CLAIMS

1. A method of treating or preventing a disease, disorder, or condition associated with one or more of inflammation, immune dysfunction, cancer, allergy, or dysbiosis of the intestinal microbiome in a subject in need thereof, the method comprising administering to the subject i) a prebiotic mixture comprising one or more human milk oligosaccharides and ii) at least one probiotic strain of bacterium capable of consuming the one or more human milk oligosaccharides; wherein the subject has undergone or will undergo a bacteriotherapy.

2. The method of any of claims 1, wherein the bacteriotherapy comprises one or more bacteria species, subspecies, or strains obtained from, isolated from, derived from, or present in a human intestinal microbiome.

3. The method any of claims 1 or 2, wherein the bacteriotherapy comprises one or more bacteria species, subspecies, or strains obtained from, isolated from, derived from, or present in a human stool.

4. The method of any of claims 1-3, wherein the bacteriotherapy comprises all or a portion of the bacteria present in a human stool or in a human intestinal microbiome.

5. The method of any of claims 1-4, wherein the bacteriotherapy comprises a fecal microbiota transfer composition.

6. The method of any of claims 1-5, wherein the bacteriotherapy comprises one or more bacterial species, subspecies, or strains that have been enriched, purified, or isolated from a stool sample obtained from of one or more healthy donors.

7. The method of claim 6, wherein the one or more bacterial species, subspecies, or strains were isolated from the stool of one or more healthy donors by a method comprising fractionating, gradient purification, solvent treatment, heat treatment, acid treatment, or immunoprecipitation.

8. The method of any of claims 1-7, wherein the bacteriotherapy is incubated in culture prior to administration to the subject.

9. The method of claim 8, wherein the bacteriotherapy is incubated in the presence of an enrichment agent prior to administration to the subject, wherein the enrichment agent comprises a human milk oligosaccharide, the prebiotic mixture, a short chain fatty acid, acetate, butyrate, or lactate.

10. The method of any of claims 1-9, wherein the bacteriotherapy comprises at least one butyrate producing strain of bacterium.

11. A method of treating or preventing a disease, disorder, or condition associated with one or more of inflammation, immune dysfunction, cancer, allergy, or dysbiosis of the intestinal microbiome in a subject in need thereof, the method comprising administering to the subject i) a prebiotic mixture comprising one or more human milk oligosaccharides, ii) at least one probiotic strain of bacterium capable of consuming the one or more human milk oligosaccharides; and iii) at least one butyrate producing strain of bacterium.

12. The method of any of claims 10 or 11, wherein the at least one butyrate producing strain is administered orally.

13. The method of any of claims 10-12, wherein the at least one butyrate producing strain comprises between one and five strains of butyrate producing bacteria.

14. The method of any of claims 10-13, wherein the at least one butyrate producing strain comprises a strain of Clostridium Cluster IV or Clostridium Cluster XIVa bacteria.

15. The method of any of claims 10-14, wherein the at least one butyrate producing strain comprises a 16S nucleic sequence having at least 95%, 98%, 99%, or 100% identity to any sequence set forth in SEQ ID NOS: 77-167.

~~16. The method of any of claims 10-15, wherein the at least one butyrate producing strain comprises one or more of *Agathobacter rectalis*, *Anaerobutyricum hallii*, *Anaerostipes caccae*, *Blautia producta*, *Clostridium leptum*, *Faecalibacterium prausnitzii*, *Anaerobutyricum soehngenii*, *Roseburia hominis*, or *Roseburia intestinalis*.~~

~~17. The method of any of claims 10-15, wherein the at least one butyrate producing strain comprises one or more of *Anaerostipes caccae*, *Clostridium innocuum*, *Roseburia hominis*, or *Roseburia intestinalis*.~~

~~18. The method of any of claims 1-17, wherein the at least one probiotic strain comprises a species, subspecies, or strain of the genus *Bifidobacterium*.~~

~~19. The method of any claims 1-18, wherein the at least one probiotic strain comprises *B. breve*, *B. bifidum*, *B. longum* subsp. *infantis*, or *B. longum* subsp. *longum*.~~

~~20. The method of any claims 1-19, wherein the at least one probiotic strain comprises *B. longum* subsp. *infantis*.~~

~~21~~1. ~~A method of treating or preventing a disease, disorder, or condition associated with one or more of inflammation, immune dysfunction, cancer, allergy, or dysbiosis of the intestinal microbiome in a subject in need thereof, the method comprising administering to the subject~~Use of i) a prebiotic mixture comprising one or more human milk oligosaccharides, ii) at least one probiotic strain of bacterium, wherein the at least one probiotic strain comprises *B. longum* subsp. *infantis*; and iii) at least one butyrate producing strain of bacterium, wherein the at least one butyrate producing strain comprises one or more of *Agathobacter rectalis, Anaerobutyricum hallii, Anaerostipes caccae, Blautia producta , Clostridium innocuum, Clostridium leptum, Faecalibacterium prausnitzii, Anaerobutyricum soehngenii, Roseburia hominis,* or *Roseburia intestinalis*~~.~~ in the manufacture of a medicament for treating or preventing a disease, disorder, or condition associated with one or more of inflammation, immune

dysfunction, cancer, allergy, or dysbiosis of the intestinal microbiome in a subject in need thereof.

~~22~~2. The ~~method~~ use of ~~any of claims 1-21~~ claim 1, wherein the prebiotic mixture comprises one or more of 2'-fucosyllactose, 3-fucosyllactose, difucosyllactose, 3'-sialyllactose, 6'-sialyllactose, Lacto-N-tetraose, Lacto-N-neo-tetraose, Lacto-N-fucopentaose I, Lacto-N-fucopentaose II, Lacto-N-fucopentaose III, Sialyl-lacto-N-tetraose a, Sialyl-lacto-N-tetraose b, Sialyl-lacto-N-tetraose c, Lacto-N-difuco-hexaose I, Lacto-N-difuco-hexaose II, Lacto-N-hexaose, para-Lacto-N-hexaose, Disialyllacto-N-tetraose, Fucosyl-Lacto-N-hexaose, Difucosyl-Lacto-N-hexaose a, Difucosyl-Lacto-N-hexaose b, lactodifucotetraose, 6'galactosyllactose, 3'galactosyllactose, 3-Sialyl-3-fucosyllactose, Sialylfucosyllacto-N-tetraose, Sialyllacto-N-fucopentaose V, disialyl-lacto-n-fucopentaose II, disialyl-lacto-n-fucopentaose V, Lacto-N-neo-difucohexaose II, 3-Fucosyl-sialylacto-N-tetraose c, para-Lacto-N-neohexose, Lacto-N-octaose, Lacto-N-neooctaose, Lacto-N-neohexaose, Lacto-N-fucopentaose V, iso-Lacto-N-octaose, para-Lacto-N-octaose, Lacto-decaose, or Sialyl-lacto-N-fucopentaose I.

~~23~~3. The ~~method~~ use of ~~any of claims 1-22~~ claim 1 or claim 2, wherein the prebiotic mixture comprises one or more of 2'-fucosyllactose, 3-fucosyllactose, 3'-sialyllactose, 6'-sialyllactose, lacto-N-tetraose, lacto-N-difucohexaose I, lactodifucotetraose, lacto-N-fucopentaose I, sialylacto-N-tetraose c, sialylacto-N-tetraose b, or disialyllacto-N-tetraose.

~~24~~4. The ~~method~~ use of any of claims ~~1-23~~ 1-3, wherein the prebiotic mixture comprises one or more of 2'-fucosyl-lactose, 3-fucosyllactose, 3'-sialyllactose, 6'-sialyllactose, Lacto-N-tetraose, lacto-N-neotetraose, or difucosyllactose.

~~25~~5. The ~~method~~ use of any of claims ~~1-24~~ 1-4, wherein the prebiotic mixture comprises one or more of 2'-fucosyllactose, 3-fucosyllactose, Lacto-N-tetraose, or lacto-N-neotetraose.

~~26~~6. The ~~method~~ use of any of claims ~~1-25~~ 1-5, wherein the prebiotic mixture comprises one or both of 2'-fucosyllactose and lacto-N-neotetraose.

~~27~~7. The ~~method~~ use of any of claims ~~1-26~~ 1-6, wherein the prebiotic mixture comprises at least 10, at least 25, at least 50, at least 100, or at least 150 human milk oligosaccharides.

~~28~~8. The ~~method~~ use of any of claims ~~1-27~~ 1-7, wherein the prebiotic mixture comprises 2'-fucosyllactose, 3-fucosyllactose, 3'-sialyllactose, 6'-sialyllactose, lacto-N-tetraose, lacto-N-difucohexaose I, lactodifucotetraose, lacto-N-fucopentaose I, sialylacto-N-tetraose c, sialylacto-N-tetraose b, and disialyllacto-N-tetraose.

~~29~~9. The ~~method~~ use of any of claims ~~1-28~~ 1-8, wherein the prebiotic mixture is, is derived from, or comprises a concentrated human milk permeate, wherein the concentrated human milk permeate is obtained by a process comprising the steps of ultra-filtering human skim milk to obtain human milk permeate and concentrating the human milk oligosaccharide content of the human milk permeate.

~~30~~10. The ~~method~~ use of claim ~~29~~ 9, wherein the human skim milk is obtained from human milk pooled from at least 25, 50, or 100 individual donors.

~~31. A method of treating or preventing a disease, disorder, or condition associated with one or more of inflammation, immune dysfunction, cancer, allergy, or dysbiosis of the intestinal microbiome in a subject in need thereof, the method administering to the subject (i) a prebiotic mixture comprising at least 10, at least 25, or at least 50 human milk oligosaccharides, wherein the human milk oligosaccharides comprise 2'-fucosyllactose, 3-fucosyllactose, 3'-sialyllactose, 6'-sialyllactose, lacto-N-tetraose, lacto-N-difucohexaose I, lactodifucotetraose, lacto-N-fucopentaose I, sialylacto-N-tetraose c, sialylacto-N-tetraose b, and disialyllacto-N-tetraose and (ii) a probiotic strain of bacterium, wherein the probiotic strain is *B. longum* subsp. *infantis*; wherein the subject has undergone or will undergo a bacteriotherapy.~~

~~32. The method of claim 31, wherein the bacteriotherapy comprises oral administration of at least one butyrate producing strain of bacterium, wherein the butyrate~~

~~comprises one or more of *Agathobacter rectalis, Anaerobutyricum hallii, Anaerostipes caccae, Blautia producta, Clostridium innocuum, Clostridium leptum, Faecalibacterium prausnitzii, Anaerobutyricum soehngenii, Roseburia hominis,* or *Roseburia intestinalis.*~~

~~33~~11. The ~~method~~ use of any of claims ~~1-32~~ 1-10, wherein the subject has, is suspected of having, or is at risk of having one or more of obesity, type II diabetes, a chronic inflammatory disease, an autoimmune disease, an infection, an infectious disease domination, bowel resection, a condition associated with chronic diarrhea, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), short bowel syndrome (SBS), celiac disease, small intestinal bacterial overgrowth (SIBO), gastroenteritis, leaky gut syndrome, pouchitis, gastric lymphoma, bacterial, viral, or parasitic infection or overgrowth, infection by drug-resistant bacteria, cancer, or graft versus host disease.

~~34. The method of any of claims 1-33, wherein one or both of the prebiotic mixture or the probiotic strain are administered prior to administration of the bacteriotherapy.~~

~~35. The method of any of claims 1-34, wherein one or both of the prebiotic mixture or the probiotic strain are administered within 28 days, 21 days, 14 days, 7 days, 5 days, 3 days, or 1 day prior to administration of the bacteriotherapy.~~

~~36. The method of any of claims 1-35, wherein the prebiotic mixture and the probiotic strain are both administered on the same days for at least 3, 5, 7, 14, 21, or 28 consecutive days prior to administration of the bacteriotherapy.~~

~~37. The method of any of claims 1-36, wherein one or both of the prebiotic mixture or the probiotic strain are administered after administration of the bacteriotherapy.~~

~~38. The method of any of claims 1-37, wherein one or both of the prebiotic mixture or the probiotic strain are administered within 28 days, 21 days, 14 days, 7 days, 5 days, 3 days, or 1 day after administration of the bacteriotherapy.~~

~~39. The method of any of claims 1-38, wherein the prebiotic mixture and the probiotic strain are both administered on the same days for at least 3, 5, 7, 14, 21, or 28 consecutive days after to administration of the bacteriotherapy.~~

~~40. The method of any claims 1-39, wherein one or both of the prebiotic mixture and the probiotic strain are administered orally.~~

~~41~~12. The ~~method~~ use of any of claims ~~1-40~~ 1-11, wherein the probiotic strain and/or the butyrate producing strain of bacterium is to be administered in an amount of at least 1 x 10^2, 1 x 10^3, 1 x 10^4, 1 x 10^5, 1 x 10^6, 5 x 10^6, 1 x 10^7, 5 x 10^7, 1 x 10^8, 5 x 10^8, 1 x 10^9, 1 x 10^{10}, 5 x 10^{10}, 5 x 10^{11}, or 1 x 10^{12} colony forming units (CFU) per day.

~~42~~13. The ~~method~~ use of any of claims ~~1-41~~1-12, wherein the probiotic strain and/or the butyrate producing strain of bacterium is to be administered in an amount of between 1 x 10^7 and 1 x 10^{10} colony forming units (CFU) per day.

~~43. The method of any of claims 1-42, wherein the prebiotic mixture and/or the probiotic strain is administered with an enteric coating.~~

~~44~~14. The ~~method~~ use of any of claims ~~1-43~~ 1-13, wherein the prebiotic mixture is to be administered in an amount of at least 100 mg, 500 mg, 1 g, 2 g, 3 g, 4 g, 5 g, or 10 g total human milk oligosaccharides per day.

~~45~~15. The ~~method~~ use of any of claims ~~1-44~~ 1-14, wherein the prebiotic mixture is to be administered in an amount of between 100 mg and 50 g, 500 mg and 25 g, 1 g and 5 g, 2 g and 3 g, 3 g and 6 g, 5 g and 10 g, 8 g and 10 g, 10 g and 20 g, 15 g and 20 g, or 17 g and 19 g of total human milk oligosaccharides per day.

~~46. A method of preparing a bacteriotherapy to treat or prevent a condition associated with dysbiosis of the intestinal microbiome; the method comprising incubating a mixture of bacteria obtained from stool with one or more enrichment agents in a culture, thereby obtaining a~~

~~cultured mixture of bacteria, wherein the one or more enrichment agents comprise one or more of an oligosaccharide, a short chain fatty acid, or lactate; and~~

~~collecting, harvesting, or isolating at least one cultured bacterium from the cultured mixture of bacteria, thereby obtaining a bacteriotherapy.~~

~~47. A method for identifying one or more bacteria suitable for a bacteriotherapy; the method comprising incubating a mixture of bacteria obtained from stool with one or more enrichment agents in a culture, thereby obtaining a cultured mixture of bacteria, wherein the one or more enrichment agents comprise one or more of an oligosaccharide, a short chain fatty acid, or lactate; and~~

~~collecting, harvesting, or isolating at least one cultured bacterium from the cultured mixture of bacteria, thereby obtaining a bacteriotherapy.~~

~~48. The method of claim 46 or 47, wherein the mixture of bacteria and the one or more enrichment agents are incubated in the presence a probiotic strain.~~

~~49. The method of claim 48, wherein the probiotic strain is not present in the mixture of bacteria prior to the incubation.~~

~~50. The method of claim 48 or 49, wherein the probiotic strain is a *Bifidobacterium*.~~

~~51. The method of any of claims 48-50 wherein the probiotic strain is *B. longum* subsp. *infantis*.~~

~~52. The method of any of claims 46-51, wherein the stool is human stool.~~

~~53. The method of claim any of claims 46-52, wherein the stool is obtained from a healthy adult human.~~

~~54. The method of any of claims 46-53, wherein the stool is pooled from the stool of two or more adult humans.~~

~~55. The method of any of claims 46-54, wherein the stool is obtained from a healthy adult with a low risk or probability for a condition associated with dysbiosis of the intestinal microbiome.~~

~~56. The method of any of claims 46-55, wherein the enrichment agent comprises one or more oligosaccharides.~~

~~57. The method of any of claims 46-56, wherein the enrichment agent comprises one or more human milk oligosaccharides.~~

~~58. The method of any of claims 46-57, wherein the enrichment agent is a mixture of human milk oligosaccharides.~~

~~59. The method of any of claims 46-58, wherein the prebiotic mixture comprises at least 2, at least 5, at least 10, at least 25, at least 30, at least 50, at least 100, or at least 150 human milk oligosaccharides.~~

~~60. The method of any of claims 46-59, wherein the enrichment agent is a prebiotic mixture that is, is derived from, or comprises a concentrated human milk permeate from obtained from the ultra-filtration of pooled human skim milk.~~

~~61. The method of any of claims 46-60, wherein the enrichment agent comprises a short chain fatty acid, optionally acetate.~~

~~62. The method of any of claims 46-61, wherein the enrichment agent comprises lactate.~~

~~63. The method of any of claims 46-62, wherein the at least one cultured bacterium comprises a plurality of cultured bacteria.~~

~~64. The method of any of claims 46-63, wherein the at least one cultured bacterium comprises all or essentially all of the cultured bacteria present in the cultured mixture of bacteria.~~

~~65. The method of any of claims 46-64, wherein the at least one bacterium is collected, harvested, or isolated from the cultured mixture of bacteria by a method comprising one or more of gradient purification, differential centrifugation, solvent treatment, heat treatment, acid treatment, immunoprecipitation, or antibiotic selection.~~

~~66. The method of any of claims 46-65, wherein a control mixture of bacteria is incubated in a culture in the absence of the enrichment agent, thereby obtaining a control cultured mixture of bacteria; and~~

~~wherein the at least one cultured bacterium from the cultured mixture of bacteria has a greater enrichment, level, presence, or abundance in the cultured mixture of bacteria than in the control cultured mixture of bacteria and/or has faster growth or expansion in the presence of the enrichment agent than in the absence of the enrichment agent.~~

~~67. The method of claim 66, wherein the control mixture of bacteria is obtained from the same stool as the mixture of bacteria.~~

~~68. The method of claim 66 or 67, wherein the control mixture is incubated in the culture with one or more control agents.~~

~~69. The method of any of claims 46-68, wherein the mixture of bacteria is obtained from a stool sample collected from a healthy donor, wherein the healthy donor was administered a prebiotic mixture and a probiotic strain within less than four weeks prior to collection of the stool sample.~~

~~70~~16. A method of preparing a bacteriotherapy, the method comprising collecting, harvesting, or isolating at least one bacterium from a mixture of bacteria,

wherein the mixture of bacteria is, originates from, or is obtained from a stool sample from a healthy donor,

wherein the healthy donor was administered a prebiotic mixture comprising human milk oligosaccharides and a probiotic strain comprising *B. longum* subsp. *infantis*, wherein the probiotic strain is capable of consuming the prebiotic mixture within less than four weeks prior to collection of the stool sample.

~~71~~17. The method of claim ~~70~~ 16, wherein the at least one bacterium comprises a plurality of bacteria that comprises two or more bacterial species, subspecies, or strains.

~~72. The method of claim any of claims 70 or 71, wherein the at least one bacterium comprises all or essentially all of the cultured bacteria present in the mixture of bacteria.~~

~~73~~18. The method of any of claims ~~70-72~~ 16 or 17, wherein the at least one bacterium is collected, harvested, or isolated from the cultured mixture of bacteria by a method comprising one or more of gradient purification, differential centrifugation, solvent treatment, heat treatment, acid treatment, immunoprecipitation, or antibiotic selection.

~~74~~19. The method of any of claims ~~70-73~~ 16-18, wherein the prebiotic mixture comprises at least 2, at least 5, at least 10, at least 25, at least 50, at least 100, or at least 150 human milk oligosaccharides, optionally at least 25 human milk oligosaccharides.

~~75. The method of any of claims 70-74, wherein the prebiotic mixture is, is derived from, or comprises a human milk permeate, wherein the human milk permeate is obtained from the ultra-filtration of pooled human skim milk, optionally wherein the pooled human milk is pooled from the milk of at least 25, 50, or 100 individual donors.~~

~~76. The method of any of claims 70-75, wherein the at least one probiotic strain of bacterium comprises *B. breve*, *B. bifidum*, *B. longum* subsp. *infantis*, or *B. longum* subsp. *longum*, optionally *B. longum* subsp. *infantis*.~~

~~77~~20. The method of any of claims ~~70-76~~ 16-19, wherein one or both of the prebiotic mixture and the probiotic strain are administered to the donor on the same days for at least 3, 5, 7, 14, 21, or 28 consecutive days prior to the collection of the stool sample.

~~78. The method of any of claims 70-77, wherein the probiotic strain is administered in an amount at least 1 x 10^7 colony forming units (CFU) per day, optionally between 1 x 10^7 and 1 x 10^{10} colony forming units;~~

~~and wherein the prebiotic mixture is administered in an amount of at least 1 g human milk oligosaccharides per day, optionally between 1 g and 20 g human milk oligosaccharides per day.~~