

# REPORT RECOMMENDATIONS

## 02 ..... ALPHA AND BETA-DIVERSITY RESISTOME DYSBIOSIS RATIOS

Firmicutes: Bacteroidetes, Proteobacteria:Actinobacteria,  
Prevotella:Bacteroides Ratio

## 04 ..... PATHOGENS

Bacteroides fragilis (with toxin gene), *Bilophila wadsworthia*,  
Campylobacter jejuni, Other Campylobacter species, Citrobacter  
freundii, Clostridium difficile, Clostridium perfringens,  
Enterococcus gallinarum, Escherichia coli, *Hafnia alvei*,  
Helicobacter pylori, *Klebsiella pneumoniae*, *Porphyromonas*  
*gingivalis*, *Proteus mirabilis*, *Proteus vulgaris*, *Pseudomonas*  
*aeruginosa*, *Raoultella ornithinolytica*, Salmonella enterica,  
Sutterella stercoricanis, Sutterella wadsworthensis, *Vibrio*  
*cholerae*, Yersinia enterocolitica, Candida species, *Geotrichum*  
*spp*, *Microsporidia spp*, *Rhodotorula spp*, *Giardia lamblia*,  
*Cyclospora cayetanensis*, *Blastocystis hominis*, *Cryptosporidium*,  
*Entamoeba histolytica*, Adenovirus, Cytomegalovirus, Epstein  
Barr virus

## 14 ..... FUNCTIONAL FIBERS TABLE

## 15 ..... KEYSTONE SPECIES

*Akkermansia muciniphila*, *Bifidobacterium adolescentis*,  
*Bifidobacterium longum*, *Butyricoccus pullicaecorum*,  
*Eubacterium rectale*, *Faecalibacterium prausnitzii*, *Roseburia*  
*intestinalis*, *Ruminococcus bromii*, *Ruminococcus flavefaciens*,  
*Lactiplantibacillus plantarum*, *Limosilactobacillus reuteri*,  
*Lacticaseibacillus rhamnosus*, Other *Lactobacillus spp*

## 19 ..... FUNCTIONS

Saccharolytic Fermentation, Butyrate production, Propionate  
production, Acetate Production, Lactate production, Proteolytic  
fermentation, Polyamine production, Histamine production,  
P-cresol production, Ammonia production, Hydrogen Sulfide  
production, Methane Production, GABA Production, Glutathione  
production, Indole production, Estrobolome (estrogen recycling),  
Vitamin Production, Vit B1 Thiamin, Vit B2 Riboflavin, Vit B5 -  
Pantothenic acid, Vit B6 - Pyridoxine, Vit B7 - Biotin, Vit B9 -  
Folate, Vit B12 - Cobalamin, Vitamin K2

## Alpha and Beta-Diversity

### IF DIVERSITY IS LOW:




See Keystone Species section for detailed recommendations.

### IF DIVERSITY IS HIGH:

No action needed.

## Resistome

### IF RESISTOME IS LOW:

-  **NUTRITION:** Increase diversity of fiber containing foods from a variety of sources such as fruits, vegetables, whole grains, nuts, and seeds. If meats and cheeses are a part of the diet, choose organic options from antibiotic-free animals whenever possible. Opt for a whole-food diet and avoid excessive intake of ultra-processed foods. Fermented foods, such as kimchi, yogurt, kefir, and natto, may also be beneficial, but only if pathogens are mostly under control.
-  **LIFESTYLE:** Avoid excessive, recurrent use of antibiotics, if possible. Drink clean, filtered water and avoid chlorinated drinking water.
-  **SUPPLEMENT:** A probiotic like *Bacillus subtilis* HU58 that produces over 12 natural and targeted antibiotics can support a more balanced gut environment without contributing to overall antibiotic resistance. Supplementing the diet with HU58 can help to support the innate immune system.

### IF RESISTOME IS HIGH:

No action needed. A high resistome indicates a more resilient gut microbiome with more richness and stability.




## Dysbiosis Ratios

### FIRMICUTES: BACTEROIDETES

#### IF RATIO IS LOW:

No action needed.

#### IF RATIO IS HIGH:

-  **NUTRITION:** Bacteroidetes can thrive on  $\beta$ -glucans, resistant starch, arabinoxylan, pectin, cellulose, and inulin. (See **Functional Fibers** table on page 26 for complete foods list) Limiting fat and animal protein consumption may also help to improve this ratio.
-  **LIFESTYLE:** Engage in moderate exercise 30-60 minutes per day, get outdoors as often as possible, and reduce sleep disturbances by practicing relaxation techniques and avoiding screen time before bed.
-  **SUPPLEMENT:** Supplements that contain  $\beta$ -glucans, resistant starches, arabinoxylan, pectin, cellulose, or inulin can improve F/B ratios.




## Dysbiosis Ratios

### PROTEOBACTERIA: ACTINOBACTERIA

#### IF RATIO IS LOW:




No action needed.

#### IF RATIO IS HIGH:

-  **NUTRITION:** Fructooligosaccharides (FOS), galactooligosaccharides (GOS), xylooligosaccharides (XOS), inulin, and arabinoxylan can all increase the abundance of Actinobacteria. Limit intake of saturated fats and sugar, as these may increase the abundance of Proteobacteria.
-  **LIFESTYLE:** Enjoy moderately intense exercise 30-60 minutes per day and avoid exposure to toxic chemicals such as glyphosate.
-  **SUPPLEMENT:** Supplements that contain FOS, GOS, XOS, inulin, or arabinoxylan can improve P/A ratios.

### PREVOTELLA: BACTEROIDES

#### IF RATIO IS LOW:

-  **NUTRITION:** Pectins,  $\beta$ -glucans, fructo-oligosaccharides (FOS), and xylo-oligosaccharides (XOS) can help to improve this ratio. Limit consumption of animal fat and protein as well as sugar.
-  **LIFESTYLE:** This ratio can be improved by limiting cigarette smoking, practicing stress-reduction techniques, especially before bed, spending time in nature with animals (when possible), and avoiding excessive sterilization of the home. Spending time outdoors can enhance exposure to beneficial microbes in the environment, time with animals or on farms is also recommended, particularly in childhood.
-  **SUPPLEMENT:** Supplements that contain fructooligosaccharides (FOS), xylooligosaccharides (XOS),  $\beta$ -glucans, and pectins can improve ratios of Prevotella:Bacteroides

#### IF RATIO IS HIGH:




No action needed.

## Pathogens

No action is needed for pathogens that are low or below detection. This is a sign of a well-balanced gut microbiome.




### BACTEROIDES FRAGILIS (WITH TOXIN GENE)

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Consume a diet rich in fiber and avoid food additives such as emulsifiers in order to maintain a healthy colonic mucosal barrier. Limit high-fat meals and a Western style diet. Yogurt containing *Bifidobacterium longum* may also be beneficial.
-  **LIFESTYLE:** Maintain a healthy weight and engage in regular, moderate exercise.
-  **SUPPLEMENT:** Probiotics containing *Bifidobacterium longum* may help. Probiotics that support a diverse microbiota population can reduce toxins secreted by *B. fragilis* and help to maintain a healthy colonic mucosal barrier.




### BILOPHILA WADSWORTHIA

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Limiting fat and protein consumption may help to control an overgrowth of *B. wadsworthia*. Consume a variety of colorful fruits and vegetables to ensure adequate intake of dietary polyphenols. Consume plenty of prebiotic fibers from foods such as apples, onions, leeks, asparagus, chicory root, and whole grains.
-  **LIFESTYLE:** Aim for 7-9 hours of sleep every night, practice stress-reducing exercises like yoga, meditation, deep breathing, massage, and acupuncture, and spend adequate time in nature.
-  **SUPPLEMENT:** Supplements containing vitamin D, calcium, polyphenols, and prebiotic fibers like cellulose, inulin,  $\beta$ -glucans, FOS, GOS, or XOS may reduce presence of *Bilophila wadsworthia* through reducing secondary bile acid production. Probiotics containing *Bacillus* spores can increase microbial diversity and indirectly boost butyrate production, which may counteract the damage induced by *Bilophila wadsworthia*. Support gut mucosal health through intake of supplemental polyphenols and bovine immunoglobulin supplements.




### CAMPYLOBACTER JEJUNI

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Avoid eating raw or undercooked eggs or meats, consuming raw or unpasteurized dairy products, and drinking untreated surface water (i.e. from lakes or streams). A typical Western diet that is high in fat and low in fiber may encourage the growth of this pathogen.
-  **LIFESTYLE:** *Campylobacter* is a key cause of diarrhea. Prevent juices from raw chicken or other raw meat from contaminating other foods. Wash hands with soap and water before and after handling food, before eating, and after coming into contact with human or pet feces. Engage in regular exercise.
-  **SUPPLEMENT:** Probiotics that support a diverse and well-balanced gut microbiome would be beneficial.

### CAMPYLOBACTER SPECIES: C. CONCISUS, C. SHOWAE, C. HOMINIS, C. UREOLYTICU

#### IF RELATIVE ABUNDANCE IS HIGH:




-  **NUTRITION:** Avoid undercooked chicken and choose milk from a reputable source. Consume more garlic, basil, cinnamon, clove, lemon, lemongrass, mandarin orange, oregano, rosemary, sage, and thyme.
-  **LIFESTYLE:** *Campylobacter* is the #1 intestinal disease diagnosed in travelers returning to the United States. Choose clean drinking water when traveling abroad. Avoid cross-contamination between raw meat and cooked foods.
-  **SUPPLEMENT:** Probiotics containing *Bacillus* endospores support healthy microbial balance within the gut.

## Pathogens

No action is needed for pathogens that are low or below detection. This is a sign of a well-balanced gut microbiome.




### **CITROBACTER FREUNDII**

#### **IF RELATIVE ABUNDANCE IS HIGH:**

-  **NUTRITION:** Limit consumption of sugar, saturated fat, processed meats. Consume fibers like gluten free whole grains, resistant starches from grains, nuts, seeds, legumes, raw potatoes, green bananas, and cooked and cooled rice and potatoes; or foods containing inulin, like bananas, sugar beets, leeks, asparagus, onions, garlic, dandelion root, Jerusalem artichoke, and chicory. Increase consumption of omega-3 containing foods, such as flax, chia, cold water fish and walnuts. Cranberry polyphenols can also reduce the abundance of *C. freundii*. Diets low in fiber can allow *C. freundii* to grow out of control.
-  **LIFESTYLE:** Make sure to wash hands regularly, especially when coming into contact with potentially contaminated substances (soil, sewage, feces, and people infected with *C. freundii*). Practice relaxation techniques like yoga, meditation, massage, or deep breathing regularly.
-  **SUPPLEMENT:** Probiotics containing *Bacillus* endospores have been shown to support a healthy balance of gut bacteria. Omega-3 fatty acids EPA, DHA, and DPA can help support a healthy gut environment.




### **CLOSTRIDIUM DIFFICILE**

#### **IF RELATIVE ABUNDANCE IS HIGH:**

-  **NUTRITION:** Avoid processed sugars. Prebiotic fibers and fermentable carbohydrates from green bananas, leeks, asparagus, onions, garlic, artichokes, chicory, and dandelion root may limit the abundance of *C. difficile*.
-  **LIFESTYLE:** *C. diff* infections are common after taking antibiotics. Wash hands thoroughly. Avoid taking antibiotics when possible, but taking a spore-based probiotic along with antibiotics can also support a more balanced gut environment. Avoid smoking cigarettes, as this is also associated with *C. diff* infections.
-  **SUPPLEMENT:** Probiotics containing *Bacillus* endospores, particularly *Bacillus clausii*, can support a healthy balance of *Clostridium difficile*. Serum-derived bovine immunoglobulins (SBI) have been shown to support healthy detoxification.

### **CLOSTRIDIUM PERFRINGENS**

#### **IF RELATIVE ABUNDANCE IS HIGH:**




-  **NUTRITION:** Consumption of kefir can decrease *C. perfringens*.
-  **LIFESTYLE:** Cook food to a safe temperature, especially beef roasts and poultry. Avoid keeping food at an unsafe temperature (between 40°F and 140°F), refrigerate leftovers within 2 hours after cooking, and reheat food to 165°F for 15 min prior to consuming.
-  **SUPPLEMENT:** Probiotics containing *Bacillus coagulans* may support a healthy balance of *C. perfringens* in the gut.

## Pathogens

No action is needed for pathogens that are low or below detection. This is a sign of a well-balanced gut microbiome.




### ENTEROCOCCUS GALLINARUM

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Consume prebiotic fibers like resistant starches and inulin. Thyme and lavender may be helpful in balancing the abundance of this pathogen. Limit consumption of chicken intestines, as this is a common source of this bacterium.
-  **LIFESTYLE:** Limit alcohol consumption and use of proton pump inhibitors and NSAIDs which can increase intestinal permeability.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores can promote a healthy gut microbiome and mucosal barrier.




### ESCHERICHIA COLI

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Limit intake of sugar, processed omega-6 fatty acids (canola oil, soybean oil, almonds, peanuts/peanut oil, sunflower oil), animal protein, and saturated fats which can feed E. coli. Fruits and vegetables like bananas, kiwis, nectarines, onions, leeks, garlic, chicory, or artichokes can help to crowd out E. coli. When consuming meats and eggs, choose organic, antibiotic-free options, as conventional meats/eggs can carry antibiotic-resistant strains of E. coli.
-  **LIFESTYLE:** Cook food thoroughly, especially meat, and avoid potentially contaminated water sources. Avoid cross-contamination between raw meat and cooked foods.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores and Saccharomyces boulardii can support a healthy balance of E. coli.




### HAFNIA ALVEI (OPPORTUNISTIC)

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Limit consumption of foods that are at a higher risk of contamination like vacuum-packed meat, raw milk, and raw fish. Consume more brightly colored fruits and vegetables to increase polyphenols in the diet. In addition, beans and whole grains are recommended to increase fiber intake.
-  **LIFESTYLE:** Practice relaxation techniques like yoga, meditation, massage, or deep breathing. Wash hands thoroughly after contact with soil, spoiled foods, or sewage. Use an effective water filter to ensure pure, clean water.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores have been shown to support a healthy balance of gut bacteria.

### HELICOBACTER PYLORI

#### IF RELATIVE ABUNDANCE IS HIGH:




-  **NUTRITION:** Consume raspberries, strawberries, blackberries, blueberries, bilberries, cauliflower, turnips, cabbage, radish, broccoli sprouts, cold-water fish, flax, walnuts, chia seeds, licorice root, or oak tree or manuka honey to limit the growth of H. pylori.
-  **LIFESTYLE:** Reduce intake of NSAIDs like ibuprofen, naproxen, and aspirin. Wash your hands before preparing or eating food. Limit direct contact with vomit or fecal matter.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores and Saccharomyces boulardii can support a healthy balance of H. pylori. Supplements containing manuka honey, licorice flavonoids, serum-derived immunoglobulins, and omega-3 fatty acids can help support healthy levels of H. pylori.

## Pathogens

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### ***KLEBSIELLA PNEUMONIAE (OPPORTUNISTIC)***

#### **IF RELATIVE ABUNDANCE IS HIGH:**

-  **NUTRITION:** Limiting iron as well as starchy vegetables, grains, and sugary foods may help to control an overgrowth of *K. pneumoniae*. Foods that are high in iron include shellfish, spinach, liver and organ meats, red meat, beans, lentils, peas, fortified cereals, and dark chocolate.
-  **LIFESTYLE:** Practice stress-reduction techniques like yoga, meditation, or massage, as stress can cause dysbiosis and allow this opportunistic pathogen to grow out of control. Make sure to take a spore-based probiotic when taking antibiotics, as this species is antibiotic resistant and may grow out of control when protective keystone strains are absent.
-  **SUPPLEMENT:** Limit iron supplementation. Probiotics containing *Bacillus subtilis* can help to support a healthy balance of gut bacteria.




### ***PORPHYROMONAS GINGIVALIS***

#### **IF RELATIVE ABUNDANCE IS HIGH:**

-  **NUTRITION:** Eat more foods that contain polyphenols such as green tea, cranberries, pomegranates, and other fruit and vegetable extracts. Consume foods that contain quercetin, particularly citrus fruits, apples, onions, parsley, sage, tea, or red wine (in moderation).
-  **LIFESTYLE:** Practice good oral hygiene habits to prevent plaque buildup.
-  **SUPPLEMENT:** Probiotics may help restore a healthy gut and oral microbiome. Supplements containing green tea, cranberry, or pomegranate extracts, quercetin, or manuka honey may help balance *P. gingivalis* growth.

### ***PROTEUS MIRABILIS***

#### **IF RELATIVE ABUNDANCE IS HIGH:**




-  **NUTRITION:** Limit foods that are high in fat and low in fiber. Avoid polysorbate-80, an emulsifier found in some processed foods that has been shown to promote the growth of *P. mirabilis*.
-  **LIFESTYLE:** Practice stress-reduction techniques like yoga, meditation, or massage, as stress can cause dysbiosis and allow this opportunistic pathogen to grow out of control.
-  **SUPPLEMENT:** Probiotics containing *Bacillus* endospores can promote a healthy gut microbiome with an acidic environment and high concentrations of short-chain fatty acids (SCFAs) to help inhibit *P. mirabilis* growth in the gut.

## Pathogens

No action is needed for pathogens that are low or below detection. This is a sign of a well-balanced gut microbiome.




### *PROTEUS VULGARIS*

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Kefir and kefir grains have been shown to inhibit the growth of *P. vulgaris*. Consume more foods that contain quercetin, particularly citrus fruits, apples, onions, parsley, sage, tea, or red wine (in moderation). Limit meals that are high in fat and low in fiber.
-  **LIFESTYLE:** Practice stress-reduction techniques like yoga, meditation, or massage, as stress can cause dysbiosis and allow this opportunistic pathogen to grow out of control.
-  **SUPPLEMENT:** Supplements containing quercetin may help support a healthy balance of gut bacteria.




### *RAOULTELLA ORNITHINOLYTICA*

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Limit consumption of potentially contaminated fish like tuna, bonito, sardines, and mackerels. Limit high-fat or ketogenic diets until balance is restored to the gut microbiome. *R. ornithinolytica* (formerly known as *Klebsiella ornithinolytica*) can feed on ketones, which are produced by high-fat or ketogenic diets.
-  **LIFESTYLE:** Wash hands after contact with fish and soil. Use an effective water filter to ensure pure, clean water. Use proper sanitation practices. This pathogen can also be transmitted through ticks, so be sure to wear proper clothing when hiking in tick-infested areas.
-  **SUPPLEMENT:** Probiotics containing *Bacillus* endospores have been shown to support a healthy balance of gut bacteria.

### *SALMONELLA ENTERICA*

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Consume prebiotic fibers from gluten-free oats, barley, seaweed, bamboo shoots, bran, legumes, cashews, pistachios, or beets to help clear *Salmonella* from the system. These foods contain B-glucans, XOS, GOS, and inulin that feed propionate-producing bacteria in the gut.
-  **LIFESTYLE:** Fasting may improve clearance of *Salmonella*. Drink plenty of fluids, as this particular bacterium can be very dehydrating. Avoid cross-contamination between raw meat and cooked foods.
-  **SUPPLEMENT:** Probiotics containing *Bacillus* endospores have been shown to support a healthy balance of *Salmonella enterica*. Products containing  $\beta$ -glucans, XOS, GOS, and inulin can also help to balance levels of *Salmonella*.






## Pathogens

No action is needed for pathogens that are low or below detection. This is a sign of a well-balanced gut microbiome.




### SUTTERELLA STERCORICANIS

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Consume a low-fat, high-fiber diet. Limit sugar consumption, as a high-sugar diet can increase Sutterella abundance. Consume foods high in resveratrol, such as peanuts, pistachios, grapes, red and white wine, blueberries, cranberries, cocoa, or dark chocolate.
-  **LIFESTYLE:** Wash hands after coming into contact with fecal matter.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores can increase butyrate-producing bacteria in the gut.




### SUTTERELLA WADSWORTHENSIS

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Consume a low-fat, high-fiber diet. Limit sugar consumption, as a high-sugar diet can increase Sutterella abundance. Consume foods high in resveratrol, such as peanuts, pistachios, grapes, red and white wine, blueberries, cranberries, cocoa, or dark chocolate.
-  **LIFESTYLE:** Wash hands after coming into contact with fecal matter.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores can increase butyrate-producing bacteria in the gut.




### VIBRIO CHOLERAЕ

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Wasabi, red chili powder, apples, hops, green tea, elephant garlic, and neem can inhibit the growth of *V. cholerae*.
-  **LIFESTYLE:** *V. cholerae* is transmitted through water. Drink water from a reputable source and/or use a good water filter.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores and Saccharomyces boulardii can support a healthy balance of *Vibrio cholerae*.

### YERSINIA ENTEROCOLITICA

#### IF RELATIVE ABUNDANCE IS HIGH:




-  **NUTRITION:** Evidence shows that Yersinia enterocolitica growth is limited by low-iron availability. Reducing iron consumption may help to control the overgrowth of *Y. enterocolitica*. Consuming foods such as apples, onions, and leeks may increase the production of butyrate, and thereby reduce inflammation.
-  **LIFESTYLE:** Avoid raw animal products, especially pork and pig intestines. When handling raw pork, make sure to avoid cross-contaminating surfaces and wash hands thoroughly after food preparation and before eating.
-  **SUPPLEMENT:** Limit iron supplementation. Probiotics containing Bacillus endospores have been shown to support a healthy balance of gut bacteria. Supplements that increase butyrate production can also help to support healthy barrier function.

## Pathogens

No action is needed for pathogens that are low or below detection. This is a sign of a well-balanced gut microbiome.




### CANDIDA SPECIES

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Limit consumption of refined sugars. Avoid consumption of alcohol. Consume plenty of non-starchy vegetables. Consume plenty of garlic and turmeric. Bee propolis has also been shown to help control yeast overgrowth in the gut. Coconut oil (caprylic acid, lauric acid) or MCT oil can help combat candida.
-  **LIFESTYLE:** Excessive antibiotic use can contribute to the overgrowth of Candida species. Limit the use of antibiotics or take antibiotics with a spore-based probiotic when necessary.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores and Saccharomyces boulardii can support a healthy balance of Candida species in the gut. Supplements containing bee propolis and undecylenic acid can support a healthy balance of yeast in the gut.




### GEOTRICHUM SPP

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Limit consumption of cheese, specifically goat cheese, along with other milk and dairy products. Limiting the consumption of carbohydrates, sugars, and/or meat products may also support a healthy balance of *Geotrichum* species in the gut.
-  **LIFESTYLE:** Excessive antibiotic and antifungal use can contribute to the overgrowth of *Geotrichum* species. Avoid overuse of these medications, as they can contribute to antibiotic and antifungal resistance.
-  **SUPPLEMENT:** Supplements containing undecylenic acid, bee propolis, Saccharomyces boulardii, prebiotics, and Bacillus spore-based probiotics can promote a healthy balance of *Geotrichum* in the gut. *Geotrichum* species are opportunistic and can only thrive when competition for energy sources are low.

### MICROSPORIDIA SPP

#### IF RELATIVE ABUNDANCE IS HIGH:




-  **NUTRITION:** Limit iron-rich foods such as red meat, liver, turkey tuna, and eggs until microbial balance is restored. Avoid foods to which you may be allergic or sensitive. Since Microsporidia spp. is an opportunistic pathogen, anything that may stress the immune system should be limited or avoided if possible. Increase consumption of resveratrol, particularly from grapes, though peanuts, berries, cranberries, and pistachios may also support a healthy microbiome. Prebiotic fibers from leeks, asparagus, onions, garlic, bananas, apples and whole grains can also promote a healthy balance of Microsporidia species in the gut.
-  **LIFESTYLE:** Choose filtered or bottled drinking water and cooked foods when traveling to tropical areas. Avoid contact with wild birds and infected fish species, which are potential carriers of microsporidia species. Practice stress-reducing techniques and moderate regular exercise to support immune health.
-  **SUPPLEMENT:** Limit iron supplementation. Supplements containing lactoferrin, transferrin, prebiotics, or probiotics containing Bacillus endospores can support a healthy balance of Microsporidia species in the gut.

## Pathogens

No action is needed for pathogens that are low or below detection. This is a sign of a well-balanced gut microbiome.




### *RHODOTORULA SPP*

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Limit very low carbohydrate and ketogenic diets, as these may worsen an overgrowth of Rhodotorula species. Avoid foods that you may be sensitive or allergic to, as this can alter the immune response. Consume foods rich in antioxidants and polyphenols, such as berries, broccoli, kale, and other richly colored produce.
-  **LIFESTYLE:** Regularly clean sinks, showers, shower curtains, and plastic surfaces of your home. Wash athletic gear regularly. Practice stress-reducing techniques and get at least 7-9 hours of sleep per night. Limit the use of plastic containers for eating or drinking.
-  **SUPPLEMENT:** Precision prebiotics and probiotics containing Bacillus endospores can support a healthy balance of Rhodotorula species. Since this is an opportunistic pathogen that flourishes in the gut following antibiotic therapy, repopulating the gut microbiome after a course of antibiotics will be key to maintaining a healthy gut environment.




### *GIARDIA LAMBLIA*

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Spirulina, whey and pea protein, and fibers found in green bananas, kiwis, pears, onions, garlic, legumes (kidney beans, chickpeas, split peas), artichokes, cashews, and pistachios can make the intestines inhospitable to parasites.
-  **LIFESTYLE:** Wash your hands thoroughly. Choose clean, filtered water and avoid raw foods when traveling to developing countries. Aim for 8+ hours of sleep and choose light, restorative exercise like yoga or walking, as excessive, intense exercise can put added stress on the body.
-  **SUPPLEMENT:** Lactate-producing Bacillus coagulans can help to support healthy intestinal barriers and balance parasites in the gut. Increasing lactate production helps support a healthy gut environment. Supplements containing prebiotic fibers like FOS and GOS that feed lactate-producing bacteria can also increase lactate production.

### *CYCLOSPORA CAYETANENSIS*

#### IF RELATIVE ABUNDANCE IS HIGH:




-  **NUTRITION:** Tannins, saponins, and linoleic acid found in beans, peanuts, soy, lentils, black or green teas, walnuts, cocoa, cinnamon, clove, brightly colored fruits and vegetables, safflower oil, hemp oil, pumpkin seeds, and pumpkin seed oil can support a healthy balance of *C. cayetanensis* in the gut.
-  **LIFESTYLE:** Avoid eating raw or undercooked foods and choose filtered or purified drinking water, especially when traveling to Haiti, Guatemala, Peru, Nepal, and other developing countries in Latin America and South East Asia. Practice stress-reducing techniques and moderate exercise. Ensure adequate hydration and electrolyte balance.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores and Saccharomyces boulardii can support host immunity and balance the abundance of parasites like *C. cayetanensis* in the gut. Supplements containing methylated forms of folate may be beneficial if treating this parasite with co-trimoxazole, as this medication decreases folate stores in the body.

## Pathogens

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### **BLASTOCYSTIS HOMINIS**

#### **IF RELATIVE ABUNDANCE IS HIGH:**

-  **NUTRITION:** Spirulina, whey and pea protein, and fibers found in green bananas, kiwis, pears, onions, garlic, legumes (kidney beans, chickpeas, split peas), artichokes, cashews, and pistachios can make the intestines inhospitable to parasites. These nutrients increase the abundance of lactate-producing bacteria like Lactobacillus more effectively than direct supplementation. Increasing lactate production can effectively recondition the gut by changing the environment rather than attempting to kill the parasite itself, which often results in a flood of toxins.
-  **LIFESTYLE:** Drink and use safe water. Wash your hands thoroughly. Cook food (especially seafood) well and eat hot.
-  **SUPPLEMENT:** Lactate-producing Bacillus coagulans and commensal yeasts like Saccharomyces boulardii can help support healthy intestinal barriers and balance levels of Blastocystis hominis. Increasing lactate production helps support a healthy gut Environment. Supplements containing prebiotic fibers like FOS and GOS that feed lactate-producing bacteria can also increase lactate production.




### **CRYPTOSPORIDIUM**

#### **IF RELATIVE ABUNDANCE IS HIGH:**

-  **NUTRITION:** Spirulina, whey and pea protein, and fibers found in green bananas, kiwis, pears, onions, garlic, legumes (kidney beans, chickpeas, split peas), artichokes, cashews, and pistachios can make the intestines inhospitable to parasites.
-  **LIFESTYLE:** Wash your hands thoroughly. Choose clean, filtered water and avoid raw foods when traveling to developing countries. Aim for 8+ hours of sleep and choose light, restorative exercise like yoga or walking, as excessive, intense exercise can put added stress on the body.
-  **SUPPLEMENT:** Lactate-producing Bacillus coagulans can help to support healthy intestinal barriers and balance parasites in the gut. Increasing lactate production helps support a healthy gut environment. Supplements containing prebiotic fibers like FOS and GOS that feed lactate producing bacteria can also increase lactate production.

### **ENTAMOEBA HISTOLYTICA**

#### **IF RELATIVE ABUNDANCE IS HIGH:**




-  **NUTRITION:** Antioxidants found in apples, grapes, raspberries, strawberries, celery, green peppers, thyme, chamomile, rosehips, red wine, and black tea have been shown to safely target amoebas.
-  **LIFESTYLE:** Avoid swimming or jumping into still, warm, brackish water that has loose bottom sediment. Wear a nose clip or hold your nose if you jump or dive into relatively warm water lakes, rivers, pools, or other similar bodies of water.
-  **SUPPLEMENT:** Probiotics containing Bacillus endospores have been shown to support a healthy balance of gut microflora.

## Pathogens

No action is needed for pathogens that are low or below detection. This is a sign of a well-balanced gut microbiome.




### ADENOVIRUS

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Limit fat and sugar in the diet. Avoid foods that are rich in iron, such as red meat, turkey, and liver. Black tea and grapes provide polyphenols that may benefit those with adenovirus.
-  **LIFESTYLE:** Practice stress-reduction techniques like yoga, meditation, massage, acupuncture, or deep breathing, which may improve immune function. Regular moderate exercise and 8-9 hours of sleep/day are also recommended, as these factors can support healthy immune function. Wash hands and clean surfaces regularly.
-  **SUPPLEMENT:** Limit iron supplements. Supplements containing lactoferrin, transferrin, high-dose vitamin C, olive leaf extract, and yeast fermentate can help to support the immune system.




### CYTOMEGALOVIRUS

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Include foods rich in resveratrol such as red grapes, red wine, blueberries, cranberries, peanuts, pistachios and cocoa. Note resveratrol is found in the SKIN of these foods. Limit high-sugar and high-fat foods as well as anything to which you may be allergic or sensitive. Opt for anti-inflammatory foods, such as brightly colored fruits and vegetables, nuts, seeds, and cold water fish. Consuming fresh ginger may also provide immune support against viruses.
-  **LIFESTYLE:** Infants, children, elderly, and otherwise immunocompromised individuals are at the highest risk of CMV reactivation. These individuals should make sure to wash hands regularly and avoid potentially contaminated foods and surfaces. In addition, avoid sharing eating utensils with these individuals. Practice stress-reduction techniques like yoga, meditation, massage, acupuncture, or deep breathing, as relaxation is beneficial to the immune system. Reduce EMF exposure, especially from cell phones.
-  **SUPPLEMENT:** Supplements containing curcumin, ginger, lactoferrin, transferrin, lauric acid, high dose vitamin C, and olive leaf extract can help to support the immune system. Limit prebiotic supplements, as butyrate has been shown to reactivate this virus.

### EPSTEIN BARR VIRUS

#### IF RELATIVE ABUNDANCE IS HIGH:

-  **NUTRITION:** Limit consumption of beans and red meat, as these foods are associated with an increased incidence of EBV.
-  **LIFESTYLE:** Avoid contact with the saliva of contagious/infected people. Practice stress reduction techniques, such as yoga, meditation, massage, acupuncture, breathing exercises, listening to music, or other relaxing activities. Reduce EMF exposure, especially from cell phones.
-  **SUPPLEMENT:** Supplements containing lactoferrin, transferrin, high-dose vitamin C, lauric acid, or olive leaf extract can help to support the immune system. Probiotics containing Bacillus endospores can also help support a healthy gut environment.

## Functional Fibers Table

### FIBER

### FOOD SOURCES

#### CELLULOSE

- Cereals: barley, oats, cereal bran, bulgur, quinoa, cornmeal, brown rice
- Cabbage family: arugula, bok choy, Brussel's sprouts, cabbage, cauliflower, collards, kale, kohlrabi, mustard greens, radishes, rutabaga, Swiss chard, turnips, turnip greens and watercress
- Fruits: avocado, berries, apples and pears with skins
- Legumes: peas, chickpeas, beans, lentils
- Nuts
- Potatoes with skins
- Seeds: pumpkin, sunflower and chia seeds

#### RESISTANT STARCH

- Beans (black, pinto, soybeans, peas, white beans, lentils)
- Starchy foods that have been cooked and cooled, such as rice, potatoes, sweet potatoes, pasta and corn tortillas
- Green bananas, plantains
- Raw potato starch, hi-maize flour
- Whole grains, including oats and barley

#### GOS

Milk, yogurt, artichoke, lentils, tofu, cashews, pistachios, red kidney beans, chickpeas, baked beans, split peas, lima beans, lentils

#### FOS

Blue agave, yacon root, garlic, onion, leeks, chicory root, Jerusalem artichokes, asparagus, bananas, burdock root

#### XOS

Milk, honey, vegetables, fruits, and bamboos shoots

#### BETA-MANNAN

Barley, whole oats, soybean

#### INULIN

Dandelion greens, Jerusalem artichoke, leeks, bananas, burdock root, yacon root, jicama

#### β-GLUCAN

Cereal grain (millet, rice, barley, oats, rye, triticale, sorghum, and corn), seaweed, algae, mushrooms (reishi, shiitake, maitake)

#### LIGNIN

Flaxseed, root vegetables (carrots, parsley, horseradish), bran, tomatoes, berries, broccoli, cabbage, green beans, peaches, peas, brazil nuts, apples

#### PECTIN




Citrus peels, apples, pear, pitted fruits (plums, apricots, peach), guava, carrots

## Keystone Species

While elevated levels of these species have not been shown to be harmful to human health, the microbial ecosystem exists in an optimal balance. If several levels of these keystone species are high, refer to diversity indices and examine diet, lifestyle, and supplement patterns for possible causes.

### AKKERMANSIA MUCINIPHILA

#### IF LOW




-  **NUTRITION:** Reduce intake of sugar, and consume more sources of fructooligosaccharides (FOS). Cranberry polyphenols have also been shown to significantly increase the abundance of Akkermansia.
-  **LIFESTYLE:** Consider intermittent fasting. Engage in moderate exercise 2-3 times a week to increase the abundance of Akkermansia. Avoid prolonged exposure to cold temperatures.
-  **SUPPLEMENT:** Consuming cranberry polyphenols and prebiotic fibers including FOS, GOS and XOS may increase abundance of *A. muciniphila*.

#### IF HIGH

No action needed.

### BIFIDOBACTERIUM ADOLESCENTIS

#### IF LOW




-  **NUTRITION:** Cocoa flavonoids **fructooligosaccharides (FOS)**, **galactooligosaccharides (GOS)**, **inulin**, **arabinoxylan**, and **resistant starches** can increase the abundance of *B. adolescentis*. Limiting beef consumption may also support the growth of *B. adolescentis*.
-  **LIFESTYLE:** Moderate exercise can increase the abundance of Bifidobacterium.
-  **SUPPLEMENT:** Supplements containing FOS, GOS, inulin, or arabinoxylan may support the growth of *B. adolescentis*.

#### IF HIGH

No action needed.

### BIFIDOBACTERIUM LONGUM

#### IF LOW

-  **NUTRITION:** This species feeds on resistant starches and fructo-oligosaccharides.
-  **LIFESTYLE:** Moderate exercise can increase the abundance of Bifidobacterium.
-  **SUPPLEMENT:** Supplements containing green tea extracts or fructo-oligosaccharides (FOS) from green kiwifruit can increase the abundance of *Bifidobacterium longum*.




#### IF HIGH

No action needed.

## Keystone Species

### *BUTYRICOCOCCUS PULLICAEORUM*

#### IF LOW




-  **NUTRITION:** Low carbohydrate diets can starve this keystone bacterium. Consume more apples, oranges, peaches, blueberries, cranberries, green beans, cabbage, broccoli, and fermented and pickled foods like kombucha and pickles. Fermented foods contain acetate, which increases the abundance of this keystone strain.
-  **LIFESTYLE:** Moderate exercise 3x/week can increase the abundance of acetate producers and indirectly increase the abundance of *B. pullicaecorum*.
-  **SUPPLEMENT:** D-mannose may increase abundance of this strain. Bacillus spore probiotics and non-digestible oligosaccharides can indirectly increase the abundance of *B. pullicaecorum* by increasing acetate production, which can be utilized by this strain and converted to butyrate.

#### IF HIGH

No action needed.

### *EUBACTERIUM RECTALE*

#### IF LOW




-  **NUTRITION:** Resistant starches as well as antioxidants from red wine, apples, coffee, cocoa, and berries, can increase the abundance of this keystone species.
-  **LIFESTYLE:** Participate in moderate exercise 2-3 times a week to increase the abundance of *Eubacterium rectale*.
-  **SUPPLEMENT:** Supplements containing resistant starches, resveratrol, or anthocyanins can increase the abundance of *E. rectale*.

#### IF HIGH

No action needed.

### *FAECALIBACTERIUM PRAUSNITZII*

#### IF LOW

-  **NUTRITION:** Diets that are high in animal meat, saturated fat, sugar, and/or processed foods and deficient in fiber may reduce the abundance of *F. prausnitzii*. Consume sources of inulin and fructo-oligosaccharide (FOS) to support this keystone species.
-  **LIFESTYLE:** Participate in moderate exercise 2-3 times a week to increase the abundance of *Faecalibacterium prausnitzii*.
-  **SUPPLEMENT:** Supplements containing FOS and inulin can increase the abundance of *Faecalibacterium prausnitzii*.

#### IF HIGH




No action needed.



## Keystone Species

### ROSEBURIA INTESTINALIS

#### IF LOW




-  **NUTRITION:** Limit consumption of protein, specifically whey and beef protein. This keystone species feeds on spirulina,  $\beta$ -mannan, and resistant starch.
-  **LIFESTYLE:** Minimize psychological stressors and participate in 30-60 minutes of aerobic exercise 3 times a week to increase the abundance of *Roseburia intestinalis*. Psychological stress can reduce the abundance of this keystone species.
-  **SUPPLEMENT:** Supplements containing spirulina,  $\beta$ -mannan, or resistant starch can increase the abundance of *Roseburia intestinalis*.

#### IF HIGH

No action needed.

### RUMINOCOCCUS BROMII

#### IF LOW




-  **NUTRITION:** Consuming more resistant starches and cellulose can increase the abundance of this keystone strain.
-  **LIFESTYLE:** No action needed.
-  **SUPPLEMENT:** Supplements containing resistant starches or cellulose may help increase the abundance of *R. bromii*.

#### IF HIGH

No action needed.

### RUMINOCOCCUS FLAVEFACIENS

#### IF LOW




-  **NUTRITION:** This keystone species feeds on cellulose and xylooligosaccharides (XOS).
-  **LIFESTYLE:** No action needed.
-  **SUPPLEMENT:** Supplements containing cellulose or XOS can increase the abundance of *Ruminococcus flavefaciens*.

#### IF HIGH

No action needed.

### LACTIPLANTIBACILLUS PLANTARUM (FORMERLY KNOWN AS LACTOBACILLUS PLANTARUM)

#### IF LOW

-  **NUTRITION:** Cocoa flavonoids, spirulina, **fructooligosaccharides (FOS)**, and **inulin** can increase the relative abundance of *L. plantarum*.
-  **LIFESTYLE:** Reduce stress
-  **SUPPLEMENT:** Prebiotics like FOS and inulin, as well as green tea powder have been shown to support the growth of *L. plantarum*.




#### IF HIGH

No action needed.

## Keystone Species

### *LIMOSILACTOBACILLUS REUTERI* (FORMERLY KNOWN AS *LACTOBACILLUS REUTERI*)

#### IF LOW




-  **NUTRITION:** Cocoa flavonoids, spirulina, and **inulin** can increase the relative abundance of *L. reuteri*.
-  **LIFESTYLE:** Practice stress-reduction techniques like yoga, meditation, or massage.
-  **SUPPLEMENT:** Supplements or functional foods containing inulin can support the growth of *L. reuteri*.

#### IF HIGH

No action needed.

### *LACTICASEIBACILLUS RHAMNOSUS* (FORMERLY KNOWN AS *LACTOBACILLUS RHAMNOSUS*)

#### IF LOW




-  **NUTRITION:** Cocoa flavonoids, spirulina,  $\beta$ -glucans, and inulin can increase the relative abundance of *L. rhamnosus*.
-  **LIFESTYLE:** Practice stress-reduction techniques like yoga, meditation, or massage.
-  **SUPPLEMENT:** Supplements containing inulin or  $\beta$ -glucans can support the growth of *L. rhamnosus*.

#### IF HIGH

No action needed.

### OTHER *LACTOBACILLUS SPP*

#### IF LOW

-  **NUTRITION:** Consume more spirulina, pea and whey protein, **inulin**, or **GOS** to increase the abundance of *Lactobacillus*.
-  **LIFESTYLE:** Moderate exercise can increase the abundance of *Lactobacillus*.
-  **SUPPLEMENT:** Supplements containing inulin, GOS, or FOS from kiwifruit and GOS can increase the abundance of *Lactobacillus* species.




#### IF HIGH

No action needed.

## Functions




### SACCHAROLYTIC FERMENTATION

#### IF LOW




-  **NUTRITION:** Increase consumption of brightly colored fruits and vegetables, with an emphasis on functional fibers. Best fibers for saccharolytic fermentation include resistant starches, inulin,  $\beta$ -glucan, FOS, XOS, and galacto-oligosaccharides such as dairy. Monitor intake of protein and high fat foods. Fermented foods are recommended to lower gut pH. Recent evidence suggests that limiting sodium intake to less than 2300 mg per day may improve SCFA production, especially in women.
-  **LIFESTYLE:** Spend adequate time outdoors, practice stress reducing techniques, get regular, moderate exercise.
-  **SUPPLEMENT:** Supplements containing prebiotics like FOS, GOS, and XOS), as well as probiotics containing Bacillus spores can improve microbial abundance and promote saccharolytic fermentation in the gut.

### BUTYRATE PRODUCTION

#### IF LOW

-  **NUTRITION:** Consume high fiber foods, rich in prebiotics. This includes bran, oat bran, Jerusalem artichoke, beans, onions, garlic, apples, tomatoes, chicory root and psyllium husk, among others. Limit high sugar, high fat diets, which may decrease butyrate production. Recent evidence suggests that limiting sodium intake to less than 2300 mg per day may improve SCFA production, especially in women.
-  **LIFESTYLE:** Address poor sleeping habits, practice regular exercise and stress-reducing techniques, and spend ample time outdoors in natural settings.
-  **SUPPLEMENT:** Supplements containing glutamate, alanine, glycine, proline, lysine, threonine, cystine, citrus polyphenols, oligosaccharides (FOS, GOS, XOS), and/or Bacillus spore-based probiotics may enhance butyrate production. Sulfuraphane may also boost butyrate production.

#### IF HIGH

-  **NUTRITION:** Consume a well-balanced diet.
-  **LIFESTYLE:** Maintain healthy exercise habits and follow a regular sleep schedule of 7-9 hours of sleep each night.
-  **SUPPLEMENT:** Bacillus spore-based probiotics may help correct gut microbial dysbiosis and promote a balanced gut microbiome.




#### IF HIGH

NO ACTION NEEDED. Butyrate is utilized by colonocytes in the gut.

## Functions




### PROPIONATE PRODUCTION

#### IF LOW

-  **NUTRITION:** Limit high-fat, high-sugar foods. Consume prebiotic fibers like inulin, cellulose, and fructooligosaccharides from foods such as oatbran, bran, sweetcorn, beans, onions, asparagus, chicory root, garlic, or tomatoes. Recent evidence suggests that limiting sodium intake to less than 2300 mg per day may improve SCFA production, especially in women.
-  **LIFESTYLE:** Avoid over-sterilizing your home environment. Spend ample time outdoors in nature, practice stress-reducing techniques, and get regular moderate exercise.
-  **SUPPLEMENT:** Supplements containing prebiotics like inulin, GOS, and FOS can increase the production of propionate in the gut. Probiotics containing *Bacillus* spores have also been shown to increase propionate production.

### ACETATE PRODUCTION




#### IF LOW

-  **NUTRITION:** Increase consumption of foods containing GOS and inulin like legumes, seaweed, asparagus, onion, garlic, Jerusalem artichoke, jicama, and chicory root. If your abundance of *F. prausnitzii* is adequate or high, you could also consume foods with acetate, such as kombucha or a variety of vinegars (apple cider, malt, plum, sherry, tomato, and wine vinegar). Limit intake of saturated fats while the gut is healing. Recent evidence suggests that limiting sodium intake to less than 2300 mg per day may improve acetate production, especially in women.
-  **LIFESTYLE:** Intermittent fasting may increase acetate production.
-  **SUPPLEMENT:** Supplements containing prebiotic fibers like inulin, GOS, FOS, and psyllium husk have been shown to increase acetate production. Supplements containing glutamate, alanine, glycine, proline, lysine, threonine, or cysteine may improve acetate production.

#### IF HIGH

Propionate production may be HIGH when lactate producers are too HIGH, which can be a sign of low microbial diversity. **See Keystone Species section for specific recommendations.**




#### IF HIGH

-  **NUTRITION:** Limit consumption of animal products, saturated fats, and sugar and increase intake of prebiotic fibers like inulin and FOS which can be found in bananas, kiwis, mangos, onions, chicory root, asparagus, leeks, jicama, watermelon, raspberry, pear, nectarine, and sugar beets.
-  **LIFESTYLE:** Participate in moderate exercise 2-3 times a week to increase the abundance of *Faecalibacterium prausnitzii* and improve bacterial conversion of acetate to butyrate.
-  **SUPPLEMENT:** Supplements containing FOS and inulin can increase the abundance of *Faecalibacterium prausnitzii*.

## Functions

### LACTATE PRODUCTION

#### IF LOW




-  **NUTRITION:** Increase consumption of kombucha, yogurt, kimchi and kefir as well as foods containing resistant starch, such as oats, barley, cooked then cooled rice, green bananas, plantains, beans peas and lentils. Approach high-fat, low-carb diets with caution.
-  **LIFESTYLE:** Avoid excessive, chronic use of antibiotics. Practice stress reducing techniques, follow a regular sleep schedule and exercise regularly at moderate intensity to reduce reactive oxygen species production in the gut.
-  **SUPPLEMENT:** Supplements that contain prebiotics like XOS, GOS, and FOS, as well as Bacillus spore based probiotics may improve gut composition and promote the growth of lactate producers, such as Bifidobacteria and Lactobacillus. Supplements containing pomegranate polyphenols, pea protein, or whey protein powder may also increase important lactate producers.

### PROTEOLYTIC FERMENTATION

#### IF LOW




NO ACTION NEEDED. Low proteolytic fermentation is normal in the healthy human gut and indicates a diverse microbiome that is utilizing saccharolytic fermentation.

#### IF HIGH

-  **NUTRITION:** Reduce intake of simple carbohydrates (glucose, lactose, maltose, sucrose) and increase consumption of galactooligosaccharides (GOS), brightly colored fruits and vegetables, red wine, raisins, prunes, or dates. Increasing consumption of pectin containing foods such as pears, apples, guavas, quince, plums, gooseberries, and oranges may improve the conversion of lactate to beneficial SCFAs like butyrate.
-  **LIFESTYLE:** Practice stress-reducing techniques and follow a regular sleep schedule. Balanced circadian rhythms may benefit certain key SCFA producers and lactate utilizers. Fasting may also improve abundance of key lactate utilizers such as *F. prausnitzii*.
-  **SUPPLEMENT:** Prebiotics containing pectin, FOS, GOS and XOS may improve conversion of lactate to SCFAs such as butyrate.

#### IF HIGH




Excessive proteolytic fermentation is associated with abnormally high gut pH and production of unfavorable metabolites. Typically, proteolytic fermentation occurs when long, undigested peptide chains reach the lower gut. Therefore, proteolytic fermentation can be an indicator of maldigestion and malabsorption.

-  **NUTRITION:** Monitor overall protein intake and aim to consume a balanced ratio of carbohydrates, protein and fats. Consume adequate fiber and plant based foods, like fruits and vegetables.
-  **LIFESTYLE:** Spend adequate time outdoors, practice stress reducing techniques, get regular, moderate exercise.
-  **SUPPLEMENT:** Supplements containing prebiotic fibers like oligosaccharides or resistant starches can increase the abundance of keystone species that utilize saccharolytic fermentation and produce protective SCFAs. Digestive enzymes may also be helpful for proper protein digestion and absorption.

## Functions

### POLYAMINE PRODUCTION

#### IF LOW

-  **NUTRITION:** Increase consumption of pectin by consuming foods such as pears, apples, guavas, quince, plums, gooseberries, oranges, and other citrus fruits. Ensure ample intake of protein from foods like pumpkin seeds, sesame seeds, walnuts, almonds, pine nuts, turkey, chicken, beef, pork, fish, peanuts, chickpeas, or seaweed. Fermented foods such as yogurt, sauerkraut, kimchi and kombucha are also recommended.
-  **LIFESTYLE:** Practice stress-reducing techniques and exercise daily at moderate intensity, as tolerated. A regular sleep schedule is also recommended.
-  **SUPPLEMENT:** Supplements containing pectin, arginine, glutamate, or tyrosine may enhance polyamine production by providing the appropriate substrates for microbial conversion. Probiotics containing *Bacillus* spores may help to increase microbial diversity in the gut.




### HISTAMINE PRODUCTION

Input: Histadine




Result: histamine, mast cell activation

Histamine can be produced in the gut and travel to distant areas of the body, where it may induce unfavorable symptoms. Patients with an overabundance of histamine-producing bacteria should focus on strengthening intestinal barrier function, as a leaky gut can allow gut-derived histamines to enter circulation and promote dietary intolerances or disruption in healthy allergic responses. High levels of gut-derived histamine are associated with high abundance of Proteobacteria, Roseburia, *Morganii morganii*, and *Klebsiella pneumoniae* and decreased abundance of Bifidobacterium. Related bacteria: *Lactobacillus buchneri*, *Clostridium perfringens*, *E. coli*, *Klebsiella pneumonia*, *Lactobacillus vaginalis* and more can all produce histamine directly. High levels of gut-derived histamine are associated with high abundance of Proteobacteria, Roseburia, *Morganii morganii*, and *Klebsiella pneumoniae* and decreased abundance of Bifidobacterium and Butyricimonas.

#### IF HIGH

-  **NUTRITION:** Limit consumption of alcohol and foods containing amines, such as aged cheeses, sausage, wine, cider, chicken skin, and smoked salmon. Avoid ketogenic and very low carbohydrate diets. Ensure adequate intake of fibers and complex carbohydrates.
-  **LIFESTYLE:** Smoking inhibits clearance of certain amines. Avoid smoking or talk to your doctor about quitting. Consult your medical practitioner about any current heart medications, antibiotics, antidepressants, antipsychotics, diuretics, muscle relaxants, or pain medications, as these medications may impact polyamine detoxification. Ensure a regular sleep schedule, exercise regularly and practice stress reducing techniques.
-  **SUPPLEMENT:** Intestinal mucosa can help to remove excessive putrescine from the gut. Supplements containing serum-derived immunoglobulins, serine, cysteine, threonine, or proline may help to rebuild the intestinal mucosa and support healthy barrier function.




#### IF HIGH

-  **NUTRITION:** Avoid foods to which you may be allergic or sensitive. Consume brightly colored fruits and vegetables. Avoid a diet high in saturated fats, leftover food, and foods that are high in histamine such as alcohol, kombucha, yogurt, sauerkraut, aged cheese, avocados, dried fruits, eggplant, smoked meats, shellfish, and tomatoes.
-  **LIFESTYLE:** Address any hormone imbalances, especially in female patients. Practice stress-reducing techniques, and make time for regular, moderate exercise and time in natural settings.
-  **SUPPLEMENT:** Probiotics containing *Bacillus* spores can increase microbial diversity in the gut. Supplements containing prebiotics like XOS, GOS, or FOS can increase the abundance of keystone species belonging to the Bifidobacterium genus which may help balance histamine production in the gut. Additionally, supplements containing serum-derived immunoglobulins, omega-3 fatty acids, or citrus polyphenols can all support the integrity and healthy function of intestinal barriers.

## Functions

### POLYAMINE PRODUCTION

#### IF LOW




-  **NUTRITION:** Increase consumption of pectin by consuming foods such as pears, apples, guavas, quince, plums, gooseberries, oranges, and other citrus fruits. Ensure ample intake of protein from foods like pumpkin seeds, sesame seeds, walnuts, almonds, pine nuts, turkey, chicken, beef, pork, fish, peanuts, chickpeas, or seaweed. Fermented foods such as yogurt, sauerkraut, kimchi and kombucha are also recommended.
-  **LIFESTYLE:** Practice stress-reducing techniques and exercise daily at moderate intensity, as tolerated. A regular sleep schedule is also recommended.
-  **SUPPLEMENT:** Supplements containing pectin, arginine, glutamate, or tyrosine may enhance polyamine production by providing the appropriate substrates for microbial conversion. Probiotics containing Bacillus spores may help to increase microbial diversity in the gut.

### P-CRESOL PRODUCTION




#### IF LOW

**NO ACTION NEEDED.** Low p-cresol production is normal in a healthy human gut. P-cresol is typically produced by unfavorable gut species and does not confer health benefits, even in small amounts. In a balanced gut microbiome, low p-cresol production is manageable and can be excreted without causing intestinal issues.

#### IF HIGH

-  **NUTRITION:** Limit consumption of alcohol and foods containing amines, such as aged cheeses, sausage, wine, cider, chicken skin, and smoked salmon. Avoid ketogenic and very low carbohydrate diets. Ensure adequate intake of fibers and complex carbohydrates.
-  **LIFESTYLE:** Smoking inhibits clearance of certain amines. Avoid smoking or talk to your doctor about quitting. Consult your medical practitioner about any current heart medications, antibiotics, antidepressants, antipsychotics, diuretics, muscle relaxants, or pain medications, as these medications may impact polyamine detoxification. Ensure a regular sleep schedule, exercise regularly and practice stress reducing techniques.
-  **SUPPLEMENT:** Intestinal mucosa can help to remove excessive putrescine from the gut. Supplements containing serum-derived immunoglobulins, serine, cysteine, threonine, or proline may help to rebuild the intestinal mucosa and support healthy barrier function.

#### IF HIGH

-  **NUTRITION:** Excessive consumption of meat, and cow-milk dairy yogurt are high in tyrosine which may increase p-cresol production. Limit consumption of protein all together and/or opt for plant-based proteins such as lentils, chickpeas, beans, nuts, and seeds. Resistant starches from foods such as plantains, green bananas, whole grain oats, peas, barley, and cooked and cooled rice or potatoes can help to limit p-cresol production.
-  **LIFESTYLE:** Practice stress-reducing techniques like yoga and meditation, drink plenty of water to support kidney function, and get regular exercise at moderate intensity.
-  **SUPPLEMENT:** Supplements containing prebiotics like FOS and GOS, as well as probiotics containing Bacillus spores, may help to increase diversity of saccharolytic bacteria.




## Functions

### AMMONIA PRODUCTION

#### IF LOW

NO ACTION NEEDED. Low ammonia production is normal in a healthy human gut. If ammonia producers are low, this indicates that protein is being sufficiently digested in the GI tract.

#### IF HIGH




-  **NUTRITION:** High-protein foods are rich in nitrogen, which is necessary for ammonia production. Consume acidic foods, such as lemon juice and apple cider vinegar, which may improve intestinal pH and thereby enhance ammonia clearance. Fermented foods as well as foods that contain prebiotics like inulin and oligosaccharides such as green bananas, garlic, jicama, whole grains, onion, leeks, and asparagus may also reduce ammonia levels in the gut.
-  **LIFESTYLE:** Follow a regular sleep schedule. Practice stress-reducing techniques. Exercise regularly at moderate intensity.
-  **SUPPLEMENT:** Probiotics that contain *Bacillus subtilis* and supplements containing omega-3 fatty acids can support healthy blood ammonia levels. Supplements or teas containing dandelion or chicory root are also recommended as a source of inulin.

### HYDROGEN SULFIDE PRODUCTION




#### IF LOW

Though H<sub>2</sub>S is generally considered to be inflammatory in high amounts, it does play an important role in microbial respiration and gut barrier function. Hydrogen sulfide producers will compete with acetate producers and methane producers for hydrogen gas. If hydrogen sulfide producers are low, make sure that acetate producers and methane producers are within healthy ranges. If acetate or methane producers are high, follow the respective recommendations.

If acetate and methane producers are also within a healthy range, consider these recommendations.

-  **NUTRITION:** Sulfur-containing foods like garlic, onions, cruciferous vegetables (e.g., cabbage, cauliflower, kale, broccoli, etc.), and durian fruit can increase the abundance of hydrogen sulfide producers.
-  **LIFESTYLE:** Practice stress reducing exercises Follow a regular sleep schedule, maintaining 7-9 hours of sleep per night.
-  **SUPPLEMENT:** Glutathione and sulforaphane supplements may be beneficial to improve detoxification and balance inflammatory responses. Supplements that support the intestinal mucosa such as *Bacillus* spore based probiotics, prebiotics (inulin, FOS, GOS, XOS,) and bovine immunoglobulins can also be beneficial.

#### IF HIGH

-  **NUTRITION:** Limit intake of sulfate-containing foods like red meat, seafood, eggs, cheddar and parmesan cheese, dried apricots, peaches, onions, leeks, garlic, cabbage, brussels sprouts, broccoli, bok choy, asparagus, spinach, kale, peanuts, brazil nuts, walnuts, almonds, cocoa, or tea.
-  **LIFESTYLE:** Follow a regular sleep schedule. Practice stress-reducing techniques. Exercise regularly at moderate intensity.
-  **SUPPLEMENT:** Supplements that contain prebiotic fibers like inulin, FOS, or GOS can increase the abundance of acetate-producers and limit the abundance of hydrogen sulfide-producing bacteria.






## Functions

### METHANE PRODUCTION

#### IF LOW




NO ACTION NEEDED. Low methane production is normal in a healthy human gut and there is no need to increase methane production. In low amounts, methane is excreted through flatulence and does not cause adverse reactions. Furthermore, low abundance of methane producers generally reflects a balanced coexistence with acetate producers. Acetate producers, methane producers, and hydrogen sulfide producers all compete with one another for access to hydrogen gas.

#### IF HIGH

-  **NUTRITION:** Red meat and animal proteins are rich in carnitine, a compound that may increase methane production in the gut. Consider plant-based proteins, seafood, and poultry for protein sources. Foods containing GOS and inulin like legumes, seaweed, asparagus, onion, garlic, Jerusalem artichoke, jicama, or chicory root may be beneficial. Ginger is a highly therapeutic food for enhancing motility and has some evidence to lower methane. Consider using in recipes, marinades, or salad dressings. If your abundance of *F. prausnitzii* is adequate, you could also consume foods with acetate, such as kombucha or a variety of vinegars (apple cider, malt, plum, sherry, tomato, and wine vinegar). Diets high in saturated fats may exacerbate intestinal inflammation.
-  **LIFESTYLE:** Follow a regular sleep schedule. Practice stress-reducing techniques. Exercise regularly at moderate intensity.
-  **SUPPLEMENT:** Supplements containing prebiotic fibers like inulin, GOS, FOS, and psyllium husk can increase SCFA production and may help to reduce methane production in the gut. Supplements containing licorice flavonoids or ginger extract may help to counteract the damaging effects of methanogens by improving gut motility.

### GABA PRODUCTION

#### IF LOW

-  **NUTRITION:** Consume foods containing glutamate such as asparagus, beets, bone broth, broccoli, carrots, cheese, corn, eggs, green tea, meat, mushrooms, onion, peas and tomatoes. Avoid monosodium glutamate (MSG). Limit caffeine intake and high fat foods. Limit caffeine intake and high fat foods.
-  **LIFESTYLE:** Engage in stress-reducing activities like yoga, deep breathing, massage, or acupuncture. Aim for 7-9 hours of sleep every night, as impaired sleep is associated with low GABA production.
-  **SUPPLEMENT:** Supplements containing vitamin B6, 5-HTP, oligosaccharides like XOS, GOS, and FOS, mushroom powders, or *Bacillus* spore-based probiotics can increase GABA production in the gut.




#### IF HIGH

NO ACTION NEEDED. GABA Production in the gut is generally regarded as positive. It is not recommended to reduce GABA-producing species as these are beneficial commensal species.

## Functions

### GLUTATHIONE PRODUCTION

#### IF LOW




-  **NUTRITION:** Ensure adequate intake of protein foods, especially those containing the amino acids glycine, glutamate, and cysteine like onion, garlic, meat, eggs, or fish. Avoid diets high in sugar and high-fructose corn syrup. Diets high in saturated fat may reduce glutathione production, though more human trials are needed to confirm these findings. Consume glutathione-containing foods, such as asparagus, avocado, cabbage, Brussels sprouts, spinach, broccoli, garlic, chives, tomatoes, cucumber, almonds, and walnuts. Green tea is also recommended.
-  **LIFESTYLE:** If currently smoking, consider a cessation program to reduce reactive oxygen species (ROS) production in the body. Stress-reducing techniques, a regular sleep schedule, and sweating from saunas or exercise can support healthy detoxification. Regular exercise at moderate to low intensity has been associated with higher glutathione levels.
-  **SUPPLEMENT:** Supplements containing melatonin or quercetin may protect against glutathione depletion. Supplements containing glycine, glutamate, or cysteine may also be beneficial. Whey protein powders have also been shown to increase glutathione levels. Glutathione can also be supplemented directly, but oral glutathione is usually poorly absorbed-liposomal glutathione is usually more bioavailable. NAC (N-acetyl cysteine) is a glutathione precursor and can also be used to enhance levels. Additionally, spore-based probiotics paired with prebiotics like FOS, GOS, and inulin may improve the abundance of glutathione-producing bacteria.

#### IF HIGH




**NO ACTION NEEDED.** Glutathione is the most abundant antioxidant in the body and is necessary for numerous biologic functions. Efforts to reduce glutathione are not recommended.

### INDOLE PRODUCTION

#### IF LOW

-  **NUTRITION:** Limit consumption of high fat foods and increase consumption of fermented foods, brightly colored fruits and vegetables, and foods rich in tryptophan, such as oats, white beans, kidney beans, pumpkin seeds, various cheeses, halibut, salmon, lobster, poultry, red meat, and eggs.
-  **LIFESTYLE:** Ensure adequate time outdoors, regular exercise, and proper sleep.
-  **SUPPLEMENT:** Bacillus spore based probiotics can improve microbial diversity and balanced indole production.




#### IF HIGH

-  **NUTRITION:** Limit consumption of tryptophan-rich foods like cheese, meat, eggs, and poultry.
-  **LIFESTYLE:** Pay attention to mental health, as a surge of indole may overstimulate important regions of the brain. Ensure adequate sleep, practice stress-reducing exercises, and spend adequate time outdoors.
-  **SUPPLEMENT:** Supplements containing Bacillus spore-based probiotics can improve microbial diversity in order to support a healthy balance of indole production in the gut.

## Functions




### ESTROBOLOME (ESTROGEN RECYCLING)

#### IF LOW




-  **NUTRITION:** Phytoestrogens may help balance hormone levels in the body, however it is important to note that genetic and ethnic factors can affect how phytoestrogens are utilized in the body. Increasing consumption of phytoestrogens from foods such as soybeans, tofu, tempeh, soy beverages, flax seed, sesame seeds,, berries, oats, barley, beans, lentils, rice, alfalfa, mung beans, apples, carrots,, and rice bran can help increase estrobolome. Consume healthy fats from nuts, nut butter, avocado, olives/olive oil and organic canola oil. Consume leeks, asparagus, onions, garlic, chicory, oats, soybeans, and Jerusalem artichoke, which are rich sources of FOS and inulin.
-  **LIFESTYLE:** Exercise in moderation and opt for exercises such as walking, light bike riding and body weight exercises. Avoid excessive, recurrent use of antibiotics.
-  **SUPPLEMENT:** Sulforaphane, curcumin and green tea extract increase  $\beta$ -glucuronidase activity which can increase estrogen recycling. Similarly, supplements containing inulin and FOS may help increase the abundance of  $\beta$ -D-glucuronidase producing species. Bacillus spore-based probiotics may improve functional diversity of gut microbiome.

### VITAMIN PRODUCTION

#### IF LOW

-  **NUTRITION:** Consume fermented foods such as natto, kimchi, kefir, yogurt, and kombucha. Consume brightly colored fruits and vegetables, rich in fiber and polyphenols.
-  **LIFESTYLE:** Spend adequate time outdoors, practice stress-reducing techniques, and get regular, moderate exercise.
-  **SUPPLEMENT:** Consider a multi-vitamin and mineral supplement. Probiotics containing Bacillus subtilis and prebiotics like FOS, GOS, and XOS can support the growth of vitamin-producing bacteria in the gut.

#### IF HIGH

-  **NUTRITION:** Limit intake of sugar, red meat, and alcohol as these can increase the production or reuse of estrogens. Increase intake of dietary fiber and cooked cruciferous vegetables like broccoli, turnips, kale, and collard greens. Broccoli and mustard seeds are particularly high in sulforaphane. Diets rich in fat or protein are associated with higher  $\beta$ -glucuronidase activity, while vegetarian diets have been shown to clear estrogens from the body 3 times more efficiently.
-  **LIFESTYLE:** Engage in stress-reducing activities like yoga, meditation, deep breathing, massage, or acupuncture. Avoid xenoestrogens in cosmetics with phthalates and parabens, plastics containing bisphenol A (BPA), cigarette smoke, car exhaust, forest fire smoke, fabric softeners, nail polish, perfumes, and non-stick cooking pans.
-  **SUPPLEMENT:** Supplements that contain calcium D-glucarate, DIM, or sulforaphane can encourage healthy excretion of circulating estrogens. Glutathione levels are also important for clearing estrogens-assess glutathione status and consider supplementing with glutathione and/or NAC accordingly. Probiotics that contain Bacillus endospores and prebiotic fibers like FOS, GOS, and XOS can work together to increase microbial diversity in the gut.




#### IF HIGH

There is no upper limit for vitamin K, vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin B5 (pantothenic acid), vitamin B7 (biotin), and vitamin B12 (cobalamin), therefore high production of these nutrients in the gut does not require any action. Similarly, adverse reactions associated with excess vitamin B6 (pyridoxine) and vitamin B9 (folate) are only possible through supplementation of 1-6 grams. The gut is not capable of producing nutrients at this volume.

## Functions

### VIT B1 THIAMIN

#### IF LOW




-  **NUTRITION:** Increase consumption of foods containing inulin. Fermented foods such as yogurt and kefir, as well as brightly colored fruits and vegetables can also improve vitamin B1 synthesis.
-  **LIFESTYLE:** Ensure adequate sleep. Avoid excessive and chronic use of antibiotics. Practice stress-reducing techniques and get regular, moderate exercise.
-  **SUPPLEMENT:** Supplements containing inulin and polyphenols may increase vitamin B1 synthesis in the gut. Probiotics containing Bacillus spores can enhance microbial diversity and support a healthy gut environment.

#### IF HIGH

No action needed.

### VIT B2 RIBOFLAVIN

#### IF LOW




-  **NUTRITION:** Increase consumption of brightly colored fruits and vegetables and foods rich in inulin. Sourdough bread may also increase riboflavin synthesis in the gut.
-  **LIFESTYLE:** Ensure adequate sleep. Avoid excessive and chronic use of antibiotics. Practice stress-reducing techniques and get regular, moderate exercise.
-  **SUPPLEMENT:** Supplements containing inulin and polyphenols may increase vitamin B2 synthesis in the gut. Probiotics containing Bacillus spores can enhance microbial diversity and support a healthy gut environment.

#### IF HIGH

No action needed.

### VIT B5 - PANTOTHENIC ACID

#### IF LOW

-  **NUTRITION:** Increase consumption of vitamin B5-containing foods such as chicken, fermented soybeans, and eggs. Consume rich sources of inulin.
-  **LIFESTYLE:** Ensure adequate sleep. Avoid excessive and chronic use of antibiotics. Practice stress-reducing techniques. Engage in regular, moderate exercise.
-  **SUPPLEMENT:** Supplements containing prebiotics like inulin, polyphenols, or Bacillus spore based probiotics can help support microbial diversity.




#### IF HIGH

No action needed.

## Functions

### VIT B6 - PYRIDOXINE

#### IF LOW




-  **NUTRITION:** Consume foods containing inulin. Foods rich in B6 are also recommended, like sweet potato, legumes, avocado, tofu, beef, and fish. B6 is better absorbed from animal sources, but plant sources are still viable options.
-  **LIFESTYLE:** Investigate prescription medications, such as hormonal contraceptives, that may cause B6 deficiency and unwanted changes to the gut microbiome. Avoid excessive or chronic use of antibiotics. Practice stress-reducing techniques, and exercise regularly at moderate intensity.
-  **SUPPLEMENT:** Probiotics containing *B. clausii* or *B. subtilis*, or supplements containing prebiotics like psyllium husk, FOS, GOS, or XOS may help to increase vitamin B6 synthesis in the gut.

#### IF HIGH

No action needed.

### VIT B7 - BIOTIN

#### IF LOW




-  **NUTRITION:** Consume foods that are rich in inulin, oligosaccharides, and resistant starches.
-  **LIFESTYLE:** Avoid excessive exercise and ensure adequate sleep. Avoid excessive and chronic use of antibiotics.
-  **SUPPLEMENT:** Supplements containing raw potato starch or other important prebiotics like inulin, resistant starch, XOS, GOS, or FOS can help to support normal biotin synthesis in the gut.

#### IF HIGH

No action needed.

### VIT B9 - FOLATE

#### IF LOW

-  **NUTRITION:** Consume fermented foods such as yogurt, kefir and kombucha. Increase consumption of green leafy vegetables and asparagus to ensure ample intake of folate in the diet. High fat diets may be detrimental to B9 producers. Consume foods rich in inulin and resistant starch.
-  **LIFESTYLE:** Ensure adequate sleep, avoid excessive and chronic use of antibiotics, and practice stress-reducing techniques.
-  **SUPPLEMENT:** Supplements that contain whey protein, pea protein, GOS, raw potato starch, dandelion root, chicory root, or inulin may increase certain folate producers, such as *L. reuteri* and *B. fragilis*. Probiotics containing Bacillus spores may improve microbial diversity and folate production in the gut.




#### IF HIGH

No action needed.

## Functions




### VIT B12 - COBALAMIN

#### IF LOW

-  **NUTRITION:** Increase consumption of inulin, glycans, and resistant starch. High-fat diets may impair B12 synthesis in the gut. Consume fermented milk products, if tolerated.
-  **LIFESTYLE:** Address any symptoms of SIBO which could cause a depletion of B12. Ensure adequate sleep, avoid excessive and chronic use of antibiotics, and practice stress-reducing techniques.
-  **SUPPLEMENT:** Supplements containing prebiotics such as GOS, FOS, XOS, raw potato starch, dandelion root, chicory root, or inulin may increase certain B12 producers, such as *B. fragilis* and *F. prausnitzii*. If the abundance of B12 producers is low, check B12 status.

### VITAMIN K2

#### IF LOW

-  **NUTRITION:** Increase consumption of fermented foods such as Natto (fermented soybeans), European hard cheeses, sauerkraut, kimchi, and kombucha. Consume foods containing oligo- and polysaccharides. Diets high in saturated fat as well as overly processed foods may inhibit K2 production in the gut.
-  **LIFESTYLE:** Avoid excessive or chronic use of antibiotics. Practice stress-reducing techniques. Follow a structured sleep schedule to ensure quality sleep and proper circadian rhythm functions. Exercise regularly at moderate intensity.
-  **SUPPLEMENT:** Probiotics containing *Bacillus subtilis* can help to increase vitamin K2 synthesis in the gut. Prebiotic supplements containing XOS, GOS, or FOS may feed K2 producers and enhance their abundance. Supplements containing natural vitamin K2 (MK-7) may also help to improve vitamin K2 status.

#### IF HIGH

No action needed.

#### IF HIGH

No action needed.