Universidad Zaragoza

Academic Year/course: 2023/24

68455 - Systems & Synthetic Biology

Syllabus Information

Academic year: 2023/24
Subject: 68455 - Systems & Synthetic Biology
Faculty / School: 100 - Facultad de Ciencias
Degree: 626 - Máster Universitario en Biofísica y Biotecnología Cuantitativa / Master in Biophysics and Quantitative Biotechnology
ECTS: 6.0
Year: 01
Semester: First semester
Subject type: Compulsory
Module:

1. General information

This obligatory course introduces the student to the quantitative modeling and understanding of the main cellular processes, providing a fundamental background for both the industry and the academic-oriented curricula. Its aims at providing the students with an overview of the challenges that the increasing amount of "-omics" data present, and with the mathematical methods (from statistical physics, nonlinear systems and network analysis) that are used to tackle such challenges.

These objectives are relevant for Objective 3 "Good Health and Well-Being" of the Sustainable Development Goals of the UN 2030 Agenda (https://www.un.org/sustainabledevelopment/), so that the learning outcomes will provide students with skills to address those goals.

It is recommended to have basic knowledge of computer programming (preferentially, Python or R), ordinary differential equations, linear algebra, molecular and cellular biology to take the course. To this end, students are encouraged to complement their background with the appropriate choice of the introductory courses of the Master, before taking this course.

2. Learning results

At the end of the course, the student:

- will know the most common strategies to study a biological system as an integrated system, combining together genes, proteins and biochemical reactions;
- will be able to define the biological networks that interrelate the elements of the system and to understand how they influence its functioning.
- will be able to analyze and design simple genetic circuits.

The ability to understand and model the dynamics of biological networks inside a cell is an important asset for a biotechnologist, complementing his/her knowledge of the experimental techniques and his/her laboratory skills, and allowing him/her to foresee how perturbations at the molecular level could affect the system level.

3. Syllabus

1. Introduction to Biological Networks: basic concepts, kind of networks, data sources in systems biology.
2. Solving simple chemical equations: boolean approach; ordinary differential equations (ODEs);
3. Complex networks: random vs scale-free networks. Motifs.
4. Metabolic Networks. Michaelis-Menten equation, Flux-balance analysis.
5. Transcription Networks; functional role of simple motifs
6. Signaling networks. Cellular communications

The course is held during 8 weeks in the period November-January (first semester of the academic year), according to the official calendar at https://ciencias.unizar.es/calendario-y-horarios.

4. Academic activities

- Lectures (22 hours)
- Practice/problems sessions, where students can apply and consolidate the theoretical understanding by solving relevant examples and problems. (13 hours)

- Computer laboratory sessions (21 hours)
- Seminar presentation (4 hours)
- Personal work on the proposed exercises/practices and preparation of the reports (50 hours)
- Personal study (38 hours)
- Evaluation (2 hours)

Optional assignments will be provided to the students interested in deepening their understanding in specific topics.

Students are expected to participate actively throughout all the activities, and will be guided into the preparation of a short seminar (individually or in small groups), in order to train their organization and presentation skills.

Course material: the Moodle platform will be used to distribute lecture notes, as well as to propose exercises and tests.

5. Assessment system

1: (45% of the final grade). Continuous evaluation of the student's progress during the practical and theoretical sessions, through the correction of the practice reports, as well as through direct interaction in the classroom, rewarding active participation during the lectures, solution of the home-works proposed by the teacher.

2: (10% of the final grade). Seminar on papers related to syllabus. A selection of articles are usually proposed by the teachers, among which students can choose. Students can also agree with the teachers on presenting articles not included in the list.

3: (45% of the final grade) Written exam, possibly resorting to the Moodle platform, on the topics discussed throughout the course.

In the seminar, the following aspects will be assessed and evaluated:

- Understanding of the subject, coherence.

- Clearness of the presentation

- Mastery of the topic presented (possibly obtained by examining further bibliography, etc), and capability of answering questions on it