Introduction to the Human Microbiome

From www.americanmicrobiomeinstitute.org/humanmicrobiome

The human microbiome refers to the assemblage of microbes that live in the human body. While these microbes inhabit all parts of our body that are exposed to the environment, such as the skin and mouth, most reside in the gut where they have a constant supply of nutrients. Taken collectively, these organisms outnumber our own human cells 10 to 1, making up 5 pounds of our body weight. We have evolved with these bacteria, passed down from mother to child, for hundreds of millions of years, and scientists are now uncovering the significant role they play in human health.

Nearly every scientific study performed that has attempted to correlate the microbiome with specific traits or diseases has been successful. In other words studies are finding that our bacteria (or lack thereof) can be linked to or associated with: obesity, malnutrition, heart disease, diabetes, celiac disease, eczema, asthma, multiple sclerosis, colitis, some cancers, and even autism.

Influence on the immune system

In early life the gut bacteria play an integral role in the formation of a strong human immune system, especially during early childhood as our adaptive immune system develops. During this time the immune system becomes accustomed to foreign antigens in our body and develops a tolerance to them. Once a homeostasis is established, non-pathogenic microbes and other harmless antigens will not induce an inflammatory response. It is this inflammatory response that has been linked to autoimmune diseases and allergies. This concept is especially illustrated in germ-free mice; that is mice which are kept sterile throughout life. These sterile mice are especially unhealthy and have drastically underdeveloped immune systems. They suffer from autoimmune diseases and exhibit undesirable traits. An important consequence of these findings is that the initial gut microbiome of an infant can have a lasting effect on his or her health.

Influence on nutrition

Other research has examined the role the gut microbiome has on nutrition and obesity. Our gut bacteria are responsible for breaking down many of the complex molecules found in foods such as meats and vegetables. These bacteria not only harvest energy for themselves from the plants we eat, but also break down the plants into smaller molecules which our body is able to digest. A simple study in mice showed that certain bacteria were associated with obesity and others with normal weight. Surprisingly, when obese mice were given the gut microbiome of normal mice, the obese mice lost weight. The reverse was also true; that is, when normal mice were given the microbiome of obese mice, the normal mice gained weight. Similar studies using human twins, disparate in weight, with similar upbringings and identical genomes, showed the same association between obesity and gut microbiome.

Research has shown a direct relationship between diet and the abundance of certain gut microbial communities. For example, vegetarians have gut flora that are better equipped to break down plant roughage, making otherwise indigestable molecules such as cellulose available for humans. During bacterial metabolism of these complex molecules chemical signals are released that end up in our brains and can affect behavior. This has led some scientists to speculate that the gut microbiome may cause cravings for certain foods and influence dietary choices.

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Influence on disease

The gut microbiome is now being implicated in many gastrointestinal diseases, especially those that are symptom based, such as Crohn's disease, ulcerative colitis, and inflammatory bowel syndrome. Each of these debilitating diseases has strong links to shifts in bacterial gut populations. While the microbiome is normally quite robust, the ingestion of antibiotics, as well as sustained diarrhea can permanently alter our flora as new bacteria repopulate the gut. For example, populations of C. difficile, which are low in a healthy gut, can explode if antibiotics destroy all competing bacteria. C. difficile infection causes diarrhea and flu-like symptoms that can lead to death if not properly treated. One therapy to treat C. difficile that has already proven effective is a microbiome transplant from a healthy donor. As new bacterial populations take hold in the gut, the patient recovers.

Influence on behavior

Recent research is beginning to unveil perhaps the most interesting influence the microbiome has on its host: behavior. There are many nerve endings that are located around the gut which transmit signals directly to the brain via the vagus nerve. It is speculated that the metabolites and other small molecules that are released from bacteria can affect everything from taste to mood. In fact, in one study scientists swapped the microbiome of risk-taking mice with cowardly mice and their risk-aversion swapped as well. Other studies have hypothesized that the kinds of food we crave and taste good to us may also be dictated by the population in our guts, and may even be related to that population's ability to utilize particular foods for energy. Finally, diseases such as depression and autism have also been linked to the microbiome.

Answer the following questions on a separate sheet of paper. Use complete sentences.

1. *What is the human microbiome?*
2. *How does our microbiome affect our immune system?*
3. *How does our microbiome affect our nutrition and digestive system?*
4. *What are some human diseases that are affected by our microbiome?*
5. *How could our microbiome be affecting our behavior?*