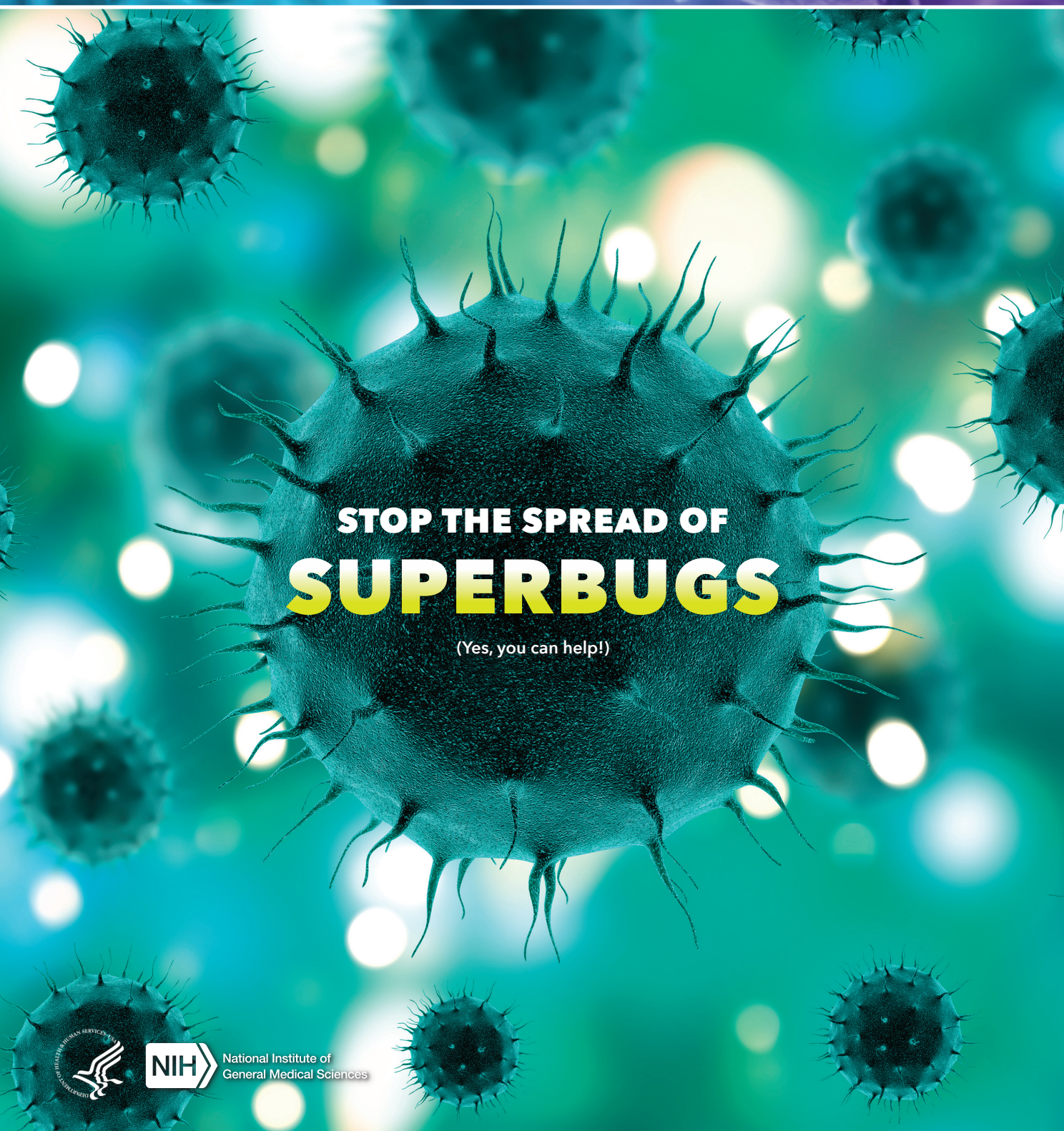
nigms.nih.gov/education/pathways

The Superbug Issue

PATHWAYS

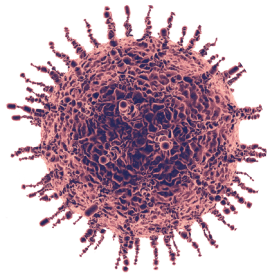


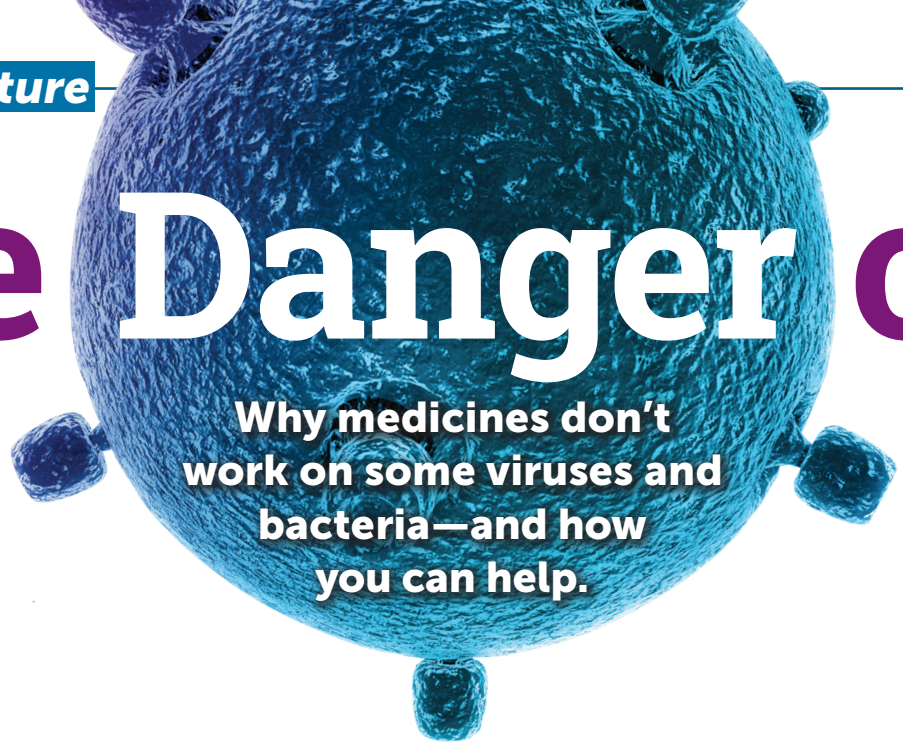
STOP THE SPREAD OF SUPERBUGS

(Yes, you can help!)

NIH National Institute of General Medical Sciences

The Danger of



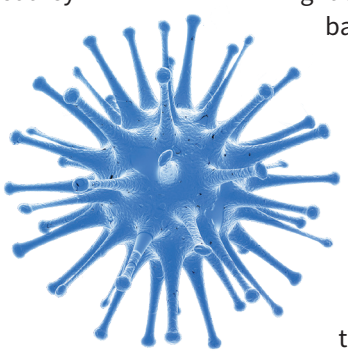


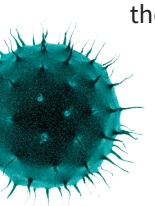
Why medicines don't work on some viruses and bacteria—and how you can help.

WHEN YOU WERE LITTLE AND HAD A PAINFUL EAR infection or strep throat, chances are your doctor prescribed you "the pink bubble gum medicine." And that medicine was likely some version of penicillin, a powerful antibiotic discovered in 1928 that has saved the lives of people around the world.

Antibiotics work by killing the bacteria that cause infections. But bacteria aren't the only things that can cause disease. Viruses like those that cause the common cold and COVID-19 can also make people sick—but antibiotics don't work on viruses. Bacteria and viruses are both types of pathogens (germs), yet they are very different.

"Many viruses replicate (copy themselves to increase their numbers in your body) much, much faster than bacteria do," explains **Matt Daugherty, Ph.D.,** an assistant professor at the University of California, San Diego. Another big difference: Bacteria have several thousand genes (that code for the proteins that make up their cells), but most viruses have only about 10 genes. "As a result, there are far fewer targets you can hit on a virus to wipe it out," says Dr. Daugherty. For these reasons, scientists have had trouble finding drugs to treat some viral infections.



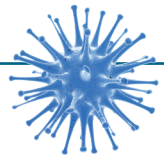


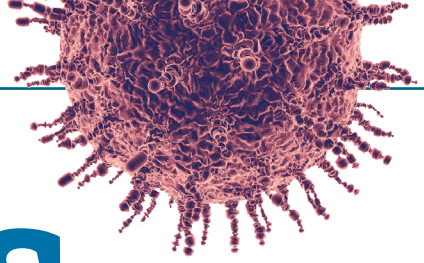
Bacteria can also live on their own—in soil, for example—or in our bodies, but viruses need to be inside of our cells to be able to replicate, says **Nels Elde, Ph.D.,** associate professor at the University of Utah. "Technically they're not really alive the way that bacteria are. When they infect a cell or they infect a host, you might consider them to almost become alive, whereas bacteria can live by themselves."

Medicine Matters

The differences between bacteria and viruses help explain why we don't fight them the same way. Since bacteria have so many proteins to latch on to, it can be easy to treat them with antibiotics. Because viruses are harder to wipe out with medicine, we usually try to prevent them with vaccines, which protect you from infection altogether, explains **Lauren Ancel Meyers, Ph.D.,** a professor at the University of Texas at Austin. Vaccines spare millions of kids each year from contagious diseases like measles and whooping cough.

When antibiotics aren't used correctly, bacteria can change and become resistant to these medicines, which means the medicines no longer work to make the person



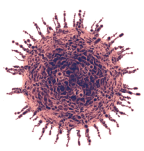


Superbugs

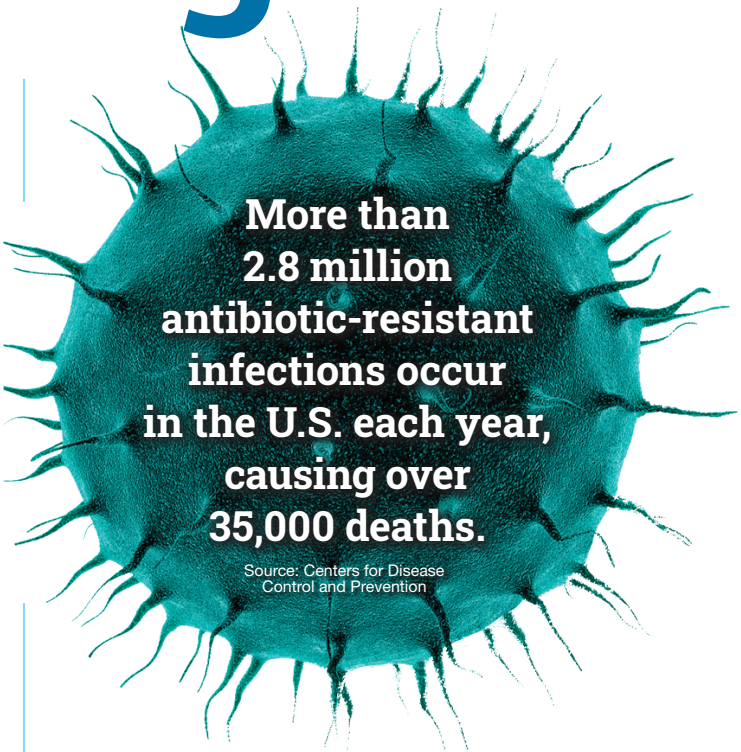
better. This can happen, for example, when someone with a bacterial infection doesn't follow their doctor's instructions about how long to take an antibiotic, or takes an antibiotic when they actually have a viral infection. Resistant bacteria—as well as viruses we can't prevent with vaccines—can be called superbugs because they can't be fought off with medicine at all. (For more about antibiotic resistance, see the infographic on the next page.)

Safety Steps

Superbugs can form in the environment, too.



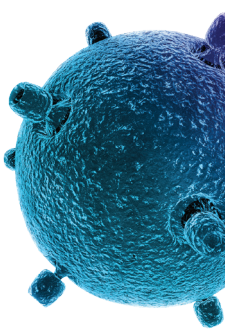
For instance, if you don't take all of your antibiotic because you start to feel better before the last day, and you pour it down the drain, that medicine can end up in our water supply. "If there's just a little bit of antibiotic in the water—and there are also some bacteria related to the kinds that make us sick that now get exposed to that antibiotic—the bacteria might mutate and evolve. Now we have more superbugs that might come and infect us," explains Dr. Elde.



More than 2.8 million antibiotic-resistant infections occur in the U.S. each year, causing over 35,000 deaths.

Source: Centers for Disease Control and Prevention

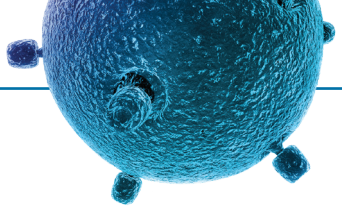
The same goes for agriculture: When farm animals are dosed with antibiotics, drug-resistant bacteria sometimes survive and mutate in their intestines. These superbugs can contaminate the meat and poultry we eat, making us sick. The resistant germs could also spread to soil through animal poop, then contaminate vegetables and fruits.



Scientists are learning as much as they can about how bacteria and viruses evolve, and what can be done to stop the spread of drug-resistant germs and keep people healthy. It may seem like solving this problem is out of your control, but there are things you can do. First, take steps to keep from getting sick: Wash your hands, cover your cough, and stay home if you don't feel well. Always take your medicine exactly as your doctor instructs. Never share antibiotics with someone else who feels sick. And dispose of all medicines safely: Bring them to your pharmacy or doctor so they don't end up in local water or soil. We all can play a role in the fight against superbugs!

Can Bacteria Be...*Delicious*?

Bacteria don't just make us sick—and they're not all bad! "They also help make the world work," says Dr. Elde. Take, for example, the good bacteria that are part of producing yogurt, pickles, and sourdough bread. "Bacteria invisibly make lots of things happen that we don't even recognize," he says. Your body also naturally contains good bacteria that help protect your digestive system, skin, and more.



Picture It

This is one way that antibiotic resistance can happen when someone has a bacterial infection.

Scientists in the Spotlight

Lauren Ancel Meyers, Ph.D., professor of biology and statistics, the University of Texas at Austin

Were you always interested in math?
Yes! I even went to math camp as a kid, and I always loved things like puzzles. In college, I spent a summer internship doing mathematical cryptography (making and breaking secret codes), and I saw how math could be used to solve real-world problems.

How did you get involved in the work you do now?
During graduate school, someone from the Centers for Disease Control and Prevention showed up asking for mathematicians who could help build a better mathematical model for controlling disease outbreaks.

What do you hope to discover with your research? My lab is trying to answer three basic questions about diseases: Where are infectious diseases spreading today around the globe? Where might they be spreading tomorrow, or next week, or next month? And how can we use our limited public health resources to slow or stop their spread?

Dustin Hancks, Ph.D., assistant professor of immunology, UT Southwestern Medical Center

Were you curious about science as a kid?
Some of my earliest memories are of reading encyclopedias. I was always interested in knowing things.

What inspired you to pursue a science career? It began when I got interested in the story that DNA can tell us. I was actually the first person in my immediate family to go to college, and eventually beyond, to grad school. My dad told me to get the best grades that I could, so that I'd have the most opportunities to choose from.

What advice do you have for aspiring scientists?
Keep at it. If possible, get into a lab and do experiments. Remember: Science really is everywhere, and it's super important when it comes to solving a variety of problems. And know that you can reach out to experts and professors by email—most of the time, people will respond! Above all, stick to your dreams, no matter what other people say.

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