Prevention

The Terrarium In Your Tummy

12-15 minutes

How can such a little sample—of waste, no less—give so much away? The bacteria swarming our guts and intestines are our bodies' biggest truth tellers. That might sound gross, since we've waged warfare on bacteria of all stripes for years, squirting hand sanitizer after subway rides, bathing in antibacterials, and popping penicillin at the first sign of an ear infection. But we've known for decades that some strains of gut bacteria can be helpful. Other strains, scientists are discovering, may be responsible for some of what ails us, predisposing us to pack on fat or nudging us toward type 2 diabetes, colitis, asthma, and even depression.

So important are these implications that a team of 40 scientists is collecting thousands of stool samples in the largest gut-sample study ever conducted: the American Gut Project. In so doing, researchers hope to learn which microbes make us sick, which keep us well, and how we can optimize our own guts for better health.

We're more microbe than we are person: Our bodies contain 10 times more bacteria than cells, meaning around 100 trillion microbes are crawling inside and on us. By far the largest collection—about 3 pounds' worth—hangs out in the stomach and intestines. "It's a great ball of life the size of a small dog," says Rob Dunn, PhD, associate biology professor at North Carolina State University. Our bacteria digest substances our human bodies can't, and they help our immune systems defend against invaders. Beyond these functions, scientists can only theorize about the role our resident microbes play. "We're kind of in this Wild West mess of a stage," Dr. Dunn says.

More from Prevention: What Belly Bacteria Say About Your Health

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So far, scientists know that everything we do and what we eat can affect our microbial colonies, which explains why researchers ask such probing questions. They wanted to know if I live in a sorority house, have a cat or dog, or use deodorant. I'm nervous about what all this might betray about me, because to be honest, my diet is terrible. I hardly cook, I love chicken nuggets, and I roll my eyes at the thought of a vegetable. I'm thin, which has hidden a multitude of dietary sins until now. Will my gut bugs give me away?

Scientists don't know precisely what our microbes are capable of, where they came from, or how we can change them. What they do know is that our bacteria are deeply connected to our health—and that they're changing in ways that may not bode well, says Martin Blaser, MD, professor of medicine and microbiology and director of the Human Microbiome Program at New York University. Dr. Blaser is one of the stomach's greatest pioneers; since 1985, he's studied bacterial species present—and absent—in our bodies for clues about how they've changed and how those changes might affect us.

Take *Helicobacter pylori*, an ancient gastric species that has wriggled around our guts for eons but is disappearing from modern colonies. Even though the microbe increases the risk of gastric cancer, its disappearance from gut flora turns out not to be a good thing. That's because the bug also seems to protect against different kinds of cancer, asthma, and allergies.

Like *H. pylori*, microbes can be difficult to classify as either "good" or "bad," because they seem to switch in function from person to person and in different contexts. And H. pylori is just one ancient strain of many that are disappearing, according to Dr. Blaser's hypothesis. But why? Scientists don't

agree on much in this emerging field, but most don't hesitate to blame overuse of antibiotics. It's probably no coincidence that our routine use of these drugs, which kill both harmful and beneficial bacteria, has skyrocketed along with the modern epidemics of obesity, types 1 and 2 diabetes, asthma, food allergies, and even celiac disease.

"That antibiotic is going anywhere there's blood," Dr. Blaser says. That means any part of the body with resident bacteria—the nose, the mouth, the vagina—will have many of its microbes wiped out by the drug. We assume everything will bounce back to normal after a course of antibiotics, but Dr. Blaser believes that species go extinct with each round we take.

Antibiotics first came into wide use after World War II, and they're more ubiquitous than ever, with the average child taking at least a dozen courses of the drugs before age 18. (Like other typical Americans, I'm no stranger to the pills. I've been taking various forms to treat adult acne for years.) Childhood is the worst time to be exposed, Dr. Blaser says, because developing bodies are more susceptible.

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He's also coming closer to proving that antibiotics might affect our waistlines. He recently coauthored a study in the journal *Nature* that found that feeding mice low, steady doses of antibiotics caused them to pack on fat. Dr. Blaser suspects that sustained, low doses of antibiotics might have a similar effect in humans. Children who drink nonorganic milk and eat antibiotic-pumped meat every day, for example, could be exposed to sustained low doses. In a study Dr. Blaser coauthored, published in the *International Journal of Obesity*, scientists studied 11,000 children and found that those exposed to antibiotics before 6 months of age had consistently higher BMIs later in life. (Other research supports the link: Livestock are routinely given small amounts of antibiotics in their feed to plump them up.)

More and more, scientists are considering the role of gut health in other 21st-century diseases, too. A study from the University of South Florida is currently following 8,600 children predisposed to type 1 diabetes from birth to age 15. "We want to determine whether there's anything uniquely happening in the gut that associates with type 1 diabetes onset," says Joseph Petrosino, PhD, an assistant professor in molecular virology and microbiology at Baylor College of Medicine. He and his team are even examining the intestinal bacteria of Peruvian mummies to see what people's gut composition looked like before the age of antibiotics and processed food. "For most of human history, the microbes that made you fat were the ones that made you survive," Dr. Dunn explains. "Now, they may well be the ones that give you diabetes." (Learn more in Does Diabetes Start In Your Gut?)

You can chalk up some of your microbes to the hand you're dealt. But are they also affected by what you do and how healthfully you eat? Definitely, says Jeff Leach, cofounder of the American Gut Project and PhD candidate at the London School of Hygiene and Tropical Medicine. This is bad news for me, because vegetables are my least favorite food group and—of course—veggies take first place when it comes to building a great gut.

Leach would know. He swabs his stool sample every day, stores it in liquid nitrogen, and has it analyzed at the lab. "There may be a week where I drink a bunch of tequila," he says. "Or I'll go all vegetarian for a week or so, then back to omnivore. How does that affect my microbiome?" By the time this 2-year project is completed, Leach hopes to be closer to an answer. Preliminary studies show that the bacteria of colons around the world are different; we just don't know exactly why. But some patterns are clear, Leach says. When you eat lots of different kinds of plants, the dietary fiber travels to your colon—a fermentation factory, basically—where microbes munch the fiber and make your colon more acidic and resistant to pathogens. Eat more plants and you feed more kinds of healthy microbes, which may help fight off the bad guys.

When my results are in, Leach calls me up. "Hmm. Do you eat salads? Leafy greens?"

"Not many."

"Right. Do you eat potatoes?"

"Do french fries count?"

They don't. Leach nails my eating habits and tells me that my gut is mostly barren of bugs that digest plants, like the *genus Blautia*, which clocks in at just 4.7% of my microbiome. (Leach, who eats a ton of plants, is 18.7% *Blautia*.) That might not be devastating now, but over time, it could leave my gut less acidic and more permeable, making it a playground for pathogens.

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Though my colonies aren't ideal, I still chart among the healthy people Leach has analyzed. But what about people who don't? Researchers have found that it's possible to repopulate the colonies of unhealthy guts plagued by inflammatory bowel disease, colitis, or a serious bacterial infection caused by *Clostridium difficile* by transferring healthy bacteria into their colons. In a procedure called a fecal transplant, doctors take feces from another person and insert the matter into a patient's colon. When a study in Amsterdam tried this in people who had *C. diff*, it cleared up 94% of cases. Antibiotics cured only 31%.

Another group in the Netherlands tried to harness the procedure for weight loss. Researchers transplanted feces from lean volunteers into obese volunteers, and while it didn't change the participants' weight, it temporarily altered their insulin sensitivity and decreased triglyceride levels. (Cosmetic fecal transplants, if they'd even work, are several years—and many ethical debates—away.)

Fecal transplants aren't without risk, says David Graham, MD, a gastroenterologist and professor of molecular virology and microbiology at Baylor College of Medicine and Houston VA Hospital. He doesn't perform the procedure for the same reason it's so intriguing: all the unknown possibilities. Other pathogens could lurk in something as bacteria dense as feces, and since researchers can't screen for diseases they're not looking for, "we could easily transmit agents we aren't aware of," Dr. Graham says. "We never want to say we're sorry."

He and others are developing a new kind of transplant—pure strains of bacteria, minus the feces. These pure cultures, like probiotics 2.0, could be turned into a pill or another form taken orally. "We don't know if it will work," Dr. Graham says, "but theoretically, every hospital would have vials of these strains around."

Understanding which strains contribute to or cure which diseases is the holy grail of microbiome research, and targeted probiotics are the future. "We'll know that if a person has condition X, we're going to treat them with bacteria Y, and that's going to change their metabolism and their immune system in very specific ways," Dr. Blaser says.

In the not-too-distant future, we'll be able to walk into the doctor's office, hand her our gut profile, and receive treatment that takes into account our bacteria and their disease associations, Dr. Petrosino speculates: "The microbiome will become a part of personalized medicine."

So what else did I learn from my own little microbe farm? Of the thousands of possible strains, a full 57% of my microbes were *Bacteroides*, signifying that my eating habits mirror the animal-fat-and-protein-heavy Standard American Diet. Compared with the other profiles Leach has analyzed—including those of a woman with celiac disease and the world's foremost omnivore-in-chief, Michael Pollan—I had the highest *Bacteroides* levels by far. So much for keeping my junk food diet a secret.

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I also had basically no *Bifidobacterium* strains—the genus often used in probiotics—despite eating yogurt several times a week. (Preliminary results show that avid yogurt eaters don't generally have higher Lactobacillus levels than those who don't eat it at all.)

On the plus side, my composition is diverse, which probably makes me more resistant to pathogens, says Leach. My *Verrucomicrobia* levels aren't too shabby, either, which may mean I interact with soil

and fresh water. It's true I'm not dirt-phobic: I leave my windows open, which welcomes in soil from the outside, and I never use antibacterial soap.

What exactly my microbes are telling me is still unclear. "This is a real frontier of scientific discovery," says Dr. Blaser. "There's something new in the journals every week. We don't know all the great things that are going to come out of this."

While researchers continue to toil away in their labs, I'm comforted by the idea that some of this may be within my control: that if I ditch the chicken nuggets and eat more plants, my gut may be healthier and I will be, too. It was enough to change my world. The day I met my microbes, I vowed to start paying attention to them—to start thinking of them as me. I dropped the antibiotic, forsook my bi-weekly burgers and rushed out to the farmers' market to buy a crop of dirty vegetables.