Intestinal Microbiota as a Crucial Ecosystem of the Human Body

Ukleba Ketevan, Chakvetadze Maia
Central European University
Akaki Tsereteli State University
Georgian Academy of Ecological Sciences

Abstract: *Dysbiosis (also referred to as dysbacteriosis) constitutes one of the most significant challenges in contemporary medicine. An imbalanced microbiota is frequently implicated in the pathogenesis of inflammatory bowel diseases as well as autoimmune and other systemic disorders.(1)*
Keywords: *dysbiosis, microbiota, autoimmune disorders.*

Dysbiosis (also referred to as dysbacteriosis) constitutes one of the most significant challenges in contemporary medicine. Its importance is driven by its high prevalence and its substantial adverse impact on human health.(4)

Dysbiosis is defined as a disruption in the balance of microorganisms within the human body, primarily affecting the intestinal microbiota. This condition is characterized by a reduction in the population of beneficial (commensal) bacteria alongside a concomitant increase in pathogenic and opportunistic microorganisms.(2)

The intestinal microbiota, or microflora, comprises millions of diverse microorganisms that together form a complex ecosystem and play a crucial role in the development and regulation of the immune system. Studies have demonstrated that approximately 70–80% of immune cells are associated with the gastrointestinal tract. Therefore, although the intestine is traditionally classified as part of the digestive system, it also represents an essential component of the immune system.

An imbalanced microbiota (dysbiosis) is frequently implicated in the pathogenesis of inflammatory bowel diseases, as well as autoimmune and other systemic disorders.(3) Through the modulation of the immune system, the intestinal microbiota plays a protective role by contributing to the prevention of a wide range of diseases, including:

- Atherosclerosis
- Obesity
- Diabetes mellitus
- Irritable bowel syndrome
- Allergic disorders
- Depression
- Chronic obstructive pulmonary disease

There is a growing body of evidence suggesting that disruptions in the intestinal microbiota may be associated with the development of neurodegenerative disorders, including Alzheimer’s disease and

Parkinson’s disease. Indeed, it is widely recognized that a bidirectional communication network exists between the intestinal and the brain, commonly referred to as the intestinal–brain axis. For this reason, the intestine is often described as the “second brain.”

In general, the principal functions of the intestinal microbiota include:

- The metabolism and synthesis of a wide range of biochemical compounds.
- Protection of the host organism against the invasion of pathogenic microorganisms;
- Regulation and modulation of the immune system.

Recent medical evidence indicates that the intestinal microbiota is closely associated with weight regulation, skin health, and even psychological well-being. (5) The intestinal microbiota contributes to host defense against infections and is involved in the production of vitamins, short-chain fatty acids, hormones, and neurotransmitters. It also functions as a complex communication network with other organ systems, exemplified by the intestinal–brain axis and the intestinal–skin axis.

Beneficial intestinal bacteria, particularly *Bifidobacterium* and *Lactobacillus* species, inhibit the growth of pathogenic microorganisms by competing for nutrients and ecological niches. In addition, they exert anti-inflammatory effects and contribute to the maintenance of the intestinal barrier. Intestinal microorganisms and their metabolic products can also modulate immune responses, either attenuating immune activity or, conversely, promoting inflammatory reactions.

According to contemporary research, the intestinal microbiota is capable of influencing the production of potent anti-inflammatory cytokines, particularly interleukin-10 (IL-10). Conversely, certain bacterial species produce pro-inflammatory mediators, thereby activating immune cells and promoting the initiation of immune responses. In the absence of the intestinal microbiota, the host organism would be deficient in a range of essential bioactive compounds, including vitamins and amino acids.

One of the most critical functions of the intestinal microbiota is the fermentation of non-digestible dietary fibers. These fibers are indispensable for the microbial synthesis of short-chain fatty acids (SCFAs), such as acetate, propionate, and butyrate. Butyrate, in particular, serves as a primary energy source for colonocytes, the epithelial cells lining the large intestine.

At present, short-chain fatty acids are recognized as key mediators in the regulation of local inflammatory processes within the intestinal environment.

Diagnosis: When should testing for dysbiosis be performed? It is recommended in the presence of the following symptoms:

- Chronic fatigue
- Digestive disturbances
- Halitosis
- Heartburn
- Diarrhea or constipation
- Acne and psoriasis
- Anxiety and depression
- Following prolonged antibiotic use
- Food intolerance and excessive gas formation
- Joint inflammation

Laboratory evaluation:

Stool bacteriological analysis and the preparation of a bacteriogram are required for the assessment of intestinal dysbiosis.

Management Strategies:

Prevention of Dysbiosis:

The prevention of dysbiosis requires adherence to a balanced diet and the maintenance of a healthy lifestyle.

Treatment of Dysbiosis:

Treatment is carried out with the help of prebiotics and probiotics. Prebiotics serve as a nutritional substrate for intestinal microorganisms. They pass through the gastrointestinal tract and reach the large intestine, where resident microorganisms ferment them and produce metabolites beneficial to the human organism, including short-chain fatty acids.

Prebiotics contribute to the production of:

- neurotransmitters, substances that mediate the intestinal–brain communication axis
- stimulation of appetite-regulating hormone synthesis
- improved bone mineralization
- enhancement of anti-inflammatory responses
- improvement of immune system function

Dietary sources of prebiotics include resistant starch and inulin. Such starch is found in green bananas, oats, barley, rice, and boiled potatoes.

Probiotics are beneficial microorganisms that help control the growth of pathogenic bacteria. The most commonly used probiotic strains include:

- Lactobacillus casei
- Lactobacillus plantarum
- Bifidobacterium breve

Probiotics can also be obtained through food and beverages, including yogurt, kefir, fermented milk-matsoni, cottage cheese, pickled cucumbers, sauerkraut, miso soup, kimchi, and others.

Conclusion: Thus, the intestinal microbiota represents a complex ecosystem that plays a crucial role in the normal functioning of the human organism. It actively participates in immune system modulation and provides resistance against the development of intestinal inflammatory processes, as well as autoimmune and other serious diseases. Modulation of the intestinal microbiota offers the potential to prevent the development of multiple severe pathological conditions.

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ქ. უკლება, მ. ჩაკვეტაძე

რეზიუმე

ადამიანის ნაწლავის მიკრობიოტა, ცნობილი როგორც მიკროფლორა, შედგება მილიონობით მიკროორგანიზმისგან რომელიც ქმნის ეკოსისტემას და უმნიშვნელოვანეს როლს თამაშობს ორგანიზმის იმუნური სისტემის განვითარებაში.

იმუნური სისტემის მოდულაციის გზით, ნაწლავური მიკრობიოტა ეხმარება ორგანიზმს მრავალი დაავადების პრევენციაში, როგორიცაა: ათეროსკლეროზი, სიმსუქნე, დიაბეტი ,გაღიზიანებული ნაწლავის სინდრომი,ალერგიები, ფილტვის ქრონიკული ობსტრუქციული დაავადება და სხვა.

დისბიოზის მკურნალობა საჭიროებს პრებიოტიკებისა და პრობიოტიკების გამოყენებას,ასევე - ბალანსირებულ კვებას და ჯანმრთელ ცხოვრების წესს.

A Mathematical Model of Mammalian Life-History Traits Based on the Life-Continuity Coefficient

Akaki Dzneladze, Akaki Girgvliani
Akaki Tsereteli State University

Abstract: *This paper proposes a mathematical model describing the interdependence of mammalian life-history traits based on a novel concept, the life-continuity coefficient. This coefficient is defined as the expected number of offspring produced by a female individual that survive to sexual maturity. The model integrates maternal and offspring survival, fecundity, reproductive cycles, and mortality factors within a unified framework. It provides a basis for analyzing life-history strategies and their evolutionary optimization*.
Keywords: *life-history traits, mammals, life-continuity, survival probability, fecundity, mortality intensity.*

Introduction. Life-history traits are quantitative characteristics of organisms that determine their ability to survive and reproduce [1]. In mammals, such traits include lifespan, age at sexual maturity, gestation length, duration of the reproductive period, fecundity, body mass, brain size, and the duration of parental care.

Mammalian species differ substantially in their life-history traits. These differences suggest that life-history traits do not evolve independently but form a system of evolutionary trade-offs. Traditional life-history theory interprets these traits as adaptive responses to environmental conditions that maximize reproductive success.

The main assumption of this paper is that natural selection shapes life-history traits in such a way that the life-continuity of the species is maximally ensured. In this study, life-continuity is understood not merely as the birth of offspring, but as the successful survival of offspring to sexual maturity, when they themselves become capable of reproduction.

The aim of the paper is to develop a mathematical model based on the life-continuity coefficient, which describes the interdependence of the main life-history traits in mammals.

Existing Theoretical Approaches. Life-history theory considers growth, development, survival, reproduction, and aging as interconnected biological processes. According to the classical approach, natural selection promotes the evolution of life-history traits that increase survival and reproductive success under given ecological conditions [1,2,3,4].

One of the most widely used models in life-history theory is the Euler–Lotka equation, which links population growth rate to age-specific survival and fecundity [1,3]. This equation is effective for evaluating population growth. However, its main criterion is the rate of population increase, whereas the continuity of a species depends not only on the birth of offspring but also on their survival to sexual maturity.