acidilacti, P. argentenicus, P. claussenii or a combinations thereof.

[0011a] In one example, there is provided a composition of a non-milk food comprising mammalian milk oligosaccharides (MMO) from a human, bovine or caprine source, or the MMO comprises HMO, BMO, BCO, GMO, GOS, FOS, or combinations thereof.

[0011b] In another example, there is provided a composition described herein, comprising a non-milk food and a bacterial culture, wherein the bacterial culture comprises commensal bacteria, the commensal bacteria optionally selected from the species of *Lactobacillus*, *Bifidobacterium*, *Pediococcus* and combinations thereof.

[0011c] In one aspect, the present disclosure refers to a composition comprising a non-milk food and mammalian milk oligosaccharides (MMO).

[0011d] In another aspect, the present disclosure refers to a composition comprising a non-milk food, a mammalian milk oligosaccharide (MMO) from a human, bovine or caprine source, and a bacterial culture, optionally wherein the MMO is selected from HMO, BMO, BCO, GMO, and a combination thereof, and wherein the bacterial culture comprises commensal bacteria selected from the species of *Lactobacillus*, *Bifidobacterium, Pediococcus* and combinations thereof.

[0012] Non-milk food, if it contains any dietary fiber, does not provide MMO as the majority of the dietary fiber. Infant formula as marketed today would be considered a non-milk food for the purposes of this disclosure, since it does not include MMO. Preferably, the non-milk food composition contributes a controlled portion of dietary fiber to adapt to the bacterial culture. For example, the non-milk food can contribute about 50%, less than 50%, less than 40%, less than 30%, less than 20%, less than 15%, less than 10%, less than 5%, less than 2.5%, less than 1%, less than 0.5% by weight of the total dietary fiber in the diet, depending on the phase of weaning. In some examples, the non-milk food can contribute more than 50%, more than 55%, more than 60%, more than 70%, more than 75%, more than 80%, more than 85%, more than 90%, more than 95%, more than 99% of the dietary fiber by weight in the composition. Fiber is described herein in grams and their percentages are described herein as percent by weight.

[0013] Preferably, the milk source of the MMO is from a human, bovine, ovine, equine, or caprine source. Preferably, the MMO contributes a controlled portion of dietary fiber. For example, the MMO can contribute more than 50%, more than 55%, more than 60%, more than 70%, more than 75%, more than 80%, more than 85%, more than 90%, more than 95%, more than 99% by weight of the dietary fiber in the composition, depending on the phase of weaning. In some examples, the non-milk food can contribute about 50%, less than 50%, less than 40%, less than 30%, less than 20%, less than 15%, less than 10%, less than 5%, less than 2.5%, less than 1%, less than 0.5% by weight of the dietary fiber in the composition, depending on the phase of weaning.

[0014] In one example, the non-milk food can contribute about 50%, less than 50%, less than 40%, less than 30%, less than 20%, less than 15%, less than 10%, less than 5%, less than 2.5%, less than 1%, less than 0.5% by weight of the dietary fiber in the composition, and the MMO can contribute more than 50%, more than 55%, more than 60%, more than 70%, more than 75%, more than 80%, more than 85%, more than 90%, more than 95%, more than 99% by weight of the dietary fiber in the composition. In another example, the non-milk food can contribute more than 50%, more than 55%, more than 60%, more than 70%, more than 75%, more than 80%, more than 85%, more than 90%, more than 95%, more than 99% by weight of the dietary fiber in the composition, and the non-milk food can contribute about 50%, less than

50%, less than 40%, less than 30%, less than 20%, less than 15%, less than 10%, less than 5%, less than 2.5%, less than 1%, less than 0.5% by weight of the dietary fiber in the composition.

[0015] In one example, the non-milk food may be a feed for a non-human mammal. The non-human mammal may be a buffalo, camel, rabbit, mouse, rat, pig, cow, goat, sheep, horse, dog, or cat. In some examples, the non-human mammal is a laboratory animal. Alternatively, the non-milk food may be a food for a human. In one example, the human may be a baby in need of weaning. The mammal may be on or have just completed a course of oral antibiotics. In one example, the mammal (e.g., human) is on or has just completed a course of chemotherapy, or the mammal (e.g., human) is preparing for, or has just completed, a fecal microbial transplant.

[0015a] In another example, there is provided a composition described herein for use in treating a subject receiving antibiotic therapy or a subject who has recently finished antibiotic therapy, or a subject receiving or who has recently received a fecal microbial transplant, wherein upon administration of said composition, the gut microbiome complexity in the subject is increased, preferably wherein the subject in need thereof is a human, and said human may not be an infant or said human may be an adult.

[0015b] In another example, there is provided a composition for use in treating a subject receiving antibiotic therapy or a subject who has recently finished antibiotic therapy, or a subject receiving or who has recently received a fecal microbial transplant, said composition comprising a non-milk food, MMO, and a bacterial culture, wherein the MMO may be derived from or substantially identical to human milk glycans, bovine milk glycans, or goat milk glycans or the MMO may comprise HMO, BMO, BCO, GMO, GOS, FOS, or combinations thereof, the milk glycans optionally representing at least 20% of the total daily dietary fiber of the diet, and wherein the bacterial culture may comprise bacteria from *Bifidobacteria*, *Lactobacillus*, *Pediococcus*, or combinations thereof, preferably wherein the bacterial culture comprising *B. infantis, B. breve, L. plantarium, L. reuteri,* or combinations thereof, preferably comprising *Bifidobacteria longum* subsp. *infantis*, the bacterial culture optionally being provided in a daily dose of from $10^7 – 10^{12}$ cfu, optionally wherein the subject is a human, preferably an adult human.

[0015c] In another aspect, the present disclosure refers to use of the composition described herein for the manufacture of a medicament for treating a subject receiving antibiotic therapy or a subject who has recently finished antibiotic therapy, or a subject receiving or who has recently received a fecal microbial transplant, wherein upon administration of said composition, the gut microbiome complexity in the subject is increased, wherein the subject in need thereof is a human, optionally said human may not be an infant or said human may be an adult.

[0015d] In yet another aspect, the present disclosure refers to use of a composition for the manufacture of a medicament for treating a subject receiving antibiotic therapy or a subject who has recently finished antibiotic therapy, or a subject receiving or who has recently received a fecal microbial transplant, said composition comprising a non-milk food, MMO, and a bacterial culture, wherein the MMO may be derived from or identical to human milk glycans, bovine milk glycans, or goat milk glycans or the MMO may comprise human milk oligosaccharides (HMO), bovine milk oligosaccharides (BMO), bovine colostrum (BCO), goat milk oligosaccharides (GMO), or combinations thereof, the milk glycans representing at least 20% of the total daily dietary fiber of the diet, and wherein the non-milk food comprises carbohydrates which release free sugar monomers that are preferred for consumption by bacteria of said bacterial culture.

[0016] In another example, this disclosure provides a composition comprising a non-milk baby food and MMO from a human, bovine, equine, or caprine source. Such compositions may be administered for a period to accommodate progressive change in the microbiome, with or without concurrent administration of probiotic bacteria. In a typical example of this disclosure, the mammal has a microbiome in need of increasing its complexity by at least 10%, preferably by at least 20%, more preferably by at least 30% of the total bacterial species present in the gut. The phrase "increase complexity" when used herein means increasing the complexity based on taxonomic classification of the bacteria in the microbiome of the mammal, and/or increasing the complexity based on the proportional number of bacteria by classification in the microbiome of the mammal, which may be generally calculated from the amount of DNA with sequences specific to a particular genus, species, or strain normalized against the total amount of DNA sequences in stool.

[0017] In one example, gut microbiome complexity of a mammal (e.g., a human infant) is increased by providing a dietary composition comprising a non-milk food, MMO, and a bacterial culture, where the MMO are from human, bovine, ovine, equine or caprine milk or the MMO are non-milk oligosaccharides substantially identical to human milk oligosaccharides, bovine milk oligosaccharides (BMO), caprine milk oligosaccharides (CMO), porcine milk oligosaccharides (PMO), equine milk oligosaccharides (EMO), and/or ovine milk oligosaccharides (OMO). The bacterial culture can be chosen from *Bifidobacterium*, *Pediococcus*, and *Lactobacillus*, which may be provided in a daily dose of from $10^7 – 10^{12}$ cfu.

[0018] In another mode, this disclosure provides methods of increasing the gut

microbiome complexity in a mammal by administering any of the compositions described herein to the mammal. In one example, gut microbiome complexity of a mammal (e.g., a human infant) is increased by providing a dietary composition comprising a non-milk food and a bacterial culture, to the mammal (e.g., a human infant), where the mammal is contemporaneously receiving MMO from another source (e.g., mother's milk). The bacterial culture can be chosen from *Bifidobacterium*, *Pediococcus*, and *Lactobacillus*, which may be provided in a daily dose of from $10^7 – 10^{12}$ cfu.

[0019] In another example, gut microbiome complexity is increased in a mammal during or following antibiotic therapy by providing a dietary composition comprising a non-milk food, MMO, and a bacterial culture, where the MMO are from human, bovine, ovine, equine, or caprine milk or the MMO are non-milk oligosaccharides substantially identical to HMO, BMO, CMO, EMO, and/or OMO, and the bacterial culture provides probiotic bacteria chosen from *Bifidobacterium, Pediococcus,* and *Lactobacillus*, or combinations thereof. The bacterial culture may be provided in a daily dose of from $10^7 – 10^{12}$ cfu. In any of these examples, at least one of the bacterial species is preferably *Bifidobacteria longum* subsp. *infantis*.

[0020] Typically, feeding the controlled diet to the mammal is continued for a period of days to weeks, for example, following the reduction in breastmilk, an increase in formula feeding, an increase in complementary foods, administration (and/or cessation) of antibiotics, administration (and/or cessation) of chemotherapy, and infusion of the fecal microbial transplant composition. Any of the examples described herein may include the administration of compositions of varying MMO and non-milk food dietary fibers. For example, the initial stage of administration may include a composition where the MMO provides more than 50% of the dietary fiber of the composition, and where the non-milk food provides less than 50% of the dietary fiber of the composition. A later stage of administration may include a composition where the MMO provides less than 50% of the dietary fiber of the composition, and where the non-milk food provides more than 50% of the dietary fiber of the composition.

[0020a] In another example, there is provided a fecal microbial transplant composition comprising a fecal microbiome from a healthy individual, milk glycan, and a bacterial culture, preferably wherein the fecal microbial transplant composition comprises 5 g of the milk glycan, and wherein the bacterial culture preferably comprises bacteria of the genus *Bifidobacteria*, *Lactobacillus*, *Pediococcus*, or combinations thereof, more preferably *Bifidobacterium infantis* subsp *infantis*, said bacterial culture optionally comprising from 1 x 10^6 to 100 x 10^9 cfu of the bacteria.

[0021] In still another mode, this disclosure provides a method of increasing the gut microbiome complexity in a human in need thereof by: (a) initiating a controlled diet comprising low fiber food and 5-40 g/day of MMO for said human for from 2-7 days prior to a fecal microbial transplant (FMT); (b) preparing a modified FMT composition comprising the fecal microbiome from a healthy individual, at least 5 g/day of MMO, and from 1-1000 x 10^8 cfu of

Bifidobacterium longum subsp. *infantis*; (c) infusing the colon of said human with the modified FMT composition; and (d) following the FMT with the controlled diet of step (a) for from 0 to 7 days. Preferably, the MMO comprise from at least from 20% to at least 70% of the total dietary oligosaccharides of the controlled diet.

[0022] In yet another mode, this disclosure provides a method of increasing the gut microbiome complexity in a human in need thereof consisting of (a) preparing a dry composition of a weaning food by cooking the food, drying the cooked food and milling the dried food to a powder usable as a weaning food; (b) growing a culture of *Bifidobacterium* and/or *Lactobacillus* which is selected from a group that consumes FSMs found in the feces of an infant fed a similar weaning food, harvesting the culture and drying the cell mass in the presence of a preservative; and (c) combining the dry composition of weaning food with the dry composition of bacterial culture in a ratio of from $10^8 – 10^{12}$ cfu of bacterial culture to 100 g of weaning food.

[0022a] In another example, there is provided a composition for use in treating or preventing colitis, diarrhea, colic, and/or scours in a mammal in need of weaning from a diet of mammalian milk and/or infant formula, wherein the composition comprises weaning food and a bacterial culture, and wherein the composition is in a dry powder form, wherein the bacterial culture preferably comprises bacteria from the genus *Bifidobacterium*, *Lactobacillus*, or combinations thereof, more preferably the bacterial culture comprises *B. infantis, B. breve, L. planatrum, L. reuteri*, or combinations thereof, wherein the bacterial culture may further comprise a preservative, said composition optionally comprising bacterial culture and weaning food in a ratio of from $10^6 – 10^{11}$ cfu of bacterial culture to 100 g of weaning food.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1: Chart showing the base 10 log change in *B. infantis* levels by day during mucosal healing diet including BMO, GOS, and *B. infantis*. The data are reported as CFU *B. infantis* per ug DNA divided by CFU total bacteria per ug DNA.

[0024] FIG. 2A: A plot showing the addition of *B. infantis* to a breast-fed infant. *B. infantis* was provided contemporaneously with breast milk to establish the dominance of *B. infantis* in the infant gut. The *B. infantis* levels were maintained by keeping the majority of fiber coming from human milk. Complementary foods were introduced at low levels during this time period.

[0025] FIG. 2B: A plot showing the addition of *B. infantis* to a breast-fed infant. *B. infantis* was provided contemporaneously with breast milk to establish the dominance of *B. infantis* in the infant gut. The *B. infantis* levels were maintained by keeping the majority of fiber coming from human milk. Complementary foods were introduced at low levels during this time period.

[0026] FIG. 3A: A plot showing the same introduction of *B. infantis* to the infant as in Figures 2A-B. *B. infantis* was provided contemporaneously with breast milk to establish the dominance of *B. infantis* in the infant gut. However, this infant switched their diet to a non-milk food, infant formula with and without low-level complementary feeding. The overall effect was a net reduction in MMO and a decrease in the abundance of *B. infantis* at later time points.

CLAIMS

1. A composition comprising a non-milk food and mammalian milk oligosaccharides (MMO).

2. The composition of claim 1, wherein the MMO is from a human, bovine or caprine source, or wherein the MMO is selected from human milk oligosaccharides (HMO), bovine milk oligosaccharides (BMO), bovine colostrum (BCO), goat milk oligosaccharides (GMO), and a combination thereof.

3. The composition of claim 1 or claim 2, wherein the dietary fiber in the composition comprises at least 20% of MMO, at least 30% of MMO, at least 50% of MMO, at least 60% of MMO, at least 70% of MMO, or wherein less than 10% of the dietary fiber in the composition is provided by the non-milk food.

4. The composition of any one of claims 1–3, wherein the non-milk food is a feed for a non-human mammal, optionally wherein the non-human mammal is a pig, cow, goat, sheep, horse, dog, or cat.

5. The composition of any one of claims 1–4, wherein the non-milk food is a food for a human, optionally wherein said human is a baby, or wherein the human has a microbiome in need of increasing its complexity by at least 10%, by at least 20%, or by at least 30%.

6. The composition of claim 5, wherein the human is receiving or has just completed a course of oral antibiotics, or wherein the human is receiving or has just completed a course of chemotherapy, or wherein the human is receiving or has just completed a fecal microbial transplant.

7. The composition of any one of claims 1–6 wherein the non-milk food comprises complex oligosaccharides from meat, fish, eggs, shellfish, fruits, vegetables, grains, nuts, seeds, or combinations thereof, and/or the non-milk food comprises complex oligosaccharides from barley, corn, hummus, lentils, oats, rice, wheat, avocado, beetroot, broccoli, squash, carrots, green beans, peas, potatoes, cassava, sweet potatoes, pumpkin, apples, bananas, plantains, blueberries, mango, peach, pear, papaya, watermelon, or combinations thereof.

8. A composition comprising a non-milk food, a mammalian milk oligosaccharide (MMO) from a human, bovine or caprine source, and a bacterial culture,

optionally wherein the MMO is selected from HMO, BMO, BCO, GMO, and a combination thereof, and

wherein the bacterial culture comprises commensal bacteria selected from the species of *Lactobacillus*, *Bifidobacterium*, *Pediococcus* and combinations thereof.

9. The composition of claim 8, wherein the *Bifidobacteria* is selected from *B. longum* subsp *longum, B. longum* subsp *infantis, B. breve*, *Bacterium pseudocatanulatum, B. bifidum, B. adolescentis, B. pseudolongum, and B. animalis*, and/or the *Lactobacillus* is selected from *L. crispatus, L. casei, L. silivarius, L. reuteri*, and *L. plantarum*, and/or the *Pediococcus* is selected from *P. pentosaceus, P. stilesii, P. acidilacti, P. argentenicus,* and *P. claussenii*.

10. The composition of any one of claims 8-9, wherein the bacterial culture is provided in a dose from $10^7 – 10^{12}$ cfu.

11. Use of the composition of any one of claims 1–10 for the manufacture of a medicament for treating a subject receiving antibiotic therapy or a subject who has recently finished antibiotic therapy, or a subject receiving or who has recently received a fecal microbial transplant, wherein upon administration of said composition, the gut microbiome complexity in the subject is increased, wherein the subject in need thereof is a human, optionally said human may not be an infant or said human may be an adult.

12. Use of a composition for the manufacture of a medicament for treating a subject receiving antibiotic therapy or a subject who has recently finished antibiotic therapy, or a subject receiving or who has recently received a fecal microbial transplant, said composition comprising a non-milk food, MMO, and a bacterial culture, wherein the MMO may be derived from or identical to human milk glycans, bovine milk glycans, or goat milk glycans or the MMO may comprise human milk oligosaccharides (HMO), bovine milk oligosaccharides (BMO), bovine colostrum (BCO), goat milk oligosaccharides (GMO), or combinations thereof, the milk glycans representing at least 20% of the total daily dietary fiber of the diet, and wherein the non-milk food comprises carbohydrates which release free sugar monomers that are preferred for consumption by bacteria of said bacterial culture.

13. The use according to claim 12, wherein the bacterial culture comprises bacteria selected from the group consisting of *Bifidobacteria*, *Lactobacillus*, *Pediococcus*, and

combinations thereof, optionally wherein the bacterial culture comprises *Bifidobacteria longum* subsp. *infantis*, *B. breve*, *L. plantarium*, *L. reuteri*, or combinations thereof, optionally wherein the bacterial culture is provided in a daily dose of from 10^7 – 10^{12} cfu, optionally wherein the subject is a human, who may be an adult human.