## Brief information about the project

Name of the project	AP09260629 "Setting of conditions for applying antibacterial coatings on the surfaces of suture and biomedical materials"
Relevance	The scientific project is aimed at developing antibacterial coatings on the surface of surgical suture materials. This is associated with an increased risk of complications due to bacterial contamination, especially during prosthetics and surgical operations. Suture material, like most implants, has a non-detachable surface to which bacteria can attach, forming bacterial biofilms and thereby complicating the course of treatment. Because of such treatments, this is a difficult moral and expensive financial burden for the patient, and in some cases, even fatal. Therefore, an important task in implantology is antibacterial protection of the surface of medical and biological products.
Purpose	Development of physico-chemical conditions for applying antibacterial coatings using the multilayer assembly method on the surface of sutures and biomedical materials (protective fabrics for gowns, bandages) to improve functional properties based on biocompatible, environmentally friendly polysaccharides in the form of nanocoatings containing bioactive agents or silver nanoparticles in multilayers.
Objectives	A way to achieve the project goal through the following logically interconnected sequential tasks: 1. To carry out a scientifically based selection of medical absorbable and non-absorbable surgical sutures and protective materials for medical and biological purposes, to study the influence of temperature, pH of the environment, solvents on the form of their presence in solutions under which modification of their surfaces is expected. 2. Conduct a scientifically based selection of bioactive compounds (natural and synthetic biodegradable polysaccharides) and methods for producing silver nanoparticles. To study the influence of temperature, pH and concentration on the viscosity and electrical conductivity of selected polyelectrolytes (polymer matrices of multilayers) to substantiate the active functional groups of selected bioactive agents for participation in the formation of nanofilms. 3. Establishment of physicochemical conditions to produce nanocoatings based on selected polyelectrolytes (polysaccharides) using the multilayer assembly method, taking into account the influence of temperature, pH of the environment, thickness of bilayers and the nature of the solvent. Study of the physical and chemical characteristics of films: thickness, SEM, IR spectra. Establishment of optimal conditions for methods of applying antibacterial agents and silver nanoparticles to the resulting multilayers and study of physicochemical characteristics: thickness, nature of silver nanoparticles, SEM and IR spectra of the resulting antibacterial coatings.

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	agents and Ag nanoparticles will be determined against the	
	pathogenic microorganisms Candida albicans, Escherichia coli	
	and Staphylococcus aureus.	
Expected and achieved	Achieved results:	
results	1. A scientifically based selection of medical absorbable and non-	
	absorbable surgical sutures, widely used in domestic medicine in	
	Kazakhstan, was carried out. Non-absorbable monofilament	
	threads - polypropylene, synthetic non-absorbable multifilament	
	twisted threads - polyamide, absorbable braided threads -	
	rumacryl, non-absorbable braided threads - rumasan, absorbable	
	natural threads - catgut. Chitosan and sodium	
	carboxymethylcellulose (CMC) were used as polymer matrices	
	for nanofilms.	
	2. Optimal conditions for obtaining nanocoatings for all types of	
	surgical sutures was developed; the optimal number of bilayers is	
	10.5 at a temperature of 37 °C, pH 3 for chitosan and 5 for CMC.	
	For nanocoatings in model samples, the influence of pH and	
	concentration on the thickness of the films and the nature of the	
	solvent were studied. Antibacterial agents were applied by	
	impregnation of films at 37 °C for 24 hours.	
	3. Study of the antibacterial activity of all modified surgical	
	sutures containing chlorhexidine after 24 hours of incubation at 37	
	°C and high humidity (~80%) showed a good zone of inhibition	
	against the museum test strain Staphylococcus epidermidis,	
	Streptococcus pneumoniae, Klebsiella pneumoniae.	
	4. Physicochemical conditions for obtaining nanocoatings on the	
	surface of medical fabrics was developed.	
	The results of the antimicrobial activity of the obtained medical	
	fabric samples were carried out in vitro against two types of	
	widespread bacteria, Escherichia coli and S. Aureus.	
	The project was successfully implemented, the results were	
	published in the form of an article in Q1 indexed journal, a utility	
	model patent was obtained, and an invention patent was filed. The	
	results were presented at the exhibition in Urumqi Xinjiang	
	University of the People's Republic of China.	
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Researcher ID, ORCID, if	Catalysis and Petrochemistry h-index-5, https://orcid.org/0000-	
available) and links to	<u>0001-9954-8575</u> , Scopus ID=55340038000; ResearcherID: ABE-	
relevant profiles	7029-2021.	
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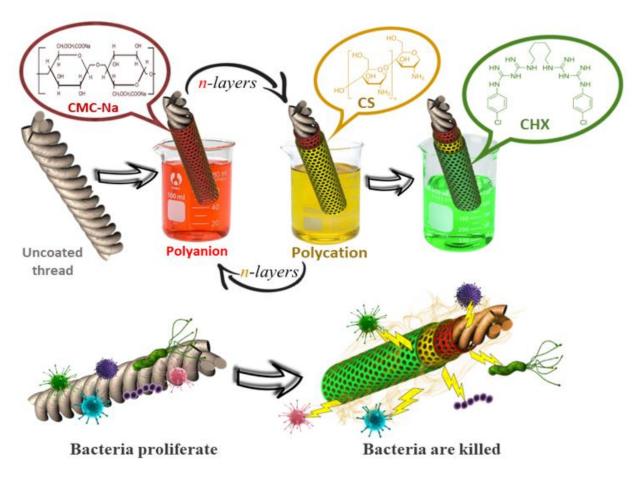
	Department of Physical Chemistry of Catalysis and Petrochemistry <u>https://orcid.org/0000-0002-8096-1068</u> . 5. Seydulayeva Ayazhan Alpeiskyzy, bachelor, specialist of the department of physical chemistry, catalysis and petrochemistry of KazNU named after al-Farabi, <u>https://orcid.org/0000-0002-7972-9624</u> . 6. Sailau Aruzhan Galymkyzy, bachelor, specialist of the department of physical chemistry, catalysis and petrochemistry of KazNU named after al-Farabi, <u>https://orcid.org/0000-0002-6174-</u>			
List of publications with links to them	5431.1. Rakhmatullayeva, D., Ospanova, A., Bekissanova, Z., Jumagaziyeva, A., Savdenbekova, B., Seidulayeva, A., & Sailau, A. (2023). Development and characterization of antibacterial coatings on surgical sutures based on sodium carboxymethyl cellulose/chitosan/chlorhexidine. International Journal of Biological Macromolecules, 2023. Vol. 236. P. 124024. Процентиль 91% (Q1). IF=8.2; https://doi.org/10.1016/j.ijbiomac.2023.124024.2. A.A. Toksanbay, Zh.B. Bekissanova (Kubasheva), D.T. Rakhmatullaeva, B.E. Savdenbekova, A.K. Ospanova, D.Zh. Batyrbayeva, N.F. Uvarov // Preparation of the antibacterial coatings based on natural mineral materials// International Journal of Biology and Chemistry 14, № 1, 184 (2021). https://doi.org/10.26577/ijbch.2021.v14.i1.021			
Patents	1. Patent RK No. 6760 for the useful model "Method of obtaining an antibacterial coating on the surface of surgical suture threads "//Ospanova A.K., Rakhmatullaeva D.T. Kubasheva Zh.B., Batyrbayeva D.J., Abdurazakov U. 15.12. 2021, No. 2021/0223.2.			

## **PUBLICATIONS AND PATENTS**



-12032534	Contents lists avai	lable at ScienceDirect	Budepial		
2-51-51 <sup>+</sup>	International Journal of	Biological Macromolecules	Machinolec		
E. She			200		
ELSEVIER	journal homepage: www	alsevier.com/locate/ijbiomac	10000		
Development	and characterization of antil	pacterial coatings on surgical	Charls for application		
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Dilafruz Rakhma	atullaveva <sup>a,b</sup> , Aliva Ospanova <sup>a,b,*</sup> , Zh	anar Bekissanova <sup>a, b</sup> .			
		zhan Seidulayeva <sup>a, b</sup> , Aruzhan Sailau <sup>a, b</sup>			
* Faculty of Chemistry and C	Chemical Technology, Al-Forabi Kazakh National University, Alma al Methodu of Research and Analysis, Almaty 050012, Kazakhata	ny 050040, Kazakhuan			
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ARTICLEINFO	ABSTRACT				
Keywords: Surgical sutures		(LBL) method was used in this work to apply antibacterial coa	tings to the surfa		
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Layer-by-layer assembly	Polyethylene terephthalate	Polyethylene terephthalate and polyamide surgical sutures were used as the substrate. At pH 5, this, uniform coatines with the ideal number of biopolymers in the film (10 bilavers) are produc			
	The pH and the shape of th	The pH and the shape of the polyelectrolyte macromolecules determine the film's thickness and form.			
		The morphology of the surface and the structure of the sutures after modification become homogeneous s smooth. Both treated and untreated sutures setain their mechanical strength, and there is no significant loss			
	tensile strength.				
	Nanofilms obtained on th	e susface of the sutures showed high antimicrobial efficacy ag rizhis coli, Klebsiella pneumonioe, Staphylococcus epidermidis, a			
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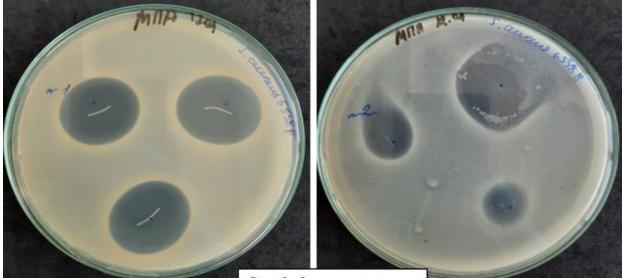
The scheme of obtaining antibacterial coatings



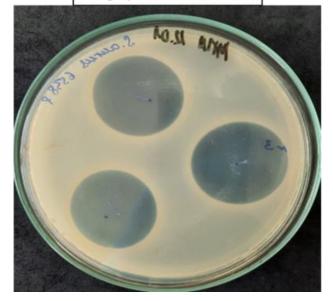
Participation in the exhibition in Urumqi



Conducting an analysis of antibacterial activity



Staphylococcus aureus



The results of the analysis of antibacterial activity