[0007] In particular, this disclosure provides methods of monitoring the health of mammals. The health of the mammals can be monitored by (a) obtaining a fecal sample from the mammal; (b) determining the amount of metabolites in the sample; and/or (c) identifying a healthy state versus a dysmetabolic state in the mammal based on the abundance or deficiency of the metabolites in the sample. The metabolites can be some of the metabolites listed in column 2 of Table 1. In some examples, the method of monitoring the health of a mammal can include treating a dysmetabolic mammal by administering bacteria, mammalian milk oligosaccharides (MMO) or both. In some examples, a method of monitoring health can include treating a dysmetabolic mammal by administering bacteria, selective oligosaccharides (OS) or both. Selective oligosaccharides are typically DP3 to DP20, selective oligosaccharides are more preferably DP3 to DP10 and may be from any source: chemical synthesis; plant; algae; yeast; bacteria; or mammals. The oligosaccharides administered are typically functional equivalents to Mammalian milk oligosaccharides (MMO). In some examples OS and MMO are structurally equivalent. The bacteria typically comprise bacteria capable of colonization in the mammalian colon. The bacteria and/or the OS can be administered in respective amounts to change the abundance of the one or more metabolites in the feces of the mammal to a non-dysmetabolic level.

[0008] The disclosure also provides methods of maintaining the health of a mammal by administering bacteria and/or OS. Additionally, a fecal sample can be obtained from the mammal, and the level of metabolite(s) in the sample can be determined. A metabolic state in the mammal can be identified based on the concentration and/or level and/or content of the metabolite(s) in the sample, and the bacteria and/or the OS can be administered in response to the identified dysmetabolic state.

[0009] In some examples, the health of a mammal can be maintained by administering bacteria or OS in an amount sufficient to change the level of metabolite(s). The amount, periodicity, and/or duration of the bacteria and/or OS that is administered can be different than the amount of the bacteria and/or OS administered in response to an identified dysmetabolic state. The bacteria can be capable of colonization of the colon.

[0009a] In one aspect, the present disclosure refers to use of a bacterial composition comprising bacteria capable of colonization of the intestine for the preparation of a medicament to reduce the risk of Juvenile Diabetes (Type I) by increasing the amount of one or more metabolites in the intestine of a mammal, wherein a) the bacterial composition is to be administered; and b) oligosaccharide (OS) is to be administered; wherein the OS comprises mammalian milk oligosaccharide (MMO); wherein the bacteria is capable of consuming MMO; wherein the bacteria comprises *Bifidobacteria*; wherein the one or more metabolites is selected from the compounds listed in column 2 of Table 1; and wherein the bacteria and the OS are to be administered in respective amounts sufficient to increase the amount of the one or more metabolites in the intestine of said mammal.

[0009b] In one aspect, the present disclosure refers to use of a bacterial composition comprising bacteria capable of colonization of the intestine for the preparation of a medicament to reduce the risk of Juvenile Diabetes (Type I), by decreasing the amount one or more metabolites in the intestine of a mammal, wherein a) the bacterial composition is to be administered; and b) OS is to be administered; wherein the OS comprises mammalian milk oligosaccharide (MMO); wherein the bacteria is capable of consuming MMO; wherein the bacteria comprises *Bifidobacteria*; wherein the one or more metabolites is selected from the compounds listed in column 2 of Table 1; and wherein the bacteria and the OS are to be

administered in respective amounts sufficient to decrease the amount of one or more metabolites in the intestine of said mammal.

[0010] In some examples, the disclosure provides a method of decreasing and/or maintaining a low level of metabolite(s) in the colon of a mammal by (a) administering a bacteria; and (b) administering OS; where the bacteria and the OS are administered in respective amounts sufficient to maintain a level of one or more metabolites in the feces of said mammal. In some examples, this method includes one or more metabolites selected from the compounds listed in column 2 of Table 1. In another example, the levels of the bacteria and/or the metabolite can be modulated by altering the level of OS in the diet

[0011] The disclosure also provides methods of establishing or altering an infant, non-infant or specific mammal's gut metabolome by administering particular bacteria and/or OS and monitoring the mammal. The mammal can be monitored by obtaining a fecal or systemic sample and determining the increase or decrease in metabolites, such as but not limited to, serotonin metabolites, tryptophan metabolites, and/or lactate conjugates such as 3-4 hydroxyphenyl lactate, indole lactate and/or phenyllactate. Evaluating the alteration of metabolite relative to a healthy state will allow for the administration of bacteria and/or OS in response to the identified dysmetabolic state.

[0012] In any of the above examples, the metabolite(s) concentrations that are monitored or altered include those such as, but not limited to γ-glutamyl-containing di- or tri-peptides, pipecolic acid, hippurate, serotonin, tryptophan, and/or lactate conjugates such as 3-4 hydroxyphenyl lactate, indole lactate and/or phenyllactate. In some examples, the abundance of γ-glutamyl-cysteine is at least 20-fold greater than the γ -glutamyl-cysteine abundance in the colon of a human infant, which is not colonized by the administered bacteria. In a preferred example, the level of pipecolic acid or salt thereof is at least 10-fold greater than the pipecolic acid level in the colon of a human infant, which is not colonized by the bacteria. In a preferred example, the level of γ-glutamyl-containing di- or tri-peptides is at least 10-fold greater than the level in the colon of a human infant which is not colonized by the bacteria. Using the above examples, oxidative stress of an infant can be reduced. Additionally, bacterial hippurate degraders can be reduced. Jaundice can be prevented or ameliorated.

[0013] In another example, one or more metabolites comprises pipecolic acid or a salt thereof. In another example, the level of pipecolic acid or salt thereof is at least 10-fold greater than the pipecolic acid level in the colon of a human infant which is not colonized by said bacteria.

[0014] Any of the methods described herein can reduce the risk of a mammal developing metabolic disorders such as, but not limited to Juvenile Diabetes (Type I), obesity, asthma, atopy, Celiac's Disease, food allergies, autism, as compared to a dysmetabolic mammal. The risk can be reduced by 20%, 30%, 40%, 50%, 60%, 70%, 80%, or 90%.

CLAIMS

1. Use of a bacterial composition comprising bacteria capable of colonization of the intestine for the preparation of a medicament to reduce the risk of Juvenile Diabetes (Type I) by increasing the amount of one or more metabolites in the intestine of a mammal, wherein
   a) the bacterial composition is to be administered; and
   b) oligosaccharide (OS) is to be administered;
   wherein the OS comprises mammalian milk oligosaccharide (MMO);
   wherein the bacteria is capable of consuming MMO;
   wherein the bacteria comprises *Bifidobacteria*;
   wherein the one or more metabolites is selected from the compounds listed in column 2 of Table 1; and
   wherein the bacteria and the OS are to be administered in respective amounts sufficient to increase the amount of the one or more metabolites in the intestine of said mammal.

2. Use of a bacterial composition comprising bacteria capable of colonization of the intestine for the preparation of a medicament to reduce the risk of Juvenile Diabetes (Type I), by decreasing the amount one or more metabolites in the intestine of a mammal wherein
   a) the bacterial composition is to be administered; and
   b) OS is to be administered;
   wherein the OS comprises mammalian milk oligosaccharide (MMO);
   wherein the bacteria is capable of consuming MMO;
   wherein the bacteria comprises *Bifidobacteria*;
   wherein the one or more metabolites is selected from the compounds listed in column 2 of Table 1; and
   wherein the bacteria and the OS are to be administered in respective amounts sufficient to decrease the amount of one or more metabolites in the intestine of said mammal.

3. The use according to any one of claims 1 or 2, wherein the one or more metabolites comprises a metabolite selected from the group consisting of γ-glutamyl-containing di- or tri-peptides, γ-glutamyl-cysteine, pipecolic acid, hippurate, 3-hydroxyhippurate, 4-hydroxyhippurate, benzoic acid, cholate, cholate sulfate, chenodeoxycholate, choline, creatine, palmitic acid-9-hydroxy-stearic acid (PAHSA 16:0/OH-18:0), and Oleic Acid-

Hydroxy Stearic Acid (OAHSA 18:1/OH-18:0), nonadeconate, arachinate, eiocosenoate, stearate, 15-methylplamitate, 17-methylpalmitate, behenate, margarate, palmitate, myristate, citrate, succinate, serotonin, tryptophan, lactate conjugates, 3-4 hydroxyphenyl lactate, indole lactate, and phenyllactate.

4. The use according to claim 3, wherein the concentration of γ-glutamyl-containing di- or tri-peptides is at least 10-fold greater than the level in the colon of a mammal which is not colonized by the bacteria, or wherein the concentration of γ-glutamyl-cysteine is at least 20-fold greater than the γ-glutamyl-cysteine abundance in the colon of a mammal which is not colonized by the bacteria.

5. The use according to any one of claims 3-4 wherein creatine is greater than the creatine abundance in the colon of a mammal which is not colonized by the bacteria.

6. The use according to any one of claims 3-5, wherein the concentration of pipecolic acid or salt thereof is at least 10-fold greater than the pipecolic acid level in the colon of a mammal which is not colonized by the bacteria.

7. The use according to any one of claims 3-6, wherein hippurate level is determined, said level of hippurate indicating detoxification of the intestine of said mammal; or wherein the amount of bacterial hippurate degraders are reduced in the microbiome, optionally wherein the bacterial hippurate degraders comprise one or more of Group B Streptococci, *Camplyobacter jejuni,* or *Listeria monocytogenes*; or wherein the level of hippurate is further compared to level of benzoic acid or other polyphenols; and optionally further comprising adding supplemental glycine to the diet if the mammal is in need of benzoic acid or polyphenol detoxification.

8. The use according to any one of claims 3-7, wherein the concentration of cholate, chenodeoxycholate, cholate sulphate is greater than cholate, chenodeoxycholate, cholate sulphate abundance in the colon of a mammal which is not colonized by the bacteria.

9. The use according to any one of claims 3-8, wherein long chain fatty acid metabolites are increased compared to levels in a mammal which is not colonized by the bacteria, said fatty acid metabolites preferably including palmitic acid-9-hydroxy-stearic acid (PAHSA 16:0/OH-18:0), Oleic Acid-Hydroxy Stearic Acid (OAHSA 18:1/OH-18:0), nonadeconate, arachinate, eiocosenoate, stearate, 15-methylplamitate, 17-methylpalmitate, behenate, margarate, palmitate, myristate, or a combination thereof.

10. The use according to any one of claims 3-9, wherein the one or more metabolites comprise a TCA cycle metabolite, said TCA cycle metbolite preferably comprising citrate or succinate.

11. The use according to any one of claims 3-10 wherein tryptophan metabolites are increased compared to levels in a mammal which is not colonized by the bacteria, said tryptophan metabolites preferably including serotonin, tryptophan, lactate conjugates, 3-4 hydroxyphenyl lactate, indole lactate, and/or phenyllactate.

12. The use according to any one of claims 1-11, wherein the MMO comprises at least one of N-acetyl lactosamine, lacto N-tetraose, lacto-N-biose, N-acetyllactosamine, lacto-N-triose, lacto-N-neotriose, lacto-N-neotetraose, fucosyllactose, lacto-N-fucopentose, lactodifucotetrose, sialyllactose, disialyllactone-N-tetraose, 2’-fucosyllactose, 3’-sialyllactoseamine, 3’-fucosyllactose, 3’-sialyl-3-fucosyllactose, 3’-sialyllactose, 6’-sialyllactosamine, 6’-sialyllactose, difucosyllactose, lacto-N-fucosylpentose I, lacto-N-fucosylpentose II, lacto-N-fucosylpentose III, lacto-N-fucosylpentose V, sialyllacto-N-tetraose, or combinations thereof.

13. The use according to any one of claims 1-11, wherein the MMO consists of carbohydrate polymers found in mammalian milk which are not metabolized by any combination of digestive enzymes expressed by mammalian genes, or wherein the OS comprises a Type II oligosaccharide core where representative species include LNnT or LNFPIII and/or a Type I oligosaccharide core where representative species include LNT or LNFPI.

14. The use according to any one of claims 1-13, wherein the bacterial composition comprises bacteria of species selected from *B. adolescentis, B. animalis, B. animalis* subsp. *animalis, B. animalis* subsp. *lactis, B. bifidum, B. breve, B. catenulatum, B. longum, B. longum* subsp. *infantis, B. longum* subsp. *longum, B. pseudocatanulatum,* and/or *B. pseudolongum*.

15. Use of a bacterial composition according to any one of claims 1-14, comprising at least one species capable of consuming MMO by the internalization of that MMO within the bacterial cell for the preparation of a medicament for reducing the risk of Juvenile Diabetes (Type I), wherein

a) the bacterial composition is to be administered, and;

b) OS is to be administered at a dose sufficient to maintain colonization of the colon of the mammal by bacteria in the bacterial composition of step (a), wherein the risk is reduced as compared to a dysbiotic infant;

wherein the bacterial composition and the OS are to be administered in respective amounts sufficient to increase or decrease the amount of one or more metabolites in the intestine of said mammal;

wherein the one or more metabolites is selected from the compounds listed in column 2 of Table 1, or the one or more metabolites comprises a metabolite selected from the group consisting of γ-glutamyl-containing di- or tri-peptides, γ-glutamyl-cysteine, pipecolic acid, hippurate, 3-hydroxyhippurate, 4-hydroxyhippurate, benzoic acid, cholate, cholate sulfate, chenodeoxycholate, choline, creatine, palmitic acid-9-hydroxy-stearic acid (PAHSA 16:0/OH-18:0), and Oleic Acid-Hydroxy Stearic Acid (OAHSA 18:1/OH-18:0), nonadeconate, arachinate, eiocosenoate, stearate, 15-methylplamitate, 17-methylpalmitate, behenate, margarate, palmitate, myristate, citrate, succinate, serotonin, tryptophan, lactate conjugates, 3-4 hydroxyphenyl lactate, indole lactate, and phenyllactate;

optionally wherein the concentration of γ-glutamyl-containing di- or tri-peptides is at least 10-fold greater than the level in the colon of a mammal which is not colonized by the bacteria;

optionally wherein creatine is greater than the creatine abundance in the colon of a mammal which is not colonized by the bacteria;

optionally wherein the concentration of pipecolic acid or salt thereof is at least 10-fold greater than the pipecolic acid level in the colon of a mammal which is not colonized by the bacteria;

optionally wherein hippurate level is determined, said level of hippurate indicating detoxification of the intestine of said mammal; or wherein the amount of bacterial hippurate degraders are reduced in the microbiome, optionally wherein the bacterial hippurate degrader comprises Group B Streptococci, *Camplyobacter jejuni*, or *Listeria monocytogenes*; or wherein the level of hippurate is further compared to level of benzoic acid or other polyphenols; and optionally further comprising adding supplemental glycine to the diet if the mammal is in need of benzoic acid or polyphenol detoxification;

optionally wherein the concentration of cholate, chenodeoxycholate, cholate sulphate is greater than cholate, chenodeoxycholate, cholate sulphate abundance in the colon of a mammal which is not colonized by the bacteria;

optionally wherein long chain fatty acid metabolites are increased compared to levels in a mammal which is not colonized by the bacteria, said fatty acid metabolites preferably including palmitic acid-9-hydroxy-stearic acid (PAHSA 16:0/0H-18:0), Oleic Acid-Hydroxy Stearic Acid (OAHSA 18:1/0H-18:0), nonadeconate, arachinate, eiocosenoate, stearate, 15-methylplamitate, 17-methylpalmitate, behenate, margarate, palmitate, myristate, or a combination thereof;

optionally wherein the one or more metabolites comprise a TCA cycle metabolite, said TCA cycle metbolite preferably comprising citrate or succinate; and

optionally wherein tryptophan metabolites are increased compared to levels in a mammal which is not colonized by the bacteria, said tryptophan metabolites preferably including serotonin, tryptophan, lactate conjugates, 3-4 hydroxyphenyl lactate, indole lactate, and/or phenyllactate.

16. The use according to any of claims 1-14, further comprising:

c) determining the amount and/or concentration, of one or more metabolites in a fecal sample that has been obtained from the mammal;

d) identifying a dysmetabolic state in the mammal,wherein the amount and/or concentration of the one or more metabolites in the sample is different

from an amount and/or concentration of said one or more metabolites in a fecal sample obtained from another mammal not in a dysmetabolic state;

e) wherein optionally the bacterial composition and/or the OS is to be administered or to be re-administered in response to the identified dysmetabolic state;

f) optionally adjusting the amount, periodicity, and/or duration of the administration of the bacterial composition and/or the OS in response to an identified dysmetabolic state; and

g) optionally wherein the amount and/or type of the bacterial composition and/or the OS to be administered in step (a) is different than the amount and/or type of the bacterial composition and/or the OS to be administered in step (f).

17. The use according to any of claims 1-14, wherein the bacteria is capable of internalization of that MMO before consuming it.