Brief information about the project

Name of the project	AP19679560 «Development of new polymeric materials with antimicrobial properties for the treatment of various surfaces»
Relevance	In recent years, synthesis of new polymers and modification of known one has become more relevant than ever. The reason is poor epidemiological situation in the world due to spread of coronavirus; high risk of infection in public places; development of resistance by microorganisms to most antibiotics; toxicity and irritant effects of commonly used biocides. Antimicrobial polymers could inhibit or kill the growth of bacteria, protozoa and fungi. In this regard, development of new non-toxic, biocompatible antimicrobial materials for treatment of various surfaces based on polymers and their complexes with biocides is in great demand. Spread of microorganisms that cause pandemic, growth of multidrug resistance of microbes, high mortality and serious economic problems in the world determine the importance sanitization of contact surfaces and development of new effective antimicrobial materials.
Purpose	Aim of the project is creation new polymers and their complexes with antimicrobial properties.
Objectives	1) study the mechanism of interaction of N-containing hydrophilic and bicompatible polymers (e.c., poly(2-ethyl-2-oxazoline), poly(2-methyl-2-oxazoline), poly(2-propyl-2-oxazoline), polyacrylamide, polyvinylacetamide) with various biocides (iodine, thymol/corvacrol) by various physico-chemical methods (UV, IR Raman spectroscopy, viscometry, titration, isothermal titration calorimetry, dynamic light scattering (DLS), thermal methods analysis, etc.) in order to obtain a basis for the development of new highly effective and non-toxic antimicrobial agents; 2) obtaining new ionenes based on polyoxazolines using the Menshutkin reaction – alkylation of tertiary amines with alkyl halides to form quaternary ammonium salts [2], in order to create new biocompatible polymers with antimicrobial properties for use as highly effective and nontoxic antimicrobial agents. Characterization of obtained ionenes by modern physico-chemical methods (NMR, IR, Raman spectroscopy, X-ray diffraction, differential scanning calorimetry (DSC), etc.) to determine their chemical composition and structure; 3) synthesis of new compounds with a Schiff base by reacting amino groups containing substances (e.c., aminopropyltrimethoxysilane) with antimicrobial aldehydes (e.c., anisaldehyde, chlorobenzaldehyde) to improve solubility and reduce volatility of hydrophobic biocides and obtain new efficient polymer nanoparticles (NPs) with biocidal properties. Obtained NPs can be used to create antimicrobial compositions for treatment of various surfaces. Characterization of obtained compounds by modern physico-chemical methods of analysis

	(NMR, IR spectroscopy, thermogravimetric analysis (TGA, DSC, DLS, etc.); 4) obtaining antimicrobial polymer compositions in the form of gels and solutions based on complexes of N-containing polymers and various biocides; new ionenes; modified polymers with biocides in composition. Determination of various physico-chemical properties (pH, viscosity, colloidal stability, swelling, etc.), release rate of biocides from polymeric materials, study of their transdermal penetrating ability through the skin of animals, determination of exposure time of polymer compositions on surfaces (animal skin, metal and plastic). Obtained results will allow to develop effectiveness and convenient antimicrobial materials with optimal characteristics; 5) study of antimicrobial properties of obtained new polymers and their complexes with various biocides using microbiological methods of analysis (determination of zone of inhibition of the growth of microorganisms, method of multiple dilution, etc.) against *Escherichia coli, E. coli, Staphylococcus aureus, Streptococcus spp, Bacillus anthracis, Bacillus cereus, Burkholderia cenocepacia*, etc. and SARS COV-2 virus; 6) conducting experiments to determine cytotoxicity using MTT analysis (determination of cell viability and proliferation) to establish the safety of using new polymers and their complexes as antimicrobial materials; 7) conducting tests to determine the local irritant, skin-resorptive action and toxicity to establish safety of using of obtained new polymeric biocidal agents.
Expected and achieved results	1) creation of new antimicrobial compositions for the treatment of various surfaces based on new polymer complexes with natural biocides and iodophors, new polycations with a quaternary ammonium group, and new nanoparticles containing aldehydes of essential oils. The resulting materials will be biocompatible, non-toxic and with a prolonged action. 2) establishment patterns of complexation of some synthetic and natural N-containing polymers with biocides (iodine, natural polyphenols); establishing the influence of the length of the alkyl group of N-containing polyoxazolines on the reaction of modification with some alkyl halides and the properties of the resulting ionenes; determining the mechanism of formation of NPs based on amino-containing compounds with EO aldehydes in order to improve the solubility and reduce the volatility of the latter and obtain NPs with biocidal properties; establishing patterns of loading and release of biocidal compounds from polymeric compositions; determination of the exposure time of the obtained antimicrobial gel and liquid polymer compositions on various surfaces; determination of the main characteristics (viscosity, pH, homogeneity, swelling capacity, thixotropic properties, transdermal activity, etc.).

	3) production of antimicrobial polymers and their compositions that are biocompatible, non-toxic and with a prolonged release of antimicrobial components; establishing the effectiveness of their use as antiviral drugs in relation to coronavirus and antibacterial drugs in relation to pathogens of 3 and 4 hazard groups; definition of safety of use. The resulting polymeric materials can be further recommended for use as antimicrobial agents. 4) to publish 2 (two) articles and (or) reviews will be published in peer-reviewed scientific journals indexed in the Science Citation Index Expanded and included in 1 (first) and (or) 2 (second) quartile by impact factor in the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 65 (sixty-five). 5) to publish 1 (one) article or review in a peer-reviewed foreign or domestic publication recommended by the CQASHE.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Irmukhametova Galiya S. – Scientific Supervisor, Chief Researcher Researcher ID AF-1026-2019 Scopus Author ID 22979722000 ORCID 0000-0002-1264-7974 2. Kaldybekov Daulet B. – Leading Researcher Researcher ID F-1321-2014 Scopus Author ID 55975396000 ORCID 0000-0002-7191-5465 3. Kenessova Zarina A. – Senior Researcher 4. Toktabayeva Assel K. – Senior Researcher 5. Nurpeissova Zhansaya A. – Senior Researcher Researcher ID A-4682-2015 Scopus Author ID 55882717400 ORCID 0000-0003-0065-8163 6. Kazybayeva Diara S. - Senior Researcher Researcher ID AAQ-9511-2020 ORCID 0000-0002-2935-6815 Scopus Author ID 57208255130 7. Makhayeva Danelya N. –Researcher Researcher ID E-9866-2016 ORCID 0000-0003-1250-9587 Scopus Author ID 57417199600 8. Alikulov Adilet Zh. – Researcher Scopus Author ID: 57208745138 ORCID: 0000-0003-0380-0612
List of publications with links to them	1. Danelya N. Makhayeva, Galiya S. Irmukhametova, Vitaliy V. Khutoryanskiy Advances in antimicrobial polymeric iodophors// Eur. Polym. J. – 2023. - V. 201, №15. –P. 112573. https://doi.org/10.1016/j.eurpolymj.2023.112573
Patents	-