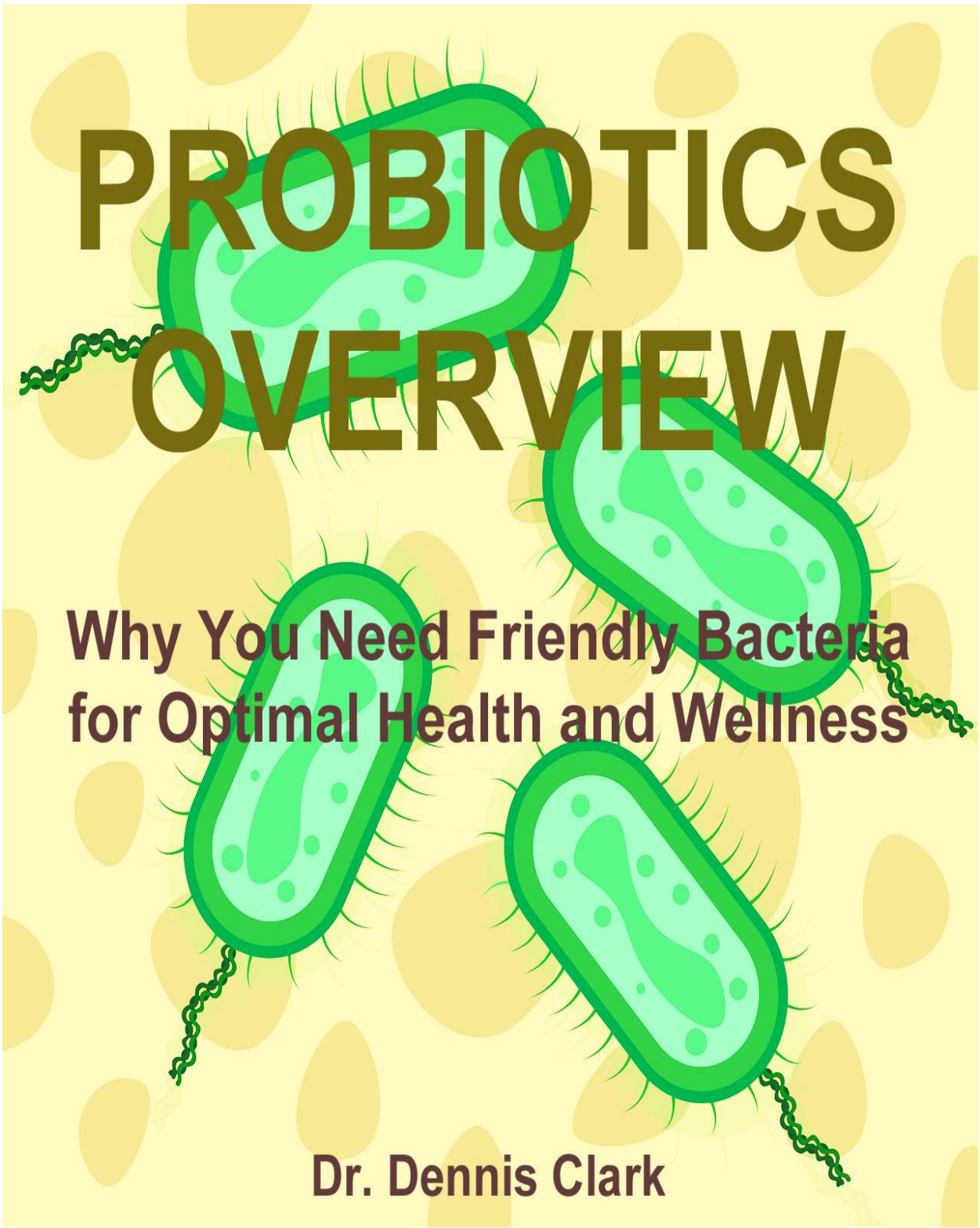

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DISCLAIMER

The purpose of this book is to provide you with knowledge about probiotics and what they can do for your health. The information herein is based on extensive scientific research. However, the book is not intended as a substitute for professional medical advice. No book can possibly replace the services of a health care practitioner who knows you personally. The author and publisher expressly disclaim responsibility for any adverse effects that may result from the use or application of the information presented here. If your health care provider is unaware of what probiotics can do for you, this book will help you educate her or him about their benefits.

TABLE OF CONTENTS

PREFACE: WHY READ THIS BOOK?

The overriding goal of this book is to provide you with what you need to know about the value of microbes to your health and longevity. The knowledge that you gain here is meant to be a guide for making well-informed decisions about your well-being.

As you will see, your life literally depends on friendly microbes, specifically those that live in your digestive system. Your mission is to take care of them so they will take care of you. This book provides what you need to know for accomplishing that mission.

Unfortunately, many aspects of modern living harm your gut microbes, much to the detriment what should be your long and healthy lifespan. The good news is that you can take control of your health by restoring and maintaining the balance of beneficial gut microbes that you need for healthy living.

The central theme herein encompasses the increasing importance of what science now refers to as your **microbiome** – that is, the community of microorganisms that live inside you. Keeping it – and you – healthy relies on many factors. One of the most important of such factors throughout human history has been the consumption of **probiotics**. That term literally means “for” (*pro*) “life” (*bios*).

More specifically, probiotics are defined by the Food and Agricultural Organization of the United Nations and the World Health Organization (FAO/WHO 2006) as follows:

Live microorganisms which when administered in adequate amounts confer a health benefit on the host.

In other words, probiotics are living microbes that you ingest for your health. Knowing about probiotics, however, is just the beginning. Getting optimal benefits from them also depends on taking good care of your own internal microorganisms.

Since so many modern lifestyle choices can harm your gut microbes, you must know what those choices are so you can make better decisions

for your health. This book points out the most common sources of damage and how to reverse it.

Countless modern diseases are either caused by or made worse by a faulty microbial population somewhere in your GI tract. You will also learn what those diseases are and how they can be treated.

In addition you will discover how microbes in your gut influence the health of your entire body, top to bottom. They impact much more than just your digestive system.

Scientific research on probiotics has accelerated at a tremendous pace over the past couple of decades. You will learn about research that explains how you can get the greatest value from them.

More than likely, you or a friend or a family member suffers from a medical condition for which conventional therapies have failed. Prescription and over-the-counter drugs treat symptoms. They do not promote true healing.

Too many people are caught in a downward spiral of chronic, nagging diseases that only seem to get worse. Most are unaware of how the microbiome underlies an amazingly broad array of them.

This book also provides you with a tool to educate your own doctor about probiotics. Medical schools focus on the roles of microbes in infectious disease. They do not teach our future doctors about the friendly microbes that we depend on for good health. Furthermore, once in practice their continuing education rests largely on pharmaceutical sales representatives and promotional information that touts the use of patented drugs.

Research in the medical literature on the microbiome clearly explains its benefits and the value of probiotics for keeping it healthy.

Before you read on and find out for yourself what your microbiome does for you and how you can reap the benefits from it, let me tell you how a personal medical disaster led me to discover the importance of gut microbes and the role of probiotics to my own health.

My Probiotic Experience

As a young university professor, I did not fully appreciate the value of a healthy microbiome for my own health until I was faced with the consequences of a chronic medical condition for which modern medicine had no cure. Because of my experience, I want you to know how I learned about probiotics and what brought me to write this book. It is a story of how my own health challenge became an opportunity for me to discover one of the greatest health secrets of all time, and how you can benefit from my scientific research, experience, and knowledge about it.

Development of a Health Disaster

It all began for me with a series of disastrous developments involving 20 years of digestive difficulties that continued to worsen over time. Those two decades saw the failure of one doctor after another to diagnose my condition correctly. Finally, after years of ineffective treatments, I was given a fancy name for my condition – ulcerative colitis. I was also informed that modern medicine had no cure for it.

Oh, sure, my doctors had prescriptions drugs to reduce the symptoms. The main drug of choice, called Azulfidine, was first approved for use in the U.S. in 1950. It provides a small anti-inflammatory effect against bowel inflammation.

A second option was prednisone, which is a dangerous corticosteroid that causes a boatload of side effects. It has been in use in the U.S. since 1955.

That was it. Nothing new since the 1950s!

As with all drugs, benefits must be weighed against side effects. Azulfidine was the choice for me. Although it offered minor relief, it also came with fewer side effects.

Unfortunately, it was such a mild treatment that it barely slowed down my raging ulcerative colitis. At one point, my internal bleeding became so excessive that I almost died from anemia.

Looking back on that experience, I am very disappointed to note that

the limited options that I had so long ago have not been replaced by better ones. At least not by mainstream medicine, anyway.

In hindsight, it is no surprise that my condition worsened over the years. It finally reached the point where my doctor decided that my colon was precancerous and had to be removed. Although I know better now, I submitted to this strategy out of fear of the consequences of not having the surgery and of ignorance about any possible alternatives.

So, without further consideration by me, my colon was removed at the end of 1990. Now I have an internal pouch, called a J-pouch, that was constructed from the end of my small intestine. It is a better-than-nothing replacement for my colon. And, much to my relief, I do not have to wear an external ostomy bag.

At first I saw my experience as a personal health disaster. There I was, without a colon, facing a future of unknown medical challenges. Then I switched gears and began to see my situation as an opportunity to look outside mainstream medicine for ways to help me with my new health challenges. This is when I first learned about probiotics. What a godsend they have been for me.

Along the way, I also found research about the role of the microbiome for colon health, even in the face of ulcerative colitis. I have no doubt that, had my doctors told me about probiotics earlier, I would have a health, fully functional colon.

It is now my pleasure to point the way for others who seek to treatments to heal themselves in spite of debilitating gut inflammation.

Discovering Probiotics

One of the shortcomings of having a J- pouch is an inflammatory condition that modern medicine creatively calls “pouchitis.” It is a miserable problem that causes pain, bloody diarrhea, cramping, fever, and frequent visits to the bathroom (I’m talking, every 10 minutes!). Pouchitis is due to overgrowth of a normal inhabitant of the colon, *Clostridium difficile* (“C-diff”).

What I discovered about C-diff infections is that they are not unique to

a J-pouch. In fact, they have become a major scourge in hospitals and other medical facilities. Everyone is susceptible, colon or not.

The conventional treatment for C-diff infections is a particular antibiotic called metronidazole, which targets several types of infectious microbes in the colon. Its listed side effects include a metallic taste (it is a lot worse than that), nausea, and diarrhea. Furthermore, the International Agency for Research on Cancer lists it as a cancer-causing drug.

On the other hand, certain types of probiotics actively suppress C-diff growth and rebalance the colon microbiome to keep it in check. As I will explain later, studies show that prevention and treatment of C-diff infections with probiotics is a much healthier choice than metronidazole for immediate and long-term colon health.

The Bonus for You

As I dug deeper into the scientific research on the microbiome and probiotics, I learned that chronic gut problems of all kinds often respond well to probiotic supplements. I realize now that I could have slowed and maybe even stopped the degeneration of my colon and brought it back into a more functional, healthy state with the addition of probiotics to my diet when my symptoms first appeared. The bonus for you, therefore, is to benefit from my personal experience and my scientific expertise to learn what you can do to avoid a medical fate such as mine.

As a result of my research, I now know that the power of probiotics extends well beyond ulcerative colitis. Probiotics help to restore and maintain microbiome balance throughout the GI tract. In turn, the microbiome influences nearly every aspect of human health – brain and nervous systems, immune system, endocrine systems, and much, more.

Finding out about the microbiome and about probiotics opened up a whole new world for me. Now I want to open it up for you.

Regardless of whether you suffer from ulcerative colitis like I did, or from any of hundreds of other health disorders, you will enjoy better health when you have friendly gut bacteria working for you.

INTRODUCTION

Microbes have a deservedly scary reputation. After all, some of them cause infectious diseases. However, germs make up a tiny minority of all known microorganisms. Published estimates point to fewer than 1% that have roles in human disease (Nature 2011).

In contrast, most microbes are not only harmless, they are beneficial. Indeed, we rely on them for nearly all aspects of our health.

Microbes have always played multiple roles in human health. People consumed them in fermented foods long before anyone even knew about their existence.

The development of synthetic antibiotics, starting in the late 1880s, signified a rise in the war on germs (Aminov 2010). Although antibiotics have saved untold numbers of lives, they also came with a new kind of health baggage. They killed
good and bad bacteria alike. Antibiotics became the number one enemy of the friendly microbes that we need for basic health.

What started out as a revolutionary war on infectious diseases has gone way too far. Hints of such realization within the scientific community slowly began to appear in the research literature by the 1950s. Those few early studies have now morphed into an avalanche of information about the importance of our gut microbes and how to better care for them.

That's not all. Starting in the 20th century, countless other advancements in modern living also began to damage our internal microbes. Antibiotics were just the beginning.

Fast forward to the present. We now suffer from an epidemic of diseases that are caused by or made worse by such damage.

The end result is clear. In modern times microbial imbalance underlies a rapidly growing list of health issues. They include everything from digestive problems to heart disease, immune system dysfunction, hormone imbalance, allergies, asthma, chronic fatigue, obesity, and much

more. The most recent research even reveals how poor microbial health in the GI tract adversely affects brain function.

That's right – gut microbes play a role in our mental health, too.

Your best bet to defend yourself against the onslaught of diseases that start in your gut is to find out how important your internal microbes are, what you do to harm them, and what you can do to restore them to a healthful balance in your GI tract.

Chapter 1 introduces you to the friendly microbes in your gut and what they are doing there. You will find out more about the normal microbial populations that differ among different locations. Chapter 2 gives you an overview of normal microbial diversity starting in your mouth and continuing through your throat, stomach, and small and large intestines.

Modern lifestyles are fraught with dozens of choices that can damage gut microbes. Although the list is extensive, you will see a list in Chapter 3 that points out those choices that do the most harm. The good news is that most of them are under your control, so you can change them yourself.

Some changes will be more difficult the others, maybe even impossible. This is where probiotics step in to help you restore and maintain a healthy balance among different microbial populations in your GI tract. Chapter 4 provides an extensive overview of what you can expect for your health when you consume probiotics. You may notice that most of the scientific research cited in that chapter is very recent. Probiotics have grown into an ultra-hot topic in health research, much to everyone's benefit.

Although Chapter 4 explains a long list of health benefits in the face of many health issues, Chapter 5 tells you about the three most important aspects of your health where probiotics have the greatest impact. These are a compromised immune system, a leaky gut, and poor mental health. The biggest surprise of the three is the third one, the role that microbes play in mental health.

Finally, Chapter 6 provides some important guidelines for choosing the right probiotic supplement for your needs. Not all products are created equally. You will learn some of the highlights of what to look for in choosing a product that gives you the best chance for improving your health

Chapter 1. FRIENDLY MICROBES IN YOUR GUT

You are made up of trillions of cells. You may be surprised to know that they are not all ‘you’. Yet your life depends on those ‘not you’ cells as much as on your own.

A good question would be, if they are not your cells, then what can they be? As it turns out, the reality is that most of the cells in your body are microbes. The majority of them live in your GI tract. All told, your digestive system hosts about 40 trillion microbial cells. Compare that number with the estimated 30 trillion cells that make up your own flesh and blood (Sender et al. 2016).

A. What Are They?

Your microbiome – also collectively referred to as your microbiota or microflora – includes at 1,000 different kinds of organisms, probably more (Rajilić-Stojanović et al. 2007). Their diversity comprises a wide variety of groups: bacteria, archaea (formerly classified as bacteria), yeasts and other fungi, and viruses. As gross as it may seem, your gut even houses a smattering of microscopic helminths (worms) and protozoans (one-celled animals). Typically the total weight of the microbiome adds up to about 4-5 pounds per person.

Be clear, though, that not all of the organisms in your microbiome are friendly. You are host to bad bacteria as well as good ones. A healthy microbiome depends on the good ones outnumbering and outworking the bad ones.

In addition, the wide diversity of microbes in the human gut represents at least 150 times more genes than your own (Zhu et al. 2010). This means that you are host to a minimum of 3.3 million genes that are constantly guiding all microbial activities inside you. The number may even be as high as nine million (Yang et al. 2009)! Whatever the number actually is, millions of microbial genes complement the 20,000 or so genes in your own genome. The ‘foreign’ set if genes in your microbiome effectively acts as your second genome.

Scientific interest in the human microbiome has skyrocketed over the past few years. Most recently, research to determine which organisms live in our gut expanded into a massive, 5-year project (2008-2012) sponsored by the U.S. National Institutes of Health. It is called the Integrative Human Microbiome Project (iHMP 2014). The iHMP is still ongoing. One of its most important aims is to establish which microbes characterize not only a healthy microbiome but also which ones represent a dysfunctional one.

One of the main findings of this project confirms earlier, simpler surveys that discovered the human microbiome to consist mostly of bacteria.

B. What Are They Doing Inside You?

What all this means is that your GI tract is a complicated microbial ecosystem. Like any other ecosystem, it works best when the populations of all of its 'players' (i.e., microbial species) interact in balance with one another. You are simply the host of this ecosystem.

The interdependence between you and your microbiota is so tight that, together, you and your microbiome are essentially a superorganism (Kutschera 2018).

Your internal microbes live throughout your digestive system, from your mouth all the way to the end of your large intestine. Although some are friendlier than others, all of them play roles in your overall health. Their optimal function – and your health – relies on how they interact with one another and with your own cells.

What are they all doing inside you? Discovering answers to that question is at the heart of research that began with a trickle of reports in the 1950s, with only three journal articles. Indeed, that's the era when the German bacteriologist, Werner Kollath, first coined the term, "probiotics" (Kollath 1953).

The appearance of further research on the topic began to accelerate shortly after those humble beginnings. Most recently, over just the past couple of decades, we have seen a tsunami of studies published in scientific journals. Currently a literature search on just one relevant term

("probiotics") at the National Institutes of Health online medical database (PubMed) yields a list of nearly 20,000 publications.

Science is continually gaining a clearer picture of what our microbiome does. The gist of this body of research is that we rely on it for nearly all aspects of our health. In return our microbiome depends on how well we take care of it.

That is the sunny side of the story. There is also a dark side.

Modern lifestyle choices often damage the delicate balance among microbes that influence your health. An out-of-balance microbial ecosystem in your gut is the foundation for dozens of health problems that pervade current society. This book explains the most common choices that you make to harm your gut ecology and what the consequences of those actions are to your health.

The good news is that you can restore and repair your gut's microbial health. The key is to reinvigorate microbial balance. Doing so can be a simple two-part process: 1) stop harming your gut microflora; and, 2) replenish them with probiotics.

There can be no doubt whatsoever - *your life depends on your microbiome*.

C. A Lifelong Balancing Act

The microbiome begins at birth. Passage through the birth canal normally bathes newborns in a host of friendly bacteria. The make-up of microbes at birth reflects the mother's microbiome. When hers is healthy, then so is that of the newborn. The balancing act among gut microbes sets the tone for a new baby's health, starting on Day 1.

If the maternal microbiome is damaged in some way, the growing infant must do some catching up to get the newly acquired microbial ecosystem back on track. Microbes in breast milk, and their various metabolic products, can do exactly that.

The most deficient microbiomes among newborns occur as a result of births by Caesarian section. The new baby simply gets no exposure to the

mother's microbes at birth. This situation is made worse by the use of antibiotics that are commonly administered in invasive surgery.

Breast feeding can still make up for some of the deficiencies. After all, mother's milk is the best source of probiotics for newborns. This is not the case, however, for babies raised on commercial infant formulas. Infant formulas are an extremely poor substitute for real mother's milk in many ways. Even when probiotics are added to baby formulas, they fall short of mimicking what mothers can provide.

Just imagine what a double-whammy downer it is for babies who are born by C-section and then fed only infant formula during the most critical stages of their early microbiome development. It should be no surprise that babies born by C-section and babies raised on infant formula, or both, suffer more health problems in early life. [ref.]: more infections, more allergies, weaker immunity, and chronic diarrhea or other digestive issues.

A massive amount of research is now directed at infant and early life microbial health. It comprises a sufficiently large body of work for a book on its own. I will therefore set that topic aside for now to focus on the care and feeding of the adult microbiome.

D. The Microbiome is Dynamic

The first stages of an adult-like microbiome begin to appear in children by around 2-3 years old (Rodriguez, J.M. et al. (2015. Thereafter its make-up normally remains stable for decades if it remains healthy. That's a big 'IF' since microbial balance can change in response to various factors.

Exploring those factors is the topic of Chapter XX. That is where you will see what it is that you do to harm your microbiome. Information in that chapter set the stage for how you can best treat your gut microbes better.

Before digging into sources of harm, let's first take a look into the main features of a healthy digestive tract and how it works hand in hand with your internal microbes.

Chapter 2. WHAT IS A NORMAL MICROBIOME?

Science has had a challenge defining what ‘normal’ means for a healthy microbiome. Nevertheless, such knowledge is pivotal for understanding what is abnormal. Comparisons between normal and abnormal are the starting point for determining treatment strategies for microbiome-dependent diseases.

Part of the issue is that the microbiome naturally varies depending on many factors.

A. Location, Location, Location

Composition of the microbiome changes radically with its location in the digestive system. This is no surprise, since the GI tract constitutes the largest surface area that exposes the inside of the body to the outside. Estimates are that the total area reaches about 300-400 m^2, or about the size of two tennis courts.

In addition to its large surface area, the GI tract also offers several different types of habitats where different microbes can grow and thrive. The mouth is at the top. The anus is at the other end. In between we have the mouth and throat, the stomach, the small intestines, and the large intestines (colon).

B. Mouth

The most recent surveys of the oral microbiome reveal more than 700 unique types of microbes (Verma et al. 2018). They live in several different habitats, including teeth, gaps between the teeth and gums, tongue, cheeks, hard and soft palates, and tonsils.

This mini-ecosystem sets the stage not only for oral health but also for the overall health of your entire body. Some of its key roles include protection against tooth decay, gum disease, and bad breath. Protection against oral disease is just the beginning.

Oral pathogens are clearly linked to several systemic diseases (Dhadse et al. 2010). They include some of the biggest health challenges

known to modern medicine: cardiovascular disease, stroke, inflammatory bowel disease, rheumatoid arthritis, pneumonia, and diabetes.

A normal, healthy oral microbiome is a crucial part of your health arsenal for guarding against all of them.

Your oral cavity is also the first line of defense against exposure to external pathogenic microbes. Every time you eat or drink, you swallow thousands of microbes. Some will be bad and others will be good. Oral microbes act as the gatekeeper for controlling pathogenic organisms that you swallow when you eat or drink. Friendly oral bacteria actually secrete substances that keep the growth of bad microbes in check.

One of the most exciting recent discoveries about the role of the oral microbiome is its influence on blood pressure (Bryan et al. 2017). Hypertension has become a nagging problem that is hard to fix. It raises the risk for heart disease and stroke. Yet even aggressive medical treatments are only partially successful.

Certain oral bacteria, however, help regulate blood pressure naturally. They do so by converting specific nitrogen-containing ions in foods into nitric oxide (NO). The role of this small gas molecule in cardiovascular health was the subject of a Nobel Prize in 1998. Now, two nearly decades later, its production by the oral microbiome in the management of hypertension offers a completely new concept in cardiovascular medicine (Kapil 2013.).

C. Throat

The throat microbiome is least understood among different parts of the digestive system. We do know, though, that it is the go-between that links microbiomes of the oral cavity and the stomach. That’s not all, since the throat also sits at the juncture connecting the nasal passage and the lungs. As such, it is part of both the digestive system and the respiratory system. Microbes in the throat link digestive health with respiratory health.

Most research on the make-up of a healthy throat microbiome focuses on its role in fighting chronic respiratory diseases – e.g., pneumonia, colds and flu, COPD, and cystic fibrosis. Specifically, a high diversity of microbes in the throat is the key to reducing susceptibility to all

types of respiratory tract infections (RTIs) (Gao et al. 2014). Loss of microbial diversity signifies a weakened resistance to RTIs.

Microbes that coat the throat (and nasal passages) are essential for protecting airway linings from air-transmitted pathogens. Again, a balance among a variety of microorganisms is the key. Interestingly, this balance becomes disrupted seasonally, which corresponds to what we know as ‘flu seasons’ or ‘a winter colds’.

D. Stomach

The environment in the stomach was originally believed to be too inhospitable to be colonized by bacteria. With its pH anywhere from 1.5 to 3.5, it was thought to be too acidic. The thickness of its mucus layer was too thick. Peristalsis – the wavelike movements of muscles that push food along – was surely too powerful for bacterial cells to attach to the stomach wall.

Such dogma was finally blown away with the 1982 discovery that the bacterium now known as *Helicobacter pylori* (*H. pylori*) resides in the stomach (Goodwin et al. 1986). This species has the ability to neutralize stomach acid, penetrate the stomach’s otherwise protective mucosal layer, and colonize the stomach lining. The result is a complex inflammatory response that underlies gastritis and peptic ulcers. The discovery of *H. pylori* and its role in disease was so significant that the scientists behind it were awarded the Nobel Prize more than a decade later (Marshall and Adams 2008).

The hunt was on for additional microbes living in the stomach. We now know that, between meals, up to 10,000 microbial cells per milliliter live there. That number grows to more than 100,000 right after a meal. Then number drops to near zero as gastric acidity climbs during digestion. The cycle continues as friendly bacteria slowly reestablish themselves between meals.

The variety of species reflects their two main sources. One source is microbes that wash down from the mouth. Many types of foods also provide additional bacteria, particularly fermented foods.

Both sources are essential for keeping *H. pylori* in check. This is one example, among many others, of friendly inhibiting the growth of a pathogenic organism. In this case, it explains why most people do not suffer from gastritis or peptic ulcers, even though at least half of the world's population is infected with *H. pylori* (Brown 2000).

Wildly fluctuating microbial populations in the stomach are the norm. As you might predict, the health of the stomach microbiome relies completely on a continuous flow of microbes from the mouth, from different foods, and from probiotics.

E. Small Intestines

Bacteria that survive in the stomach continue their journey into the small intestines. They immediately encounter a radically different environment from the stomach. The acidity quickly reverses, rising to a pH between 6.0 and 7.4. Digestive juices flow in from the pancreas, liver, and gall bladder. Such conditions suppress the number of microbes in the early segments of the small intestine. They range from an initially undetectable amount, up to about 10,000 cells per milliliter (Angelakis et al. 2015).

The small bowel is responsible for most of your body's nutritional uptake and your immunity toward infectious microbes. Unfortunately, science has not fully characterized the microbiota in the region of the GI tract because of the difficulty in sampling it.

Nevertheless, we do know that by the time digestive juices reach the end of the small intestines, its microbiome is distinct from that of the stomach. We also know that the diversity and abundance of microbes in the small intestines both peak out just before the transition to the large intestines.

F. Large Intestines (Colon)

The environment of the GI tract changes once again, going from the small to the large intestines. The pH range (5.5-7.0) is comparatively similar to that of the small intestine. However, the walls of the colon are smoother and covered with a thicker mucous layer. The colon also does not possess digestive enzymes or hormones that characterize the small

intestines. The main roles of the colon are to absorb water, electrolytes, and digested nutrients the small bowel.

Colon bacteria also synthesize several vitamins: biotin, vitamin B_{12}, folic acid, thiamin, and vitamin K (Gorsach 1996).

The colon contains the largest microbial ecosystem in the body (Hollister et al. 2014). It houses the greatest microbial diversity – perhaps half of the total species in the GI tract overall. Cell numbers can be as low as 100 billion per gram of dry feces, up to more than 10 trillion. The most striking feature of the colon microbiome is that 99% of it consists of anaerobic organisms – those that can grow only in the absence of oxygen.

The two most important factors for regulating the colon microbiome are the amount and the variety of nutrients available to it. In other words, it is heavily influenced by diet. You must consume foods that nourish the colon microbiome for it to stay healthy. You will see later in the book what kinds of nutrients the colon microbiome needs.

G. Normal, Yet Potentially Dangerous

The GI tract normally houses a number of pathogenic microbes. One example is *H. pylori*. Others include types of bacteria that can go into suspended animation by forming tough endospores. Endospores can weather whatever environmental challenge there might be by forming a tough coat and by almost complete stoppage of metabolism.

Endospores can survive against dehydration, nutrient deprivation, and extreme heat. Killing endospores outside the body requires a combination of high heat and high pressure. This is the required strategy, for example, that kills botulinum bacteria (*Clostridium botulinum*) when canning fruits and vegetables.

One of the most troublesome types of endospore-forming bacteria that commonly inhabit the colon include a relative of *C. botulinum*. It is *Clostridium difficile*, or C-diff. Of course, eliminating C-diff by applying high heat and high pressure to the colon is not safe. However, C-diff can remain a harmless member of the normal microbiome as long as your friendly gut microbes are plentiful enough to fight against it.

H. First, Do No Harm

The above brief overview gives you a better perspective on what makes up a normal microbiome. As previously mentioned, maintaining microbial health in your gut requires that you learn about and eliminate whatever it is that harms them.

The list of factors that can damage your microbiome is extensive. It includes dozens of aspects of modern living. As you will see in the next chapter, you control many of them yourself.

Chapter 3. HARMING YOUR MICROBIOME

You may be surprised at the diversity of seemingly unrelated health issues that are linked to a damaged microbiome. Science continues to discover new links every year, so a comprehensive list would constantly change. Nevertheless, just focusing on the main ones will give you a much better idea about how microbes affect your health.

Arming yourself with this knowledge will help you make better decisions about your health.

A. When Things Go Wrong

Let's start with a quick summary of the key health problems that are associated with poor microbial health. The term that science coined for denoting a damaged microbiome, way back in the 1950s, is **dysbiosis**. A quick search at PubMed using that term yields a list of nearly 4,500 research articles on the topic between 1959 and the present.

The following list comprises the main health conditions that are associated with dysbiosis. This list of microbiome-related health issues has been culled from scientific reviews published over just the past decade (Dukowicz et al. 2007; Leclercq et al. 2016; Thursby and Juge 2017; Wang et al. 2017; Zhang et al. 2018).

- Acne
- Alcoholic liver disease
- Alzheimer's disease
- Antibiotic-associated diarrhea
- Asthma/allergies
- Autism
- Autoimmune diseases
- Cancer
- Candidiasis (yeast overgrowth)
- Cardiovascular diseases
- Cirrhosis
- Dementia
- Dental cavities
- Depression and anxiety
- Diabetes
- Digestive disorders
- Eczema
- Gastric ulcers
- Hardening of the arteries
- Hormone imbalance
- Inflammatory bowel diseases
- Leaky gut syndrome
- ADHD

- Malnutrition
- Metabolic syndrome
- Non-alcoholic fatty liver disease
- Obesity
- Osteoporosis
- Parkinson's disease
- PTSD
- Respiratory infections (colds, flu, pneumonia)
- SIBO (small intestinal bacterial overgrowth)

The list above reveals the phenomenal breadth of impact the microbiome has over your entire body. Although it resides in the gut, its influence includes much, much more than the digestive system. It strongly influences metabolism, the endocrine system, and the immune system. Most recently it has been discovered to function as a second brain, which influences both the peripheral and central nervous systems, including your main brain.

Dozens of factors are known to alter the microbiome. Just knowing the most important ones should give you a good idea for what you can do to reduce your exposure to them. The following are at the top of the list.

B. Diet

Your microbiome changes every time you eat. Populations of various microbes fluctuate normally during and after a meal. However, depending on what you eat, your food may be ruining your microbiome.

The most recent scientific reviews of dietary factors that influence the microbiome highlight the main dangers of a Western Diet or Standard American Diet (Sonnenburg and Bäckhed 2016; Zinöcker and Lindseth 2018). Research reveals two primary themes about how diet can harm your microbiome: 1) in general, damage is characterized by a loss of diversity – i.e., fewer microbial species; and, 2) the main dietary culprits consist of processed foods.

What is it about processed foods that causes harm to friendly bacteria? The one thing that they share is that they all promote gut inflammation, which directly alters the microbiome. The main offenders are foods that contain the following:

1. Refined Sugars and Other Processed Carbohydrates

These foods comprise probably the top dietary culprit leading to chronic gut inflammation (Manning et al. 2008).

Glucose is the simple blood sugar that we normally depend on for cellular energy. However, it is widely used as an absorption enhancer in processed foods. Overconsumption causes the gut to literally spring leaks that lead to body-wide inflammation.

Crohn's disease patients have a higher dietary intake of refined sugars and carbohydrates that accelerate inflammation of the colon.

Excess added sugars also bind to proteins, forming what science calls advanced glycation end-products (AGEs). AGEs are highly inflammatory complexes that also cause gut leakiness. What's more, they can be a significant factor in the development of many degenerative diseases, such as diabetes, atherosclerosis, chronic kidney disease, and Alzheimer's disease (Rapin and Wiernsperger 2010).

Although gluten is a protein, it accompanies all foods that contain processed carbohydrates from wheat, barley, and rye. It is infamous for overstimulating gut microbes that underlie celiac disease and other autoimmune diseases. It also leads to a long list of other health disorders, including non-celiac gluten sensitivity, nutritional deficiencies, impaired bone health, reproductive abnormalities, and even neurologic and neuropsychiatric disorders (Bathrellou et al. 2018).

Wheat gluten has become such a health challenge in modern times that medical doctors have published two recent New York Times bestsellers addressing it. The first to appear describes a whole-body phenomenon that starts with gut inflammation (Davis 2011). The second book expands on the disastrous effects of gluten on brain health (Perlmutter 2013).

2. Refined Vegetable Oils

Refined oils from canola, corn, and soybean contain high levels of omega-6 fatty acids. We do need these fatty acids for normal metabolism. However, we are healthiest with a ratio of omega-6 to omega-3 fatty acids

of between 1:1 and 2:1. Overuse of refined vegetable oils in a typical Western Diet drives up the ratio to over 15:1.

Excessive levels of omega-6 fatty acids over omega-3s promote many modern diseases. The worst ones include cardiovascular disease, cancer, and multiple autoimmune diseases (Simopoulos 2002).

Most recently, researchers have begun to establish the role of omega-3 fatty acid levels for good mental health, even in the face of Alzheimer's disease (Amen et al. 2017; (Zamroziewicz et al. 2017). As you will see later, the link between gut microbiota and the brain has been attracting much more interest than it had just a few years ago.

3. Conventional Meats, Poultry, and Eggs

Conventional meats, poultry and eggs also contain excessive levels of omega-6 fatty acids. The source is animal feeds. Domestic animals are commonly raised on corn and soy or other cheap ingredients that alter the composition of foods that are derived from them. When you eat meat, you eat what the animals were raised on.

4. Dairy Products

Modern dairy is highly inflammatory for two main reasons. The first is that it comes from pasteurized milk. Pasteurization destroys many of the nutritional components that characterize fresh milk. One common result is dairy allergies

The other reason is less well known known by the public. It turns out that one form of the main milk protein, casein, can be highly inflammatory. Specifically, inflammatory casein is a type known as A1 beta-casein. Its effects contrast with the non-inflammatory form, A2 beta-casein (Ho et al. 2014; Jianqin et al. 2016).

A1 beta-casein is the most common type found in cow's milk in the United States, Europe (excluding France), Australia, and New Zealand. It comes from Holstein cows, which make up more than 90% of the cows on U.S. dairy farms (Holstein Association USA).

A2 milk is commercially available as an import from New Zealand. In addition, the caseins from human, goat, sheep, and buffalo are non-inflammatory “A2-like” forms.

5. Hydrogenated Fats

Synthetic trans-fats, which are made by hydrogenation (adding hydrogens) to natural oils, have been known for years for their role in cardiovascular and gastrointestinal diseases. More recently, the link between such diseases and trans-fats has been discovered to depend on gut microbes. Damage to friendly bacteria by trans-fats is associated with obesity, metabolic syndrome, and GI tract disease (Zhang and Yang 2016).

6. Additives and Adulterants

The number of chemicals added to processed foods is a never ending story. The total reaches upward of tens of thousands of ingredients. Most of the worst ones can be categorized into a few groups that you can watch for on package labels (Lerner and Matthias 2015). They all share a common feature – that is, they lead to a **leaky gut** that disrupts how you interact with your microbiome.

At the top of the list are refined sugars, processed carbohydrates, and gluten, which I have already explained above. The other top offenders include the following:

a. Artificial Sweeteners. Saccharine (Sweet’N Low), aspartame (NutraSweet), and sucralose (Splenda) head the list of the most pervasively used artificial sweeteners. Their use is associated with obesity and metabolic syndrome. However, only recently has science discovered their role in damaging the microbiome (Bian et al. 2017a,b; Chi et al. 2018; Suez et al. 2015).

Even at ultra-low doses, artificial sweeteners are toxic to friendly bacteria. Such harm explains how these synthetic chemicals can have an incredibly wide variety of negative influences on human health. Everything that depends on healthy gut microbes can suffer: digestive health, mental health, and all aspects of the immune, nervous, and endocrine systems.

b. Salt. Consuming processed foods containing high amounts of salt also inflame the gut to become leaky. In addition, excess sodium initiates an interaction with glucose that makes gut leakage and subsequent inflammation even worse.

Although salt is more widely known as a potential danger for blood pressure and cardiovascular health, it is equally problematic for its impact on the gut-based immune system. Salt-driven immune dysfunction in the gut is now believed to trigger several autoimmune diseases (Kleinewietfeld et al. 2013).

c. Emulsifiers. These substances are used to stabilize mixtures of water-soluble and fat/oil-soluble ingredients in various foods and beverages. As such, they improve food and drink texture and shelf life in, for example, ice cream, frozen baked goods, non-dairy creamers, dill pickles, bread, processed meats, chocolate, chocolate milk, salad dressings, and veggie burgers. Two of the most common emulsifiers to look out for are polysorbate 80 and carboxymethylcellulose (also known as cellulose gum).

Emulsifiers act like detergents to disrupt the lining of the gut. Their detergent-like actions also damage friendly intestinal bacteria. The resulting chronic, low-level inflammation promotes leaky gut, IBS, colitis, metabolic syndrome, and even colorectal cancer (Chassaing et al. 2015; Viennois et al. 2017).

d. Organic Solvents. Ethanol and its oxidized breakdown product, acetaldehyde, are two organic solvents that you are most likely to encounter in foods and beverages. They both inflame the gut to the point of leakage.

Gut inflammation from the oxidation products of ethanol destroys the lining of the GI tract. The resulting alterations in protein complexes of the lining are a factor in developing cancer of the upper digestive tract and in worsening autoimmune disorders such as multiple sclerosis (Barragán-Martínez 2012).

e. Meat Glue. This is the more common name for the microbial transglutaminase enzyme that is used to hold proteins together in a whole slew of processed foods (Kieliszek and Misiewicz 2014). Its deceptive and

widespread use is almost a secret of the food industry. Here is where you can expect to find it…

- Artificial "steaks" made out of glued together meat chunks
- Imitation crab meat, chicken nuggets, and fish balls
- Reconstituted steaks, fillets, roasts, and cutlets
- Meat mixtures (sausages, hot dogs) not packed into casings
- Processed packaged meats
- Novel meat combinations like lamb with scallops or bacon with beef
- Meat noodles (shrimp noodles) and other cuisine oddities
- Artificially thickened egg yolks
- Strengthened dough mixtures
- Stiffened dairy products (yogurt, cheese)
- Tofu

Meat glue causes gut inflammation in three main ways. One is from its linkage with protein complexes that become allergenic, leading immediately to chronic immune issues in the gut. One such protein that it links to is gluten.

A second source is from a high level of bacterial contamination in glued meats. Meat surfaces that are exposed to the air are easily contaminated. Glued steak made up of several pieces of previously exposed meat has a 100-fold increased likelihood of harboring pathogens inside the meat.

The third danger from meat glue, and possibly the greatest one of the three, is how it damages the thin intestinal gut lining that prevents passage of undigested food particles out of the GI tract and into the bloodstream (Lerner and Matthias 2015).

Health concerns about meat glue have led to its complete ban in the European Union.

f. Nanometric Particles. These super tiny particles of titanium dioxide and other materials improve the taste, color, look, uniformity and texture of foods. They are also used in food packaging to help bottled beverages prevent CO_2 loss.

In addition, they are added to drug formulations and nutritional supplements because of their ability to increase the gut permeability of large molecules.

Their role in damaging gut permeability is exactly why they are harmful as food additives. Their small size allows them into the body by crossing several barriers in the GI tract. They leave holes in the intestinal wall that open up the leakiness of the gut, which spreads inflammatory molecules into your bloodstream and throughout your body (Lerner and Matthias 2015; Zoroddu et al. 2014).

g. Other Additives: Too Many to Count. As many as 3,000 different chemicals have been approved by the FDA as food additives. They include those described above, plus a huge variety of so-called “natural” flavorings and colorings, flavor enhancers, texturing and bulking agents, preservatives, stabilizers, and even synthetic vitamins.

Research lags on testing so many additives for their potential influence on gut microbes. Nevertheless, those that have been studied often prove to harm the microbiome in some way (Dudek-Wicher et al. 2018; Gillois et al. 2018).

Caution applies to the use of any kind of food additives. Their use is primarily in processed foods. Avoiding processed foods is a step in the right direction for reducing the harm than befalls your microbiome from your diet.

C. Antibiotics Everywhere: A Modern Crisis

The term “antibiotic” means “against life.” It specifically refers to killing bacteria. Penicillin is the most well-known antibiotic. It became one of the miracle drugs that achieved prominence in the early 1940s. At that time, penicillin and its chemical relatives signaled a new era in fighting infectious diseases.

Antibiotics were originally believed to spell the end to fatal bacterial diseases. Indeed, they have saved millions of lives from what used to be killer bacteria.

Now, more than 70 years later, we are surrounded by a sea of antibiotics. Once considered a miracle of modern medicine, these drugs

are now at the root of a health crisis. Why?

The answer is that the overuse and widespread misuse of antibiotics have fostered the development of antibiotic-resistant strains of all of the major infectious bacteria. Health agencies in the U.S. now estimate that doctors' prescriptions for antibiotics are unnecessary at least half the time. Furthermore, hospital uses of antibiotics are estimated to be inappropriate about 60% of the time.

Antibiotic use has simply become an example of too much of a good thing.

1. Rise of the Superbugs

The development of antibiotic-resistant bacteria has become one of the biggest worries in modern medicine. By now even the public has heard of the "superbugs" that no longer respond to antibiotics. Some of them have even become resistant to multiple antibiotics.

Superbugs first appeared in hospitals. That is where antibiotic use is the most common. More than ever, going to the hospital presents an added danger of infections by superbugs. In a hospital setting, typically your immune system is already in trouble. Illness or injury challenge your immunity.

In addition to whatever health issue brings you to a hospital, when you take antibiotics while there, you are also more susceptible to infection by your own bacteria. This is why pneumonia is so common after surgery

Concern about antibiotic resistance has not, however, nurtured the development of new antibiotics. Indeed, research in this area has been a monumental failure for several decades. Researchers have become so desperate for new drugs that they have even resurrected antibiotics that were first used more than 50 years ago (Gould and Bal 2013). So far, this effort has been of little help.

Extensive scientific reviews have recently concluded that new policies and renewed research efforts will be necessary to manage this growing crisis (Ventola 2015 a,b). So far any mention about the potential role probiotics has been mentioned only peripherally (Spellberg and Gilbert

2014; Spellberg et al. 2013).

As you will see in a later chapter, modern medicine is woefully behind regarding the modern antibiotic crisis. This, in spite of substantial research that clearly shows the value of friendly bacteria for keeping the nasty bugs in check.

2. Antibiotics in Foods

Medical prescriptions are not the only source of antibiotics that get into your body. Depending on what you eat, you may also be consuming antibiotics in your food. They are routinely added to animal feed. About half of the antibiotics that are made each year end up being fed to animals.

This development began when modern agriculture discovered that antibiotics do much more than help control infectious diseases. They also promote faster growth. Animals that get bigger faster can go to market sooner. The net result is increased production rates, accompanied by greater profits.

Now we have meat, milk, cheese, poultry, eggs and other animal products that come with a bonus: antibiotics.

What does a steady diet of antibiotics do to your health? The biggest problem is that this frequent exposure to such drugs causes your intestinal bacteria to be continually out of balance. This means that your microbiome is less able to fight for you the way it is supposed to. Ultimately, you become more susceptible to infections, especially by superbugs, and to the side effects of antibiotic use.

3. MRSA: The Nastiest Superbug of All?

One of the biggest worries stems from the rise of a superbug called “MRSA.” The abbreviation stands for *methicillin-resistant Staphylococcus aureus*. It is a staph infection that has become resistant to the primary antibiotic that used to kill it, methicillin. A series of other antibiotics have substituted for methicillin. The result is we now have another type of MRSA: ***multiple****-resistant Staphylococcus aureus*.

MRSA was first identified in the 1960s as a hospital-based bacterium

that arose out of the rampant overuse of antibiotics in clinical settings. Since then it has escaped the hospital setting and become increasingly widespread in the community. Its name has even modified to *community-acquired MRSA* (CA-MRSA) (Zetola et al. 2005). As recently as 2007, the Journal of the American Medical Association estimated the number of deaths caused by MRSA in the U.S. to be greater than the number of deaths caused by AIDS (Klevens et al. 2007).

The combination of widespread staph bacteria with the overuse of antibiotics has created conditions for the appearance of the nastiest superbug known to modern medicine. It is no longer restricted to patients who already suffer from weakened immunity. Some of the latest occurrences even include youth football and wrestling teams. Common cuts and skin abrasions from playing these and other sports have offered opportunities for MRSA that have resulted in extraordinary trouble, including fatalities.

One scientist has already proposed an old-time solution to preventing MRSA infections. Professor Mark Spigelman suggested that doctors might be better off washing their hands with yogurt instead of relying on antiseptic soaps (Spigelman 2005). Widespread use of antiseptics, as does the overuse of antibiotics, acts to promote the development of resistant bacteria.

4. Clostridium and Antibiotic-Associated Diarrhea

The most common side-effect of antibiotic therapy is probably diarrhea. Upwards of 20%-40% of patients develop it. Antibiotic-associated diarrhea is partially due to destruction of friendly bacteria, which opens the door to the unfriendly ones that normally lurk in your GI tract in low numbers.

The nastiest of these opportunistic bacteria is *Clostridium difficile* – or, C-diff. When it blooms in your colon, it secretes toxins that cause the inflammation associated with diarrhea.

A mild C-diff infection causes watery diarrhea a few times a day, often accompanied by abdominal cramping. As the infection ramps up, it hastens bouts of diarrhea to as many as 15 times a day, often with much more cramping and pain. If left unchecked, other symptoms can include

rapid heart rate, fever, blood or pus in the stool, nausea, dehydration, loss of appetite, weight loss, and even kidney failure. Even mild to moderate C-diff infections can be fatal.

Heavy use of antibiotics in patients before and after surgery disrupts the normal microflora. As you might expect, C-diff has taken advantage of such antibiotic overuse that it has developed antibiotic-resistant strains. This relatively new superbug has led to an epidemic of colon infections (Bartlett 2006; Johnston and Conly 2007). In fact, it has escaped hospital settings into the community. Infection by C-diff now occurs increasingly in people who haven't been hospitalized or taken antibiotics.

D. Acid Reflux Drugs

The huge industry for drug treatment of heartburn ("acid reflux") and its more intense relative, GERD (gastroesophageal reflux disease) rests on a dangerous premise. It is the faulty assumption that such problems arise from too much stomach acid.

Nothing could be further from the truth.

The root of the problem is actually a faulty lower esophageal sphincter (valve). It is supposed to close as soon as food passes through it into the stomach. However, when it doesn't fully close in time, acid can creep upward into the esophagus. That is what "reflux" means.

Modern medicine provides three kinds of treatments, all of which designed to reduce stomach acid. This is a big mistake since stomach acid is required for good digestion. You need plenty of it for a healthy stomach. That means enough hydrochloric acid to maintain a gastric pH below 3.5, even as low as 1.5.

Your stomach microbiome is adapted to that highly acidic environment. Acid-lowering drugs reduce the acidity to the point that gut microbial diversity suffers. Raising the pH is also counterproductive, since it causes the stomach to automatically secrete even more acid in an effort to restore the proper pH level.

Drugs that reduce stomach acidity upset the pH balance of the stomach, which suppresses the growth of friendly bacteria. Such

suppression gives the “bad bugs” the opportunity for taking over. It has long been known, for example, that this is what leads to overgrowth by *H. pylori* (Kuipers et al. 1996).

More recently, reducing stomach acid has been discovered to influence the entire GI tract. Specifically, the drug-damaged stomach microbiome even drives repeated C-diff infections in the colon (Tariq et al. 2017).

The most frequently used acid-reducing drugs include antacids, H2 blockers, and proton pump inhibitors. Some have always been available as over-the-counter drugs. Others are prescription only. Still others used to be prescription only, before the drug industry successfully lobbied to make them freely accessible to the public.

1. Antacids

Antacids are right behind antibiotics as the biggest enemies of a healthy gut microflora. Antacids do provide fast, temporary relief from indigestion. They are typically composed of calcium, magnesium, and aluminum salts. The most prominent ones in the public eye include Alka-Selzer, Milk of Magnesia, Maalox, Mylanta, Pepto-Bismol, Rolaids, and Tums. Supplemental sodium bicarbonate (baking soda) also belongs to this group.

2. H2 Blockers (Histamine Type 2 Receptor Agonists)

H2 blockers work by inhibiting the secretion of a substance in the body that encourages the production of stomach acid. They are now mostly available over-the-counter. Examples include Pepcid AC, Tagamet HB, Zantac, and Axid AR.

3. Proton Pump Inhibitors

PPIs are the most potent and most dangerous class of conventional drugs for treating acid reflux. Yet they are among the most widely sold drugs in the world.

These drugs work by ***permanently*** blocking an enzyme system called the “gastric proton pump” that makes protons available in the

stomach as a way to keep the pH down. Popular PPIs include Nexium, Aciphex, Prevacid, and Prilosec. More of them are approved for over-the-counter availability in the U.S. than in any other country.

Note that targeting the action of a single enzyme, which is a typical strategy in drug development in general, often has unintended consequences. Targeted enzymes usually have more than one role.

In the case of PPIs, some of the worst side effects occur when the microbiome is damaged by too little stomach acid. These include higher rates of C-diff infections, a nearly 10-fold increase in SIBO (small intestinal bacterial overgrowth), and a surge in all inflammatory bowel diseases (Dial et al. 2005; Lombardo et al. 2010).

In addition to those dangers, the use of PPIs can also cause a rebound effect – that is, they aggravate the very process that they are supposed to treat (Reimer et al. 2009). This discovery is behind the new worry that overuse of PPIs might lead to a dependency on them

E. Other Non-Antibiotic Drugs

Over the years many drugs have been suspected of altering the composition of the microbiome. Up until recently the extent of these effects has been largely unexplored. However, a remarkably thorough study addressing the effects of 1,000 different drugs on gut microbes was just published in the journal, *Nature* (Maier et al. 2018).

The main result showed that, depending on different drug classes being tested, 24% to 78% of them inhibit at least one bacterial species. Many inhibit multiple species. In general drugs simulate the actions of antibiotics. Some even induce antibiotic resistance.

The results of this large survey of drugs fall in line with the general antimicrobial nature of synthetic chemicals of all kinds.

Aside from antibiotics and antacids, the most common damage to the microbiome can be attributed to non-steroidal anti-inflammatory drugs (NSAIDs). This category of drugs includes over-the-counter medications such as ibuprofen (Advil, Motrin), acetaminophen (Tylenol) and acetylsalicylic acid (Aspirin).

In addition, prescription NSAIDs are the most widely prescribed drugs worldwide for treating pain and inflammation. Examples include Oxaprozin, Etodolac, Indomethacin, Naproxen, Nabumetone, and Diclofenac.

The value of NSAIDs for relieving pain is undermined by the inflammation they cause in the GI tract. NSAIDs-based gut inflammation leads to a leaky gut (Sigthorsson et al. 1998).

In other words, NSAIDs are anti-inflammatory drugs that actually cause gut inflammation. Damage begins with disruption of your friendly gut bacteria.

Our intestinal bacteria are adversely affected by drugs of all kinds, regardless of whether they are prescription or non-prescription. Besides antibiotics, antacids, and NSAIDs, many other drugs harm the microbiome. Just a short list would include ulcer medications, immunosuppressants, steroid hormones, and cancer chemotherapy treatments. In general, you can expect that synthetic medications will harm your friendly gut bacteria.

The health of our normal intestinal bacteria is continually challenged by these and newer chemicals that appear constantly in our foods, new buildings, clothing, cars, and just about everywhere that we live and breathe.

F. The Microbiome-Destroying Herbicide

The active ingredient in the most heavily used herbicide in human history is called glyphosate. The most well-known brand of glyphosate-based herbicide treatments is Roundup. The U.S. federal government approved its use based on claims by the manufacturer, Monsanto, that it is safe for human consumption.

That is a dangerously wrong claim.

Glyphosate works by inhibiting an enzyme, EPSP synthase, that plants need for basic metabolism. The result of such inhibition is the death of plants that are exposed to it.

Now get this: *Bacteria also depend on EPSP synthase!*

That means that glyphosate is a danger to your microbiome. Unfortunately, industry lobbying has suppressed this information so that the public is unaware of how pervasive and damaging to human health this herbicide can be.

Nevertheless, new studies are beginning to emerge. At present, research already shows the harmful effects of glyphosate on gut microbes. Glyphosate is now seen as a pathway to all modern diseases that are caused or made worse by a damaged microbiome (Samsel and Seneff 2013).

The consequences of glyphosate toxicity include most of the diseases associated with a Western diet. Leading the list are gastrointestinal disorders, obesity, diabetes, heart disease, depression, autism, infertility, cancer, and Alzheimer's disease.

More recently, the Cesare Maltoni Cancer Research at the Ramazzini Institute in Bologna, Italy, has undertaken a pilot study to document the damage that glyphosate can do to gut microbiota (Mao et al. 2018). The research group has already discovered that the exposure levels considered safe are capable of modifying the gut microbiota. Microbial damage is especially impactful in early development, before the onset of puberty.

Based on its prevalence of use worldwide and it potential to damage the microbiome, health researchers are beginning to regard glyphosate as the worst environmental toxin of all time.

What can you do about it? The first step is, of course, to do whatever you can to restore a microbiome that has become damaged from any cause. In addition, consuming only foods that are clearly labeled 'Certified Organic" will be limit your exposure to glyphosate.

You can also reduce or eliminate the worst offenders in your diet, including soy and all cereal grains. Cereal grains include wheat (the worst offender), oats, barley, corn, rice, millet, sorghum, rye, and triticale. That includes domestic cattle that are raised on soy or cereal grains.

Finally, you may take a page out of the industrial agriculture playbook. The best research on how to treat glyphosate toxicity comes

from studies on domestic cattle. The health of feedlot animals depends on their microbiomes. Several treatments have been shown to reduce glyphosate levels excreted in urine, which helps to rebalance the microbiome and to improve the animals' health (Gerlach et al. 2014).

G. The Biggest, Baddest Harm to Your Microbiome Ever?

Modern technology is a gargantuan elephant in the room when considering all the factors that can damage the microbiome. Most people are completely unaware of it.

Technology in this context refers to what scientists call *non-native electromagnetic fields* (nnEMF). Sources of nnEMF include wi-fi, cell phones and cell phone towers, computers, electronic notebooks, TVs, microwave towers, artificial lighting, electrical systems, appliances, cordless phones, broadcast transmission towers.

Think about this scary observation for a moment:

> *The first mile above the Earth's surface is now filled with **two million times** the amount of EMF that we faced in 1900!*

In addition, the U.S. Environmental Protection Agency was forced to stop measuring EMF over our country in 1979. Even though the U.S. leads the world in technology productivity, we have no agency that is monitoring the nnEMF levels that we are increasingly exposed to.

Furthermore, there is essentially no regulation on the nnEMF output of industry.

In essence, we are all involuntary "guinea pigs" for a long-running health experiment that has already gone awry.

How can modern technology be harmful? Evidence for its negative impact on our health has been accumulating since the 1960s (Marino 2010); Pall 2018).

However, the damaging effects of nnEMF have been the subject of scandal and bias at the highest level of scientific research. This should be no

surprise, considering the financial bonanza from new developments in the technology, communications, and power industries.

Scientists studying the effects of nnEMF on the microbiome have been johnny-come-latelies to the party. Basically, what we know so far is that different nnEMF energies can either promote or inhibit bacterial growth (Taheri et al. 2017). Among other effects, nnEMF induces overgrowth by normal colon bacteria such as *E. coli*, which then becomes pathogenic.

Comparable studies are starting to reveal similar such effects as a trend across different frequencies of nnEMF (Crabtree et al. 2017; Soghomonyan et al. 2016; Tadevosyan et al. 2008).

In addition, a recent study found that two of our most important friendly gut bacteria (*Lactobacillus plantarum* and *Lactobacillus rhamnosus*) are highly susceptible to nnEMF frequencies from 6.41 to 7.62 GHz (Vasistha and Garg 2016). These frequencies destroy bacterial DNA.

That study points to the health disaster that we and our microbiomes are facing. Those frequencies are close to the 5 GHz wi-fi networks that have become so popular everywhere. What is even more disturbing is that new 5G wi-fi networks, which operate at 15 GHz, are set to invade our cities, neighborhoods, and schools.

None of these discoveries should come as a big surprise to science. Studies from as far back as the 1920s revealed that bacteria communicate with one another by means of electromagnetism (Trushin 2003). Disruptions by nnEMF disrupt the information exchange among bacteria that they rely on for healthy growth and metabolism.

The most damaging consequences of nnEMF to the microbiome so far involve the tight link between gut health and autoimmunity (Marshall and Heil 2017). The authors of that study predicted that future therapies for any autoimmune disease will have to contend with the effects of nnEMF.

Even with the limited research on the effects of nnEMF on gut microbes that we have so far, we can clearly see a health catastrophe in the making.

Chapter 4. PROBIOTICS TO THE RESCUE

Everything that damages your own health by harming your microbiome can be relieved by consuming probiotics. The known ancient uses of probiotics as well as modern scientific research reveal a long list of health benefits from them.

Probiotics are not new. They have been rescuing people from digestive problems, infections, and dozens of other microbiome-dependent maladies can be traced back to ancient times, nearly 10,000 years ago (

According to Persian history, for example, Abraham in the Old Testament lived a long and healthy life in part because he drank fermented milk. In the1500s, King Francis I of France was said to have been cured of an illness after eating yogurt. The best current examples of the benefits of probiotics are from people in certain parts of the world who regularly live to be more than 100 years old and are far healthier than most of us. In a nutshell, they eat fermented food, such as yogurt, that contains lots of live, friendly bacteria. Of course, the notion that dietary bacteria, the probiotics themselves, explain the health benefits of these examples was unknown until the 20th century.

Of course, historically people were unaware of the fact that they were eating bacteria. What they did know was that certain fermented foods were beneficial to their health.

Now we know that fermented foods containing live bacterial cultures were the original sources of probiotics.

Fast forward to the early 20th century, when the Nobel Prize winner, Dr. Elie Metchnikoff, got the science behind probiotics started. It began with his simple observation that many Bulgarians were living more than 100 years. He deduced that their consumption of yogurt and sour milk was the key to their long and healthy lives.

Metchnikoff attributed the health benefits of yogurt to the activity of its live cultures to prevent the “putrid digestion” that was thought to be the major cause of serious diseases. He found yogurt to be laden with lactic acid bacteria, including lactobacilli and bifidobacteria.

Metchnikoff discovered that many disease-causing organisms died or failed to grow when exposed to fermented milk containing lactic acid bacteria. The bacteria produced lactic acid from lactose (milk sugar), creating the acidity that is hostile to many pathogenic bacteria. He even named the primary bacterial species from cultured yogurt in honor of the Bulgarians: *Lactobacillus bulgaricus*.

Now, more than a century later, *L. bulgaricus* remains one of the most valuable species of probiotic bacteria for human health. Over the years it has been joined by many other species that, all told, provide an extraordinary list of health benefits.

A. Probiotics in Foods

Modern probiotic-containing foods and products are the direct descendants of early fermented foods. Fermentation was originally an ancient tool for preserving foods. Food preservation relied on probiotic microbes to lower the pH, thereby inhibiting spoilage by microbes that ruined foods.

The accidental discovery of fermentation was repeated in prehistoric times throughout the world. Ancient Egyptians, Greeks, Romans, and Sumerians, and Hindus consumed many fermented milk products – typically milk, cheese, and butter.

The peoples of Japan, China, and Korea relied heavily on fermentation as a pickling agent for various vegetables. Chief among them were cabbage, turnip, eggplant, cucumber, onion, squash, and carrots. Starting around 300 B.C., fermented vegetables were a regular part of the diet of Chinese workers during the construction of the Great Wall of China.

One lacto-fermented vegetable, sauerkraut, was known to ancient Romans for its “delicious taste” and its medicinal properties. The Roman Emperor Tiberius carried it on long voyages to prevent intestinal disorders. Nearly 2,000 years later, Captain James Cook and his crew similarly consumed sauerkraut on their long voyages to prevent scurvy.

Of course, the fermentation process occurs in other microbes besides bacteria. Fungi, particularly yeasts, have also been used for their ability to

ferment foods. Leavening of bread by yeast was discovered by allowing dough to sit untouched for several hours.

Fermentation by yeast was discovered for making beer from cereal grains, wine from grapes and other fruits, and mead from honey at least 7,000 years ago.

B. Commercialization of Probiotic Foods

Probiotics were originally marketed as live cultures in foods. At first this entailed primarily fermented dairy. In western cultures yogurt was the most popular source. In Japan it was Yakult. Both types of products are still widely available commercially.

The beginnings of the antibiotic era in the 1940s saw a drop in the use of probiotic foods. The rise of antibiotic-resistant pathogens in the 1960s spawned a renewed interest in probiotics as a non-antibiotic strategy to prevent and potentially treat a variety of infections.

In the U.S., the 1994 passage of the Dietary Supplement Health and Education Act (DSHEA) opened the floodgates for the sale and marketing of probiotic foods and supplements.

The main concerns about probiotic foods are that they may contain no live cultures at all. Or, if they do, the diversity and dosage of microbes is inadequate. Fortunately, rules about food labeling require that the diversity of bacterial species and the dose per serving are very clear on the packaging of every product.

In addition, in modern times, some formerly fermented foods are not fermented at all. This is the case for many fermented vegetables such as sauerkraut, pickles, kimchi, and miso. The main tipoff for products that have not actually been fermented is the absence of any mention of live cultures on product labels. Moreover, such foods generally do not have to be refrigerated.

The top probiotic foods still include yogurt as perhaps the most popular. The list also includes several other foods from fermented dairy or vegetables, as follows:

1. Yogurt

Most cultured or Greek yogurt is made from the milk of cows, goats, or sheep. There is a large variation in the quality of yogurts on the market today. Live cultures may be absent. Sweeteners, food dyes, so-called natural flavors, and other additives undermine the health benefits of yogurts as sources of probiotics.

2. Kefir

Kefir is similar to yogurt. It differs by the addition of “kefir grains” to milk fermentation. Kefir grains may have first appeared up to 3,000 years ago in the Northern Caucasus Mountains. They consist of living organisms aggregated into small, gel-like “grains” containing a unique type of polysaccharide called kefiran.

Although it is similar to yogurt, kefir is also fermented by yeasts as well as by bacteria. The final product may have anywhere from 10 to 34 strains of microbes.

3. Coconut Kefir

Coconut kefir is a dairy-free option for kefir. It is made by fermenting the juice of young coconuts with kefir grains. It has some of the same probiotics as traditional dairy kefir, although in lower dosages.

4. Sauerkraut

Sauerkraut is typically made by fermenting cabbage. Many other vegetables can be fermented with it. It is not as diverse in probiotics as other foods. Nevertheless, its high acidity from lactic acid supports the growth of good bacteria in your gut.

5. Kimchi

Kimchi is the Korean cousin of sauerkraut. The main substrate is Chinese cabbage, which is mixed with a variety of other vegetables. Its spiciness ranges from low to high “heat.” At the high end it rivals some of the spiciest foods from around the world.

6. Natto

Natto is a popular dish in Japan consisting of fermented soybeans. It is unusual due to its being the rare source of an extremely powerful probiotic species, *Bacillus subtilis* var. *natto*. Natto is an acquired taste because of its powerful smell, strong flavor, and sticky, slimy constancy.

A health bonus from natto is the production of an enzyme called nattokinase. This enzyme provides a number of health benefits, especially for the cardiovascular system. Fortunately for those who have no access to or desire for natto, nattokinase is available by itself as a nutritional supplement.

7. Miso

Miso is a mainstay of traditional Japanese medicine. It is made by fermenting soybeans with salt and a mold called koji (*Aspergillus oryzae*). Miso may also be fermented with rice, barley, or seaweed. Most of the Japanese population begins each day with a warm bowl of miso soup. In the U.S., it is widely available in Japanese restaurants.

8. Kombucha Tea

Kombucha is an effervescent beverage made by fermenting sweetened black or green tea with a SCOBY (symbiotic culture of bacteria and yeast). It has been around for over 2,000 years. Until the 1990s it was only available as a home brew. Since then it has become easy to find in health food stores and supermarkets.

9. Raw Dairy

Commercial dairy products are required by law to be pasteurized. Pasteurization is a heat treatment that is supposed to eliminate pathogens and extend a product’s shelf life. Industrial pasteurization of milk began in the late 1800s in Europe and in the early 1900s in the U.S.

Pasteurization easily kills probiotic bacteria. Certain kinds of undesirable microbes are not eliminated by pasteurization. This means that, unlike non-pasteurized milk, pasteurized milk that goes sour is not good for you health.

Raw milk from cows, goats, and sheep are otherwise rich sources of probiotics. The challenge is that raw dairy must be must be sourced locally. Ideally it should come from grass-fed, pasture-raised animals, not from feedlot cattle.

10. Buyer Beware

Yogurt is a convenient food for many people. It is often marketed as a "wonder food" for all of the health benefits that have been passed down through the generations. Indeed, when it is genuinely cultured and still 'live', it can be a phenomenal health food.

Unfortunately, the modern truth about yogurt is that the vast majority of yogurts sold in industrialized countries have little to do with the real thing. They are mostly degraded during assembly-line production that never even includes the friendly bacteria that old-time yogurt used to have.

Furthermore, even when they incorporate live cultures, most commercial yogurt manufacturers pasteurize their product ***after*** the culturing process. Such methods ensure that the resulting yogurts are completely devoid of probiotic bacteria.

The absence or reduced presence of live probiotic bacteria translates into a failure to provide health-enhancing effects.

Another drawback to commercial yogurts is that, even when live cultures are used, they do not incorporate the right bacteria. The most important species that were traditionally used to manufacture yogurt were *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

More recently, manufacturers have begun to substitute or add another species, *L. acidophilus*. This species does offer certain health benefits. However, when added to a yogurt culture, the *L. bulgaricus* that is already there destroys the acidophilus. In this case, *L. bulgaricus* produces hydrogen peroxide, which rapidly kills *L. acidophilus* (Gilliland and Speck 1977).

Although *L. acidophilus* is marketed as a probiotic in yogurt, you will receive little benefit from it when *L. bulgaricus* is included in the culture.

C. Probiotic Supplements

Probiotics have become a huge industry over the past few decades. The global market increased from $15.9 billion in 2007 to $39.2 billion in 2017. It is predicted to grow to $57.2 billion by 2022 (Kumari 2018).

A significant slice of the market consists of probiotic supplements. They are more convenient and easy to use than probiotic foods. Besides, probiotic foods are so highly processed that they are no longer a reliable source of the good bacteria that you need for replenishing your own intestinal microflora.

Probiotic supplements, in the form of capsules, gel caps, or powders, have simply become increasingly important for your overall health. Indeed, it is now possible for you to take probiotic supplements to harness the same old-fashioned simple and powerful strategy for a longer and better life that people used to get from eating fermented foods.

1. The Science Behind Probiotics for Human Health

As previously mentioned, nearly 20,000 articles about probiotics have been published in research journals since the1950s. Get this - more than 19,000 of those have appeared just since the beginning of the 21st century!

To say that probiotics have piqued the interest of the scientific community would be a tremendous understatement. Studies now show how versatile probiotics can be for preventing and treating as many as 100 diseases.

A hallmark of so much research is that scientists, as is their wont, have begun to publish research reviews on the many roles of probiotics in human health. Reviews summarize the state of knowledge based on original studies. Together they present a nearly comprehensive overview of what you can expect from probiotics.

Citing all of the original supporting research would add thousands of references to the list at the end of this book. Rather than doing that, I will refer the interested reader to the most significant reviews themselves for

the original source materials. Each one is included in the reference section, organized alphabetically the last name of the lead author.

They are as follows:

Azad et al. 2018
Clarke et al. 2014
Czerucka et al. 2007
Downey 2014
Fujimura et al. 2010
Gagliardi 2018
Galland 2014
Hungin et al. 2013
Hungin et al. 2018
Kang and Cai 2018
Kerry et al. 2018
Kumar et al. 2012
Lee et al. 2018
Markowiak and Śliżewska 2017
McFarland et al. 2018
Nazir et al. 2018
Pascal et al. 2018
Rezac et al. 2018
Roychowdhury et al. 2018
Scott et al. 2018
Scriven et al. 2018
Singh et al. 2013
Soccol et al 2010
Wang et al. 2017
Zhang et al. 2018
Zúñiga et al. 2018

Now let's have a look at what probiotics can do for your health according to those current scientific reviews.

At the top of the list are the more well-known, traditional benefits that we have known for decades. They entail the capacity of probiotics to help with the following:

- Diarrhea (especially following treatment with certain antibiotics)
- Constipation
- Vaginal yeast infections and urinary tract infections
- Irritable bowel syndrome (IBS) and ulcerative colitis
- Certain intestinal infections
- The severity and duration of colds and flu

Probiotics are now known to protect against numerous additional diseases. A comprehensive list would be more than 100. The following include some of the most rampant and problematic diseases in modern times:

- Metabolic syndrome

- Diabetes
- Obesity
- Cardiovascular disease
- Cancer
- Osteoporosis
- Respiratory infections
- Digestive problems of all kinds
- GERD (acid reflux)
- Antibiotic resistance
- Mental illness (e.g., depression, autism, Alzheimer's & Parkinson's diseases)
- Chronic inflammation
- Skin disorders
- Food allergies
- High blood pressure
- Non-alcoholic fatty liver disease
- Rheumatoid arthritis
- Kidney stones
- Tooth decay and periodontal disease
- Liver disease
- Infections by harmful bacteria, viruses, or fungi
- C-diff overgrowth
- H. pylori overgrowth
- Candida (yeast) overgrowth
- MRSA infections

Highlights explaining the main benefits of probiotics in the face of so many diseases include the following:

a. Digestive disorders. The first major benefit of probiotics is as a promoter of good digestive health. According to a meta-analysis conducted by Dalhousie University in Nova Scotia,

> *"Probiotics are generally beneficial in treatment and prevention of gastrointestinal disease. When choosing to use probiotics in the treatment or prevention of gastrointestinal disease, the type of disease and probiotic species (strain) are the most important factors to take into consideration."*

Probiotic supplements help to protect the GI tract from inflammatory bowel diseases, including ulcerative colitis and Crohn's disease. The evidence is stronger, however, for an improvement in ulcerative colitis, while Crohn's disease may not benefit as greatly.

Large bodies of evidence suggest that probiotics are effective against several forms of diarrhea, including antibiotic-associated diarrhea, acute diarrhea, traveler's diarrhea and other associated diarrhea symptoms.

Probiotics have also been found in meta-analyses to reduce the pain and severity of IBS symptoms and aid in the eradication of *H. pylori* and C-diff infections.

Probiotic bacteria also assist the stomach microbiome by secreting more acid to counter the effects of GERD (acid reflux, "heartburn").

Different species of Lactobacillus and Bifidobacterium have been shown to support intestinal function and improve both diarrhea and constipation.

b. Metabolic syndrome. Probiotics address every facet of this syndrome. The cluster of medical conditions that make up this syndrome include diabetes, obesity, high blood pressure, high blood sugar, imbalance in blood lipids (high triglycerides, high LDL and total cholesterol, low HDL cholesterol), cardiovascular disease, type 2 diabetes. Each one will be addressed separately below.

c. Diabetes. The two most powerful groups of probiotic bacteria – the lactobacilli and the bifidobacteria – help to significantly reduce insulin resistance and blood sugar levels. They also improve A1c levels, which is a measure of long-term blood sugar control.

Several large-scale studies and two meta-analyses have confirmed that probiotics should be a major addition to the arsenal of natural remedies for diabetes.

In a massive study involving almost 200,000 subjects and a total of 15,156 cases of Type 2 diabetes, researchers confirmed that the consumption of probiotics reduced the risk of developing diabetes.

According to a 2014 meta-analysis, probiotics benefit diabetics by improving insulin sensitivity and decreasing the autoimmune response found in diabetes.

Combining probiotics with **prebiotics** (nondigestible fibers that are fuel for bacterial growth) may also help manage blood sugar, particularly when blood sugar levels are already elevated.

d. Obesity. Studies have shown that there is an association between the overuse of antibiotics and obesity. This should be no surprise, since agricultural scientists long ago that adding antibiotics to animal feed fattens animals quickly. Research in both animals and humans shows that supplementing with probiotics significantly reduces body weight, fat accumulation, and body mass index (BMI).

Human and animal studies show that probiotics also attenuate nonalcoholic fatty liver disease (NAFLD) due to obesity and a high-fat diet.

In one study, prenatal and postnatal probiotic supplements (from about four months before birth to six months after) prevented excessive weight gain in new mothers and in their newborns. Effects on the children lasted right through to 10 years of age.

e. High blood pressure. A large analysis reviewed available research and determined that probiotics help to lower blood pressure by improving lipid, reducing insulin resistance, regulating renin levels (a protein and enzyme secreted by the kidneys to lower blood pressure) and activating antioxidants. Researchers consider them valuable prospects in the treatment of high blood pressure because their side effects are generally minimal or non-existent.

These effects are most pronounced in people who already have hypertension (high blood pressure). The greatest improvements occur when subjects consume multiple probiotic strains for at least eight weeks in supplements containing 100 billion or more colony-forming units (CFUs).

f. Cardiovascular disease. In studies conducted on both animals and humans, the use of probiotics decreased total and LDL cholesterol, and increased HDL cholesterol. In addition, recent studies suggest that

supplements of beneficial bacteria can reduce cholesterol absorption and inflammation due to excess fat storage. These changes contribute to a significant decrease in the formation of inflammatory, cholesterol-laden plaques observed in early atherosclerosis.

g. Cancer. Probiotics can prevent or reduce several kinds of cancer. Supplementation with *Lactobacillus acidophilus* and *Bifidobacterium longum*, significantly decreases the DNA damage that can trigger malignant cell development.

Also, patients with colon cancer and those with pre-cancerous polyps had sharply reduced proliferation of abnormal colon cells and a significant decline in harmful Clostridium bacteria when supplemented with probiotic bacteria.

In addition, scientists have demonstrated that probiotic organisms turn on a number of protective signaling mechanisms that play a role in preventing cancer. For instance, probiotics have been documented to:

- Boost populations of immune cells that seek out and destroy cancers
- Upregulate inflammatory cytokines that operate during an acute stage of cancer or other threats
- Suppress the inflammatory responses to cancer that can cause tissue or organ damage
- Suppress bacteria that convert harmless pro-carcinogen molecules into carcinogens
- Bind to potential carcinogens, promoting their excretion
- Downregulate an enzyme that converts harmless molecules into carcinogens
- Stimulate the expression of liver enzymes that detoxify carcinogens
- Suppress bacteria that convert pro-carcinogen molecules into carcinogens
- Decrease enzymes implicated in the development of carcinogens
- Boost populations of immune cells that play a role in tumor inhibition

The best anticancer results of probiotics so far include cancers of the colon, liver, breast, bladder, cervical, and prostate.

h. Osteoporosis. Nutrition scientists have discovered that the absorption of calcium increases when it is taken as part of or as a supplement to food. The explanation for this observation is that food stimulates the stomach to secrete acid and enzymes for digestion. Probiotic bacteria add their own acid to the mix, thereby further increasing stomach acidity and, as a consequence, enhancing the absorption of calcium. As a bonus, probiotics also help to reduce estrogen balance, which directly affects bone health.

Probiotics also influence other hormones that affect bone health, including serotonin and cortisol.

In addition, probiotics support the microbiome's ability to regulating growth factors that control bone health.

i. Respiratory infections. Probiotics can significantly suppress respiratory infections such as the common cold and the flu. They work best whenyou begin supplementing prior to cold and flu season. Studies show that people who supplemented for 3-6 months with different strains of bifidobacteria and lactobacilli reduced the duration of symptoms by an average of one to two or even more days, with a similarly impressive reduction in symptom severity. Two studies in children who were given both Lactobacillus and Bifidobacterium twice daily for 3 to 6 months had reduced symptoms and shorter durations of infection. These benefits resulted in a significant decrease in school absenteeism and in the use of antibiotics.

Colonization of the nose by potentially pathogenic bacteria, a common complication of colds, was shown to be reduced by 19% with regular probiotic use compared with the untreated group. This effect could save the lives of those who are older, or who have a compromised immune system due to chronic disease such as diabetes, or who have recently undergone a major operation. All of those factors lead to a higher risk of being overwhelmed by bacterial infections, particularly those infections affecting the lungs.

j. Antibiotic resistance. *Helicobacter pylori* is a common bacterium infecting about half of the world's population. It can cause a diverse spectrum of gastrointestinal disorders, including ulcers. However, due to antibiotic resistance and patient noncompliance, several studies have shown that there is a widespread failure of antibiotic therapy in treating *H. pylori*.

A meta-analysis of 33 randomized, controlled trials found that several strains of Lactobacillus and one strain of Bifidobacterium, when added to antibiotic therapy, significantly increase *H. pylori* eradication rates.

The World Health Organization considers antibiotic resistance to be, "…one of the biggest threats to global health, food security and development today." Probiotics help rebuild the diversity of gut bacteria once it develops after a course of antibiotics.

k. Skin disorders. Many studies have examined the role of probiotics in skin health, especially in children. Meta-analyses have found that probiotic supplements are effective in the prevention of pediatric atopic dermatitis and infant eczema. The integrity of gut bacteria is also connected to the development of acne, although the way this happens is still unclear.

The benefits of probiotics for skin health also seem to be connected to the reduction of inflammation seen in healthy gut bacteria. One species of Lactobacillus, *L. casei*, can reduce allergic skin inflammation. Indeed, research suggests that having a balanced gut environment has benefits for both healthy and diseased human skin.

l. Nonalcoholic fatty liver disease. NAFLD affects 80 to 100 million people in the U.S. alone. As its name implies, it is characterized by fatty buildup in the liver. Without treatment, it can lead to cirrhosis, ending in liver failure or death for some patients.
A 2013 meta-analysis of studies on probiotics and NAFLD found that using probiotics can improve a number of important factors for patients with the disease, prompting the study's authors to state that: "Modulation of the gut microbiota represents a new treatment for NAFLD."

m. Aging. Aging is not really a disease. However, a poorly functioning microbiome hastens it. Unfortunately, many of the things we do to harm the microbiome accelerate the development of diseases that are thought of as age-related. The primary effect is loss of microbial diversity. Although a drop in microbial diversity is associated with aging, certain species of probiotic bacteria can restore the microbiome to a more youthful composition. The most influential of these are the bifidobacteria (Arboleya et al. 2016).

Much of the research on the benefits of probiotics against aging involve the skin. Probiotics are now known to restore acidic skin pH, relieve oxidative stress, reduce the effects of photoaging, improve skin barrier function, and even enhance hair quality (Sharma et al. 2016).

Probiotics are clearly important for addressing many so-called age-related diseases. Research on the potential of probiotics for boosting longevity, however, is just getting started by modern science. One of the most recent studies, for example, shows how certain genes in our gut microbiota help protect the host from the age-related progression of tumor growth and the amyloid-beta accumulation that underlies Alzheimer's disease (Han et al. 2017).

2. There's a Friendly Fungus, Too

Yeasts are well-known examples of fungi. One group, the Saccharomyces yeasts, includes yeasts for baking and brewing. Less known among them is a friendly gut fungus, *Saccharomyces boulardii*.

As you may recall from earlier, a wide diversity of microbes lives in the GI tract. When the microbiome is healthy, they all live in harmony. In other words, different kinds of microbes are adapted to living with each other, including fungi.

The vast majority of research on probiotics involves the bacterial component of the microbiome. Nevertheless, *S. boulardii* has attracted significant enough attention that it can also been developed into a probiotic. It provides many of the same benefits as probiotic bacteria: preventing and treating Crohn's disease, diarrhea, IBS, and ulcerative colitis.

An added bonus is that, since it is a fungus, *S. boulardii* is not directly harmed by antibiotics. In fact, it produces its own antibiotics that help it control harmful bacteria from getting out of hand.

Probably because *S. boulardii* is not a native microbe of the human gut, it is particularly effective in reducing C-diff overgrowth. Indeed, it may the best probiotic of all for battling this dreaded colon infection.

Scientific support for the uses of *S. boulardii* continues to grow. A recent meta-analysis of 27 clinical studies confirmed its benefits to include

prevention and treatment of C-diff infections, IBS, ulcerative colitis, diarrhea from several causes (antibiotics, traveling, HIV), Crohn’s disease, and giardiasis (a parasitic disease) (McFarland 2010).

Chapter 5. THE “BIG 3” OF PROBIOTIC POWER

Probiotics are clearly very powerful for alleviating all manner of health challenges. However, the previous list is incomplete. Three additional areas of probiotic uses stand out for their growing value to overall well-being. They have become so dominant in probiotic research that they are presented separately in this section to emphasize their significance.

These areas are: 1) disorders of the immune system; 2) leaky gut syndrome; and, 3) mental illness.

A. Immunity Starts in Your GI Tract

Your immune system is the best defense you have against infectious diseases of all kinds. You may be surprised to learn that about 70% of the immune cells that your body produces come from the small intestine (Furness et al. 1999).

Your intestinal bacteria influence how those cells work in at least two main ways. One is that they strengthen certain kinds of immune cells, called lymphocytes. Lymphocytes are part of the GI tract. Plenty of active lymphocytes, backed by friendly bacteria, continually suppress the growth of infectious bacteria.

The second way that our friendly bacteria help our immune system is more complicated. It seems that bacteria have a communication system that tells immune cells outside the GI tract when to get busy. They do this without even leaving the GI tract. Their signaling molecules go straight to specific immune cells with directions on where the cells are to go and what they are to do when they get there.

Probiotic bacteria can also directly modify the immune system. They improve the gut’s antibody responses. They also keep a tight control over the balance between pro-inflammatory and anti-inflammatory hormones that regulate immune function (Hessle et al. 2000).

This communication system partly explains why our head-to-toe immunity against disease, toxins, and allergens begins with a healthy and vigorous population of friendly bacteria in our GI tract.

That's not all. Immune cells in the small intestine work closely with the nervous system and the endocrine system. All interactive systems – immune, nervous, endocrine – have special cellular 'detectors' in the gut mucosa. The gut mucosa is the largest and most dynamic immunological environment of the body. As such, it represents a beachhead into the rest of the body.

The mucosa forms the key lining of the gut that, when healthy, enables the efficient absorption of nutrients. At the same time, it also protects against the intrusion of harmful toxins and microbes that may enter the digestive system.

DNA from probiotic bacteria directly influences how gut immunity works. It reduces gut inflammation by inhibiting the secretion or activation of several hormones that damage the gut mucosa (Jijon et al. 2004). Normalizing the gut microflora by probiotics counteracts such harm by rejuvenating the immune system (Candore et al. 2008).

Probiotics do much more than aid the immune system against infections and gut inflammation. Two of the more well-studied roles of probiotics and immunity involve allergies and autoimmune diseases.

1. Immune System and Inflammation

A special tissue in the GI tract, called the gut-associated lymphoid tissue (GALT), is where immunity starts in the gut. That is where 70% of the body's immune system cells come from. The GALT is where critical protection begins in the battle against all of the constant challenges to the immune system that come from food allergens and infectious microbes.

Conceptually, the GALT can be thought of as the largest immune organ in the body. As such, it is an organ that works best when you have a healthy microbiome that communicates clearly between your two brains.

Normally a strong immune response provides a quick burst of inflammation to stamp out infections and other immune challenges. Microbes in your gut regulate these responses. In other words, your microbiome induces quick-hitting inflammation when you need it.

On the other hand, an unhealthy microbiome fails to tell the immune system when to cease its inflammatory responses when they are no longer needed. The result is chronic or long-term inflammation, which is the root of all modern disease.

Restoring microbial balance to the microbiome has now become a prominent strategy for reinvigorating the immune system and reducing chronic inflammation (Mazmanian et al. 2008). More recent research, for example, shows the potential for this strategy to reverse the chronic inflammation that underlies colitis, arthritis, and asthma (Maslowski et al. 2009).

2. Allergies

Allergies are an overreaction by the immune system to various stimulants (“allergens”). Probiotics help reduce allergies of all kinds by rendering many allergens harmless (Castellazzi et al. 2013; Guarner et al. 2006; Krzych-Falta et al. 2018). This is a direct aid to the immune system.

The most recent studies showed how probiotics help us to successfully regulate allergic rhinitis (hay fever), atopic disorders (e.g., eczema) and food allergies (Prakash et al. 2014).

3. Autoimmune Diseases

One of the most insidious overreactions of the immune system does not involve external allergens. It involves your own cells, tissues, and their products. The result is autoimmune. The term literally means “self” (*auto*) immunity. Depending on which cells and where in the body autoimmunity develops, it accounts for dozens of diseases.

The most common ones are:

Celiac disease	Addison's disease
Type 1 diabetes	Rheumatoid arthritis
Sarcoidosis	Ankylosing spondylitis
Lupus	Polymyositis
Sjögren's syndrome	Dermatomyositis
Graves' disease	Multiple sclerosis
	Hashimoto's thyroiditis

In general poor gut health is closely tied to autoimmunity. This relationship is the foundation for a number of studies that have found probiotics to be helpful for treatment autoimmune diseases.

Research on the use of probiotics for treating autoimmunity has mostly focused on rheumatoid arthritis. So far scientists have discovered that one species of probiotic bacteria, Lactobacillus casei, is particularly helpful for decreasing arthritic inflammation and progression of the disease (Pineda et al. 2011; Vaghef-Mehrabany et al. 2014).

Autoimmunity doesn't suddenly appear for no reason, though. It is almost always associated with gut inflammation – that is, when your gut is on fire.

B. When Your Gut is on Fire

Three factors that characterize gut inflammation are intimately tied together in a complex network of cause-and-effect interactions. They are leaky gut syndrome, small intestinal bacterial overgrowth (SIBO), and candidiasis (candida yeast overgrowth).

1. Leaky Gut Syndrome

Modern medicine is confused about **leaky gut syndrome**. On one hand, it is considered to be a hypothetical, medically unrecognized condition. On the other hand, all of the health problems associated with it are cleverly classified as consequences of increased **intestinal permeability**. They are simply two names for the same problem.

At its most basic level, leaky gut is characterized by the formation of gaps in the lining of the intestines. Normally the lining consists of tight junctions (TJ) that act as the gateway between your intestines and your bloodstream. They control what is allowed to pass into the bloodstream from your digestive system. More than 40 different TJ proteins have now been recognized to play a role in gut health.

Tight junctions have a very precise job. They act as the control point for the delicate balance between allowing nutrient absorption while

simultaneously preventing foreign particles from passing through the gut and into the bloodstream.

Several symptoms appear when TJs get too loose – that is, become leaky. They should all look familiar to you. They show up as symptoms of many of the gut-based problems that you read about earlier in this book. The most common ones include the following:

- Food sensitivities
- Inflammatory bowel disease
- Autoimmune disease
- Thyroid problems
- Nutrient malabsorption
- Inflammatory skin conditions
- Mood and autism

Of course, as you have already learned, probiotic bacteria are powerful aids to gut health in dozens of ways. These include multiple mechanisms for reinvigorating a leaky gut (Ulluwishewa et al. 2011). These mechanisms include boosting levels of TJ proteins, reversing the gut-damaging effects of pathogens, and even guiding TJ proteins to where they are most useful.

2. SIBO

Small intestinal bacterial overgrowth sounds like many of the syndromes that develop as a result of gut inflammation that harms the microbiome. Every factor that we know of that harms gut microbes can lead to SIBO. (See Chapter 3: Harming Your Microbiome.)

SIBO has now joined the pantheon of gastrointestinal symptoms and distress that includes leaky gut syndrome, Crohn's and celiac disease, and irritable bowel syndrome. Occurrences of all of them continue to increase worldwide. Now we have SIBO following the same pattern. It is particularly frequent in those who suffer from certain other underlying conditions.

When you have SIBO food passes through the small intestine less efficiently. The bacterial overgrowth interferes with the healthy digestive and absorption process. The bacterium associated with SIBO actually

consumes some of the foods and nutrients, leading to unpleasant SIBO symptoms, including gas, bloating and pain.
Relapse rates are high even when treating SIBO with antibiotics.

The indications of SIBO mirror the symptoms of other gastrointestinal disorders. According to a study published in the *World Journal of Gastroenterology*, there's good reason for the similar symptoms. There is a clear association, for example, between SIBO and IBS (Ghoshal and Srivastava 2014). Researchers suggest that physicians give consideration of excluding SIBO before giving a definitive diagnosis of IBS.

Common symptoms that are shared between SIBO and IBS include:

- Nausea
- Bloating
- Vomiting
- Diarrhea
- Malnutrition
- Weight loss
- Joint pain
- Fatigue
- Rashes
- Acne
- Eczema
- Asthma
- Depression
- Rosacea

All those symptoms should look familiar to you by now. They all have their roots
in a damaged microbiome. They all point to the same factors that you read about earlier on what people do to harm their gut microbes.

The treatment of choice in mainstream medicine is antibiotics. Even with antibiotics, SIBO is difficult to treat. In fact, a study published in 2008 concluded that SIBO patients treated with antibiotics have a high recurrence rate and that gastrointestinal symptoms increased during the recurrences (Lauritano et al. 2008).

More recently a pilot study at the Center for Medical Education and Clinical Research in Buenos Aires, Argentina, found probiotics have a higher efficacy rate than metronidazole for individuals with SIBO (Soifer et al. 2010).

In this study, *Lactobacillus casei, Lactobacillus plantarum, Streptococcus faecalis* and *Bifidobacterium brevis* were administered for

five days to half of the study group, while the other half of the study group received antibiotics for five days. All participants ate the same diet, which limited consumption of dairy products, legumes, leafy green vegetables and alcohol.

The results were astounding. An average of 82 percent of the probiotic treatment group reported clinical improvement. In contrast, only 52 percent of the antibiotics group reported any improvement.

Once again, probiotics come to the rescue.

3. Candidiasis

The type of yeasts that we host in our GI tract are collectively called Candida, even though several species come under this umbrella name. The main culprit, however, is one particular species. It has the scientific name, *Candida albicans*. Even though *C. albicans* is a parasite, it is easily controlled by a healthy microbiome.

Yes, this another of the growing list of maladies that arise when we harm our friendly gut microbes. Yeast overgrowth (**candidiasis**) starts in the GI tract. Trouble amplifies when yeast cells escape the digestive system, such as through a leaky gut, and influence the whole body.

Once it escapes the GI tract, it acts like a foreign invader. The expected response of the immune system often goes haywire to the point that autoimmunity appears. Candidiasis is strongly associated with all autoimmune diseases. Once again, though, probiotics have a curative effect on autoimmunity by tamping down yeast overgrowth (Leão et al. 2018).

In addition, probiotics produce antifungal substances that directly inhibit yeasts from invading the intestinal mucosa in the first place (Matsubara et al. 2016).

Focus on treating candidiasis with probiotics is especially valuable because they restore the normal bacterial defense system that keeps Candida in check.

By the way, the popular notion that a so-called “yeast infection” is a

woman's problem could not be further from the truth. Men and women alike are susceptible to yeast overgrowth. All that Candida needs is a warm, dark digestive system, preferably one that houses a damaged microbiome.

Candidiasis had already reached epidemic proportions by the 1980s (Fisher-Hoch and Hutwagner1995). It has only worsened over the years (Chakravarthi and Haleagrahara 2011). Currently it is a worldwide health disaster that keeps getting worse.

C. Taking Care of Your Two Brains

You read that right. You have two brains. In fact, they work together to keep your body running smoothly in nearly every way you can imagine.

You already know about the brain in your head, of course. What you may not know is that **you also have a brain in your gut**.

How important is it? How's this: your life depends on your second brain every bit as much as it does on your main brain. In fact, both of your brains are connected to one another.

What that means, simply, is that your gut microbes play a role in the health of two brains.

Crosstalk between your second brain and your main brain shows how most so-called mental disorders have just as much to do with your gut as with your main brain. Indeed, gut issues underlie the most devastating mental ailments of all time, including Alzheimer's disease and other types of dementia, autism spectrum disorder, depression, and Parkinson's disease.

In addition, your gut brain literally tells your main brain what to do with hormone levels, emotions, and even how you think. Whether you are happy or depressed, count on your gut to be behind your mood.

1. What Exactly is Your Second Brain?

Your second brain is technically referred to as your ***enteric nervous system*** (ENS). It consists of around 500 million neurons, compared with about 100 billion in your main brain.

Your second brain (i.e., ENS) is not as well known to the public as your main brain, although science has suspected its existence at least since the 19th century.

If you are having a hard time grasping the concept of a second brain, you are in good company. The suggestion that another brain exists, in your gut, still seems incredible. Even modern science didn't truly start believing it until the mid-1960s. That's when studies by Dr. Michael Gershon at Columbia University showed that the mood hormone, serotonin, was produced by and functioned in the gut. In other words, serotonin can originate and work in the gut, not just in the main brain.

Research on the second brain has expanded so fast over the past few decades that Dr. Gerson has already written the first major book on it: *The Second Brain: The Scientific Basis of Gut Instinct and a Groundbreaking New Understanding of Nervous Disorders of the Stomach and Intestines* (Gershon 1998).

This book represents a relatively new field of study, called *neurogastroenterology*. Several scientific societies and their research journals are now dedicated to this field of study around the world.

Researchers are still figuring out the complete picture of how your two brains interact with each other to keep you healthy. Nevertheless, it is abundantly clear that your health depends on a healthy gut-brain and its interaction with your main brain.

It is equally clear that many modern diseases appear when your gut-brain doesn't work properly.

The good news is that you can achieve good health, mentally and physically, by taking good care of your second brain.

Now let's take a deeper look into what your second brain does for you, how it connects to your main brain, and what you must do to keep both of them in optimal working condition for your health.

2. The Gut-Brain Axis

As exciting as research in neurogastroenterology has become, studies generally only address the gut-brain (ENS) by itself. However, how it actually works is intimately tied to its connection to the main brain. This crucial connection is called the **gut-brain axis** (GBA).

Understanding the GBA is the foundation for discovering how to prevent and reverse many of the most disastrous mental and physical diseases of modern times.

Now for the real kicker about your GBA.

The most notable discoveries about how the gut-brain axis works is its reliance on the microbiome.

Your microbiome is in the driver's seat for directing much of what your two brains do for you. In recognition of its importance, science now refers to it as the **microbiome-gut-brain axis** (MGBA). Research on the MGBA clearly shows how gut microbes influence your mental health.

3. Science Behind Your Two-Brain System

The first studies on the GBA as an interactive system began to appear in the scientific literature in the early 1980s. Since that time more than 1,200 journal articles have been published about it. Although it continues to attract attention as its own field of study, scientifically the GBA is still the new kid on the block.

Nevertheless, this relatively new area of research has already produced some eye-opening insights into what you can do for achieving good health through your GBA. The most exciting of these studies point directly at the role of the microbiome in keeping your two brains – and you – in top form.

4. Microbiome-Gut-Brain Connections

The influence of the microbiome on gut health has been known for more than a century. Revelations about its roles in the gut-brain connection are much more recent. New discoveries have been appearing right and left

over the past few year (Carabotti et al. 2015; Clapp et al. 2017; Galland 2014; Grenham et al. 2011; Mayer et al. 2015; Prinsloo and Lyle 2015; Liu and Zhu 2018).

Highlights of the latest point to the microbiome as the command center for a two-way communication system between the gut-brain and the main brain.

The most important of these are as follows.

a. The Vagus Nerve. This nerve is the most prominent physical connection along the MGBA. It is the longest cranial (brain) nerve, extending directly from both sides of your main brain all the way to your gut. It reaches to your esophagus, stomach, small intestine, and colon.

Along the way to your GI tract, the vagus nerve also connects to the heart, lungs, liver, spleen, and kidneys.

Communication between the vagus nerve and its various connections goes both ways. Your main brain sends signals through the vagus nerve to the gut and other organs. Likewise, the vagus nerve receives signals from your gut and all other organs attached to it, then sends those signals back to the main brain.

This means that your gut talks to your main brain, which in turn talks to your gut-brain. Your gut essentially uses the vagus nerve like a walkie-talkie to tell your brain how well your gut and other organs are working.

Microbes in your microbiome secrete dozens of substances that directly control vagal nerve transmission from your gut-brain to your main brain.

The experiences of having “butterflies” in your stomach, “gut-wrenching” feelings, or “gut instincts” are very real. They begin in your gut. Your gut, in turn, communicates your feelings right up through your vagus nerve to your main brain.

A drop in vagal tone – i.e., how well the walkie-talkie communicates between your two brains – is responsible for such symptoms as fatigue, food sensitivities, many gut problems, and brain fog. Typical gut problems

tell your main brain, for example, about indigestion**,** nausea, urge to vomit, acid reflux, ulcerative colitis, anorexia, and bulimia, to name a few**.**

Dozens of factors influence vagal tone. The latest thinking on how to keep the vagus nerve humming along focuses on balancing the microbiome. Probiotics, for example, represent the newest therapeutic strategy for treating gut-based mood disorders (Forsythe and Kunze 2013).

b. Gut Hormone Signaling. Dr. Gerson's early research on serotonin production in the gut, mentioned earlier, just scratched the surface about hormones in the GI tract. We now know that 95% of the serotonin in your body is found in your bowels. That's not all. Your gut uses more than 30 neurotransmitters, just like your brain (Hadhazy 2010).

Certain of these neurotransmitters are produced directly by intestinal bacteria.

In addition, the gut produces several other kinds of hormones that regulate the communication between the gut-brain and the main brain. These include hormones that tell the main brain about nutrient levels and how to respond to them. This is how you know that you are full when you eat.

Research on gut hormones explains how disruptions in the MGBA can lead to obesity, diabetes, and other metabolic disorders (Dockray 2014).

Hormone signaling pathways are so tightly controlled by gut microbes that the microbiome functions as a virtual endocrine gland. As such, it is a crucial part of an endocrine system that includes the pineal, pituitary, thyroid, and adrenal glands, plus the thymus, pancreas, ovary and testis.

A 2014 review in the journal, *Molecular Endocrinology* referred to the microbiome as the "neglected endocrine organ." Its role in gut hormone signaling is neglected no more (Clarke et al. 2014).

The microbiome is clearly the key to preventing and treating disorders of what modern medicine calls the metabolic syndrome. This means that gut microbes have major impacts on hormone-driven health issues, including obesity, cardiovascular disease, high blood pressure, poor

cholesterol profiles, insulin resistance, and type 2 diabetes (Rastelli et al. 2018).

c. Microbes on the Brain. Although normally you don't actually have microbes infecting your brain, your microbiome is clearly at the root of your brain function. Science is rapidly catching up to the roles that microbes have on brain health.

The microbiome influences brain development, cognition, behavior, and mood (Rogers et al. 2016). Damage to the microbial community in the GI tract due to a poor diet or to the use of antibiotics or antidepressants is associated with mental illness. On the other hand, probiotic therapies that restore the microbial balance in your gut can reverse or lessen mental problems.

Altered communication between the microbiome and the GBA characterizes several major psychiatric disorders (Fond et al. 2014). These include depression, schizophrenia, and anxiety.

It is no surprise that this list now also includes autism spectrum disorder (Strati et al. 2017).

One of the most fearsome mental disorders in modern times is Alzheimer's disease. The incidence of this insidious disease continues to rise in older adults. At the same time it is also reaching back more often to afflict those in younger generations.

Many competing theories purport to explain the causes of Alzheimer's disease. Different explanations point to a variety of potential treatments, all with limited or no success. One of the most promising approaches, however, addresses the role of the microbiome.

For example, a 2016 study showed that probiotic-treated Alzheimer's patients made significant improvements in their mental states, while subjects in the control group continued to deteriorate (Akbari et al. 2016).

More recently, the consumption of a common gut microbe (*Bifidobacterium breve*) was found to suppress certain genes that are induced by the amyloid plaque proteins that characterize Alzheimer's disease (Kobayashi et al. 2017).

The benefits of probiotics do definitely seem to include a reduction in depression symptoms, according to a 2016 meta-analysis, the first review of its kind (Huang et al. 2016). Taking probiotics might also help reduce re-hospitalizations from manic episodes for those with manic depression (Dickerson et al. 2018).

A slightly more surprising result, however, seems to be the way that probiotics may impact some of the symptoms of autism. Autism and gut health have been discussed for some time, as patients with the disorder typically suffer from a large number of digestive issues. However, based on animal studies, it seems possible that altering the quality of gut bacteria might benefit not only the digestive system but the abnormal behaviors in autism, too (Mayer et al. 2014).

In 2016, a case study was published about a boy with severe autism who was taking probiotic supplements. Probiotics were administered to treat his digestive problems. The patient spontaneously improved on the ADOS scale, a diagnostic rating system for people with autism. The score dropped from 20, down three points, to a stable 17. According to the report, ADOS scores do not, "…fluctuate spontaneously along time…" and are normally absolutely stable (Grossi et al. 2016).

Because of results like those above, human studies are currently underway to determine if probiotic supplements may improve not only the GI symptoms seen in autism but also on the core deficits of the disorder, on cognitive and language development, and on brain function and connectivity (Santocchi et al. 2016)..

Chapter 6. PROBIOTIC GUIDELINES

Research and development behind probiotic supplements points to two main criteria to guide you in choosing products that will work based on science. Note that, as you discover what to look for, you will realize that commercial probiotic foods almost always fail to meet one or more of these criteria. On the other hand, good probiotic supplements that fulfill these criteria are widely available.

First and foremost, like any other health treatment, **dosage** reigns supreme. You simply must get a sufficient number of organisms per serving to make a difference.

Of equal importance, in parallel with dosage, is **bacterial diversity**. How many different species of bacteria do you need for harvesting all of the marvelous benefits of probiotics that you read about in the preceding chapters? Answering this question goes hand in hand with choosing which species to look for in a good supplement.

A recent review of basic recommendations appeared in the journal, Clinical Gastrogenterology and Hepatology, which is the official clinical practice journal of the American Gastroenterological Association (Ciorba 2012). That review cited the latest overview of the Triennial Yale/Harvard Workshop on Probiotic Recommendations, which has since been updated to 2014 (Floch 2014; Floch et al. 2015).

Professional recommendations such as these are excellent sources of advice for choosing the best dosages and the most effective bacterial species for restoring and maintaining a healthy microbiome. Such recommendations underscore the value of probiotics against all of the ***intestinal and non-intestinal diseases*** that begin in the GI tract (de Vrese and Schrezenmeir 2008).

What about safety? Safety is of prime importance for any kind of supplement, including probiotics. Neither the FDA nor any other regulatory agency tests supplements for safety. In this regard, “buyer beware” is your best approach. Fortunately, plenty of information is available for you to make a safe selection for your probiotic supplement.

A. Dosage

The potency of a probiotic is measured in the number live cells or colony forming units (CFU) per serving. The CFU count should be clearly stated on a product label. Typically, different products will range as low as 1-2 billion CFU, up to tens of billions.

There is no generally accepted optimum recommended dosage, although many probiotics experts suggest a maintenance dose of 8 to 50 billion per day. In checking the label on a probiotic supplement, you will find good products with dosages in this range and you will find products that have a fraction of this number.

The high end daily dose of 50 billion CFU ensures that your microbiome is healthy enough to provide all the benefits that you can expect from your gut bacteria.

How high can a dosage be? A prescription product called VSL#3 provides the highest dosage known for any one product. It is a blend of 8 different bacterial species that total 450 billion CFU in a single dose. Research study using four doses per day (i.e., **3.6 trillion CFU** daily!) revealed no side effects even at such extreme levels (Tursi et al. 2010). This product is very expensive and not available in health food stores or over the counter. Nevertheless, its successful use at such high dosages shows that there is no practical upper limit to how much you can take.

B. How Many Species?

With advancing technology, scientists have been able to select specific strains of organisms to accomplish precise tasks. Evidence now shows that individual species of probiotics within two particular groups of bacteria – the Lactobacillus group and the Bifidobacterium group – are the most powerful overall for supporting the microbiome in the face of chronic disease.

These two groups are often combined with species of two other groups, Streptococcus and Bacillus, for further boosting the benefits from lactobacilli and bifidobacteria.

There are many specific types of bacteria within these groups. The health benefits associated with each of them may be unique, although they often overlap. This means that using multiple different species delivers better odds of reversing the negative effects of dysbiosis (Chapman et al. 2011, 2012).

Experts have not determined a one-size-fits-all for how many kinds of bacteria are best for everyone. Generally, though, that number hovers around 8-12 different species. The following are the names that you should look for on the label of whatever probiotic product that you are considering for your own use and the research-based benefits that you can expect from them.

Lactobacillus acidophilus

- Reduces diarrhea and improves bowel function in cases of radiation-induced enteritis
- Increases HDL (good) cholesterol
- Improves markers for metabolic syndrome, inflammation, and heart disease
- Improves allergy-driven immune response
- Improves markers for ulcerative colitis and irritable bowel disease
- Increases control of blood sugar
- Decreases the DNA damage that can trigger malignant cell development

Lactobacillus rhamnosus

- Reduces diarrhea and improves bowel comfort in cases of radiation-induced enteritis
- Improves markers for metabolic syndrome, inflammation, and heart disease
- Reduces allergic response to milk in milk-sensitive patients
- Improves markers for ulcerative colitis and irritable bowel disease, including Crohn’s disease

Lactobacillus paracasei

- Enhances therapeutic management of Minimal Hepatic Encephalopathy (MHE), which is poor mental function due to liver failure
- Improve markers for metabolic syndrome, inflammation, and heart disease in elderly patients
- Improve markers for ulcerative colitis and irritable bowel disease
- Reduces markers of inflammation
- Improves markers for ulcerative colitis and irritable bowel disease

Lactobacillus plantarum

- Protects from candida yeast overgrowth)
- Supports detoxification
- Enhances nutrient absorption

Lactobacillus casei

- Improves immunity
- Reduces allergies, especially in newborns
- Lowers LDL cholesterol levels and raise HDL cholesterol levels
- Reduces triglyceride levels
- Reduces diarrhea and constipation
- Maintains remission of diverticular disease
- Reduces occurrence, risk and symptoms of IBS
- Inhibits *H. pylori* infection
- Decreases milk intolerance
- Prevents colorectal tumor growth
- Inhibits tumor growth of stomach cancer
- Inhibits candida yeast overgrowth
- Inhibits infections by viruses and pathogenic bacteria
- Inhibits overgrowth by *Clostridium difficile* (C-diff)

Lactobacillus brevis

- Boosts immune system health
- Supports heart health

- Prevents replication of harmful bacteria
- Helps fight side effects of repeated antibiotic treatment
- Combats ulcers
- Helps the health and condition of the gums
- Boosts the effectiveness of antibiotics

Lactobacillus salivarius

- Improves digestive health
- Improves immunity
- Improves dental health
- Helps fight bad bacteria, especially *E. coli* and Salmonella
- Aids in the digestion of proteins
- Inhibits candida yeast overgrowth
- Helps prevent strep throat
- Reduces ulcerative colitis and IBS

Lactobacillus gasseri

- Reduces belly fat
- Inhibits fat production
- Speeds up metabolism
- Reduces allergies
- Reduces asthma
- Reduces constipation and diarrhea
- Inhibits *H. pylori* infection
- Reduces high cholesterol
- Reduces menstrual pain

Lactobacillus bulgaricus

- Promotes liver health
- Reduces symptoms of the common cold
- Fights diarrhea caused by antibiotics
- Diminishes IBS
- Reverses atopic dermatitis (eczema)
- Helps against hay fever
- Prevents tooth decay

Bifidobacterium lactis

- Improves immune function in healthy, elderly individuals
- Boosts weight gain and reduces gut inflammation in preterm infants
- Improves immune response and respiratory symptoms from birch pollen allergies in children
- Increases control of blood sugar

Bifidobacterium bifidum

- Improves markers for liver inflammation and damage in alcohol-related liver disease
- Improves inflammation profiles in ulcerative colitis and irritable bowel disease
- Decreases liver damage

Bifidobacterium longum

- Increases HDL cholesterol
- Reduces ulcerative colitis, IBS and Crohn's disease
- Reduces diarrhea and improved bowel function in cases of radiation-induced enteritis
- Improves markers for ulcerative colitis and irritable bowel disease, including Crohn's disease
- Decreases the DNA damage that can trigger malignant cell development
- Improves immune function in healthy, elderly individuals.
- Boosts weight gain and reduces gut inflammation in preterm infants
- Improves immune response and respiratory symptoms from pollen allergies in children
- Increases control of blood sugar

Bifidobacterium breve

- Improves skin tone
- Reduces allergies

- Reduces asthma
- Combats obesity
- Alleviates constipation and diarrhea
- Reduces symptoms of celiac disease
- Fights infections
- Boosts BDNF (brain-derived neurotrophic factor for brain function)

Bifidobacterium adolescentis

- Inhibits cervical cancer virus (human papillomavirus)
- Synthesizes various B vitamins
- Prevents immune system aging in the elderly

Streptococcus thermophilus

- Improves digestion
- Reduces antibiotic associated diarrhea
- Improves lactose digestion
- Decreases IBS symptoms
- Prevents ulcers caused by *H. pylori*
- Fights *Clostridium difficile* infections (C-diff)
- Increase HDL (good cholesterol)

Streptococcus salivarius

- Reduces incidence of sore throats
- Decreases occurrence of ear infections
- Inhibits formation of dental plaque
- Lessens levels of sulfur-based compounds that cause bad breath
- Promotes healthy inflammatory response in the gums

Bacillus coagulans

- Boost lactic acid levels for working muscles
- Improve absorption of nutrients from food
- Protect against mercury toxicity

- Enhance immune system

Saccharomyces boulardii (yeast)

Since *S. boulardii* is not bacterial, it must be cultured and prepared differently than other probiotic microbes. This means that products containing it only provide just this one species.

- Reduces symptoms of Crohn's disease
- Decreases diarrhea
- Inhibits irritable bowel syndrome
- Helps against ulcerative colitis
- Fight *Clostridium difficile* infections (C-diff)

C. Other Considerations

Besides dosage and species diversity, what else should you look for in a probiotic supplement? Some of the more obvious factors include:

- Choosing a reputable brand that you trust. After all, you have to take their word for it that it's a high-quality product.
- Determining CFU shelf life. You don't want just the CFU at "time of manufacture." You also need to know how long they will retain their viability.
- Making sure the package is re-sealable. Is it being stored as directed on the product label?
- Ensuring that it does not contain any genetically bioengineered ingredients (GMOs).
- Confirming that the product is manufactured according to current Good Manufacturing Practices (cGMP).

1. Acid and Bile Resistance

Probiotics must pass through the acid and bile of the stomach and reach the small intestine unharmed to be effective. Different products may accomplish this by sealing the capsule with an enteric coating that is supposed to slowly dissolve in the stomach, releasing the contents at just the right time for entering the small intestine. Be aware, however, that some enteric coatings are applied with heat that can destroy bacteria, and

that some ingredients of enteric coatings are not acceptable to people who want an all-natural product.

Other products use strains that have been developed in the laboratory to be naturally resistant to the harsh environment of the stomach. This strategy mimics nature, since the bacteria that originally colonized our intestines had to already be strong enough to get through the stomach.

2. Special Formulas

Some products address specific groups of people or specific conditions based on different mixtures of probiotic strains. For example, women's formulas contain strains with the most benefit for a healthy vaginal flora and urinary balance in the face of Candida overgrowth. Special formulas are also available in products for infants and children for conditions where the normal microflora has not yet been built or where it has been damaged by antibiotics.

Sinus health also suffers from Candida overgrowth, which means that probiotics can be helpful for addressing sinus infections. High-potency probiotic formulas that are targeted for sinus conditions are available for supporting sinus and bronchial health.

3. How Long Should You Take Probiotics?

Probiotic supplements contain living microorganisms that have a limited lifespan. In addition, many strains do not colonize the gut and are passed through the GI tract quickly (Sanders 2011). They may be completely gone in as little as 1-4 weeks.

Even though such "short-term" microbes may not hang around for long, they do alter gene expression patterns in the host's resident microbiome (McNulty et al. 2011). However, it is a transient effect that is confined only to the time of the probiotic consumption. Any sustained benefit from such probiotic bacteria, therefore, requires continued consumption.

On other words, taking probiotic supplements should be a daily, lifelong endeavor.

4. What to Do When Taking Antibiotics

Consuming probiotics while also taking antibiotics may seem futile. Antibiotics are not selective. They kill friendly bacteria as well as pathogenic ones.

The key for keeping your microbiome healthy while taking antibiotics is a matter of timing. However delaying taking probiotics all the way through an antibiotic series can cause devastating, long-lasting harm to your microbiome.

Nevertheless, you should not take antibiotics and probiotics at exactly the same time. The secret to combining their use is to delay taking the probiotic supplement a few hours before or after taking the antibiotic.

FINAL REMARKS

Recently science has become very clear about the old paradigm that "you are your genes." Such thinking is now viewed, at on the leading edge of health research, as flat out wrong.

You still have genes. Yet it is what you do to make them work that makes you who you are. Actually, we know now that it is not what **YOU** do to your genes as much as it is what your internal **MICROBES** do them. The actions your 20,000 or so human genes are dwarfed by the trillions of genes that comprise your microbiome.

You are much, much more than a human. You are, indeed, more like a **superorganism** that combines your own 30 trillion cells with the 40 trillion microbial cells that live inside you.

This concept has become a touchstone for a revolution in healthcare. It has already spawned a major book on the topic: *The Human Superorganism: How the Microbiome is Revolutionizing the Pursuit of a Healthy Life* by Cornell University Professor, Dr. Rodney Dietert (Dietert 2016).

Virtually all of the best research that addresses this concept, even if indirectly, has appeared in the scientific literature within the past couple of decades. You should not be surprised to find out that mainstream medicine, probably including your own doctor, has been slow to embrace it.

This means that it is up to you to learn about how your superorganism works and what you can do to make it work better. This book represents a peek into what you need to know at this time. The knowledge base, however, is growing daily.

You are your microbes, and they are you.

ABOUT THE AUTHOR

Dr. Dennis Clark holds a bachelor's degree in Biological Sciences from Sacramento State College and a Ph.D. in Botany, specializing in plant chemistry, from the University of Texas at Austin. He spent his entire 30-year professional career in teaching and research at Arizona State University. He has also been Visiting Professor at the University of California and at the University of Heidelberg in Germany. He is currently an adjunct professor at the Southwest College of Naturopathic Medicine.

Dr. Clark is a leading expert on plant natural products chemistry and integrative medicine, an award-winning teacher, and co-author of a best-selling college textbook on botany. He has been awarded grants for his research from the National Science Foundation, the U.S. Department of Agriculture, and the Alexander von Humboldt Foundation. His studies have been published in dozens of national and international scientific journals. He has lectured at international conferences in the U.S., Canada, Mexico, Germany, Belgium, and England.

Dr. Clark's journey into medical botany and natural health began when, as a young university professor, he found that his knowledge of plant chemistry could be used to explain how plant natural products affect human health. This led to his discovering which botanicals were best for enhancing the health of his family and friends. He soon found that his university students also wanted the same kind of information. Their ever growing demand for his science-based approach to natural health led to several new classes in integrative medicine, medical botany, and natural products pharmacology.

As Dr. Clark states, "I feel blessed to have a background that enables me to evaluate both the scientific literature and the popular press on natural medicines and to dig out, understand, and explain to the public how and why these medicines work. People should be able to get straightforward answers to simple questions about which natural medicines will work for them and what commercial brands are reliable for what they need.

Unfortunately, these answers are not easy to find for people who do not have an extensive scientific background. My role is to provide this service, to bring the best research available on medicinal plants to the public's attention and to lead the way in the evaluation and development of quality products."

Over the years Dr. Clark has gathered the best information available on natural approaches for preventing and overcoming many human disorders. These include herpes, obesity and overweight, menopause and hormone imbalance, cancer, osteoporosis, arthritis, stress, cardiovascular disease, diabetes, digestive problems, candida (yeast) overgrowth, and many others. He uses his expertise from many years of teaching, researching, and writing to provide the public his clear, powerful, and often entertaining views of a research scientist about being healthy naturally.

Dr. Clark is in demand as a guest speaker for local groups and radio and TV programs on many aspects of wellness.

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