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Gut Check: How Microbiome Research is Reshaping our View of Bacteria in Human Health

Rachel Reardon

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How Microbiome Research is Reshaping our View of Bacteria in Human Health

Written by Rachel Reardon
Illustrated by Maria Altier

Ever since I can remember, I've been conditioned to view germs as the enemy. Parents and teachers constantly warn children about the perils of these invisible villains, microbes on a mission to invade and infect the human body. I was conditioned to scour my hands before meals and in the bathroom, to never rub my eyes or mouth during the day, and to stay away from sick friends, lest the tiny organisms causing their illness should corrupt my own immune system. I'd imagine most children in the U.S. had similar experiences. By the time children reach grow up, they're well aware that bacteria are to be avoided and eliminated at all costs.

However, scientists now have ample reason to believe that this mantra isn't quite accurate. Of course, no one is suggesting that hand washing is useless, or that bacteria can't act as pathogens. But recent research has found that our bodies are in fact complex ecosystems, housing and nourishing both our own body cells as well as an approximately equal number of microbial ones. It turns out that many of these bacteria are actually on our side, and they play instrumental roles in maintaining our own health.

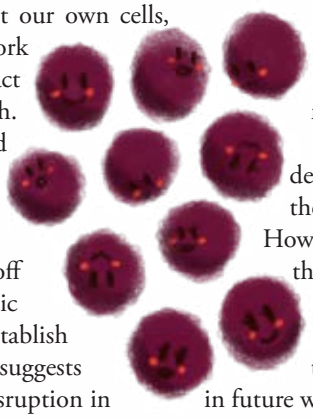
The collection of microorganisms that live within our body space are collectively known as our microbiota, and when studied together with their genetic material, are referred to as the microbiome. Bacteria are found in several areas throughout the body, including the skin, mouth, nose, and digestive tract. In most cases, one or a few species of microbes will dominate the population in a given area — anywhere from 17% to 84% of a particular site, according to one study performed in the Harvard School of Public Health. What's interesting is that the actual species of bacteria present varies widely between individuals.

We inherit our microbiota from our mothers on the day we are born. Bacteria present in the birth canal provide infants with their first coating of microbes, while breast milk contains unique compounds called oligosaccharides that cannot be digested by babies. Oligosaccharides can, however, be utilized by bacteria, providing evidence that our bodies have evolved to live in mutualism with our microbes. Skin-to-skin contact with parents throughout infancy continues to establish the child's

unique microbiome, which the Harvard researchers believe remains relatively stable throughout a person's lifetime. Claire Fraser, a microbiome researcher at the University of Maryland, reports that the community appears to stabilize around age three. So, the exposures one has during early development could have lasting effects on the makeup and lasting health of their microbiome.

The gut is perhaps the best-researched area of the microbiome, since without the bacteria that live there we would be unable to effectively digest the foods we eat. In a review article examining recent advancements in this area, Andrew Shreiner, John Kao, and Vincent Young explained the varied functions of gut microbes. Most notably, these bacteria are able to extract energy from foods that we can't digest on our own by producing accessible short chain fatty acids (SCFAs) from fibers that our digestive systems can't process. These SCFAs are critical for the regulation of immune responses, and for maintaining the protective mucous layer in our intestines. Fraser explains that if gut bacteria don't have an adequate supply of fiber, they will instead feed on this mucous layer. Over time, this causes an inflammatory response in the digestive tract that can cause discomfort and gastrointestinal distress.

All of these discoveries have important ramifications in how we understand human health and treat diseases. Our current disease treatments and prevention methods will affect not just our own cells, but also our important microbial partners. Fraser's work focuses heavily on an obvious point of interest: the impact of antibiotics on bacteria essential to human health. Her research has shown that the use of antibiotics, and particularly various classes of antibiotics in succession, can seriously decrease the number of bacterial species present in the gut. As the medicines wipe out the pathogens they are intended to destroy, they also kill off the helpful bacteria in our bodies. Following antibiotic treatment, it is very difficult for the microbiota to re-establish their healthy balance. In some cases, Fraser's research suggests that these changes can even become irreversible. This disruption in bacteria balance also correlates to an increase in chronic gut inflammation, a condition that has been tied to many bodily disease states since it alters the conditions of the immune system.



While the use of antibiotics does present significant dangers to the balance of a healthy bacterial community, these drugs are still crucial in modern treatment of bacterial diseases. In the distant future, options like species-specific antibiotics could help mediate their negative effects. However, in the meantime there are some strategies available to protect the health of the human microbiome. Elisabeth Bik at Yale University reviewed a collection of microbiome research and suggested that our gut microbes are particularly responsive to changes in diet. A comparison in the microbiomes of Western subjects with traditional communities in Africa and South America showed significant differences in bacteria species diversity. It seems that populations who consume more whole-food, high-fiber diets have more species of microbes present in their digestive systems.

Thinking about this trend in the context of findings regarding the bacterial ability to consume and digest tough fibers makes sense. The more you feed your gut good bacteria, the more robust their community will be. As such, some researchers recommend consuming more fiber, found in foods like fruits, vegetables, and whole grains, and eating fewer simple or refined carbohydrates. These dietary recommendations fall in line with traditional advice of eating your fruits and veggies, but a new level of understanding has been reached with the knowledge that this type of diet goes beyond just feeding our cells. It's essential to the health of the bacterial community that keeps us functioning at our best. Other gut-friendly foods can include fermented products like yogurt, miso, and sauerkraut. The fermentation process introduces "friendly" bacterial species that can help replenish the populations in our gut.

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But buyer beware, companies are catching on to the discovery of the importance of healthy gut bacteria. It's not uncommon to find "microbiome experts" online or in the media attempting to sell probiotic/live bacterial supplements or giving readers advice on how to maintain optimal gut health. These claims are often made by people with no expertise in the area who are simply trying to sell products. Moreover, because of the incredible variability between individuals, it's impossible to predict whether a particular treatment or supplement will help or harm a person's specific balance of microbiota.

We know that the microbiome is a crucial yet delicate factor in overall human health. We also understand the importance of fiber-rich foods to sustaining these microbes. However, research is still inconclusive in regards to the precise role that the microbiome plays in various disease states. Bik and Fraser both remind us that much of the microbiome research done up to this point has been conducted on mice. While these studies can provide insight and open up new directions in future work, their findings cannot be immediately applied to humans. Mice have very different mechanisms involved in diseases like obesity and colitis, sometimes involving genetic mutations that don't correlate to the human genome. The microbiome is a rapidly growing field of scientific research and for good reason. As researchers continue to develop more specific and rigorous experiments, our understanding of the unique ecosystem housed within the human body will surely impact the way we approach healthcare.