Holistic Gut Health Guide

Improve your gut health using natural healing methods and finally discover true wellness

by Stefan Burns

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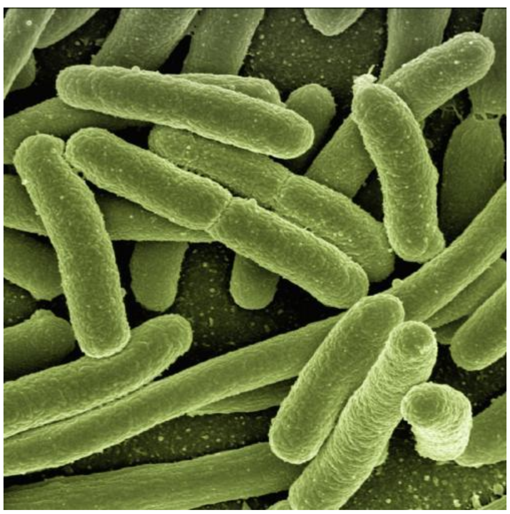
4 - The Gut Microbiome

Inside every person's digestive system are approximately one hundred trillion microorganisms, outnumbering human cells roughly ten to one. The human gut microbiome is one of the most densely populated microbial communities on Earth.

Definition: Microbiome

Microbiomes are communities of microorganisms that live together. Microbiomes can be found in and on all multicellular organisms. Microbiota found in microbiomes include bacteria, archaea, protists, fungi, parasites, and viruses.



An easy way to think of microbial microbiomes is to compare them to the societies we live in. Just as there are productive members of society that contribute to their communities' overall welfare, there are members of society who don't contribute much and instead simply float about. Then there are the members of society who actively exploit and damage the system for their own benefit. These members of society exist in different ratios depending on their environment. Microbial societies are similar in many ways to our human societies.

Microorganisms live outside the digestive system on the skin in different parts of the body like the nose, ears, and vaginal canal, as well as in all parts of the digestive system from the mouth to the rectum. The most densely populated part of the microbiome lives in the large intestine. Within the large intestine, the microbiome strips and up-cycles whatever is left of food after being stripped of its absorbable fats, carbohydrates, and proteins.

Symbiotic microorganisms are the productive members of society. In the large intestine, they facilitate the transformation of indigestible fiber into short-chain fatty acids that the large intestine then passes into the bloodstream. In addition to the conversion of fiber into fuel, symbiotic microorganisms also convert plant phytochemicals like flavonoids into secondary metabolites that have numerous beneficial biologic effects throughout the body. The absorption of fatty acids and other useful compounds by the large intestine is extremely valuable from a metabolic standpoint.

The fatty acids created from fibers and resistant starches by the gut microbiome provides continuous "base-load" energy to the body among other biologically valuable functions in the body and brain. A diverse well-functioning microbiome is necessary to have a good metabolism and cognition.

Symbiotic (mutualistic) microorganisms are the productive and helpful members of the microbiome, and pathogenic microorganisms are the destructive and harmful members of the microbiome. Both symbiotic and pathogenic microorganisms take whatever makes its way into the large intestine and process it for their use and survival. The difference between symbionts and pathogens is that symbionts produce biologically useful compounds due to their metabolic processes, whereas pathogens produce harmful toxins to create an environment only they can survive in, which the body has to detoxify and process.

Inside these coral polyps, yellow algae protist known as Zooxanthellae live in the digestive tissues producing energy from photosynthesis, an energetic process that requires cellular respiration byproducts produced from the host coral. Corals are given a source of dependable energy from the Zooxanthellae, and Zooxanthellae are given protection from the elements.

In between symbiotic and pathogenic microorganisms are neutral commensal microorganisms. Commensal microorganisms provide some valuable metabolic byproducts to their host but they may also produce toxins occasionally. Commensal microbes are typically the most numerous in number and can be shifted to become more symbiotic or pathogenic in nature over time depending on the diet eaten and the conditions they experience.

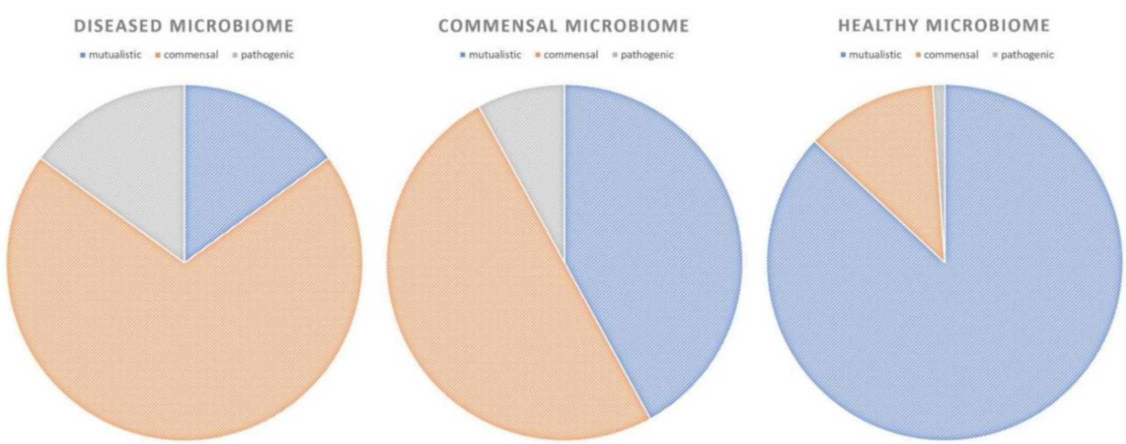


Figure 4 - The microbiome is a diverse community of microbes, and the ratio between symbiotic, pathogenic, and commensal microorganisms in the gut microbiome has a tremendous impact on gut health and overall health and wellness. Improving the diversity of the microbiome and increasing the size of symbiotic mutualistic microorganism populations has a profound impact on one's health. Whether done gradually or rapidly, the reference healthy microbiome on the right is the desirable endpoint. The ratios shown here are for illustrative purposes only.

4.1 - Different Sections of the Gut Microbiome

To have excellent gut health, the entire microbiome of the gastrointestinal system needs to be healthy, diverse, and balanced. Each section of the digestive system harbors its own microbiome community and has an influence over the other sections of the microbiome as some microorganisms inevitably travel between the different sections of the microbiome due to the movement of food and digestive fluids.

The mouth and tongue have their own microbiome communities, as do the esophagus, stomach, small intestine, appendix, and large intestine. Usually, it's the microbiome of the large intestine that has the biggest impact on gut health but occasionally other parts of the gut microbiome will be unbalanced and cause gut health problems. Some examples of microbiome imbalances in different parts of the digestive system include:

1. Small intestinal bacterial overgrowth (SIBO) can cause or contribute to digestive problems, such as gas, bloating, flatulence, incomplete digestion of food, and food intolerances.

2. H. pylori is the most common worldwide human infection, and an overgrowth of Helicobacter pylori bacteria in the stomach can cause or contribute to upper gastrointestinal health problems like chronic gastritis (inflammation of the stomach lining), stomach ulcers, and stomach cancer.

3. Appendicitis occurs when the small appendix organ attached to the beginning of the large intestine becomes dysfunctional and inflamed, most likely from a bacterial infection.

As demonstrated by the above microbiome-caused gut health problems, the diversity and health of different microbiome populations has a direct impact on gut health and, therefore, overall wellness.

4.2 - Evolution of the Microbiome

All life undergoes evolution at different timescales, and the force of evolution is applied much faster to microorganisms than it is for humans. Some bacteria can divide in as little as twenty minutes, whereas other microorganisms will divide every couple of hours, and some divide every twelve-twenty-four hours. In just one day, the microbiome that existed at the beginning of the day has evolved into a new microbiome. Whether food was eaten, what food was eaten, any stress encountered, and many other factors will influence the evolution of the microbiome, and knowing this, it's possible to influence the evolution of the microbiome towards better symbiotic function by consciously changing dietary and lifestyle factors.

Abstaining from eating all food during a forty-eight-hour fast, for example, will apply strong evolutionary pressure on the entire gut microbiome by greatly reducing nutrient availability. Microorganisms that best adapt to the period of nutrient scarcity by working more closely with the host (you) will preserve their populations better than less evolutionary adaptable microorganisms. When healthy eating is resumed, these symbiotic microorganisms make up a greater percentage of the microbiome, and as the overall microbiome expands in population once again from the influx of new nutrients, symbiotic microbiome diversity will have increased, and the entire microbiome will have evolved towards greater symbiosis.

The evolutionary demands you place on the microbiome determine the composition of the microbiome and its expression. What scientists are discovering is that two microorganisms identified as the same Lactobacillus species can express differences in their function and interaction with their host depending on their environment or even in the same environment. The Lactobacillus you get from eating yoghurt will be different from the same Lactobacillus species that's spent sufficient time in your gut microbiome. How the body and microbiome interact is highly individual and there are many ways to arrive at the same end destination of having good gut health and a healthy symbiotic gut microbiome.

An extreme example of the nature of the host-microbiome dynamic is observed in the relationship between vultures and their gut microbiome. Anaerobic pathogens Clostridia and Fusobacteria are found in high concentrations in the gut microbiome of new world vultures, with Clostridia causing severe food poisoning in humans, while the presence of Fusobacteria in the microbiome influences the development of colon cancer. In the gut of the turkey vulture, though, these microorganisms aid in the digestion of the rotten and decaying meat that vultures feed on, and as such, they exist in high concentrations without any apparent detriment to the vultures.

Another example of how the microbiome is constantly evolving can be observed just via the defecation process. On average, 75% of feces are water, with the remaining 25% being solid materials. Bacterial biomass makes up 25-55% of the solids in feces (6-14% total). This bacterial biomass is composed of dead and living bacteria, and therefore, every bowel movement changes the microbiome because it's removing a portion of the total living microorganism population out of the body.

If a healthy meal is eaten rich in vegetables and fiber, it behooves you, the host, to give the microbiome more time to process the stool in the large intestine in exchange for more useful secondary metabolites. In the context of a healthy meal, the longer symbiotic microorganisms have before some are flushed, the more they will thrive and expand, and therefore, defecation less often (but still within normal limits) is advantageous. In the context of an unhealthy meal that will expand the population of pathogens faster than symbionts, quicker defecation is more advantageous to the host because it provides less time for pathogen populations to produce toxins and expand, even if it's at the expense of having gut health problems like IBS and frequent diarrhea.

The fact that gut health problems exist is your clue that the microbiome needs some attention. With time and the right evolutionary pressures, pathogenic microorganism populations can be reduced and become less damaging in their activities, commensal microorganisms can become more symbiotic, and symbiotic organisms can strengthen their mutualistic relationships with their host even more.

4.3 - What are Microbial Biofilms?

Biofilms are structures that certain microorganisms create that provide them shelter and help them adhere to surfaces. Biofilms are made of mostly polysaccharides, proteins, nucleic acids, and lipids. By living in biofilms, microorganisms have greater protection from the outside environment. The biofilm also serves as the boundary of an "external digestive system" by keeping metabolic enzymes they release close by and able to react with collected nutrients. Biofilms are arguably the most successful form of life on Earth, existing in nearly every environment.

In the gut environment, both pathogenic and symbiotic microorganisms produce biofilm structures. Most commonly, these biofilms adhere to the intestinal mucosa and can persist for a long period of time. If intestinal mucosa layers are thin and/or uneven, then these biofilms instead adhere directly to the intestinal epithelial lining, causing an inflammatory immune response and increasing intestinal permeability. Pathogens that form biofilms directly on intestinal epithelial layers are especially problematic because they produce endotoxins that spread into their local environment, causing an even greater inflammatory response and causing cellular mutations and apoptosis through reactive DNA damage.

Biofilms are a compelling explanation as to why some microbiome-based gut health problems persist inexplicably after the use of antibiotics or after sweeping dietary changes. Microorganisms within biofilms enjoy greater protection from antibiotics, and they are also better able to retain nutrients and water in their local environment, maintain close proximity to each other, and can even eat the biofilm for survival if needed. Biofilms (and the appendix) also explain how the gut microbiome can survive long periods of nutrient scarcity during multi-day fasts when the digestive system is completely empty of food.

One reason why probiotics are partly effective in remedying gut health problems is that some of the microorganisms contained in the probiotic will form biofilms in the gut mucosa that can persist for a week or longer, and if probiotics are taken daily then many probiotic biofilms colonize the gut and permanently change the diversity and composition of the microbiome. Biofilms are hard to dislodge, so in order to enact meaningful permanent changes to the microbiome, long time spans of treatment are needed when pathogenic biofilms exist in large quantities.

4.4 - Diet and the Microbiome

One of the largest evolutionary drivers on the gut microbiome is the diet of an individual. The foods and liquids you drink directly impact the diversity and growth of the microbiome. This relationship is made most obvious with the consumption of fermented foods like yoghurt, pickles, kimchi, kombucha, and many others. Fermented foods have their own microbiome, and when fermented foods are eaten, the microbiome of the fermented food that survives the acidic conditions of the stomach combines with the existing gut microbiome increasing overall microbiome diversity.

Another clear link in the relationship between diet and the microbiome is the consumption of fiber-containing foods. Fiber is a type of carbohydrate that is indigestible by the body, with some fibers able to dissolve into water while other fibers are insoluble. Fiber can also be further defined as being fermentable or non-fermentable. Non-fermentable fibers are indigestible to microorganisms but add useful weight and bulk to stool, whereas fermentable fibers can be consumed as food by microorganisms with valuable metabolites like short-chain fatty acids being produced in the process.

A diet high in fiber-rich and fermented foods nourishes the microbiome and body by promoting the growth of symbiotic microorganisms. A diet that contains too many highly processed, chemical-laden junk foods disrupts symbiotic and commensal microorganism communities and instead promotes the growth of pathogenic microorganisms that aren't as affected by the harsh conditions poor-quality food places upon the microbiome.

The nutrient deprivation of a long fast, like a forty-eight-hour fast, will alter the gut microbiome notably, and the composition of the first meal eaten after a fast (known as a refeed meal or traditionally *break*fast) is just as important for the development of a symbiotic microbiome as the last couple meals eaten before a fast. Every meal eaten influences the microbiome but the meals eaten around a fast are particularly important due to the unique biological conditions at play.

The key principle to keep in mind with the gut microbiome is that its diversity and functional expression is highly dynamic and always changing. With conscious attention and the right choices, the microbiome can continuously be pressured evolutionarily towards greater symbiotic integration with you, which has numerous health and wellness benefits that extend beyond improved digestion and better energy metabolism; it also helps the brain and improves cognitive abilities.

Key Concept: Directing the evolution of your gut microbiome is one of the most beneficial things you can do for your gut health, overall wellness, and cultivation of greater consciousness.

4.5 - The Microbiome & Gut-Brain Axis

There exists a strong connection between the gut and brain that influences the nervous system, cognition, psychology, and more. The microbiome produces a large portion of the neurotransmitters the body uses, directly producing dopamine, GABA, and norepinephrine, and indirectly influencing the body's natural production of serotonin through its interactions with epithelial enterochromaffin cells (intestinal epithelial cells that play a governing role in intestinal motility and secretion). The gut microbiome also regulates stress hormones produced by the HPA-axis and sends direct signals to the brain via the vagus nerve. Through these interactions with the brain, the microbiome has a strong ability to influence human behavior.

As the microbiome changes, its behavioral and cognitive influence over you changes. This happens because the amount and ratios of the neurotransmitters the microbiome produces change depending on the diversity and composition of the microbiome and the evolutionary pressures placed upon it.

By changing the composition of the microbiome to improve gut health and metabolism, an added benefit is that mental health improves and cognitive abilities increase. In addition to this, the body's hormone system is made more stable and resistant to external stressors, and the immune system strengthens. For more on the gut-brain axis read chapter 11.

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