Syllabus BP: Problems of Modern Biophysics

Course Description	Principles of cell biology is a cornerstone of modern biophysics, an essential part of study in graduate biological physics. The course concentrates on topics relevant to the research in biophysics being conducted at SibFU. These include introduction to the fundamental biology, heredity as law of mixed lineage, biological signals and transducers, cell-to-cell interaction, elements of the theory of Kolmogorov's complexity and the theory of multidimensional biological interaction.
Goals and Learning Outcomes	The course aims to give students a broad picture of modern biological measures and signals to help develop a cohesive understanding of biophysics through the combined use of mathematical, physical, and biological methods. Moreover, the course is intended to equip students with biophysical tools and techniques and provide an appropriate background for further study of the subject and their own research. By the end of this course, students should be able 1. to understand and apply the basic concepts of the 5 course topics, 2. to formulate the main biological principles of the course topics and recognize the biophysical situations these principles can be applied, 3. to identify the key arguments in the proofs of these principles, 4. to understand the notions and ideas related to the relevant contemporary studies.
Literature	1. G Plopper. Principles of Cell Biology. 2nd Ed. Jones & Bartlett Learning. 2016. 566 p. 2. A V Finkelstein, O B Ptitsyn. Protein Physics, 2nd Ed. Elsevier. 2016. 468 p. 3. D Noble. The Music of Life. Sourcebook (version 5, August 2015). 116 p. The Music of Life: Biology Beyond Genome. OUP Oxford. 1st Ed. 2008. 176 p. 4. G Plopper, D Sharp, E Sikorski, B Lewin. Lewin's Cells. 3rd Ed. Jones & Bartlett Publishers. 2015. 1056 p. 5. R Milo, R Phillips. Cell Biology by the Numbers. Garland Science. 2015. 400 p. 6. R Phillips, J Kondev, J Theriot, N Orme, H Garcia. Physical biology of the cell. 2nd Ed. Garland Science. 2013. 1089 p. 7. Shapiro J.A. How life changes itself: The Read–Write genome // Phys Life Rev 10, 287 (2013). 8. E V Koonin. The Logic of Chance: The Nature and Origin of Biological Evolution. Pearson Education. 2012. 528 p. 9. D Boal. Mechanics of the Cell. 2nd Ed. Cambridge University Press.2012. 622 p.
Structure of the Course	The course ECTS value is 2 credits. The course consists of • 36 hrs of lectures • 36 hrs of self-study time. Students are to prepare and deliver in class presentations for selected topics of the lecture course.

Assessement	Homework assignments 30%, presentations 20%, final examination 50%.
Course Main Content	Lecture 1. Act life is action Lecture 2. Biological bonds are multidimensional nature Lecture 3. Cellular continuum: harmony of incessancy and discreteness Lecture 4. Development & diversity are biological laws Lecture 5. Emergence is created by life Lecture 6. Function & biological signals Lecture 7. Genome is organ of cell Lecture 8. Heredity is law of mixed lineage Lecture 9. Integrity & individuality Lecture 10. Joint measures & gauges Lecture 11. Kolmogorov's complexity in cell biology Lecture 12. Logic of bio chance & event

Course Contents BP: Problems of Modern Biophysics

Lecture 13. Act life is action

13.1. The principle of permanent restless of live nature.

13.2. Any living cell has not the ground state! Therefore, biological quasiparticles strong differ from collective excitations in condensed matter physics where quasiparticle defines small oscillations around the main stable state at given temperature.

13.3. Any motion into cell has big adjustment and fluctuations that has the own timbre and biological content.

Lecture 14. Biological bonds are multidimensional nature

14.1. The biological interaction exists when the biological action is not equal to opposite action as usually.

14.2. Biological mediator (vesicles, liposomes) mediates biological interaction, same to elementary particle physics, where the field quanta mediates physical interactions.

14.3. Empathy is a good example of biological interactions.

Lecture 15. Cellular continuum: harmony of incessancy and discreteness

15.1. The self-consistency of continuous "strings of life" and discrete nature of any living organism in a finite region of space and finite time of living;

15.2. Biological diversity is cause of infinite "strings of life"

Lecture 16. Development & diversity are biological laws

16.1. The biological diversity ensures the continuity of the string of life in changing environment.

Lecture 17. Emergence is created by life

17.1. The principle of the permanent emergence, all living things, that - or indeed creates.

17.2. Creative property is able to create – live!

Lecture 18. Function & biological signals

18.1. Existence of biological signals, which has always a big dimension and exist only in relation to the meter.

18.2. Any natural biological signal is relative always, essentially depends on the measurer.

Lecture 19. Genome is organ of cell

19.1. "The genome is an organ of the cell" (Barbara McClintock).

19.2. Gene: complexity, organization, hierarchy.

19.3. Any living substance has many levels of organization, hierarchy and high complexity, which implements by the Kolmogorov's algorithm.

Lecture 20. Heredity is law of mixed lineage

20.1. Each cell has a cell program and life changes itself by the read-write (RW) genome in every cell division.

Lecture 21. Integrity & individuality

21.1. Tight connection of integrity with individuality, i.e. any organism, tissue and cell changes the individuality to save functional integrity while they are alive.

Lecture 22. Joint measures & gauges

22.1. Biological measurements.

22.2. The understanding of biological measures lies in the study how one cell measures other cell.

Lecture 23. Kolmogorov's complexity in cell biology

23.1. Kolmogorov: the legacy in cell biology.

23.2. The hierarchy codes system exists in living systems, i.e. genetic, histones, epigenetic, cellular, tissue codes etc.

Lecture 24. Logic of bio chance & event

24.1. Finally, it is not recent but perhaps main principle that the Logic of chance is real logic of biological events with the emergence of slight dominants.

24.2. This principle is essence as the nature and origin of biological evolution as the future exact laws of live nature that undoubtedly we will be formulate in the coming years.

The course ECTS value is 2 credits. The course includes 12 lectures and 36 hours of self-study.