Course BIOLOGICAL ENGINEERING

Basic Information

This is a course, which contributes to MSc award in Biology

Course period	From October 1st till February 1st, 1 semester (16 weeks)
Study credits	6 ECTS credits
Duration	216 hours
Language of instruction	English
Academic requirements	– BSc degree in Biology, Physics, Biophysics, Chemistry, Biochemistry, Environmental Sciences or equivalent (transcript of records), – good command of English (certificate or other official document)

Course Description

Biological engineering (BE) offers interdisciplinary approach envisaging strong interlinks of underlying engineering concepts (analysis and synthesis) with fundamental biological sciences. BE offers basic and applied understanding of emerging areas of research (biosensor/nanosensor, microfluidics, multiplexed analytical platform) widely applicable in health and environmental monitoring.

Special Features of the Course

The course covers the key foundations of BE including: fundamental principles of bioconjugate chemistry, enzyme purification and stabilization techniques, microbiology principles and applications, nanomaterial based bioprobes applications and design, aptamer design and selection, immunological approaches, robust biorecognition element (BRE) designing using whole cells and tissues.

Course Aims

The course aims to introduce students the general aspects and interdisciplinary nature of BE, acquaint them with recent trends in the area of biosensor research and provide with understanding of fundamental principles related to BRE design.

Course Objectives

The course is designed to:

- provide students with thorough knowledge of various biological molecules and their application in biosensor research;
- equip students with practical and applied skills of functional nanomaterials usage in designing biosensing agents for their application in medicine and environmental monitoring;
- make students familiar with fundamentals of immobilization and bioconjugate chemistry;
- give knowledge of designing novel biosensing strategies and construction microfluidics based multiplexed analytical platform.

Learning Outcomes of the Course

A successful completion of this course will enable students to:

- apply basic skills of enzyme purification and stabilization;
- synthesize different types of nanomaterials and characterize them;
- demonstrate basic microbiological techniques;
- generate and modify bioconjugation techniques for their wide usage in biosensor design;
- create biochips and microfluidic platforms.

Course Outline

Week	Lectures	Practical work/Assignments	Hours
1 - 6	**Module 1 «Introduction to Biological Engineering and Biosensors»**		30
	Responsive lecture «Introduction to biological engineering (BE), aims and scope» **Lecture** «Recent trends in functionalization of complex biomolecules, biosensor design and basic principles» **Lecture** «Introduction to biorecognition elements (BRE) and their components»	***Problem set № 1-4*** ***Home assignment № 1-4***	

	Lecture «Aptamers, enzymes, whole cell, tissues, antibodies, functionalized nanomaterials» **Lecture** «Introduction to physical transducers (Amperometric, optical, piezoelectric)» **Lecture** «Biosensor design and fabrication»	**Lab** «Synthesis and functionalization of nanomaterials» **Lab** «Whole cell biosensor, enzyme biosensor» **Lab** «Biosensor design»	
7 - 14	**Module 2 «Enzymes, aptamers, whole cell biosensors, antibodies and immobilization techniques»** **Lecture** «Introduction to enzymology, basic physical and biochemical characteristics of enzymes» **Lecture** «Extraction and purification; stabilization of enzymes as biosensing elements» **Lecture** «Aptamer design and selection, aptamers as biosensing elements» **Lecture** «Recent research in aptasensors» **Lecture** «Whole cell biosensors, immobilization techniques (physical and chemical)» **Lecture** «Recent trends in whole cell biosensor» **Lecture** «Diversity of antibody, structure, basic properties» **Lecture** «Immunosensors, recent research and scope in bio- diagnostics»	***Problem set № 5-8*** ***Home assignment № 5-8*** **Lab** «Extraction of an enzyme» **Lab** «Whole cell immobilization»	40
15-16	**Module 3 «Introduction to nanotechnology and microfluidics» «Discussion and Final Assessment»** **Lecture** «Introduction to	**Lab** «Fabrication of biochips»	10

	nanotechnology, basic properties» **Lecture** «Functionalized nanomaterials, application of nanomaterials in biological engineering» **Lecture** «Introduction to microfluidics. Lab on a chip, fabrication of biosensor» **Lecture** «Biochips, multiplexed analytical platform»	***Problem set № 9-10*** ***Home assignment № 9-10*** ***Final test***	
17	Final exam		

Lecturer and Contact Information

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Assessment

The overall course percentage grade will consist of the final test results (40%) and the combined grades of 3 modules assignments (60%).

The score for each module is the sum of the following assignments:

- *Module 1* (20%):

Home assignments and class participation (5%) Lab work (7.5%)
Problem set (5%)
Attendance (2.5%)

- *Module 2* (20%):

Home assignments and class participation (5%) Lab work (7.5%)
Problem set (5%)
Attendance (2.5%)

- *Module 3* (20%):

Home assignments and class

participation (5%) Lab work (7.5%)

Problem set (5%)

Attendance (2.5%)

The overall course percentage grade will be converted into a letter grade as follows:

A = 91-100%

B = 81-90%

C = 71-80%

D = 61-70%

E = less than 61%.

Attendance Policy

It is advised to attend the classes regularly since lab work, home assignments and class participation requires physical presence of the students. Attendance of at least 75% is mandatory.

Web page of the course

The webpage of the course *«Biological engineering»* is available through E-learning SibFU web site: www.e.sfu-kras.ru . You must be logged in to access this course. Course Guide and all accompanying materials are also available at the course web-page.

Core reading

1. *Coursebook.*
2. *Esimbekova, E., Kratasyuk, V. and Shimomura, O., 2014. Application of enzyme bioluminescence in ecology. In Bioluminescence: Fundamentals and Applications in Biotechnology-Volume 1 (pp. 67-109). Springer Berlin Heidelberg.*
3. *Thakur, M.S., Ranjan, R., Vinayaka, A.C., Abhijith, K.S. and Sharma, R., 2013. Nanoparticles and biophotonics as efficient tools in resonance energy transfer-based biosensing for monitoring food toxins and pesticides. In Advances in applied nanotechnology for agriculture (pp. 55-84). American Chemical Society.*
4. *Thakur, M.S. and Ragavan, K.V., 2013. Biosensors in food processing. Journal of food science and technology, 50(4), pp.625-641.*