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# MODERN SCIENCE: TRENDS, CHALLENGES, SOLUTIONS




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# TABLE OF CONTENTS

## AGRICULTURAL SCIENCES


1. ***Запольська Н. М., Шендрик К. М.*** 7
ОСОБЛИВОСТІ ПОШИРЕННЯ ТА РОЗВИТКУ ХВОРОБ КОРЕНЕПЛОДІВ ЦУКРОВИХ БУРЯКІВ, ВИКЛИКАНИХ ФАКУЛЬТАТИВНИМИ ПАТОГЕНАМИ В РІЗНИХ АГРОЕКОЛОГІЧНИХ ЗОНАХ
2. ***Ковтунюк З. І., Усатюк О. О.*** 16
ПЕРСПЕКТИВИ ПРОМИСЛОВОГО ВИРОЩУВАННЯ ЧЕБРЕЦЮ В УКРАЇНІ У КОНТЕКСТІ СВІТОВОЇ КОН'ЮНКТУРИ РИНКУ


## VETERINARY SCIENCES


3. ***Vus U., Gutyj B., Mahrelo N., Krempa N., Martyshuk T.*** 20
MORPHOLOGICAL BLOOD PROFILE OF COWS UNDER THE INFLUENCE OF ABIOTIC FACTORS AND THE ADMINISTRATION OF "DEVIVIT CARNITINE"


## MEDICAL SCIENCES


4. ***Isaieva I. M., Pandikidis N. I., Hostieva D. V.*** 26
NEUROPHYSIOLOGICAL MECHANISMS OF ATTENTION AND EMOTION REGULATION: RELATIONSHIP OF ATTENTION DEFICIT DISORDER WITH HYPERACTIVITY, DEPRESSION AND SLEEP
5. ***Kutashevych Ya., Oliinyk I., Dzhorayeva S., Zavorina V.*** 31
SERUM ANNEXIN A1 AS A BIOMARKER OF STEROID RESISTANCE IN PATIENTS WITH PEMPHIGUS VULGARIS
6. ***Добродуб І. В., Безбородов А. С.*** 34
КЛІНІЧНА РОЛЬ ВИМІРЮВАННЯ СЕРЦЕВОГО ТРОПОНІНУ І У ПАЦІЄНТІВ З ГІПЕРТЕНЗИВНИМ КРИЗОМ


## TECHNICAL SCIENCES


7. ***Валовой О. І., Валовой М. О., Крікуненко М. Є.*** 42
ОСНОВИ ТА ПРИНЦИПИ ПРОЄКТУВАННЯ БУДІВЕЛЬНОГО ГЕНЕРАЛЬНОГО ПЛАНУ
8. ***Шорнікова С. В.*** 47
КОНСТРУКТОРСЬКА ДОКУМЕНТАЦІЯ – ЗАПОРУКА ТЕХНІЧНОГО КОНТРОЛЮ ТА ЯКОСТІ ПРОДУКЦІЇ


## PEDAGOGICAL SCIENCES


9. ***Булгак М. В.*** 50
МЕТОДИЧНІ ЗАСАДИ РЕАЛІЗАЦІЇ МІЖДИСЦИПЛІНАРНОЇ ПІДГОТОВКИ МАЙБУТНІХ ФАХІВЦІВ СОЦІОНОМІЧНОЇ СФЕРИ ДО КОНСУЛЬТАТИВНОЇ ДІЯЛЬНОСТІ

# MEDICAL SCIENCES

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## NEUROPHYSIOLOGICAL MECHANISMS OF ATTENTION AND EMOTION REGULATION: RELATIONSHIP OF ATTENTION DEFICIT DISORDER WITH HYPERACTIVITY, DEPRESSION AND SLEEP

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**Abstract.** Attention deficit hyperactivity disorder, depressive disorders, and sleep disturbances share common neurobiological mechanisms that affect attention, emotional regulation, and cognitive functioning. The aim of this study was to summarize current evidence on the neurophysiological mechanisms underlying these conditions. A narrative review of PubMed-indexed publications (2022–2025) was conducted, including systematic reviews, clinical studies, and neuroimaging investigations. The analysis demonstrated that serotonergic dysfunction, impaired prefrontal cortex–amygdala connectivity, reduced emotional regulation flexibility, and chronic sleep deprivation are key mechanisms contributing to cognitive and emotional dysfunction. These findings support the need for an integrated approach to prevention and treatment, combining pharmacotherapy, psychotherapy, lifestyle modification, and sleep optimization.

**Keywords:** attention deficit hyperactivity disorder, depression, sleep, emotional regulation, neurophysiology.

Modern achievements in neuroscience and clinical psychiatry indicate the need for an integrated approach to the study of neurobiological mechanisms underlying cognitive impairment, emotional regulation and behavior. Attention deficit hyperactivity disorder, depressive disorders, and sleep disorders are common conditions that significantly affect quality of life, social functioning, and cognitive performance. Despite differences in clinical manifestations, current studies demonstrate the presence of common pathophysiological mechanisms associated with dysfunction of neurotransmitter systems, impaired functional interaction between the prefrontal cortex and limbic structures, as well as changes in neuroplasticity processes [1].

Of particular interest is the relationship between attention deficit hyperactivity disorder, depressive disorders and sleep quality, since these conditions are often combined, mutually aggravate each other's course and have common neurobiological foundations. Generalization of modern scientific data allows us to better understand the mechanisms of their development and justify an integrated approach to prevention and treatment [2].

**The aim of the study** was to summarize current evidence regarding the neurophysiological mechanisms underlying attention deficit hyperactivity disorder, depressive disorders, and sleep regulation, and to analyze their common neurobiological pathways involved in attention, emotional regulation, and cognitive functioning.

**Materials and Methods**

A narrative review of contemporary scientific literature published between 2022 and 2025 was conducted. Publications indexed in the PubMed database were analyzed, including systematic reviews, clinical studies, neuroimaging investigations, and review articles addressing the neurobiology of attention deficit hyperactivity disorder, depressive disorders, emotional regulation, and sleep. The selected studies were analyzed using comparative and analytical methods to identify common neurophysiological mechanisms and their clinical significance.

*Neurobiological mechanisms of attention deficit hyperactivity disorder*

One of the most studied neurodevelopmental disorders is attention deficit hyperactivity disorder, the pathogenesis of which has long been associated mainly with dysfunction of the dopaminergic system. However, modern research shows that serotonergic neurotransmission also plays an important role in the development of clinical manifestations of this disorder. Impaired functioning of the serotonin system is associated with decreased impulsivity control, emotional dysregulation, and impaired executive functions [2].

Current ideas about attention deficit hyperactivity disorder have also changed in relation to its age-specific characteristics. If in childhood the clinical picture is mainly characterized by motor hyperactivity and inattention, then in adulthood disorders of executive functions, activity planning, attention maintenance, organization of daily activities and social functioning dominate [1].

Due to the complexity of the neurobiological mechanisms of the development of attention deficit hyperactivity disorder, modern therapeutic approaches are aimed not only at reducing clinical symptoms, but also at restoring neurotransmitter balance. This creates prerequisites for increasing the effectiveness of psychotherapeutic and psychosocial rehabilitation of patients [1].

*Neurobiological mechanisms of depressive disorders in adolescence*

Adolescence is a critical period of neurobiological development, accompanied by intensive structural and functional maturation of the central nervous system. During this period, the formation of neural networks responsible for emotional regulation, cognitive control and adaptive response to stressors occurs. One of the key risk factors for developing depressive disorders in adolescents is the lack of flexibility of emotional regulation, which is characterized by a tendency to rumination, maladaptive cognitive strategies and avoidance of stressful situations [3].

The results of modern neuroimaging studies indicate that in depressive disorders there is a violation of the functional interaction between the prefrontal cortex and the amygdala. The weakening of the regulatory influence of the prefrontal cortex on the structures of the limbic system leads to an increase in emotional

reactivity, negative emotional perception and impaired social adaptation. Such changes contribute to the formation and maintenance of depressive symptoms [4].

*The role of sleep in the regulation of cognitive and emotional functions*

An important component of maintaining the functional state of the central nervous system is physiological sleep. During sleep, the processes of glymphatic cleansing of the brain, memory consolidation, restoration of energy metabolism and maintenance of neuroplasticity occur, which ensure the normal functioning of cognitive and emotional processes [5]. Modern research confirms that chronic sleep deprivation is accompanied by a decrease in the activity of the prefrontal cortex and a violation of its functional connection with limbic structures, primarily the amygdala. The consequence of this is a deterioration in concentration, executive functions, emotional regulation and an increase in reactivity to stressful stimuli [5, 6]. In patients with attention deficit hyperactivity disorder and depressive disorders, sleep disturbances can aggravate the clinical manifestations of the disease, negatively affect cognitive functioning, and reduce the effectiveness of complex therapy [5, 6].

**Conclusions**

Thus, modern scientific data indicate that the regulation of attention, emotions and behavioral reactions is provided by a complex interaction of neurotransmitter systems, functional neural networks and physiological mechanisms for maintaining homeostasis of the central nervous system.

Dysfunction of serotonergic neurotransmission, impaired functional interaction between the prefrontal cortex and the amygdala, lack of flexibility in emotional regulation, and chronic sleep deprivation are interrelated neurobiological mechanisms involved in the development of attention deficit hyperactivity disorder and depressive disorders.

Understanding the commonality of these mechanisms justifies the feasibility of an integrated approach to prevention and treatment, which combines pharmacotherapy, psychotherapeutic interventions, lifestyle modification and optimization of sleep quality as an important factor in maintaining cognitive and psycho-emotional health.

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