

PhD STUDIES COURSE UNIT DESCRIPTION

Name of subject	Field of science, code	Faculty / Center	Department
Application of nanomaterials in bioanalytical chemistry	Chemistry N 003	Faculty of Chemistry and Geosciences, Institute of Chemistry	Department of Analytical and Environmental Chemistry
Student's workload	Credits	Student's workload	Credits
Lectures		Consultations	3
Independent study	7	Seminars	

Course annotation

Nanomaterials are widely applied in many scientific fields, including bioanalytical chemistry. Due to their unique physical, chemical, and biological properties, nanomaterials improve analytical methods' sensitivity, selectivity and reliability. They allow for the simultaneous determination of multiple analytes in a small sample volume. PhD students seeking to deepen their knowledge in this area are assigned the task of preparing a report on a relevant topic and presenting it to the exam committee, other members of the VU community, and students interested in this topic. The PhD student must participate in the discussion and answer questions raised by the audience.

Application of Nanomaterials in Bioanalytical Chemistry Course Content: Introduction to nanobiotechnologies. Overview of advanced nanoparticles widely used in the last five years, their main properties, and practical application areas. Modifying nanomaterials with biomolecules (proteins, aptamers, DNA, RNA), the main methods used, their advantages and disadvantages. Methods for characterizing nanobioconjugates. Nanoparticles for concentration and separation of biomolecules from complex samples. Application of nanobioconjugates for cell detection and imaging. Nanobioconjugates and electrophoresis method for detection of analytes. Immunological methods - enzyme-linked immunosorbent assay with nanomaterials. Rapid tests for antigen and antibody detection. Microarrays as high-throughput tools for biomolecule detection. Lab-on-a-chip devices with integrated nanomaterials for rapid detection of biomarkers. Biosensors and immunosensors (optical, electrochemical). Application of nanobioconjugates for analytical signal amplification in biosensors. Prospects for the application of nanomaterials in bioanalysis.

Reading list

1. Springer Handbook of Nanomaterials. Ed. Robert Vajtai. Series Title: Springer Handbooks, Springer Berlin, Heidelberg 2013. <https://doi.org/10.1007/978-3-642-20595-8>.
2. The Detection of Biomarkers: Past, Present and the Future Prospects. Eds.: S. A. Ozkan, N. K. Bakirhan and F. Mollarasouli. Academic Press; 1st edition 2021.
3. Nanobiotechnology for sensing applications. From lab to field. Eds: A. K. Kaushik and C.K. Dixit. Apple Academic Press 2016.
4. Handbook of nanostructured biomaterials and their applications in nanobiotechnology. Ed. H.S. Nalwa. Vol. 1: Biomaterials; Vol. 2: Applications in nanobiotechnology. American Scientific Publishers 2005.
5. Greg T. Hermanson. Bioconjugate techniques. Academic Press 2013. <https://doi.org/10.1016/C2009-0-64240-9>.

The names of consulting teachers	Science degree	Main scientific works published in a scientific field in last 5 year period
Almira Ramanavičienė	Prof. (HP) dr.	1. B. Brasiunas, A. Popov, V. Lisyte, A. Kausaite-Minkstimiene, A. Ramanaviciene*. ZnO nanostructures: A promising frontier in immunosensor development. <i>Biosensors and Bioelectronics</i> 2024, 246, 115848. 2. A. Popov, B. Brasiunas, K. Blazevic, A. Kausaite-Minkstimiene, A. Ramanaviciene*. Ultra-sensitive electrochemical immunosensors for clinically important biomarker detection: Prospects, Opportunities, and Global Trends. <i>Current Opinion in Electrochemistry</i> 2024, 46, 101524.

		3. N. German, A. Popov, A. Ramanaviciene*. The development and evaluation of reagentless glucose biosensors using dendritic gold nanostructures as a promising sensing platform. <i>Biosensors</i> 2023, 13, 727. 4. A. Kausaite-Minkstimiene*, A. Popov, A. Ramanaviciene*. Surface plasmon resonance immunosensor with antibody-functionalized magnetoplasmonic nanoparticles for ultrasensitive quantification of the CD5 biomarker. <i>ACS Applied Materials & Interfaces</i> 2022, 14, 20720–20728. 5. B. Brasiunas, A. Popov, A. Ramanavicius, A. Ramanaviciene*. Gold nanoparticle based colorimetric sensing strategy for the determination of reducing sugars. <i>Food Chemistry</i> 2021, 351, 129238
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Certified during Doctoral Committee session on March 3 rd , 2025. Protocol No. 15600-KT-79.
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Committee Chairman prof. habil. dr. Audrius Padarauskas.
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