Research Article

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Paradigm Shift Between Micro Biota & Micro Biome: A Key Role in The Adaptation of Mammals to Their Diverse Lifestyles

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Abstract

Your 'gut micro biome' is made up of the trillions of microorganisms and their genetic material that live in your intestinal tract. These microorganisms, mainly comprising bacteria, are involved in functions critical to your health and wellbeing. Micro biota are the range of microorganisms that may be commensal, symbiotic, or pathogenic found in and on all multicellular organisms, including plants. Micro biota include bacteria, archaea, protists, fungi, and viruses, and have been found to be crucial for immunologic, hormonal, and metabolic homeostasis of their host. The term micro biome describes either the collective genomes of the microbes that reside in an ecological niche or within the microbes themselves. Micro biota is usually defined as the assemblage of living microorganisms present in a defined environment. As phages, viruses, plasmids, prions, viroids, and free DNA are usually not considered as living microorganisms, they do not belong to the micro biota. The micro biome comprises all of the genetic material within a micro biota (the entire collection of microorganisms in a specific niche, such as the human gut). This can also be referred to as the metagenome of the micro biota".

Key words: Micro biota, Micro biome, Metagenome, Bacteria, Archaea, Protista, Fungi, Virus

Overview: Animals, plants, and even oceans and soils have their own individual biomes made up of specific inhabitants. Our bodies are not just ours, they are home to a vast collection of microorganisms. Ask most people to define micro biome, and a handful might say that it refers to a bacterial ecosystem that lives in a specific place. They may even mention the gut [1].

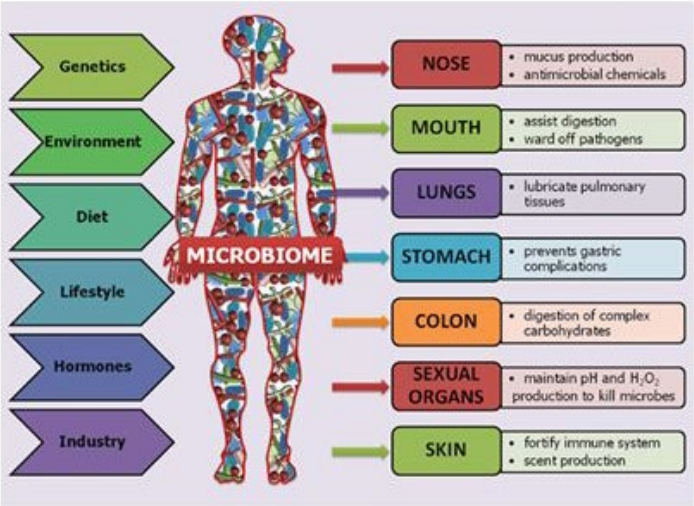

Figure 1: Micro biome source

Micro biome vs micro biota: Although the terms are used interchangeably, there is a slight difference between micro biome and micro biota. In many contexts, micro biota and micro biome are often synonymous, but you could be forgiven for thinking they are separate entities. It's better to think of them as overlapping definitions instead. Basically, there are some small but relevant differences for researchers, as Miguel Toribio-Mateas, a nutritionist and clinical neuroscientist, explains: "Although they're often used interchangeably, micro biota is the actual bugs and micro biome is the bugs AND their genes." In contrast, your gut micro biota describes the different microbe populations present in your large intestine, including bacteria, archaea, and viruses. It has evolved alongside humans to get to where we are today, living in a mutually beneficial relationship. There are many types of bacteria present in the gut micro biota. However, although it was previously estimated that the body was home to 10 times more bacterial cells than human cells, it's now believed that we have approximately the same number of both [2].

Figure 2: Microbes found in gut

Micro biome: Microorganisms (and their genes) living in a specific environment. Refers to the bacteria (primary) and their genes (secondary).
Micro biota: Microorganisms (by type) living in a specific environment. Refers to the taxonomy (name) of microorganisms present.
Metagenome: The genes of microorganisms in a specific environment. Refers to the collective functions of microbial genes.

Some bacteria are beneficial because they provide an essential function for health, like the production of vitamins or butyrate. Others are deemed probiotic when they contribute several important functions, like bifid bacterium and *Lactobacillus.* We also have small amounts of opportunistic microbes, which have the ability to make us sick if they aren't controlled by the rest of our micro biota. And finally, there are many commensal microbes, which are harmless and live in harmony in the ecosystem.

Micro biome definition: it's about the genes: The micro biome definition in biology refers to the microorganisms and their genes whereas the micro biota only refers to the microbes themselves. If you just want to talk about all the genes in an environment, it is called the metagenome — and it's a common source of interest in scientific study too. In other words, when we define micro biome, we're referring to the microbes and their genetic material, and how they contribute to the health (or not) of the human body. Remember, pathogens will also make up some of your micro biome, not just the beneficial or commensal ones. The gut micro biota definition refers to the microorganisms found in a specific environment by type. This includes **bacteria, fungi, viruses, protozoa, and archaea**, and the diversity of the micro biota will vary from person to person. Different bacteria have specific names determined by a branch of science called taxonomy, where biology experts are tasked with allocating a name and a rank in the tree of life.

For example, the probiotic *L. rhamnosus* is actually a species of *Lactobacillus*, a genus that belongs to the *Formicates* phylum, which is a member of the Kingdom of Bacteria (as opposed to that of plants or animals). Different bacteria live on different parts of the body, prefer different foods, and perform different functions. There is an oral micro biota of the mouth, a micro biota of the skin that has many subcategories (the armpits, nose, feet, etc.), and a gut micro biota — among many others of course. The trillions of bacteria in our gut have a profound influence on our health, metabolism, and even disease protection. When we hear the words microbe, bacteria, or virus, we tend to think of something bad, but not all of these microorganisms cause disease. In fact, we rely on them to perform the functions we may not be able to. The bacteria in our gut help to breakdown the plant fibres we eat because our bodies don't produce enough enzymes for this arduous task.

By doing so, they turn carbohydrates into beneficial metabolites, like butyrate and vitamins. A balanced micro biota with beneficial and probiotic bacteria performs many other functions, like maintaining the correct pH to deter pathogens and keeping the gut lining healthy. Research even shows that gut microbes are involved in maintaining a healthy body weight. Explore our gut bacteria and their functions with micro biome test. It can give us real insight into the unique ecosystem of our gut [3]. The Atlas Micro biome Test uses advanced DNA sequencing technology to screen the genes of our gut microbes and determine what bacteria are inside us and what they're doing. Just order the test online, collect a tiny stool sample, and send it back. Here's what we can learn from it:

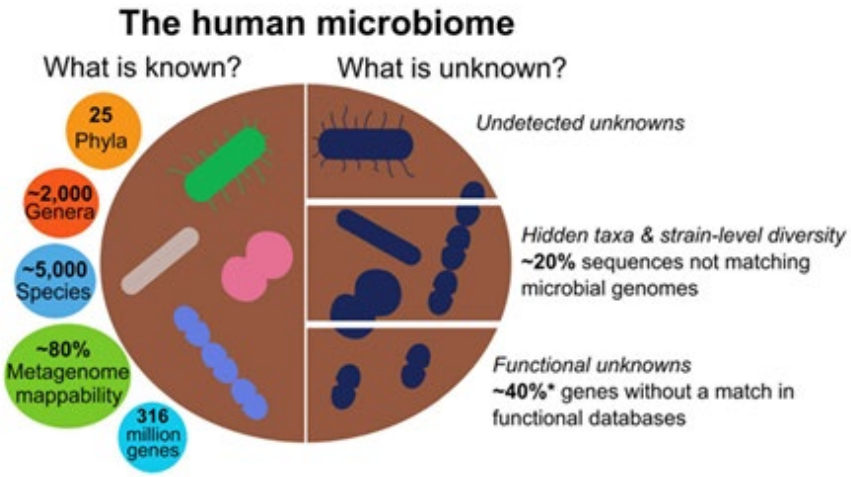

Figure 3: Human micro biome [dark and bright part]

How well our gut microbes protect us from disease. How our diet is affecting us gut microbes. Discover our gut microbes ability to make vitamins. Get personalized food recommendations based on our results. Micro biota describes the actual bacteria, and micro biome is the bacteria and their genes. The terms micro biota and micro biome are used so interchangeably that it's easy to think they mean exactly the same thing. While they are not exactly identical, you'll be fine if you use one or the other. We do on the blog too, and all of our articles are reviewed by micro biome experts. So unless you're conducting some very specific scientific research, you don't need to beat yourself up about the tiny differences. Be it gut micro biome or gut micro biota, we are still referring to the trillions of microbial cells in your colon. For scientists, a biome is an ecosystem made up of flora and fauna.

They use the word micro to indicate that this ecosystem is invisible to the human eye. It is made up of mostly bacteria, but also viruses, archaea, and fungi, which all play a role in maintaining the environment's stability. Prebiotic foods (whole grains, bananas, greens, onions, garlic, soybeans, and artichokes) act as food for healthy gut bacteria. Probiotic foods like yogurt are full of good bacteria already. The micro biome and host emerged during evolution as a synergistic unit from epigenetics and genetic characteristics, sometimes collectively referred to as a holobiont. The presence of micro biota in human and other metazoan guts has been critical for understanding the co-evolution between metazoans and bacteria. Micro biota play key roles in the intestinal immune and metabolic responses via their fermentation product (short-chain fatty acid), acetate [4].

However, despite the new and predominantly medical attention, the concept actually has its roots in the early days of microbial ecology. A popular assumption is that Nobel Laureate and Microbiologist, Joshua Lederberg, first coined the term "micro biome" in 2001. Joshua Lederberg, (May 23, 1925 – February 2, 2008) was an American molecular biologist known for his work in microbial genetics, artificial intelligence, and the United States space program.

He was 33 years old when he won the 1958 Nobel Prize in Physiology or Medicine for discovering that bacteria can mate and exchange genes (bacterial conjugation). He shared the prize with Edward Tatum and George Beadle, who won for their work with genetics. A micro biome (small and life) is the community of microorganisms that can usually be found living together in any given habitat. It was defined more precisely in 1988 by Whipps et al. as "a characteristic microbial community occupying a reasonably well-defined habitat which has distinct physio-chemical properties.

Figure 4: Joshua Lederberg [Micro biome inventor]

The term thus not only refers to the microorganisms involved but also encompasses their theatre of activity". In 2020, an international panel of experts published the outcome of their discussions on the definition of the micro biome. They proposed a definition of the micro biome based on a revival of the "compact, clear, and comprehensive description of the term" as originally provided by Whipps et al., but supplemented with two explanatory paragraphs. The first explanatory paragraph pronounces the dynamic character of the micro biome, and the second explanatory paragraph clearly separates the term micro biota from the term micro biome. The micro biota consists of all living members forming the micro biome. Most micro biome researchers agree bacteria, archaea, fungi, algae, and small protists should be considered as members of the micro biome. The integration of phages, viruses, plasmids, and mobile genetic elements is more controversial. Whipps's "theatre of activity" includes the

essential role secondary metabolites play in mediating complex interspecies interactions and ensuring survival in competitive environments.

Quorum sensing induced by small molecules allows bacteria to control cooperative activities and adapts their phenotypes to the biotic environment, resulting, e.g., in cell-cell adhesion or biofilm formation. All animals and plants form associations with microorganisms, including protists, bacteria, archaea, fungi, and viruses. In the ocean, animal–microbial relationships were historically explored in single host–symbiont systems. However, new explorations into the diversity of microorganisms associating with diverse marine animal hosts is moving the field into studies that address interactions between the animal host and the multi-member micro biome. The potential for micro biomes to influence the health, physiology, behaviour, and ecology of marine animals could alter current understandings of how marine animals adapt to change. This applies to especially the growing climate-related and anthropogenic-induced changes already impacting the ocean. The plant micro biome plays key roles in plant health and food production and has received significant attention in recent years. Plants live in association with diverse microbial consortia, referred to as the plant micro biota, living both inside (the endosphere) and outside (the episphere) of plant tissues.

They play important roles in the ecology and physiology of plants. The core plant micro biome is thought to contain keystone microbial taxa essential for plant health and for the fitness of the plant holobiont. Likewise, the mammalian gut micro biome has emerged as a key regulator of host physiology, and coevolution between host and microbial lineages has played a key role in the adaptation of mammals to their diverse lifestyles. Micro biome research originated in microbiology back in the seventeenth century. The development of new techniques and equipment boosted microbiological research and caused paradigm shifts in understanding health and disease. The development of the first microscopes allowed the discovery of a new, unknown world and led to the identification of microorganisms. Infectious diseases became the earliest focus of interest and research [5].

However, only a small proportion of microorganisms are associated with disease or pathogenicity. The overwhelming majority of microbes are essential for healthy ecosystem functioning and known for beneficial interactions with other microbes and organisms. The concept that microorganisms exist as single cells began to change as it became increasingly obvious that microbes occur within complex assemblages in which species interactions and communication are critical. Discovery of DNA, the development of sequencing technologies, PCR, and cloning techniques enabled the investigation of microbial communities using cultivation-independent approaches. Further paradigm shifts occurred at the beginning of this century and still continue, as new sequencing technologies and accumulated sequence data have highlighted both the ubiquity of microbial communities in association within higher organisms and the critical roles of microbes in human, animal, and plant health. These have revolutionized microbial ecology. The analysis of genomes and metagenomes in a high-throughput manner now provide highly effective methods for researching the functioning of both individual microorganisms as well as whole microbial communities in natural habitats [6].

Figure 5: Bacterial species in gut

Examples include bacterial species of the genera *Staphylococcus, Streptococcus, Enterococcus, Klebsiella, Enterobacter, and Neisseria.* The micro biome consists of trillions of living microbes inside our gut. These little mood elevators work around the clock producing happy-chemicals such as serotonin and dopamine. Making sure that we have a diverse and thriving micro biome can help not only with our mental health, but can prevent things like the urge to over-eat, and can help regulate your digestive system. Below, we have compiled a list of ways you can ensure that you have a happy and healthy micro biome[7].

1. Make sure to eat your vegetables! Especially the leafy green ones! Vegetables are loaded with fibres, which cannot be digested by people but are consumed by the good bacteria in your gut. It has been observed that people who follow a diet rich with fruits and vegetables are less likely to grow disease-causing bacteria. Some great examples of vegetables that feed your microbes are: Leeks, Onions, Asparagus, Broccoli, Spinach, Artichokes

2. Cut out sugar and avoid processed foods: You're sweet enough already! Fast digesting sugars, otherwise known as Monosaccharaides, are digested so quickly that your little microbes don't get a chance to take a bite out of them! If you eat too many simple sugars too regularly, you run the risk of literally starving your micro biome to death. Additionally, hungry microbes will resort to munching away at the lining in your intestine, which can lead to inflammation. Try to alter your diet to include more foods with complex sugars, to ensure a happy and healthy micro biome. Here's a list of some sweet foods that will keep both you and your gut happy: Honey, Dark Chocolate, Coconut Flour, Apples, Berries, Bananas, Mango, and Sweet Potatoes. Also make sure you keep out an eye for dreaded hidden sources of monosaccharides. Sugar can sneak into foods you would never expect them to be. Keep an eye on sugar levels in things like smoothies, nut butters, protein bars, and salad dressings and even in a gut-favourite… yogurt!

3. Probiotics are great for your gut: Probiotics are chock-full of live bacteria that will help ensure your gut is populated by mostly the good types of microbes. You can get a good probiotic supplement at your local health food store, however, make sure you ask your doctor what strains of cultures are best for you, and the condition you are trying to treat. There are many probiotic products out there that claim to have live cultures but do not, so it is important to do your research beforehand and speak to a registered dietitian or health care professional about choosing a probiotic that is right for you [8].

4. Avoid Antibiotics: If probiotics are your gut's best friend, then Antibiotics are your gut's worst enemy! Antibiotics work buy wiping out any and all bacteria, which makes them very effective for treating illnesses, but very bad for your micro biome. The antibiotic cannot recognize the difference between good gut bacteria and bad bacteria. They work on a 'kill now ask questions later' model. Try to buy meat products that were raised without antibiotics, and if you do have to take an antibiotic to treat a virus, make sure to take a probiotic daily for the duration of your prescription to help replenish your gut bacteria.

5. Stock up on dietary sources of prebiotics: Prebiotics are food for your micro biome! It's important to feed these little guys to give them the energy they need to complete their very important task of managing your enteric nervous system. Here is a list of dietary prebiotics that should be staples in your home kitchen: Whole Grains, Apples, Leeks, Onions, Garlic, Cocoa Extracts, Bananas, Asparagus, Nuts, Seeds, Red Wine Extracts, Root Vegetables, Beans, Lentils, Chickpeas, and Green Tea Extracts [9].

Figure 6: Gut friendly food

6. Fermented Foods are gut-friendly: Fermented foods are another great source of probiotics. The crowd favourite is yogurt, however, if you're going to be eating a lot of yogurt, make sure that it is sugar-free! There are several other options that are a great source of good bacteria. Kombucha [Manchurian mushroom] is becoming a very popular source of probiotics. You can also eat things like pickles, kimchee, and kefir to ensure that you're getting enough live cultures to keep your gut healthy and happy [10].

7. Try to cut back on the red meat: Aside from the fact that these days, many meat brands are known for raising their livestock with antibiotics, which is detrimental to your gut, there have been several studies that show healthier micro biomes in vegetarians. A vegetarian's gut for example, will have a significantly smaller number of disease-causing bacteria that an omnivore's gut. However, it is still unclear if this is due to the lack of meat being consumed, or the fact that vegetarians and plant-based individuals tend to consume a great deal more fiber than the average person.

8. It's past your bedtime! Getting enough rest is so important! Studies have shown that people with erratic sleeping patterns run the risk of disrupting their micro biome and running the risk of developing inflammatory diseases. Try to make sure that you get at least 8 hours of sleep a night [11].

9. Hit the Gym: Your microbes feel that if they're working hard to keep you healthy, then you should be working hard too! The micro biomes of physically active people are more healthy and diverse. It also has to be said that one of the best ways to de-stress after a long day is by working out. Even just walking for 30 minutes a day could really impact your gut health, and help these little microbes continue to make sure that your stress levels are managed and your mental health stays intact [12].

10. Make time for you! Say 'no' more often, explore meditation, mindfulness, yoga, or Tai. Establishing balance in your life will support your mental and emotional health and optimize your gut and overall health. Stress can negatively affect your micro biome and you need a healthy micro biome to manage help you manage your stressors. If you're not careful, and you may get caught in an unhealthy cycle if you do not give yourself time to re-energize [13].

Conclusion: About 100 trillion bacteria, both good and bad, live inside your digestive system. Collectively, they're known as the gut micro biota. Science has begun to look more closely at how this enormous system of organisms influences—and even improves—health conditions, from heart disease to arthritis to cancer. First, the number of bacteria in your gut is vast – 50 trillion or so, which equals about one for every human cell in our bodies. The makeup of this bacterial collection, or micro biome, is affected by many things, including diet, exercise and cultural influences. Maintaining a healthy gut contributes to better overall health and immune function. By making appropriate lifestyle and dietary changes, people can alter the diversity and number of microbes in their gut for the better. Positive changes a person can make include taking probiotics, following a fiber-rich vegetarian diet, and avoiding the unnecessary use of antibiotics and disinfectants. Other simple lifestyle changes a person can make include getting enough sleep and exercising regularly. However, a person should talk to their doctor before making any drastic changes to their diet. This is because for some people, such as those with irritable bowel syndrome or other medical conditions, probiotics and fiber-rich or vegetarian diets may not be helpful.

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