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MICROBIOLOGY IN SCHOOLS ADVISORY COMMITTEE
50th Anniversary Articles

Gut microbes: we are not alone

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Our bodies are home to millions of different and useful microbes. These microbes are collectively known as the microbiota (or microbiome), and we need them just as much as they need us.

Who are our gut microbes? The human adult gut microbiota can weigh up to 2 kg! Bacteria make up most of the gut microbiota but fungi, viruses, protozoa and Archaea are also members of this complex community. As researchers, one of our main objectives is to identify and characterise all the micro-organisms present. Classically, the study of microorganisms starts by culturing them on a dish in the laboratory. Unfortunately, this is impossible with most of the microbes that live in the intestine as they do not grow in the presence of oxygen and/or require specific conditions to grow. The composition of the microbiota is therefore mostly determined from analysis of faecal material using sequencing to analyse the genetic material (DNA and RNA) of the microbiota. This allows us to identify the variety and types of microorganisms that are present. Nowadays, we estimate that between 300 and 1000 different bacterial species live in our gut and each of us carries a unique, diverse and balanced microbiota.

What do our gut microbes do? The gut microbiota is essential to our health and wellbeing. Every microbe has a job to do and groups of microbes cooperate to get the job done. The gut microbiota helps the body to digest certain foods, such as cellulose, a common component of vegetables. Gut bacteria also produce important nutrients and synthesise vitamins (B and K). They teach our immune system to recognise 'friends' (harmless microbes) from 'foes' (pathogenic or disease-causing microbes) and can protect us against harmful pathogens.

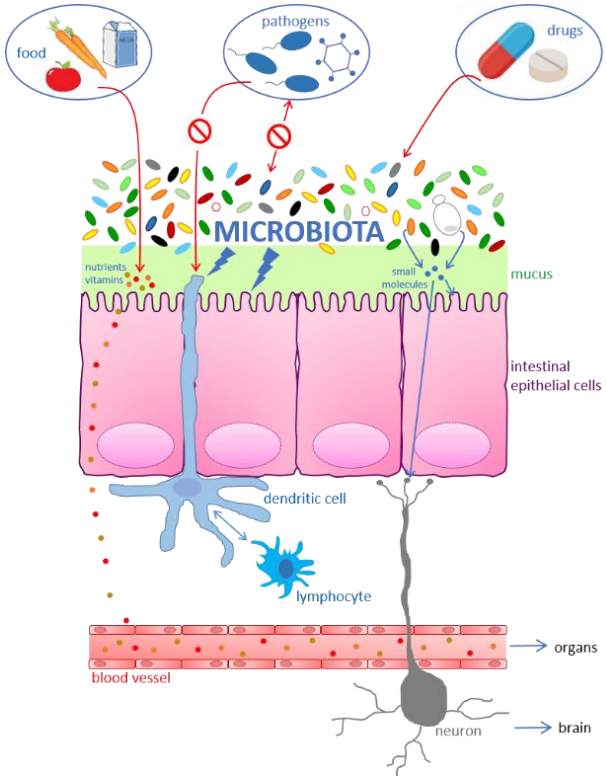

Figure 1. Main functions of human gut microbiota. Our gut microbiota is constantly influenced by different factors such as food, environment and medication (antibiotics, drugs). It has to stay diverse and balanced to exert its functions.

Surprisingly, studies have shown that the bacteria in our intestines can affect aspects of our health beyond the gut. For example, recent studies show that our gut microbiota produce molecules such as short chain fatty acids or the neurotransmitter serotonin that travel around the body and can communicate

with our brain and therefore influence our mood and behaviour. As a consequence of these findings, some researchers have proposed that we start to define our gut microbiota as our 'second brain'!

What happens if the composition of our gut microbiota changes? Throughout our lives, our gut microbiota is influenced by different factors such as food, environment and medication (antibiotics, drugs) and has to adapt to stay diverse and balanced. A loss of diversity in the gut microbiota, *i.e.* changes in the range of microbes present, or in the relative abundance of some microbes compared to others is called 'dysbiosis'. Dysbiosis has been linked to many diseases, such as inflammatory bowel diseases (IBD), allergies, obesity, diabetes, anxiety and autism. We still do not know if the observed dysbiosis is the cause or the consequence of these diseases and scientists are working hard to answer this question. For example, they have transferred the microbiota of an obese human to a germ-free mouse (a mouse without any gut microbiota) and observed that the mouse gained weight, indicating that gut microbiota plays an important role in obesity.

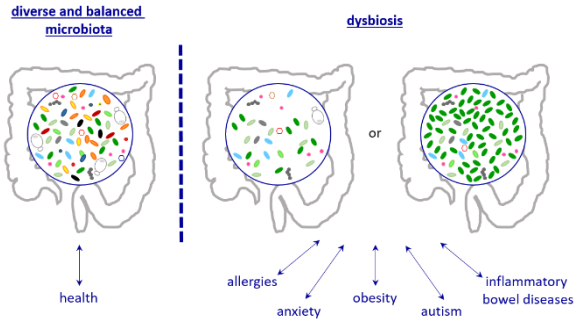

Figure 2. Correlation between gut microbiota and health.

How can we keep our gut microbes happy? We still do not know exactly which microbes keep our gut in a healthy state, but we do know that a healthy gut contains a variety of organisms. Therefore, a diverse and well-balanced diet should help to keep our gut microbes happy. Probiotics (live micro-organisms conferring a health benefit) that are present in some fermented foods such as yogurts could also help to maintain gut microbial balance and diversity.

Concluding remarks. Our knowledge and understanding of the fascinating collection of microbes that inhabit the human gut is increasing at a rapid rate. However, there are many questions to be answered and more research is needed to characterize the role of each microbe in our gut, the interplay between the different microorganisms and the link between dysbiosis and disease. My research aims to decipher the mechanisms involved in the complex cross-talk between the gut microbiota and the host in health, and its alterations in IBD using cell culture, artificial intestine models, animal models and faeces from humans. I hope that in the future we will understand how to manipulate the microbiota (by using probiotics, adding beneficial microbes or by transferring faecal microbiota) to treat gut-microbiota-related diseases such as IBD.

WANT TO KNOW MORE?

http://www.gutmicrobiotaforhealth.com/en/home

AUTHOR PROFILE

Nathalie Rolhion is a microbiologist with an interest in science education. During her PhD, she worked on the bacteria and inflammatory bowel diseases. After postdoctoral research at Imperial College London (London, UK) and at the Pasteur Institute (Paris, France) on *Salmonella* and *Listeria* respectively, she recently joined the INSERM (Institut National de la Santé Et de la Recherche Médicale) in France. Since the beginning of her career, she has been involved in teaching, outreach activities for public, students and schools.