

## Invasion of alien microorganisms: Humans are a walking petri dish, and our genes have been infiltrated

From childhood, we're taught to think of microorganisms as entities that are apart from us. They live in petri dishes in the laboratory and in water samples from streams, and some of them can make us sick. Scientists are even looking for [microorganisms on Mars](#) and other planets and moons. If they find any, the tiny creatures will probably gain new respect from humans, but there's another reason why they deserve respect. Our bodies are full of them.

As one [Scientific American](#) blogger puts it: "We are practically walking Petri dishes, rife with bacterial colonies from our skin to the deepest recesses of our guts." Each of us carries something like 100 trillion bacterial cells, greatly outnumbering our own human cells, affecting our health, and even who and what we are.

Every human depends on microbes for good health. Changes in the populations of our bacteria, particularly in the gut, are associated with health changes, both positive and negative. This should be no surprise, given how bacterial cells outnumber human cells in your body, the cells carrying the DNA that determines your genetic identity. Essentially hitching a ride, the microbes benefit from the environment that your body provides, and also provide benefits to you. They are paying passengers.

In a wonderful [TED talk](#), human microbe pioneer Robert Knight characterizes microbes as an under-appreciated component of the human body. This makes sense for a whole bunch of reasons, the first one being the sheer numbers. Microorganisms in the body exist in various communities. The mouth has a microbial colony, the gut has one, the vagina and on through the body. Adding up the microbial communities, the typical human harbors more than 100 trillion bacterial cells, while the human cells in our bodies number on the order of just 10 trillion. So, something like 90 percent of our cells are bacterial (although our human cells dominate our mass and weight).

A similar comparison can be made with genes. While we carry approximately 20,000 genes in our human DNA (in the chromosomes of our human cells), the genes of our collective microbial communities number 2-20 million. So, we're outnumbered in more ways than one, just within our bodies.

### **Sick gut microbes**

It's common today for people to buy probiotics, pills and gummies full of certain species of the good bacterial that live in our large intestine (colon). The jury is not out yet on whether this actually promotes health, but the rationale is sound. It's based on the idea that the good bacterial strains compete with bad strains that make us sick. Furthermore, taking the idea to the extreme actually does work to cure people who are ill with a potential fatal form of colitis caused by a harmful bacterial species called *Clostridium difficile*. When this condition develops, typically it's because of long periods antibiotic therapy that was necessary to treat a different condition, but that harmed the friendly bacteria –the paying passengers– of the patient's gut. As a result, the *C. difficile* strain of bacteria—not a paying passenger, but a hijacker–thrived.

By taking the idea to the extreme, I do not mean that the patients take large mounts of probiotics, Rather, they're treated by what's known as a [fecal transplant](#). There are a few different ways to do it, but in the most common method fecal matter from a donor is mixed with saline fluid and given to a patient through a tube that goes through the nose and down to the stomach. Or, the mixture can be pumped into the recipient's colon through the anus. While it may not sound very appetizing, early clinical results suggest that it works dramatically well.

“Out of the 35 people in whom I have carried out this transplant procedure, over 90% have been treated successfully,” [explains](#) Alisdair MacConnachie, a gastroenterologist at Gartnavel General Hospital in Glasgow, Scotland. And that 90 percent success rate is fairly consistent with rates in various clinical studies of the procedure around the planet, with all studies collectively involving hundreds of people in whom other treatments (powerful antibiotics against *C. difficile*) have failed.

“If you're a patient who has had multiple recurrences of *C. difficile*, your perception of what makes you squeamish is probably different to people who haven't,” MacConnachie points out. “They are more concerned about getting rid of *C. difficile*.” Still, he admits that fecal transplant suffers from “aesthetic problems”.

But it does appear to work. As noted earlier, the human gut contains trillions of friendly bacterial cells, plus there are multiple species, and to get those numbers and species diversity into someone whose friendly bacteria are depleted, you really do need to move a large amount of poop. Probiotic pills do not provide the numbers and diversity of species. Also, large numbers of the bacterial cells could be destroyed in the stomach before they even reach the colon.

## **Non-human genes in our DNA**

Not only are bacteria living in and on us, but their genes have also worked their way into our DNA, along with genes from fungi and viruses. Because of a phenomenon called horizontal gene transfer, a new study from University of Cambridge (published in the journal *Genome Biology*) has found that our DNA is heavily contaminated with non-DNA from numerous species. We acquire most of the communities of microbes living in our bodies from interacting with our mothers' skin and milk during infancy and bacterial genes transfer very easily between bacterial cells and our own cells. Thus, bacterial genes may actually be an important source of genes that cause traits that we once assumed had to be from human genes.

According to a new Washington University study published in the prestigious journal *Nature*, [traits](#) provided by genes of bacterial origin include weight and even possibly certain aspects of our behavior.

Putting this all together, the way that we think about evolution and identity may have to change. Our sentience—our consciousness, self-awareness— is in our brain, which is made of human cells. However, since non-human cells supply and transport genes that affect our physiology and how we act, they actually contribute to our humanity. So, in a way, bacteria are much more than paying passengers. They're not just coming along for the ride. They're actually handling a lot of the driving.

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