# The Brain - Intestine Symbiosis

# "A Symbiotic Relationship between the Brain and the Intestines, Which Precedes Any Other Relational Connection"

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## Abstract

The gut microbiome is involved in the aetiology of many diseases. For example, obesity has been directly linked to the gut microbiota. In addition, there is increasing evidence that an altered gut microbiota is associated with autism and neurodegenerative diseases such as Parkinson's disease, dementia, depression. The gut-brain axis is a bidirectional communication between the central nervous system and the enteric system, linking the emotional and cognitive centres of the brain with peripheral gut functions.

*Keywords: gut brain axis, diet, microbiome, dysbiosis, symbiotic relationship, cognitive, autism, mitochondria.*

## What Is the Microbiota?

The human microbiota is a real ecosystem realized by our evolutionary nature that has combined the best biological mechanisms by assimilating them into a superorganism-Man.

Already known that we actually live in an ocean of microorganisms, the human body contains about 37 trillion cells.

Microbes are found throughout the human body, mainly on external and internal surfaces, including the gastrointestinal tract, skin, saliva, oral and conjunctival mucosa.

The term microbiome encompasses all organisms that are in an environment along with all their genetic information-DNA.

Bacterial cells housed in the human gastrointestinal tract exceed the number of host cells. These microbes associated with the human digestive tract are called the intestinal microbiome. The human intestinal microbiome and its role in both health and disease has been the subject of extensive research, establishing its involvement in human metabolism, nutrition, physiology and immune function.

In other words, *we are more bacteria than humans*, if we compare the 22,000 genes that encode proteins in the human body versus the 2.5 million genes that are found in the human microbiome.

The intestinal microbiota performs many important functions for the host, such as digestion of nutrients, maturation of the host's immune system, maintenance of the integrity of the epithelial cell layer and protection from pathogens.

The human gut microbiome is dominated by two phylotypes of bacteria, respectively - Bacteroidetes and Firmicutes - which account for more than 90% of the detected phylotypes. The concept of three enterotypes that allow the stratification of human individuals according to the composition of their intestinal microbiome has been proposed.

## Implications of the Microbiome with Human Health

The intestinal microbiome is involved in the etiology of many diseases. For example, obesity was directly related to the intestinal microbiota. The epidemic of obesity is partly caused by the diet rich in sugar and fat consumed in developed countries; it is known that this diet affects the composition of the intestinal microbiota. In addition, there is growing evidence that an altered intestinal microbiota is associated with autism and neurodegenerative diseases such as Parkinson's disease, dementia, depression.

The intestinal microbiota plays a central role in regulating the metabolism of the host, and also guides the development and proper functioning of the immune system.

## The Relationship Between the Gut and the Brain

The gut-brain axis (AIC) consists of a two-way communication between the central and enteric nervous systems, connecting the emotional and cognitive centres of the brain with peripheral intestinal functions. Recent advances in research have described the importance of the gut microbiota in influencing these interactions.

This interaction between the microbiota and the AIC appears to be *bidirectional*, namely through signalling from the intestinal microbiota to the brain and from the brain to the intestinal microbiota through neural, endocrine, immune and humoral connections. In this review, we summarize the available evidence that supports the existence of these interactions, as well as the possible pathophysiological mechanisms involved. In clinical practice, evidence of microbiota-Gut Brain Axis interactions comes from the association of dysbiosis with central nervous disorders (e.g., autism, anxious-depressive behaviours) and functional gastrointestinal disorders. In particular, irritable bowel syndrome can be considered an example of disruption of these complex relationships, and a better understanding of these changes could provide new targeted therapies.

Research indicates a possible link between autistic spectrum disorder (ASD) and the intestinal microbiota, as many autistic children have concomitant gastrointestinal problems. Various altered levels of metabolites have been observed in the blood and urine of autistic children, many of which are of bacterial origin, such as short-chain fatty acids (SCFA), indoles and lipopolysaccharides (LPS). A less integrative intestinal-blood barrier is abundant in autistic people. This explains the outflow of bacterial metabolites in patients, triggering new body responses or an altered metabolism. Other co-current symptoms have also been detected, such as *mitochondrial dysfunction*, oxidative stress in cells, alteration of tight junctions in the blood-brain barrier, and structural changes in the cortex, hippocampus, amygdala and cerebellum.

## What Role Do Mitochondria Play with the Human Microbiome?

A link to call it indirect, but recent studies have shown that mitochondria evolved from an endosymbiotic alphaproteobacterium (violet) in a host cell derived from the archaea, which was most closely related to the Archaea Asgard (green). The earliest ancestor of the mitochondria (which is also not an ancestor of an existing alphaproteobacterium) is the pre-mitochondrial alphaproteobacterium. The transition from endosymbiotic bacterium to permanent organs involved a massive number of evolutionary changes.

So, we can say that mitochondria is a kind of parasite taken over by the host, from which through a natural evolutionary incorporation both primordial organisms have benefited, one survived by evolving through specialization of energy production and finally, we humans, benefited from this energy factory to become more connected to the external environment. by

internalizing pieces of nature to become more adapted. In the end we are nothing more than the sum of some pieces of the puzzle that architecturally ended up functioning like a Swiss clock.

There is a growing interest in microbiome engineering for microbiota modelling. Currently, there are several microbiota manipulation strategies that can be classified as additive, subtractive or modulatory. An additive therapy involves adding specific strains or communities to the host microbiota. These strains or communities can be natural or artificial microorganisms. *Subtractive therapy* refers to a therapy by which certain strains must be eliminated or the production of certain metabolites should be reduced in order to improve or cure a disease. A *modulating therapy* involves probiotics and/or prebiotics that modulate the composition of the endogenous microbiome.

One therapy that has gained a lot of attention over the years is *fecal microbiota transplantation* (FMT). This method restores the gut microbiome by transplanting stool from a healthy donor into the gastrointestinal tract of the microbiome associated with the disease. FMT is based on established microbial communities from healthy donors, a refined approach to transplantation can be obtained through the design of *synthetic communities*. These synthetic communities could replicate the same functions as the natural communities that are present in healthy donors.

*The first generation* of microbiome therapies consisted of prebiotics and probiotics. Prebiotics are indigestible foods that are degraded by intestinal bacteria. Most prebiotics consist of carbohydrates such as *fructus, starches and oligosaccharides*. Fermentation of these prebiotics results in the production of short-chain fatty acids, which can have multiple effects on the human body.

It has been widely reported that the consumption of the modern Western diet containing less fiber and vegetables has tended to lead to the *loss* of important microbial species in western (urban) communities. In rural communities, diets have a strong impact on the microbial diversity of individuals in different populations.

## Nutritional Dietary Impact on the Brain-Gut Axis

The importance of food diversity, seasonal food rotation is, the use of naturally grown foods in organic regime, intermittent fasting, consumption of naturally fermented foods -probiotics, consumption of fiber with a prebiotic role, avoidance of highly processed foods, avoidance of artificial additives with various food colorings, etc., - all have been shown to have a role in maintaining the diversity of the microbiota at the optimum level for human health, in restoring the eubiotic flora, restoring the intestinal barrier, preventing gastrointestinal infections and even in reducing the risks of chronic, metabolic or neurodegeneration-related diseases.

## Conclusions

The individual's integrase can be viewed through the interdependence of the external nature that is intimately found within human macro-organizationism. This gives us a reflection on the future of *integrative medicine* that will look at the human body as an extension of the entire external ecosystem and that will promote *the prevention* of many pathologies by maintaining the integrity of the intestinal microbiota.

A symbiotic relationship between the brain and the intestines, which precedes any other relational bond that has endured for millennia, is going through a difficult trial in this century: an attempt at rupture, a dysbiosis of symbiosis both between them and between them and the human host. This would result in a modern man with many brain health and behavior problems, leaving the medical world in a limited therapeutic derision.

The next time you choose to consume some foods that are not friendly to your microorganisms, think about what *ecological disaster* it can cause on the tireless workers who live with you in a perfect symbiotic relationship of friendship, since the primordial beginnings of life on earth.

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