbreviation: 5°C)) and accelerated (25°C / 60% RH (abbreviation:

25°C)) storage conditions for the second dose batch. Total Cell Count (TCC) was determined by Coulter counter. Figure 16B is a graph showing Moisture Content Stability Profile over time long-term (2-8°C) and accelerated (25°C / 60% RH (abbreviation: 25°C)) storage conditions for the secondlow dose batch. Moisture content was determined by the Karl Fisher method.

Incorporation by Reference

[982] All publications patent applications mentioned herein are hereby incorporated by reference in their entirety as if each individual publication or patent application was specifically and individually indicated to be incorporated by reference. In case of conflict, the present application, including any definitions herein, will control.

Equivalents

[983] Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific embodiments of the invention described herein. Such equivalents are intended to be encompassed by the following claims.

Claims

What is claimed is:

1. A solid dosage form of a pharmaceutical composition comprising:

a pharmaceutical agent having a total pharmaceutical agent mass that is at least 2.5% and no more than 95% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises bacteria and/or microbial extracellular vesicles (mEVs) derived therefrom;

a diluent having a total mass that is at least 1% and no more than 98% of the total mass of the pharmaceutical composition;

a lubricant having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and

a glidant having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition.

2. The solid dosage form of claim 1, wherein the bacteria are Gram positive bacteria.

3. The solid dosage form of claim 1, wherein the bacteria are Gram negative bacteria.

4. The solid dosage form of any one of claims 1 to 3, wherein the bacteria are aerobic bacteria.

5. The solid dosage form of any one of claims 1 to 3, wherein the bacteria are anaerobic bacteria.

6. The solid dosage form of any one of claims 1 to 5, wherein the bacteria are acidophile bacteria.

7. The solid dosage form of any one of claims 1 to 5, wherein the bacteria are alkaliphile bacteria.

8. The solid dosage form of any one of claims 1 to 5, wherein the bacteria are neutralophile bacteria.

9. The solid dosage form of any one of claims 1 to 8, wherein the bacteria are fastidious bacteria.

10. The solid dosage form of any one of claims 1 to 8, wherein the bacteria are nonfastidious bacteria.

11. The solid dosage form of any one of claims 1 to 10, wherein the bacteria are from a taxonomic group (e.g., class, order, family, genus, species or strain) listed in Table 1, Table 2, or Table 3.

12. The solid dosage form of any one of claims 1 to 10, wherein the bacteria are from a bacterial strain listed in Table 1, Table 2, or Table 3.

13. The solid dosage form of any one of claims 1 to 10, wherein the bacteria are from bacteria from a taxonomic group (e.g., class, order, family, genus, species or strain) listed in Table J.

14. The solid dosage form of any one of claims 1 to 10, wherein the bacteria are from a bacterial strain listed in Table J.

15. The solid dosage form of claim 1, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is at least 5% and no more than 95% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises *Prevotella histicola* bacteria or microbial extracellular vesicles (mEVs) derived therefrom; and

the diluent has a total mass that is at least 1% and no more than 95% of the total mass of the pharmaceutical composition.

16. The solid dosage form of claim 15, wherein the *Prevotella histicola* is *Prevotella histicola* Strain B (NRRL accession number B 50329).

17. The solid dosage form of claim 1, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is at least 2.5% and no more than 70% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises *Veillonella parvula* bacteria or microbial extracellular vesicles (mEVs) derived therefrom;

the diluent has a total mass that is at least 30% and no more than 98% of the total mass of the pharmaceutical composition;

the lubricant has a total mass that is at least 0.5% and no more than 2.5% of the total mass of the pharmaceutical composition; and

the glidant has a total mass that is at least 0.1% and no more than 1% of the total mass of the pharmaceutical composition.

18. The solid dosage form of claim 17, wherein the *Veillonella parvula* is *Veillonella parvula* Strain A (ATCC Deposit Number PTA-125691).

19. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is at least 4% and no more than 65% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is at least 35% and no more than 95% of the total mass of the pharmaceutical composition.

20. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 5% to about 60% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 38% to 93% of the total mass of the pharmaceutical composition.

21. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is at least 20% and no more than 55% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is at least 45% and no more than 80% of the total mass of the pharmaceutical composition.

22. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 8% to about 92% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 5% to 90% of the total mass of the pharmaceutical composition.

23. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 20% to about 50% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 50% to 80% of the total mass of the pharmaceutical composition.

24. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 30% to about 50% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 45% to 70% of the total mass of the pharmaceutical composition.

25. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 50% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 48.5% of the total mass of the pharmaceutical composition.

26. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 8% to about 92% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 5% to 90% of the total mass of the pharmaceutical composition.

27. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 10% to about 90% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 8.5% to 88.5% of the total mass of the pharmaceutical composition.

28. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 13.51% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 84.99% of the total mass of the pharmaceutical composition.

29. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 90.22% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 8.28% of the total mass of the pharmaceutical composition.

30. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 5% to about 50% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 50% to 95% of the total mass of the pharmaceutical composition.

31. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 8% to about 45% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 55% to 90% of the total mass of the pharmaceutical composition.

32. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 40% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 58% of the total mass of the pharmaceutical composition.

33. The solid dosage form of any one of claims 1-18, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 10.6% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 87.4% of the total mass of the pharmaceutical composition.

34. The solid dosage form of any one of claims 1 to 33, wherein the diluent comprises mannitol.

35. The solid dosage form of any one of claims 1 to 34, wherein the lubricant comprises magnesium stearate.

36. The solid dosage form of any one of claims 1 to 35, wherein the glidant comprises colloidal silicon dioxide.

37. The solid dosage form of any one of claims 1 to 36, wherein the diluent comprises mannitol; the lubricant comprises magnesium stearate; and the glidant comprises colloidal silicon dioxide.

38. The solid dosage form of any one of claims 1 to 37, wherein the pharmaceutical agent comprises bacteria.

39. The solid dosage form of claim 38, wherein the bacteria are lyophilized bacteria.

40. The solid dosage form of any one of claims 1 to 39, wherein the pharmaceutical agent comprises isolated bacteria (e.g., from one or more strains of bacteria (e.g., bacteria of interest) (e.g., a therapeutically effective amount thereof)).

41. The solid dosage form of any one of claims 1 to 40, wherein the pharmaceutical agent comprises bacteria that have been gamma irradiated, UV irradiated, heat inactivated, acid treated, or oxygen sparged.

42. The solid dosage form of any one of claims 1 to 41, wherein the pharmaceutical agent comprises live bacteria.

43. The solid dosage form of any one of claims 1 to 41, wherein the pharmaceutical agent comprises dead bacteria.

44. The solid dosage form of any one of claims 1 to 41, wherein the pharmaceutical agent comprises non-replicating bacteria.

45. The solid dosage form of any one of claims 1 to 44, wherein the pharmaceutical agent comprises bacteria from one strain of bacteria.

46. The solid dosage form of any one of claims 1 to 45, wherein the bacteria are lyophilized (e.g., the lyophilized product further comprises a pharmaceutically acceptable excipient) (e.g., a powder form).

47. The solid dosage form of any one of claims 1 to 46, wherein the bacteria are gamma irradiated.

48. The solid dosage form of any one of claims 1 to 46, wherein the bacteria are UV irradiated.

49. The solid dosage form of any one of claims 1 to 46, wherein the bacteria are heat inactivated (e.g., at 50°C for two hours or at 90°C for two hours).

50. The solid dosage form of any one of claims 1 to 46, wherein the bacteria are acid treated.

51. The solid dosage form of any one of claims 1 to 46, wherein the bacteria are oxygen sparged (e.g., at 0.1 vvm for two hours).

52. The solid dosage form of any one of claims 1 to 51, wherein the pharmaceutical agent comprises microbial extracellular vesicles (mEV).

53. The solid dosage form of any one of claims 1 to 52, wherein the pharmaceutical agent comprises isolated mEVs (e.g., from one or more strains of bacteria (e.g., bacteria of interest)) (e.g., a therapeutically effective amount thereof).

54. The solid dosage form of any one of claims 1 to 53, wherein the pharmaceutical agent comprises mEVs and the mEVs comprise secreted mEVs (smEVs).

55. The solid dosage form of any one of claims 1 to 53, wherein the pharmaceutical agent comprises mEVs and the mEVs comprise processed mEVs (pmEVs).

56. The solid dosage form of any one of claims 1 to 53, wherein the pharmaceutical agent comprises pmEVs and the pmEVs are produced from bacteria that have been gamma irradiated, UV irradiated, heat inactivated, acid treated, or oxygen sparged.

57. The solid dosage form of any one of claims 1 to 53, wherein the pharmaceutical agent comprises pmEVs and the pmEVs are produced from live bacteria.

58. The solid dosage form of any one of claims 1 to 53, wherein the pharmaceutical agent comprises pmEVs and the pmEVs are produced from dead bacteria.

59. The solid dosage form of any one of claims 1 to 53, wherein the pharmaceutical agent comprises pmEVs and the pmEVs are produced from non-replicating bacteria.

60. The solid dosage form of any one of claims 1 to 59, wherein the pharmaceutical agent comprises mEVs and the mEVs are from one strain of bacteria.

61. The solid dosage form of any one of claims 1 to 60, wherein the mEVs are lyophilized (e.g., the lyophilized product further comprises a pharmaceutically acceptable excipient).

62. The solid dosage form of any one of claims 1 to 61, wherein the mEVs are gamma irradiated.

63. The solid dosage form of any one of claims 1 to 61, wherein the mEVs are UV irradiated.

64. The solid dosage form of any one of claims 1 to 61, wherein the mEVs are heat inactivated (e.g., at 50°C for two hours or at 90°C for two hours).

65. The solid dosage form of any one of claims 1 to 61, wherein the mEVs are acid treated.

66. The solid dosage form of any one of claims 1 to 65, wherein the mEVs are oxygen sparged (e.g., at 0.1 vvm for two hours).

67. The solid dosage form of any one of claims 1 to 51, wherein the pharmaceutical agent comprises bacteria and the dose of bacteria is about 1 x 10^7 to about 2 x 10^{12} (e.g., about 3 x 10^{10} or about 1.5 x 10^{11} or about 1.5 x 10^{12}) cells, wherein the dose is per capsule or tablet or per total number of minitablets in a capsule.

68. The solid dosage form of any one of claims 1 to 51, wherein the pharmaceutical agent comprises bacteria and the dose of bacteria is about 1 x 10^9, about 3 x 10^9, about 5 x 10^9, about 1.5 x 10^{10}, about 3 x 10^{10}, about 5 x 10^{10}, about 1.5 x 10^{11}, about 1.5 x 10^{12}, or about 2 x 10^{12} cells, wherein the dose is per capsule or tablet or per total number of minitablets in a capsule.

69. The solid dosage form of any one of claims 1 to 68, wherein the pharmaceutical agent comprises bacteria and/or mEVs and the dose of the pharmaceutical agent (e.g., bacteria and/or mEVs) is about 10 mg to about 1500 mg, wherein the dose is per capsule or tablet or per total number of minitablets in a capsule.

70. The solid dosage form of any one of claims 1 to 68, wherein the pharmaceutical agent comprises bacteria and/or mEVs and the dose of the pharmaceutical agent (e.g., bacteria and/or mEVs) is about 30 mg to about 1300 mg (by weight of bacteria and/or mEVs) (about 25, about 30, about 35, about 50, about 75, about 100, about 120, about 150, about 250, about 300, about 350, about 400, about 500, about 600, about 700, about 750, about 800, about 900, about 1000, about 1100, about 1200, about 1250, about 1300, about 2000, about 2500, about 3000, or about 3500 mg, wherein the dose is per capsule or tablet or per total number of minitablets in a capsule.

71. The solid dosage form of any one of claims 1 to 70, wherein the pharmaceutical agent comprises bacteria and/or mEVs and the dose of the pharmaceutical agent (e.g., bacteria and/or mEVs) is about 2x10^6 to about 2x10^{16} particles (e.g., wherein particle count is determined by NTA (nanoparticle tracking analysis)), wherein the dose is per capsule or tablet or per total number of minitablets in a capsule.

72. The solid dosage form of any one of claims 1 to 71, wherein the pharmaceutical agent comprises bacteria and/or mEVs and the dose of the pharmaceutical agent (e.g., bacteria and/or mEVs) is about 5 mg to about 900 mg total protein (e.g., wherein total protein is

determined by Bradford assay or BCA), wherein the dose is per capsule or tablet or per total number of minitablets in a capsule.

73. The solid dosage form of any one of claims 1 to 72, wherein the solid dosage form further comprises one or more therapeutic agents.

74. The solid dosage form of any one of claims 1 to 73, wherein the solid dosage form further comprises an excipient (e.g., an excipient described herein, e.g., a diluent, a binder and/or an adhesive, a disintegrant, a lubricant and/or a glidant, a coloring agent, a flavoring agent, and/or a sweetening agent).

75. The solid dosage form of any one of claims 1 to 74, wherein the solid dosage form is a capsule.

76. The solid dosage form of claim 75, wherein the capsule comprises HPMC.

77. The solid dosage form of claim 75, wherein the capsule is banded with an HPMC-based banding solution.

78. The solid dosage form of any one of claims 1 to 77, further comprising an enteric coating.

79. The solid dosage form of any one of claims 1 to 78, wherein the enteric coating comprises a methacrylic acid ethyl acrylate (MAE) copolymer (1:1).

80. The solid dosage form of any one of claims 1 to 79, wherein the enteric coating comprises cellulose acetate phthalate (CAP), cellulose acetate trimellitate (CAT), poly(vinyl acetate phthalate) (PVAP), hydroxypropyl methylcellulose phthalate (HPMCP), a fatty acid, a wax, shellac (esters of aleurtic acid), a plastic, a plant fiber, zein, Aqua-Zein (an aqueous zein formulation containing no alcohol), amylose starch, a starch derivative, a dextrin, a methyl acrylate-methacrylic acid copolymer, cellulose acetate succinate, hydroxypropyl methyl cellulose acetate succinate (hypromellose acetate succinate), a methyl methacrylate-methacrylic acid copolymer, or sodium alginate.

81. The solid dosage form of any one of claims 1 to 80, wherein the enteric coating comprises an anionic polymeric material.

82. A method of preventing or treating a disease of a subject, the method comprising administering to the subject a solid dosage form of any one of claims 1 to 81.

83. Use of a solid dosage form of any one of claims 1 to 81 for the treatment or prevention of a disease of a subject.

84. Use of a solid dosage form of any one of claims 1 to 81 for the preparation of a medicament for treating or preventing a disease in a subject.

85. The solid dosage form of any one of claims 1 to 81 for use in the treatment or prevention of a disease of a subject.

86. A method of preventing or treating a disease of a subject, the method comprising administering to the subject a solid dosage form of any one of claims 1 to 81.

87. Use of a solid dosage form of any one of claims 1 to 81 for the treatment or prevention of a disease of a subject.

88. Use of a solid dosage form of any one of claims 1 to 81 for the preparation of a medicament for treating or preventing a disease in a subject.

89. A solid dosage form of any one of claims 1 to 81 for use in the treatment or prevention of a disease of a subject.

90. The method/solid dosage form/use of any one of claims 82 to 89, wherein the solid dosage form is orally administered (e.g., is for oral administration).

91. The method/solid dosage form/use of any one of claims 82 to 89, wherein the solid dosage form is administered on an empty stomach (e.g., one hour before eating or two hours after eating).

92. The method/solid dosage form/use of any one of claims 82 to 89, wherein the solid dosage form is administered (e.g., is for administration) 1, 2, 3, or 4 times a day.

93. The method/solid dosage form/use of any one of claims 82 to 89, wherein the solid dosage form comprises a capsule and 1, 2, 3, or 4 solid dosage forms are administered (e.g., are for administration) 1, 2, 3, or 4 times a day.

94. The method/solid dosage form/use of any one of claims 82 to 93, wherein the subject is in need of treatment (and/or prevention) of a cancer.

95. The method/solid dosage form/use of any one of claims 82 to 93, wherein the subject is in need of treatment (and/or prevention) of an autoimmune disease.

96. The method/solid dosage form/use of any one of claims 82 to 93, wherein the subject is in need of treatment (and/or prevention) of an inflammatory disease.

97. The method/solid dosage form/use of any one of claims 82 to 93, wherein the subject is in need of treatment (and/or prevention) of a metabolic disease.

98. The method/solid dosage form/use of any one of claims 82 to 97, wherein the subject is in need of treatment (and/or prevention) of a dysbiosis.

99. The method/solid dosage form/use of any one of claims 82 to 98, wherein the solid dosage form is administered in combination with a therapeutic agent.

100. A method of preparing a solid dosage form of a pharmaceutical composition, the method comprising:

(a) combining into a pharmaceutical composition:

(i) a pharmaceutical agent having a total pharmaceutical agent mass that is at least 2.5% and no more than 95% of the total mass of the pharmaceutical composition, wherein the pharmaceutical agent comprises bacteria and/or microbial extracellular vesicles (mEVs);

(ii) a diluent having a total mass that is at least 1% and no more than 98% of the total mass of the pharmaceutical composition;

(iii) a lubricant having a total mass that is at least 0.1% and no more than 5% of the total mass of the pharmaceutical composition; and

(iv) a glidant having a total mass that is at least 0.01% and no more than 2% of the total mass of the pharmaceutical composition; and

(b) loading the pharmaceutical composition into a capsule.

101. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is at least 4% and no more than 65% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is at least 35% and no more than 95% of the total mass of the pharmaceutical composition.

102. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 5% to about 60% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 38% to 93% of the total mass of the pharmaceutical composition.

103. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is at least 20% and no more than 55% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is at least 45% and no more than 80% of the total mass of the pharmaceutical composition.

104. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 8% to about 92% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 5% to 90% of the total mass of the pharmaceutical composition.

105. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 20% to about 50% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 50% to 80% of the total mass of the pharmaceutical composition.

106. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 30% to about 50% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 45% to 70% of the total mass of the pharmaceutical composition.

107. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 50% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 48.5% of the total mass of the pharmaceutical composition.

108. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 8% to about 92% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 5% to 90% of the total mass of the pharmaceutical composition.

109. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 10% to about 90% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 8.5% to 88.5% of the total mass of the pharmaceutical composition.

110. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 13.51% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 84.99% of the total mass of the pharmaceutical composition.

111. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 90.22% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 8.28% of the total mass of the pharmaceutical composition.

112. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 5% to about 50% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 50% to 95% of the total mass of the pharmaceutical composition.

113. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 8% to about 45% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 55% to 90% of the total mass of the pharmaceutical composition.

114. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 40% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 58% of the total mass of the pharmaceutical composition.

115. The method of claim 100, wherein:

the pharmaceutical agent has a total pharmaceutical agent mass that is about 10.6% of the total mass of the pharmaceutical composition; and

the diluent has a total mass that is about 87.4% of the total mass of the pharmaceutical composition.

116. The method of any one of claims 100 to 115, further comprising the step of enterically coating the solid dosage form to obtain an enterically coated solid dosage form.

117. The method of any one of claims 100 to 116, further comprising the step of performing wet granulation on the pharmaceutical agent prior to the combining step.

118. A method of performing wet granulation on a pharmaceutical agent comprising bacteria and/or microbial extracellular vesicles (mEVs), the method comprising:

(i) mixing the pharmaceutical agent with a granulating fluid;

(ii) drying mixed pharmaceutical agent and granulating fluid; and

(iii) milling the dried pharmaceutical agent and granulating fluid;

wherein the milled pharmaceutical agent and granulating fluid are then combined with the one or more excipients to prepare a pharmaceutical composition.

119. The method of claim 118, wherein the wet granulation comprises mixing the pharmaceutical agent with water.