BIOSCIENTIST
The Salford Biomedicine Society Magazine

Does our gut microbiome affect the way we think?

Bruce Veloso

Trillions of microorganisms inhabit the human body at any one time, collectively known as the microbiome. The largest proportion of the microbiome (more than 100 million microorganisms) is in the human gut – up to 100 times the number of eukaryotic cells in the body[1].

Dietary content directly affects the composition of the gut microbiome. For example, it was shown that the composition of gut bacteria present in Europeans is significantly different from that of Africans, a phenomenon which may be attributed to the differences in their regular eating habits[2]. It was observed that the gut bacteria present in Europeans was mainly composed of the Bacteroides enterotype. In contrast to this, the African gut microbiome was mainly composed of Prevotella enterotype.

Furthermore, Wu et al. observed from examination of stool samples from 98 people that Bacteroides spp. are mainly associated with a diet high in animal fat, whereas Prevotella spp. are closely associated with a diet high in carbohydrates[2].

Zhu et al. explain that after many years of co- existence, some gut bacteria – including six predominant phyla of Firmicutes, Bacteroidetes, Proteobacteria, Actinomycetes, Verrucomicrobia, and Fusobacteria – have developed a ‘symbiotic relationship’ with humans by forming a large portion of the gut microbiome and helping us with a multitude of tasks such as digesting food and preventing growth of pathogenic bacteria[1].

However, the influence of the gut microbiome extends far further than previously believed. The gut and the brain form the ‘gut-brain axis’, where changes in either organ directly impact the other. Experimental evidence suggests that the multiform interactions between the gut and brain likely contribute to several neurological and mental illnesses, such as depression, Alzheimer's disease and schizophrenia[1].

Here are a few examples:

Microorganisms in the gut can affect the brain of the host organism by regulating the brain- derived neurotrophic factor (BDNF, a nerve growth agent which supports and differentiates neurons) and N-methyl-D- aspartate (NMDA, an amino acid that acts as an agonist, copying the action of glutamate, a neurotransmitter) receptors[1]. Changes in BDNF expression are associated with cognitive dysfunction of patients suffering from schizophrenia[1]. Interestingly, when the expression of NMDA receptors in a host is enhanced, symptoms are relieved and cognitive ability improves[1].

Additionally, studies have shown that the microbiota can influence the central nervous system by altering hippocampal neurogenesis (process in which new nerve growth takes place in the hippocampus)[1]. According to Zhu et al, the hippocampus and lateral ventricle areas of the brain have an important function in learning and memory and therefore, can influence the pathogenesis of neurological disorders and symptoms in conditions such as epilepsy, depression, Alzheimer's disease and Parkinson’s disease[1].

DOI: https://doi.org/10.57898/biosci.135

Intriguingly, 95% of serotonin, a neurotransmitter mainly associated with mood and emotion, is produced in the gut, and microorganisms present in the gut may be essential for its production: in sterile mice, serotonin production was reduced to 60%[1]. Certain compositions of the gut microbiota may promote the development of depressive disorders. It is fascinating to speculate that we may be able to treat depression and related health conditions using specific food types or even by faecal replacement therapy.

References

1. Zhu X, Han Y, Du J, Liu R, Jin K, Yi W. Microbiota-gut-brain axis and the central nervous system. Oncotarget. 2017;8(32):53829-53838. doi:10.18632/oncotarget.17754

2. Wu GD, Chen J, Hoffmann C, et al. Linking Long-Term Dietary Patterns with Gut Microbial Enterotypes. Science. 2011;334(6052):105-108. doi:10.1126/science.1208344

DOI: https://doi.org/10.57898/biosci.135