

ISSN 2518-1467 (Online),  
ISSN 1991-3494 (Print)



«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ  
ҰЛТТЫҚ ҒЫЛЫМ

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ  
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ

# Х А Б А Р Ш Ы С Ы

---

---

**ВЕСТНИК**

РОО «НАЦИОНАЛЬНОЙ  
АКАДЕМИИ НАУК  
РЕСПУБЛИКИ КАЗАХСТАН»

**THE BULLETIN**

OF THE ACADEMY OF SCIENCES  
OF THE REPUBLIC OF  
KAZAKHSTAN

PUBLISHED SINCE 1944

**1 (413)**

JANUARY – FEBRUARY 2025

---

ALMATY, NAS RK

---

## БАС РЕДАКТОР:

**ӘБЛҚАСЫМОВА Алма Есімбекқызы**, педагогика ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Педагогикалық білім беруді дамыту орталығының директоры, Абай атындағы ҚазҰПУ математика, физика және информатиканы оқыту әдістемесі кафедрасының меңгерушісі (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57191275199>, <https://www.webofscience.com/wos/author/record/2076124>.

## БАС РЕДАКТОРДЫҢ ОРЫНБАСАРЫ:

**СЕМБИЕВА Ләззат Мықтыбекқызы**, экономика ғылымдарының докторы, Л.Н.Гумилев атындағы Еуразия ұлттық университетінің профессоры (Астана, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57194226348>, <https://www.webofscience.com/wos/author/record/38875302>.

## РЕДАКЦИЯ АЛҚАСЫ:

**РИШЕЛЬ Мариновски**, білім беру саласындағы PhD, Летбридж университеті педагогика факультетінің профессоры, (Альберта, Канада), <https://www.scopus.com/authid/detail.uri?authorId=57070452800>, <https://www.webofscience.com/wos/author/record/16130920>.

**ШИШОВ Сергей Евгеньевич**, педагогика ғылымдарының докторы, профессор, К.Разумовский атындағы Мәскеу мемлекеттік технологиялар және басқару университетінің кәсіби білім беру педагогикасы және психологиясы кафедрасының меңгерушісі (Мәскеу, Ресей), <https://www.scopus.com/authid/detail.uri?authorId=57191518233>, <https://www.webofscience.com/wos/author/record/2443966>.

**ӘБЛДИНА Салтанат Қуатқызы**, педагогика ғылымдарының докторы, профессор, Е.А.Бөкетов атындағы Қарағанды университетінің педагогика кафедрасының меңгерушісі (Қарағанды, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=56128026400>, <https://www.webofscience.com/wos/author/record/4131549>.

**РЫЖАКОВ Михаил Викторович**, педагогика ғылымдарының докторы, профессор, Ресей білім академиясының академигі, «Білім берудегі стандарттар мен мониторинг» журналының бас редакторы (Мәскеу, Ресей), <https://www.scopus.com/authid/detail.uri?authorId=6602245542>, <https://www.webofscience.com/wos/author/record/13675462>.

**БОЛАТБАЕВА Күлжанат Нұрымжанқызы**, педагогика ғылымдарының докторы, профессор, Б. Алтынсарин атындағы Ұлттық білім академиясының бас ғылыми қызметкері (Астана, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57202195074>, <https://www.webofscience.com/wos/author/record/40173122>.

**ПЕТР Хайек**, PhD, Юникорн университеті, Қаржы департаментінің қауымдастырылған профессоры (Чех Республикасы), <https://www.scopus.com/authid/detail.uri?authorId=35726855800>, <https://www.webofscience.com/wos/author/record/672404>.

**ЖҰМАН Жаппар**, экономика ғылымдарының докторы, профессор, Қазақстанның Еңбек сіңірген қайраткері, ҚР ҰҒА құрметті академигі, әл-Фараби атындағы Қазақ ұлттық университетінің Халықаралық қолданбалы зерттеулер орталығының директоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=59238481900>; <https://www.scopus.com/authid/detail.uri?authorId=56658765400>, <https://www.webofscience.com/wos/author/record/60977874>.

**ЛУКЪЯНЕНКО Ирина Григорьевна**, экономика ғылымдарының докторы, профессор, «Киево-Могилянская академия» ұлттық университеті кафедрасының меңгерушісі (Киев, Украина), <https://www.scopus.com/authid/detail.uri?authorId=57189348551>, <https://www.webofscience.com/wos/author/record/939510>.

**ЕСІМЖАНОВА Сайра Рафихқызы**, экономика ғылымдарының докторы, Халықаралық бизнес университетінің профессоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=56499485500>, <https://www.webofscience.com/wos/author/record/45951098>.

**«Қазақстан Республикасы Ұлттық ғылым академиясы РҚБ-нің Хабаршысы».**

**ISSN 2518-1467 (Online),**

**ISSN 1991-3494 (Print).**

Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.). Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінің Ақпарат комитетінде 12.02.2018 ж. берілген

№ 16895-Ж мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *«іргелі ғылым салалары бойынша жаңа жетістіктердің нәтижелерін жариялау»*

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19

<http://www.bulletin-science.kz/index.php/en/>

© «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ, 2025

## ГЛАВНЫЙ РЕДАКТОР:

**АБЫЛКАСЫМОВА Алма Есимбековна**, доктор педагогических наук, профессор, академик НАН РК, директор Центра развития педагогического образования, заведующая кафедрой методики преподавания математики, физики и информатики КазНПУ им. Абая (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57191275199>, <https://www.webofscience.com/wos/author/record/2076124>.

## ЗАМЕСТИТЕЛЬ ГЛАВНОГО РЕДАКТОРА:

**СЕМБИЕВА Ляззат Мыктыбековна**, доктор экономических наук, профессор Евразийского национального университета им. Л.Н. Гумилева (Астана, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57194226348>, <https://www.webofscience.com/wos/author/record/38875302>.

## РЕДАКЦИОННАЯ КОЛЛЕГИЯ:

**РИШЕЛЬ Мариновски**, PhD в области образования, профессор факультета педагогики Летбриджского университета, (Альберта, Канада), <https://www.scopus.com/authid/detail.uri?authorId=57070452800>, <https://www.webofscience.com/wos/author/record/16130920>.

**ШИШОВ Сергей Евгеньевич**, доктор педагогических наук, профессор, заведующий кафедрой педагогики и психологии профессионального образования Московского государственного университета технологий и управления имени К. Разумовского (Москва, Россия), <https://www.scopus.com/authid/detail.uri?authorId=57191518233>, <https://www.webofscience.com/wos/author/record/2443966>.

**АБИЛЬДИНА Салтанат Куатовна**, доктор педагогических наук, профессор, заведующая кафедрой педагогики Карагандинского университета имени Е.А. Букетова (Караганда, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=56128026400>, <https://www.webofscience.com/wos/author/record/4131549>.

**РЫЖАКОВ Михаил Викторович**, доктор педагогических наук, профессор, академик Российской академии образования, главный редактор журнала «Стандарты и мониторинг в образовании» (Москва, Россия), <https://www.scopus.com/authid/detail.uri?authorId=6602245542>, <https://www.webofscience.com/wos/author/record/13675462>.

**БУЛАТБАЕВА Кулжанат Нурымжановна**, доктор педагогических наук, профессор, главный научный сотрудник Национальной академии образования имени Ы. Алтынсарина (Астана, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57202195074>, <https://www.webofscience.com/wos/author/record/40173122>.

**ПЕТР Хайек**, PhD, университет Юникорн, ассоциированный профессор Департамента финансов, (Чешская Республика), <https://www.scopus.com/authid/detail.uri?authorId=35726855800>, <https://www.webofscience.com/wos/author/record/672404>.

**ЖУМАН Жаппар**, доктор экономических наук, профессор, заслуженный деятель Казахстана, почетный академик НАН РК, директор Центра Международных прикладных исследований Казахского национального университета им. аль-Фараби (Алматы, Казахстан) <https://www.scopus.com/authid/detail.uri?authorId=59238481900>; <https://www.scopus.com/authid/detail.uri?authorId=56658765400>, <https://www.webofscience.com/wos/author/record/60977874>.

**ЛУКЪЯНЕНКО Ирина Григорьевна**, доктор экономических наук, профессор, заведующая кафедрой Национального университета «Киево-Могилянская академия» (Киев, Украина), <https://www.scopus.com/authid/detail.uri?authorId=57189348551>, <https://www.webofscience.com/wos/author/record/939510>.

**ЕСИМЖАНОВА Сайра Рафихевна**, доктор экономических наук, профессор Университета международного бизнеса (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=56499485500>, <https://www.webofscience.com/wos/author/record/45951098>.

«Вестник РОО «Национальной академии наук Республики Казахстан».

ISSN 2518-1467 (Online),

ISSN 1991-3494 (Print).

Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы). Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и коммуникаций и Республики Казахстан № 16895-Ж, выданное 12.02.2018 г.

Тематическая направленность: *«публикация результатов новых достижений в области фундаментальных наук».*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

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

<http://www.bulletin-science.kz/index.php/en/>

© РОО «Национальная академия наук Республики Казахстан», 2025

#### EDITOR-IN-CHIEF:

**ABYLKASSIMOVA Alma Yesimbekovna**, Doctor of Pedagogical Sciences, Professor, Academician of NAS RK, Director of the Center for the Development of Pedagogical Education, Head of the Department of Methods of Teaching Mathematics, Physics and Computer Science at Abai KazNPU (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57191275199>, <https://www.webofscience.com/wos/author/record/2076124>.

#### DEPUTY EDITOR-IN-CHIEF:

**SEMBIEVA Lyazzat Myktybekovna**, Doctor of Economics, Professor of the Eurasian National University (Astana, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57194226348>, <https://www.webofscience.com/wos/author/record/38875302>.

#### EDITORIAL BOARD:

**RICHELLE Marynowski**, PhD in Education, Professor, Faculty of Education, University of Lethbridge, ( Alberta, Canada), <https://www.scopus.com/authid/detail.uri?authorId=57070452800>, <https://www.webofscience.com/wos/author/record/16130920>.

**SHISHOV Sergey Evgenievich**, Doctor of Pedagogical Sciences, Professor, Head of the Department of Pedagogy and Psychology of Professional Education, Moscow State University of Technology and Management named after K. Razumovsky (Moscow, Russia), <https://www.scopus.com/authid/detail.uri?authorId=57191518233>, <https://www.webofscience.com/wos/author/record/2443966>.

**ABILDINA Saltanat Kuatovna**, Doctor of Pedagogical Sciences, Professor, Head of the Department of Pedagogy, Karaganda University named after E.A. Buketov (Karaganda, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=56128026400>, <https://www.webofscience.com/wos/author/record/4131549>.

**RYZHAKOV Mikhail Viktorovich**, Doctor of Pedagogical Sciences, Professor, Academician of the Russian Academy of Education, Editor-in-Chief of the journal “Standards and Monitoring in Education” (Moscow, Russia), <https://www.scopus.com/authid/detail.uri?authorId=6602245542>, <https://www.webofscience.com/wos/author/record/13675462>.

**BULATBAEVA Kulzhanat Nurymzhanovna**, Doctor of Pedagogical Sciences, Professor, Chief Researcher of the National Academy of Education named after Y. Altynsarin (Astana, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57202195074>, <https://www.webofscience.com/wos/author/record/40173122>.

**PETR Hájek**, PhD, Unicorn University, Associate Professor, Department of Finance, ( Czech Republic), <https://www.scopus.com/authid/detail.uri?authorId=35726855800>, <https://www.webofscience.com/wos/author/record/672404>.

**JUMAN Jappar**, Doctor of Economics, Professor, Honorary Academician of NAS RK, Honored Worker of Kazakhstan, Director of the Center for International Applied Research Al-Farabi Kazakh National University (Almaty, Kazakhstan) <https://www.scopus.com/authid/detail.uri?authorId=59238481900>; <https://www.scopus.com/authid/detail.uri?authorId=56658765400>, <https://www.webofscience.com/wos/author/record/60977874>.

**LUKYANENKO Irina Grigorievna**, Doctor of Economics, Professor, Head of Department of the National University of Kyiv-Mohyla Academy (Kyiv, Ukraine), <https://www.scopus.com/authid/detail.uri?authorId=57189348551>, <https://www.webofscience.com/wos/author/record/939510>.

**YESIMZHANOVA Saira Rafihevna**, Doctor of Economics, Professor of the University of International Business (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=56499485500>, <https://www.webofscience.com/wos/author/record/45951098>.

#### **Bulletin of the National Academy of Sciences of the Republic of Kazakhstan.**

**ISSN 2518-1467 (Online),**

**ISSN 1991-3494 (Print).**

Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty). The

certificate of registration of

a periodical printed publication in the Committee of information of the Ministry of Information and Communications

of the Republic of Kazakhstan **No. 16895-Ж**, issued on 12.02.2018.

Thematic focus: *«publication of the results of new achievements in the field of fundamental sciences»*

Periodicity: 6 times a year.

Circulation: 300 copies.

Editorial address: 28, Shevchenko str., of. 220, Almaty, 050010, tel. 272-13-19

<http://www.bulletin-science.kz/index.php/en/>

© National Academy of Sciences of the Republic of Kazakhstan, 2025

BULLETIN OF NATIONAL ACADEMY OF SCIENCES  
OF THE REPUBLIC OF KAZAKHSTAN  
ISSN 1991-3494  
Volume 1. Number 413 (2025), 96–111

<https://doi.org/10.32014/2025.2518-1467.885>

UDC 37.013.75  
IRSTI 14.35.09

**A. Duisembekova, A. Soltabayeva\*, A. Zhuravel, D. Kanayeva\*, 2025.**

Department of Biology, School of Sciences and Humanities, Nazarbayev  
University, Astana, Kazakhstan;

\*E-mail: [aigerim.soltabayeva@nu.edu.kz](mailto:aigerim.soltabayeva@nu.edu.kz)

## **INTEGRATION OF AN AGAR ART TO A RESEARCH-ORIENTED MICROBIOLOGY LABORATORY SYLLABUS**

**Duisembekova Assem** – M.Sc., Instructor, Department of Biology, School of Sciences and Humanities, Nazarbayev University, Astana, Kazakhstan, E-mail: [aduisembekova@nu.edu.kz](mailto:aduisembekova@nu.edu.kz), ORCID ID: <https://orcid.org/0009-0000-9997-1517>;

**Soltabayeva Aigerim** – Ph.D., Assistant Professor, Department of Biology, School of Sciences and Humanities, Nazarbayev University, Astana, Kazakhstan, E-mail: [aigerim.soltabayeva@nu.edu.kz](mailto:aigerim.soltabayeva@nu.edu.kz), ORCID ID: <https://orcid.org/0000-0001-8150-438X>;

**Zhuravel Arina** – Ph.D. student, Department of Biology, School of Sciences and Humanities, Nazarbayev University, Astana, Kazakhstan, E-mail: [arina.zhuravel@nu.edu.kz](mailto:arina.zhuravel@nu.edu.kz), ORCID ID: <https://orcid.org/0009-0001-7277-2427>;

**Kanayeva Damira** – Ph.D., Associate Professor, Department of Biology, School of Sciences and Humanities, Nazarbayev University, Astana, Kazakhstan, E-mail: [dkanayeva@nu.edu.kz](mailto:dkanayeva@nu.edu.kz), ORCID ID: <https://orcid.org/0000-0002-3669-7810>.

**Abstract.** Microbiology laboratory courses at universities are traditionally conducted by having students follow instructions to perform the experiments strictly. Such an approach, called a “cookbook” method, is perceived as tedious by students, although it is widely used in research-based universities with condensed curricula. It is not only seen as tedious by science-major students due to the lack of clear connections between learned methods, but they also experience difficulties in their practical applications. To address this issue, we successfully introduced artistic creativity that represents a unique creation in a Petri dish using living microorganisms. Here, we present our method of integrating Agar art into the microbiology laboratory course syllabus, being the first of its kind in Central Asia. Throughout the course, students characterized an unknown bacterium to the species level and designed colorful pieces of Agar art. This pilot project was non-graded, yet students enthusiastically participated in presenting their work as poster presentations. Collectively, Agar art integration exposed students to working collaboratively, enhancing their scientific communication skills, and better understanding lab topics

of the condensed research-focused lab syllabus with a further perspective to engage non-major/major microbiology students in taking the lab course.

**Keywords:** course-based undergraduate research experience, Agar art, microbiology, laboratory

**А.Ж. Дүйсембекова, А.Д. Солтабаева\*, А. Журавель, Д.А. Канаева\*, 2025.**

Биология Департаменті, Жаратылыстану және Гуманитарлық ғылымдар мектебі, Назарбаев Университеті, Астана, Қазақстан.

\*E-mail: aigerim.soltabayeva@nu.edu.kz

### **АГАР АРТ-ТЫ МИКРОБИОЛОГИЯНЫ ЗЕРТТЕУГЕ БАҒЫТТАЛҒАН ЗЕРТХАНАЛЫҚ СИЛЛАБУСҚА ЕНГІЗУ**

**Дүйсембекова Әсем Жомартқызы** – магистр, инструктор, Биология департаменті, жаратылыстану және гуманитарлық ғылымдар мектебі, Назарбаев Университеті, Астана, Қазақстан, E-mail: aduisembekova@nu.edu.kz, ORCID ID: <https://orcid.org/0009-0000-9997-1517>;  
**Солтабаева Айгерім Даулетбекқызы** – Ph.D., ассистент профессор, Биология департаменті, жаратылыстану және гуманитарлық ғылымдар мектебі, Назарбаев Университеті, Астана, Қазақстан, E-mail: aigerim.soltabayeva@nu.edu.kz, ORCID ID: <https://orcid.org/0000-0001-8150-438X>;

**Журавель Арина** – докторант, Биология департаменті, жаратылыстану және гуманитарлық ғылымдар мектебі, Назарбаев Университеті, Астана, Қазақстан; E-mail: arina.zhuravel@nu.edu.kz, ORCID ID: <https://orcid.org/0009-0001-7277-2427>;

**Канаева Дамира Ашимхановна** – Ph.D., қауымдастырылған профессор, Биология департаменті, жаратылыстану және гуманитарлық ғылымдар мектебі, Назарбаев Университеті, Астана, Қазақстан, E-mail: dkanayeva@nu.edu.kz, ORCID ID: <https://orcid.org/0000-0002-3669-7810>.

**Аннотация.** Университеттердегі микробиология бойынша зертханалық сабақтар дәстүрлі түрде студенттер эксперимент жүргізу нұсқауларын қатаң сақтайтындай етіп өткізіледі. «Аспаздық кітап» деп аталатын бұл әдіс тығыз оқу бағдарламалары бар зерттеу университеттерінде кеңінен қолданылғанымен, студенттерге жалықтырғыш ретінде қабылданады. Жаратылыстану ғылымының студенттері үйренген әдіс-тәсілдердің арасында анық байланыстың жоқтығы жалықтырып қана қоймайды, сонымен қатар осы әдіс-тәсілдердің нақты тәжірибелерде қолдану қиынға соғады. Бұл мәселені шешу үшін біз тірі микроағзаларды қолданатын Петри табақшасында бірегей туынды болып табылатын «көркем шығармашылықты» сәтті енгіздік. Мұнда біз осы Агар арт шығармашылығын микробиология зертханасының оқу бағдарламасына Орталық Азияда бірінші болып енгізу әдісімізді ұсынып отырмыз. Курс бойы студенттер белгісіз бактерияны түр деңгейіне дейін сипаттап, Агар арттың түрлі-түсті туындыларын жасады. Бұл пилоттық жоба болғандықтан студенттерді бағалау жүйесін қамтымады, бірақ студенттер өз жұмыстарын постерлік презентация негізінде көрсетуге бар ынтасымен қатысты. Тұтастай алғанда, Агар арт студенттерге бірлесіп жұмыс істеуге, ғылыми коммуникация дағдыларын жақсартуға және зертханалық бағдарламаның тақырыптарын жақсы түсінуге мүмкіндік берді. Бұл әдіс келешекте микробиология және

микробиологиядан тыс оқитын студенттерді зертханалық курсты өтуге тарту үшін енгізілді.

**Түйін сөздер:** бакалавриат деңгейіндегі зерттеу тәжірибесі, Агар арт, микробиология, зертхана.

**А.Ж. Дуйсембекова, А.Д. Солтабаева\*, А. Журавель, Д.А. Канаева, 2025.**

Департамент Биологии, Школа Естественных и Гуманитарных Наук,

Назарбаев Университет, Астана, Казахстан.

\*E-mail: aigerim.soltabayeva@nu.edu.kz

## **ИНТЕГРАЦИЯ АГАР АРТ В СИЛЛАБУС В ИССЛЕДОВАТЕЛЬСКО-ОРИЕНТИРОВАННЫЕ ЛАБОРАТОРНЫЕ ЗАНЯТИЯ ПО МИКРОБИОЛОГИИ**

**Дуйсембекова Асем Жомартовна** – магистр, инструктор, департамент биологии, школа естественных и гуманитарных наук, Назарбаев Университет, Астана, Казахстан, E-mail: a Duisembekova@nu.edu.kz, ORCID ID: <https://orcid.org/0009-0000-9997-1517>;

**Солтабаева Айгерим Даулетбеккызы** – PhD, ассистент профессор, департамент биологии, школа естественных и гуманитарных наук, Назарбаев Университет, Астана, Казахстан, E-mail: aigerim.soltabayeva@nu.edu.kz, ORCID ID: <https://orcid.org/0000-0001-8150-438X>;

**Журавель Арина** – докторант, департамент биологии, школа естественных и гуманитарных наук, Назарбаев Университет, Астана, Казахстан, E-mail: arina.zhuravel@nu.edu.kz, ORCID ID: <https://orcid.org/0009-0001-7277-2427>;

**Канаева Дамира Ашимхановна** – PhD, ассоциированный профессор, департамент биологии, школа естественных и гуманитарных наук, Назарбаев Университет, Астана, Казахстан, E-mail: dkanayeva@nu.edu.kz, ORCID ID: <https://orcid.org/0000-0002-3669-7810>.

**Аннотация.** Лабораторные курсы по микробиологии в университетах традиционно проводятся таким образом, что студенты строго следуют инструкциям по проведению экспериментов. Такой подход, называемый методом «кулинарной книги», воспринимается студентами как скучный, хотя он широко используется в исследовательских университетах с сжатыми учебными программами. Студенты естественных наук не только считают это скучным из-за отсутствия четких связей между изученными методами, но и испытывают трудности при их практическом применении. Чтобы решить эту проблему, мы успешно внедрили «художественное творчество», или Агар Арт, которое представляет собой уникальное творение в чашке Петри с использованием живых микроорганизмов. Здесь мы представляем наш метод интеграции данного творчества Агар арт в учебную программу микробиологической лаборатории, который является первым в своем роде в Центральной Азии. На протяжении всего курса студенты описывали неизвестную бактерию до видового уровня и создавали красочные произведения Агар арт. Этот пилотный проект не вовлекал оценочной системы, однако студенты с энтузиазмом участвовали в представлении своих работ в виде постер презентаций. В целом интеграция Агар арт позволила студентам работать совместно, улучшить свои навыки научной коммуникации, и лучше понять лабораторные темы

сжатой исследовательско-фокусированной лабораторной программы с дальнейшей перспективой привлечения студентов, не специализирующихся на микробиологии, к прохождению лабораторного курса.

**Ключевые слова:** опыт исследовательской работы на уровне бакалавриата, Агар арт, микробиология, лаборатория.

**Introduction.** Microbiology methods have been taught in universities through protocol-based instructions, where students strictly follow a step-by-step guide. This approach allows little room for student-driven hypothesis creation and testing, making it challenging for many universities to deliver the course and achieve the intended learning outcomes. However, some universities in the United States have developed an exciting alternative by incorporating Agar art into their microbiology courses, where it has gained popularity for teaching foundational concepts of microbes (Adkins, et al., 2018; Adkins-Jablonsky, et al., 2021; Danna, 2017; Smith, 2022).

The Agar art contest, launched by the American Society for Microbiology (ASM) in 2015, has generated tremendous public interest in the colorful and diverse world of microorganisms (Chan-Laddaran, 2015; ASM, 2017). These tiny organisms produce various pigments or unusual colors when grown on specific media, with the Petri dish serving as a canvas for microbial art (Charkoudian, et al., 2010). This initiative has been well-received in high schools (Lontok, 2019; Wu, et al., 2018) and universities (Adkins-Jablonsky, et al., 2021), where microbiology syllabi are not solely research-oriented and mainly cover essential concepts about microorganisms. Its goal is to illustrate the strong connection between art and science in historical discoveries. Art is inseparable from STEM (Science, Technology, Engineering, and Mathematics) subjects today, as artistic training enhances scientific inquiry by promoting imagination and developing observational skills (Adkins, et al., 2018). A prime example is Sir Alexander Fleming, a self-taught artist who often painted bacteria on agar plates and discovered penicillin, saving countless lives. His ability to observe bacterial growth aesthetically allowed him to notice fungi inhibiting bacteria, which others overlooked (Dunn, 2010). Therefore, creative activities in practical settings, such as lab courses, can enhance students' attention to detail, nurture creative thinking, and encourage enjoyment as they express their individuality in experiments. This involvement leads to a more significant personal investment in the outcomes of their work (Adkins, et al., 2018) and invites open-ended discussions about unexpected results (American Association for the Advancement of Science., 2009).

Furthermore, creating paintings on Agar plates with differently pigmented bacteria promotes scientific communication through visual arts. Previous studies have demonstrated the effectiveness of an Agar art curriculum in boosting student engagement, helping them feel like real scientists as they formulate new hypotheses, thus creating a course-based undergraduate research experience (CURE) from an introductory lab with minimal investment from the university (Adkins, et al., 2018). Additionally, out of three CURE activities, including Agar art, experimental design, or poster presentations used to assess student engagement and understanding of the



nature of science (scientific thinking, experimental design competence, and academic performance), Agar art achieved the highest student engagement and outcomes linked to the nature of science, where interviewed students described the activity as enjoyable and as a way to apply knowledge in practice, thereby connecting research to classroom learning (Adkins-Jablonsky, et al., 2021). Another application of microbial painting in the microbiology curriculum conducted in Bulgaria, where students grew pigmented microorganisms on nutrient media, interpreting the resulting color patterns using an international standard system for color coordinates, the CIELab system. This marked a first for the numerical presentation and discrimination of microbial pigment coloration through spectrophotometric measurements (Todorova, et al., 2015). It also enabled the exploration of how nutrient medium composition, pH, and the type of carbon source influence pigment coloration. Agar art painting was also used as an extension to a transformation protocol in a high school microbiology class, where competent *Escherichia coli* cells were transformed with commercially available plasmids yielding fluorescent proteins, selecting and painting transformed colonies on agar plates, then visualizing the art under UV light. Students appreciated the project's outcome because microbial art offered them a real-world application of genetics, allowing them to gain hands-on experience with bacteria while understanding the replication of bacteria and inheritance of the genes for fluorescent proteins (Wu, et al., 2018). Kansas State University utilized *E. coli* in its undergraduate teaching in the food microbiology laboratory by incorporating three engagement strategies. Agar art served as a method for identifying foodborne pathogens by isolating and confirming them on differential media. Student engagement increased when all three strategic tools were applied (Mendez, et al., 2020) compared to years when few or no tools were utilized, consistent with findings from the University of Alabama (Morris & Adkins, 2018). Agar art also played a key role in the upper-level biochemistry course, where students engaged in active learning by working with specific plasmids that displayed distinct colors while experimenting with various antibiotics and inducers to implement their artwork successfully. The authors aimed to integrate art into the class to foster creative learning and deepen understanding of gene expression using inducible promoters with UV-light or blue-LED excited fluorescent proteins (Jefferies, et al., 2022). As can be seen, this activity has been gaining popularity in recent years not only for aesthetic enjoyment but also for learning more about the microbial world, including their role in food science and the study of inducible promoters.

Finally, Agar art led to mastering artistic practice among introductory and advanced art students to recreate famous artists' paintings or their own concepts after learning safe bacterial handling and culturing. As a result of this activity, students enhanced their confidence in handling microorganisms and aesthetically creating microbial art. Furthermore, some students even became finalists in the ASM's Agar art contest, thereby validating the success of the interdisciplinary project between the biology and art departments (Torruellas Garcia, et al., 2022). Table 1 summarizes the use of Agar art in educational settings. It is evident from the table that Agar art has been extensively employed in North America, but no Central Asian countries have yet integrated it into their course curriculum.

Country	Study conducted, years	University (-ies)	Outcome achieved	Parameters evaluated	No. of students participated	Ref.
Bulgaria	2015	Razgrad Branch of University of Ruse "Angel Kanchev"	The possibility of microbial pigments' color measurement and discrimination using the CIELab system was revealed.	Not available	Not available	(Todorova et al., 2015)
USA	2016 - 2017	University of Alabama at Birmingham	Identification of unknown microorganisms in control and active groups from labstock culture and nearby park, respectively	Concept mastery, attitudes toward science, student demographic characteristic in control and active groups before and end of semester	15 out of 30 students (control group); 33 out of 48 students (active group)	(Adkins et al., 2018)
USA	2018-2020	Fred Hutchinson Cancer Research Center, Science Education Partnership; Center School, Seattle Public Schools; Eastside Preparatory School, Kirkland	Use of bacteria as paint promoted their understanding of bacterial genetics, employment of plasmids as a molecular tool, as well as reinforced creative and critical thinking in class	Lack of cross-contamination, expression of transformed plasmids with fluorescent proteins, color visualization under normal and UV light	3 respondents; unknown number of class participants	(Wu et al., 2018)
USA	2016- 2018	Kansas State University	Creative engagement activities, including Agar art, outbreak case studies and a research group project improve students' learning outcomes and engagement in food microbiology and food safety.	1. Learning outcomes for the Food microbiology class (quizzes, exams, lab notebooks, in-class participation evaluation scores) compared across student groups with/without creative activities implemented; 2. Students engagement (through pre- and post-questionnaires)	173	(Mendez N et al., 2020)

USA	2018- 2021	University of Alabama at Birmingham and Jefferson State Community College, Alabama	Participation in the CURE improved both research university and community college students' course engagement, scientific thinking capabilities, experimental design competence, and overall academic outcomes. Agar art was found to be the most engaging among three creative activities tested	1. Course engagement Nature of science questions evaluated on a Likert scale: 2. Scientific thinking 3. Experimental design competence 4. Academic performance	82 (25 community college students, 57 research university students)	(A d k i n s - Jablonsky et al., 2021)
USA	2020- 2021	U.S. Air Force Academy Department of Chemistry	Understanding biochemical concepts (cloning, antibiotic use, protein fluorescence); incorporation of scientific concept visual art through Agar art	Pre-activity and post-activity quizzes; Understand differences between constitutive and inducible promoters antibiotic selection concept; emission of light by FP at different wavelengths		(Jefferies L, et al., 2022)
USA	2021- 2022	Halmos College of Arts and Sciences, Nova Southeastern University, Fort Lauderdale, Florida	To integrate fundamental microbiology laboratory techniques and utilize them as innovative tools for artistic expression among undergraduate Arts students	Aesthetic, conception, and technical proficiency in handling the bacteria among undergraduate Arts students	Introductory (n=17) and advanced art (n=33) students	(Torruellas Garcia et al., 2022)

Table 1. Agar art Application as a Course-Based Undergraduate Research Experience in Biology Undergraduate Students

Introduction to Microbiology Laboratory course is offered to undergraduate students at Nazarbayev University (NU), a research-based university established in Central Asia, Kazakhstan. The course syllabus primarily emphasizes research-oriented content with different lab topics encompassing various microbiological methods. After running the course for several years, students' feedback from previous years' class evaluations indicated a lack of innovative teaching methods, potentially leading to a lack of interest in the course and hindering its popularity among other students.

To address this issue, our undergraduate students were put into a routine microbiologist workflow where they could get a CURE. Therefore, the course is considered research-oriented due to its component of identifying and characterizing unknown bacteria, where students define their hypotheses and investigate pathogens to generate new knowledge. Moreover, we successfully integrated Agar art into the laboratory to understand the science behind developing artwork on a Petri dish. In the current paper, we aim to share our method of embedding Agar art into the research-oriented curriculum for the Introduction to Microbiology laboratory course for its further popularization to engage more students and create a learning environment where students use their artistic work to find discoveries.

### **Methods and materials.**

This section aims to share a curricular approach to implementing the Agar art activity throughout the course syllabus, which contains 14 weeks with 12 weeks of wet labs. The first lab session was dedicated to microbiology lab safety, where students gained knowledge and training on aseptic techniques followed by appropriate handling, culturing, and disposal of microorganisms. They were given a task to identify and characterize an unknown bacterium (further referred to as Bacterium X) causing an infection. Instructors gave a bacterial mixture containing Bacterium X. Students spent one month identifying the Bacterium X.

Over one month, instructors ensured that the students received adequate safety training to handle procedures for interpreting results in the context of Bacterium X characterization as microbiologists. During this period, they learned to isolate a specific bacterium from a bacterial mixture. This process involved streaking from the mixture followed by its inoculation into an agar slant, allowing them to define the type and morphology of a bacterium (Figure S1). Furthermore, students were taught to conduct simple and differential staining methods (Figure S2).

During the second month of the course, students were immersed in methodologies used in research, such as selecting different types of bacteria and differentiating closely related microorganisms using selective and differential media such as crystal violet (CV) agar, MacConkey agar (MCA), eosin methylene blue (EMB) agar, and mannitol salt agar (MSA) (Figure S3). Once selective and visually differentiated growth of the unknown pathogen was achieved, our students were assigned to determine the nature of the Bacterium X. Identifying an unknown bacterium allowed students to deeply understand each method outlined in the syllabus from weeks 2 to 5 and comprehend the methods' practical application.

Students employed sophisticated lab methods such as indole, methyl red, Voges Proskauer, citrate (IMViC) tests, nitrate reduction, and analytical profile index 20E (API 20E) to characterize it further. As per the syllabus, students learned widely used methods in antibiotics assay and analyzed spectrophotometer-obtained data to determine generation time for their bacterial growth curve. To continue, students had a lab session on the use of different extracellular and intracellular enzymatic activities of microorganisms (starch, gelatin, lipid hydrolysis, catalase, and oxidase assays) followed by determining hydrogen sulfide production and motility in the bacteria of interest (data not shown). At the same time, our students were investigating Bacterium X for the abovementioned biochemical activities, and these experiments further confirmed the correct identification of Bacterium X from week 5.

For each assay students were provided with a positive control to ensure quality of results comprised of the following strains: *E. coli* (Migula) Castellani and Chalmers (ATCC 23735), *Serratia marcescens* Bizio (ATCC 4003), *Bacillus cereus* (ATCC 14579), *Enterobacter aerogenes* (ATCC 13048, now available as *Klebsiella aerogenes*), and *Staphylococcus aureus subsp. aureus* Rosenbach (ATCC 25923).

The first half of the third month of the syllabus served as an introductory session for the food microbiology lab, an upper-level course offered as an elective one to identify coliform contamination in food samples. Enterobacteriaceae was differentiated by IMViC assay to differentiate *E. coli* from *E. aerogenes*. API 20E test revealed the enteric bacterium to the species level. Similarly, a Bacterium X was tested along with controls, and API 20E complemented the findings from the IMViC tests to confirm the Bacterium X to be an *E. coli* strain with a 99% match according to the APIWEBTM, an online bacteria and yeast database (<https://apiweb.biomerieux.com/login>) (Figure S4).

To finalize the biochemical part of the syllabus, students also learned to interpret the results of nitrate reduction assay and understand how bacteria employ nitrates to produce nitrite or nitrogenous gases. To further extend research-targeted methods conducted with bacteria, we included a lab experiment with bacteriophage culturing and their enumeration using double-layer and spot-phaging methods. Students also performed the immunological assay called a ring precipitation test, a qualitative test for the presence of an antibody-antigen complex (data not shown). The last week of labs was devoted to teaching students how to preserve the bacterial culture long-term in glycerol, an essential technique to be mastered by each microbiologist.

Integrating the Agar art into the course syllabus was made as smooth as possible: lab procedures for its preparation were broken into specific parts from mid-semester until the end by simultaneously performing research-based methodologies with the unknown Bacterium X as given in the course syllabus (Figure 1).

To upload their Agar artwork, our students used an online bulletin board called Padlet (<https://padlet.com>) to prepare a poster presentation to be defended during the final week of classes. All lab procedures were conducted by wearing personal protective equipment (i.e., lab coat, closed-toed shoes, gloves, and safety glasses).

### **Results.**

The Introduction to Microbiology laboratory course is organized to include a

three-hour lab practicum once a week over 14 weeks (Figure 1). As presented, the syllabus is intensive and heavily packed with essential and sophisticated research-based lab methods for a student taking microbiology labs for the first time. We “softened” the course syllabus by incorporating creative agar artwork to alleviate the burden. Midway through the semester, students commenced their Agar art project, having already acquired essential techniques such as aseptic culturing of bacteria, simple and differential staining to observe bacterial morphology, preparation of culture media, and inoculation of bacteria on different selective/nutritive/differential media (see Procedure and Figure 1). Fifty undergraduate students participated for the first time in the history of NU. They had already acquired knowledge and practical experience on the characteristics of various bacteria used in the lab to decide which bacterium to choose for their Agar art project.

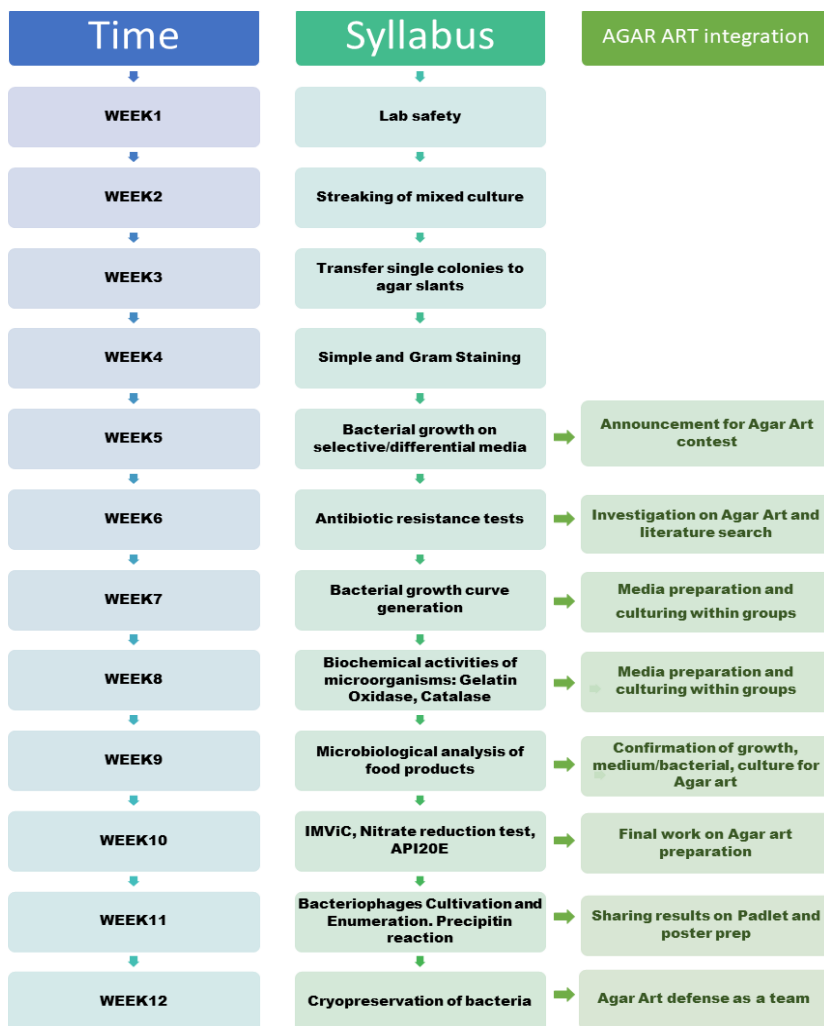
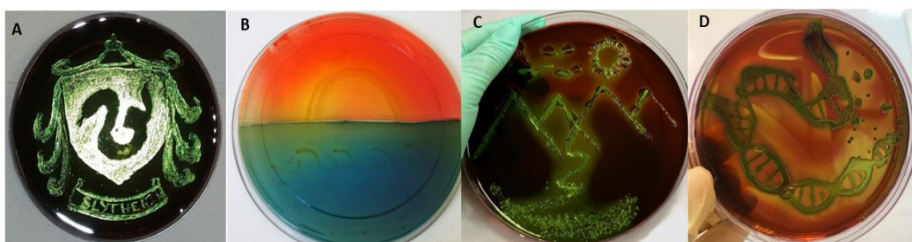


Figure 1. A flowchart on the integration of Agar art into the course syllabus.

Participation in this activity was voluntary and non-graded for all students in this course. The following weeks, 6-11, were devoted to preparation for the project. During week 6, the students were shown outstanding works of Agar art winners from previous years on the ASM website that motivated and demonstrated how colorful the bacterial world can be (ASM, 2017). By this time, a group of two or three students had formed to start this project. Moreover, trained teaching assistants and instructors closely monitored the progression of each step in the project by giving timely feedback. As the syllabus layout shows (Figure 1), students continued following lab course experiments and running their Agar art projects in parallel. In week 6, students were tasked with determining the media and bacterial culture types required for their work. To accomplish this, they conducted a literature overview on the growth of microorganisms in various selective and differential media. Some students used an isolated bacterial strain from a bacterial mixture given to them at the beginning of the labs. In contrast, others used another type of bacteria for their artwork creation. We allowed our students to use all available growth media in our lab, including those reserved for advanced elective lab courses.

Once students chose media and bacterial cultures, week 7 was devoted to media inoculation. Week 8 was busy observing the results of week 7's bacterial growth on students' media. We allowed the students to have it repeated, if necessary, in case of contamination or getting unexpected results. Week 9 was set as a concluding week to establish media and microorganisms of choice, having obtained results from weeks 7-8. Notably, the students prepared media independently and poured plates that served as a canvas for their Agar art. Students used week 10 lab to finalize their project by creating agar art on a Petri dish. In week 11, students uploaded Agar art results and artwork descriptions into the Padlet, where they observed each other's works. An example of a group result submitted to the Padlet is demonstrated in Figure S5 and available following the link: [https://padlet.com/aigerim\\_soltabayeva/agar-art-3z9wuo068dcj](https://padlet.com/aigerim_soltabayeva/agar-art-3z9wuo068dcj). It was observed that sharing one team's work with others effectively increased interest in the task among peers, thereby enhancing student discussion. Week 12 culminated with a poster presentation where each group presented their Agar art, explaining the choice of media and "drawings" on a Petri plate (Figure 2).



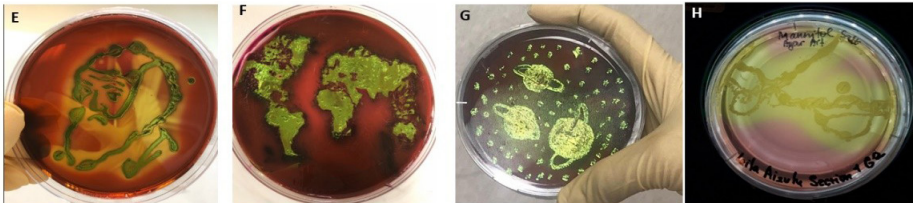


Figure 2. Agar artwork performed by students enrolled in the microbiology laboratory course in the Fall of 2019. The compositions are labeled as follows: Slytherin (A); Sunset Over the Ocean (B); Atameken (C); Egoism (D); Charles Darwin aka Father of Evolution (E); Save the Mother Earth (F); Universe of three planets: Saturn, Uranus, and LeRim (G); Sign (H).

The entire poster with all student groups' projects and descriptions is provided in Figure S6. Then, the students were invited to participate in an International Agar art competition organized by the ASM using Bacterium X in their art pieces. One group submitted their work to the ASM (Figure S7). We investigated the impact of integrating Agar art into the course on students' academic performance. To evaluate this, we compared two cohorts of students: one from 2018, when Agar art was not integrated into the curriculum, and one from 2019, when it was introduced. We found that, on average, the inclusion of Agar art stimulated better academic performance. Interestingly, the percentage of students with grades ranging from 90% to 94.99% was slightly higher with the inclusion of Agar art, although the number of students taking the lab course with Agar art was two times less in 2019 ( $n=50$ ) compared to 2018 ( $n=105$ ). As for the number of high-achievers, 30% of students had exceptional performance by gaining a grade between 95% and 100% compared to 21% with no Agar art when it was not integrated into the syllabus. Notably, there were no failing students in the class with agar art, in contrast to 2% of students who failed the lab in the previous year (Figure 3).

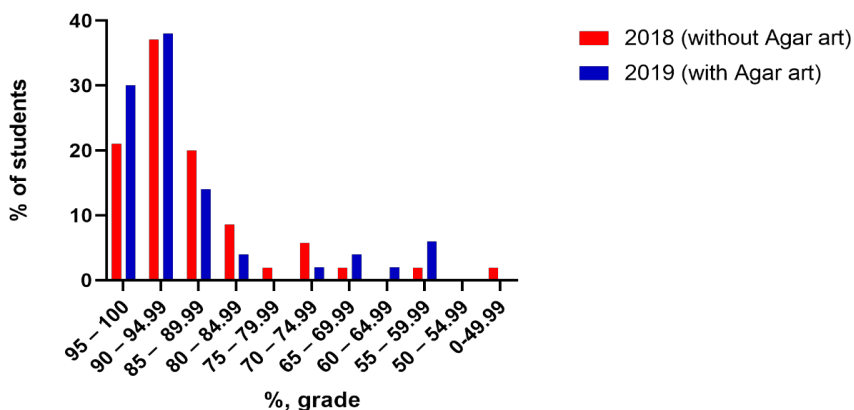


Figure 3. Distribution of students' grades in the Introduction to Microbiology course for two different years: 2018, when Agar art was not integrated ( $n = 105$  students), and 2019, when it was integrated ( $n = 50$  students).



Our observations were backed up with several comments from the course feedback survey, where students outlined what they most enjoyed while taking the course. As evidenced, students notably understood fundamental and applied lab techniques as they were implemented. More importantly, Agar art was considered one of the favorite parts that motivated students to perform well (data not provided). Due to the pandemic that commenced in the Spring semester of 2020, students switched to an online mode of learning, and, unfortunately, the Agar art project did not find further implementation.

### **Discussion.**

The course goes through the annual monitoring assessment on the departmental and university levels, where we collect student feedback that serves as a basis for improvements and corresponding changes in the syllabus year by year. Previous years' course feedback demonstrated that students perceived the course as boring due to a lack of innovative teaching methods. With an attempt to bring a novel method of teaching the course and simultaneously show a practical link among the learned laboratory techniques, students were put into a routine day of a microbiologist who is involved in the identification and characterization of an infectious-causing pathogen named Bacterium X using different microbiological techniques which are outlined in the course syllabus. The course learning outcomes were achieved as the students learned research methods weekly encompassing major topics on bacterial staining, metabolic activities, antibiotics resistance, enumeration of bacteriophages, serological testing, differentiation of Enterobacteriaceae members, and bacterial count in food products as presented in Figure 1.

We aimed to keep the research component of the course and, at the same time, smoothen the syllabus by introducing Agar art to bring more creativity to the scientific module (Figure 1). Its smooth integration took place by applying the methods each week that permitted students to complete their projects in a non-stressful way. Since it was a pilot project, completion of the Agar art was optional to complete the course. However, all fifty enrolled students participated and successfully defended their project as teamwork by presenting a poster in class, where each team member explained the media/bacteria used for their microbial painting and the philosophy behind the artwork. All results were collected and broadcast on the university channel and put into a poster that further increased first-year students' interest in the world of microorganisms (Figure S6). Most notably, we could keep all the lab topics by having more engaged students with better academic performance (Figure 3). The Agar art was a culmination point of the course, where students could express their ideas using living microorganisms and creating beautiful color patterns of pigmented bacteria. Such an activity allowed students to develop critical thinking skills during results interpretation and teamwork skills to prepare the Agar art project. Our results also support the findings of Adkins-Jablonsky et al. (2021), who revealed that students selected Agar art as a curricular tool that is relevant and favored by students. Our students simultaneously had an experience of a typical

day of a microbiologist investigating the pathogen, thereby comprehending a link between diverse microbiological experiments.

There is a pressing need to develop robust evaluation methodologies to measure the impact of Agar art exposure in prospective research endeavors. Therefore, implementation of a pre-/post-activity assessment design could further strengthen the rigor of these investigations, ultimately enhancing understanding of the educational impact of Agar art. Subsequently, future studies will encompass including pre- and post-activity questionnaires involving more students from diverse institutions. This comparative analysis can also consider students' personal backgrounds and social identities to investigate the impact of Agar art integration, as most often, the impact of educational interventions may vary significantly among students with different background characteristics. Regrettably, this aspect remains unaddressed, mainly in studies incorporating Agar art into course curricula, as presented in Table 1. Notably, the design of the assessments should seek to ascertain the extent to which Agar art enhances collaborative work, fosters scientific and communication skills, and deepens students' understanding of laboratory topics. In addition, introducing new bacterial strains that have not yet been used in Agar art competitions can enhance student interest and make the contest more motivating and engaging.

### **Conclusion.**

The Bachelor of Science in Biological Sciences program is taught in English and can be compared in scope and structure to available programs in internationally leading academic institutions. Introduction to Microbiology laboratory course has been running for 10 years, and its learning outcomes match soundly with the B.Sc. in Biological Sciences program outcomes wherein a graduate will be able to apply scientific methods and integrate fundamental theoretical concepts to address real-world problems in biology-related fields, communicate clearly, and analyze data in biological sciences both ethically and critically. In this study, we maintained a research-oriented microbiology syllabus by obtaining all course learning outcomes and smoothly integrating artistic creativity. The latter resulted in a total student participation rate, which augmented their scientific and communication skills.

To the best of our knowledge, this case was the first in the Central Asia region to successfully integrate Agar art into microbiology laboratory training for initial explorations of the impact of such activity on students. This will be further continued by disseminating such a curricular approach with local universities in Kazakhstan to find a correlation with our findings.

Having integrated Agar art into our research-based syllabus, we could maintain CURE, increase the number of high achievers, and support the comprehension of each applied experimental method. Popularization of the course with Agar art incorporation among current and future students in science and non-science majors potentially enhances student engagement with STEM classes and, therefore, their retention in STEM careers. Our long-term goal is to develop a curriculum that other universities can use as a CURE in their microbiology courses.

**Acknowledgments.** We thank the Biology Department, School of Sciences and Humanities, NU, for their generous provision of reagents, equipment, and support. Additionally, we extend our thanks to the following students: Yerbol Tagay, Shynar Akhmetova, Valeriya Stepanova, Azhar Maulet Khan, Nikita Kalygin, Leila Ulmanova, Aigerim Malikova, Meruyert Ashkenova, Ayazhan Dauletova, Liza Orazmukhametova, Adiya Tauassarova, and Anar Ormantayeva, who permitted us to use their Agar artwork in this paper. We are also grateful to our teaching assistants, Aizada Bexeitova and Yerkebulan Yesbolatov, for their assistance and contribution to this study.

### References

- Adkins SJ, Rock RK, Morris JJ. Interdisciplinary STEM education reform: dishing out art in a microbiology laboratory. *FEMS Microbiol Lett.* 2018 Jan 1;365(1). <https://doi.org/10.1093/femsle/fnx245> (in English)
- Adkins-Jablonsky SJ, Arnold E, Rock R, Gray R, Morris JJ. Agar Art: a CURE for the Microbiology Laboratory. *J Microbiol Biol Educ.* 2021;22(2):e00121-21. DOI:10.1128/jmbe.00121-21 (in English)
- American Association for the Advancement of Science. Washington, DC. 2009 [accessed 2023 May 7]. Vision and change in biology undergraduate education, a call for action. Available from: <https://www.aaas.org/programs/inclusive-stemm-ecosystems-equity-diversity-iseed> (in English)
- ASM. ASM Agar Art Contest 2017. Washington DC:ASM [Internet]. 2017 [accessed 2023 Apr 2];2017. Available from: <https://asm.org/Events/ASM-Agar-Art-Contest/Home> (in English)
- Chan-Laddaran K. Scientists paint with bacteria to make art | KSL.com [Internet]. 2015 [accessed 2023 May 7]. Available from: <https://www.ksl.com/article/37046443/scientists-paint-with-bacteria-to-make-art> (in English)
- Charkoudian LK, Fitzgerald JT, Khosla C, Champlin A. In Living Color: Bacterial Pigments as an Untapped Resource in the Classroom and Beyond. *PLOS Biology.* 2010 Oct 5;8(10):e1000510. DOI: 10.1371/journal.pbio.1000510 (in English)
- Danna C. Stevenson University. 2017 [accessed 2023 Apr 2]. Biology Students Create Agar Art. Available from: <https://www.stevenson.edu/academics/undergraduate-programs/biology/blog-news-events/biology-students-create-agar-art/> DOI:10.1128/jmbe.00160-21 (in English)
- Dunn R. Painting With Penicillin: Alexander Fleming's Germ Art | Science | Smithsonian Magazine [Internet]. 2010 [accessed 2023 May 7]. Available from: <https://www.smithsonianmag.com/science-nature/painting-with-penicillin-alexander-flemings-germ-art-1761496/> (in English)
- Jefferies L, Giordano A., Hicks B. Agar Art as an Instructional Tool to Teach Inducible Promoters via Fluorescent Protein Expression | Journal of Chemical Education. *JChemEduc.* 2022;99(12):4181–5. DOI:<https://doi.org/10.1021/acs.jchemed.2c00004> (in English)
- Lontok K. Inspiring High School Students' Creativity and Design Thinking with Agar Art [Internet]. 2019 [accessed 2023 Apr 10]. Available from: <https://asm.org/Articles/2019/August/Inspiring-High-School-Students-Creativity-and-Desi> (in English)
- Mendez N, Jones C, Trinetta V. Food Protection Trends - May/June 2020 - Engaging Undergraduate Students in Food Safety Study and Food Microbiology Research. *Food Protection Trends.* 2020;40(3):164–70 (in English)
- Morris JJ, Adkins SJ. CureNET Course Based Undergraduate Research Experience. 2018 [accessed 2023 Apr 2]. The Art of Microbiology: an Agar Art Microbiology Lab CURE. Available from: <https://serc.carleton.edu/curenet/collection/216123.html> (in English)
- Smith MA. Science of Agar Art: Bringing Science and Art Together [Internet]. 2022 [accessed 2023 Aug 23]. Available from: <https://urfm.psu.edu/resources/opportunities/science-agar-art-bringing-science-and-art-together> (in English)
- Todorova, Dimitrov, T, Ivanova I, Muradov H, Spiridonova R, Nedelcheva R, et al. Innovations in teaching and learning microbiology – painting with pigment microorganisms. 2015 (in English)
- Torruellas Garcia J, López-Moreno K, Côté V, Crump K. Creating an Interdisciplinary Curriculum

---

within the Undergraduate Arts and Sciences through Agar Art. *J Microbiol Biol Educ.* 2022 Apr 29;23(1):e00160-21. DOI: 10.1128/jmbe.00160-21 (in English)

Wu, Brinkema, C, Peterson, M, Waltzer, A, Chowning J. STEAM Connections: Painting with Bacteria | *The American Biology Teacher* | University of California Press. *The American Biology Teacher.* 2018;80(4):305–7 (in English)

## CONTENTS

## PEDAGOGY

<b>P. Abdurazova, A. Ussenbay, M. Aldanazarova</b> ADVANCING INCLUSIVE EDUCATION: THE IMPACT AND POTENTIAL OF VIRTUAL LABORATORY SIMULATIONS FOR STUDENTS WITH DISABILITIES IN CHEMISTRY.....	5
<b>A.M. Abdykhalykova, A.K. Serdalina, G. Baigunissova</b> EFFECTIVENESS OF WEB 2.0 TESTING PROGRAMS IN TEACHING ENGLISH IN HIGHER EDUCATION INSTITUTIONS.....	23
<b>Zh.S. Assanova, Sh.M. Maigeldiyeva, Zh. Saparkyzy</b> POSSIBILITIES OF USING SMART TECHNOLOGIES IN THE TRAINING OF FUTURE TEACHERS.....	39
<b>A.E. Bitemirova, Sh.Zh. Mutalieva, K.Z. Kerimbaeva</b> STUDYING THE IMPORTANCE AND FEATURES OF USING VR IN CHEMISTRY LESSONS AT UNIVERSITIES.....	55
<b>Y. Gelişli, A. Kuralbayea, L. Kazykhankyzy</b> EXAMINING THE RELATIONSHIP BETWEEN UNDERGRADUATE STUDENTS' ATTITUDES TOWARDS THEIR LECTURERS AND ACADEMIC SELF-CONFIDENCE.....	68
<b>M.B. Dzhanaev, K.A. Baigutov</b> THEORETICAL PROBLEMS OF ETHNOAESTHETICS IN ART EDUCATION.....	79
<b>A. Duisembekova, A. Soltabayeva, A. Zhuravel, D. Kanayeva</b> INTEGRATION OF AN AGAR ART TO A RESEARCH-ORIENTED MICROBIOLOGY LABORATORY SYLLABUS.....	96
<b>M.M. Duisenova, A.N. Zhorabekova, T.A. Ainabekova</b> GAMIFICATION STRATEGIES IN PRIMARY SCHOOL ENGLISH CLASSES: ENHANCING MOTIVATION AND LANGUAGE ACQUISITION THROUGH DIGITAL GAMES.....	112
<b>D. Erdembekova, A. Issakyzy, B.K. Ospanova</b> THE INFLUENCE OF REGGIO PEDAGOGY ON THE DEVELOPMENT AND EDUCATION OF PRESCHOOL CHILDREN.....	129
<b>G.S. Yersultanova, R.K. Toleubekova, M.P. Asylbekova</b> FEATURES OF THE FORMATION OF PROFESSIONAL FUNCTIONS OF THE FUTURE SOCIAL PEDAGOGUE IN THE COURSE OF SCIENTIFIC AND PRACTICAL TRAINING.....	148

<b>N. Zhienbayeva, K. Zhumabay, A. Karabayeva</b> EFFECTIVE WAYS TO TEACH STUDENTS TO WRITE ESSAYS IN THE FORMATION OF READING AND WRITING LITERACY.....	170
<b>A.K. Kaldarova, M.A. Vasquez, T.A. Kulgildinova</b> IMPROVING ORAL PROFICIENCY IN STUDENTS THROUGH CASE STUDY-BASED PEDAGOGICAL APPROACHES.....	184
<b>B.S. Kapalbek, A.E. Kalenbekova</b> POSITIONS OF AKYMET BAITURSYNOV IN RELATION TO PRIMARY SCHOOL.....	196
<b>M.B. Kengessova, L. Demchenko</b> METAPHOR IN THE ASPECT OF SPEECH DEVELOPMENT OF SCHOOLCHILDREN IN GRADES 5-8.....	207
<b>Y.A. Kumarev, N.V. Mirza, Y. Gelişli</b> INSTAGRAM AS A TOOL FOR THE FORMATION AND DEVELOPMENT OF CRITICAL THINKING AMONG STUDENTS IN ENGLISH LESSONS.....	221
<b>G. Makharova</b> ENHANCING THE LINGUODIDACTIC POTENCIAL OF PRE-SERVICE PRIMARY SCHOOL TEACHERS THROUGH THE USE OF DIGITAL TOOLS.....	235
<b>A.Zh. Murzalinova, N.I. Pustovalova, N.T. Ualiyeva</b> THE PRACTICE OF INCLUSIVE EDUCATION IN THE INTEGRATION WITH CONTINUOUS PROFESSIONAL PROGRESS OF THE STUDENTS WITH SPECIAL EDUCATIONAL NEEDS.....	255
<b>S.K. Mussina, S.K. Mukanova, M.A. Serebryanikova</b> TEACHING FOREIGN LANGUAGE IN INCLUSIVE EDUCATIONAL ENVIRONMENT AT UNIVERSITY.....	271
<b>A. Tuzdybayeva1*, U. Kyakbayeva 1, Ayşe Dilek Öğretir Özçelik</b> THE PROBLEM OF DEVELOPING CRITICAL THINKING SKILLS IN PRESCHOOLERS.....	284
<b>N.Kh. Shadieva</b> EFFECTIVE METHODS OF ONLINE TEACHING KAZAKH LANGUAGE.....	297

## ECONOMICS

<b>Zh.M. Abuova, A.K. Akpanov, S.S. Abdildin</b> THE IMPACT OF FINANCIAL SUPPORT FOR ENTREPRENEURSHIP ON THE DEVELOPMENT OF SMALL AND MEDIUM-SIZED BUSINESSES IN KAZAKHSTAN.....	312
<b>Zh. Assylbekova, T. Apendiyev, Z. Aktamberdieva</b> RENEWAL AND REVIVAL OF NATIONAL INDUSTRIAL PERSONNEL OF KAZAKHSTAN (1991-2009).....	324
<b>K.T. Auyezova, A.A. Shametova, A.K. Yelemesov</b> SMALL BUSINESS AS A FACTOR IN THE DEVELOPMENT OF THE REGIONAL ECONOMY (USING THE EXAMPLE OF THE EAST KAZAKHSTAN REGION OF KAZAKHSTAN).....	344
<b>A.K. Bakenova, Dmitry V. Bakhteev</b> IMPROVING MECHANISMS OF MANAGERIAL DECISION-MAKING USING ARTIFICIAL INTELLIGENCE TECHNOLOGIES.....	363
<b>A.M. Yessirkepova, D.M. Makhmud, R.N. Serikova</b> STUDY OF NATURAL RESOURCES UTILIZATION IN AGRO- INDUSTRIAL COMPLEX WITHIN THE FRAMEWORK OF CHANGING CLIMATIC CONDITIONS.....	380
<b>N.N. Zhanakova, A.T. Кабиева, A.T. Karipova</b> REAL INCOMES OF THE POPULATION: CURRENT TRENDS AND CAUSES OF INEQUALITY.....	401
<b>A.T. Kokenova, J.S. Kazanbayeva, A.K. Kupesheva</b> RESEARCH OF THE DYNAMICS OF THE LIVESTOCK INDUSTRY DEVELOPMENT.....	414
<b>N. Mazhitova, M. Umirzakova, A. Abdimomynova</b> INTELLECTUAL CAPITAL AS A DRIVER OF ECONOMIC GROWTH.....	436
<b>L.M. Sembiyeva, A.A. Sharipbay, A.S. Turginbayeva</b> NEW TRENDS IN THE DEVELOPMENT OF FINANCIAL ANALYTICS OF AN EXCHANGE TRADER.....	449
<b>L. Taizhanov, Zh. Zhetibayev, A. Mutaliyeva</b> THE IMPACT OF ORGANIZATIONAL CULTURE ON EMPLOYEE MOTIVATION AND ITS ECONOMIC IMPLICATIONS FOR BUSINESS PERFORMANCE.....	460

**МАЗМҰНЫ**

**ПЕДАГОГИКА**

**П.А. Абдуразова, А.Ү. Үсенбай, М.Ш. Алданазарова**  
ИНКЛЮЗИВТІ БІЛІМ БЕРУДІ ІЛГЕРІЛЕТУ: МҮМКІНДІГІ ШЕКТЕУЛІ  
ОҚУШЫЛАРҒА АРНАЛҒАН ВИРТУАЛДЫ ХИМИЯ ЗЕРТХАНАСЫНЫҢ  
СИМУЛЯЦИЯСЫНЫҢ ӘСЕРІ МЕН ӘЛЕУЕТІ.....5

**А.М. Абдыхалыкова, А.К. Сердалина, Г. Байгунисова**  
ЖОҒАРЫ ОҚУ ОРЫНДАРЫНДА АҒЫЛШЫН ТІЛІН ОҚЫТУДА  
WEB 2.0 ТЕСТІЛЕУ БАҒДАРЛАМАЛАРЫНЫҢ ТИІМДІЛІГІ.....23

**Ж.С. Асанова, Ш.М. Майгельдиева, Ж. Сапарқызы**  
БОЛАШАҚ ПЕДАГОГТАРДЫ ДАЙЫНДАУДА СМАРТ  
ТЕХНОЛОГИЯЛАРДЫ ҚОЛДАНУ МҮМКІНДІКТЕРІ.....39

**А.Е. Битемирова, Ш.Ж. Мүталиева, К.З. Керимбаева**  
ЖОҒАРҒЫ ОҚУ ОРНЫНДА ХИМИЯ САБАҒЫНДА VR-ДЫ  
ҚОЛДАНУДЫҢ МАҢЫЗДЫЛЫҒЫН ЖӘНЕ ЕРЕКШЕЛІКТЕРІН  
ЗЕРТТЕУ.....55

**Ю. Гелишли, А. Күралбаева, Л. Қазыханқызы**  
БАКАЛАВРИАТ СТУДЕНТТЕРІНІҢ ӨЗ ОҚЫТУШЫЛАРЫНА ДЕГЕН  
КӨЗҚАРАСТАРЫ МЕН ӨЗІНЕ ДЕГЕН АКАДЕМИЯЛЫҚ СЕНІМДІЛІК  
АРАСЫНДАҒЫ БАЙЛАНЫСТЫ ЗЕРТТЕУ.....68

**М.Б. Джанаев, К.А. Байгутов**  
КӨРКЕМ БІЛІМДЕГІ ЭТНОЭСТЕТИКАНЫҢ ТЕОРИЯЛЫҚ  
МӘСЕЛЕЛЕРІ.....79

**А.Ж. Дүйсембекова, А.Д. Солтабаева, А. Журавель, Д.А. Канаева**  
АГАР АРТ-ТЫ МИКРОБИОЛОГИЯНЫ ЗЕРТТЕУГЕ БАҒЫТТАЛҒАН  
ЗЕРТХАНАЛЫҚ СИЛЛАБУСҚА ЕНГІЗУ.....96

**М.М. Дуйсенова, А.Н. Жорабекова, Т.А. Айнабекова**  
БАСТАУЫШ СЫНЫПТАРҒА АҒЫЛШЫН ТІЛІН ОҚЫТУДА  
ГЕЙМИФИКАЦИЯ СТРАТЕГИЯЛАРЫ: ЦИФРЛЫҚ ОЙЫНДАР АРҚЫЛЫ  
МОТИВАЦИЯ МЕН ТІЛДІ МЕНГЕРУДІ ЖЕТІЛДІРУ.....112

**Д.А. Ердембекова, А. Исақызы, Б.К. Оспанова**  
РЕДЖИО ПЕДАГОГИКАНЫҢ МЕКТЕП ЖАСЫНА ДЕЙІНГІ БАЛАНЫ  
ДАМУЫ МЕН ТӘРБИЕЛЕУГЕ ӘСЕРІ.....129



<b>Г.С. Ерсултанова, Р.К. Толеубекова, М.П. Асылбекова</b> ҒЫЛЫМИ-ПРАКТИКАЛЫҚ ДАЙЫНДЫҚ БАРЫСЫНДА БОЛАШАҚ ӘЛЕУМЕТТІК ПЕДАГОГТЫҢ КӘСІБИ ФУНКЦИЯЛАРЫН ҚАЛЫПТАСТЫРУ ЕРЕКШЕЛІКТЕРІ.....	148
<b>Н. Жиенбаева, К. Жұмабай, А. Карабаева</b> ОҚУШЫЛАРДЫҢ ОҚУ ЖӘНЕ ЖАЗУ САУАТТЫЛЫҚТАРЫН ҚАЛЫПТАСТЫРУДА ЭССЕ ЖАЗУҒА ҮЙРЕТУДІҢ ТИІМДІ ТӘСІЛДЕРІ.....	170
<b>А.К. Калдарова, М.А. Васкес, Т.А. Кульгильдинова</b> КЕЙС-СТАДИ ӘДІСІНЕ НЕГІЗДЕЛГЕН ПЕДАГОГИКАЛЫҚ ТӘСІЛДЕР АРҚЫЛЫ СТУДЕНТТЕРДІҢ АЙТЫЛЫМ ДАҒДЫЛАРЫНЫҢ ДЕҢГЕЙІН ЖЕТІЛДІРУ.....	184
<b>Б.С. Қапалбек, А.Е. Каленбекова</b> АҚЫМЕТ БАЙТҰРСЫНҰЛЫНЫҢ БАСТАУЫШ МЕКТЕПКЕ ҚАТЫСТЫ ҰСТАНЫМДАРЫ.....	196
<b>М.Б. Кеңесова, Л.Н. Демченко</b> 5-8-СЫНЫП ОҚУШЫЛАРЫНЫҢ СӨЙЛЕУІН ДАМЫТУ АСПЕКТІСІНДЕГІ МЕТАФОРА.....	207
<b>Я.А. Кумарев, Н.В. Мирза, Ю. Гелишли</b> INSTAGRAMДЫ АҒЫЛШЫН ТІЛІ САБАҒЫНДА ОҚУШЫЛАРДЫҢ СЫНИ ОЙЛАУЫН ҚАЛЫПТАСТЫРУ ЖӘНЕ ДАМЫТУ ҚҰРАЛЫ РЕТІНДЕ ПАЙДАЛАНУ.....	221
<b>Г.С. Махарова</b> ЦИФРЛЫҚ ҚҰРАЛДАРДЫ ПАЙДАЛАНУ АРҚЫЛЫ БОЛАШАҚ БАСТАУЫШ МЕКТЕП МҰҒАЛІМДЕРІНІҢ ЛИНГВОДИДАКТИКАЛЫҚ ӘЛЕУЕТІН АРТТЫРУ.....	235
<b>А.Ж. Мурзалинова, Н.И. Пустовалова, Н.Т. Уалиева</b> ЕРЕКШЕ БІЛІМ БЕРУ ҚАЖЕТТІЛІГІ БАР СТУДЕНТТЕРДІҢ ҮЗДІКСІЗ КӘСІБИ ДАМУЫН ИНКЛЮЗИВТІ БІЛІМ БЕРУМЕН ИНТЕГРАЦИЯЛАУ ТӘЖІРИБЕСІ.....	255
<b>С.Қ. Мусина, С.Қ. Мұқанова, М.А. Серебряникова</b> УНИВЕРСИТЕТТЕ ИНКЛЮЗИВТІ БІЛІМ БЕРУ ОРТАСЫНДА ШЕТ ТІЛІН ОҚЫТУ.....	271

**А.Т. Туздыбаева, У.Қ. Қыяқбаева, Ayşe Dilek Öğretir Özçelik**  
МЕКТЕП ЖАСЫНА ДЕЙІНГІ БАЛАЛАРДА СЫНИ ТҮРҒЫДАН  
ОЙЛАУ ДАҒДЫЛАРЫН ДАМУ МӘСЕЛЕСІ.....284

**Н.Х. Шадиева**  
ҚАЗАҚ ТІЛІН ОНЛАЙН ОҚЫТУДЫҢ ТИІМДІ ӘДІСТЕРІ.....297

### **ЭКОНОМИКА**

**Ж.М. Абуова, А.К. Акпанов, С.С. Абдильдин**  
ҚАЗАҚСТАНДА ШАҒЫН ЖӘНЕ ОРТА БИЗНЕСТІ ДАМУҒА  
КӘСІПКЕРЛІКТІ ҚАРЖЫЛЫҚ ҚОЛДАУДЫҢ ӘСЕРІ.....312

**Ж. Асылбекова, Т. Әпендиев, З. Ақтамбердиева**  
ҚАЗАҚСТАН ИНДУСТРИЯСЫНЫҢ ҰЛТТЫҚ КАДРЛАРЫН ЖАҒАРТУ  
ЖӘНЕ ҚАЙТА ЖАҒҒЫРТУ (1991-2009 жж.).....324

**К.Т. Ауезова, А.А. Шаметова, Ә.К. Елемесов**  
ШАҒЫН БИЗНЕС ӨНІРЛІК ЭКОНОМИКАНЫҢ ДАМУ ФАКТОРЫ  
РЕТІНДЕ (ШЫҒЫС ҚАЗАҚСТАН ОБЛЫСЫНЫҢ МЫСАЛЫНДА).....344

**А.К. Бакенова, Д.В. Бахтеев**  
ЖАСАНДЫ ИНТЕЛЛЕКТ ТЕХНОЛОГИЯЛАРЫН ПАЙДАЛАНА  
ОТЫРЫП БАСҚАРУШЫЛЫҚ ШЕШІМДЕР ҚАБЫЛДАУ ТЕТІКТЕРІН  
ЖЕТІЛДІРУ.....363

**А.М. Есиркепова, Д.М. Махмуд, Р.Н. Серикова**  
КЛИМАТТЫҚ ЖАҒДАЙЛАРДЫҢ ӨЗГЕРУІ ШЕҢБЕРІНДЕ  
АГРОӨНЕРКӘСІПТІК КЕШЕНДЕ ТАБИҒИ РЕСУРСТАРДЫ  
ПАЙДАЛАНУДЫ ЗЕРТТЕУ.....380

**Н.Н. Жанакоева, А.Т. Кабиева, А.Т. Карипова**  
ХАЛЫҚТЫҢ НАҚТЫ КІРІСТЕРІ: ТЕҢСІЗДІКТІҢ ҚАЗІРГІ  
ТЕНДЕНЦИЯЛАРЫ МЕН СЕБЕПТЕРІ.....401

**А.Т. Көкенова, Ж.С. Казанбаева, А.К. Купешева**  
МАЛ ШАРУАШЫЛЫҒЫ САЛАСЫНЫҢ ДАМУ ДИНАМИКАСЫН  
ЗЕРТТЕУ.....414

**Н.Ә. Мәжитова, М.А. Умирзакова, А.Ш. Абдимомынов**  
ЗИЯТКЕРЛІК КАПИТАЛ ЭКОНОМИКАЛЫҚ ӨСІМНІҢ  
ДРАЙВЕРІ РЕТІНДЕ.....436

---

**Л.М. Сембиева, А.Ә. Шәріпбай, А.С. Тургинбаева**  
БИРЖАЛЫҚ ТРЕЙДЕРДІҢ ҚАРЖЫЛЫҚ АНАЛИТИКАСЫН  
ДАМУ ТУДАҢ ЖАҢА ТЕНДЕНЦИЯЛАРЫ.....449

**Л.Т. Тайжанов, Ж.К. Жетібаев, А.А.Мугалиева**  
ҰЙЫМДЫҚ МӘДЕНИЕТТІҢ ҚЫЗМЕТКЕРЛЕР МОТИВАЦИЯСЫНА  
ӘСЕРІ ЖӘНЕ БИЗНЕСТІҢ НӘТИЖЕЛІЛІГІ ҮШІН ЭКОНОМИКАЛЫҚ  
САЛДАРЫ.....460

**СОДЕРЖАНИЕ**

**ПЕДАГОГИКА**

- П.А. Абдуразова, А.У. Усенбай, М.Ш. Алданазарова**  
ПРОДВИЖЕНИЕ ИНКЛЮЗИВНОГО ОБРАЗОВАНИЯ: ВЛИЯНИЕ И  
ПОТЕНЦИАЛ ВИРТУАЛЬНЫХ ЛАБОРАТОРНЫХ СИМУЛЯЦИЙ ПО  
ХИМИИ ДЛЯ УЧАЩИХСЯ С ОГРАНИЧЕННЫМИ  
ВОЗМОЖНОСТЯМИ.....5
- А.М. Абдыхалыкова, А.К. Сердалина, Г. Байгунисова**  
ЭФФЕКТИВНОСТЬ ПРОГРАММ ТЕСТИРОВАНИЯ WEB 2.0 ПРИ  
ОБУЧЕНИИ АНГЛИЙСКОМУ ЯЗЫКУ В ВЫСШИХ УЧЕБНЫХ  
ЗАВЕДЕНИЯХ.....23
- Ж.С. Асанова, Ш.М. Майгельдиева, Ж. Сапаркызы**  
ВОЗМОЖНОСТИ ПРИМЕНЕНИЯ СМАРТ-ТЕХНОЛОГИЙ В  
ПОДГОТОВКЕ БУДУЩИХ ПЕДАГОГОВ.....39
- А.Е. Битемирова, Ш.Ж. Муталиева, К.З. Керимбаева**  
ИЗУЧЕНИЕ ВАЖНОСТИ И ОСОБЕННОСТЕЙ ИСПОЛЬЗОВАНИЯ VR  
НА УРОКАХ ХИМИИ В ВУЗАХ.....55
- Ю. Гелишли, А. Куралбаева, Л. Казыханкызы**  
ИЗУЧЕНИЕ ВЗАИМОСВЯЗИ МЕЖДУ ОТНОШЕНИЕМ СТУДЕНТОВ  
БАКАЛАВРИАТА К СВОИМ ПРЕПОДАВАТЕЛЯМ И АКАДЕМИЧЕСКОЙ  
УВЕРЕННОСТЬЮ В СЕБЕ.....68
- М.Б. Джанаев, К.А. Байгутов**  
ТЕОРЕТИЧЕСКИЕ ПРОБЛЕМЫ ЭТНОЭСТЕТИКИ В  
ХУДОЖЕСТВЕННОМ ОБРАЗОВАНИИ.....79
- А.Ж. Дуйсембекова, А.Д. Солтабаева, А. Журавель, Д.А. Канаева**  
ИНТЕГРАЦИЯ АГАР АРТ В СИЛЛАБУС В ИССЛЕДОВАТЕЛЬСКО-  
ОРИЕНТИРОВАННЫЕ ЛАБОРАТОРНЫЕ ЗАНЯТИЯ  
ПО МИКРОБИОЛОГИИ.....96
- М.М. Дуйсенова, А.Н. Жорабекова, Т.А. Айнабекова**  
СТРАТЕГИИ ГЕЙМИФИКАЦИИ НА УРОКАХ АНГЛИЙСКОГО ЯЗЫКА В  
НАЧАЛЬНОЙ ШКОЛЕ: ПОВЫШЕНИЕ МОТИВАЦИИ И  
ЭФФЕКТИВНОСТИ ОБУЧЕНИЯ С ПОМОЩЬЮ ЦИФРОВЫХ ИГР.....112
- Д.А. Ердембекова, А. Исакызы, Б.К. Оспанова**  
ВЛИЯНИЕ РЕДЖИО ПЕДАГОГИКИ НА РАЗВИТИЕ И ВОСПИТАНИЕ  
ДЕТЕЙ ДОШКОЛЬНОГО ВОЗРАСТА.....129

---

<b>Г.С. Ерсултанова, Р.К. Толеубекова, М.П. Асылбекова</b> ОСОБЕННОСТИ ФОРМИРОВАНИЯ ПРОФЕССИОНАЛЬНЫХ ФУНКЦИЙ БУДУЩЕГО СОЦИАЛЬНОГО ПЕДАГОГА В ХОДЕ НАУЧНО- ПРАКТИЧЕСКОЙ ПОДГОТОВКИ.....	148
<b>Н. Жиенбаева, К. Жумабай, А. Карабаева</b> ЭФФЕКТИВНЫЕ СПОСОБЫ ОБУЧЕНИЯ НАПИСАНИЮ ЭССЕ ПРИ ФОРМИРОВАНИИ ЧИТАТЕЛЬСКОЙ ГРАМОТНОСТИ И ПИСЬМЕННОЙ РЕЧИ УЧАЩИХСЯ.....	170
<b>А.К. Калдарова, М.А. Васкес, Т.А. Кульгильдинова</b> СОВЕРШЕНСТВОВАНИЕ РАЗГОВОРНЫХ НАВЫКОВ СТУДЕНТОВ С ПОМОЩЬЮ МЕТОДИЧЕСКИХ ПОДХОДОВ, ОСНОВАННЫХ НА КЕЙС-СТАДИ.....	184
<b>Б.С. Капалбек, А.Е. Каленбекова</b> ПОЗИЦИИ АКЫМЕТА БАЙТУРСЫНОВА ПО ОТНОШЕНИЮ К НАЧАЛЬНОЙ ШКОЛЕ.....	196
<b>М.Б. Кенесова, Л.Н. Демченко</b> МЕТАФОРА В АСПЕКТЕ РЕЧЕВОГО РАЗВИТИЯ ШКОЛЬНИКОВ 5-8 КЛАССОВ.....	207
<b>Я.А. Кумарев, Н.В. Мирза, Ю. Гелишли</b> INSTAGRAM КАК ИНСТРУМЕНТ ФОРМИРОВАНИЯ И РАЗВИТИЯ КРИТИЧЕСКОГО МЫШЛЕНИЯ У УЧАЩИХСЯ НА УРОКАХ АНГЛИЙСКОГО ЯЗЫКА.....	221
<b>Г.С. Махарова</b> ПОВЫШЕНИЕ ЛИНГВОДИДАКТИЧЕСКОГО ПОТЕНЦИАЛА БУДУЩИХ УЧИТЕЛЕЙ НАЧАЛЬНОЙ ШКОЛЫ ПУТЕМ ИСПОЛЬЗОВАНИЯ ЦИФРОВЫХ ИНСТРУМЕНТОВ.....	235
<b>А.Ж. Мурзалинова, Н.И. Пустовалова, Н.Т. Уалиева</b> ПРАКТИКА ИНКЛЮЗИВНОГО ОБРАЗОВАНИЯ В ИНТЕГРАЦИИ С НЕПРЕРЫВНЫМ ПРОФЕССИОНАЛЬНЫМ РАЗВИТИЕМ СТУДЕНТОВ С ОСОБЫМИ ОБРАЗОВАТЕЛЬНЫМИ ПОТРЕБНОСТЯМИ.....	255
<b>С.К. Мусина, С.К. Муканова, М.А. Серебряникова</b> ОБУЧЕНИЕ ИНОСТРАННОМУ ЯЗЫКУ В ИНКЛЮЗИВНОЙ ОБРАЗОВАТЕЛЬНОЙ СРЕДЕ УНИВЕРСИТЕТА.....	271

**А.Т. Туздыбаева, У.К. Кыякбаева, Ауşe Dilek Öğretir Özçelik**  
ПРОБЛЕМА РАЗВИТИЯ НАВЫКОВ КРИТИЧЕСКОГО МЫШЛЕНИЯ  
У ДОШКОЛЬНИКОВ.....284

**Н.Х. Шадиева**  
ЭФФЕКТИВНЫЕ МЕТОДЫ ОНЛАЙН-ОБУЧЕНИЯ КАЗАХСКОМУ  
ЯЗЫКУ.....297

### ЭКОНОМИКА

**Ж.М. Абуова, А.К. Акпанов, С.С. Абдильдин**  
ВЛИЯНИЕ ФИНАНСОВОЙ ПОДДЕРЖКИ ПРЕДПРИНИМАТЕЛЬСТВА  
НА РАЗВИТИЕ МАЛОГО И СРЕДНЕГО БИЗНЕСА  
В КАЗАХСТАНЕ .....312

**Ж. Асылбекова, Т. Апендиев, З. Ақтамбердиева**  
ОБНОВЛЕНИЕ И ВОЗРОЖДЕНИЕ НАЦИОНАЛЬНЫХ  
ИНДУСТРИАЛЬНЫХ КАДРОВ КАЗАХСТАНА (1991-2009 гг.) .....324

**К.Т. Ауезова, А.А. Шаметова, А.К. Елемесов**  
МАЛЫЙ БИЗНЕС КАК ФАКТОР РАЗВИТИЯ РЕГИОНАЛЬНОЙ  
ЭКОНОМИКИ (НА ПРИМЕРЕ ВОСТОЧНО-КАЗАХСТАНСКОЙ  
ОБЛАСТИ КАЗАХСТАНА).....344

**А.К. Бакенова, Д.В. Бахтеев**  
СОВЕРШЕНСТВОВАНИЕ МЕХАНИЗМОВ ПРИНЯТИЯ  
УПРАВЛЕНЧЕСКИХ РЕШЕНИЙ С ИСПОЛЬЗОВАНИЕМ ТЕХНОЛОГИЙ  
ИСКУССТВЕННОГО ИНТЕЛЛЕКТА.....363

**А.М. Есиркепова, Д.М. Махмуд, Р.Н. Серикова**  
ИССЛЕДОВАНИЕ ИСПОЛЬЗОВАНИЯ ПРИРОДНЫХ РЕСУРСОВ В  
АГРОПРОМЫШЛЕННОМ КОМПЛЕКСЕ В РАМКАХ ИЗМЕНЕНИЯ  
КЛИМАТИЧЕСКИХ УСЛОВИЙ.....380

**Н.Н. Жанакоева, А.Т. Кабиева, А.Т. Карипова**  
РЕАЛЬНЫЕ ДОХОДЫ НАСЕЛЕНИЯ: СОВРЕМЕННЫЕ ТЕНДЕНЦИИ  
И ПРИЧИНЫ НЕРАВЕНСТВА.....401

**А.Т. Кокенова, Ж.С. Казанбаева, А.К. Купешева**  
ИССЛЕДОВАНИЕ ДИНАМИКИ РАЗВИТИЯ ОТРАСЛИ  
ЖИВОТНОВОДСТВА.....414

---

<b>Н.А. Мажитова, М.А. Умирзакова, А.Ш. Абдимомынова</b> ИНТЕЛЛЕКТУАЛЬНЫЙ КАПИТАЛ КАК ДРАЙВЕР ЭКОНОМИЧЕСКОГО РОСТА.....	436
<b>Л.М. Сембиева, А.А. Шарипбай, А.С. Тургинбаева</b> НОВЫЕ ТЕНДЕНЦИИ РАЗВИТИЯ ФИНАНСОВОЙ АНАЛИТИКИ БИРЖЕВОГО ТРЭЙДЕРА.....	449
<b>Л.Т. Тайжанов, Ж.К. Жетибаев, А.А. Муталиева</b> ВЛИЯНИЕ ОРГАНИЗАЦИОННОЙ КУЛЬТУРЫ НА МОТИВАЦИЮ СОТРУДНИКОВ И ЕЕ ЭКОНОМИЧЕСКИЕ ПОСЛЕДСТВИЯ ДЛЯ ЭФФЕКТИВНОСТИ БИЗНЕСА.....	460

## **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 work described 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 originality detection service Cross Check <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 сайте:

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

**ISSN 2518–1467 (Online),**

**ISSN 1991–3494 (Print)**

**<http://www.bulletin-science.kz/index.php/en>**

Директор отдела издания научных журналов НАН РК *А. Ботанқызы*

Редакторы: *Д.С. Аленов, Ж.Ш. Әден*

Верстка на компьютере *Г.Д. Жадыранова*

Подписано в печать 28.02.2025.

Формат 60x881/8. Бумага офсетная. Печать - ризограф.

41,0 п.л. Заказ 1.