

CONTEMPORARY ISSUES OF BIOPHYSICS

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	4 ECTS credits
Duration	144 hours
Language of instruction	English
Academic requirements	<ul style="list-style-type: none">– BSc degree in Biology, Chemistry, Physics, Biophysics, Biochemistry or Environmental Sciences or equivalent (transcript of records),– Good command of English (certificate or other official document)

Course Description

The course is a part of International Master Program “Biological Engineering” offered by Siberian Federal University. Biological engineering exploits new developments of different biological fields and applies these breakthroughs to understand living systems with a strong emphasis on solving natural problems with these systems. Therefore progress in the solution of biological problems creates new possibilities for biological engineering. Fundamental biological problems are the problems for biophysics but the approach of Biophysics to investigate these problems is different from biological one.

The course consists of four parts (modules). In the first module some of principal problems of biology and methodological specificity of biophysical approach to these problems are considered. The second module is devoted to outlining key attribute or an essence of life as phenomenon, and to closely connected problem of life origin. The third module acquaints students with the problem of structure-function relationship and associated problems of uniqueness and predictability of evolution. Possible approach to the promotion on the issues is discussed. The fourth module is based on the necessity to consider biological systems up to population level as machines providing signal transformation to appropriate action. This point of view allows coming to understanding some aspects of living matter and creates new problems. Moreover, the problem of cellular processes organization and regulation, and associated problem of morphogenesis are discussed. Obvious progress in these fields deserves special attention in a historical context, since it demonstrate an important role of theoretical concepts in scientific research.

Special Features of the Course

The course is based on the consideration of the key problems of biophysics and biology and possible approach to their solution by means of physics methodology.

Course Aims

One of the features of studying complex systems is that it is impossible to determine in advance what approach or method will be effective in the study of this particular complex system. Biological systems are undoubtedly complex. Therefore, it is natural to use a variety of methods and concepts, which allow us to describe and understand biological systems from different points of view. Biophysics gives an ability to look at biological systems differently than biology does it. The primary aim of the course is to acquaint students with physical approach, which is presented in concepts and methodology of the biophysics, to the solution of biological problems.

Course Objectives

The course objectives are:

- to acquaint students with the essence of the key problems of modern biology;
- to enable students to experience the broad set of conceptual description of biological systems on the different levels of their organization;
- to give students an understanding general principles of biological systems organization as they seen in the moment.

Learning Outcomes of the Course

After completing the course students should be able to:

- understand fundamental processes of life by applying the methodology of physics and modern concepts of life to biological systems;
- understand theoretical and computer techniques application for solving some of the outstanding problems of biology.

Course (module) Structure

Learning Activities	Hours
Lectures	16
Practice sessions / Seminars,	16
Self-study Assignments	76
Final Exam (including preparation)	36
Total study hours	144

Course Outline

Week	Lectures	Practical work / Assignments	Hours
1-4	Module 1 «Key problems of biology and the methodology of biophysics»		8
	<ul style="list-style-type: none"> Lecture “Principal problems of biology: significance and interrelations” Lecture “Biophysics – physical approach to biological problems” 	<ul style="list-style-type: none"> Seminar “Ideal objects and models in science, physics and biophysics” 	
5-8	Module 2 «Essence, origin and searching for life»		8
	<ul style="list-style-type: none"> Lecture “On the key attribute of life – different points of view” Lecture “Principal problems in scientific scenario of life origin” Lecture “Two different views on the problem of the origin of life” Lecture “Multivariate oligomer scenario of life origin” 	<ul style="list-style-type: none"> Seminar “Necessary and sufficient conditions for the origin of life. The possibility of experimental verification” 	
9-12	Module 3 «Machine-like structure of biological systems»		8
	<ul style="list-style-type: none"> Lecture “Construction as key concept and property of life” Lecture “Protein as a machine. Mechanisms 	<ul style="list-style-type: none"> Seminar “Molecular machines” 	
13-16	Module 4 «Organization of cellular processes»		
	<ul style="list-style-type: none"> Lecture “Biochemical signaling and information processing. Multienzymatic 	<ul style="list-style-type: none"> Seminar “Intracellular media, mechanical and statistical aspects of cellular processes” 	

	cascade reactions” <ul style="list-style-type: none"> • Lecture “Principles of polyenzymes cellular systems organization and regulation” 		8
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Course Instructors and Tutors, Contact Information



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Assessment

The overall course percentage grade will be computed from the final test results (25%) and the combined grades of 3 modules assignments (75%).

The each module scores are the sum of the following assignments:

- Module 1 (15% from 75%):
 - lecture attendance (each 2%, 6% total),
 - written answers to 3 question sets (each 3%, 9% total).
- Module 2 (30% from 75%):
 - lecture attendance (each 2%, 12% total),
 - written answers to the 3 question sets (each 3%, 18% total).
- Module 3 (15% from 75%):
 - lecture attendance (each 2%, 6% total),
 - written answers to 3 question sets (each 3%, 9% total).

Module 4 (15% from 75%):

- lecture attendance (each 2%, 6% total),
- written answers to 3 question sets (each 3%, 9% total).

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

Since almost every class contains material, which is not presented in literature in compact form, attendance of all of them is highly desirable.

Students are expected to attend classes regularly. In the case of missing seminar the student must prepare essay on corresponding topic with additional specification (will be given by the lecturer) within one week.

Every topic has the home assignment work that must be done in written form. The report on the assignment must be submitted to the lecturer within 5 days from the moment you've got a list of the problems. The final mark will be made according to the same grade policy as for a final exam.

Web page of the course

The webpage of the course «[Contemporary issues of biophysics](#)» 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

Initial introduction into fundamental problems of modern biology can be obtained from Dev's paper "Unsolved problems in biology – The state of current thinking" published in 2015. The reading will give some (not complete) context for effective starting of this course.

A material for stimulated starting discussion on the one of the most mysterious topic – essence of life and its origin – can be taken from selected chapters "Chemical Evolution" and "Basic Phenomena" from the book ["Chemical Evolution and the Origin of Life"](#) by Rauchfuss H., Mitchell T.N. and the paper ["Emergence of life: Physical chemistry changes the paradigm"](#) by Spitzer J., Pielak G.J., Poolman B.

Facilities, Equipment and Software

The program is designed with a strong emphasis on theoretical knowledge. Lectures and seminars take place in rooms equipped with interactive tablets and direct projection boards.