

Human Microbiome: The Role of Microbes in Human Health

by American Museum of Natural History

This article is provided courtesy of the American Museum of Natural History.

You Are an Ecosystem

An ecosystem is a community of living things that interact with each other and with the non-living things in their physical environment. Forests, lakes, and caves are ecosystems. Each contains a unique mix of living components, like plants and animals, and non-living ones, like air, sunlight, rocks, and water. The human body is also an ecosystem. We are home to thousands of kinds of bacteria, viruses, fungi, and other microscopic organisms, which number in the trillions. These organisms are called microbes. Together they form communities that make up the human microbiome. Like fingerprints, no two human microbiomes are the same. That makes each person not just an ecosystem, but a *unique* ecosystem.



Photo Credit: AMNH

The human body is an ecosystem. We are home to trillions of microbes.

Microbes first appeared over 3.5 billion years ago, making them the oldest form of life on Earth. Over the past six million years, humans and microbes have coevolved to form complex relationships. Humans need a microbiome to stay healthy, and the microbiome needs environments provided by the human body in order to survive.

Just like larger organisms, the species that make up a microbiome interact with each other and rely on these interactions to thrive. Different species live in different places in and on our bodies, and are adapted to these environmental conditions.

Scientists are studying how these microorganisms work in our bodies, and learning about the balance among different bacterial communities. Products like antibacterial hand sanitizers can wipe out all bacteria on a patch of skin, good and bad alike. Antibiotic drugs also destroy helpful bacteria along with their targets. Fungi evolved the ability to produce anti-bacterial chemicals as they competed with

bacteria over millions of years of evolution. By studying these fungi, scientists learned how to manufacture these anti-bacterial chemicals and turn them into antibiotic drugs, which have saved millions of lives. At the same time, studies suggest that rapidly increasing antibiotic use in the United States has reduced the diversity of our microbiomes.

Supporting Players

Do the bacteria in your body act as friend or foe? As pathogen or protector? It depends.

Thousands of species of bacteria inhabit our bodies, and researchers are only beginning to understand the complex interrelationships among them-and between microbial cells and human ones. We know that some are pathogens and cause disease. Scientists are increasingly finding that the majority of bacteria are not harmful. Rather, many benefit us in a variety of ways, from aiding digestion to protecting our teeth.

Scientists are just beginning to understand what roles these organisms play in human health. It's a complicated dynamic and the effects on human health depend on the population size of the microorganisms and on conditions in their ecosystem, the human body. The key? Balance. Here are some of the species that play an important part in maintaining a healthy equilibrium-bacteria that, you might say, have your back.

Skin Deep

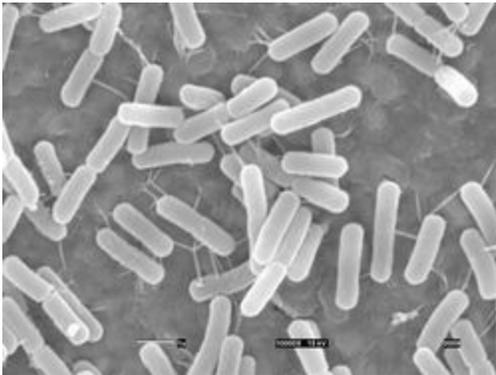


Photo Credit: iGEM

Bacillus subtilis releases toxic chemicals to kill fungus, possibly including *Trichophyton interdigitale* and other species that cause athlete's foot.

Perhaps not surprisingly, skin-our interface with the world-supports a large number of the body's most diverse populations of bacteria. There are at least 1,000 different species of skin bacteria, along with dozens of fungi and other microbes. Most aren't harmful, and many protect us. They live among the dead skin cells that make up our skin's outer layer, and defend their own turf against other microbes. One strain of the bacterium *Bacillus subtilis*, which can be found on the skin, produces bacitracin, a toxin that helps it fight off other microbes. Scientists have taken advantage of bacitracin's antibiotic properties, using it in over-the-counter antibiotic ointments.

Gut Feeling

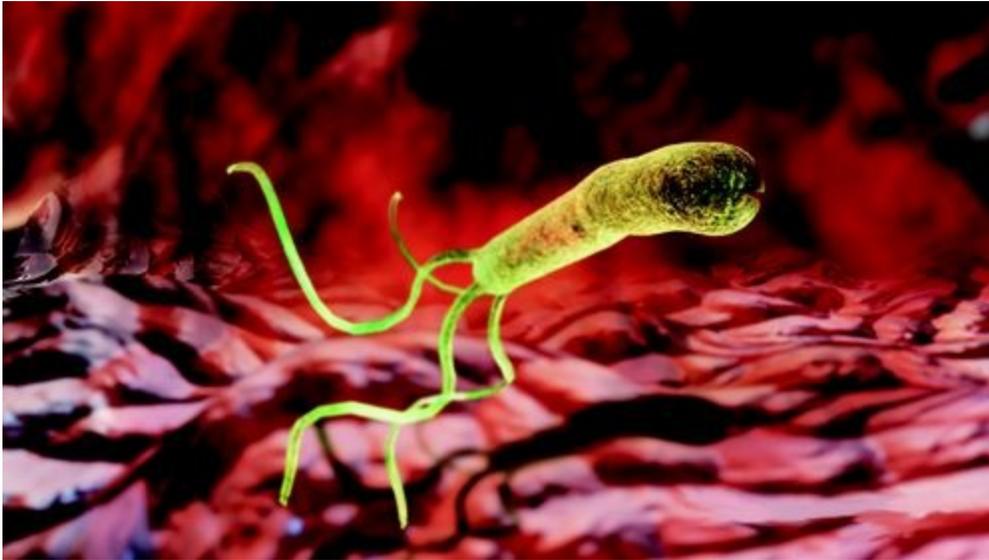


Photo credit: AMNH

H. pylori can cause diseases like gastritis. It also helps protect against diseases that include asthma, allergies, and even cancer.

In the mid-1980's, internist Barry J. Marshall infected himself with the corkscrew-shaped bacterium *Helicobacter pylori*. This earned him not only the nickname "guinea-pig doctor" but also the Nobel Prize, which he shared in 2005 with pathologist J. Robin Warren for their discovery that this common organism was a pathogen. *H. pylori* caused gastritis (irritation or inflammation of the stomach lining) and peptic ulcers, diseases long thought to be caused by excess acid resulting from stress. Treatment with antibiotics led to the near-eradication of stomach ulcers in developed countries, as well as to a drop in stomach cancers, for which gastritis is a risk factor. But as welcome as these cures are, researchers now think *H. pylori* also serves a positive role in human health. New diseases related to the loss of *H. pylori* are on the rise. Studies strongly suggest that it is essential to the prevention of asthma, allergies, gastroesophageal reflux disease, and esophageal cancer.

Look, Ma, No Cavities!

Who isn't familiar with the dreaded strep throat? An extremely painful inflammation of the back of the throat, it's caused by the bacterium *Streptococcus pyogenes*, which gave strep throat its name. The same bacterium causes rheumatic heart disease. But there are more than 50 recognized species of *Streptococcus*, many regularly found in the human mouth, respiratory tract, and other organs. Some, like *S. pyogenes*, are proven pathogens, causing conditions that range from cavities (*S. mutans*) to pneumonia.

(*S. pneumonia*). But others seem to do no harm, and may even work against troublesome strains of fellow *Streptococci*. *Streptococcus salivarius*, for example, which is found in the human mouth and respiratory tract, can be dangerous to people with weakened immune systems if it escapes outside the oral cavity. But in the mouth it appears to help prevent both gum disease and tooth decay.

Colon Colony

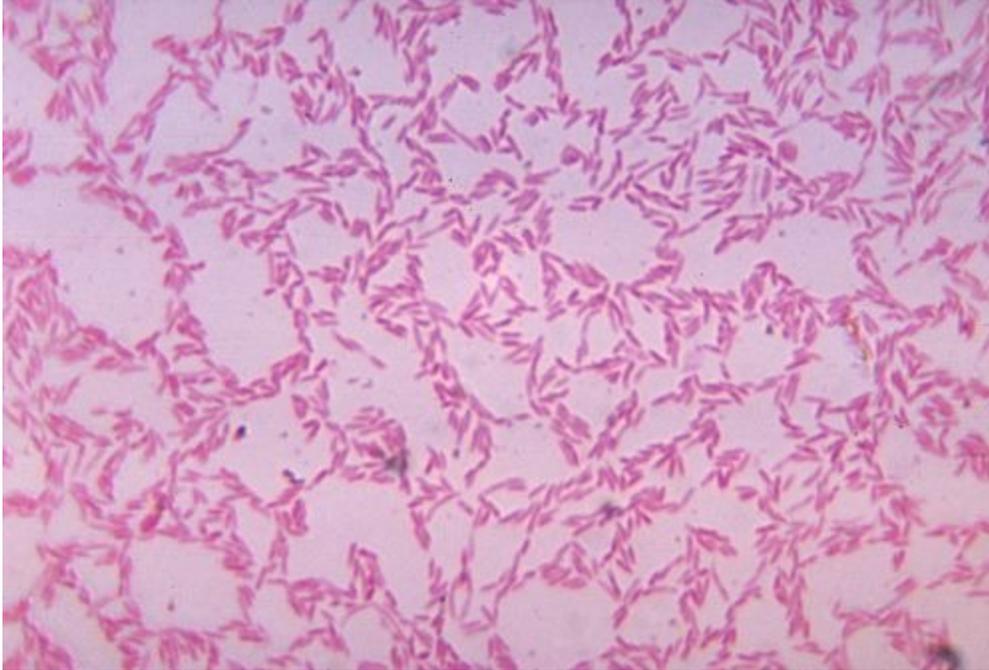


Photo Credit: AMNH

Bacteroides are by far the most numerous bacteria in the human body. They help the human body digest food.

Far more bacteria live in the colon than anywhere else in the human body. Most species are anaerobic, which means they don't require oxygen. That includes species that belong to the genus *Bacteroides*, which are among the most predominant. Outside of the gut, strains of *Bacteroides* can cause abscesses in the abdomen, brain, liver, pelvis, and lungs, as well as bacteremia, an infection of the bloodstream. But in the colon they break down carbohydrates, produce enzymes that target specific foods, and extract energy from those foods. One species, *B. fragilis*, appears to stimulate immune cells called regulatory T-cells, which restrain aggressive inflammatory T-cells that can trigger colitis and other disorders. Researchers are also beginning to tease out the possible relationship between the overall makeup of a person's gut microbiome and a propensity toward obesity. Studies have even found that microbiomes have an effect on the moods of mice, suggesting that the bacteria in our gut could play a role in conditions like depression. It's probably impossible to overstate the usefulness of bacteria in the colon.

Being Healthy Means Having a Balanced Microbiome

We're covered in bacteria and other microorganisms from the time we are born. Our microbiome grows and changes with us over the course of our lives. It reflects the places we go, the things we do, and the food we eat. We now understand that a diverse and balanced microbiome is essential for a strong immune system. Some scientists think that infants who lack exposure to microorganisms develop a higher rate of allergies, asthma, eczema and other health problems. In fact, the microbiome is so important that it is like an additional organ—a part of the body that serves a vital function, like the skin or kidneys. Nurturing it helps keep our bodies functioning properly.

Name: _____ Date: _____

1. What is the human microbiome?

- A. all of the communities of microbes in and on the human body
- B. a drug that destroys helpful bacteria along with harmful bacteria
- C. a species of bacteria that helps protect humans against asthma
- D. a group of people in developed countries who are infected with *Helicobacter pylori*

2. To organize this text, the author divides it into sections with subheadings. What contrast does the author make in the section with the subheading "Look, Ma, No Cavities!"?

- A. The author contrasts the harmful effects of *Helicobacter pylori* with the positive role it may play in human health.
- B. The author contrasts the number of bacteria on our skin with the number of bacteria in our colon.
- C. The author contrasts harmful species of *Streptococcus* with a species of *Streptococcus* that can be helpful.
- D. The author contrasts the effects of *Bacteroides* inside the colon with the effects of *Bacteroides* outside the colon.

3. Some species of bacteria benefit humans.

What information in the text supports this statement?

- A. *S. mutans* is a bacterium that causes cavities, and *S. pneumoniae* is a bacterium that causes pneumonia.
- B. Fungi evolved the ability to produce anti-bacterial chemicals as they competed with bacteria over millions of years.
- C. The bacterium *Streptococcus pyogenes* causes strep throat and rheumatic heart disease.
- D. Species of bacteria belonging to the genus *Bacteroides* help the human body digest food.

4. Bacteria that are helpful in one place may be harmful in another.

What information in the text supports this statement?

A. *Helicobacter pylori* is a bacterium that causes gastritis (irritation or inflammation of the stomach lining) and peptic ulcers, diseases which were once thought to be caused by too much acid.

B. *Streptococcus salivarius* appears to help prevent tooth decay in the mouth but can be dangerous to people with weakened immune systems if it gets outside the mouth.

C. *Bacillus subtilis* releases toxic chemicals to kill fungus, possibly including *Trichophyton interdigitale* and other species that cause athlete's foot.

D. Skin, which is our interface with the world, supports a large number of the human body's most diverse populations of bacteria, including *Bacillus subtilis*.

5. What is the main idea of this text?

A. Microbes first appeared over 3.5 billion years ago and have coevolved with humans over the past six million years.

B. Studies suggest that rapidly increasing antibiotic use in the United States has reduced the diversity of our microbiomes.

C. *Bacteroides* are the most numerous bacteria in the human body and help it digest food.

D. The human body is an ecosystem made up of microbes that play a variety of roles in human health.

6. Read these sentences from the text.

"Perhaps not surprisingly, skin-our interface with the world-supports a large number of the body's most **diverse** populations of bacteria. There are at least 1,000 different species of skin bacteria, along with dozens of fungi and other microbes. Most aren't harmful, and many protect us."

Based on this information, what does the word "**diverse**" probably mean?

A. having a lot of variety

B. being harmful to others

C. being helpful to others

D. moving from one place to another

7. Read this sentence from the text.

"In fact, the microbiome is so important that it is like an additional organ-a part of the body that serves a vital function, like the skin or kidneys."

What word or phrase could replace the second "like" in this sentence without changing the sentence's meaning?

- A. instead
- B. such as
- C. except
- D. later on

8. What is a species of bacteria that causes disease?

9. What is a species of bacteria in your body that helps protect you? Support your answer with evidence from the text.

10. Describe the different roles that bacteria play in human health. Support your answer with evidence from the text.

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8. What is a species of bacteria that causes disease?

Suggested answer: Answers may vary as long as they reflect the text. For example, students may name *Streptococcus pyogenes*.

9. What is a species of bacteria in your body that helps protect you? Support your answer with evidence from the text.

Suggested answer: Answers may vary as long as they reflect the text. For example, students may identify *Helicobacter pylori* as a species of bacteria that helps protect people. Studies suggest that it helps prevent "asthma, allergies, gastroesophageal reflux disease, and esophageal cancer."

10. Describe the different roles that bacteria play in human health. Support your answer with evidence from the text.

Suggested answer: Answers may vary, but students should recognize that bacteria plays positive and negative roles. Students may point out that some bacteria, such as *Helicobacter pylori* and *Streptococcus salivarius*, play helpful roles by protecting people from various diseases. Other bacteria play harmful roles. One example is *Streptococcus pyogenes*, which causes strep throat and rheumatic heart disease.