

THINK MICROBES ARE BAD GUYS? THINK AGAIN.

MICROBES—life forms too tiny to see—play a surprisingly large role in life on Earth. Humans depend on microbial communities in more ways than you can imagine. For example, microbes:

- Make air breathable
- Keep us healthy
- Provide sources of new drugs
- Help us digest food
- Clean up hazardous chemicals
- Support and protect crops

“...WITHOUT MICROBES ALL HIGHER PLANTS AND ANIMALS — INCLUDING OURSELVES — WOULD DIE.”

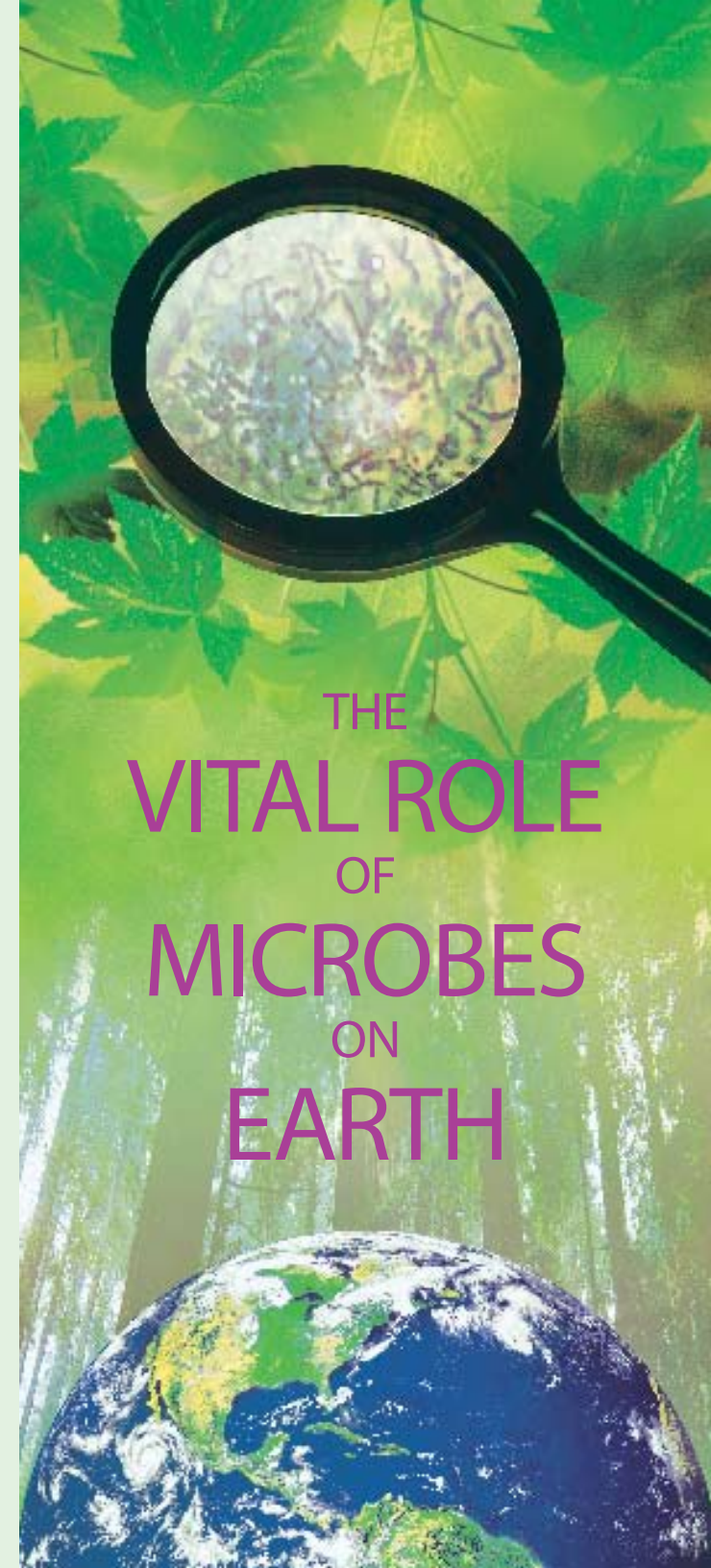
— The New Science of Metagenomics:
Revealing the Secrets of Our Microbial Planet
(National Research Council, 2007)

For more information about the role of microbes in human health and the environment, contact the Board on Life Sciences at bls@nas.edu or visit <http://dels.nas.edu/microbes>. Support for this publication was provided by the Presidents' Circle Communications Initiative of the National Academies.

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THE VITAL ROLE OF MICROBES ON EARTH

MICROBES MAKE LIFE ON EARTH POSSIBLE

There are millions in a spoonful of yogurt. Trillions inhabit your intestines. Microbes are everywhere. And it's a good thing, too, because microbes, which include bacteria, viruses, some fungi, and other life forms too tiny to see, are essential to all other forms of life.

But wait, don't microbes—also known as germs—make people sick? True, some microbes are responsible for causing disease. But of the millions of types of microbes on the planet, disease-causing microbes (pathogens) make up only a very tiny fraction. The vast majority of microbes, which inhabit nearly every environment on Earth, are no threat to human life. Many actually benefit human health directly by defending us against pathogens, by providing sources of new drugs, and even by helping us digest food. Amazingly, only about 1 out of 10 cells in the human body is actually a human cell: most of the cells that make up our bodies are microbes!

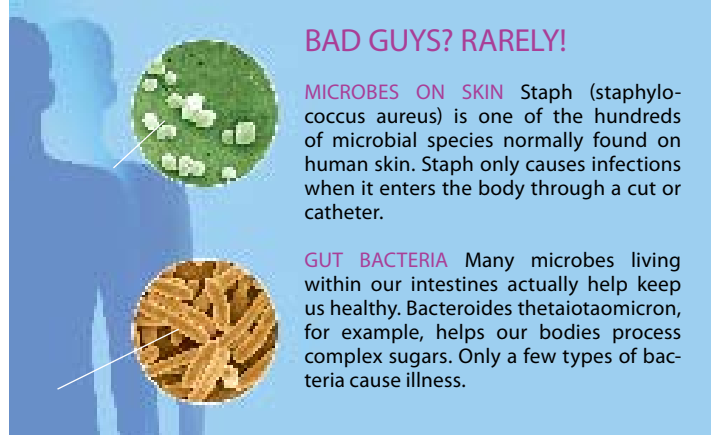
In fact, humans couldn't have evolved without microbes. Billions of years ago, microbes converted the Earth's entire atmosphere from nitrogen-based to oxygen-based, making it possible for larger forms of life to evolve. Human evolution has been inextricably linked with the microbes that have surrounded us from the very beginning.



MICROBES KEEP US HEALTHY

Most of our interactions with microbes actually do a lot more good for human health than harm. Some of the microbes living in our bodies actually help us fight against pathogens by competing against them for space. This mutually beneficial relationship helps to protect us from getting diseases while giving the microbes a place to live.

PARTNERS FOR LIFE. From the moment we were born, microbes began living in and on our bodies. These early colonizers helped to "educate" our immune systems to differentiate good microbial partners from pathogenic microbes.



BAD GUYS? RARELY!

MICROBES ON SKIN Staph (staphylococcus aureus) is one of the hundreds of microbial species normally found on human skin. Staph only causes infections when it enters the body through a cut or catheter.

GUT BACTERIA Many microbes living within our intestines actually help keep us healthy. Bacteroides thetaiotaomicron, for example, helps our bodies process complex sugars. Only a few types of bacteria cause illness.

INVITE A MICROBE TO DINNER. Many of the foods we eat would be indigestible without the 10-100 trillion microbes living within our guts. Microbes also play a major role in creating many of the foods we love, such as cheese, yogurt and bread.

NATURE'S MASTER CHEMISTS. Hundreds of drugs available today were derived from chemicals first found in microbes. Scientists can use the amazing variety of chemicals microbes naturally produce to create new medicines.

NEW POSSIBILITIES. Major scientific advances are opening new doors to exploring how microbes can benefit human health and the environment. The emerging field of metagenomics allows scientists to study how whole communities of microbes function without having to separately culture individual species, making more microbes accessible to science than ever before.

MICROBES KEEP OUR PLANET HEALTHY

When tiny microbes join forces, they can have a major impact on life on Earth.



LIVABLE CLIMATE. Without microbes, we wouldn't have oxygen to breathe. Plants aren't the only things that carry out photosynthesis: photosynthetic microbes are responsible for about half of the photosynthesis on Earth, simultaneously increasing the amount of oxygen and decreasing the amount of carbon dioxide in the air. Through this process, microbes are helping to mitigate some of the greenhouse gases that cause global warming.

HEALTHY FARMS.

Microbes living in the soil provide plants with natural protection from pests and diseases. They also are essential for converting nitrogen and other nutrients into forms that plants can use to grow.



CLEANING UP. Because of their special adaptations, some microbes actually degrade—and there by render harmless—chemicals that are extremely dangerous to humans. These microbes can help clean up gasoline leaks, oil spills, sewage, nuclear waste, and many other types of pollution.

PRODUCTIVE ECOSYSTEMS. Humans aren't the only ones that depend on microbes for digesting our food, fighting disease, and maintaining a livable planet—no plants or animals could live without microbes.



IT TAKES A VILLAGE. Most of the things microbes do for our world could never be done by a single type of microbe alone, but require a complex community working together. These communities are like a "bucket brigade"—each individual does just one part to help the whole group function.