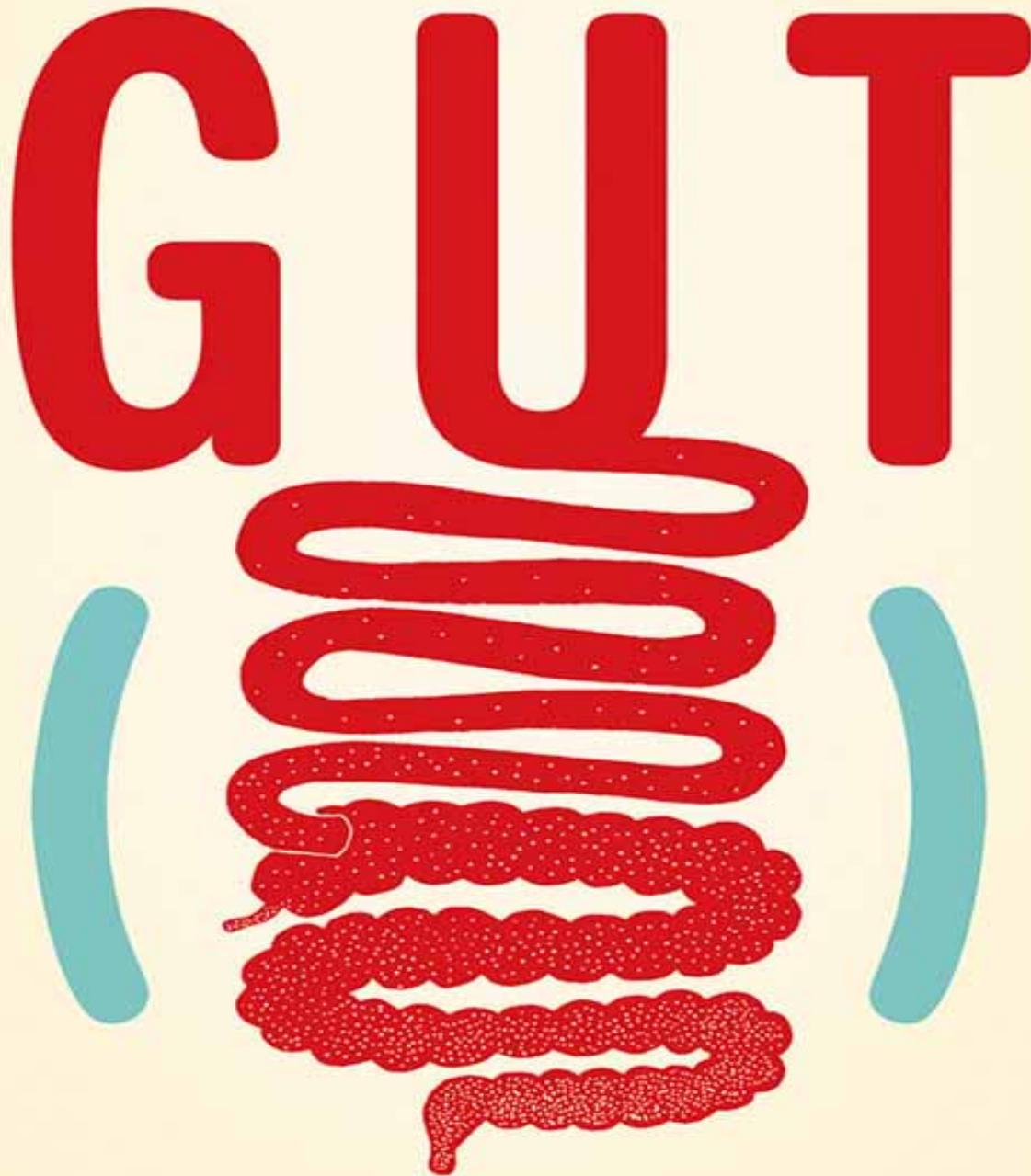


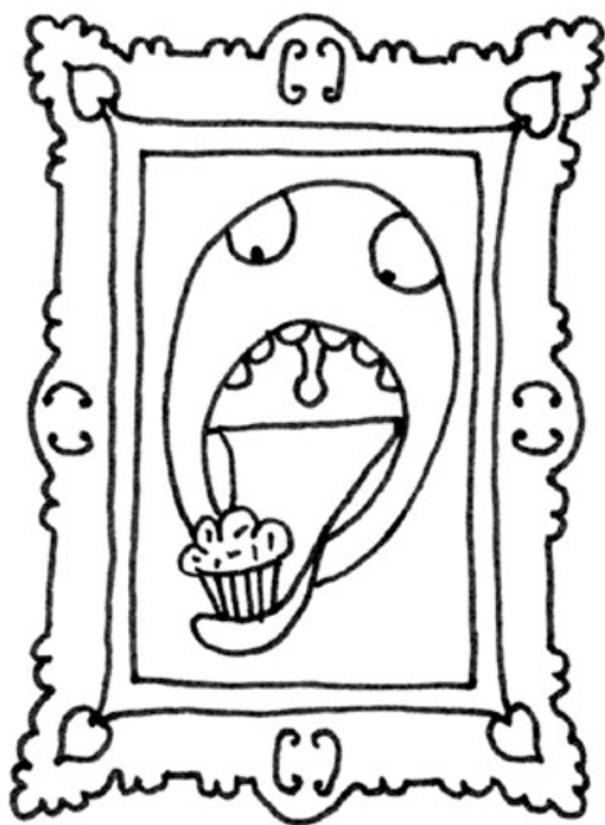
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GIULIA ENDERS
illustrations by **Jill Enders**



**The Inside Story of Our Body's
Most Underrated Organ**



(**GIULIA ENDERS**)
ILLUSTRATIONS BY JILL ENDERS

Translation by DAVID SHAW

GUT

**The Inside Story of Our Body's
Most Underrated Organ**



GREYSTONE BOOKS

VANCOUVER/BERKELEY

For all single parents who put as much energy and love into bringing up their children as our mother did for my sister and me.

And for Hedi.

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Preface

I WAS BORN BY cesarean section and could not be breast-fed. That makes me a perfect poster child for the intractability of the gastrointestinal tract in the twenty-first century. If I had known more about the gut back then, I could have placed bets on what illnesses I would contract later in life. At first I was lactose intolerant. I never thought about why I was suddenly able to drink milk again at the age of five. At some point I got fat, then thin again. Then, for a long time, I was fine—until I got “the sore.”

When I was seventeen, I developed a small sore on my right leg, for no apparent reason. It stubbornly refused to heal, and after a month I went to see my doctor. She didn't really know what it was and prescribed me some cream. Three weeks later, my entire leg was covered in sores. Soon they spread to my other leg, my arms, and my back. Sometimes they appeared on my face. Luckily, it was winter at the time, and everyone thought I had cold sores and a graze on my forehead.

No doctor was able to help me—giving me vague diagnoses of some kind of nervous eczema. They asked me about stress and psychological problems. Cortisone helped a little, but as soon as I stopped using it, the sores just came back. For a whole year, in summer and in winter, I wore tights to stop my sores from weeping through my pants. Then I pulled myself together and started doing some research of my own. By chance, I came across a report about a very similar skin condition. A man had contracted it after taking antibiotics, and I, too, had had to take a course of antibiotics just a couple of weeks before my first sore appeared. It occurred to me that although the sores were on my skin, their appearance might be

related to what was going on inside me. Perhaps the course of antibiotics was key? Had they somehow affected my gut?

From that moment on, I ceased to treat my skin like the skin of a person with a dermatological problem and began to see it as the skin of a person with an intestinal condition, though just what that condition might be, I did not know. I decided to cover all the bases. I stopped eating dairy products, cut out gluten almost entirely, swallowed various bacterial cultures, and generally improved my diet. I also carried out some pretty crazy experiments on myself. If I had already been studying medicine at that time, I wouldn't have dared do half of them. Once, I overdosed on zinc for several weeks, causing me to have an extremely heightened sense of smell for the next few months.

With a few tricks, I finally managed to get my condition under control. This success gave me a lift, and I experienced with my own body that knowledge is power. That's when I started studying medicine.

In my first semester as a student, I was at a party where I ended up sitting next to a guy who had the smelliest breath I have ever smelled. It wasn't a typical bad-breath smell—not the scratchy hydrogen-breath odors of stressed-out middle-aged gentlemen nor the sugary, fetid funk from the mouth of an elderly aunt with too sweet a tooth. After a while, I moved away and sat somewhere else. The next day, he was dead. He had killed himself. I couldn't get him out of my mind. Was there a way his gut might have contributed to this? Just like my skin condition, which at first appeared unrelated? Now I had some experience in medical school, I wondered if it could have been a diseased gut creating that smell, and if so, could a diseased gut also have affected that man's psychological state?

A week later, I decided to share my suspicion with a good friend. And a few months after that, the same friend contracted a bad case of gastroenteritis, which left her feeling very poorly. The next time we met, she told me she thought there might be something in my theory, as her illness had made her feel worse than she ever had felt before, psychologically as well as physically. Her comments inspired me to start looking more closely at this subject matter.

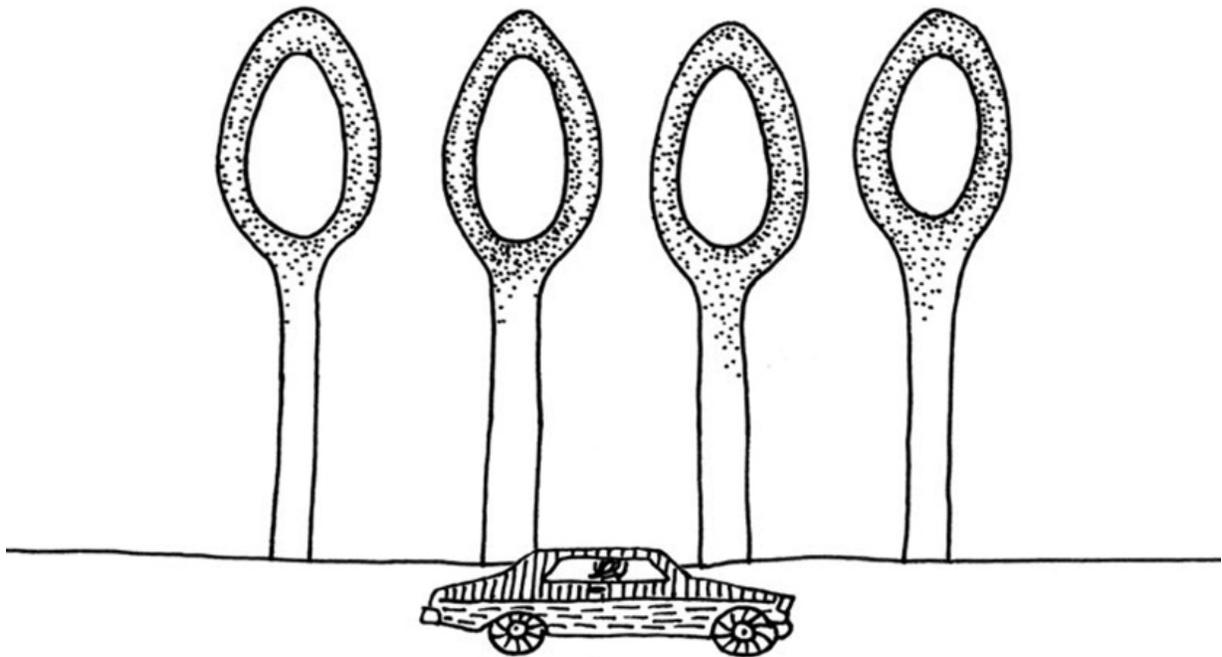
Soon, I discovered there was an entire branch of medical research investigating the links between the gut and the brain. It's a rapidly growing field of study. Ten or so years ago, there were hardly any published studies on the subject; now there are several hundred academic articles covering the field. The influence of the gut on our health and well-being is one of *the* new lines of research in modern medicine. The renowned American biochemist Rob Knight told the journal *Nature* that the field offered at least as much promise as stem cell research. I had stumbled upon a subject I found more and more fascinating.

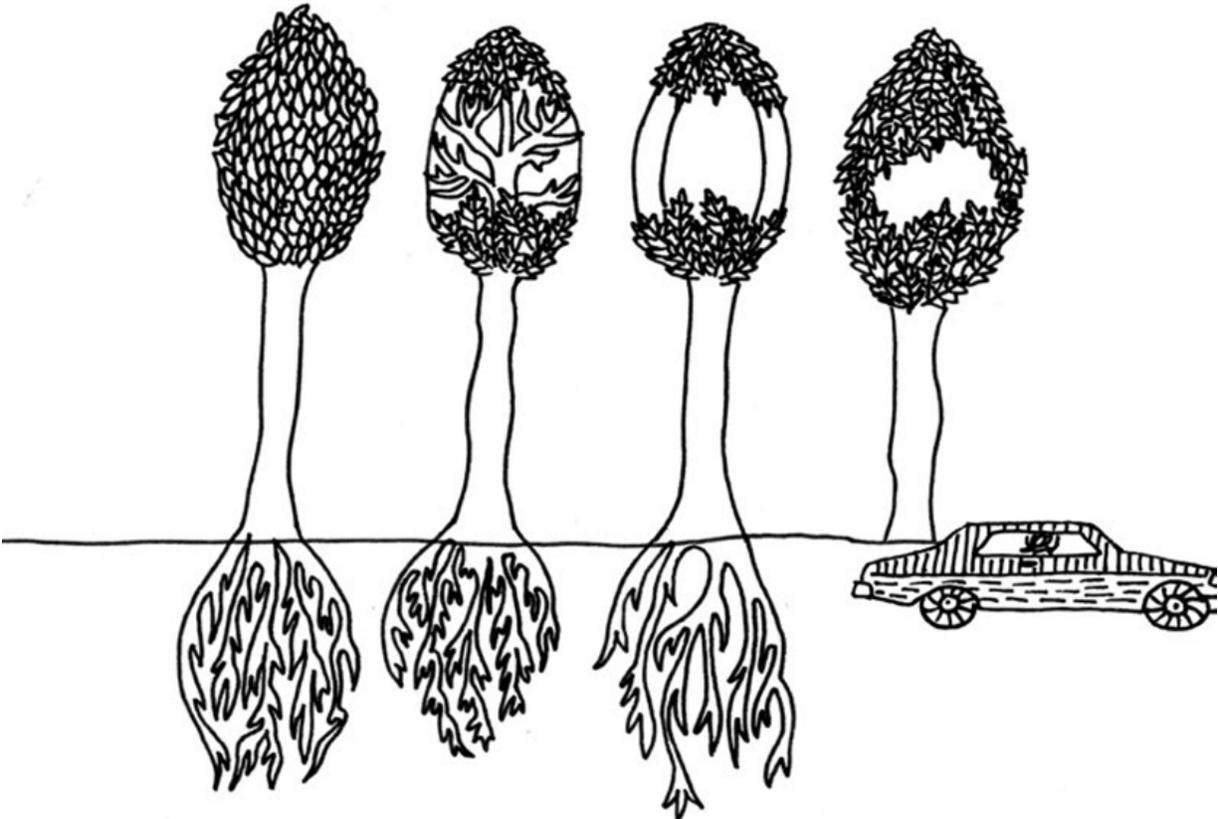
As I continued my medical degree, I got more insight into how my cesarean birth and lack of breast-feeding might have influenced my health later in life. I also realized how neglected, even looked down upon, this area still is in the medical world. This is all the more surprising when you consider what an extraordinary organ the gut is. It accounts for two-thirds of our immune system, extracts energy from sandwiches and vegetarian sausages, and produces more than twenty unique hormones. Most doctors learn very little about this in their training. When I visited the Microbiome and Host Health symposium in Lisbon in May 2013, the number of participants was modest. About half came from institutions with the financial wherewithal to allow them to be among the pioneers, including Harvard, Yale, Oxford, and the European Molecular Biology Laboratory (EMBL) at Heidelberg University.

I'm sometimes shocked by the way scientists huddle behind closed doors to discuss their important research results without informing the public about them at all. Academic caution is often preferable to premature publication, but fear can also destroy opportunities. It is now generally accepted in scientific circles that people with certain digestive problems often suffer from nervous disorders of the gut. Their gut then sends signals to the part of the brain that processes negative feelings, although they have done nothing bad. Such patients feel uneasy but have no idea why. If their doctors simply treat them as irrational mental cases, it can be extremely counterproductive! And this is just one example of why some research results should be published more quickly.

And that is my aim in writing this book. I want to make new knowledge available to a broad audience and communicate the information that scientists bury in their academic publications or discuss behind closed doors at scientific meetings, while many ordinary people out there are searching for answers. I know there are many patients suffering from unpleasant conditions who are frustrated by the medical world. I can't offer any panaceas, and keeping your gut healthy is not a miracle cure for everything, but what I can do is to show, in an entertaining way, why the gut is so fascinating, what exciting new research is currently underway, and how we can use this new knowledge to improve our daily lives.

My medical studies and my doctoral research at the Institute for Medical Microbiology in Frankfurt, Germany, have given me the skills to sift and sort scientific data. My own personal experience has helped me develop the ability to communicate this knowledge to people. My sister has given me the support I needed to keep me on the right track—listening to me read aloud from my manuscript and saying, with a charming grin, “I think you better try that bit again.”





(PART ONE)

GUT FEELING



THE WORLD IS a much more interesting place if we look beyond what is visible to the naked eye. There is so much more to see! If we start to look more closely, a tree can be more than a spoon-shaped thing. In a highly simplified way, “spoon” is the general shape we perceive when we look at a tree: a straight trunk and a round treetop. Seeing that shape, our eyes tell us “spoon-like thing.” But there are at least as many roots beneath the ground as there are branches above it. Our brain should really be telling us something like “dumbbell,” but it doesn’t. The brain gets most of its input from our eyes, and that information is very rarely in the form of an illustration in a book showing trees in their entirety. So, it faithfully construes a passing forest landscape as “spoon, spoon, spoon, spoon.”

As we “spoon” our way through life like this, we overlook all sorts of wonderful things. There is a constant buzz of activity beneath our skin. We are perpetually flowing, pumping, sucking, squeezing, bursting, repairing, and rebuilding. A whole crew of ingenious organs works so perfectly and efficiently together that, in an adult human being, they require no more energy than a 100-watt light bulb. Each second, our kidneys meticulously filter our blood—much more efficiently than a coffee filter—and in most cases they carry on doing so for our entire lives. Our lungs are so cleverly designed that we use energy only when we breathe in. Breathing out happens without any expenditure of energy at all. If we were transparent, we would be able to see the beauty of this mechanism: like a wind-up toy car, only bigger, softer, and more lung-y. While some of us might be sitting around thinking “Nobody cares about me!”, our heart is currently working its seventeen-thousandth twenty-four-hour shift—and would have every right to feel a little forgotten when its owner thinks such thoughts.

If we could see more than meets the eye, we could watch as a clump of cells grows into a human being in a woman’s belly. We would suddenly see how we develop, roughly speaking, from three tubes. The first tube runs right the way through us, with a knot in the

middle. This is our cardiovascular system, and the central knot is what develops into our heart. The second tube develops more or less parallel to the first along our back. Then it forms a bubble that migrates to the top end of our body, where it stays put. This tube is our nervous system, with the spinal cord, including the brain, at the top and myriad nerves branching out into every part of our body. The third tube runs through us from end to end. This is our intestinal tube—the gut.

The intestinal tube provides many of the furnishings of our interior. It grows buds that bulge out farther and farther to the right and left. These buds will later develop into our lungs. A little bit lower down, the intestinal tube bulges again and our liver has begun to develop. It also forms our gall bladder and pancreas. But, most importantly, the tube itself begins to grow increasingly clever. It is involved in the complex construction of our mouth, creates our esophagus, with its ability to move like a break dancer, and develops a little stomach pouch so we can store food for a couple of hours. And, last but not least, the intestinal tube completes its masterpiece—the eponymous intestine or gut.

The masterpieces of the other two tubes—the heart and the brain—are generally held in high regard. We see the heart as central to life since it pumps blood around the body. The brain is admired for its ability to create a dazzling array of new mental images and concepts every second. But the gut, in most people’s eyes, is good for little more than going to the toilet. Apart from that, people think, it just hangs around inside our bellies, letting off a little “steam” every now and then. People do not generally credit it with any particular abilities. It would be fair to say that we underestimate our gut. To put it more bluntly, we don’t just underestimate it, we are ashamed of it—more “guilt feeling” than “gut feeling”!

I hope this book will change that by making use of the wonderful ability that books possess to show us more than the world we see around us. Trees are not spoons, and the gut is our body’s most underrated organ. This is its inside story.

How Does Pooping Work? And Why That's an Important Question

MY FLATMATE WANDERED into the kitchen one day, saying, “Giulia, you study medicine—so how does pooping work?” It probably wouldn’t be a great idea for me to begin my autobiography with that question, but that little query did literally change my life. I withdrew to my room, sat on the floor, and was soon poring over three different textbooks. The answer I eventually discovered left me flabbergasted. This unspectacular daily necessity turned out to be far more sophisticated and impressive than I ever would have imagined.

Every time we go to the toilet, it’s a masterly performance—two nervous systems working tirelessly in tandem to dispose of our waste as discreetly and hygienically as possible. Very few other animals do their business in such an admirable and orderly manner. Our bodies have developed all sorts of mechanisms and techniques to help us poop properly. The first surprise is the sophistication of our sphincters. The vast majority of people are familiar only with the outer sphincter: the muscle we can consciously control, opening and closing it at will. There is another, very similar muscle close by—but this is one we can’t control consciously.

Each of the two sphincters looks after the interests of a different nervous system. The outer muscle is a faithful servant of our consciousness. When our brain deems it an unsuitable time to go to the toilet, the external sphincter obeys and stays closed with all its might. The internal sphincter represents our unconscious inner world. Whether Great-Aunt Bertha approves of breaking wind or not is no concern of the *sphincter ani internus*. It is only interested in making sure everything is okay inside us. Is the gas pressure rising?

The inner sphincter's mission is to keep all unpleasantness at bay. If it had its way, Great-Aunt Bertha would break wind more often. The main thing for the internal sphincter is to keep everything comfortable and in its place.

These two sphincter muscles have to work as a team. When what's left of our food reaches the internal sphincter, that muscle's reflex response is to open. But it does not just open the floodgates and let everything out, leaving the outer sphincter to deal with the deluge. First, it allows a small "taster" through. The space between the internal and external sphincter muscles is home to a large number of sensor cells. They analyze the product delivered to them, test it to find out whether it is solid or gaseous, and send the resulting information up to the brain. This is the moment when the brain realizes, "It's time to go to the toilet!" Or maybe, "It's just a bit of wind." It then does what it is so good at with its conscious awareness: it adapts to the environment we find ourselves in. It compares the information it receives from our eyes and ears to the data in its memory bank of past experience. In this way, the brain takes just a matter of seconds to make an initial assessment of the situation and send a message back to the sphincter: "I've had a look and we're at Great-Aunt Bertha's, in the living room. We might get away with breaking a little wind if we can squeeze it out silently—anything more solid might not be such a good idea."

The external sphincter gets the message and dutifully squeezes itself closed even more tightly than before. The internal sphincter receives this signal from its more outgoing partner and respects the decision—for now. The two muscles work together and maneuver the taster back into a holding pattern. Of course, it will have to come out sooner or later, just not here and not now. After a while, the internal sphincter will simply give it a try with another little taster. If by then we're back within our familiar four walls, it's full steam ahead!

Our internal sphincter is a no-nonsense little guy. His motto is "If it's gotta come out, it's gotta come out!" Not much room for argument there. The external sphincter, on the other hand, has to deal with the vagaries of the outside world and its many options. It might, theoretically, be possible to use this stranger's toilet, but is that a

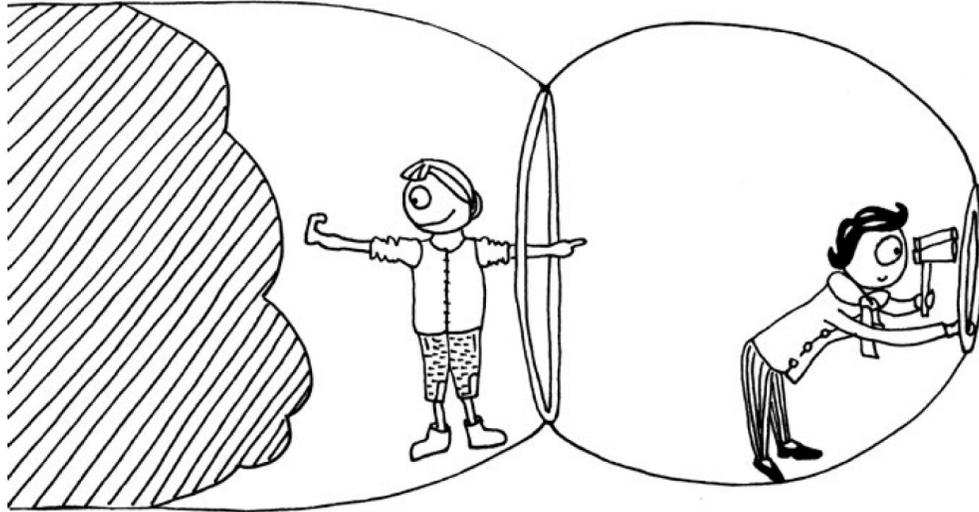
good idea? Have my new girlfriend/boyfriend and I been together long enough for farting in front of each other to be okay—and if so, is it down to me to break the ice and go first? If I don't go to the toilet now, can I wait until this evening or will I get caught short?

The considerations of our sphincter may not sound worthy of a Nobel Prize, but in fact they are concerned with some of the most basic questions of human existence: how important to us is our inner world, and what compromises should we make to get by in the external world? There are those who clench with all their might to keep the wind in, come what may, eventually struggling home wracked with bellyache. Others get Granny to pull on their finger at a family party, making a funny, if slightly inappropriate, magic show out of their need to break wind. The best compromise is probably somewhere in the middle.

If we suppress our need to go the toilet too often or for too long, our internal sphincter begins to feel browbeaten. In fact, we are able to reeducate it completely. That means the sphincter and the surrounding muscles have been disciplined so often by the external sphincter that they become cowed. If communication between the two sphincters breaks down completely, constipation can result.

Even without such defecatory discipline, something very similar can happen to women during labor. Childbirth can cause tearing of the delicate nerve fibers that allow the two muscles to communicate with each other. The good news is that those nerves can heal and reconnect. Irrespective of whether the damage was caused by childbirth or in some other way, one good treatment option is what doctors call biofeedback therapy. Biofeedback therapy is offered by some gastroenterologists or gastroenterology departments. It teaches the two sphincters to overcome their estrangement and get to know each other again. A machine is used to measure how efficiently the internal and external sphincters are working together. If messages from one to the other get through, the patient is rewarded with a sound or light signal. It's like one of those quiz shows on early-evening television, where the whole set lights up and fanfares blare when a contestant gets the answer right—only it's at a medical practice, not on television, and the "contestant" has a sensor

electrode up his or her butt. That may seem extreme, but it's worth it. When the two sphincters are talking properly to each other again, going to the little girls' or little boys' room is an altogether more pleasant experience.



Sphincters, sensor cells, consciousness, and electrode-up-the-butt quiz shows. My flatmate was probably not expecting all that in answer to his casual question about pooping, nor did the group of rather prim female business studies students who had meanwhile gathered in the kitchen for his birthday party. Still, the evening turned out to be fun, and it made me realize that a lot of people are actually interested in the gut. Some interesting new questions were raised at the birthday party. Is it true that we don't sit on the toilet properly? How can we burp more easily? Why can we get energy from steaks, apples, or fried potatoes, for example, but cars are much more restricted in their fuel options? Why do we have an appendix? Why are feces always the same color?

My flatmates have learned to recognize the familiar look on my face when I rush into the kitchen, bursting to tell them my latest gut anecdote—like the one about the tiny squat toilets and luminous poop.

Are You Sitting Properly?

IT'S A GOOD idea to question your own habits from time to time. Are you really taking the shortest and most interesting route to the bus stop? Is that comb-over to hide your increasing bald patch elegant and chic? Or, indeed, are you sitting properly when you go to the toilet?

There will not always be a clear, unambiguous answer to every question, but a little experimentation can sometimes open up whole new vistas. That is probably what was going through the mind of Dov Sikirov when the Israeli doctor asked twenty-eight test subjects to do their daily business in three alternative positions: enthroned on a normal toilet; half-sitting, half-squatting on an unusually low toilet; and squatting with no seat beneath them at all. He recorded the time they took in each position and asked the volunteers to assess the degree of straining their bowel movements had required. The results were clear. In a squatting position, the subjects took an average of 50 seconds and reported a feeling of full, satisfactory bowel emptying. The average time when seated was 130 seconds and the resulting feeling was deemed to be not quite so satisfactory.

Why the difference? The closure mechanism of our gut is designed in such a way that it cannot open the hatch completely when we are seated. There is a muscle that encircles the gut like a lasso when we are sitting or, indeed, standing, and it pulls the gut in one direction, creating a kink in the tube. This mechanism is a kind of extra insurance policy, in addition to our old friends, the sphincters. Some people will be familiar with this kinky closing mechanism from their garden hose. You ask your sister to check why there's no water coming out of the hose. When she peers down the end, you quickly unbend the kink, and it's just a few minutes until your parents ground you for a week.

But back to our kinky rectal closure mechanism: it means our feces hit a corner. Just like a car on the highway, turning a corner means our feces have to put on the brakes. So, when we are sitting

or standing, our sphincters have to expend much less energy keeping everything in. If the lasso muscle relaxes, the kink straightens, the road ahead is straight, and the feces are free to step on the gas.

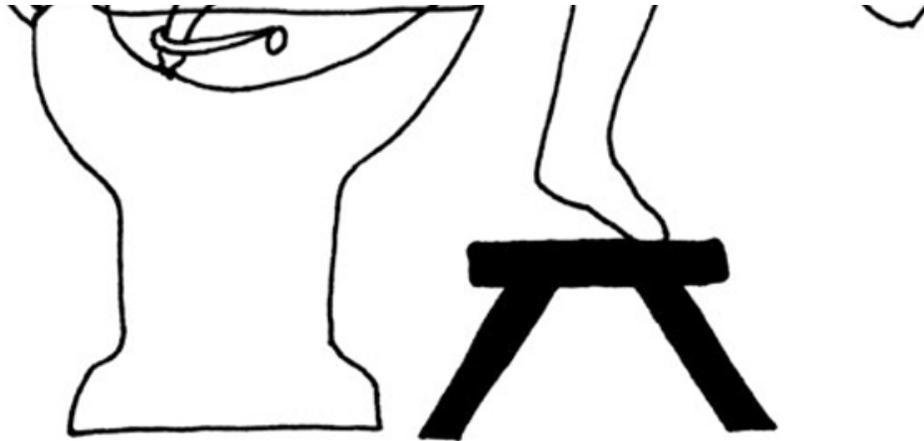
Squatting has been the natural defecation position for humans since time immemorial. The modern sitting toilet has existed only since indoor sanitation became common in the late eighteenth century. But such “cavemen did it that way” arguments are often met with disdain by the medical profession. Who says that squatting helps the muscle relax better and straightens the feces highway? Japanese researchers fed volunteers luminous substances and X-rayed them while they were doing their business in various positions. They found out two interesting things. First, squatting does indeed lead to a nice, straight intestinal tract, allowing for a direct, easy exit. Second, some people are nice enough to let researchers feed them luminous substances and X-ray them while they have a bowel movement, all in the name of science. Both findings are pretty impressive, I think.

Hemorrhoids, digestive diseases like diverticulitis, and even constipation are common only in countries where people generally sit on some kind of chair to pass their stool. This is due not to lack of tissue strength, especially in young people, but to the fact that there is too much pressure on the end of the gut. Some people tend to tense up all their abdominal muscles when they are stressed. Often, they don't even realize they are doing it. Hemorrhoids prefer to avoid internal pressure like that by dangling loosely out of the anus. Diverticula are small light-bulb-shaped pouches in the bowel wall, resulting from the tissue in the gut bulging outward under pressure.

Of course, the way we go to the toilet is not the only cause of hemorrhoids and diverticula; however, it remains a fact that the 1.2 billion people in this world who squat have almost no incidence of diverticulosis and far fewer problems with hemorrhoids. We in the West, on the other hand, squeeze our gut tissue until it comes out of our behinds and we have to have it removed by a doctor. Do we put ourselves through all that just because sitting on a throne is more “civilized” than silly squatting? Doctors believe that straining too

much or too often on the toilet can also seriously increase the risk of varicose veins, a stroke, or defecation syncope—fainting on the toilet.





A text message I received from a friend who was on holiday in France read, “The French are crazy! Someone’s stolen the toilets from the last three service stations we stopped at!” I had to laugh, first, because I suspected my friend was actually being serious, and second, because it reminded me of my first experience of French squat toilets. “Why am I being forced to squat here when you could just as easily have put in a proper toilet?” I mournfully complained to myself as I recovered from the shock of the emptiness I saw before me. Throughout much of Asia, Africa, and southern Europe people squat briefly over such toilets in a kind of martial arts or downhill skiing pose to defecate. We, by contrast, take so long, we have to while away the time until we’ve finished our business with reading the paper, carefully prefolding pieces of toilet paper for imminent use, scanning the corners of the bathroom to see if they could do with a clean, or staring patiently at the opposite wall.

When I read this chapter out to my family in our living room, I looked up to see disconcerted faces. Are we going to have to descend from our porcelain thrones and squat precariously over a hole to poop? Of course not, hemorrhoids or no hemorrhoids! That said, it might be fun to try climbing up onto the toilet seat to do our business while squatting there. But there’s no need for that, either. It is possible to squat while sitting. It’s a particularly good idea when things don’t come so easily, so to speak. To do it, just incline your upper body forward slightly and put your feet on a low footrest placed in front of the toilet, et voilà!—all the angles are correct, and

you can read the paper, prefold your tissue, or stare at the wall with a clear conscience.