



## GUT MICROBIOTA AS A REGULATOR OF PHYSIOLOGICAL HOMEOSTASIS: MECHANISMS AND SYSTEMIC INTERACTIONS

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**Annotation:** This work is devoted to the study of the important role of gut microbiota in the regulation of physiological homeostasis. The community of microorganisms inhabiting the human intestine actively participates in maintaining metabolic balance, regulating immune system activity, and influencing neuroendocrine processes. The study analyzes the mechanisms by which microbiota affects the host organism, including the production of metabolites such as short-chain fatty acids, modulation of the immune response, and interactions through the gut-brain axis.

In addition, systemic interactions between the gut microbiota and various organs and systems are examined, highlighting its impact on overall health. Disruption of microbiota composition (dysbiosis) is considered an important factor in the development of metabolic, inflammatory, and neurological diseases. Understanding these mechanisms is essential for developing new therapeutic approaches aimed at restoring homeostasis.

**Keywords:** gut microbiota, physiological homeostasis, dysbiosis, metabolic balance, immune system, short-chain fatty acids, gut-brain axis, microorganisms, neuroendocrine system, systemic interactions, inflammatory processes, metabolic diseases, microbiota modulation, health and disease.

**Аннотация:** Данная работа посвящена изучению важной роли кишечной микробиоты в регуляции физиологического гомеостаза. Совокупность микроорганизмов, обитающих в кишечнике человека, активно участвует в поддержании метаболического баланса, регуляции иммунной системы и воздействии на нейроэндокринные процессы. В исследовании анализируются механизмы влияния микробиоты на организм, в частности, продукция метаболитов, таких как короткоцепочечные жирные кислоты, модуляция иммунного ответа и взаимодействие через ось «кишечник-мозг».

Кроме того, рассматриваются системные взаимодействия кишечной микробиоты с различными органами и системами организма, а также её влияние на общее состояние здоровья. Нарушение состава микробиоты (дисбиоз) оценивается как важный фактор развития метаболических, воспалительных и неврологических заболеваний. Изучение этих механизмов имеет важное значение для разработки новых терапевтических подходов, направленных на восстановление гомеостаза.

**Ключевые слова:** кишечная микробиота, физиологический гомеостаз, дисбиоз, метаболический баланс, иммунная система, короткоцепочечные жирные кислоты, ось «кишечник–мозг», микроорганизмы, нейроэндокринная система, системные взаимодействия, воспалительные процессы, метаболические заболевания, модуляция микробиоты, здоровье и болезнь.

### Annotatsiya

Mazkur ish ichak mikrobiotasining fiziologik gomeostazni boshqarishdagi muhim o'rnini yoritishga bag'ishlangan. Inson ichagida yashovchi mikroorganizmlar majmuasi organizmda metabolik muvozanatni saqlash, immun tizim faoliyatini tartibga solish hamda neyroendokrin jarayonlarga ta'sir ko'rsatishda faol ishtirok etadi. Tadqiqotda mikrobiotaning organizmga ta'sir mexanizmlari, xususan, qisqa zanjirli yog' kislotalari kabi metabolitlar ishlab chiqarish, immun javobni modulyatsiya qilish va "ichak–miya o'qi" orqali o'zaro ta'sir qilish jarayonlari tahlil qilinadi.

Shuningdek, ichak mikrobiotasining turli organ va tizimlar bilan tizimli o'zaro aloqalari ko'rib chiqilib, uning umumiy sog'liq holatiga ta'siri ochib beriladi. Mikrobiota tarkibining buzilishi (disbiroz) metabolik, yallig'lanish va nevrologik kasalliklarning rivojlanishida muhim omil sifatida baholanadi. Ushbu mexanizmlarni o'rganish gomeostazni tiklashga qaratilgan yangi davolash yondashuvlarini ishlab chiqishda muhim ahamiyat kasb etadi.

**Kalit so'zlar:** ichak mikrobiotasi, fiziologik gomeostaz, disbiroz, metabolik muvozanat, immun tizim, qisqa zanjirli yog' kislotalari, ichak–miya o'qi, mikroorganizmlar, neyroendokrin tizim, tizimli o'zaro ta'sirlar, yallig'lanish jarayonlari, metabolik kasalliklar, mikrobiota modulyatsiyasi, sog'liq va kasallik.

In recent years, the gut microbiota has been extensively studied as an essential component of the human body. Trillions of microorganisms residing in the intestine not only participate in the digestive process but also play a crucial role in regulating the body's overall physiological state, including metabolic balance, immune response, and neuroendocrine system activity. Therefore, the gut microbiota is considered one of the key factors ensuring physiological homeostasis.

Modern scientific research demonstrates the existence of complex interactions between the microbiota and the host organism. In particular, the production of metabolites by microbiota, its role in modulating the immune system, and its connection with the central nervous system through the "gut–brain axis" are of great importance. These interactions play a significant role in maintaining internal balance within the body.

However, disruption of the gut microbiota composition, known as dysbiosis, is closely associated with the development of various diseases. These include metabolic syndrome, inflammatory diseases, and neurological disorders, all of which can be linked to changes in microbiota balance. Therefore, studying the mechanisms by which the gut microbiota regulates physiological homeostasis is important not only from a theoretical perspective but also for practical medicine.

The aim of this work is to analyze the role of the gut microbiota in regulating physiological homeostasis, its main mechanisms, and its interactions with different body systems.

The gut microbiota is a complex ecosystem of bacteria, viruses, fungi, and other microorganisms that inhabit the human intestine and exist in a symbiotic relationship with the

host. Modern studies show that the gut microbiota plays an important role not only in digestion but also in maintaining the overall homeostasis of the organism.

Role of microbiota in metabolic processes.

Gut microorganisms break down dietary components and produce metabolites essential for the host. In particular, short-chain fatty acids (acetate, propionate, and butyrate) serve as the main energy source for intestinal epithelial cells. Butyrate maintains the integrity of the intestinal mucosa, exhibits anti-inflammatory effects, and regulates epithelial cell proliferation. Additionally, the microbiota influences lipid and glucose metabolism, acting as a key factor in the development of metabolic syndrome, obesity, and type 2 diabetes.

Interaction with the immune system.

The gut microbiota plays a decisive role in the development and functional activity of the immune system. Microorganisms activate intestinal lymphoid tissues and regulate both innate and adaptive immune responses. A normal microbiota helps maintain immune tolerance, enabling the body to distinguish between beneficial and harmful antigens.

In cases of dysbiosis, immune balance is disrupted, which may lead to the development of autoimmune diseases, allergies, and chronic inflammatory processes.

Gut–brain axis and neuroendocrine effects.

The gut microbiota establishes bidirectional communication with the central nervous system, known as the “gut–brain axis.” Microorganisms are involved in the synthesis of neuroactive substances, including serotonin, dopamine, and gamma-aminobutyric acid (GABA). These substances play a crucial role in regulating mood, behavior, and stress responses.

Moreover, the microbiota influences the hypothalamic–pituitary–adrenal (HPA) axis, modulating mechanisms of adaptation to stress.

Systemic interactions and effects on organs.

The gut microbiota affects not only the intestine but also the function of other organs. For example, through the “gut–liver axis,” it regulates liver metabolism, and through the “gut–lung axis,” it influences respiratory immunity. Metabolites produced by microbiota enter the bloodstream and are distributed throughout the body, affecting various tissues.

Overall, the gut microbiota is a critical regulator of physiological homeostasis, influencing multiple systems and processes within the human body.

Dysbiosis and pathological conditions.

Disruption of the structural and functional composition of the gut microbiota—known as dysbiosis—is an important factor in the development of many diseases. As a result of dysbiosis, the intestinal barrier function is impaired, leading to what is known as “leaky gut syndrome.” Consequently, toxins and bacterial components enter the bloodstream, enhancing systemic inflammation.

This condition has been associated with obesity, cardiovascular diseases, inflammatory bowel diseases (IBD), as well as depression and neurodegenerative disorders.

Conclusion.

In conclusion, the gut microbiota plays a central role in maintaining physiological homeostasis in the human body. Research shows that the microbiota contributes to maintaining internal balance by regulating metabolic processes, modulating the immune system, and interacting with the neuroendocrine system.

Disturbances in the composition of the gut microbiota, namely dysbiosis, lead to the development of metabolic, inflammatory, and neurological diseases. Therefore, restoring the microbiota and supporting its normal function is an important strategy for maintaining homeostasis and preventing diseases.

Future research will help expand opportunities for improving health and preventing various diseases through the development of microbiota-targeted therapeutic approaches.

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