Libyan International Medical University
Faculty of Basic Medical Science

Communication between gut bacteria and the brain

Submitted by: Salem mohammed , Second Year Student, Faculty of Basic Medical Science, Libyan International Medical University.
Supervisor: Dr. Fatma , Tutor, Faculty of Basic Medical Sciences, Libyan International Medical University.
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Abstract:

Although the interaction between our brain and gut has been studied for years, its complexities run deeper than initially thought. It seems that our minds are, in some part, controlled by the bacteria in our bowels. The gut has defenses against pathogens, but, at the same time, it encourages the survival and growth of "healthy" gut bacteria, and here in this report the communication between the gut bacteria and the brain will be discussed(1).

Introduction:

The vast majority of these single-celled visitors are based in the colon, where no less than 1 trillion reside in each gram of intestinal content. Estimating the number of bacterial guests in our gut is challenging; to date, the best guess is that 40 trillion bacteria call our intestines home - partially dependent on the size of your last bowel movement (poop's major ingredient is bacteria). To put that unwieldy number into perspective, our bodies consist of roughly 30 trillion cells. So, in a very real sense, we are more bacteria than man. Most of our gut bacteria belong to 30 or 40 species, but there can be up to 1,000 different species in all. Collectively, they are termed the microbiome.Of course, bacteria do benefit from the warmth and nutrition in our bowels, but it is not a one-way relationship - they also give back. Some species benefit us by breaking dietary fiber down into short-chain fatty acids that we can then absorb and use. They metabolize a number of compounds on our behalf and play a role in the synthesis of vitamins B and K(2).

Discussion:

On the other side of the fence, recent research infers that dysregulation of gut bacteria might be an important factor in inflammatory and autoimmune conditions. The microbiome's role in health and disease is only slowly giving up its secrets. The latest and perhaps most remarkable finding is the ability that gut bacteria have to moderate our brain and behavior. The goings on in our guts are a matter of life or death. If the gut is empty, our brain must be told; if there is a problem with our gut that will hinder food processing and therefore nutrition absorption, the brain will need to be informed. If our gut is facing a pathogen attack, our brain should be kept in the loop. The links between our gut and brain are hormonal, immunological, and neural, via the central nervous system and the enteric nervous system, which governs the function of the gut. Collectively, they are termed the gut-brain axis. Although, at first glance, the connections between the gut and brain might seem surprising, we have all experienced it in action. The relationship between stress, anxiety, and a swift bowel movement are no stranger to anyon. These gut-brain conversations have been studied for some time. However, a new level to this partnership has recently been glimpsed; researchers are now considering the

influence of our microbiome on the gut-brain axis. In other words, researchers are asking: do the bacteria in our gut affect our psychology and behavior?

In humans, the hypothalamic-pituitary-adrenal (HPA) axis is the primary responder to stresses of any kind. It is one of the major players in the limbic system and is heavily involved in emotions and memory.Stress activates the HPA axis and eventually results in the release of cortisol - the "stress hormone" - which has a variety of effects on many organs, including the brain and gut.In this way, the brain's response to stress has a direct influence on the cells of the gut, including epithelial and immune cells, enteric neurons, interstitial cells of Cajal (the pacemakers of the bowels), and enterochromaffin cells (serotonin synthesizing cells). Conversely, these cell types are also under the influence of our resident army of bacteria. Although the mechanisms by which the microbiota regulate the brain are less clear, evidence is mounting that there is, indeed, a two-way dialogue. Stress is known to increase the permeability of the intestinal lining; this gives bacteria easier access to both the immune system and the neuronal cells of the enteric nervous system.This may be one of the ways in which bacteria find a way to influence us. However, another, more direct route has also been demonstrated. One study, using food-borne pathogens, provided evidence that bacteria in the intestines can activate stress circuits by directly activating the vagus nerve - a cranial nerve supplying a number of organs, including the upper digestive tract. A more direct route still might involve direct contact of the microbiome with the sensory neurons of the enteric nervous system. Microbes have the capacity to manipulate behavior and mood through altering the neural signals in the vagus nerve, changing taste receptors, producing toxins to make us feel bad, and releasing chemical rewards to make us feel good. Around 100 million neurons are stationed in the gut, collectively forming the enteric nervous system, also called the "Second Brain." The enteric nervous system is connected to the human brain via the vagus nerve(3). Thanks to this setup, bacteria are granted streamlined pass to the brain, and they're equipped to take advantage. For example, microbes have genes that allow them to produce hormones like serotonin and dopamine. microbes may control the eating behavior of hosts through a number of potential mechanisms including microbial manipulation of reward pathways, production of toxins that alter mood, changes to receptors including taste receptors, and hijacking of neurotransmission.Basically, bacteria will send positive signals to the brain when you eat foods that they like, and negative signals when you eat foods they don't like(4).

Conclusion:

There is a long and winding path ahead of those scientists brave enough to investigate the strange reality of the microbiome-gut-brain axis. No doubt a multitude of molecules are involved in various ways to differing degrees.

In the far-flung future, perhaps medicines specifically targeting the microbiome will be created for psychiatric conditions; the microbiome may become an early warning system for certain diseases or even a diagnostic tool.For now, all we can do is ponder the influence that bacteria have on our everyday state of mind. We should also be amazed and amused that humans, as intelligent as we consider ourselves, are partially under the control of single-celled lifeforms. Perhaps we would do well to remember that bacteria predate us by billions of years and are highly likely to outlive our species by billions more.

References:

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