"With a 'wow' on every page, *Gut Check* is an essential manual for what to eat and why to eat it. I learned so much from this book."
—JAMES NESTOR, AUTHOR OF THE *NEW YORK TIMES* BESTSELLER *BREATH*

GUT CHECK

UNLEASH THE POWER OF YOUR MICROBIOME TO REVERSE DISEASE AND TRANSFORM YOUR MENTAL, PHYSICAL, AND EMOTIONAL HEALTH

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THE PLANT PARADOX

GUT CHECK

Unleash the Power of Your Microbiome to Reverse Disease and Transform Your Mental, Physical, and Emotional Health

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HARPER WAVE

An Imprint of HarperCollins*Publishers*

Dedication

To Pearl, Flo and Milt, Bev and Bob:
Thanks for making Penny my soulmate!

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What if I told you that free will is an illusion but that instead of a vast, mysterious universe out there controlling our fates, there is actually a vast, mysterious universe within us that we are on the verge of being able to comprehend? By the end of this book, I hope to convince you that this is true, teach you how this universe was designed to guide and support you, and empower you with the ability to restore this universe—which we have unknowingly decimated—to heal anything that currently ails you.

Have you ever seen the movie *Men in Black*? In one scene, there's a little alien named Frank the Pug who tells the main characters that the galaxy they are looking for is here on Earth: "The galaxy is in Orion's belt." The humans are understandably confused. They assume that he is referring to the well-known constellation Orion, which, first of all, is not on Earth, and second, whose belt is made up of three stars. Galaxies have an estimated one hundred million stars. How could three measly stars contain an entire galaxy?

As Frank goes on to explain, "You humans! When are you going to learn that size doesn't matter? Just because something's important, doesn't mean it's not very, very small!"

Over the course of the film, the protagonists come to understand, as I have, that whole galaxies can exist in unexpected places. And that was exactly what the little Frank the Pug was trying to communicate. It turns out that an unfathomably vast galaxy of stars, solar systems, and planets filled with beings is actually hanging off the collar of a cat named Orion. Get it? Orion's belt.

Those characters made the same mistake as humans everywhere. But instead of looking up at the stars, we've looked in all the wrong places for answers about our health and longevity. We've focused our search externally, assuming that the most important things are physically big and therefore must live outside us, whereas in reality the most significant, far-reaching contributors to our well-being and health are actually the

smallest. And to find them, we must look inward.

The truth is that inside your digestive system lives a galaxy made up of trillions of bacteria belonging to at least ten thousand different species, plus an as-yet-undetermined number of viruses, fungi, and other microbes. This is your gut biome. You also have an oral biome with seven hundred species of bacteria and a skin biome with a thousand different species. As I've written before, all these living microscopic creatures collectively make up your holobiome. Among them, these microbes contain more than three million genes, whereas the human genome contains a mere twenty-three thousand.

Take a moment to consider just how vast this thing is. There are somewhat more than eight billion human beings on this planet. That means there are *12,500 times* as many bacteria in your own gut as there are humans on Earth. If you prefer plants to humans, consider this: it was recently calculated that there are approximately three trillion trees on Earth.[1] That's more than seven times as many as experts previously believed, despite the billions that humans cut down each year. Even with that discovery, however, there are *ninety-seven trillion* more bacteria in your gut than there are trees on Earth.

When I was in medical school back in the Stone Age, we were taught that the human gut was basically a hollow tube. Food went in, digestion occurred, proteins, sugars, and fats were absorbed, and whatever waste was left over came out as feces. Now we know that our gut is akin to a teeming tropical rain forest with its own diverse ecosystem, communities, and multiple signaling devices, languages that single-celled organisms use to talk among themselves.

Quite startlingly, they also use these languages to tell your mind and body how to think, feel, and behave and how to maintain your skin, muscles, joints, organs, cells, and even the organelles within your cells to keep them healthy—or, conversely, to attack them with inflammation and disease. These billions of single-celled organisms manipulate and control us in unfathomable and downright shocking ways.

It's been only six years since I wrote *The Plant Paradox*. I thought I knew a lot back then, and I'm pleased to say with the passage of time that I was on the right track. But in the time that has elapsed since the publication of that book, scientists have discovered a whole new world of information about the microbiome and the multiple languages its members use to interact with every part of our bodies, to communicate with one another, and, most important, to control the power plants in our cells, our mitochondria. Through these communication signals, they exert control

over every aspect of our health, wellness, and longevity. And you are about to learn how to decipher this system and use it to your advantage.

Let me start with a small (literally) example of how these bugs can control us.

Many of us are familiar with the single-celled organism *Toxoplasma gondii*, which is responsible for the disease toxoplasmosis. Pregnant women are told to avoid close proximity to cat litter and to have their partner "scoop the poop" for the duration of their pregnancy because cats can pass along toxoplasma in their feces. If a pregnant woman becomes infected with toxoplasmosis, it can cause severe health problems in her unborn child. But of course, most of us don't stop to consider how this single-celled creature came to live in cat litter to begin with.

Bear with me for a moment. I promise that whether or not you ever plan on getting pregnant or owning a cat, this relates to you in more ways than you can probably imagine.

Toxoplasma has two life cycles. There is a host that the organism ultimately wants to get to, and it uses an intermediary host before arriving at that final destination. In this case, the final objective is a cat. It can be a tiger, a house cat, any kind of cat. Toxoplasma can reproduce only in the gut of a cat—and, like all life-forms, its end goal is to reproduce and pass on its genes to the next generation.

To get into a cat, toxoplasma uses a rodent as its intermediary host. This makes pretty good sense. After all, rodents are famously cats' favorite prey. Just look at *Tom and Jerry*, my favorite cartoon when I was a kid. It seems logical enough for toxoplasma to hang out in the rodent, hoping that it will eventually be eaten by a cat so it can end up in that feline's gut.

But toxoplasma has evolved over millions of years so that it doesn't have to just wait around; it can actually change the rodent's behavior so that it's far more likely to get eaten by a cat. What's that? A single-celled organism can manipulate the actions of a mammal? Yes, it can, and if I teach you anything in this book, hopefully it's that single-celled organisms are far more intelligent than we've ever considered—and that they not only are capable of controlling us but in fact are already doing it. Constantly.

Okay, then, you might be thinking, the toxoplasma must paralyze the rodent or something similar to make it easier feline prey. That would certainly make sense, but it actually chooses a much more complex and nuanced mode of manipulation than that. Unlike brave little Jerry, most rodents are innately afraid of cats. They are repelled by the sight of a cat or even the smell of cat urine. In fact, if you take a rodent that's never been

exposed to a cat (or its urine) in its life and expose it to the smell, it will run away. That fear and the associated stress response are hardwired into the rodent for its survival.

Toxoplasma undoes that fear response. It manipulates the fear pathways in the rodent's brain to make it not only less afraid of cat urine but actually attracted to the smell of it. Now, instead of running away, the rodent will approach the cat urine. *Sniff, sniff . . . hey, that smells pretty good!* Uh-oh, here comes the tomcat! And now the rodent is much more likely to end up in its belly.

How does toxoplasma do this? In his lab at Stanford University, Robert Sapolsky, one of my heroes and a professor of biology, neurology, and neurosurgery, studied the brain chemistry of rats that were infected with toxoplasma. What he discovered was shocking.[2]

In both rodents and humans, the amygdala is the part of the brain associated with fear. Toxoplasma infiltrates the nervous system of the rodent, travels to the amygdala, and shrivels the dendrites, which are the branches through which neurons receive information from other neurons. This disconnects the fear circuits in the amygdala. But toxoplasma is even more precise than that; it leaves the circuits associated with other types of fear alone and disconnects only the ones associated with the fear of predators.

Now the rodent is no longer afraid of cat urine and will no longer exhibit a stress response and run away when exposed to its smell. That's pretty good. But how do you get it to be attracted to the urine instead? It turns out that in its genome, toxoplasma has the necessary genes to produce the main enzymes found in dopamine, the neurotransmitter that's all about pleasure, attraction, anticipation, and reward. And it produces that dopamine and sends it to the rodent's brain, activating a different circuit this time: the one that's associated with sexual attraction.

When the rodent smells cat urine now, it no longer experiences a stress response because the pathways associated with the fear of predators have been deactivated. Even better, it really likes the smell because the sexual attraction circuitry is activated instead. The rodent will now run toward danger in the form of cat urine instead of away from it, often leading to its own demise.

This brilliant single-celled organism has completely hijacked the brain chemistry and behavior of a mammal for its own selfish purposes. Pretty darn impressive, isn't it? But these little buggers don't stop with rodents. In 2022, field biologists noted that many of the gray wolves in Yellowstone National Park were infected with toxoplasma and wondered

if the wolves' behavior was also being manipulated. It turned out that wolves with toxoplasma were forty-six times as likely to become pack leaders[3,4] as wolves without toxoplasma. Obviously, pack leaders must be bold risk-takers, and toxoplasma infection was causing them to take more risks. But why is toxoplasma bothering with wolves? Because the main predators of gray wolves are cougars, aka mountain lions, aka cats.

By now you might be thinking back to the cat litter situation. What is going on with toxoplasma and humans? When humans become infected with toxoplasmosis, they can get very sick, but many remain asymptomatic while toxoplasma lives in the body. An estimated one-third of the population in developed countries is infected with toxoplasma. Those people are considered asymptomatic because they are not sick, but that doesn't mean that they aren't affected by it.

In fact, it is during this latent stage that toxoplasma begins producing the enzymes that make up dopamine. We may not become attracted to cat urine, but humans with toxoplasma do become a little more impulsive, tend to disregard rules, and are more likely to put themselves into harm's way to save others! So all of those so-called heroes out there may just be acting as tools for toxoplasma.[5] Humans with toxoplasma also have two to three times the likelihood of dying in a car accident due to reckless driving as do people without toxoplasma.[6] That extra dopamine certainly makes us run toward danger.

There is also an interesting link between toxoplasmosis and schizophrenia.[7] We know that patients with schizophrenia have altered dopamine levels in the brain. And if rodents that have toxoplasma are treated with the same drugs that are used to treat schizophrenia, they stop being attracted to cat urine. Pretty wild.

But why would toxoplasma want to mess with a human? After all, it can't reproduce in our gut. In some parts of the world, humans and great apes have always been the main food choice of tigers and other big cats. Indeed, some researchers have looked at our closest relatives, chimpanzees, which are the prey of leopards. Lo and behold, chimps do in fact lose their aversion to leopard urine when they are infected with toxoplasma.[8] And remember, toxoplasma isn't picky about which breed of cats it lands in; it's just as happy reproducing in the gut of a tiger or leopard as it is in Tom's belly.

In other words, toxoplasma uses us (and our close chimpanzee relatives) in the exact same way it does rodents: it eliminates our fear and causes us to run toward danger so that we turn ourselves into easy prey. We think that we're the highest-functioning organism on the planet and

that our mind has complete control over our behavior, but in the hands of a simple single-celled organism, we are essentially nothing more than a giant lab rat.

Is this a mic drop moment or what? I assure you, there are plenty more to come.

The thing is, this is not a rare pattern. Like toxoplasma, the other single-celled organisms that use us as their hosts exert their control over us in a multitude of highly complex, sophisticated, intelligent ways.

As Frank the Pug asked, "You humans, when are you going to learn?" The truth is that there's still a lot we don't know about this microscopic galaxy. But we can't afford to wait until we have the full picture to act. For too long, we've overlooked these microbes in favor of the relatively tiny number of cells that constitute what we think is human. Now we are paying the price. There is power in numbers, and those numbers tend to dislike being ignored.

Yet that is exactly what we have done. In fact, we've gone far beyond simply ignoring the majority; we've treated it with outright hostility. Over the past fifty years, we have introduced innovation after innovation that has overlooked, depleted, and destroyed our microbiomes. It's no coincidence that in the same time frame there has simultaneously been a stark increase in major diseases, from obesity to the current mental health crisis to the autoimmune epidemic that I treat in my clinics every day.

In this book, you'll see how each of these diseases, and many more, are directly tied to the ways that modern living has decimated the majority shareholders in our guts. It's safe to say that these microbes are angry, and they're not going to take it anymore. We are all in dire need of a *Gut Check*.

The good news is that the vast majority of the bugs living in our guts do not want us to run toward danger as toxoplasma does. Quite the opposite! They want us to stay healthy and thriving because it is in their own best interest. As far as these gut buddies, as I like to call them, are concerned, we're the cat; they want to reproduce in our guts and pass on their genes.

Our relationship with these bugs is symbiotic. Your body is their home. Ever since the time of Louis Pasteur, we have been taught that these bugs are our enemies and mean us harm, or that at the very least we would be better off without them. But as we now know, we can't live well without them. And if you treat them well, they will in turn take good care of you.

Hippocrates was 100 percent correct more than twenty-four hundred

years ago when he said, “All disease begins in the gut.” He also believed that a physician’s purpose was to be a detective. He proposed that we all have within us (translated from Greek) a “green life-force energy” that provides perfect health. The physician’s job, he suggested, is to identify the factors that prevent our green life-force energy from flourishing and teach the patient to remove those causes with no further intervention.

At the risk of sounding a bit woo-woo, I believe that Hippocrates was right about our life force. No matter what is ailing my patients, I investigate until I discover the root cause, which without fail lies in their gut. As I’ve written elsewhere, once we restore the gut to a state of equilibrium, the disease often abates or even disappears. I don’t have to do anything except act as Sherlock Holmes. Our green life force is the galaxy of very, very small beings living behind your belt! And now that scientists are discovering the mechanisms behind these diseases, I propose advancing Hippocrates’ theory a step further to say that all diseases can be *cured* in the gut, too. And with the *Gut Check* program, that is exactly what you will be able to do.

So let’s get going. We’ve got a whole galaxy to explore.

Chapter 1

Your Body Is a Rain Forest

Imagine that you are hosting a big party. As you consider your invite list, there's a lot to think about. You have many different groups of friends from various parts of your life: your old college buddies, your work friends, and some others that you've picked up along the way. Then there are your partner's different groups of friends to consider, too.

It would be nice if everyone got along, but unfortunately, that's not the case. In particular, your work friends and your college friends don't seem to like each other very much. They disagree on some political issues, and previous parties have gotten awkward. A few times, arguments have even broken out.

It might be tempting to hang out with each group separately, but this time, you want to throw a really fun, robust party. Maybe it's a special occasion. You've also noticed that a little competition among groups isn't always a bad thing; it keeps everyone on their toes. Plus, each group brings slightly different qualities to the table, and they tend to complement one another. One work friend makes an amazing artichoke dip, but it's nothing without the (grain-free, of course) crackers that a friend from another group buys at a store near her home. One of your partner's friends has a family member who runs an organic winery, and the wine from there pairs beautifully with a goat cheese from another friend's farm. Any party without all of the guests and everything they contribute would feel incomplete.

So what do you do? You text invitations to all of your guests. Before RSVP-ing, most of them text you back, asking "Is so-and-so coming?" or "Can I bring a plus-one?" or "What can I bring?" Once they feel assured that other members of their group will be there, they agree to attend and confirm what goodies they'll bring.

Believe it or not, something remarkably similar is happening within your gut every minute of every hour of every day. Your gut buddies aren't just getting together to party, though. They work together, play together,

and make great efforts to maintain a state of homeostasis—stable equilibrium between interdependent elements—as long as you have a healthy microbiome that includes the right balance of different species that support and challenge one another.

Depending on the mix, they will find a way to work together either to harm or to benefit you, each taking its own unique actions that are all a part of the greater plan. Because of their interrelated functions and the ways they like to compete with one another, diversity is of the utmost importance. But each species will not act until it knows that enough of its members are there to provide backup.

How do they do all this? Well, they talk to one another, of course, using a language that scientists are just beginning to understand.

YOUR HARDWORKING GUT BUDDIES

For just a moment, let's move away from the party analogy and toward another one that I like to use for the microbiome, an ecosystem that is akin to a rain forest in its population density and diversity. In fact, it isn't much of an analogy. The gut microbiome is its own lush, dense ecosystem, teeming with different interrelated, competing, and often mutually dependent species.

Though each of our microbiomes is unique (more on this in a moment), all healthy human microbiomes share the same core patterns, at least from a functional perspective. This means that even if you and I have different species living in our guts, if we are both healthy, our microbiomes will function in very similar ways. Again, this is similar to a rain forest: all rain forests around the world share similar patterns, while each individual rain forest contains its own unique mix of species.[1]

Both rain forests and gut communities contain all kinds of characters: helpful bugs, hardworking bugs, lazy bugs, and a fair share of bad guys, too, whom I like to refer to as "thugs." In the gut, as in a rain forest, these species are interdependent. Each has its own job to do, but they rely on one another in various ways to get their jobs done. No gut bug is an island!

Many bacteria's jobs support one another, and some species cannot complete their job unless another one does its first. Imagine this as an assembly line. The second worker in line (and all the subsequent ones) can't do much of anything until they have the part from the first one. Conveniently, some species of bacteria have similar functional niches and can stand in for one another when needed. So there is more than one worker on the assembly line making the first part. This is how our microbiomes can function similarly, even if their exact makeups are

different.

We need this wide mix of characters, even the bad guys. The goal is not to have an entire microbiome filled with happy, helpful, protective bugs. You'll never get rid of the bad guys completely. The idea is to keep them in check with an overwhelming majority of good gut buddies.

You may be wondering: What is the goal? The three most important markers of a healthy microbiome are stability, diversity, and the right balance of cooperation and competition. There is also an interplay among all three of these factors, meaning that the more diverse your microbiome is, the more stable it will become.

Before we get to the three aspects of the microbiome, let's make sure we understand the various roles that gut bugs play. Most of us are aware that our gut bugs help us digest our food. That is true. But scientists are learning more every day about the complex roles they play within this process.

Your gut bugs process your food and deliver vitamins, minerals, and proteins to where they are needed in your body. But it's not as though any old gut bug can process any old type of food. Some bacteria are experts at breaking down starches. Others know how to ferment proteins. Some want to eat only one particular nutrient, such as oxalates[2] (a type of plant compound). Some may need to eat one kind of short-chain fatty acid (SCFA), such as acetate, before they can make another SCFA, such as butyrate.[3] And so on. Each of them has its own niche.

This means that if you don't have the right mix of gut buddies working for you, you won't be able to get all of the nutrients from your food, no matter what kind of diet you follow. As I like to say: *You are not what you eat. You are what your gut buddies digest.* I've known this for a while and discussed it in some of my previous books, but I've learned only recently that we need our gut buddies to process much more than just sugars, starches, proteins, and fats; they also activate some of the most important compounds in our foods, such as polyphenols.

For ages, we've been told that polyphenols are antioxidants that protect our cells from oxidative stress, which is essentially the wear and tear that ages our cells. But I've recently discovered two shocking things about polyphenols: one, they are beneficial for an entirely different reason, which I'll discuss in great detail later, and two, they cannot benefit you at all if you don't have the right mix of gut buddies to process them and make them active. Moreover, polyphenols can regulate which gut buddies are allowed to exist in the gut to begin with and/or prevent them from making harmful compounds that can wreak havoc on the linings of your

blood vessels.[4]

But the story doesn't end there. Your gut buddies also control large parts of your hormonal (endocrine) system, your nervous system, and, perhaps most important, your immune system. This means that if you don't have the right microbes, you will be faced with far greater than just GI problems. Your hormone levels will become imbalanced, you will be more likely to struggle with your mental health and suffer from depression and anxiety, and your immune system will get the wrong idea about when and where to launch an attack, leading to widespread inflammation and disease.

Paramount in all of this, part of your microbiome is in charge of "manning the gates" to your body via your gut lining. These "bouncers" decide what is allowed in and what will be kept out. If your gut buddies are working against you or you don't have enough of the right ones to do their jobs effectively, pathogens and other crap are going to end up where they shouldn't—in your bloodstream—leading to a host of problems. (Get it?)

It's no surprise, then, that working closely with my patients to restore their gut biome and gut wall leads to remarkable health transformations, healing everything from skin, bone, and joint conditions to heart disease, Alzheimer's disease and dementia, mental health issues, diabetes, cancer, and all types of autoimmune diseases. In fact, I've come to realize that many of these diseases are actually autoimmune in nature and stem directly from gut dysfunction.

The obvious question, which you're probably already asking yourself, is how exactly your gut buddies exert all of this control. By communicating with every part of your body, of course! Over the past few years, I have focused my research on learning to translate this language, and I am constantly amazed by both its brilliance and its complexity. You will be learning a good deal of this language throughout the book.

First, now that you're beginning to understand the importance of a healthy microbiome, let's take a look at its three defining factors.

THE HALLMARKS OF A HEALTHY MICROBIOME

Ecological Stability

The term *ecological stability* means that a system has the ability to return to a state of equilibrium after a disruption. This is what makes any ecosystem sustainable over time.

Unless it is faced with a major upheaval, the microbiome, like a rain forest, maintains ecological stability. Individuals generally contain their

own unique mix of bacterial species in their guts, and that combination remains consistent for long periods of time.[5] In fact, if we were to compare samples from your microbiome taken decades apart, they would be more similar to each other than a sample of yours and mine taken on the same day.

The microbiome's ecological stability is of utmost importance. Patients with stable microbiomes can recover more quickly from a perturbation, whether it's due to a nasty bug such as listeria, a course of broad-spectrum antibiotics, or something else. Though some people's guts respond differently from others, just a short course of antibiotics creates significant disturbances in the microbiome that can last for up to two years![6] The disruption becomes more severe, and it becomes more difficult to return to equilibrium, each time we are exposed to the same antibiotic.[7,8]

What happens if our gut biome cannot return to equilibrium and is therefore unstable? Remember that your gut contains a wide mix of both good and bad bugs. If your microbiome is unstable, the appearance of a few new bad guys could potentially throw off its balance. Those bad guys could reproduce rapidly and find a way to take over. If you're lucky, that will make you feel very sick. Then you know to take action. But if you don't feel the disturbance initially, the bad bugs will have ample time to create an environment that will set the course for a lifetime of chronic disease conditions.

With a stable microbiome, on the other hand, you may still get sick from a nasty bug such as listeria, but the good guys will win the day and return to a state of equilibrium much more quickly. To put it simply, a stable microbiome is far more resilient than an unstable one.[9] It makes sense, then, that a major disruption to the microbiome, creating instability, can lead to disease.[10,11]

Notably, the one time when you do not want a stable microbiome is as an infant. In fact, the infant microbiome is considered to be volatile because it changes so quickly until it stabilizes after about three years of age. Pardon the brief "thread drift" here, but this is important. Contrary to what we believed only a few years ago, during pregnancy, the mother's oral, gut, and vaginal microbiomes affect the health of the fetus in significant ways. The placenta even contains bacteria! These maternal microbiomes all naturally become even more stable than usual during a healthy pregnancy to support the fetus's growth.

During a vaginal birth, the infant interacts with the maternal microbiome even more, and its gut is seeded with these bacteria, which form the foundation of their own microbiomes. Yet after birth, during the

first two to three years of life, the infant's microbiome changes rapidly to establish a complex community of gut bugs. This happens through a process similar to ecological succession, the way the mix of species in a habitat changes over time.[12] This involves various communities naturally replacing one another, with each community creating the conditions that allow the next one to thrive.

Back to the forest for a moment: If a large field in the right climate is left alone for many years (which would be unlikely today, unfortunately), it will first become a meadow. The grass will add nutrients to the soil, allowing bushes to grow, followed by trees, which will eventually form a forest. Eventually, this succession will stop, and the system is stable.

The same thing happens in the infant's gut. The early "pioneer" species from the mother undergo a systematic series of turnovers, with each community setting the stage for the next one to thrive. Finally, a complex, stable community is formed. This transformation happens in order to develop and mature the infant's immune system. That's right; during early development and into adulthood, the gut bacteria shape the tissues, cells, and molecular profile of our gastrointestinal and whole-body immune systems.[13]

The infant microbiome also changes to effectively process the infant's changing dietary needs, from breast milk or formula to solid foods. At around the age of two or three, the immune system has been shaped and the toddler begins eating a wider variety of solid foods. The microbiome becomes increasingly rich, diverse, and stable[14] and hopefully stays that way through adulthood.

This long-term stability does not happen by chance. It takes effort on the part of your gut buddies. They work hard to maintain equilibrium and even harder to restore it after it has been disturbed. They do this through feedback loops. Let's say, for example, that one type of bacterium starts to reproduce beyond a certain threshold. This poses a threat to the microbiome's stability, whether the reproducing bacteria are good guys or bad guys.

Luckily, there's a backup plan for that. All bacteria produce metabolites, which are substances created as a result of digestion. These metabolites are used as signaling molecules, and they are more important than anyone previously imagined. In this case, the signal goes out that there are too many of these particular guys around, which triggers changes to the gut environment that make it more difficult for those specific bacteria to grow.[15] This quickly restores balance. Pretty impressive, isn't it?

To take this a step further, many of the bacteria in your gut exist specifically for the purpose of maintaining stability. These "keystone species," as they are called, do not interact with you, their host, at all; they simply work to keep things happy and stable in the gut.[16] You can think of these as being akin to the people you might have stationed outside your big party, checking to make sure that everyone who arrives is in fact on the guest list. Those people don't even attend the party, yet they have a large influence over what happens inside.

The immune system also works to maintain the stability of the microbiome, which is fascinating when you think about it, considering that it's the microbiome that develops the stability of the immune system in the first place. These two systems continue their tight-knit, multidirectional relationship throughout your lifetime, and it is this relationship that determines pretty much every aspect of your health. When the microbiome is disturbed, bacteria signal the immune system to attack, and the immune system works to suppress the bacteria that are overgrowing and causing instability.[17] Once again, equilibrium is restored.

Perhaps most important, diversity, another hallmark of a healthy microbiome, also increases its stability.

Diversity Matters

When it comes to the gut, diversity means that you have a high number of different species that are evenly spread across your microbiome. This is key to a healthy, resilient, stable gut. A diverse gut biome is directly linked to good health and longevity,[18] and low diversity is associated with acute diarrheal disease,[19] inflammatory bowel disease (IBD),[20] liver disease,[21] and cancer.[22]

Research shows that, among other factors, people who are obese have lower gut diversity than lean people do.[23] Low-diversity microbiomes that are associated with disease tend to resemble the volatile microbiomes of infants. In other words, a sick adult has a microbiome similar to that of a healthy baby! This can be explained by another phenomenon seen in the forest—this time in the case of a forest fire. In a forest or the gut, when a disturbance kills off the complex community that creates diversity, the bugs from the early pioneer species discussed previously are more resilient and are able to survive the disturbance.[24,25] This is called secondary succession. It leads the gut to revert to its immature, less diverse state.

Think back to what you read a few minutes ago about the infant microbiome. It starts with pioneer species and then goes through the