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# NUTRITION
## MY QUINTESSENTIALS

How to Stay Strong and Healthy for Longer

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# The Connection between the Head and the Stomach

## How the Gut and the Liver Determine our Health

Our digestion is crucial to our overall health. It is an incredible feat of regulation and communication within our body, a multidisciplinary collaboration between the brain, neurons, and muscle cells, between enzymes, hormones, and transmitters. Everything we consume (often in excessive amounts) on a daily basis needs to be thoroughly filtered, broken down, transformed, converted, recycled, or entirely disposed of. At the end of these procedures is the nutrient uptake, which provides us with the energy we need to live and on which our health ultimately depends. Since the ingredients and the combinations of diverse foodstuffs are complex, and we tend to eat too much, too often, and too quickly, the body is overburdened and pushed to the limits of its capacity to self-regulate.

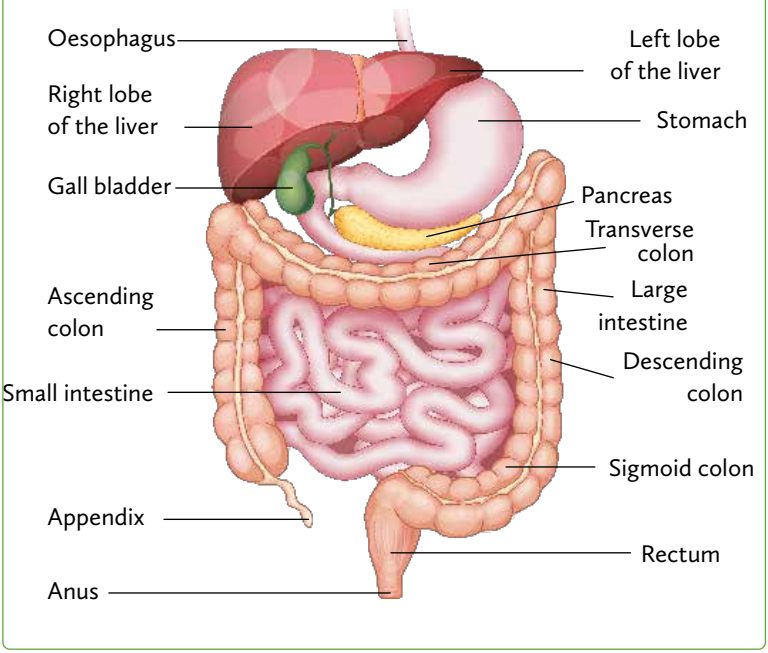
# Research Decodes the Central Role of the Gut for our Health

After centuries of being treated like the ugly stepsister of medical world, in recent times, we have finally ceased underestimating the gut. Indeed, the gut and the ensemble of billions of microorganisms it hosts – the microbiota or "microbiome" – are now one of the hottest topics in the medical world. The gut can cause a whole range of unpleasant symptoms. Irritable bowel syndrome causes bloating, diarrhoea, and stomach pain. Inflammation leads to acute infections and severe symptoms, and at worst, can foster the development of bowel cancer. Food intolerances are on the rise, with a recent representative study finding that around a fifth of all Germans suffer from some intolerance or other. While I was at university, I learned that when it came to the hierarchy of digestion (but also on the ladder of all the bodily organs) the large intestine was right down near the bottom. If we decide to ignore the microbiome, that seems fair enough, at least if we view the process of digestion ass merely a process of digesting and expelling food. Viewed from another perspective, however, digestion begins in the head by way of the activation of complex neurohormonal signals in the brain. In order to coordinate the process, before and during the process of eating, neurotransmitters are released, which communicate with other systems in the body. The food, which is (hopefully) well chewed and coated in saliva in the mouth, is swallowed and moved through the oesophagus to the stomach, where it lands in an acid bath. Due to its extremely acidic PH value of 1.5 to 2, stomach acid is a highly effective form of protection against unwanted microbes and bacteria. There are only a few bacteria that are able to survive in this environment. One kind of bacteria is of enormous importance here: Helicobacter pylori. For their work revealing that these little rod-shaped guests are the primary cause of stomach ulcers, two Australian researchers – Barry Marshall and

John Robin Warren – were awarded the Nobel Prize in 2005. As soon as this bacterium has made itself at home and begun causing symptoms, it ought to be immediately driven out using antibiotics. Once the food has reached the stomach, though, hydrochloric acid, enzymes, and powerful rocking motions transform the foodstuffs into a viscous mass.

Depending on what we have eaten, the stomach needs between one and two hours for easily digested foods like fruit or vegetables, and six to eight hours for high-protein food (primarily meat) or fatty foodstuffs. The stomach is a bit like the woodchip machine of the human body. It is only when the larger bits of food have been broken down to the size of a pea that this mass, called "chyme", is released into the small intestine. That is where the detailed work begins, and the various components of the food head off on their separate paths. The bile produced in the liver is collected in the gallbladder and released into the bile ducts, the pancreas produces special enzymes that break down the protein. All of this then ends up in the duodenum. In the small intestine, together with other juices from the pancreas and bile, the corrosive stomach acid is neutralised.

The small intestine, which winds around through the abdomen over a length of up to five metres, is a high-performance machine. A key role in this performance is played by its massive surface are, which is made even larger by what are known as villi: small, finger-like protuberances, about a millimetre in length, which are themselves covered in countless, tiny, thread-like protrusions. This structure makes the interior surface of the small intestine enormous. A few years ago, we thought that it might measure up to 300 square metres. Nowadays we know that it is just 30 square metres. But nevertheless, this surface area facilitates the rapid and comprehensive uptake of nutrients from the partly digested chyme. Before this, enzymes break up the already partly broken-down foodstuffs into increasingly small molecules: proteins are broken down into amino acids, carbohydrates into sugars, and fats into fatty acids and monoglyceride. Only in this form can these nutrient-rich particles




**From a purely visual perspective, the intestines are no thing of beauty. At least that was my impression when I worked as a surgeon. It is made up of large and small intestinal loops that fill the abdominal cavity. The small intestine looks a bit like the inner tube of a bicycle tyre, while the contours of the large intestine are, as the name suggests, somewhat larger in volume. On the inside, they are reminiscent of a relief sculpture on the walls of a cloister.**

enter the bloodstream via the intestinal wall together with the vitamins and minerals that have been absorbed. The bloodstream takes them to the liver. From here, the material that our intestinal tract has squeezed out of the food is ultimately transported by the blood to the cells, where everything reaches its "end user", so to speak, and this new energy allows us to continue living.

This process, which takes place every day and sounds so simple, is in truth an impressive achievement, particularly on the part of the small intestine. But it is also so demanding for the cells of the

intestinal wall that every day, billions of new epithelial cells are produced and the intestinal mucosa is continually being renewed. Every three or four days, it is completely regenerated! The remains of the cells that are shed are expelled in our faeces. That is one of the reasons why even during long periods of fasting, we still have small bowel movements.

Once the small intestine has done its job, the undigested remains of the food make their way into the large intestine. At first glance, you could be forgiven for thinking that the large intestine is just the place where the food remains are prepared to be expelled. Any leftover water and salt is extracted and distributed back into the bloodstream, making the faeces drier. Mucus is added to help lubricate its passage. But that is only one function of the large intestine, and perhaps its least interesting one. In a simplified fashion, we can summarise the division of tasks as follows: the small intestine digests, the large intestine metabolises. Because the food residue that arrives in the large intestine – first and foremost the fibre, which is not able to be completely broken down – now comes into contact with the world of the microbiome. Billions of bacteria and microorganisms eagerly await the arrival of this food residue, and they descend upon it, digesting it by way of enzymes and fermentation, feeding on it. With a high-fibre diet made up of lots of vegetables and whole grains, it is a feast for the microbiome, with junk food and animal-based foodstuffs, it is a paltry affair with few positive effects.

Nowadays, we know that the microbiome is utterly crucial for our overall health. That which, up until the beginning of this century, was described under the catch-all term "gut flora" and was an object of attention almost exclusively in natural medicine circles, has in recent years evolved into one of the most dynamic and important fields of medical research. The microbiome of the gut (derived from the Greek *mikrós* "small", and *bios* "life") is a gigantic collection of microbes that live with us: bacteria, viruses, fungi, archaea, and even parasites. While the relationship between microbiome, nutrition, health, and sickness is complex, the fundamental

principle of our symbiosis with our inhabitants is utterly simple: they receive food and board free of charge, and in exchange, they help us to extract the things from the food we eat that our body needs. The gut bacteria break up the fibre, producing short-chain fatty acids that are good for the gut, and they even produce a number of vitamins and amino acids, which are then turned into important proteins. On top of this, these microorganisms remove toxins, such as those produced by the breakdown of bile acid. What's more, they also regulate the pH level of the gut.

There are plenty of impressive things about the microbiome, beginning with the also the sheer number of microorganisms that make it up and the fact that it can weigh a good two kilograms. It is a large ecosystem. Some people invoke the image of a jungle, teeming with an uncountable number of larger and smaller animals. For a long time, the field of medicine tended to throw its arms up in the air in the face of this complexity.

For more than two decades, I attempted to use microbiological stool analyses to draw conclusions about the gut health of my patients and to understand the progression of their illnesses, using the classical laboratory procedures of microbiology to count the bacteria on petri dishes. I never had any success with it, and at some point, my faith in this diagnostic method evaporated, as it proved to be too susceptible to error. If the tubes sat around at warm temperatures, for example, or took too long to get to the lab, the results would be distorted. Gastroenterologists are of the view that in order to achieve reliable results, the samples need to be taken via a colonoscopy. But who would put themselves through a colonoscopy just to have their microbiome analysed?

Eventually, there was a revolution in the diagnostic techniques. We saw the dawning of the era of genetic analysis of microorganisms in stool samples, known as gene sequencing. Initially, there was a great deal of surprise when researchers discovered that classical microbiological analysis had only identified around 1 per cent of the microbes, meaning we were only fishing on the very surface and thus knew next to nothing about the microbiome. Since then,

things have moved along at a rapid pace. First with 16S RNA sequencing, then with so-called shotgun sequencing, and now with AI-supported biomathematical processing. This is an extremely complex task that would be impossible without powerful computer programs. The volume of data that is produced through the genetic sequencing of billions of microorganisms and an understanding of their interplay with other factors allow us to gain insights into the digestive system that were for a long time inconceivable.

Researchers discovered that half of the tiny organisms they could identify in the microbiome were unknown to them. They had no biological names. So the researchers gave some of them nicknames. To date, 30 per cent of these microscopic entities have been distinguished. And though researchers presume that it won't take them long to classify all of these microorganisms, we still have a way to go before the findings of this research can be applied in a targeted fashion in the practice of medicine.

It seems relatively clear that a good balance in the gut generally leads to less inflammation and to a reduction of aging within the body, a process known as "inflammaging". It was Russian-Ukrainian immunologist Ilya Ilyich Mechnikov (1845–1916) who discovered the cells known as macrophages. In the early years of the 20th century, Mechnikov, who would later be awarded the Nobel Prize, divined how important certain bacteria are for us. He hypothesized that the secret behind the long lifespans he observed among Bulgarian miners was related to the leather receptacles in which they transported their milk. On longer trips, the milk stored inside these receptacles would become sour thanks to the effect of "good" bacteria, making it into a kind of probiotic drink. A significant demand emerged for this drink containing Lactobacillus bulgaricus, which seemed to gift its consumers many extra years of life. Mechnikov carried out a great deal of research in this area, demonstrating that the bacteria that create lactic acid – as in soured milk and yoghurt, but particularly in the drink kefir – inhibit dangerous bacteria.

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## How the Gut Gets Stressed

Today, scientists all agree that the microbiome is of central importance to our health. Drawing on big data from more than 50,000 participants, teams of researchers at renowned institutions such as King's College in London have identified 50 species of bacteria as primarily healthy, and 50 that they have categorised as unhealthy. Their connection with nutrition – but also with smoking, alcohol consumption, exercise, medication, or infections, such as COVID-19 – is clear. Negative influences such as poor nutrition can lead to an overgrowth of bacteria in the gut, to what is known as a dysbiosis, or a disruption in the natural balance of the microbiome. Our diet is likely the primary reason why, in the industrialised countries of the West, the state of our microbiome has become an increasing problem. Overeating, the typical "diet", with an excess of junk food, sugar, bad fats, and carbohydrates, too much meat and too little in the way of vegetables, pulses, fruit, and whole grains lead to an impoverishment of the microbiome and to dysbiosis, which paves the way for numerous illnesses and disorders.

For a long time, people have referred to high-fibre foodstuffs that are particularly nutritious for our microbiome as **prebiotics**. Good examples are whole grains and plants that include large amounts of the specific fibre inulin, which can be found in black salsify, parsnips, in root vegetables more generally, in onions and garlic, endives, Jerusalem artichokes, and artichokes. These prebiotics feed the microbiome and promote the domination of good bacteria in the gut.

For a long time, we understood nothing about the interplay between the microbiome and our body, about what these microorganisms ultimately do with the food that we consume – for example, which metabolic products are produced by fermentation. Eventually, a technical term was coined to describe what our bodies gain from the food we eat at the very end of the digestive process: **postbiotics**, also known as postbiotic metabolites. There are thousands of metabolic products, but we typically know little about

how they work, what good they do us or how they harm us. But we know that the end products of these bacterial digestive processes also cause gases, for example when eating pulses. Pulses contain polysaccharides, which are consumed by bacteria that produce gas. So when it comes down to it, flatulence is also one of the byproducts of a functioning microbiome.

There is also consensus among the scientific community that a group of substances produced by the microbiome are extremely positive for our health, namely short-chain fatty acids such as propionic acid, acetic acid, or butyric acid. These provide a great example of the symbiosis between humans and bacteria. During fermentation, the bacteria of the microbiome can turn fibre into short-chain fatty acids. These fatty acids have a beneficial effect on the immune system of the gut, have anti-inflammatory properties, and reduce the risk of obesity, type 2 diabetes, and autoimmune conditions. Primarily, though, the fatty acids nourish the intestinal cells and thus contribute to overall gut health. So it shouldn't be surprising that a deficiency of short-chain fatty acids in the gut seems to contribute to the development of chronic inflammatory bowel diseases such as Crohn's disease or ulcerative colitis.

These short-chain fatty acids also create an acidic environment in the intestines, which promotes the production of beneficial postbiotics and makes it more difficult for salmonella and other pathogens to make us sick. Recent research has found that patients suffering from neurological disorders such as multiple sclerosis, Alzheimer's, or Parkinson's have reduced numbers of bacterial strains in their gut that produce propionic acid. Scientists are currently investigating whether taking sodium propionate supplements may help to combat these conditions.

When the British physician James Parkinson (1755–1824) wrote his essay on "Shaking Palsy" in 1817, he made explicit mention of the symptoms affecting the gastrointestinal tract and stressed the role they played in the condition. Two centuries later, the search for clues in the gut is finally being taken up again and has led us to the microbiome. Many Parkinson's patients experience symptoms

such as constipation and a loss of the sense of taste years before any neurological symptoms emerge. Recent research has identified a misfolded protein in the brain, alpha-synuclein, as one of the causes of Parkinson's. In people with Parkinson's, however, this alpha-synuclein protein is also found in the gut. Doctors suspect that it travels along the vagus nerve, the neural highway linking the gut and the head, entering the brain as an uninvited guest. Is it possible to influence this dysbiosis in the gut and thus to protect ourselves against Parkinson's, or even to treat the disease once it has developed? Scientists have already achieved this in animal experiments. However, that does not mean the same will be true for humans.

Short-chain fatty acids also determine whether sport and exercise actually have a positive effect on the metabolism. We have long known that not all diabetes patients benefit from exercise. Some patients exhibit a "resistance to exercise". In a study by the University of Hong Kong, 39 patients in the early stages of type 2 diabetes engaged in a structured exercise regime. At the same time, researchers analysed their microbiomes. After 12 weeks, weight loss was observed in all participants, but only two thirds showed an improvement in their diabetes and blood lipids; for the rest, nothing changed. The microbiomes of these so-called non-responders contained high levels of bacteria that produce toxins such as cresol and phenol as well as branched-chain amino acids, while the responders produced high levels of short-chain fatty acids.

In some people, stress causes their digestion to accelerate to a damaging degree. This can impair nutrient uptake, which can lead to deficiencies, despite the fact that they have plenty of nutritious food on their plate each day. Often, however, the opposite occurs: faeces remains in the large intestine for far too long without us realising it. But if our gut has to deal with food residue for too long, it can cause an inflammation of the mucous membrane. Which in turn can lead to food intolerances and an increased risk of bowel cancer. The dangerous thing is that we are not even aware that faeces is lingering in our bowels for days despite the fact that we're going to the bathroom regularly.

For this reason, science measures what is known as the "transit time" of the food we eat. The ideal transit time is estimated to be around 24 hours, and 48 hours is the maximum. You can easily measure your own transit time at home by doing the "beetroot test". You simply eat a portion of beetroot and then wait to see when your stool turns red. The best way to achieve an ideal digestion speed is through a combination of a gut-friendly and plant-heavy diet containing plenty of fibre, remembering to chew your food thoroughly and also avoid stress.

In contrast, the kind of protein-rich diet favoured by many athletes can lead to incomplete digestion in the stomach and duodenum, causing the food residue to move sluggishly through the large intestine, which can lead to the production of ammonia, which in turn can lead to muscle weakness, lethargy, and exhaustion. A similar effect can be caused by the regular consumption of proton-pump inhibitors, which are often prescribed to control the production of gastric acid. The stomach is no longer overly acidic and heartburn and gastritis may disappear, but the downside is that the medication can inhibit the digestion of proteins. Leading to undesirable reactions in the large intestine.

### Patient History – Auto-Brewery Syndrome

- This patient history took place quite some time ago, but it left a real impression on me. A man in his mid-fifties was admitted to our hospital's internal medicine ward. He was overweight, had high blood pressure, early-stage diabetes, and the patient told us that an ultrasound carried out by his internist had shown signs of a fatty liver. We were also intrigued by the fact that his wife reported that her husband seemed increasingly unfocussed and short-fused, and was often drowsy, almost woozy during the day. We planned to investigate his sleeping patterns in more detail, but we were able to rule out a severe sleep disorder such as sleep apnoea as the cause for his frequent bouts of

drowsiness. Once all the lab results came in, we were shocked by the extent of his liver dysfunction and his other liver scores. We found signs of inflammation from a fatty liver. We spoke with the patient again in detail about his alcohol consumption. He vehemently denied drinking alcohol, but he also reported that he often felt as if he were drunk. Because a number of natural medicine textbooks refer to a condition known as auto-intoxication syndrome, whereby the patient is poisoned by their own gut bacteria, we took copious blood samples and measured his blood alcohol level. To our great surprise, his blood alcohol reading was 1.6, despite the fact that the patient had already been in hospital for three days and swore that he hadn't left the hospital grounds.

My superior at the time delivered the diagnosis of "auto-brewery syndrome", or internal intoxication. The cause was a dysbiosis of the gut bacteria, which was ultimately borne out by a stool analysis. We treated the patient with a regime of fasting, a seven-day programme as outlined by Mayr, and also administered healthy probiotic bacteria. The treatment delivered rapid results. In a few days, the man felt fresher and more alert, and his blood alcohol level was zero.

Since then, studies have proven the existence of "auto-brewery syndrome". The cause is indeed a dysbiosis of bacteria and fungi in the gut, for example through the presence of the fungus Saccharomyces or the bacteria Klebsiella, which produce alcohol as part of their metabolic processes, which then enters the bloodstream via the intestine.

This story is a particularly striking case, but it is just the tip of the iceberg, so to speak. Harmless nutrients such as carbohydrates can lead to the production of damaging toxins if the microbiome is not functioning well. In natural medicine, this phenomenon was described by the doctor Karl Pirlet (1920–2010) many decades ago. He referred to it as auto-intoxication.

Postbiotics can produce good things such as vitamins, but they can also make people ill. Apart from auto-brewery syndrome, an example of this is trimethylamine (TMA). This gas is produced when we consume choline or L-carnitine and is found in large measure in meat and eggs. If this food is not thoroughly digested in the stomach and the small intestine, the bacteria in the large intestine can turn it into TMA, which smells like rotten fish. This gas becomes dangerous for our body if the liver turns it into trimethylamine *N*-oxide (TMAO), which increases the risk of heart disease, type 2 diabetes, and prostate cancer.

A study conducted by researchers at the renowned Cleveland State University garnered a great deal of attention. The researchers gave the subjects a meal with plenty of choline – namely two hard-boiled eggs – and a little later measured their

TMAO values. The tests showed that their levels had risen sharply. The researchers then gave the test subjects antibiotics that attack the dangerous gut bacteria, and repeated the procedure. This time, no toxic TMAO could be found in the blood. Of course, the solution cannot be to gulp down some antibiotics each day when eating eggs and meat. The consequences of that would be even worse. It is also important to point out that not everybody reacts negatively to choline and L-carnitine, it depends, once again, on the state of our microbiome. Since we are not currently able to determine which people's bodies create an excess of TMAO out of choline and L-carnitine, I recommend the safe route: consuming little or no eggs and avoiding meat. That allows a healthier microbiome to develop.

We keep seeing more and more of these kinds of findings. For example, it has long been known that salt can cause high blood pressure. For many years, it was thought that the cause was increased water retention in the blood vessels and kidneys. However recent studies have shown that certain gut bacteria love the taste of salt. These bacteria then proliferate, and their metabolic process ultimately creates the increased pressure in the blood vessels.

The function of the gut is not limited to digestion. It also houses 70 per cent of the body's immune cells, which together with

the intestinal mucosa and the microbiome form a highly effective defence system. Good bacteria fend off pathogenic bacteria or fight off intruders with self-formed antibacterial substances. The intestinal bacteria are located deep in the stomach, separated from the intestinal epithelial cells by a layer of mucus. The intestinal epithelial cells contain transport systems and can absorb nutrients, and are held together by flexible protein connections known as tight junctions. If these are functioning well, they let all the beneficial nutrients through and prevent the passage of unwanted microorganisms and toxins into the body. If this "bouncer role" is not working so well, it leads to what we call a "leaky gut", caused by damage to the intestinal mucosa, which can in turn cause health problems. In addition, various forms of immune cells form a last line of defence against pesky intruders, an immune system known as GALT, which stands for gut-associated lymphoid tissue. This bodily fighting unit is designed to combat pathogens in a targeted fashion while being friendly toward the body's own cells and to nutrients.

The reason I am describing these processes in such detail is because they are of extreme importance to our health. Because this multi-layered defence system can be weakened by infections, inflammation, stress, and poor nutrition. Disruptive strains of bacteria that are kept under control in a healthy microbiome can cause serious damage if this sensitive defence system is malfunctioning. An unhealthy diet leads to even more unhealthy metabolic byproducts. This can trigger conditions such as colitis ulcerosa, Crohn's disease, or irritable bowel syndrome. But even food allergies are ultimately the result of imprecise defence mechanisms in the gut.

If the immune system is unfit due to a dysbiosis, it can end up mistaking the body's own cells for foreign cells. We now suspect that autoimmune diseases such as rheumatoid arthritis, ankylosing spondylitis, multiple sclerosis, or Parkinson's disease are "triggered" by an unbalanced microbiome. Recent studies have also shown that the microbiome plays a role in the emergence of Alzheimer's disease. Changes in the microbiome can be detected from the very earliest stages of the disease. Research is ongoing, and it could be the case

that in a few years, the analysis of a stool sample can provide information about how high our risk of developing dementia is.

## How to Get Your Gut Running Smoothly Again

The task of interpreting the genetic sequencing of the microbiome is complex and ultimately still too difficult to be incorporated into the practice of medicine right now. But it seems fair to assume that rapid progress will be made in the coming years, particularly with the increasing prominence of artificial intelligence. However, there is one finding that is already clear and easy to assess: the biodiversity of the microbiome. A large variety of organisms is not only a prerequisite for a healthy ecosystem on our planet, it also plays a major role in our bellies. When animals, plants, insects, and microbes live together in the forest, they complement each other and benefit from each other. Some live from the waste or the faeces of others and vice versa. The symbiosis within our body works in the very same way, with the microbiome and the human being both profiting from the relationship. A diverse microbiome stabilises our health and protects us against illness and disease.

To date, we have identified more than 1,500 species of microbes and bacteria in the human gut, and that number is continually rising as our methods of measuring them are refined. Around 150 bacterial species can be found in the microbiome of an individual European. That number might sound huge, but it's actually not a great result. Our modern diet and lifestyle have wrought havoc on our microbiome. Among populations who live a more traditional lifestyle, that number is typically upward of 300. The microbiome in indigenous tribes contains about twice as many bacterial species as the gut flora of people in the Western world.

Research has repeatedly shown that the more natural and traditional our diet is and the more natural our lifestyle, the more types of bacteria can be found in our microbiome. But this is not just some fluke of nature, we can do plenty to increase the diversity of

our microbiome: eat lots of fibre, fermented foods, and a wide range of different plants. The biomathematicians at leading microbiome laboratories have been able to associate typical bacterial strains with every plant-based food, including coffee, peas, nuts, and apples. The rule is: the more plant-based food we eat, the more diverse our microbiome will be.

My recommendation is to eat 30 different types of plants per week. That might sound like a lot at first, but it's actually much easier than you might think. You have wheat, rye, oats, linseed, rice, potatoes as a filling base to your meals, then there's onion, garlic, a few leaves of basil, parsley, cumin, ginger, olive (oil) and vinegar, jams and marmalade (not too sweet!), a few walnuts and almonds, coffee, tea, and a few pieces of dark chocolate. And then you only need ten plant-based products from the plethora of fruit, vegetables, leafy greens, and pulses, and your microbiome is happy.

Ultimately, though, we need to take care not to expect too much of our microbiome. There are certain things the microbiome does not like at all, for example alcohol, smoking, stress, industrialised food packed with additives, sweeteners, and preservatives, as well as certain medications. Besides antibiotics, drugs that are harmful to the microbiome include proton-pump inhibitors, which are prescribed far too frequently, along with various kinds of painkillers. When it comes to medication, we doctors bear a particular responsibility. Antibiotics are a godsend when it comes to serious illnesses, but they should not be prescribed for a common cold. There have been initiatives such as the "Choosing Wisely" campaign, but so far, the impact has been limited. Antibiotics are still being prescribed far too frequently. We can all do our part to combat this; by making sure we get some bed rest when we get a cold and try some herbal remedies and teas before we head to the doctor.

Incidentally, the gut microbiome is connected with the microbiome in the mouth. Both can influence each other positively and negatively. Therefore, my advice is to take good care of your teeth and gums, use dental floss, scrape your tongue if necessary, and in the case of gum disease, try oil pulling.

### Oil Pulling

The practice of rinsing your mouth in the morning with edible oil comes from ayurvedic medicine. It does not ensure that the body "pulls" out waste products, as is often claimed, however swishing oil around in your mouth can kickstart your digestion early in the day by way of the saliva. Studies have shown that oil pulling is effective in treating gum disease and gingivitis, fights pathogens in the mouth, and helps to prevent bad breath. And it has fewer undesirable effects than a chemical mouthwash. This is how you do it: Every morning, take a tablespoon of organic edible oil (for example, sunflower, sesame, or olive oil) into your mouth. Swish the oil in your mouth for about three to five minutes. Make sure it also gets between your teeth by forcing it through the spaces with your tongue. Spit the oil out and then rinse your mouth with water. Then brush your teeth.

## Every Microbiome Is Unique

Recent research into the microbiome has made it increasingly clear that every person's microbiome is different, and that even the way that our microbiome responds to various nutrients is individual. This means that it is also difficult to define the optimal make-up of a microbiome. Interestingly, though, there is much less variation when it comes to the bacterial strains that can be found in the rectum.

The colonisation of the gut with microbes begins at birth. Studies in primates have shown that the diet of the mother during pregnancy has an influence on the microbiome of her children. The mode of delivery also plays a role, whether a child comes into the world by caesarean section or natural birth. Natural childbirth

is better for the microbiome, and breastfeeding also has a positive influence. During the first year of the child's life, around half the strains of micro-organisms found in the stool samples of mother and child are the same. Through a permanent process of exchange with their immediate environment (primarily through the food they consume), a child's microbiome continues to develop over the first two or three years of life. By the age of three, it already resembles that of an adult, and the proportion of shared organisms in the microbiomes of mother and child has reduced to around 25 per cent. The situation then stabilises, and by the age of 18, the figure is around 19 per cent. Certain commonalities remain even once the child is no longer living at home, and at the age of 30, the figure is 14 per cent. And there is still an overlap even in older adults. Evidently, mothers leave a lifelong mark on the microbiomes of their children, whereby the intergenerational lifestyle and nutritional habits also play a role.

There is plenty of evidence to suggest that the composition of our microbiome is not heavily influenced by hereditary factors. Our lifestyle and our proximity to other people are influential. People who live under the same roof – regardless of whether they are a family or just housemates – also exhibit commonalities in their microbiomes. A study published in 2023 in the journal *Nature* even found commonalities among neighbours and people who live in the same village. Even cities have their "own" microbiomes!

These finding are hugely relevant. They show that our lifestyle has a major influence on what goes on in our gut. And they show that there is plenty we can do to stay healthy. The first two to three years of a child's life are particularly important. They set the tone for the rest of our lives. For this reason, we should avoid excessive hygiene practices during early childhood and refrain from using antibiotics for every little sniffle. However, this does not mean that there is no need to make an effort to look after our microbiome because everything has been determined during our infancy. On the contrary, the microbiome is a site of constant and dynamic change. The microbiome remains capable of changes and shifts throughout

our entire lifetime, and it usually takes around three to six months for a major shift to occur. If we dramatically alter our diet – for example, if a passionate meat-eater goes vegetarian – this change can be even more rapid. This means that we largely hold the fate of our microbiome in our own hands.

## The Aging of Our Immune System

While most of us are not too happy to get wrinkles and grey hair, from a medical perspective, they are irrelevant. One of the more dangerous consequences of aging, however, is immunosenescence, or the aging of our immune system. As the immune system grows weaker and weaker, we become increasingly susceptible to life-threatening infections such as pneumonia and other serious conditions. The efficacy of vaccinations also drops. Some studies have shown that our diet has a major influence on the aging of the immune system, and this is particularly true of our consumption of fruit and vegetables. Here, too, the microbiome plays a major role. In principle, the microbiome also changes with age. The main thing that happens is a reduction in biodiversity. Studies on supercentenarians (people who live to the age of 110 or older) showed that they manage to preserve a remarkably high level of biodiversity. Researchers also found that these healthy Methuselahs are more likely to have bacteria such as Bifidus, Akkermansia or Christensenellaceae growing in their gut, and that they produce high levels of short-chain fatty acids. However, we cannot yet say which one is the chicken and which is the egg. What we can say, though, is that these extremely healthy seniors eat a microbiome-friendly diet. There are numerous companies around the world currently conducting research into the effects of probiotics, supplements, or food products with live microorganisms, such as lactic acid bacteria. It will be interesting to see whether this will eventually lead to the development of an anti-aging pill.

## Weight-Gain through Bacteria

Research into the microbiome has placed one of the established laws of nutritional science in question. For decades, "a calorie is a calorie" has been one of the key mantras of the field. If you consume more calories than you burn, you'll gain weight. Nowadays, we know that overweight people have a different microbiome to people who are of average weight. Their microbiome extracts more energy from the same amount of food. The proof was delivered in 2023 by a team of researchers led by Steven Smith from Arizona State University. In a strictly controlled setting, for a period of 11 days, researchers gave the participants two different diets containing the same number of calories. The difference was that one diet was unfriendly to the microbiome, and the other was designed to nourish it. The healthy diet consisted mainly of dietary fibre, resistant starch, and not too finely ground and pureed food. The result was astonishing: those consuming the microbiome-enhancing diet lost an additional 116 kcal per day in their faeces. There were two reasons for this: a few calories in the coarse dietary fibres presumably escaped digestion in the small intestine. But there was also an increase in beneficial bacteria, which fermented – or used up – the nutrients.

This shows that a calorie is by no means always a calorie, at least not once it has made its way into the gut. This also explains why some studies have found that overweight patients with low levels of bacterial diversity and more "bad" bacteria in the gut respond poorly to low-calorie diets. This proved that obese people have lower levels of biodiversity in the gut than slim people. Researchers made a truly surprising discovery in tests on mice. They transplanted the faeces from overweight mice into thin mice and found that the thin mice suddenly became fat without having changed their diet at all. The hypothesis is that composition of the microbiome can have a decisive influence on nutrient uptake. What's more, some bacteria contain enzymes allowing them to convert indigestible fibre into sugar and fatty acids, which the body then absorbs. The result is that

the body extracts more energy from the food, and this is particularly true of carbohydrates.

The "excuse" of many overweight people that they can't do anything about those extra pounds because they have a high nutrient uptake is thus not entirely untrue. But it's not hormones or some gland or another that are responsible for this, as was assumed in the past. What the microorganisms in our gut do with the food we eat is not determined by nature. We can do a lot to help ensure that our gut functions well. When it comes to our health, the following rule applies: what matters is what we eat, how we eat, and what our intestinal bacteria does with the food that we eat.

Researchers at the Weizmann Institute in Rechovot, Israel, have revealed how important the microbiome is and how much it suffers when we live an unhealthy lifestyle. They discovered that the microbiome has its own biorhythm. Its diurnal rhythm is determined by the time of food intake. This might be one of the reasons for the positive effects of intermittent fasting. My theory is that our internal clock is soothed by the fasting, which contributes to a reduction in body weight. And the findings of these Israeli researchers also help to explain why things like shift work and jet lag can wreak havoc on our digestion.

This also raises the question of how resilient the microbiome is. What effect does it have when we indulge with food and drink during the holidays or on the weekend? Does it do real damage if we spend a few days living off junk food, soft drink, and booze? Unfortunately, the answer is clear: it does. When we indulge to the extreme – for example, eating nothing but chicken nuggets, burgers, schnitzel and fries for an entire week – the microbiome suffers. Though it is quite resistant and has the ability to regenerate, to do so, it needs to be stable before being subjected to such excesses. And when we push it to the limit like this, it's important not to overdo it. A good way to think of the microbiome is to imagine it like a spring: if it is stretched too often and for too long, eventually, it will get worn out.

Since the microbiome is a complex entity, at present, it is still difficult to diagnose what the specific causes of a particular symptom might be. And it's even more difficult to figure out the right treatment when it's clear that the microbiome is not doing well. If you head to a pharmacy nowadays, you'll be confronted by the sight of countless packets of probiotics, most with "flora", "bio", and "biotics" in the name somewhere, and it's easy to get the impression that they can be used to alleviate just about any illness. However, the data from reliable studies is currently very limited, and many of the effects that these products claim to deliver are still pure conjecture – supported primarily by flashy marketing campaigns. If we imagine the microbiome as a huge jungle with more than a thousand different species, then the addition of a mere two or three bacterial strains begins to look like little more than an endearing effort at therapy. The crucial question is: How do we get bacteria to take up permanent residence in our gut? It's no good if they just pass through our intestines as travellers and then disappear again.

We can be certain, though, that the number of conditions that can be successfully treated with probiotics will grow. Possible candidates include intestinal inflammation and irritable bowel syndrome, diarrhoea, constipation, and allergies. Initial findings on the effects of probiotics on colds and flu infections are truly fascinating. But it will likely be some time before we find out how specific conditions can be treated long-term or prevented altogether through the administering of bacteria.

But back to the holes in the intestines. We can imagine the intestinal wall like a closed mouth through which nothing can pass. The spaces between the teeth (to stick with the image) are closed with a kind of zipper. They are formed by protein molecules, the "tight junctions" I spoke of earlier. Like the mouth, the intestine can open when required, without us ever realising it. The doorknob is a protein called zonulin, which is produced by the intestinal epithelial cells, and it can be measured in the faeces. Substances found in plants, such as the flavonoids present in fruit and berries, help this intestinal barrier to function correctly. Additives in industrially

produced food, medicines such as antibiotics and painkillers, alcohol, or large quantities of fructose and sugar are harmful to it, as are preservatives.

If we put too much of a strain on our gut, the tight junctions between the cells loosen, the barrier formed by our intestinal mucosa becomes leaky, causing the condition referred to as a "leaky gut", through which pathogens such as viruses, bacteria and fungi, toxins and the waste products of the intestinal bacteria can then enter the bloodstream. This means that toxic substances – endotoxins – from the husks of dead bacteria can enter into the bloodstream and from there into the connective and fatty tissue, where they cause inflammation. This can happen after a meal with a lot of saturated fats. Just a few years ago, researchers still disputed the existence of a "leaky gut". In recent years, though, the existence of these holes has been sufficiently proven, primarily through blood tests. There is now also a fascinating new technique, confocal laser endoscopy (CLE), which allows the holes in the intestinal wall to be seen during a colonoscopy. A contrast agent is also injected, and if the intestinal epithelial barrier is intact, it will prevent the contrast agent from entering the small intestine.

This new technology also helps to get to the bottom of the question of whether in the case of food intolerances – for example to lactose or gluten – the intestinal mucosa is also affected. If there is an intolerance, we see the leakage of the contrast agent into the intestine. Of course, this technology is still too time-consuming and too invasive to systematically test all foodstuffs, but it has certainly confirmed the existence of a leaky gut. And it is already being used as a diagnostic tool for patients with irritable bowel syndrome. It is also possible that the sense of fatigue that some people experience after difficult to digest meals (the so-called "food coma") is related to a leaky intestinal barrier. Toxic substances and bacterial particles can enter the bloodstream and make people lethargic. With the use of laser endoscopy, it may be possible to help many of these people in the future.

## Quintessentials: The Gut

- The gut likes healthy food, especially plant-based food. Try to eat a varied diet, including 30 different plants a week. Try to eat all the colours of the rainbow, red, orange, yellow, green, even violet. The colours indicate high levels of polyphenols. These are part of the plant's natural defence system and are excellent food for good bacteria.
- Bitter substances, spices, and nuts are great for the gut and aid digestion, as are sauerkraut, kimchi, yoghurt (including vegan yoghurt), sourdough bread, tempeh, mature cheese, cold potatoes and pasta salad, and fermented gherkins (most gherkins sold in jars are not fermented but just pickled in vinegar).
- Protect the gut from toxins. This primarily refers to industrialised food, highly processed foods and ready-to-eat meals. These shouldn't touch your plate any more than processed meats or fish containing heavy metals.
- Avoid sweeteners and remember that alcohol harms the microbiome. The gut is a robust machine, but even it needs a break from time to time. So try fasting – even if it's just for a few hours.