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NEUROPLASTICITY AND CONNECTION OF BRAIN WITH GUT MICROBIOT THROUGH GUT-BRAIN AXIS NEUROLOGICAL DISORDERS

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ABSTRACT
Neuroplasticity is the capacity of the brain to change its structure as well as function in response to external stimuli, damage, and learning, it involves the production of new neurons. Previously, studies show that the brain stopped developing after childhood and neurons did not regenerate. Nevertheless, the current study shows that the brain is adaptable throughout the life. So, neuroplasticity is useful in treating neurological disorders. Trillions of microorganisms are present within our body, it is familiar that the gut has a powerful connection with the central nervous system in health and disease. The gut-brain axis is the bidirectional communication between the gut and brain.[1] Bacteria and chemicals produced in the gut can be responsible for the brain's health so it may be possible to improve brain health. We all know that gut microbes play a critical role in the development of some neurological and neuropsychiatric problems like depression, addiction, anxiety, and Alzheimer's disease due to dysbiosis because changes in gut microbiota are detected in patients with depression. This review is designed to inspect how gut microbiota can affect neuroplasticity and also is responsible for the development of neurological disorders. In this review, we also discuss current studies that connect gut microbes to different types of neurodevelopmental conditions.[2]

KEYWORDS: Neuroplasticity; gut brain axis; dysbiosis; neurological disorders; brain bacteria relation.

INTRODUCTION
A recent study shows that gut microbes can be responsible for regulating many neuronal processes like neurogenesis, glial cell functioning, and myelination and also contribute to the development of blood-brain barrier permeability. The capacity of neural connection in the brain to change the growth and reorganization of neurons because of many different factors like external stimuli, and injury and also involve new learning processes; it can define neuroplasticity. The connection between the brain axis to gut microorganisms can affect many different types of brain functions like neurogenesis, and synthesis of neurotransmitters and also affect overall human physiology.

We all know that gut microorganisms can affect the absorption as well as the metabolism of many drugs from which different types of aspects of the drug should be determined like drug availability and toxicity; whereas, the drug itself is responsible for changes in gut flora which directly affects on pharmacological activity of drug. However, the change in gut microbes which is "dysbiosis" is a condition that is not only affects on gastrointestinal tract-related problems but also other vital organ dysfunction and CNS disorders. The communication between the gut and CNS is responsible for the development of many neuronal and it's related inflammatory conditions like depression, Multiple Sclerosis, Anxiety, Alzheimer's Neuropsychiatric disorders and Parkinson's diseases. So that, there is a good circumstance to use the gut- brain axis for the management of neuronal conditions and to improve the neurophysiological processes.[3] The microbes in the gut can give shape to neuronal function in postnatal life, it is very important to understand the mechanism of - how gut flora can improve the neuronal processes. Therefore, we can use it in therapeutic interventions for many neurodevelopment and neurodegenerative diseases.

Details about the diversity and composition of gut microbiota
On this planet, including all mammals humans are also colonized by a large number of microbes which consist of bacteria, fungi, archaea, protozoa, and viruses throughout the body but most abundantly in the gastrointestinal tract 10 bacteria. Approximately 200 common bacterial species are present in the human gut, mostly belonging to phyla Firmicutes and Bacteroidetes and both phyla represent about 70-75% of the total. Other common phyla include Actinobacteria,

Proteobacteria and Verrucomicrobia.[4] The main genera are Bacteroides, Clostridium, Faecalibacterium, Eubacterium, Ruminococcus, Peptidococcus, Peptidostreptococcus, and Bifidobacterium.

The gut of newly born humans is sterile but after birth it gets colonized immediately by Actinobacteria and proteobacteria phyla. The microbiotas are stable up to one year of baby and then after, in adult introduce anaerobic bacteria Firmicutes and Bacteroidetes. The study also suggests that, healthy mother milk can help in the development of right gut microbiotes colonies in a baby.

It is shown that, the diet should have great impact on gut microbiotes so the imbalance between microbes in the gut can be responsible for dysbiosis.

Different type of factors can affect on microbiotas of the gut

- Diet
- Age
- Stress
- Lifestyle
- Infection
- Geography
- Mothers milk
- Immune
- System
- Environmental contact

Based on the microorganism discription, the human population is classified into three enterotypes given as follows

- **Bacteroides:** People consume high protein and animal fat.
- **Ruminococcus**: These enterotypes include the human which consume.
- **Prevotella**: People included in this group which consume carbohydrates and simple sugar.

The gut microbiotas perform many important processes as well as also show a direct effect on the enteric nervous system {ENS} and gut mucosa. The microbiotas are responsible for the metabolism in the host body and release the chemical substances mainly hormonal into the blood. These secretions are produced into intestinal tissue absorbed into blood and lymph capillaries and transported into the targeted organ like the brain and these chemicals are effective in low concentration.[5]

FUNCTION OF GUT MICROBES

Different types of chemical substances are produced by microbes which we call as hormones. Mainly these substances are produced by multiple types of microbes which are described below - Neurotransmitters like Serotonin, Dopamine, GABA, and Noradrenaline.

1. **Serotonin** produced by the bacterial strain of Lactococcus lactis subsp. Cremoris, L. lactis subsp. Lactis, Lactobacillus plantarum, Streptococcus thermophilus, E-coli K-12, Morganella morganii, klebsiella pneumonia.
2. **Noradrenaline** can be obtained by E-coli K-12, S. marcescens, P. vulgaris, B. subtilis, B. mycoides bacterial stain
3. **Dopamine** can play a very crucial role in maintaining cognitive behavior, mood as well as emotions so for these purposes it is important to synthesize properly by the bacteria H. alvai, Bacillus cereus, B. subtilis, Proteus vulgaris, B. Mycoides, S. aureus, Serratia marcescens, E.coli, K. Pneumoniae, M. morganii.
4. **GABA [Gamma Amino-Butyric Acid]** is an amino acid and it mainly acts as an inhibitory neurotransmitter for CNS as well as acts an immunomodulator for many activities. For these purposes, production is important in the correct amounts by the bacteria L. brevis, B. dentium, B. infantis, B. olescentis, L. rhamnosus.
5. **Acetylcholine** has involvement in attention, memory, and also in involuntary movement like contraction of the muscles. Choline plays an important role in different types of brain function. It is the organic compound obtained by L. plantarum and L. Lactis subsp. Lactis, L. lactis subsp. Cremoris, S. thermophiles, K. pneumoniae, M. morganii, H. alvai bacterial stain and responsible for the metabolism of lipid.

Different types of gastrointestinal hormones are also produced by gut bacteria like Ghrelin, Leptin, and Glucagon-like peptide chemical substances.[6] As we see the above neurotransmitters can participate in CNS-related conditions like maintaining mood, cognitive functions, motility, and movement. So ultimately with the help of these pathways we can solve the many problems related to the brain.

RELATION BETWEEN MICROBIOTES AND CNS

As we know, microbes have a direct connection with the central nervous system [CNS] which is known as the Gut-Brain Axis. Different types of studies suggest that, the microbial constituted in the gut to be the development of appropriate stress response in life[7] and also there is a particular period in life where proper colonization of bacteria is necessary to ensure the development of the mature immune system and also decrease the brain-derived neurotropic factors [BDNF]. The Administration of probiotics can be play a role in microbiota in anxiety- like behaviour. Somehow there is an probiotics are responsible for the production of neuroactive substances[8] and bound to them that surround the immunological, neurophysiological microbiological components. The indigenous microflora can be responsible for the stimulation of the immune system and ultimately it leads to the inhibition of colonization of pathogens.[9]

The Use of antibiotics also causes dysbiosis due to imbalance between GI bacteria. It may be neurophysiological degeneration is seen as followes:

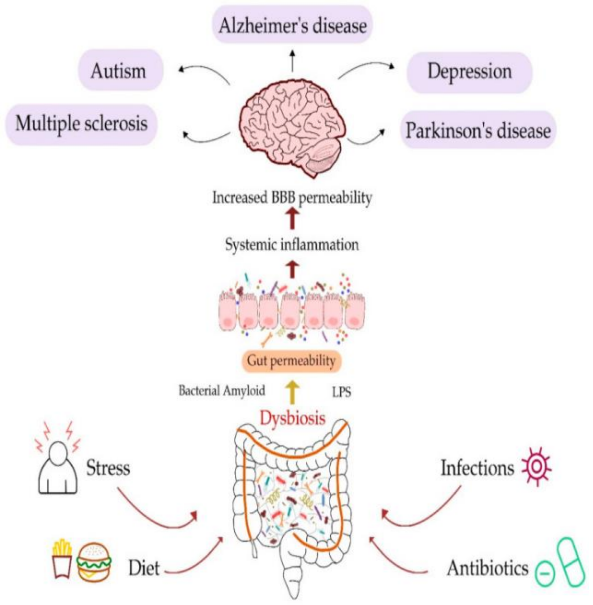

Fig.1.

The gut-brain axis is the bidirectional communication network between the gut microbes and the brain.[10] Alterations in the interaction between the brain and gut microbes are mainly seen in various immunological, psychiatric, neurological disorders.[11] It has been identified that there is a causative role of microbes in irritable bowel syndrome.[12] Stress-related gut-brain disorders are due to dysbiosis.[7] Fecals of obese humans are studied and it is seen that it is more in firmicutes and less in Bacteroides as compared to lean humans. obesity is of course multifactory condition but these are also suggest that the accumulation of fat in the body leads to restricting microbial flora.

As we see the microbial alteration seen in IBD, here we conclude that, how mucosal microbes and altered fecal are in IBD - in IBD some findings are decreased in lactobacillus spp, bifidobacterium and faecalibacterium spp., also less no of methanogens, bifidobacteria are comparatively fewer. Now we see the increased no. Of bacteria as increased in the ratio of the firmicutes to bactereroidetes and also increased the no of dorea, ruminoccocus, and clostridium spp. veillonella and lactobacillum in IBD.[13]

Some finding in the case of a condition like obesity are decrease in the ratio of firmicutes to bacteroids, an increased no. of firmicutes, and Bacteroids during calorie restriction and a decrease in bacteroids in obesity. The studies also suggest that the microflora of infants during the treatment of antibiotics penicillin and cephalosporins the E. Coli are increased but if alternatives used like cotrimoxazole and erythromycin. When treatment of cotrimoxazole and cephalosporin are given than enterococci no are increased where whereas penicillin and erythromycin can suppress them.[14] Our immune system will be interact with the neurotransmitter and neurological factors so it can be responsible for depression.

GUT-MICROBES AND NEUROLOGICAL AND NEUROPSYCHIATRIC DISORDER

The gut can design and build the neuronal network of the nervous system by modulating the neurotransmitters.[15] BBB consists of endothelial cells produced by the different types of neuronal cells like astrocytes, and pericytes internally by tight junction proteins [claudin, occludin], and gut microbes can affect the BBB. So if there is a depletion of microbes in the gut are seen than permeability of BBB is greater. Now in this part of the review article, we can explain how the microbes of the gut affect on various neurological conditions.[16]

Depression and anxiety: Hyper-activation of the immune system due to modification in microbes of the gut can be responsible for the synthesis of inflammatory mediators like cytokines which are seen in depression.[17] Depression is related with the alteration in the production of neuroactive metabolites and hormones which can lead to disruption of intestinal barrier function. Ultimately it is responsible for alteration in behaviour and mental state. The prophylaxis or treatment is given by administering probiotics and prebiotics. Both can nourish the gut microbiotas and help in balancing the microbial flora.[18]

CONCLUTION

In these reviews, we conclude that our physical as well as mental health not only depends on lifestyle and environmental factors but also on what we eat. We focused on the importance of gut microbiota in neurological conditions. Gut microbes have a great impact on the central nervous system as well as the enteric nervous system. By using prebiotics and probiotics we can recolonize the gut flora and decline the growth of neurodegenerative conditions.

All over the words, there is an increasing percentage of CNS-related problems and it's mainly seen in today's young generation. So it is necessary to understand the importance of the lifestyle and to focus on our dietary habits. Here we see that there is a direct correlation between the gut flora to the central nervous system and gut flora is mostly depends on what we can eat. accordingly to it, flora going to grow and microbial colonies are pushed to that direction for growth. Their impact is seen in the CNS.

There is a great scope in the gut-brain axis for therapeutic management. More and more research areas are available so more studies should be conducted to help in various therapies and treatment of autoimmune systems by improving the immune system, and neurological conditions.

REFERANCE

1. Damiani F, Cornuti S, Tognini P. The gut-brain connection: Exploring the influence of the gut microbiota on neuroplasticity and neurodevelopmental disorders. *Neuropharmacology*, 2023; 231: 109491. doi:10.1016/j.neuropharm.2023.109491
2. Cryan JF, O'Riordan KJ, Cowan CSM, et al. The Microbiota-Gut-Brain Axis. *Physiol Rev*., 2019; 99(4): 1877-2013. doi:10.1152/physrev.00018.2018
3. Suganya K, Koo BS. Gut-Brain Axis: Role of Gut Microbiota on Neurological Disorders and How Probiotics/Prebiotics Beneficially Modulate Microbial and Immune Pathways to Improve Brain Functions. *Int J Mol Sci*., 2020; 21(20). doi:10.3390/ijms21207551
4. Murciano-Brea J, Garcia-Montes M, Geuna S, Herrera-Rincon C. Gut Microbiota and Neuroplasticity. *Cells*., 2021; 10(8): 2084. doi:10.3390/cells10082084
5. neuro.
6. Clarke G, Stilling RM, Kennedy PJ, Stanton C, Cryan JF, Dinan TG. Minireview: Gut microbiota: The neglected endocrine organ. *Mol Endocrinol*, 2014; 28(8): 1221-1238. doi:10.1210/me.2014-1108
7. Rutsch A, Kantsjö JB, Ronchi F. The Gut-Brain Axis: How Microbiota and Host Inflammasome Influence Brain Physiology and Pathology. *Front Immunol*, 2020; 11: 604179. doi:10.3389/fimmu.2020.604179
8. Lyte M. Probiotics function mechanistically as delivery vehicles for neuroactive compounds: Microbial endocrinology in the design and use of probiotics. *Bioessays*, 2011; 33(8): 574-581. doi:10.1002/bies.201100024
9. Doroszkiewicz J, Groblewska M, Mroczko B. The Role of Gut Microbiota and Gut-Brain Interplay in Selected Diseases of the Central Nervous System. *Int J Mol Sci*., 2021; 22(18). doi:10.3390/ijms221810028
10. Grenham S, Clarke G, Cryan JF, Dinan TG. Brain-gut-microbe communication in health and disease. *Front Physiol*,. DEC. 2, 2011. doi:10.3389/fphys.2011.00094
11. Heiss CN, Olofsson LE. The role of the gut microbiota in development, function and disorders of the central nervous system and the enteric nervous system. *J Neuroendocrinol*, 2019; 31(5): e12684. doi:10.1111/jne.12684
12. Mayer EA, Nance K, Chen S. The Gut-Brain Axis. *Annu Rev Med*., 2022; 73: 439-453. doi:10.1146/annurev-med-042320-014032
13. Bastiaanssen TFS, Cussotto S, Claesson MJ, Clarke G, Dinan TG, Cryan JF. Gutted! Unraveling the Role of the Microbiome in Major Depressive Disorder. *Harv Rev Psychiatry*, 2020; 28(1): 26-39. doi:10.1097/HRP.0000000000000243
14. Bennet R, Eriksson M, Nord CE. The fecal microflora of 1-3-month-old infants during treatment with eight oral antibiotics. *Infection*, 2002; 30(3): 158-160. doi:10.1007/s15010-002-2140-z
15. Tognini P. Gut Microbiota: A Potential Regulator of Neurodevelopment. *Front Cell Neurosci*, 2017; 11: 25. doi:10.3389/fncel.2017.00025
16. Socała K, Doboszewska U, Szopa A, et al. The role of microbiota-gut-brain axis in neuropsychiatric and neurological disorders. *Pharmacol Res*., 2021; 172. doi:10.1016/j.phrs.2021.105840
17. Miller AH, Raison CL. The role of inflammation in depression: from evolutionary imperative to modern treatment target. *Nat Rev Immunol*, 2016; 16(1): 22-34. doi:10.1038/nri.2015.5
18. The indigenous gastrointestinal microflora - ScienceDirect. https://www.sciencedirect.com/science/article/abs/pii/0966842X96100573