

ISSN 2518-1629 (Online),  
ISSN 2224-5308 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ  
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ  
С. Ж. Асфендияров атындағы Қазақ ұлттық медицина университеті

# Х А Б А Р Л А Р Ы

---

---

## ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК  
РЕСПУБЛИКИ КАЗАХСТАН  
Қазақстан Республикасының  
Ғылым Академиясының  
С. Ж. Асфендияров атындағы  
Қазақ ұлттық медицина университеті

## NEWS

OF THE NATIONAL ACADEMY OF SCIENCES  
OF THE REPUBLIC OF KAZAKHSTAN  
Asfendiyarov  
Kazakh National Medical University

S E R I E S  
OF BIOLOGICAL AND MEDICAL

**3 (345)**  
MAY–JUNE 2021

PUBLISHED SINCE JANUARY 1963

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

## Бас редактор

**НҮРҒОЖИН Талғат Сейітжанұлы**, медицина ғылымдарының докторы, профессор, ҚР ҰҒА корреспондент мүшесі (Алматы, Қазақстан) Н = 10

### РЕДАКЦИЯ АЛҚАСЫ:

**БЕРСІМБАЕВ Рахметқажы Ескендірұлы** (бас редактордың орынбасары), биология ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан) Н = 12

**ЖАМБАКИН Қабыл Жапарұлы** (бас редактордың орынбасары), биология ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан) Н = 2

**БИСЕНБАЕВ Амангелді Қуанышбайұлы**, биология ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан) Н = 7

**ХОХМАНН Джудит**, Сегед университетінің фармацевтика факультетінің фармакогнозия кафедрасының меңгерушісі, жаратылыстану ғылымдарының пәнаралық орталығының директоры (Сегед, Венгрия) Н = 38

**РОСС Самир**, PhD докторы, Миссисипи университетінің өсімдік өнімдерін ғылыми зерттеу ұлттық орталығы Фармация мектебінің профессоры (Оксфорд, АҚШ) Н = 35

**ФАРУК Асана Дар**, Хамдард Аль-Маджида шығыс медицина колледжінің профессоры, Хамдард университетінің Шығыс медицина факультеті (Карачи, Пәкістан) Н = 21

**ТОЙШЫБЕКОВ Мәкен Молдабайұлы**, ауыл шаруашылығы ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан) Н = 2

**САҒИТОВ Абай Оразұлы**, биология ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан) Н = 4

**ХУТОРЯНСКИЙ Виталий**, философия докторы (Ph.D, фармацевт), Рединг университетінің профессоры (Рединг, Англия) Н = 40

**БЕНБЕРИН Валерий Васильевич**, (бас редактордың орынбасары), медицина ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Қазақстан Республикасы Президенті Іс Басқармасы Медициналық орталығының директоры (Алматы, Қазақстан) Н = 11

**ЛОКШИН Вячеслав Нотанович**, ҚР ҰҒА академигі, медицина ғылымдарының докторы, профессор, "PERSONA" халықаралық клиникалық репродуктология орталығының директоры (Алматы, Қазақстан) Н = 8

**СЕМЕНОВ Владимир Григорьевич**, биология ғылымдарының докторы, профессор, Чуваш республикасының еңбек сіңірген ғылым қайраткері, морфология, Акушерлік және терапия кафедрасының меңгерушісі, "Чуваш мемлекеттік аграрлық университеті" Федералдық мемлекеттік бюджеттік жоғары білім беру мекемесі (Чебоксары, Чуваш Республикасы, Ресей) Н = 23

**ЩЕПЕТКИН Игорь Александрович**, медицина ғылымдарының докторы, Монтана штаты университетінің профессоры (АҚШ) Н = 27

**«ҚР ҰҒА Хабарлары. Биология және медициналық сериясы».**

**ISSN 2518-1629 (Online), ISSN 2224-5308 (Print)**

**Меншіктеуші:** «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан Республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 01.06.2006 ж. берілген №5546-Ж мерзімдік басылым тіркеуіне қойылу туралы куәлік.

**Мерзімділігі:** жылына 6 рет.

**Тиражы:** 300 дана.

**Редакцияның мекенжайы:** 050010, Алматы қ., Шевченко көш., 28; 219 бөл.; тел.: 272-13-19

<http://biological-medical.kz/index.php/en/>

## Главный редактор:

**НУРГОЖИН Талгат Сейтжанович**, доктор медицинских наук, профессор, член-корреспондент НАН РК (Алматы, Казахстан) H = 10

## РЕДАКЦИОННАЯ КОЛЛЕГИЯ:

**БЕРСИМБАЕВ Рахметкажи Искендерович** (заместитель главного редактора), доктор биологических наук, профессор, академик НАН РК (Алматы, Казахстан) H = 12

**ЖАМБАКИН Кабыл Жапарович** (заместитель главного редактора), доктор биологических наук, профессор, академик НАН РК (Алматы, Казахстан) H = 2

**БИСЕНБАЕВ Амангельды Куанбаевич** (заместитель главного редактора), доктор биологических наук, профессор, академик НАН РК (Алматы, Казахстан) H = 7

**ХОХМАНН Джудит**, заведующий кафедрой Фармакогнозии Фармацевтического факультета Университета Сегеда, директор Междисциплинарного центра естественных наук (Сегед, Венгрия) H = 38

**РОСС Самир**, доктор PhD, профессор Школы Фармации национального центра научных исследований растительных продуктов Университета Миссисипи (Оксфорд, США) H = 35

**ФАРУК Асана Дар**, профессор колледжа Восточной медицины Хамдарда аль-Маджида, факультет Восточной медицины университета Хамдарда (Карачи, Пакистан) H = 21

**ТОЙШИБЕКОВ Макен Молдабаевич**, доктор сельскохозяйственных наук, профессор, академик НАН РК (Алматы, Казахстан) H = 2

**САГИТОВ Абай Оразович**, доктор биологических наук, профессор, академик НАН РК (Алматы, Казахстан) H = 4

**ХУТОРЯНСКИЙ Виталий**, доктор философии (Ph.D, фармацевт), профессор Университета Рединга (Рединг, Англия) H = 40

**БЕНБЕРИН Валерий Васильевич**, доктор медицинских наук, профессор, академик НАН РК, директор Медицинского центра Управления делами Президента Республики Казахстан (Алматы, Казахстан) H = 11

**ЛОКШИН Вячеслав Нотанович**, академик НАН РК, доктор медицинских наук, профессор, директор Международного клинического центра репродуктологии «PERSONA» (Алматы, Казахстан) H = 8

**СЕМЕНОВ Владимир Григорьевич**, доктор биологических наук, профессор, заслуженный деятель науки Чувашской Республики, заведующий кафедрой морфологии, акушерства и терапии, Федеральное государственное бюджетное образовательное учреждение высшего образования «Чувашский государственный аграрный университет» (Чебоксары, Чувашская Республика, Россия) H = 23

**ЩЕПЕТКИН Игорь Александрович**, доктор медицинских наук, профессор Университета штата Монтана (США) H = 27

«Известия НАН РК. Серия биологическая и медицинская».

ISSN 2518-1629 (Online), ISSN 2224-5308 (Print)

Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан №5546-Ж, выданное 01.06.2006 г.

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28; ком. 219, тел. 272-13-19

www.nauka-nanrk.kz / biological-medical.kz

### **Editor in chief:**

**NURGOZHIN Talgat Seitzhanovich**, Doctor of Medicine, Professor, Corresponding Member of NAS RK (Almaty, Kazakhstan) H = 10

### **EDITORIAL BOARD:**

**BERSIMBAEV Rakhmetkazhi Iskendirovich** (deputy editor-in-chief), Doctor of Biological Sciences, Professor, Academician of NAS RK, L.N. Gumilyov Eurasian National University (Nur-Sultan, Kazakhstan) H = 12

**ZHAMBAKIN Kabyl Zhaparovich**, Professor, Academician of the NAS RK, Director of the Institute of Plant Biology and Biotechnology (Almaty, Kazakhstan) H = 2

**BISENBAEV Amangeldy Kuanbaevich** (Deputy Editor-in-Chief), Doctor of Biological Sciences, Professor, Academician of NAS RK (Almaty, Kazakhstan) H = 7

**HOHMANN Judith**, Head of the Department of Pharmacognosy, Faculty of Pharmacy, University of Szeged, Director of the Interdisciplinary Center for Life Sciences (Szeged, Hungary) H = 38

**ROSS Samir**, Ph.D., Professor, School of Pharmacy, National Center for Scientific Research of Herbal Products, University of Mississippi (USA) H = 35

**PHARUK Asana Dar**, professor at Hamdard al-Majid College of Oriental Medicine. Faculty of Oriental Medicine, Hamdard University (Karachi, Pakistan) H = 21

**TOISHIBEKOV Maken Moldabaevich**, Doctor of Agricultural Sciences, Professor, Academician of NAS RK (Almaty, Kazakhstan) H = 2

**SAGITOV Abai Orazovich**, Doctor of Biological Sciences, Professor, Academician of NAS RK (Almaty, Kazakhstan) H = 4

**KHUTORYANSKY Vitaly**, Ph.D., pharmacist, professor at the University of Reading (Reading, England) H = 40

**BENBERIN Valery Vasilievich**, Doctor of Medicine, Professor, Academician of NAS RK, Director of the Medical Center of the Presidential Property Management Department of the Republic of Kazakhstan (Almaty, Kazakhstan) H = 11

**LOKSHIN Vyacheslav Notanovich**, Professor, Academician of NAS RK, Director of the PERSONA International Clinical Center for Reproductology (Almaty, Kazakhstan) H = 8

**SEMENOV Vladimir Grigorievich**, Doctor of Biological Sciences, Professor, Honored Scientist of the Chuvash Republic, Head of the Department of Morphology, Obstetrics and Therapy, Chuvash State Agrarian University (Cheboksary, Chuvash Republic, Russia) H = 23

**TSHEPETKIN Igor Aleksandrovich**, Doctor of Medical Sciences, Professor at the University of Montana (Montana, USA) H = 27

**News of the National Academy of Sciences of the Republic of Kazakhstan. Series of biology and medicine.**  
**ISSN 2518-1629 (Online), ISSN 2224-5308 (Print)**

**Owner:** RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty).

The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 5546-Ж, is sued 01.06.2006.

Periodicity: 6 times a year.

Circulation: 300 copies.

**Editorial address:** 28, Shevchenko str. of. 219, Almaty, 050010; tel. 272-13-19  
<http://nauka-nanrk.kz/biological-medical.kz>

## NEWS

OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN

SERIES OF BIOLOGICAL AND MEDICAL

ISSN 2224-5308

Volume 3, Number 345 (2021), 53– 58

<https://doi.org/10.32014/2020.2519-1629.80>

УДК: 61.616.9

**Kulbayeva Z., Klyuyev D., Kaliyeva S.**

«Medical University of Karaganda» Non-commercial joint-stock company, Karaganda, Kazakhstan  
E-mail: klyuyev@qmu.kz

**NEUROLOGICAL SYMPTOMS AND COMPLICATIONS OF COVID19. MINIREVIEW**

**Abstract.** Since the first official case of COVID-19 in China in December 2019, researchers have been trying to uncover the mechanism of action of the severe acute respiratory syndrome Coronavirus 2 (Sars-CoV-2), which attacks several organs in addition to the lungs and causes circulatory changes that can lead to death not only from lung failure but also due to commitment of other organs. Objective: The aim of this study is to find out the neurological consequences of COVID-19. Material and methods: A systematic review of the literature was concretized by mobilizing the descriptors: «Sars-Cov-2», «coronavirus infections» and «Neurological Consequences». Results and discussion: Although the effects of Sars-CoV-2 on the lung are exemplary and frightening, the long-term effects on the nervous system may be greater and even more overwhelming, as the regeneration of nerve tissue is difficult and can lead to general disability, as the nervous system coordinates the functions of the entire body. All studies show the presence of any kind of injury (mild or severe) to Central Nervous System, but some of them highlight the need for further studies to have great certainty. Conclusion: It can be said that the studies all agree on the possibility of existing neurological sequelae and a majority agree on the need for other studies.

**Key words:** coronavirus, SARS-CoV-2, neurological consequences, coronavirus pathogenesis.

**Introduction.** Often, infectious diseases are the cause of local outbreaks. With the active spread of the process, local outbreaks develop into epidemics, pandemics. So, in December 2019 in the city of Wuhan, China-Cases of a previously unknown infection characterized by severe acute respiratory syndrome have been reported for the first time. As a result, it was found that the causative agent is RNA containing the SARS-CoV-2 (COVID-19) virus, according to WHO data [1]. Earlier SARS-CoV and MERS-CoV epidemics were registered CoV, but the SARS-CoV-2 virus is more virulent and pathogenic, which was the reason for the announcement of a pandemic in December 2020. To date, more than 140 million cases have been registered worldwide, while in Kazakhstan this figure is 367 thousand.

Most often, coronavirus infection manifests itself with respiratory syndrome, and more attention is paid to studying these issues. However, neurological manifestations were reported in 30-80% of patients with COVID-19. Nervous system-related symptoms may include headache, dizziness, impaired consciousness, agitation, acute stroke, seizures, ataxia, and peripheral nervous system symptoms such as syndrome Guillain-Barre, changes in the sense of smell and taste, as well as painful neuropathy [2,3,4,5,6,7]. According to studies of previous respiratory pandemics, neurological symptoms can occur both in the acute period and in the long-term. So, after the Spanish Flu pandemic, the number of cases of Parkinson's disease, lethargic encephalitis, increased. After SARS-CoV, MERS, the incidence of encephalitis, encephalopathies, neuromuscular, demyelinating diseases, Guillain-Barre [8,9,10,11].

To date, the literature contains data on the manifestation, features of the clinical course of coronavirus infection, including damage to the nervous system. However, there is insufficient information about the long-term consequences that may develop 3-6 months or more after the infection. The study of the consequences will allow evaluating the effectiveness of the treatment, as well as improve the prevention of undesirable consequences.

**Pathogenesis of coronavirus infection.** In December 2019, in hospitals in Wuhan began to receive patients with atypical pneumonia. During the examination of patients, their bronchopulmonary passage was studied.

A virus that was later named SARS-CoV -2 was detected in the passage of patients. Earlier, there were local outbreaks of coronavirus infection, but this mutation led to a pandemic. At the moment, the issue of the pathogenesis of the development of coronavirus infection remains one of the most relevant. There are several theories about the mechanisms of infection development.

**ACE2 receptor.** Currently, there are several hypotheses about the mechanisms that cause the signs and symptoms associated with SARS-CoV-2 infection. According to a number of studies, it is known that coronavirus infection interacts with ACE2 receptors, which are found in the cells of the nervous system, in muscles and respond to the regulation of blood pressure in the RAS system. This type of receptor is also found in the brain, namely in the brainstem, in the medulla oblongata in the thalamus, which makes them a potential target for coronavirus infection [12,13].

**Direct damage to nerve cells.** According to the literature, some of the symptoms of coronavirus infection are anosmia, aughesia. The olfactory nerve is the entrance gate of the virus to the central nervous system. The peculiarity of the olfactory nerves and the olfactory bulb is that this nerve is like a channel between the nasal epithelium and parts of the brain, especially the brain stem [14]. Virus infections in the nervous system. In the brain stem, there are centers that regulate the work of the heart and lungs, which can also cause a severe course of the disease, as well as the development of consequences against the background of a transferred coronavirus infection [15,16,17].

**Immune response.** One of the most relevant hypotheses is systemic inflammation as a result of the body's immune response to the pathogen. As a result of the immune response, there is an increase in the secretion of inflammatory mediators, cytokines, which leads to a cytokine storm and systemic damage. This phenomenon can lead to damage to endothelial cells and subsequent changes in the permeability of the blood-brain barrier. Infection can also cause autoimmune encephalitis due to the presence of autoantibodies attacking neurons and endothelial cells in blood vessels, thus activating the hypothalamic-pituitary-adrenal axis, which causes stress and other physiological changes due to excessive activation of glucocorticoid effectors and their receptors [18].

#### **Clinic for coronavirus infection.**

This viral disease is highly contagious and rapidly spreading. The main routes of transmission of coronavirus infection are: airborne droplets and contact.

Initial symptoms of coronavirus infection include: fever, cough, shortness of breath, myalgia or fatigue, headache. In a number of patients, the manifestation occurs with neurological symptoms. Neurological manifestations were reported in 30-80% of patients with COVID-19. The most common symptoms are headache, myalgia, dizziness, fatigue, and sleep disorders. Thus, a study was conducted in which 214 patients were admitted with coronavirus infection to a hospital in Wuhan, 36.4% had neurological manifestations, of which: CNS 24.8%, peripheral NS 10.7% and musculoskeletal 10.7% [4].

In the literature, cases of manifestation of coronavirus infection with encephalitis in a 56-year-old patient from Wuhan were described. [19,20]. The patient was admitted to the intensive care unit and presented with a reduced level of consciousness, so a CT scan of the brain was performed, which was normal. The diagnosis of encephalitis was confirmed by isolation of SARS-CoV-2 from the cerebrospinal fluid by genomic sequencing. There was also a case of acute hemorrhagic necrotizing encephalopathy in a patient with a coronavirus infection who developed symptoms of fever, cough, and changes in mental state. The diagnosis was made by detecting SARS-CoV-2 by PCR in a nasopharyngeal sample. CT scans of the brain revealed a symmetrical and bilateral area of hypodensity in the medial nucleus of the thalamus. MRI showed an increase in hemorrhagic lesions after contrast injection, multifocal and symmetrical, ring-shaped both in the thalami, insula and medial temporal lobe region. Acute necrotizing encephalopathy, although relatively rare, is a complication described in some viral infections, including the influenza virus. The authors suggest that its pathogenesis will be associated with the cytokine storm syndrome described by coronavirus infection [21].

Depending on the course, the following degrees of severity of coronavirus infection are distinguished: mild, moderate, severe and critical. Patients with mild severity are characterized by an asymptomatic course, or a mild clinical manifestation without radiological changes. Patients with moderate severity are characterized by lung damage up to 25%, saturation is not lower than 93%. moderate clinical manifestations. Patients with a severe degree are characterized by lung damage up to 75%, saturation up to 90%, as well as pronounced clinical manifestations. In the case of a critical degree, lung damage is more than 75%, saturation is less than 90%, and multiple organ damage is characteristic [22].

As with any infectious process, coronavirus infection is characterized by periods of development of the disease. The incubation period, which on average lasts from 2 to 14 days, is characterized by the replication of the virus in the body, usually without any clinical manifestations. The initial period, as a rule, is 1-7 diseases

with characteristic clinical manifestations, as well as laboratory changes. The height of the disease is divided into two main phases: early and late pulmonary phases. The early pulmonary phase lasts on average from 8-14 days, and the late pulmonary phase lasts 15-28 days. The main difference between the early and late pulmonary phases is the severity of the clinical course [23].

According to the literature, there are also 3 main stages, which are characterized by both clinical and laboratory changes. The first stage is the stage of early infection. It is characterized by the introduction of the virus into the lung parenchyma through the ACE2 receptor. The main marker of this stage is lymphocytopenia. The second stage is pulmonary. It is characterized by the development of viral pneumonia, lymphopenia, and an increase in transaminases, such as CRP. As a rule, the patient is hospitalized at this stage. The third stage is hyperinflammation. The most severe stage of the disease. It is characterized by the development of a cytokine storm up to ARDS, MVS. At this stage, patients are admitted to the intensive care unit. In the blood, an increase in all markers of inflammation is characteristic. At the same time, other organs and systems of the body are damaged at this stage [24].

**Consequences of coronavirus infection.** According to the literature, coronavirus infection does not pass without a trace. So, in a study of the long-term consequences of infection, it was found that 63% of the examined people developed general muscle weakness, 26% had sleep disorders, and 23% had anxiety. Also, most patients have respiratory system disorders. To a greater extent, patients who have suffered from coronavirus infection a more severe coronavirus infection are more susceptible to adverse consequences. At the stage of patient selection, cases of fatal outcome were registered as a result of insufficiency on the part of various organs and systems. At the same time, there were cases of repeated hospitalization of patients due to an increase in complaints and deterioration of the condition [25].

Today, it is difficult to talk about the long-term consequences of coronavirus infection due to the fact that the outbreak began relatively recently. A number of authors, based on the experience of previous outbreaks, suggest that the most pronounced consequences will be from the respiratory system. Thus, according to the literature, among patients who had SARS-CoVa history of SARS - CoV a year, two and fifteen years ago, persistent changes in the lungs, foci of fibrosis. These changes lead to impaired breathing and quality of life, respectively [26,27].

Coronavirus infection is characterized by a rapid course and multiple organ damage. According to a number of authors, the interaction of the virus with the ACE2 receptor contributes to damage to the kidneys, heart, blood vessels, nervous system and other organs. As a result, patients after coronavirus infection develop diabetes mellitus, arterial hypertension, thrombosis, and diseases of the nervous system. However, it is not fully known whether coronavirus infection causes the development of somatic pathologies or only contributes to the manifestation of a disease that has already been latent [28].

It has long been known that viruses, including respiratory viruses, can enter the central nervous system (CNS) (neuroinvasion), infect both neurons and glial cells (a property known as neurotropism), and cause various neurological pathologies. According to the literature, coronavirus infection also has neuroinvasive properties. Such assumptions were made on the basis of: the experience of previous coronavirus infections, clinical manifestations, and the creation of models of animal infection with coronavirus infection [29].

To date, the issue of the frequency of occurrence of neurological complications remains relevant. It is noted that patients who have suffered a coronavirus infection in severe form are more likely to develop neurological consequences. According to the literature, against the background of coronavirus infection, patients may develop brain edema, destruction of neurons.

Anosmia and taste disorders are very common in people with coronavirus infection, and can occur suddenly [30]. The prevalence of olfactory and gustatory dysfunctions was analyzed in the case register of 12 European hospitals. The study involved 417 patients with mild to moderate coronavirus infection. Patients completed taste and smell disorder questionnaires based on the nutrition and health survey and a short version of the Olfactory Taste and Smell Disorder questionnaire. The most common symptoms were cough, myalgia, and loss of appetite. Olfactory and gustatory disorders were reported in 85.6% and 88% of patients, respectively, and olfactory dysfunction was the initial symptom in 12% [31].

Patients with coronavirus infection suffer from severe hypoxia, which is a risk factor for encephalopathy. In a study by Mao et al., 15% of patients with severe coronavirus infection had a disturbed level of consciousness, while only 2.4% of patients with mild coronavirus infection had a disturbed level of consciousness [4]. Also, according to a number of authors, the immune-mediated mechanism of damage in coronavirus infection contributes to the development of acute cerebral circulatory disorders. Most often, patients with concomitant pathology, as well as patients who have suffered *коронавирусную* severe coronavirus infection, are subject to impaired cerebral circulation.

The literature also describes cases of damage to the peripheral nervous system against the background of coronavirus infection. A case of the syndrome Guillain-Barre, associated with SARS-CoV-2 infection, was described in a 62-year-old female patient who had motor weakness in the lower extremities. The study of cerebrospinal fluid showed an increase in protein (124 mg /dl) and the absence of cells. Neurophysiological examination showed an increase in distal delays and the absence of F-waves, indicating a form of demyelinating GBS. The authors suggest that the patient was infected with SARS-CoV-2 SARS at the beginning of HBS symptoms, as she had lymphopenia and thrombocytopenia [32].

**Conclusion.** To date, the literature describes multiple cases of damage to organs and systems, including the nervous system, during coronavirus infection. However, there is still insufficient data on the long-term effects of coronavirus infection on the nervous system. To date, it is not fully known whether coronavirus infection is the root cause or a factor that stimulates the activation of latent processes. In this regard, this issue remains relevant and requires further study to prevent adverse consequences.

**Disclosures:** There is no conflict of interest for all authors.

**Acknowledgements:** *This research has been funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant AP09562567)*

**Кульбаева З.Д., Ключев Д.А., Калиева Ш.С.**

«Қарағанды медициналық университеті» коммерциялық емес акционерлік қоғамы, Қарағанды,  
Қазақстан.

E-mail: klyuev@qmu.kz

### **COVID -19 НЕВРОЛОГИЯЛЫҚ СИМПТОМДАРЫ МЕН САЛДАРЫ. ҚЫСҚАША ШОЛУ**

**Аннотация.** Қытайда COVID-19 алғашқы ресми жағдайынан бастап, 2019 жылдың желтоқсан айында зерттеушілер бірнеше мүшелерге әсер ететін ауыр жедел респираторлық синдромның (SARS-CoV-2) әсер ету механизмін ашуға тырысты. COVID-19 өкпе және қан айналымының өзгеруіне әкеледі, бұл тек өкпе жеткіліксіздігімен ғана емес, сонымен қатар басқа органдардың зақымдалуымен де өлімге әкелуі мүмкін. Бұл зерттеудің *мақсаты* – COVID-19-дың неврологиялық әсерін анықтау. *Материал және әдістер.* Әдебиеттерге жүйелі шолу дескрипторларды жұмылдыру арқылы нақтыланады: “Sars-Cov-2” ,”коронавирустық инфекциялар” және “неврологиялық әсерлер”. *Нәтижелер мен талқылау:* SARS-CoV-2-нің өкпеге тигізетін әсері қауіпті және қорқынышты болғанымен, жүйке жүйесіне әсері айтарлықтай және біз ойлағаннан да ауыр болуы мүмкін, Жүйке тінінің қалпына келуі қиын болғандықтан тіпті, мүгедектікке әкелуі де мүмкін. Өйткені жүйке жүйесі бүкіл дененің функцияларын үйлестіреді. Көптеген зерттеулер орталық жүйке жүйесінің кез-келген жарақатының (жеңіл немесе ауыр) болатынын, ал кейбіреулері (сенімділік үшін) одан әрі зерттеу қажеттілігін көрсетеді. *Қорытынды:* барлық зерттеулер неврологиялық асқынулардың мүмкіндігімен келіседі деп айтуға болады, ал көпшілігі басқа зерттеулер жүргізу қажеттілігін алға тартады.

**Түйінді сөздер:** коронавирус, SARS-CoV-2, неврологиялық әсерлер, коронавирустың патогенезі.

**Кульбаева З.Д., Ключев Д.А., Калиева Ш.С.**

Некоммерческое акционерное общество «Медицинский университет Караганды», Караганда,  
Қазақстан.

E--mail: klyuev@qmu.kz

### **НЕВРОЛОГИЧЕСКИЕ СИМПТОМЫ И ПОСЛЕДСТВИЯ COVID19. МИНИОБЗОР**

**Аннотация.** С момента первого официального случая COVID-19 в Китае в декабре 2019 года исследователи пытались раскрыть механизм действия тяжелого острого респираторного синдрома Coronavirus 2 (Sars-CoV-2), который поражает несколько органов в дополнение к легким и вызывает изменения кровообращения, которые могут привести к смерти не только из-за легочной недостаточности,



но и из-за поражения других органов. Цель: цель этого исследования - выяснить неврологические последствия COVID-19. Материал и методы. Систематический обзор литературы конкретизирован путем мобилизации дескрипторов: «Sars-Cov-2», «коронавирусные инфекции» и «Неврологические последствия». Результаты и обсуждение: Хотя эффекты Sars-CoV-2 на легкие образцовые и пугающие, долгосрочные эффекты на нервную систему могут быть более значительными и даже более серьезными, поскольку регенерация нервной ткани затруднена и может привести к общей инвалидности, так как нервная система координирует функции всего тела. Все исследования показывают наличие любого вида травмы (легкой или тяжелой) центральной нервной системы, но некоторые из них подчеркивают необходимость дальнейших исследований для большей уверенности. Заключение: можно сказать, что все исследования согласны с возможностью существующих неврологических осложнений, и большинство согласны с необходимостью проведения других исследований.

**Ключевые слова:** коронавирус, SARS-CoV-2, неврологические последствия, патогенез коронавируса.

#### Information about the authors:

**Kulbayeva Z.** - Master of Medicine, 1st year doctoral student in medicine NPJSO "MUK". E-mail: zkulbaeva@qmu.kz. Kazakhstan, Karaganda. Mobile phone: +7 775 6471435^

**Klyuyev D.** - Candidate of Medical Sciences, Head of the Department of Biomedicine, NPJSO "MUK". E-mail: klyuev@qmu.kz, Kazakhstan, Karaganda. **ORCID ID** 0000-0003-2012-2227^

**Kaliyeva S.** - Candidate of Medical Sciences, Head of the Department of Clinical Pharmacology and Evidence-based Medicine, NPJSO "MUK". E-mail: S-Kalieva@qmu.kz, Kazakhstan, Karaganda. **ORCID ID** 0000-0003-1252-86577

#### REFERENCES

1. World Health Organization Coronavirus disease (COVID-19) situation report 102/ <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/> (2020).
2. Filatov A, Sharma P., Hindi F., P.S. Espinosa Neurological complications of coronavirus disease (COVID-19): encephalopathy. *Cureus*. (2020); 12 (3).
3. Munster V., Koopmans M., Doremalen N. A novel coronavirus emerging in China-key questions for impact assessment. *N. Engl. J. Med.* (2020); 382 (8):692-694.
4. Mao L., Jin H., Wang M. Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. *JAMA Neurol.* (2020); e201127.
5. Spinato G., Fabbris C., Polesel J. et al. Alterations in smell or taste in mildly symptomatic outpatients with SARS-CoV-2 infection. *JAMA.* (2020); e206771.
6. Helms J., Kremer S., Merdji H. et al. Neurologic features in severe SARS-CoV-2 infection. *N. Engl. J. Med.* (2020); c2008597.
7. Toscano G., Palmerini F., Ravaglia S. et al. Guillain-Barré syndrome associated with SARS-CoV-2. *N.Engl.J.Med.*(2020); c2009191.
8. Kim J.E., Heo J.H., Kim H.O., Song S.H., Park S.S., Park T.H., Ahn J.Y., Kim M.K., Choi J.P. Neurological complications during treatment of middle east respiratory syndrome. *J. Clin. Neurol.* 2017;13:227–233. doi: 10.3988/jcn.2017.13.3.227.
9. Manjunatha N., Math S.B., Kulkarni G.B. et al. The neuropsychiatric aspects of influenza/swine flu: A selective review. *Ind. Psychiatry J.*(2011);20:83–90.
10. Tsai L., Hsieh S., Chao C., et al. Neuromuscular disorders in severe acute respiratory syndrome. *Arch. Neurol.* (2004);61:1669–1673.
11. Wu H., Zhuang J., Stone W.S. et al. Symptoms and occurrences of narcolepsy: a retrospective study of 162 patients during a 10-year period in Eastern China. *SleepMed.*(2014);15:607–613.
12. Miller A., Arnold A. The renin–angiotensin system in cardiovascular autonomic control: recent developments and clinical implications. *Clinical Autonomic Research.* (2019);29(2): 231-43.
13. Gowrisankar Y., Clark M. Angiotensin II regulation of angiotensin-converting enzymes in spontaneously hypertensive rat primary astrocyte cultures. *In Journal of Neurochemistry.*(2016);138(1): 74-85.
14. Koyuncu O., Hogue I., Enquist L. Virus infections in the nervous system. *Cell host & Microbe.* (2013);13(4): 379-93.
15. Steardo L., Steardo Jr L., Zorec R. et al. Neuroinfection may contribute to pathophysiology and clinical manifestations of COVID-19. *Acta Physiologica.* (2020); e13473.

16. Netland J., Meyerholz D., Moore S. et al. Severe acute respiratory syndrome coronavirus infection causes neuronal death in the absence of encephalitis in mice transgenic for human ACE2. *Journal of Virology*. (2008); 82(15): 7264-75.
17. Gandhi S., Srivastava A., Ray U. et al. Is the collapse of the respiratory center in the brain responsible for respiratory breakdown in COVID-19 patients? *ACS Chemical Neuroscience*. (2020);11(10):1379-81.
18. Chen C., Zhang X., Ju Z. et al. Advances in the research of cytokine storm mechanism induced by Corona Virus Disease 2019 and the corresponding immunotherapies. *Zhonghua Shao Shang Za Zhi*. (2020); 36(0): E005-E005.
19. Wu Y, Xu X, Yang L. et al. Nervous system damage after COVID-19 infection: presence or absence? *BrainBehavImmun*.(2020); 87: 55.
20. Xiang P, Xu X, Gao L. et al. First case of 2019 novel coronavirus disease with encephalitis. *China Xiv*. (2020); 202003: 00015.
21. Marc Desforges, Alain Le Coupanec, Philippe Dubeau. Human Coronaviruses and Other Respiratory Viruses: Underestimated Opportunistic Pathogens of the Central Nervous System? *Viruses*.(2020); 12(1):14.
22. Negai NA, Altynbekov KS, Shaikhyslamova E.B. Coronavirus infection COVID -19 in adults. Protocol #143 of 05.07.2021. HM RK.
23. Yang, W, Cao, Q, Qin, L. et al. Clinical characteristics and imaging manifestations of the 2019 novel coronavirus disease (COVID-19): a multi-center study in Wenzhou city, Zhejiang, China. *J Infect*. (2020);80:388–93.
24. Ciaccio M, Agnello L. Biochemical biomarkers alterations in Coronavirus Disease 2019 (COVID-19). *Diagnosis*.(2020); June 24.
25. Chaolin Huang, Lixue Huang, Yeming Wang at al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *Lancet*.(2021);16-22 January; 397(10270): 220–232.
26. Ngai JC, Ko FW, Ng SS, et al. The long-term impact of severe acute respiratory syndrome on pulmonary function, exercise capacity and health status. *Respirology*.(2010);15:543–50.
27. Zhang P, Li J, Liu H, et al. Long-term bone and lung consequences associated with hospital-acquired severe acute respiratory syndrome: A 15-year follow-up from a prospective cohort study. *Bone Res*.(2020);8:8.
28. Wang F, Kream R, Stefano G. Long-Term Respiratory and Neurological Sequelae of COVID-19. *Med Sci Monit*.(2020); 26.
29. Arbour N, Cote G, Lachance C. et al. Acute and persistent infection of human neural cell lines by human coronavirus OC43. *J Virol*.(1999); 73: 3338-50.
30. Giacomelli A, Pezzati L, Conti F et al. Self-reported olfactory and taste disorders in SARS-CoV-2 patients: a cross-sectional study. *Clin Infect Dis*.(2020); Mar 26. [Epub ahead of print].
31. Lechien JR, Chiesa-Estomba CM, De Siati DR et al. Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus disease (COVID-19): a multicenter European study. *Eur Arch Otorhinolaryngol*.(2020); Apr 6. [Epub ahead of print].
32. Zhao H, Shen D, Zhou H , Liu J, Chen S. Guillain-Barré syndrome associated with SARS-CoV-2 infection: causality or coincidence. *Lancet Neurol*.(2020); Apr 1. [Epub ahead of print].

## МАЗМҰНЫ

<b>Әбдірешов С.Н., Аубакирова А.Б., Молдакарызова А.Ж., Наурызбай У.Б., Алиев С.А.</b> ҰЙҚЫ БЕЗІНІҢ ИНКРЕТОРЛЫҚ ҰЛПАЛАРЫНА ЖӘНЕ ЛИМФА ТҮЙІНДЕРІНЕ АЛЛОКСАННЫҢ ӘСЕРІ.....	5
<b>Балакирев Н.А., Шумилина Н.Н., Драгунова Т.С., Ларина Е.Е., Юлдашбаев Ю.А.</b> ІРІКТЕУДІҢ ӘРТҮРЛІ БАҒЫТЫНДА КҮМІС-ҚАРА ТҮСТІ ТҮЛКІЛЕРДІҢ ӘЛЕУЕТТІ, НАҚТЫ ӨСІМТАЛДЫҒЫ МЕН ЭМБРИОНАЛДЫҚ ӨЛІМІН ЗЕРТТЕУ.....	14
<b>Бодыков Г.Ж., Құрманова А.М.</b> БАЛАЛАР КАРДИОХИРУРГИЯ ҚЫЗМЕТІНДЕГІ ЭНДОВАСКУЛЯРЛЫҚ ТЕХНОЛОГИЯЛАР.....	23
<b>Добросмыслова И.А., Сазанова А.А., Семенов В.Г., Мамырова Л.К., Есембекова З.Т.</b> АСБҰРШАҚ ӨСІРУ БАРЫСЫНДА НАТРИЙ СЕЛЕНИТІН ЖӘНЕ ЦЕОЛИТТІ ҚОЛДАНУДЫҢ АГРОЭКОЛОГИЯЛЫҚ АСПЕКТІЛЕРІ.....	30
<b>Дюльгер Г.П., Седлецкая Е.С., Обухова М.Е., Леонтьева И.Л., Бычков В.С.</b> МЫСЫҚТАРДАҒЫ СҮТ БЕЗІ ОБЫРЫН ЕМДЕУДІҢ ЗАМАНАУИ ӘДІСТЕРІ.....	37
<b>Кондручина С.Г., Баймуканов Д.А., Толстова С.Л., Лукина Н.М., Исхан К.Ж.</b> БИОПРЕПАРАТТАРДЫ ҚОЛДАНУДА БҰЗАУЛАРДЫҢ ӨНІМДІЛІК ҚАСИЕТІ ЖӘНЕ САҚТАЛУЫ.....	45
<b>Кулбаева З.Д., Клюев Д.А., Калиева С.</b> COVID-19 НЕВРОЛОГИЯЛЫҚ БЕЛГІЛЕРІ МЕН АСҚЫНУЛАРЫ. ШАҒЫН ШОЛУ.....	53
<b>Попов Н.Н., Канбетов А.Ш., Барбол Б.І.</b> ОРТА КАСПИЙДІҢ ҚАЗАҚСТАНДЫҚ СЕКТОРЫНДАҒЫ СИНГИЛЬДІҢ LIZA AURATA (RISSO, 1810) 2018-2020 ЖЫЛДАР АРАЛЫҒЫНДАҒЫ КӘСІПТІК ҮЙІРІНІҢ СИПАТТАМАСЫ ҮШІН.....	59
<b>Самсонова И.Д., Баймуканов Д.А., Саттаров В.Н., Семенов В.Г., Каргаева М.Т.</b> АБИОТИКАЛЫҚ ФАКТОРЛАР МЕН БИОМОРФОЛОГИЯЛЫҚ БЕЛГІЛЕРГЕ БАЙЛАНЫСТЫ ОРМАН БАЛЫНЫҢ БАЛШЫРЫНДАНУ ДИНАМИКАСЫ.....	65
<b>Шәмшідін А.С., Бисембаев А.Т., Сагинбаев А.К., Абылгазинова А.Т., Қожахметова А.Н.</b> ТҮМСА СИБІРЛАРДЫҢ СҮТ ӨНІМДІЛІГІ ЖӘНЕ ОЛАРДЫҢ ОРТАША ЖАСЫ.....	74

## СОДЕРЖАНИЕ

<b>Абрешов С.Н., Аубакирова А.Б., Молдакарызова А.Ж., Наурызбай У.Б., Алиев С.А.</b> ВЛИЯНИЕ АЛЛОКСАНА НА ИНКРЕТОРНУЮ ТКАНЬ ПОДЖЕЛУДОЧНОЙ ЖЕЛЕЗЫ И ЛИМФАТИЧЕСКИЕ УЗЛЫ.....	5
<b>Балакирев Н.А., Шумилина Н.Н., Драгунова Т.С., Ларина Е.Е., Юлдашбаев Ю.А.</b> ИЗУЧЕНИЕ ПОТЕНЦИАЛЬНОЙ, ФАКТИЧЕСКОЙ ПЛОДОВИТОСТИ И ЭМБРИОНАЛЬНОЙ СМЕРТНОСТИ У СЕРЕБРИСТО-ЧЕРНЫХ ЛИСИЦ РАЗНОГО НАПРАВЛЕНИЯ СЕЛЕКЦИИ.....	14
<b>Бодыков Г.Ж., Курманова А.М.</b> ЭНДОВАСКУЛЯРНЫЕ ТЕХНОЛОГИИ В ДЕТСКОЙ КАРДИОХИРУРГИЧЕСКОЙ СЛУЖБЕ.....	23
<b>Добросмыслова И.А., Сазанова А.А., Семенов В.Г., Мамырова Л.К., Есембекова З.Т.</b> АГРОЭКОЛОГИЧЕСКИЕ АСПЕКТЫ ИСПОЛЬЗОВАНИЯ СЕЛЕНИТА НАТРИЯ И ЦЕОЛИТОВ ПРИ ВЫРАЩИВАНИИ ГОРОХА.....	30
<b>Дюльгер Г.П., Седлецкая Е.С., Обухова М.Е., Леонтьева И.Л., Бычков В.С.</b> СОВРЕМЕННЫЕ МЕТОДЫ ТЕРАПИИ ЗАБОЛЕВАНИЯ РАКА МОЛОЧНОЙ ЖЕЛЕЗЫ У КОШЕК.....	37
<b>Кондручина С.Г., Баймуканов Д.А., Толстова С.Л., Лукина Н.М., Исхан К.Ж.</b> СОХРАННОСТЬ И ПРОДУКТИВНЫЕ КАЧЕСТВА ТЕЛЯТ ПРИ ИСПОЛЬЗОВАНИИ БИОПРЕПАРАТОВ.....	45
<b>Кулбаева З.Д., Ключев Д.А., Калиева С.</b> НЕВРОЛОГИЧЕСКИЕ СИМПТОМЫ И ОСЛОЖНЕНИЯ COVID 19. МИНИ-ОБЗОР.....	53
<b>Попов Н.Н., Канбетов А.Ш., Барбол Б.І.</b> ХАРАКТЕРИСТИКА ПРОМЫСЛОВОГО СТАДА СИНГИЛЯ LIZA AURATUS (RISSE, 1810) В КАЗАХСТАНСКОМ СЕКТОРЕ СРЕДНЕГО КАСПИЯ ЗА 2018-2020 гг. ....	59
<b>Самсонова И.Д., Баймуканов Д.А., Сагтаров В.Н., Семенов, В.Г., Каргаева М.Т.</b> ДИНАМИКА НЕКТАРОВЫДЕЛЕНИЯ ЛЕСНЫМИ МЕДОНОСАМИ В ЗАВИСИМОСТИ ОТ АБИОТИЧЕСКИХ ФАКТОРОВ И БИОМОРФОЛОГИЧЕСКИХ ПРИЗНАКОВ.....	65
<b>Шәмшидин А.С., Бисембаев А.Т., Сагинбаев А.К., Абылгазинова А.Т., Кожрахметова А.Н.</b> МОЛОЧНАЯ ПРОДУКТИВНОСТЬ КОРОВ-ПЕРВОТЁЛОК И ИХ СРЕДНИЙ ВОЗРАСТ ПРИ ПЕРВОМ ОТЁЛЕ.....	74

---

## CONTENTS

<b>Abdreshov S.N., Aubakirova A.B., Moldakaryzova A.Zh., Nauryzbay U.B., Aliyev S.A.</b> EFFECT OF ALLOXAN ON PANCREATIC ENDOCRINE TISSUE AND LYMPH NODES.....	5
<b>Balakirev N.A., Shumilina N.N., Dragunova T.S., Larina E.U., Yuldashbaev Yu.A.</b> THE STUDY OF POTENTIAL, ACTUAL FECUNDITY AND EMBRYONIC MORTALITY IN SILVER-BLACK FOXES OF DIFFERENT BREEDING AREAS.....	14
<b>Bodykov G.Zh., Kurmanova A.M.</b> ENDOVASCULAR TECHNOLOGIES IN PEDIATRIC CARDIAC SURGERY SERVICE.....	23
<b>Dobrosmyslova I.A., Sazanova A.A., Semenov V.G., Mamyrova L.K., Yessembekova Z.T.</b> AGROECOLOGICAL ASPECTS OF THE USE OF SELENITE SODIUM AND ZEOLITES WHEN GROWING PEAS.....	30
<b>Dyulger G.P., Sedletskaia E.S., Obukhova M.E., Leontieva I.L., Bychkov V.S.</b> MODERN TREATMENT METHODS FOR MAMMARY CANCER IN CATS.....	37
<b>Kondruchina S.G., Baimukanov D.A., Tolstova S.L., Lukina N.M., Iskhan K.Zh.</b> PRESERVATION AND PRODUCTIVE QUALITY OF CALVES WHEN USING BIOPREPARATIONS.....	45
<b>Kulbayeva Z. Klyuyev D., Kaliyeva S.</b> NEUROLOGICAL SYMPTOMS AND COMPLICATIONS OF COVID19. MINIREVIEW.....	53
<b>Popov N.N., Kanbetov A.Sh., Barbol B.I.</b> CHARACTERISTICS OF THE COMMERCIAL HERD OF THE SINGIL LIZA AURATA (RISSO, 1810) IN THE KAZAKHSTAN SECTOR OF THE MIDDLE CASPIAN SEA FOR 2018-2020.....	59
<b>Samsonova I.D., Baimukanov D.A., Sattarov V.N., Semenov V.G., Kargaeyeva M.T.</b> DYNAMICS OF NECTAR EXCRETION BY FOREST HONEY PLANTS DEPENDING ON ABIOTIC FACTORS AND BIOMORPHOLOGICAL CHARACTERISTICS.....	65
<b>Shamshidin A.S., Bisembayev A.T., Saginbayev A.K., Abylgazinova A.T., Kozhahmetova A.N.</b> DAIRY PRODUCTIVITY OF FIRST-CALF COWS AND THEIR AVERAGE AGE AT FIRST CALVING IN THE CONTEXT.....	74

## **Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan**

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct ([http://publicationethics.org/files/u2/New\\_Code.pdf](http://publicationethics.org/files/u2/New_Code.pdf)). To verify originality, your article may be checked by the Cross Check originality detection service <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:

[www.nauka-nanrk.kz](http://www.nauka-nanrk.kz)

ISSN 2518-1629 (Online), ISSN 2224-5308 (Print)

<http://biological-medical.kz/index.php/en/>

**Редакторы:** *М.С. Ахметова, Д.С. Аленов, А. Ботанқызы, Р.Ж.Мрзабаева*  
**Верстка на компьютере** *Жадыранова Г.Д.*

**Подписано в печать** 15.06.2021.  
Формат 60x881/8. Бумага офсетная. Печать – ризограф.  
4,6 п.л. Тираж 300. Заказ 3.