The Microbiome, the Environment, and Your Health

The microbiome is the collection of all microbes, such as bacteria, fungi, viruses, and their genes, that naturally live on and inside our bodies.

The microbiome is diverse, and each body site — for example, the gut, skin, and oral and nasal cavities — is home to a community of microbes.

Although small enough to require a powerful microscope to see them, the microbes in a microbiome can affect human health in big ways.

Your microbiome acts as a key interface between your body and the environment. Environmental substances are chemicals or compounds — in air, water, food, soil, dust, or even some consumer products — that can affect health.

Can the microbiome affect health?

In the federally funded Human Microbiome Project, a consortium of researchers organized by the National Institutes of Health mapped the structure, function, and diversity of the human microbiome. Remarkably, they found all healthy microbiomes are unique. Therefore, people may have different microbial communities but still be healthy.

In your microbiome, some microbes can make environmental substances more toxic, while others act as a buffer and make environmental substances less harmful.

Environmental exposures may disrupt the microbiome and increase the chance of developing conditions such as diabetes, obesity, cardiovascular and neurological diseases, allergies, and inflammatory bowel disease. Scientists want to figure out the key factors affecting a microbiome that may lead to disease in one circumstance but not in another.

What is NIEHS doing?

The National Institute of Environmental Health Sciences (NIEHS) studies the human microbiome to gain a better understanding of its complex

relationships with the environment, and how these interactions may contribute to disease. This knowledge could help revolutionize the way scientists test new chemicals for toxicity. Such insight may also lead to better prevention and treatment strategies for diseases that have environmental causes.

Much research concerns the gut microbiome. Some of these studies involve mice because many genes responsible for diseases are common between them and humans. A variety of environmental factors are considered by NIEHS in microbiome research.

Environmental Factors

Air pollution – Breathing ultrafine particles, a component of air pollution, altered the gut microbiome and changed lipid metabolism in mice with atherosclerosis.[1] A different study showed that exposure to traffic-related air pollution (called TRAP) resulted in more types of bacteria in the respiratory microbiome of children, potentially leading to airway inflammation.[2]

Antimicrobials – Triclosan, an antibacterial ingredient found in some personal care products, significantly changed the composition and function of the gut microbiome in mice.[3] This finding may provide insight into the association of triclosan with hormone disruption.

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Chronic stress – Chronic stress disturbed the gut microbiome in mice, triggering an immune response and promoting the development of colitis.[4] This finding may help explain how stress is related to inflammatory bowel disease in humans.

Diet – Our diets, in particular fat and fiber intake, can have immediate and dramatic impacts on the makeup of our microbiome. A high-fat diet altered the gut microbiome of mice in a way that predisposed them to develop obesity. These changes may also be associated with colon cancer development.[5]

Heavy metals – A study in mice suggested that certain bacteria in the microbiome could provide protection from the toxic effects of arsenic.[6] In addition, research in a mouse model of Alzheimer's disease demonstrated that exposure to cadmium altered an important communication pathway between the gut microbiome and the central nervous system called the gut-brain axis.[7]

Pathogens – Certain microbes, or pathogens, in the human oral microbiome may affect the chance of developing pancreatic cancer.[8]

Pesticides – Exposure to diazinon, a widely used agricultural insecticide, changed the gut microbiome of mice, more so in male than female mice. This study provides insight into previous sex–specific findings on this toxicant's effects on the nervous system.[9]

Health Effects

Infant health – Many microbes are passed from mother to infant during passage through the birth canal. The composition of the vaginal microbiome at birth, as observed in a mice study, can have lasting effects on offspring growth, immunity, and brain development.[10]

Child health – The gut microbiome is established in early years, and its composition can last throughout adulthood. But dietary and environmental exposures early in life may alter long-term health status. Researchers are finding links between the gut microbiome and allergies, asthma, and diabetes in children.[11]

Liver disease – Several studies show the gut microbiome affects liver health. For example, early life exposure in mice to certain toxic industrial chemicals resulted in a lifelong increased chance of liver disease. This risk may be shaped partly by the gut microbiome.[12] To help diagnose this association, NIEHS-funded researchers developed a rapid, low-cost test using stool samples to detect microbial changes that lead to liver cirrhosis.[13]

Next steps for microbiome research

Research has yielded tremendous insight into links between the microbiome, environmental exposures, and human health. Yet questions remain and are the focus of continuing research within and outside of NIEHS. Scientists will continue to analyze microbes and how they interact with the body's cells. More studies are warranted on how the gut microbiome relates to brain function.

Innovative therapeutic approaches are being developed that use the microbiome to treat disease and to support health. Future studies may use microbial communities as a basis for personalizing therapies and possibly assessing the risk for certain diseases.[14]

For more information on the National Institute of Environmental Health Sciences, go to **https://niehs.nih.gov**.

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