Design of Multienzyme systems. Practical course

Basic Information

Title of the Academic Program	Master's Degree Programs in English “Medical and Biological Physics”
Type of the course	core /mandatory
Course period	Fall semester, 1 semester (16 weeks)
Study credits	4 ECTS credits
Duration	144 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

The course is devoted to the practical study of modern methods of enzyme inhibition-based analysis and its application in medical and environmental fields.

Special Features of the Course

The course examines the basics of enzymatic analysis based on the inhibition of single-enzyme system, coupled enzyme reaction or multienzyme system. The main principles and mechanisms of action of toxicants on enzymes are considered within lab activities and seminars. Laboratory works are practical exercises in which students learn the basics of working with enzyme analysis, determine the sensitivity of enzyme systems of varying complexity to model toxicants and test samples, such as saliva, water, soil, snow, etc. At seminars, students discuss modern research in the field of enzymatic analysis. As a final work, students should compose a multi-enzyme system, determine its sensitivity to model substances and conduct a medical or environmental analysis.

Course Aim

The aim of the course is to introduce students to enzyme inhibition-based analysis for medical and environmental research.

Course Objectives

1) to enable students to build up their knowledge and skills pertaining to the use of enzymes for solving topical issues related to the life sciences;

2) to give students an introduction of recent trends in the area of enzyme inhibition-based analysis;

3) to provide students with practical skills of designing monoenzymatic and coupled enzyme assays, and multienzyme systems.

Learning Outcomes of the Course (module)[1]

By the end of the course students will be able:

1) to demonstrate basic methods of designing bioluminescent and multienzyme systems;

2) to interpret the obtained data after enzyme inhibition-based analysis;

3) to independently collect information from professional publications;

4) to apply successful laboratory practice principles in experiment planning, conducting and control.

Teaching and Learning Methods

The course consists of 6 modules: an introduction, 4 labs and a final project. Teaching Methods: learner-centered teaching, classroom discussion, individual research projects, laboratory experiments, creating and giving a presentation.

Course Structure

Learning Activities	Hours
Practice sessions	24
Seminars	12
Self-study Assignments	108
Final Exam (including preparation)	0
Total study hours	**144**

Course (module) Outline

Week	Practice sessions	Seminars	Assignments	Hours
Chapter 1 «Introduction»				
1	Lab safety Rules and Precautions	Basis of enzyme inhibition-based analysis	-	1/1/0
Chapter 2 «Single-enzyme systems»				
2	Single-enzyme systems:	Examples of using single-enzyme	Make a report with a	2/1/8

	preparation for analysis, procedure	systems for medical and environmental research	presentation on the selected article	
3	Single-enzyme systems: analysis (EC_{20}, EC_{50} determination)	Examples of using single-enzyme systems for medical and environmental research	Make a report with a presentation on the selected article	2/1/8
Chapter 3 «Coupled enzyme systems»				
4	Coupled enzyme systems: preparation for analysis, procedure	Examples of using couple enzyme systems for medical and environmental research	Make a report with a presentation on the selected article	2/1/8
5	Coupled enzyme systems: analysis (EC_{20}, EC_{50} determination)	Examples of using couple enzyme systems for medical and environmental research	Make a report with a presentation on the selected article	2/1/8
Chapter 4 «Multienzyme systems»				
6	Multi-enzyme systems: preparation for analysis, procedure	Examples of using multi-enzyme systems for medical and environmental research	Make a report with a presentation on the selected article	2/1/8
7	Multi-enzyme systems: analysis (EC_{20}, EC_{50} determination)	Examples of using multi-enzyme systems for medical and environmental research	Make a report with a presentation on the selected article	2/1/8
Chapter 5 «Enzyme inhibition-based analysis»				
8-9	Enzyme inhibition-based analysis for medical research	-	Searching information about the application of the analysis. Participation in the discussion.	2/0/8
10-11	Enzyme inhibition-	-	Searching information	2/0/8

	based analysis for environmental research		about the application of the analysis. Participation in the discussion.	
Chapter 6 «Final project_»				
12-15	Final project	Final project	Make a presentation for the final project defense.	7/2/36
16	-	Presentation of the final project	Make a presentation for the final project defense.	0/3/8

Course Instructor, Contact information

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Assessment

The course assignments include:

- Labs (preparation, execution, progress report), each successfully completed lab - 8 points;
- Seminars: presentations, discussions - max 20 points;
- Final project - max 40 points.

To pass the course a student should have more than 85 points.

Attendance Policy

Students are expected to attend all courses and course activities for which they are registered. Any class meeting missed, regardless of cause, reduces the opportunity of learning and may adversely affect a student's achievement in the course. Students are required to attend at least 90% of the class meetings in order to receive credit for the course. An accurate record of attendance will be kept for each course. If a student misses one third or more of a class session, the student will be counted absent.

Web page of the course

The webpage of the course 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

The books:

- Nelson D. L. and Cox M. M. Lehninger Principles of Biochemistry. 5th edition. (http://archive.org/)
- Lee J. Bioluminescence, the Nature of the Light. – 2016. (http://athenaeum.libs.uga.edu/)
- Shimomura O. Bioluminescence: Chemical Principles and Methods, Revised Edition. – 2012. (http://ebookcentral.proquest.com/lib/krasu-ebooks/)
- Lakowicz J. R. Energy Transfer. In Principles of Fluorescence Spectroscopy. 3rd edition. 2006. Springer. ISBN: 978-0-387-46312-4 (Online) (http://link.springer.com)

Journal articles:

- Esimbekova E.N., Torgashina I.G., Kalyabina V.P., Kratasyuk V.A. Enzymatic Biotesting: Scientific Basis and Application // Contemporary Problems of Ecology, 2021, Vol. 14, No. 3, pp. 290–304. DOI: 10.1134/S1995425521030069
- Sutormin O. S., Sukovataya I. E., Pande S., Kratasyuk V. A.Effect of viscosity on efficiency of enzyme catalysis of bacterial luciferase coupled with lactate dehydrogenase and NAD (P) H: FMN-Oxidoreductase //Molecular Catalysis. – 2018. – V. 458. – P. 60-66.
- Kolosova E.M., Sutormin O.S., Stepanova L.V., Shpedt A.A., Rimatskaya N.V., Sukovataya I.E., KratasyukV.A. Bioluminescent enzyme inhibition-based assay for the prediction of toxicity of pollutants in urban soils // Environmental Technology & Innovation. – 2021. – V. 24. – P. 101842.
- Kalyabina V. P., Esimbekova E. N., Torgashina I. G., Kopylova K. V., Kratasyuk V. A. Principles for construction of bioluminescent enzyme biotests for analysis of complex media // Doklady Biochemistry and Biophysics. – Pleiades Publishing, 2019. – V. 485. – №. 1. – P. 107-110.

Facilities, Equipment and Software

A student should bring their laptop or print learning materials in advance. Learning materials are provided to students in either Adobe PDF, Microsoft Office, Google files or compatible formats.

Laboratory work is carried out in specially equipped rooms. The laboratory room should contain the following equipment and reagents: a spectrophotometer, a luminometer, a pH meter, an analytical balance, pipettes, labware, enzymes (e.g. NAD(P)H:FMN- oxidoreductase, bacterial luciferase, dehydrogenases, tripsin), their substrates and other required reagents and salts.