The Human Microbiome

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The Universe Within Human Beings

With analogies comparing atoms to solar systems and the entire Universe with neurons in a human brain. Coincidentally, the number of stars in a galaxy, galaxies in the Universe, atoms in a cell, and cells in a living being shares approximately a common size. We coexist with other planets in the solar system and all forms of life are dependent on the Sun. Have it ever occurred to you that we may be living in a larger sentient organism; exactly like how our bodies are fundamental to all those microorganisms that inhabit our body, and to which we provide shelter and nutrients.

The human body is a territory much more densely populated than a large metropolis; we can find a great variety and an immense number of microorganisms only in our skin, mainly bacteria (Amon & Sanderson, 2017). All these microorganisms constitute what is known as the Human Microbiome.

In itself, the Human Microbiome is the set of bacteria, archaea, viruses, fungi and protists that live both inside and above a person. These organisms live together with us taking advantage of some of the substances that we secrete as nutrients, helping us to digest part of our food, and even helping us to fight infections of other external bacteria and viruses. A person who is in good health has a relationship of mutualism with its microbiome; that is, both the person and the microbiome benefit from living together (Lloyd-Price, Abu-Ali & Huttenhower, 2016).

This scientific research focuses on this vast universe that lives within us, its origins, functions and how its importance has given way to projects such as the Human Microbiome Project (HMP), which has significant clinical and pharmacological repercussions.

The Human Microbiome: An Overview

The human microbiome is the set of microorganisms with their respective genetic material present in the human body. Eukaryotes, archaea, bacteria, and viruses live in it, assuming more than 3% of its total weight (Sender, Fuchs & Milo, 2016). Some of them have no direct effect on the health of the human being, either because it has not yet been described, or simply because they maintain an uncomplicated relationship of coexistence; however, the vast majority play an essential role in the health care of the person (D'Argenio, 2018).

Depending on the location, many known pathologies are associated with microbiome imbalance, such as Crohn's disease, obesity, asthma, cystic fibrosis, hypertension or skin disorders, among others (Gilbert et al., 2018).

The microbiome is an integral part of our body, but many may ask: where does it come from? Has it always been the same? When we were born, the first contact towards the development of the microbiota is the birth path, either via vaginal delivery or c-section; the second contact is the type of food that we ingest, whether it is via breastfeeding or formula, having multiple microbiota variations. At the end of the first year of life, the intestinal microbiome forms a characteristic profile of the adult type (D'Argenio, 2018).

Functions of the Microbiome: Our Friendly Bugs

We have always associated bacteria, fungi, and viruses as bugs that harm us, but these microorganisms that inhabit us provide benefits that we would never have imagined.

To distinguish good microorganisms from pathogens, researchers call the first ones "commensals" which literally means "people who sit down to eat at the same table" (Clemente, Ursell, Parfrey, & Knight, 2012).

These commensals have different functions. For example, some feed on the greasy secretions

of the skin cells and produce a moisturizing layer that keeps the skin flexible and prevents it from cracking (Wang, Yao, Lv, Ling, & Li, 2017).

Our microscopic hosts also generate vitamins and anti-inflammatory substances that our body can not produce independently, for example, in the digestive tract, the components of the intestinal microbiota help us assimilate nutrients and make certain food compounds digestible (Wang et al., 2017).

On the other hand, the bacteria present in our lungs help to reduce the response of our immune system to dust and some other pathogens, preventing asthma attacks (Wang et al., 2017). For this and much more, the microbiome has been called "the forgotten organ" (Clemente et al., 2012) with the essential functions that it plays in our body.

The Human Microbiome Project (HMP)

The microbiome is a legacy of the human genome, which helps mainly to the protection against infectious agents (Amon & Sanderson, 2017).

Similar to the well-known Human Genome Project, which is the largest biomedical research project in history, whose ultimate goal was the achievement of the complete sequence of the human genome that contains instructions for building a human being (Wilson & Nicholls, 2015), researchers created the Human Microbiome Project (HMP).

The HMP is a program of the National Institutes of Health (NIH) that began in 2008, that aims to answer existing questions about the behaviour of non-pathogenic microorganisms in the human body (National Institutes of Health, 2012).

The Human Microbiome Project started ten years ago, where little was known about it and where the number of scientific articles on the subject was just over a hundred. Today, thousands of articles are published every year, and metagenomics and bioinformatics sciences

help identify the vast diversity of microorganisms present in the different holes and spaces of the human body, such as the respiratory system, the oral cavity, the skin, the digestive tract or the urogenital tract (D'Argenio, 2018).

What do these findings imply?

In recent years we have seen how microbiota can influence many aspects of our biology and our health. Therefore, there are different strategies to intervene in the structure and function of the microbiota to maintain health, prevent diseases, or even improve forecasts (National Institutes of Health, 2012). This is the goal of probiotics, which are dietary supplements that contain strains of bacteria and living yeasts; prebiotics, which are nondigestible nutrients that stimulate the growth and activity of our own bacteria; and even the transplantation of microbiota. However, manipulating the microbiota or restoring it in case of illness is much more complicated than we could imagine. The reason is that the microbiota is a complex consortium of millions of interactions between the microbes themselves and the host cells (Kumar et al., 2015).

The Future: Our Microbes are Changing the Concept of Ourselves

We have known for centuries that animals, including humans, are carriers of many different microorganisms that until very recently had been treated with great indifference. However, in recent years thanks to the new techniques of massive sequencing that allow us to study microbial communities without the need to grow them, we begin to know that for the normal development and maintenance of health we depend on our microbes (Gilbert et al., 2018).

In the future, procedures such as transplants of faecal matter will be possible. It sounds insane and disgusting, but it is already being used in the United States to combat serious gastrointestinal disorders such as the one that the Clostridium difficile bacterium produces. This bacterium usually invades the intestines of people who have received treatments with antibiotics, and as it is resistant to them, there is no way to combat it. With the transplant (through suppositories) of faecal matter from healthy individuals, experts like Alexander Khoruts of the University of Minnesota, who already prepares clinical trials, have managed to reestablish the microbial population capable of evicting the undesirable tenant. It is also looking to extract from the excrement the bacteria necessary to introduce them into the patient's organism without the unpleasant, although effective, faecal transplant (Juul et al., 2018)

In Conclusion: Are We More Human or Bacteria?

All the bacteria that live with us can live in other environments, and although we can exist without the vast majority of them, we need their presence to keep us healthy. Some researchers suggest that we should begin to recognize that the rest of the animals and we are supraorganisms that live together with our microbiome because they have shaped our diets, habits, and genome.

When reading this scientific paper, we may realize that humans have a microbiome that is different from other animals, but, the type of bacteria and the proportions they maintain in our body is very similar in all of us. At the same time, the microbiome of each person, even that of the twins, is different, helping us to be unique. We are more than just humans. We are not individuals, but discrete entities with a host of ever-changing interactions with our microbes.

References

Amon, P., & Sanderson, I. (2017). What is the microbiome? *Archives of Disease in Childhood - Education & Practice Edition, 102*(5), 257–260.doi:10.1136/archdischild-2016-311643

Clemente, J. C., Ursell, L. K., Parfrey, L. W., & Knight, R. (2012). The impact of the gut microbiota on human health: An integrative view. *Cell, 148*(6), 1258–1270. DOI:10.1016/j.cell.2012.01.035

D'Argenio, V. (2018). Human microbiome acquisition and bioinformatic challenges in metagenomic studies. *International Journal of Molecular Sciences, 19*(2), 383.doi:10.3390/ijms19020383

Gilbert, J. A., Blaser, M. J., Caporaso, J. G., Jansson, J. K., Lynch, S. V., & Knight, R. (2018). Current understanding of the human microbiome. *Nature Medicine, 24*(4), 392–400. DOI:10.1038/nm.4517

Juul, F. E., Garborg, K., Bretthauer, M., Skudal, H., Øines, M. N., Wiig, H., … Adami, H.-O. (2018). Fecal microbiota transplantation for primary Clostridium difficile infection. *New England Journal of Medicine, 378*(26), 2535–2536.doi:10.1056/nejmc1803103

Kumar, H., Salminen, S., Verhagen, H., Rowland, I., Heimbach, J., Bañares, S., … Lalonde, M. (2015). Novel probiotics and prebiotics: road to the market. *Current Opinion in Biotechnology, 32, 99–103*.doi:10.1016/j.copbio.2014.11.021

Lloyd-Price, J., Abu-Ali, G., & Huttenhower, C. (2016). The healthy human microbiome. *Genome Medicine, 8(1).* DOI:10.1186/s13073-016-0307-y

National Institutes of Health. (2012). NIH Human Microbiome Project defines normal bacterial makeup of the body. Retrieved June 23, 2019, from https://www.nih.gov/news-events/news-releases/nih-human-microbiome-project-defines-normal-bacterial-makeup-body

Sender, R., Fuchs, S., & Milo, R. (2016). Revised estimates for the number of human and bacteria cells in the body. *PLOS Biology, 14(8), e1002533*.doi:10.1371/journal.pbio.1002533

Wang, B., Yao, M., Lv, L., Ling, Z., & Li, L. (2017). The human microbiota in health and disease. *Engineering, 3(1), 71 82*.doi:10.1016/j.eng.2017.01.008

Wilson, B., & Nicholls, S. G. (2015). The Human Genome Project, and recent advances in personalized genomics. *Risk Management and Healthcare Policy, 9*.doi:10.2147/rmhp.s58728