

## **FIBER and the MICROBIOME**

In 2006, we knew of only 200 species of bacteria which inhabited the gut. With improvements in lab techniques at that time, we were able to identify almost 17,000 and today, we think the variety of species may be as high as 36,000. The "microbiota" refers to the variety of microbes and the "microbiome" refers to the genetic code of this community of microorganisms which number more than 40 trillion. Some scientists think there are as many as 100 trillion. They consist mostly of 5 types:

- 1) Bacteria. These are single-cell organisms. There is a balance of good and bad bacteria. *E. coli* and *Pseudomonas* are normal components of our microbiota but they are kept in check by the good microbes. It's only when they are allowed to overgrow that they cause problems.
- 2) Fungi. They are multicellular, similar to plants and animals. They are also normal in our gut but in balance with the other microbes, especially the bacteria. *Candida* is an example. Overgrowth is called thrush but candid is always everywhere, just kept in check.
- 3) Viruses. Not even considered living creatures, these are basically packages of genetic material, either DNA or RNA. We think of them as bad but also make up a healthy microbiome.
- 4) Parasites. Although they are not thought to provide any benefit to humans, they are part of the biome. They vary in size in nature, from the microscopic, to almost 80 feet long. About 18% of Americans are chronically infected with *Toxoplasma Gondii* but don't know it because they have no symptoms.
- 5) *Archaea*. These ancient organisms have been around since before there was oxygen on Earth, 4 billion years ago. Their exact role and with which microbes they compete is still not clear.

Every microbe eats something unique and everything you eat either feeds something or starves something. If you permanently remove a food group, the microbes that feed on those foods die off and become extinct. They procreate so quickly that food choices you make in 24 hours will alter the evolution of 50 generations of microbes. It doesn't take days or weeks, just one bite. That's also why each person's microbiome is as unique as a fingerprint.

"Post-biotics" are what we call the health-promoting compounds produced by our microbes, like short chain Fatty acids (SCFA).

"Dysbiosis" describes that lack of harmony and balance in the gut. Loss of microbial diversity leads to overpopulation of pro-inflammatory compounds which lead to gut wall disruption, leaky-gut and spillage of endotoxin by overpopulated harmful bacteria like *E. coli*.

Healthy bacteria mold our food into something that reduces inflammation and promotes health and balance. These compounds are post-biotics. But the opposite is also true if you feed unhealthy foods to unhealthy microbes as is the case with the pro-inflammatory compound TMAO, produced from choline derived from meat and eggs.

Even drugs function is impacted by gut health. The chemotherapeutic drug Cyclophosphamide actually relies on healthy gut bacteria to activate it. If your gut is not healthy, the drugs are less efficient and your cancer treatment may be compromised.

Gut microbes control release of hormones which control appetite and energy balance like ghrelin, leptin, glucagon-like peptide-1 (GLP-1) and peptide YY.

The gut is the largest endocrine organ in the body. It is crucial to hormonal balance. For example, gut microbes secrete the enzyme beta-glucuronidase which activates estrogen so it can do what it is supposed to in the body. There is a feedback loop between how much estrogen we need and how much of that enzyme we secrete. If you have too much estrogen, conditions like hormonal cancers (breast and endometrial) and endometriosis develop. If too little enough estrogen is activated, there is an over production of androgens (male sex hormones) which is controlled in part by a microbe *Clostridium scindens*. Too much of that microbe (i.e. dysbiosis) and you get too many androgens leading to polycystic ovarian syndrome (PCOS).

Our microbiome also impacts on our interactions with each other. Every time we kiss, we exchange 80 million microbes. It is thought that this behavior may have evolved as a means of sampling the others microbiome. Microbes also control the release of guaiacol and other phenolic compounds which produce our odor profile. Different microbes produce different smells. This is thought to also be how dogs identify each other... by sniffing their backsides. Every dog's odor profile is unique.

The GI tract is also called the enteric nervous system, or the "second brain". It contains 500 million nerves, 5x more than exist in the spinal cord. Most of these nerves send information back and forth to the brain via the Vagus nerve. The gut microbes also communicate with the brain through the release of neurotransmitters, hormones and signaling molecules. Neurotransmitters like serotonin and dopamine play a role in our mood, energy levels, motivation and reward mechanisms. But microbes both produce and respond to such neurotransmitters like serotonin, dopamine, GABA and norepinephrine. 90% of serotonin and 50% of dopamine are actually produced in the gut. Gut serotonin is responsible for gut motility, mood, appetite, sleep and brain function. The gut makes more than 30 different kinds of neurotransmitters. This is also how gut microbes control cravings. If you feed the chocolate-loving microbes, they will proliferate and they will lead to chocolate cravings.

Whereas 99.9% of human genes are identical, up to 90% of your microbiome is unique to you alone.

When people with Celiac disease, essentially an allergy to gluten, consume gluten, the immune system reacts by causing inflammation in the gut. This chronic inflammation is associated with an increased risk for small intestinal lymphoma which is almost universally fatal. About 35% of Americans carry the gene for Celiac disease but less than 1% manifest the disease. The 3 factors leading to this manifestation include:

1. Presence of the gene
2. Exposure to gluten
3. Alteration and/or damage to the gut microbiota

**CHEMICALS AND MEDICATIONS.** There is no question that all the fertilizers, herbicides, fungicides and insecticides used in the agricultural industry damages the gut. Many of these compounds are actually antibiotic as well. As far as the food industry goes, we started adding chemicals to foods after WW2. Today there are well over 10,000 chemical additives, 99% of which have never been properly tested for safety in humans. They are called GRAS, Generally Recommended As Safe. In 1994, genetically modified organisms (GMOs), came onto the scene. Today 80% of all genetically modified crops grown worldwide are engineered to be herbicide tolerant so much more herbicide is now used on them.

Buying organic is not just a personal choice for health but it's also a choice for a healthier planet.

Antibiotics, although life-saving in many situations, wreak havoc on the gut microbiome. Only 5 days of ciprofloxacin (Cipro), used commonly in urinary tract infections, wipes out 1/3rd of your healthy gut bacteria. Most species recover within 4 weeks but it can take up to 6 months. With clarithromycin (Biaxin) and metronidazole (Flagyl), the effects are evident up to 4 years after treatment. With broad spectrum antibiotics like clindamycin (Cleocin) and amoxicillin clavulanate (Augmentin), especially if used in combination, they can permanently wipe out the beneficial bacteria. Other medications can also affect the gut microbiome. Acid reducers like Prilosec increase the risk of *C. Difficile* (C. Diff) infection and SIBO (small intestinal bacterial overgrowth) and non-steroidal anti-inflammatories (NSAIDs) like Motrin can destroy the gut lining and cause ulcers. Birth control pills have been associated with Crohn's disease and Ulcerative Colitis. In fact, 24% of non-antibiotic drugs tested had some effect on the gut or the microbiome.

Artificial sweeteners, like Splenda and Aspartame, induce changes in the microbiome which promote inflammation, insulin resistance and liver injury. One in particular, trehalose, which is also used to "improve" the stability and texture of food, promotes the growth of a particularly virulent strains of *C. Diff*. It's implementation in the food industry times perfectly with the worldwide explosion of those specific strains of *C. Diff*.

FATS. Unhealthy saturated fats encourage the growth of inflammatory microbes like *Bilophia wadsworthia*, alter intestinal permeability and cause release of bacterial endotoxin. Monounsaturated fats (MUFAs), like the ones in olive oil and avocado, and omega-2 polyunsaturated fats (PUFAs) from plant foods like seeds and nuts, promote growth of beneficial microorganisms, correct dysbiosis and reduce endotoxin release.

PROTEIN. Plant protein increases growth of anti-inflammatory bugs like *Bifidobacterium* and *Lactobacillus* and suppress the bad bugs like *Bacteroides fragilis* and *Clostridium perfringens*. Animal protein however increases growth of inflammatory microbes like *Bilophila Wadsworthia*, *Alistipes* and *Bacteroides* which produce toxins like amines, which cause food sensitivity, sulfides, which are associated with UC and secondary bile salts, which are associated with cancer of the colon, esophagus, stomach, small intestine, liver, pancreas and biliary tract. Animal protein, specifically red meat, eggs and fish, contain L-carnitine which get converted into the inflammatory molecule TMAO.

FAD DIETS. Paleo (low carbohydrate, higher fat and animal protein) diets, which have much higher meat content than is in general advisable, result in higher TMAO levels, reduced *Roseburia*, a microbe which protects against inflammatory bowel disease, reduced *Bifidobacterium*, which protects against irritable bowel and PND obesity and increased *Hungatella*, which also produces TMAO. Ketogenic diets (similar to the Paleo diet) result in dramatic microbiome changes even within 24 hours. There was a clear shift away from healthier bacteria and towards unhealthy ones.

THE FIBER SOLUTION: Short-Chain Fatty Acids and Postbiotics

Fiber, which you only get from plants, is the most powerful solution to restoring and maintaining a healthy microbiome and your overall health. 97% of Americans consume too much protein. 97% of Americans don't even reach the minimum requirements for fiber. Fiber is what makes up plant cellular structure. It ONLY comes from plants. There is NO fiber in animal products. Fiber is a complex carbohydrate. A sugar, made up of chains of more simple sugar molecules. Other than the mechanical disruption which occurs in the mouth and stomach, fiber remains unchanged until it reaches the large bowel where bacteria start to work and feed on it.

## FIBER MYTHS:

- All fiber is the same. There are over 300,000 edible plants and millions of types of fiber. Fiber can be divided into soluble (dissolvable in water) and insoluble, all types of fiber have a combination of both.
- Fiber just passes through us. The fiber you buy at the store in a jar does that (except for the added sugars and chemicals which you absorb), but otherwise, plant fiber is fuel for the healthy microbes in your gut which then go on to generate healthy compounds called post-biotics. Humans lack the enzymes to break down fiber. We need the bacteria for that. We do have enzymes called glycoside hydrolases which help break down the complex carbohydrates but we only have about 17 types of those enzymes. None of them are designed to break down fiber. The microbes in the gut, on the other hand, generate almost 60,000 different types of enzymes designed to break down complex carbohydrates and fiber.

SHORT-CHAIN FATTY ACIDS (SCFAs). Our gut microbes convert fiber into carbon compounds called SCFAs. There are 3 main types:

- 1) Acetate, made up of 2 carbon atoms connected together
- 2) Propionate, made up of 3 and
- 3) Butyrate, made up of 4.

They are produced in different amounts based on the type of fiber and work together. Each type of fiber consume produces a different combination of these SCFAs.

## PRE, PRO and POST BIOTICS.

- Probiotics are living bacteria which have been demonstrated to be of benefit to humans.
- Prebiotics are the food the healthy bacteria consume to flourish.
- Postbiotics are the healthy compounds (SCFAs) produced by bacterial metabolism

Prebiotics + Probiotics = Postbiotics.

Not all fiber is prebiotic. The soluble part is but the insoluble part, the roughage, is not. It basically makes big poop. Prebiotics also consist of resistant starch, found in oats, rice, potatoes and legumes. It's technically not fiber but behaves and is digested by microbes the same way. Mother's milk also contains human milk oligosaccharides, or HMOs which feed the baby's developing microbiome. Other prebiotics include antioxidant polyphenols from plants like cocoa, green and black tea, pomegranate, apples and blueberries. Omega-3 PUFAs, found in walnuts and flax seeds, are also prebiotics. Although these polyphenols don't lead to the production of SCFAs, they do help produce other postbiotic compounds.

## SCFAs do a lot:

- a) They make the colon more acidic which prevents growth of inflammatory bacteria.
- b) They also directly suppress the growth of certain strains like *E. Coli* and *Salmonella*.
- c) SCFAs also repair colonocytes and provide up to 70% of the energy they use. In fact, they provide up to 10% of your entire body's caloric needs.
- d) Butyrate directly repairs leaky gut by increasing the expression of tight junction proteins.
- e) Butyrate also suppresses endotoxin release from bad bacteria.
- f) Butyrate increases colonic motility (movement) and decreases visceral hypersensitivity which is what leads to diarrhea.

## INFLAMMATION AND AUTOIMMUNITY

- g) They inhibit 3 of the most powerful inflammatory signaling molecules in the body: NF-kappa B, IFN-gamma and TNF-alpha.
- h) They make immune cells more tolerant to the gut bacteria which make them more tolerant to your food, preventing or reversing food allergies and sensitivities. It's why breast-fed babies have more allergies and food sensitivities.
- i) They communicate with suppressor, regulatory T cells which "cool off" the immune system assisting with autoimmune disease.
- j) Crohn's disease is a gut inflammatory condition which most commonly affects the small bowel but can affect the entire GI tract, from the mouth to the anus. Crohn's patients routinely have gut dysbiosis with loss of butyrate-producing *Faecalibacterium prausnitzii* and an overgrowth of pathological, invasive *E. Coli*.
- k) Just 2 weeks on a low-fiber diet causes alteration in the gut microbiota and the lining of the intestines start to get eaten away causing leaking.

## CANCER

- l) Cancer is a process where cells multiply and grow without any stopgaps. For this to happen, cancer cells' DNA must be able to copy itself before the cell divides. For this to occur, you need the enzyme histone deacetylase, which is inhibited by butyrate.
- m) SCFAs also support the apoptosis (spontaneous cell death) of cancerous cells.
- n) Fiber from Whole Foods has been linked with lower rates of colorectal, breast and esophageal cancer.
- o) For every 5-gram increase in fiber consumption, there is an 18% drop in death from colorectal cancer risk and 14% drop in all-cause mortality risk.

## HEART DISEASE, STROKE AND WEIGHT LOSS

- p) SCFAs are linked with lower rates of
  - Weight.
  - Type 2 Diabetes.
  - Total cholesterol and blood pressure.
- q) They improve insulin sensitivity and suppress fatty acid production in the liver.
- r) The "Lentil effect" is also called the "second meal effect" which describes how a meal with a lot of fiber impacts not only on the present glucose effect but also on the following meal hours later.
- s) SCFAs lower cholesterol by directly impacting on the enzyme responsible for cholesterol formation in the liver. It also increases cholesterol excretion in bile.
- t) They also directly activate fat cell receptors which decrease fatty acid uptake suppressing fat accumulation.
- u) They release satiety hormones.
- v) SCFAs also protect against CHF, Hypertension and atherosclerosis.

## COGNITION

- w) Butyrate has a profound positive effect on learning and memory. This has been shown with Alzheimer's Disease, heavy metal toxicity, Traumatic Brain Injury and neurological infections.
- x) SCFAs interfere with amyloid formation.

THE HADZA vs AMERICANS. The Hadza are a modern hunter-gatherer people living in northern Tanzania. The Americans live in North America and, for the most part, eat a terrible diet.

- Hadza consume >100 grams of fiber a day and more than 600 varieties of plants a year.

- Americans consume only 15 grams a day and <50 different varieties of plants.
- Hadza have 40% more biodiversity of their microbiota than Americans
- Rural Africans in general have 65x less colon cancer than Americans.
- Only 2 weeks of switching a typical African diet for a SAD had the following results:
  - o The African diet reduces secondary bile acids by 70% while a SAD increases them by 400%
  - o Butyrate levels went up 2.5x when the SAD eaters switched to the African diet whereas levels dropped in half the other way around.
  - o TMAO levels also rose significantly in those eating the SAD diet.

## **EAT THE RAINBOW**

In May 2018, The American Gut Project published the first results of a study looking at the human gut microbiome. Over 15,000 microbiome samples from over 11,000 participants from mostly the United States, United Kingdom and Australia but also from 42 other countries and territories were analyzed. Lifestyle habits, including diet diaries were analyzed. The single greatest predictor of a healthy gut microbiome was the diversity of plants in one's diet. 30 different plants a week was the greatest predictor of microbial diversity.

There are 400,000 varieties of plants and 300,000 ( $\frac{3}{4}$  of them) are edible. Combined globally, humans consume only 200 species and 60% of the calories and proteins humans obtain from plants come from only 3: rice, corn and wheat. In the last 100 years alone, we've abandoned 75% of our agricultural diversity because of pressures on farmers.

Every plant has its own unique mix of gut healing fibers:

- Barley. It has the prebiotic beta-glucan which promotes growth of healthy microbes, lowers LDL and regulates blood sugar. It has lots of selenium, important for thyroid health.
- Oats also have beta-glucans and also have phenolic acid, which are anti-inflammatory and are antioxidant.
- Flaxseeds are 40% prebiotic fiber. Make sure you grind it since flax has an undigestible shell.
- Wheat Bran contains a special fiber made of arabinoxylan oligosaccharides
- Potatoes contain resistant starch, which increases in amount when you reheat potato leftovers.
- Seaweed contains 50% soluble prebiotic fiber.

PHYTOCHEMICALS. There are over 8000 different kinds of plant compounds and we only have some understanding of about 150 of them. As an example, an apple contains 4.4 grams of fiber,  $\frac{2}{3}$  insoluble and  $\frac{1}{3}$  soluble. There are numerous phytochemicals including quercetin, which protect against colon and lung cancer, heart disease, diabetes, liver damage and asthma, and catechins, which protect against lung cancer, coronary artery disease, stroke and COPD. There are many others and each part of the apple has a different mix. Apples also have a microbiome. Each apple can contain 100 million, live bacteria.

Plant compounds also have an additive effect when combined. For example:

- Tomatoes and Avocados. The lycopene in tomatoes is more bioavailable through the healthy fats from avocados.
- Mixed Fruit. The antioxidant activity from the individual fruits is synergistic when combined together.

- Kale and Lemon. Kale is a great source of non-heme iron, much healthier than heme iron which meat provides. The vitamin C from lemon increases absorption of iron from kale.
- Turmeric and Pepper. The active ingredient in turmeric, curcumin is absorbed 2000x better when combined with pepper.

WHOLE GRAINS. They are a great source of prebiotic fiber.

- Every daily serving of whole grains reduces risk premature overall death by 5% and premature cardiovascular death by 9%
- The people who consume the most whole grains have a 14% lower incidence of stroke.
- For every 3 servings of whole grains a day, there is a 20% lower colorectal cancer risk.
- Diabetes risk is 30% lower with 3 servings a day.
- Those who consume whole grains have lower BMI and lower weight.
- Inflammation decreases. It lowers CRP, a marker of inflammation, by 21%.

GLUTEN. An important protein found in wheat, barley and rye, it is really the refined forms of these grains which cause all the problems. Without gluten, we have a less diverse microbiome. Some people must obviously avoid it but for the vast majority of us, it is an important protein to consume.

LEGUMES. The average American consumes only 6.3 pounds of beans a year, mostly in the form of refried beans in fast food and canned, sugar and salt-laden frank and beans. This is in comparison to only 50 years ago when we consumed 20% more and they were unprocessed. Just one example of their power is how much they lower inflammation with CRP levels dropping by 40%. When beans and grains are combined, you have a complete protein package. They are loaded with fiber.

- Green peas 7 grams/cup
- Lentils 16 grams/cup
- Pinto beans 30 grams/cup

SOY. Packed with healthy phytoestrogens called isoflavones, soy is very healthful. There are 3 specific kinds of isoflavones: genistein, daidzein, and glycitein. They lower cholesterol, strengthen bones, treat menopausal symptoms, decrease risks of coronary artery disease as well as hormonal cancers like breast and prostate. Certain gut bacteria which feed on soy produce equol, (4',7-isoflavandiol), an isoflavandiol estrogen which is metabolized from daidzein. It is produced in 60% of Asians, who consume a lot of soy but only 30% of Westerners. Antibiotics hinder production of equol.

LECTINS. These are a group of protein compounds found in nature which are known to bind carbohydrates. They are ubiquitous in nature including all plants, animals, fungi and microorganisms. Unfairly labeled as "antinutrients", nothing could be more far from the truth. They protect against cancer, weight loss, blood pressure, cholesterol, insulin resistance, inflammation, SCFA production, as well as cardiovascular disease. Although they are in all foods, some have higher levels and some include:

- Cow's milk
- Eggs
- Beans
- Tomatoes
- Potatoes
- Eggplant
- Fruit
- Grains

**GUT SENSITIVITY.** As many as 80% of people with irritable bowel syndrome (IBS), have food sensitivities. The irony is that the people who need fiber the most are the people who struggle with it the most. Elimination of foods, particularly elimination of whole categories, may help reduce symptoms in the short term but is not a good strategy for the long term. As you eliminate foods, you also eliminate the healthy bacteria which feed on those foods, assuming they are healthy foods. Eliminating sugar and processed food or excessive amounts of animal products are good classes to eliminate but not any plant classes.

If you look at your gut like a muscle, you gain "strength" in the gut by feeding it a diversity of plants. The gut thrives on fiber, just like muscle rebuilds and grows with protein. However, your gut is adaptable to whatever you feed it. This can serve you or harm you. We see seasonal variations in the microbiome in populations who eat seasonally grown foods. On the other side of the coin, if you are lactose intolerant, you may be able to tolerate small amounts of lactose or even train your body to tolerate lactose despite 75% of the world's population lacking the enzyme lactase dehydrogenase, which breaks down lactose. Long-term studies show that consumption of dairy during teenage years provided no protection against hip fractures in adult life however such consumption does increase the risk of developing hormonal cancers such as breast and prostate. In addition, dairy is a significant contributor to acne. Ironically, the lactose in dairy is actually a prebiotic and as such, can have a beneficial impact on the gut microbiome. If you eat a lot of meat, you feed and grow the bacteria which thrive on meat but these bacteria also generate dangerous inflammatory compounds like TMAO.

**CONSTIPATION.** There is a vicious cycle which occurs with constipation. Methane gas slows gut motility which causes constipation and this in turn, leads to more methane gas formation. The most severe constipation actually presents with diarrhea, which is called "overflow diarrhea". It's the water which makes its way around the impacted stool in the colon. Although fiber is important in preventing constipation, you can't just jump in and start consuming it since it may make things worse. You need to slowly increase the amounts and variety of plants you eat.

**FOOD ALLERGY vs FOOD SENSITIVITY.** Food allergy is your immune system reacting to a specific food when it's stimulated. IgE, the antibody responsible for typical allergic reactions, misidentify foods as foreign and trigger an over exuberant cascade of inflammation, trying to rid the body of the apparent invader. Resulting symptoms include hives, itchiness, swollen lips, swelling of the throat, trouble breathing and potentially loss of consciousness. Although you can develop tolerance, it is complicated. The most common food allergies are to:

- Dairy. Not just lactose intolerance but actual allergy to the proteins.
- Fish. Usually, allergy is to all fish but not necessarily to shellfish or mollusks (clams and mussels)
- Shellfish. You can be allergic to any combination of the 3 types, shrimp, crab and lobster. Sometimes, it is not the shellfish, but a microbe that lives in its gills. Usually, shellfish allergy does not include mollusks.
- Eggs. Both the white and the yolk.
- Nuts. Usually all tree nuts at the same time. Peanuts are NOT a nut, but a legume.
- Peanuts.
- Wheat. You can be allergic to gluten (Celiac Disease) or other wheat components.
- Soy. Sometimes this is a reaction to the pesticides so make sure you use organic soy.

Food sensitivity, on the other hand, is your body's inability to process a particular food, primarily because of the lack of the appropriate microbes which break down that food, or the lack of an enzyme responsible for that breakdown (like lactose intolerance). Symptoms consist mostly of bloating, cramping, diarrhea or constipation, abdominal discomfort and fatigue. You can more easily retrain your



body to tolerate these foods by slowly reintroducing them, allowing the microbes which thrive on those foods, to develop.

GLUTEN. There are 3 groups of people who should avoid gluten and 2 groups who should absolutely consume them. 90% of the population should consume them.

The 3 groups who should avoid it:

- A) CELIAC DISEASE. This is a true allergy to gluten, a protein which is in wheat, barley and rye. If you are truly allergic, it should be avoided at all costs. The chronic inflammation which occurs from consuming it, in addition to generalized chronic inflammation, can lead to intestinal T-cell lymphoma which is universally lethal. Only 1% of Americans are truly Celiac sufferers although the genes which put you at risk are thought to be present in as much as 40% of the population. Even if you have the gene however, there is a 97% chance of not getting the disease. The gold standard for making the diagnosis is an endoscopy and biopsy of your small intestine. Antibody tests are less reliable, especially if negative. The reason not everyone gets Celiac Disease is that there are 3 criteria which must be met to develop it:
  - 1) You must have the genes for it (HLA-DQ2 or DQ8).
  - 2) You must consume gluten
  - 3) You must activate the gene through a disrupted microbiome (dysbiosis).
- B) WHEAT ALLERGY. It is important to make the distinction between wheat allergy and gluten allergy since with the former, you can still consume barley and rye without any difficulty. It very rarely develops after childhood and affects about 0.4% of American kids.
- C) NON-CELIAC GLUTEN SENSITIVITY WITH EXTRAINTESTINAL SYMPTOMS. This is very rare and takes some trial and error. Symptoms include: joint or muscle pain, leg or arm numbness, neurological symptoms, altered mental status, loss of balance or muscle control or a rash. Although psoriasis is associated with Celiac Disease, the rash with non-celiac is called dermatitis herpetiformis and is itchy, vesicular and involves the elbows, knees, butt and trunk. However, 85% of people with DH have Celiac.

The 2 groups who should consume gluten (again, 90% of us):

- a) Anyone who is symptom free.
- b) Non-celiac gluten sensitivity with only digestive symptoms. These people are actually sensitive to a different carbohydrate found in many plants including the ones containing gluten.

Healthy non-gluten containing grains include:

- Quinoa
- Buckwheat
- Millet
- Sorghum
- Oats
- Brown Rice.

FODMAPs. These are simple or short-chain carbohydrates found in our plant food which are difficult to digest and in some people with a disrupted gut flora, can cause a multitude of GI and non-GI symptoms. This term stands for Fermentable Oligosaccharides, Disaccharides, Monosaccharides and Polyols. They are poorly digested by everyone and make their way to the large intestine relatively unchanged but only cause a problem if you lack the microbes in the colon to break them down. With poor digestion

and absorption, they can pull water into the colon and cause diarrhea, cramping and bloating. Although eliminating these foods provides some temporary relief, this diet was developed at Monash University in Australia to be temporary, while you sort out the gut issues which cause the malabsorption in the first place. There are 5 categories for FODMAPs:

1. Lactose. A disaccharide found in dairy products.
2. Fructose. This monosaccharide is found in many fruits like cherries, apples and watermelon as well as some vegetables like asparagus and artichokes. They are also found in high fructose corn syrup and honey.
3. Fructans. These are Oligosaccharides found in many foods including gluten containing grains (wheat, barley and rye) as well as fruits and veggies like onions and garlic.
4. Galacto-Oligosaccharides (GOS). These are complex sugars found in beans.
5. Polyols are monosaccharide sugar alcohols like mannitol and sorbitol often found in artificial sweeteners and some fruits and vegetables.

**FERMENTATION.** Fermentation was the original form of food preservation. Here are some examples of ancient fermentation findings:

1. 14,000-year-old bread was found at a site in Jordan belonging to the Natufian hunter-gatherers.
2. 13,000-year-old wheat-barley beer found in an Israeli cave.
3. 9,200-year-old pits to preserve fish were found in Sweden.
4. 9,000-year-old rice-honey and fruit fermented drink was found in China.

More modern examples of fermentation include:

1. Sauerkraut from Germany.
2. Kvass, a fermented drink from Eastern Europe.
3. Kimchi, a Korean version of sauerkraut.
4. Natto, fermented soy from Japan.
5. Tempeh, another form of fermented soy from Indonesia.
6. Injera, a fermented bread from Ethiopia.
7. Sourdough bread from San Francisco.

Fermentation continued as the main source of preservation until the 19th century when the modern techniques of canning, pasteurization, refrigeration freezing and chemical preservation was developed. All forms of preservation involve altering microbes in one way or another. Some kill them and some use their qualities to improve food quality. With microbial destructive preservation techniques however, you lose all their benefits.

The reason fermented foods have a slightly sour taste has to do with the production of lactic acid and other acids which lower the pH and alter bacterial balance. Lactic acid specifically has been shown to decrease inflammation and is an antioxidant in the gut. Vinegar, the result of fermented alcohol, improves insulin sensitivity, promotes weight loss and lowers both blood pressure and cholesterol.

Consuming fermented foods increases the number of gut microbes 10,000x. Various microbes generate specific beneficial enzymes:

- Lactobacillus produce various enzymes known to enhance the conversion of flavonoids in fruit like cherries as well as broccoli.
- When soybeans are fermented into Natto, the enzyme nattokinase is generated which has been shown to:
  - Break up clots.
  - Impact on platelet stickiness, reducing clot formation in the first place.

- Lower blood pressure
- Lower cholesterol.
- Stabilize established clots.
- Fermentation of red ginseng increases bioactive saponins, steroid compounds which bind with bile salts or cause the bile salts to bind to the polysaccharides in dietary fiber, which can help control blood sugar.
- Sourdough bread contains more than 25 different antioxidant peptides.
- Fermentation of soy milk activates isoflavones which increase bone density.

Microbes from fermentation generate exopolysaccharides, supercharged forms of fiber which inhibit unhealthy microbes, regulate the immune system, decrease inflammation, lower cholesterol and protect against cancer.

Common fermentation questions:

1. Is it safe to eat fermented foods? If done properly, it is absolutely safe. When fermented foods are contaminated with such things as *salmonella* or *E. Coli*, they are usually on the foods before they are fermented to begin with so make sure they are clean if you are making it yourself.
2. What about botulism? This rare neurological condition is caused by the bacteria *Clostridium botulinum*. Botulism is associated with canning, NOT fermentation. *C. Botulinum* produces a spore which is not destroyed by heat, surviving pasteurization in the canning process. It can thrive in a low oxygen environment which is what canning provides. Fermentation on the other hand avoids high heat, which kills all bacteria, including the good ones which actually produce an acid which destroys *C. botulinum*.
3. Can fermented food cause cancer? Although the general answer to this question is YES, the more subtle answer is IT DEPENDS. Fermented/processed meat and fish is linked to various cancers including: colorectal, stomach, nasopharyngeal, esophageal, lung and pancreatic cancers. Most cases however, are also linked to *Helicobacter pylori*, the bacterium commonly associated with reflux and other stomach issues. It is present in about 70% of Japanese and Koreans, where stomach cancer is very common, but rates are much lower in the US. There is a much higher prevalence of particularly stomach cancer in the Far East and the rates are much lower in the West. Rates of cancer from H. Pylori alone are still considered to be very low. Their higher cancer rates have also been thought to be impacted by higher rates of salt intake. That having been said, in those countries, they eat fermented foods with almost every meal. Too much of anything is not good for you. Cancer concerns, especially if you consume reasonable amounts of plant-based fermented foods, are not an issue. The benefits far outweigh the risks.

FERMENTED FAVORITES:

1. Sauerkraut. The easiest to purchase and the easiest to make, fermented cabbage is fantastic for you.
2. Kimchi. This is a Korean form of sauerkraut which also has other vegetables and some spicy veggies in it.
3. Miso. This is a form of fermented soy which is used to make miso soup. Although it has a fair amount of salt in it, studies show that it has no impact on blood pressure.
4. Tempeh. Another fermented soy product, popular in Indonesia, this is a little firmer than tofu and can be eaten raw, on a salad for example, or can be cooked.
5. Sourdough bread. Popularized in San Francisco, this fermented bread is often much easier to tolerate if you are sensitive to gluten since the bacteria break down the gluten. Fermentation also removes other "anti-nutrients" like phytic acid by 62%. This bread is often made from a starter batch which can live indefinitely. In fact, the famous San Francisco sourdough Boursin

Bakery, uses the original yeast culture made by the founder Isidore Boursin 170 years ago! In many European families, sourdough “starters” are often passed down from generation to generation.

6. Kombucha. This fermented tea is all the rage and has been made into various, not-so healthy, sugar sweetened beverages so be careful. However, it is a great source of healthful bacteria and yeast.

**FERMENTED DAIRY.** Although fermentation of dairy, producing products like yogurt, sour cream and kefir, there are too many downsides to dairy to justify consuming them. Lactose is broken down during fermentation, making them, along with some hard cheeses, tolerable by those who are lactose intolerant, however, the galactose which results is linked to ovarian cancer in women. These days, there are plenty of plant-based yogurt alternatives if you crave those products.

#### PREBIOTICS, PROBITICS AND POSTBIOTICS.

First and foremost, food always comes first. The amount and variety of plants is #1. Eating whole plants and fermented foods provide the prebiotics (fuel for the healthy bacteria), probiotics (healthy bacteria and yeast) leading to the production of postbiotics like SCFAs.

**PREBIOTICS.** If you struggle with gut issues, taking a prebiotic supplement might help. Some of the known benefits include:

- Promotion of growth of SCFA producing beneficial bacteria.
- Inhibition of growth of damaging bacteria.
- Reduced bacterial endotoxin production.
- Reduced inflammatory markers in the blood.
- Improved blood sugar control.
- Lower total cholesterol.
- Lower triglycerides.
- Increased HDL (good cholesterol).
- Reduced fat mass.
- Improved satiety from increased production of satiety hormones like GLP-1 and peptide.
- Improve mineral absorption like calcium and magnesium.

Some great prebiotic supplements include:

- **BETA GLUCANS.** These are naturally found in oats, barley, wheat and rye. They are also found in seaweed and mushrooms.
- **PSYLLIUM.** This comes from the husk, the outer coating, of the *Plantago ovata* plant's seeds. It sometimes goes by the name ispaghula.
- **PARTIALLY HYDROLYZED GUAR GUM.** The term “gum” means sap. This particular one comes from the leguminous guar seed grown in India and Pakistan.
- **ACACIA POWDER.** Native to Africa, the acacia tree produces a legume, acacia gum, which is then ground down.
- **WHEAT DEXTRIN.** Popularly known as Benefiber, it is separated from gluten but contamination can occur.
- **ISOMALTO-OLIGOSACCHARIDE (IMO).** Prepared through fermentation, this prebiotic is found in miso, soy sauce and honey.

**PROBIOTICS.** These are essentially live microorganisms, generally bacteria and yeast, which “confer a health benefit to the host”. In theory, they mimic the effects of our own healthy microbiome. Although

they can be helpful, in general, they do not colonize (i.e. repopulate) the gut. As soon as you stop taking them, their benefits disappear within days. As far as taking them after taking a course of antibiotics for an infection they are actually shown to impair the guts reestablishment of a healthy balance. The better-quality probiotics are more expensive, contain various species, in the 25-50 billion (minimum) range, be delayed-release so they make it past the stomach where acids destroy them, and preferably individually packaged in blister packs. All the rest are probably not of any benefit.

**FERMENTED FOODS vs PROBIOTICS.** Although both contain live bacteria, a probiotic is a highly concentrated version of a limited number of microbes. Fermented foods on the other hand, are living foods with a much wider variety of microorganisms. In addition, fermented foods have many other healthful compounds such as exopolysaccharide prebiotics, vitamins, healthy acids, bioactive peptides and polyphenols.

## FIBER-FUELED FOOD

There is no one "superfood". Volume and variety of plants is the key. The acronym F GOALS highlights some of the standouts.

F: Fruit and Fermented.

G: Greens and Grains.

O: Omega-3 seeds (flax, chia and hemp).

A: Aromatics (onions and garlic).

L: Legumes.

S: Sulforaphane (cruciferous plants), Shrooms and Seaweed.

Alcohol can be toxic to the gut microbiota. Too much is definitely not helpful. The most benefits are from good quality beer, and red wine. The benefits of red wine have to do with the TMA reducing effects of resveratrol. By reducing TMA production, less TMAO, a very cardiotoxic compound, is formed. If you are on a plant-based diet, you don't make TMAO in the first place so there is little additional benefit.

When you go plant based, many positive changes can occur also most immediately. For example, blood sugars can plummet within even 1-2 days. The same with blood pressure. The microbiome takes a little longer however. About 1 months is the magic time-frame for significant change. It takes 28 days for the microbiome to adapt to dietary fiber, get the necessary digestive enzymes necessary to process fiber and increase SCFA production. It also takes about 4 weeks for the microbiome to return to its pre-antibiotic treatment state. For some antibiotics, it can take much longer. It also takes 4 weeks for TMAO levels to either increase, when fed a meat-heavy diet, or decrease significantly when you remove the meat.