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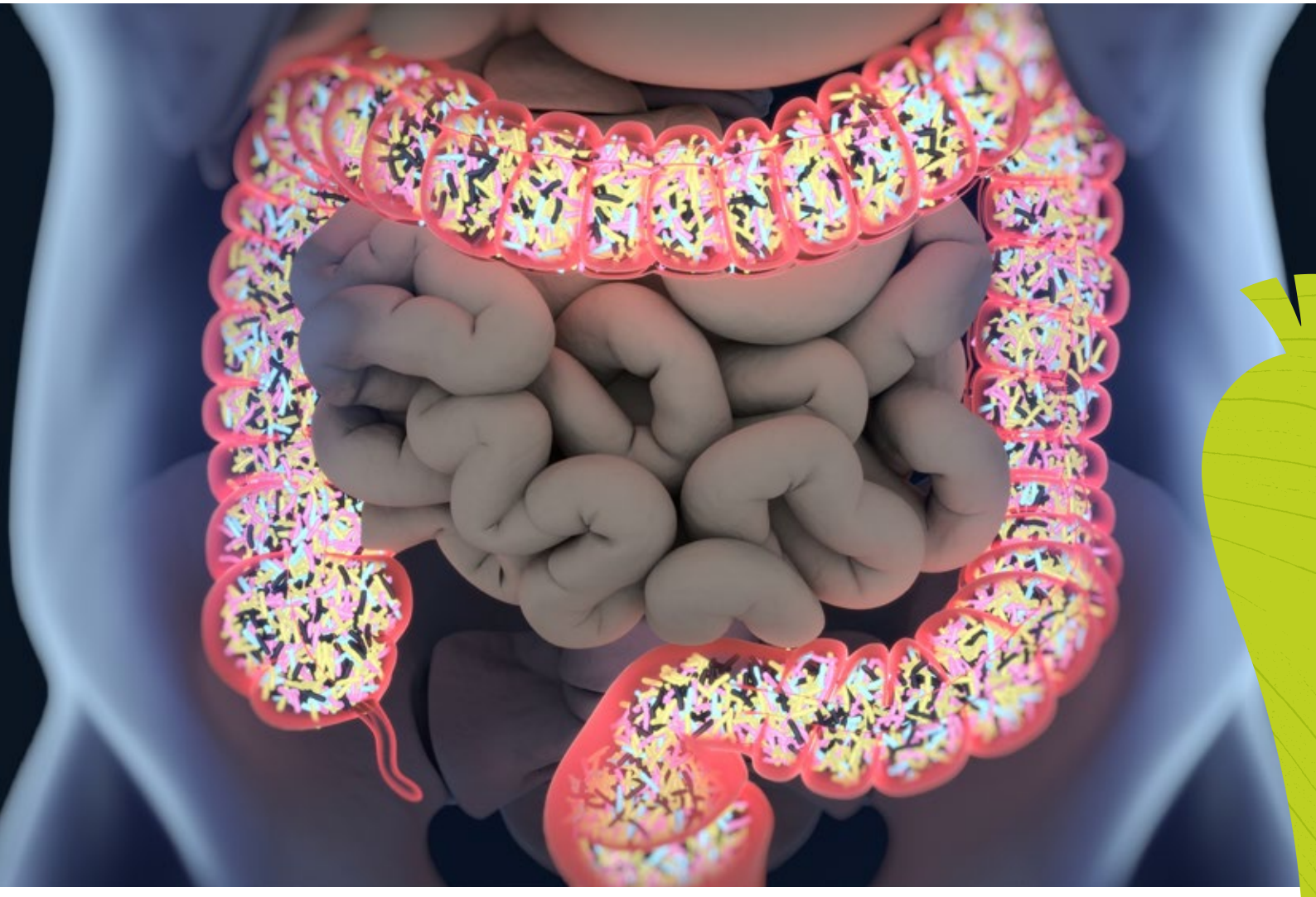
What is the microbiome?



Inspired by Inulin

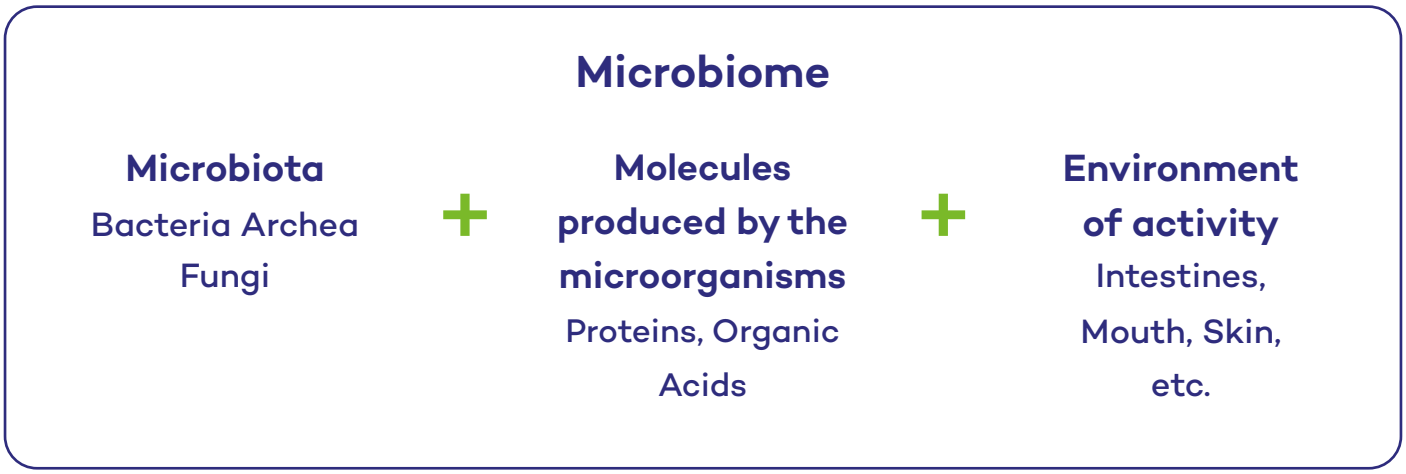
1. Introduction

An enormous amount of microorganisms, also referred to as the human microbiota, live both on, as well as inside the human body. These microorganisms and the human body live in symbiosis, which means they both benefit from the interaction with each other. Other terms are often used in relation to this human microbiota, such as the microbiome. This paper will further explain what the microbiome is, and why it is important for your health, while focusing on the microbiome with the highest density of microorganisms: the gut microbiome.

2. The human microbiome

The human body is home to different communities of microorganisms, also called the human microbiota, which includes bacteria, archaea and fungi. These microbiota are estimated to greatly outnumber the human cells comprising our bodies. They can be found on the skin, in the digestive tract, the vaginal, urinary tract and the oral cavity. These microbiota, the environment where they are active and the whole spectrum of molecules produced by the microorganisms are called the microbiome. Although there are different interpretations of the term microbiome, this definition is probably the most accurate as explained in a recent review paper[1]. The environment defines the microbiome, hence we have a skin microbiome, gut microbiome (digestive tract), oral microbiome, etc. The human microbiome is important, since it contributes to a person's biology and development, and it protects us against pathogens[2,3]. So, although microbiota which contain bacteria might sound scary, in fact the majority of them play a role in maintaining and even stimulating our health.

Figure 1. A schematic visualization of the composition of the term microbiome



3. What is the gut microbiome?

The *gut microbiome* refers to the microbiota (e.g. bacteria) with their collective activity in the gastrointestinal (GI) tract. This is the part of the human body where the greatest density and numbers of microbiota are found and where the majority of research is focused on. This is due to the important role that the microbiota in the GI tract play in digestion, the production of essential vitamins, and protection against pathogens[4].

There is a difference between the abundance and composition of bacteria in the small intestine and those in the colon. The small intestine, the main location for food digestion and absorption, has a low pH and a short transit time. Therefore, the bacterial numbers found here are much lower compared with the colon. In the colon the numbers are much higher, because the bacteria residing here ferment complex carbohydrates to end products like organic acids which support our health, and this process results in a longer transit time[3,4].

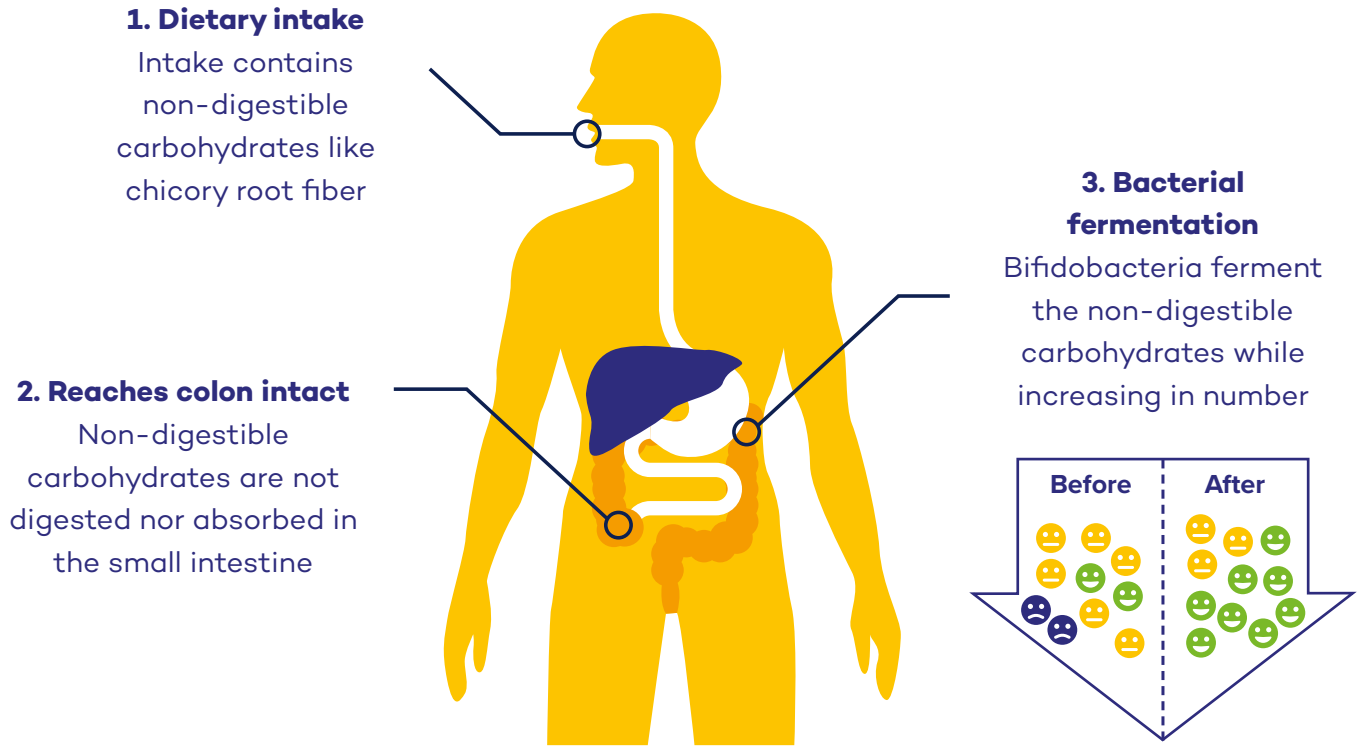
When the gut microbiota of a large group of individuals (e.g. more than 100) is investigated, the ratio of bacterial species is not the same in all individuals. Even more so, studies have shown that the microbiome of healthy individuals is as unique as a fingerprint. However, some of the microbial communities in the GI tract are comparable between individuals, e.g. because people are genetically related, similar in age or have common diets[4].

The intestine of a newborn infant is believed to be almost sterile and becomes colonized with mostly *Lactobacillus* at birth when it passes through the birth canal. Infants born by cesarean section apparently miss many of these native bacteria. The gut microbiota of an infant is also influenced by breast-feeding or formula feeding. Fortunately today's infant formulas are supplemented with prebiotics to mimic the gut microbiota of breast milk[5]. The differences in gut microbiota seem to decrease after solid foods are introduced to the infants diet. During adolescence the gut microbiota are influenced by sex hormones and afterwards remain stable during adulthood. However, the gut can be temporally changed by, for example, an infection or antibiotics and permanently changed by, for example, immigration or a continuous change in dietary habits[6].

4. What are the benefits of a healthy gut microbiome?

There is a large diversity of microbes harbored in our GI tract, however some specific groups are more abundant than others, for example *Bacteroides, Faecalibacterium, Alistipes, Ruminococcous* and *Clostridium*. Another highly prevalent microbe in the human gut, which is considered beneficial for human health, is the *Bifidobacterium*[7]. Bifidobacteria ferment non-digestible carbohydrates while increasing in number, the so-called 'bifidogenic effect', while simultaneously producing organic acids[8].

Figure 2: The bifidogenic effect



The fermentation of non-digestible carbohydrates and subsequent growth of bifidobacteria and other gut microbes increasing organic acids, results in an increase in fecal bulk and improved stool consistency, which will improve a person's bowel regularity[9].

Moreover, besides improved digestive health, there is increasing evidence that a healthy gut microbiome with production of lots of organic acids is associated with an improved immunity and less inflammation[10]. Conversely, an imbalance between good and bad bacteria in the GI tract, called dysbiosis, is implicated in developing issues such as Irritable Bowel Syndrome and impaired metabolism such as diabetes[3]. Recently, an association with decreased obesity[3,11] and improved mental health has been suggested[12].

5. How do we keep the gut microbiome healthy?

A simple way to improve the composition of the gut microbiota is by increasing the intake of non-digestible carbohydrates like dietary fibers, in particular prebiotics. Prebiotics are defined by the International Scientific Association of Probiotics and Prebiotics (ISAPP) as 'substrates that are selectively utilized by host microorganisms conferring a health benefit'[13]. This means that they are fermented by one or several bacterial groups, for example the bifidobacteria, but not by all bacteria in the gut, and that this fermentation leads to a health benefit such as improved bowel habit. Inulin and oligofructose extracted from the root of the chicory plant are among the few ingredients, and the only plant-based ones, that are officially recognized as prebiotics by ISAPP. Studies have shown that the intake of chicory inulin and oligofructose increases the number of bifidobacteria in the gut, therefore they contribute to a healthy gut microbiome.

6. Conclusion

The microbiota inside and on our body, together with the environment where they are active and the whole spectrum of molecules produced by the microorganisms, are called the microbiome. The most dense microbiome is the gut microbiome. It is home to a large variety of bacteria, archaea and viruses. The most well-known bacterium is the Bifidobacterium, of which an abundance is associated with a healthy gut. A wealth of human studies show that an increase in bifidobacteria can be achieved by increasing intake of prebiotics, namely chicory inulin and oligofructose and thereby support a healthy gut microbiome. This is clearly essential for our health, since recent evidence shows that the impact of chicory inulin and oligofructose on the gut microbiome is associated with improved bowel habits, immunity and possibly even mental health.

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The Sensus team will support you with information. Visit our website **www.inspiredbyinulin.com** or feel free to contact us at **info@sensus.nl** or call us at **+31 165 582 500**