

COURSE OUTLINE "SYSTEMS BIOLOGY"

1. GENERAL

SCHOOL	HEALTH SCIENCES		
DEPARTMENT	MOLECULAR BIOLOGY AND GENETICS		
LEVEL OF STUDIES	ISCED LEVEL 6		
COURSE CODE	MBG405	SEMESTER	7 th
COURSE TITLE	SYSTEMS BIOLOGY		
TEACHING ACTIVITIES <i>If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.</i>		HOURS/WEEK	ECTS CREDITS
		3	4
COURSE TYPE <i>Background, General Knowledge, Scientific Area, Skill Development</i>	SCIENTIFIC AREA		
PREREQUISITES:	NO		
TEACHING & EXAMINATION LANGUAGE:	GREEK ENGLISH FOR ERASMUS STUDENTS		
COURSE OFFERED TO ERASMUS STUDENTS:	YES		
COURSE URL:	https://eclass.duth.gr/courses/ALEX01304/		

2. LEARNING OUTCOMES

<p>Learning Outcomes <i>Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.</i></p> <p>The overall objective of the course is to provide to the students the theoretical background and to familiarize them with the methodologies and applications of Systems Biology.</p> <p><i>The objectives of the course are:</i></p> <ul style="list-style-type: none"> • To understand the complexity that defines the field of Systems Biology. • To familiarize with the approaches applied in big scale datasets. • To study the basic principles of constructing biological networks. • To study the holistic approaches and basic principles of chromatin organization and gene regulation. • To understand that in modern biology, holistic approaches are applied in order to decode the complexity of biological systems, which are based on the notion that networks are a sum of their units. Thus, Systems Biology is studying a "forest" and not a single "tree". <p><i>Learning outcomes</i> Upon the successful completion of the course, the students will be able:</p> <ul style="list-style-type: none"> • To know the basic theories and principles of Systems Biology and their impact on Biosciences. • To understand that the combination of the experimental and computational biology can provide the answer on various complex questions. • To understand the basic principles of the chromatin organization and compartmentalization (1D -> 4D), their relationship to transcription factories, chromatin re-organization, regulatory elements, transcription factories and their role in various biological processes with emphasis on gene regulation.
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- To familiarize with the basic methodologic approaches of Systems Biology and to appreciate and understand the obtained results.
- To identify the various biological networks and to be able to apply the basic principles of constructing biological networks

General Skills

Name the desirable general skills upon successful completion of the module

*Search, analysis and synthesis of data and information,
ICT Use*

Adaptation to new situations

Decision making

Autonomous work

Teamwork

Working in an international environment

Working in an interdisciplinary environment

Production of new research ideas

Project design and management

Equity and Inclusion

Respect for the natural environment

Sustainability

Demonstration of social, professional and moral responsibility and sensitivity to gender issues

Critical thinking

Promoting free, creative and inductive reasoning

- Search, analysis and synthesis of data and information, using the necessary technologies
- Adaptation to new situations
- Decision-making
- Teamwork
- Work in an interdisciplinary environment
- Production of new research ideas
- Exercise of criticism and self-criticism
- Promotion of free, creative and inductive reasoning

3. COURSE CONTENT

1. Introduction in Systems Biology: Models, networks, data integration, model organisms and general principles.

2. Access in sequence data: Databases and familiarize with them. Data acquisition and analysis.

3. Next generation sequencing.

4. Analysis of next generation sequencing data: Fastq, alignment, SAM/BAM/BED, peak calling, count exons, variant calling, visualization and interpretation of the results.

5. Transcription factors: Properties of transcription factors. Methods to identify transcription factors (ChIP-seq), analysis and interpretation. Motif analysis and interpretation in relation to network development. How transcription factors control gene regulation?

6. Chromatin organization: From the 1D structure of DNA up to the 3D and 4D structure of chromatin. Principles of chromatin organization and structure. Nucleosomes. RW/GL, MLS, Fractal Globule, RL. Chromosome territories. Chromatin architecture. TADs and LADs. What they regulate? How to interpret 3D and 4D structure? Relationship between gene regulation and nucleus organization.

7. Chromatin remodeling: Epigenetics. Euchromatin. Heterochromatin. Histones. Methylation, acetylation and other histone modifications. Relationship between histones and transcription factor binding on DNA. Polycomb proteins and other protein complexes. PRC1/2 and gene regulation.

8. Analysis of transcriptome. Methods to analyze transcriptome and gene expression (RNA-seq, DNA microarrays, etc). Differential expression analysis. PCA and hierarchical clustering.

9. Analysis of gene expression. Gene categorization. Gene ontologies. Biological pathways. GO, GSEA, SEA, MEA

10. Proteomics: Structure and techniques.

11. Biological networks: Types of biological networks, regulatory networks, metabolic networks, signalling networks, protein networks, interactions between networks. Feedback and feed-forward loops. Density of network and node degree.

12. Big dataset biology. Full scale genomics. Complexity of gene expression. Identification of genome wide binding positions of transcription factors. Genome wide epigenetic modifications. Genome wide chromatin structure. Organization and visualization of the information. Identification of peaks from ChIP-seq. Networks of transcriptional regulation.

13. Systems Biology with an example

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD <i>Face to face, Distance learning, etc.</i>	Face to face	
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) <i>Use of ICT in Teaching, in Laboratory Education, in Communication with students</i>	Use of ICT in teaching Use of ICT in communication with the students	
TEACHING ORGANIZATION <i>The ways and methods of teaching are described in detail.</i> <i>Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.</i> <i>The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.</i>	Activity	Workload/semester
	Lectures	39
	Bibliographic research and analysis	71
	Project	10
	Course Total	120
STUDENT EVALUATION <i>Description of the evaluation process</i> <i>Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others</i> <i>Please indicate all relevant information about the course assessment and how students are informed</i>	Student evaluation languages Greek, English Method (Formative or Concluding) Formative Student evaluation methods Written exams with short-answer questions (25%) Written exams to answer scientific questions (75%) The methods of evaluation are also available at eclass.duth.gr	

5. SUGGESTED BIBLIOGRAPHY

1. Βιοπληροφορική και Λειτουργική Γονιδιωματική. Εύδοξος: 86054818. Ακαδημαϊκές Εκδόσεις Μπάσδρα.
2. Ανασυνδυασμένο DNA. Εύδοξος: 2625. Ακαδημαϊκές Εκδόσεις Μπάσδρα.
3. Υπολογιστική Βιολογία. Εύδοξος: 320114. Ελληνικά Ακαδημαϊκά Ηλεκτρονικά Συγγράμματα και Βοηθήματα - Αποθετήριο "Κάλλιπος"