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TABLE OF CONTENTS

AGRICULTURAL SCIENCES

1. ***Shamsiyev A., Usmonova M., Axmedova I.*** 12
IMPACT OF DIFFERENT MULCHING TYPES ON THE GROWTH AND DEVELOPMENT OF SWEET POTATO (*IPOMOEA BATATAS*)

BIOLOGICAL SCIENCES

2. ***Богінська В. А., Шелюк Ю. С.*** 19
ОЦІНКА ЯКОСТІ ВОДИ Р. ГУСКА ЗА ФІТОПЛАНКТОНОМ
3. ***Петренко К. О.*** 22
ВИКОРИСТАННЯ ДЕКОРАТИВНИХ ЧАГАРНИКІВ ТА ТРАВ'ЯНИСТИХ РОСЛИН У БЛАГОУСТРОЇ РЕКРЕАЦІЙНИХ ПУНКТІВ

MEDICAL SCIENCES

4. ***Balak O. K., Vorobiei Ye. S., Balak S. O.*** 25
STRESS-INDUCED CHANGES IN HUMAN MICROBIOME AND METHODS OF THEIR NON-PHARMACOLOGICAL CORRECTION
5. ***Ganushchak A. V., Motuzyuk I. M.*** 30
FEATURES OF BREAST ASYMMETRY IN WOMEN
6. ***Karmazina I., Kyzym S., Sheludko S.*** 36
NEUROPHYSIOLOGICAL MECHANISMS OF BODY IMAGE AND THEIR DISORDERS
7. ***Ovcharova O. A., Bulynina O. D.*** 39
PHYSIOLOGY OF ANDROGENS, THEIR EFFECT ON SEBUM SECRETION AND ACNE EXACERBATION
8. ***Герасименко О. І., Герасименко Є. О.*** 43
ЗАКОНОМІРНОСТІ МЕТАСТАЗУВАННЯ РАКУ ШЛУНКА
9. ***Гончаренко О. В., Жмур А. А., Завальнюк О. О., Круглова І. А.*** 48
ДИНАМІКА ЗМІН НУТРИТИВНОГО СТАТУСУ У ПАЦІЄНТІВ З ГОСТРИМ ПАНКРЕАТИТОМ В УМОВАХ ГОЛОДУВАННЯ ТА НЕДОСТАТНЬОГО ПАРЕНТЕРАЛЬНОГО ХАРЧУВАННЯ
10. ***Жмудь Т. М., Ковальська А. Р., Ісаєнкова Л. А., Завальнюк О. О.*** 50
КЛІНІЧНИЙ ВИПАДОК ОРГАНОЗБЕРЕЖНОГО ЛІКУВАННЯ СПАДКОВОЇ БІЛАТЕРАЛЬНОЇ РЕТИНОБЛАСТОМИ З ВИКОРИСТАННЯМ СУПЕРСЕЛЕКТИВНОЇ ІНТРААРТЕРІАЛЬНОЇ ХІМІОТЕРАПІЇ
11. ***Іванців О. Р., Боднарюк М. А., Білан Д. М., Турик В. Р.*** 55
ОСОБЛИВОСТІ МІННО-ВИБУХОВИХ ТРАВМ НИЖНІХ КІНЦІВОК У КОНТЕКСТІ СУЧАСНОЇ РОСІЙСЬКО-УКРАЇНСЬКОЇ ВІЙНИ
12. ***Кихтенко О. В., Потапов С. М., Сметанюк М. Р.*** 58
МОРФОЛОГІЧНІ ОСОБЛИВОСТІ ГЛІОБЛАСТОМИ

MEDICAL SCIENCES

STRESS-INDUCED CHANGES IN HUMAN MICROBIOME AND METHODS OF THEIR NON-PHARMACOLOGICAL CORRECTION

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Relevance. The human microbiome is a complex set of microorganisms that maintain the metabolic, immune and neuroendocrine homeostasis of the body [1]. Of particular importance is the intestinal microbiota, which participates in the processes of digestion, synthesis of biologically active substances, regulation of the immune response and functioning of the central nervous system. In modern conditions of constant psycho-emotional stress, the problem of the impact of stress on the state of the microbiome becomes particularly relevant.

Chronic stress is one of the leading risk factors for development of functional and organic disorders of various body systems. It has been established that prolonged psycho-emotional impact causes activation of hypothalamic-pituitary-adrenal system, increased levels of cortisol and catecholamines [2], that negatively affects the functional state of intestine and the composition of microbiota. Disruption of microbiome balance is associated with the development of gastroenterological diseases, metabolic disorders, decreased immune reactivity, as well as the emergence of anxiety and depression [3]. In this regard, the search for effective non-drug approaches to the prevention and correction of stress-induced changes in microbiome

requires special attention.

The aim of the work is to analyze current scientific data about mechanisms of influence of psycho-emotional stress on human microbiome and determine the effectiveness of non-drug methods for correcting stress-associated microbiome disorders.

The main mechanisms of stress influence on microbiome. One of the key mechanisms of stress on the microbiome is the disruption of gut-brain axis, which provides a two-way interaction between the central nervous system, enteric nervous system and intestinal microbiota. In response to stress factors the hypothalamic-pituitary-adrenal system is activated, accompanied by excessive production of cortisol. An increase in the level of this hormone causes changes in intestinal motility, impaired mucus secretion and increased permeability of intestinal barrier [4]. Disruption of intestinal barrier function creates conditions for translocation of bacterial components and activation of a systemic inflammatory response [5]. At the same time, there is a decrease in bacterial diversity and in number of commensal microorganisms, in particular *Lactobacillus spp.* and *Bifidobacterium spp.*, together with an increase in number of opportunistic bacteria. Such changes are characterized by the development of dysbiosis and deterioration of functional state of intestinal ecosystem [6].

The influence of the microbiome on the synthesis of neurotransmitters and the regulation of the psycho-emotional state is an important aspect as intestinal microorganisms participate in synthesis of serotonin, dopamine, gamma-aminobutyric acid and other biologically active compounds [7]. Changes in microbiome composition can disrupt the production of these substances and contribute to increased anxiety, development of depressive manifestations and cognitive disorders. Thus, a pathological circle is formed, within which stress causes dysbiotic changes, and microbiome disorders, in turn, negatively affect psycho-emotional state of a person.

Non-drug methods of correction. In modern research, considerable attention is paid to non-drug methods of correction of stress-associated changes in

microbiome. One of the most effective areas is stress management practices aimed at normalizing the functioning of nervous and endocrine systems. Such methods include meditation, mindfulness practices, breathing techniques, yoga, and psycho-emotional self-regulation.

Regular meditation and breathing practices help to reduce cortisol levels, reduce the activity of sympathetic nervous system and improve the regulation of "brain-gut" axis. As a result, there is a decrease in severity of systemic inflammation and an improvement in functional state of intestinal barrier. In addition, these practices have a positive effect on emotional state, help to reduce anxiety and increase stress resistance [8].

Regular physical activity is important. Moderate physical activity helps to increase microbiome diversity and increase the number of bacteria that produce short-chain fatty acids, which maintain the integrity of intestinal epithelium and have an anti-inflammatory effect. Physical activity also improves metabolic processes and helps to normalize the psycho-emotional state [9].

Good sleep is one of the important factors in maintaining microbiome homeostasis. Disruption of circadian rhythms and chronic sleep deprivation are associated with changes in intestinal microbiota composition, impaired immune regulation and increased systemic inflammation. Normalizing sleep patterns helps to stabilize neuroendocrine regulation and improve the functional state of microbiome [10].

A promising direction is also the comprehensive combination of anti-stress practices with a balanced diet rich in dietary fiber, fermented foods, and natural prebiotics [11], that creates favorable conditions for restoring microbiome balance.

Conclusions. Psychoemotional stress is an important factor in development of dysbiotic changes in human microbiome due to disruption of neuroendocrine, immune and barrier regulation of intestine. Chronic stress is accompanied by a decrease in bacterial diversity, development of systemic inflammation and impaired synthesis of neurotransmitters, that negatively affects both the physical and psychoemotional state of the body.

Non-drug correction methods, in particular stress management practices, physical activity, breathing techniques, meditation and sleep normalization, demonstrate a positive effect on functional state of microbiome and can be considered as an effective component of prevention and comprehensive support of human health. Further research in this area is promising for the development of personalized strategies for the correction of stress-associated microbiome disorders.

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