ARTICLE: TEACHER VERSION

About this Article

Lexile: 1155

Wordcount: 1212

Text Complexity: The Lexile level for this text falls in the upper range of the grade 9-10 CCSS text complexity band. However, science content and qualitative factors make this text appropriate for students in grades 9-12. Teachers should use their knowledge of students' independent reading levels to determine the appropriate level of support students need to read this text with a high level of comprehension."

Note: Assign partners prior to reading this text aloud with students and have them assign a "partner A" and "partner B."

Key for Teacher Notes

- Green text
  specific strategies
- Regular text
  instructions for teachers
- *Italicized text*
  teacher's instructions to students
- Underlined text
  important domain-specific words

Human Microbiome: The Role of Microbes in Human Health

You are an Ecosystem

An ecosystem is a community of living things that interact with each other and 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.

Think-Pair-Share: *Wow—each one of us is an ecosystem! Many of you have probably learned about ecosystems, but not quite in this way… Take a moment to talk to your partner about what you know about the way ecosystems work. Think of an example of an ecosystem that you have heard of before.* Listen in to get a sense of students' knowledge base about the concept of ecosystem. Invite students to share out what they know about ecosystems and jot notes on chart that define "ecosystem" in general terms.

Think Aloud: *So, each one of us is home to a unique ecosystem. Just as bears, wolves and elk interact in the ecosystem of Yellowstone National Park, the living organisms that interact within our microbiome are microbes such as bacteria, viruses and fungi. Our body plus our microbiome is an ecosystem.*

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 five 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 between 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 the ability to produce anti-bacterial chemicals as they competed

Think-Pair-Share: *What more have you learned about the* **human microbiome** *from this section? Listen in and select student(s) to share out. It is important for students to understand that our microbiome is crucial for our health (even if they cannot explain exactly why yet), and that different locales on the human body provide ideal environments for different microbes to get what they need to thrive.*

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.

Think Aloud: *This paragraph is giving us important information about antibiotic hand sanitizers and antibiotic drugs.*

Think-Pair-Share: *Discuss the following questions with your partner...*

1) How did antibiotic medication originate?
2) Why is overuse of antibiotic medication problematic?

3) Why is using antibiotic hand sanitizers problematic?

Explain your answers in your own words, but refer to the text as needed.

Listen in and select students to share out answers for each question.

Supporting Players

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

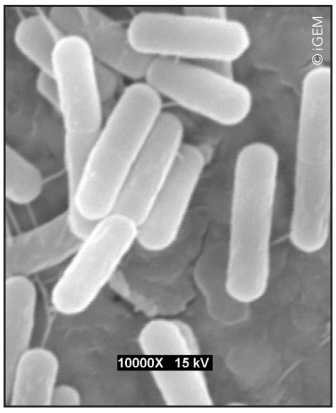
Thousands of species of bacteria inhabit our bodies, and researchers are only beginning to understand the complex interrelationships among them—and between microbial cells and human ones. We know that some are pathogens and cause disease. Scientists are increasingly finding that the majority of bacteria 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 depends on the size of their populations 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.

Think-Pair-Share:
With your partner, in your own words, answer the question that was posed in the first paragraph of this section. Refer back to the text when you need to, but look away from the text and use your own words when answering the question. Listen in and select student(s) to share out. The goal is for students to know that there are microbes that harm us (pathogens) and microbes that help us (beneficial bacteria). Before moving on to the next section, think aloud about how having balance in the microbiome is crucial (referring to the second paragraph of this section). End this section with a Think Aloud: *This last sentence is setting us up for what we are going to learn about next. Look at the next four subtitles and notice the parts of the body that are mentioned.* Call on a student to read the next four subtitles aloud. For one, you may want to ask students if they can think of any examples of microbes either helping or hurting us in that part of the body. (E.g., antibiotics can give you stomach trouble–students may not know exactly why but activating their knowledge before reading on may aid their understanding).

The next four sections of the text describe the impact that different species of bacteria have on the body–some are beneficial, some are harmful, and some can be both depending on various factors. Explain to students that to keep track of this, they will use a strategy called text coding. When students come to the name of a specific species of bacteria, they should draw a box around it. When they find evidence that the bacteria is beneficial, they should underline the words that suggest that, and code them with a "B" for "Beneficial." When they find evidence that the bacteria is harmful, they should underline the words that suggest that, and code them with an "H" for harmful. **Through doing this, students will realize that some bacteria can be both beneficial and harmful.** Tell students that one type of bacteria may be coded with both a "B" and an "H." The coding will help students complete the Graphic Organizer Note Taking Sheet after the read aloud. You may opt to demonstrate coding on the next section if the strategy is new to students, or you can just have them work independently for the next four sections. To provide more support, you may have students read and code in partners.

Skin Deep



***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.

Coding Text: Demonstrate on the document camera or Smartboard. Draw a box around *Bacillus subtilis*. Underline "produces bacitracin, a common ingredient in many over-the-counter antibiotic ointments" and code with "B." Tell students that they should use that same coding strategy for the next three sections as they read on their own (or with a partner). If most students are struggling readers, read next three sections aloud and code on document camera, inviting students to offer suggestions for what to code after you have demonstrated adequately.

Gut Feeling

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

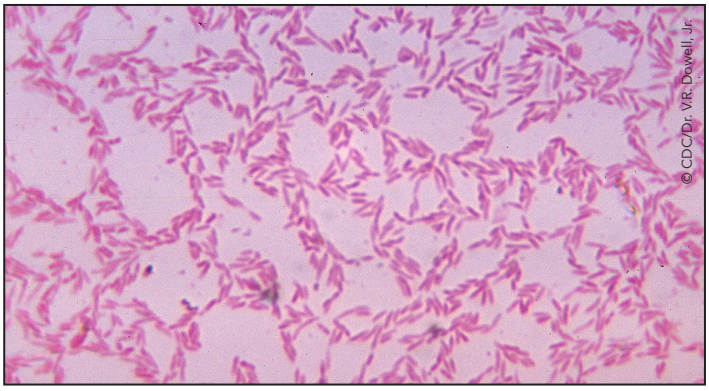
In the mid-1980's, internist Barry J. Marshall infected himself with the corkscrew-shaped bacterium *Heliobacter pylor*i. This earned him not only the nickname "guinea-pig doctor" but also the Nobel Prize, which he shared in 2005 with pathologist J. Robin Warren for their discovery that this common organism 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.

Coding Text continued

Colon Colony



***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.

Coding Text continued

After the interactive read aloud, students can complete the following graphic organizer (see attached). Going back to look at their coding in the text will help them to this. To provide more support, this can be done as a whole-group activity with the teacher, as a partner activity, or a combination of the two. The graphic organizer can be completed before the quick-write and class discussion at the end so that students can refer to it during discussion.

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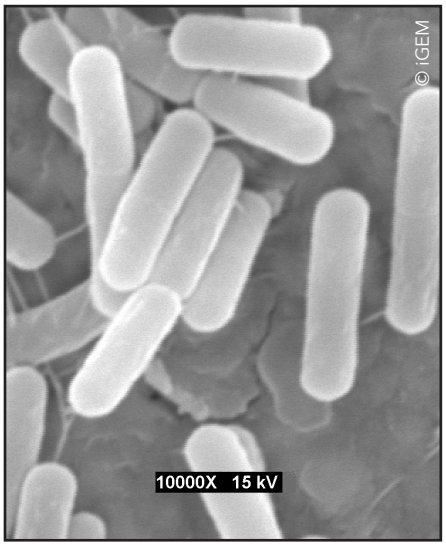

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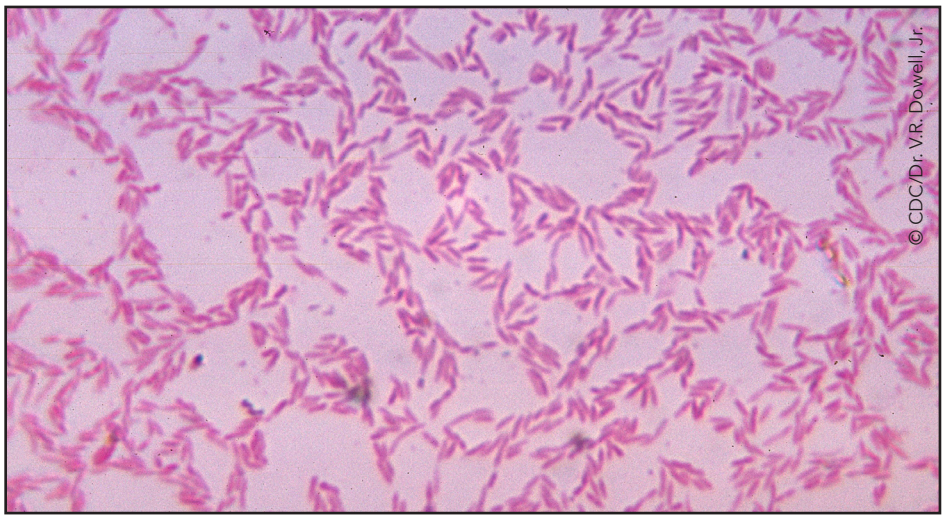

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