Universidad Zaragoza

Academic Year/course: 2022/23

68455 - Systems & Synthetic Biology

Syllabus Information

Academic Year: 2022/23
Subject: 68455 - Systems & Synthetic Biology
Faculty / School: 100 - Facultad de Ciencias
Degree: 626 - Máster Universitario en Biofísica y Biotecnología Cuantitativa/Biophysics and Quantitative Biotechnology
ECTS: 6.0
Year: 01
Semester: First semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The objectives of the course are:

- To get acquainted with the basics of the methods and techniques (theory of dynamical system, network analysis) that are used in systems biology to describe transcription and regulation networks, among others.

- To be able to simulate with a computer program the behavior of simple biological dynamical systems

- To acquire the sufficient knowledge on both the experimental and theoretical techniques, to be able to progress autonomously in the field

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 help reaching those goals.

1.2. Context and importance of this course in the degree

This course, theoretical in its nature but strictly connected to the experimental techniques in molecular and cell biology, introduces the student to the modelling and understanding of fundamental biological processes, providing a fundamental background for both the industry-oriented and for the academic-oriented curricula. It also sets the basis for further advancements in modeling and bioinformatics analysis, provided by the "Biostatistics and Bioinformatics" and "Modelling of Biological Systems" and "Big Data in Biology" courses during the second semester

1.3. Recommendations to take this course

It is recommended to have basic knowledge of computer programming (preferentially, Python or R), ordinary differential equations, linear algebra, molecular and cellular biology. Since no Bachelor degree course provides all the spectrum of recommended knowledge, the students backgrounds are complemented within the three introductory courses of the Master, that are preparatory to the rest of this course.

2. Learning goals

2.1. Competences

Basic and general

CG 01 ? To arrange, analyze critically, understand and synthesize information
CG 02 ? To obtain information from different types of sources and evaluate their reliability
CG 03 ? To learn efficiently through autonomous study and acquire a significant level of independence
CG 04 ? To implement the acquired knowledge and solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to the study area
CG 05 ? To formulate, analyze, evaluate and compare new or alternative solutions for different problems
CG 06 - To be able to work in multidisciplinary and international teams.
CG 07 ? To develop capacity for criticism and self-criticism.

CG 08 ? To make decisions taking into account social, ethical and legal responsibilities
CG 09 - To be able to develop a project, participating in the stages of bibliographic search, planning of experiments, obtention , interpretation, and dissemination of of results.
CB 6 ? To manage sufficient knowledge to grant a basis and opportunity for originality in the development and / or implementation of ideas, often in a research context
CB 7 ? To know how to implement the acquired knowledge and to solve problems in new or little known environments within broader (or multidisciplinary) contexts related to their area of ??study
CB 8 ? To be able to integrate knowledge and face the complexity or provide opinions based on limited information, being aware of the social and ethical responsibilities linked to the application of knowledge and opinions.
CB 9 - To be able to communicate results and conclusions, including the reasons that support them , to specialized and non-specialized audiences in a clear and unambiguous way
CB 10 - To acquire the learning skills that allow them to continue studying, largely self-directed or autonomously.

Transversal
CT 01 - To properly manage of the available resources and time for solving a problem or developing a project
CT 02 ? To communicate results and conclusions, together with the reasons that support them, to specialized and non-specialized audiences in a clear and unambiguous way.
CT 03 - To transmit oral, written or graphical information using the appropriate presentation tools and within the constraints imposed in time or space.
CT 04 - To communicate fluently in English (to understand scientific texts, write reports, participate in talks, colloquiums, exhibitions, etc.).
CT 05 - To use Information and Communications Techniques (ICTs) as a tool for expression and communication
CT 07 - To develop technological applications of biochemical processes and transfer solutions to industry in the food, chemical, cosmetic, pharmaceutical and healthcare sectors

Specific
CE 01 - To know how to build a biological network from the experimental data present in the literature
CE 02 - To know how to characterize the network from the point of view of its structural properties
CE 03 - To know the characteristics and functions of the main biological interest networks
CE 04 - To know the dynamic processes that take place in biological networks
CE 05 - To know how to plan and perform a simulation of the dynamics in real networks, to reproduce the experimental data

2.2. Learning goals

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; he/she will be able to define the biological networks that interrelate the elements of the system and to understand how they influence its functioning. The student will be able to analyze and design simple genetic circuits of a synthetic or regulatory nature.

2.3. Importance of learning goals

The ability to understand and model biological networks inside a cell and their dynamics 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. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

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). Seminars on the topics proposed by the teacher

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

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives through the implementation of a wide range of teaching and learning tasks, such as lectures, exercises and practice sessions in the computer laboratory room.

The virtual platform Moodle will be used to distribute lecture notes, as well as to propose exercises and tests, and to

broadcast relevant news.

Students will be encouraged to present a short seminar, to train their organization and presentation skills.

Students are expected to participate actively in the class throughout the semester.

Course material: Notes written by the lectures will be available on the course's Moodle webpage.

4.2. Learning tasks

The course includes the following learning tasks:

- Lectures (using slides or blackboard, and possibly videoconferencing tools as required) deal with the explanation of theory and methods, organized according to the syllabus of the course.

- Practice/problems sessions, where students can apply and consolidate the theoretical understanding by solving relevant examples and problems.

- Computer lab sessions, for the numerical solution of more advanced problems

- The presentation of a short seminar (around 15 minutes), individually or in small groups, on a topic proposed by the teacher.

4.3. Syllabus

The course will address the following topics:

Topic 1. Introduction to Biological Networks: basic concepts, kind of networks, experimental techniques and data sources in systems biology.

Topic 2. Solving simple chemical equations:

- boolean approach

- ordinary differential equations (ODEs);

Topic 3. Complex networks: random vs scale-free networks. Motifs.

Topic 4. Metabolic Networks. Michaelis-Menten equation, Flux-balance analysis.

Topic 5. Transcription Networks; functional role of simple motifs

Topic 6. Signalling networks. Cellular communications

4.4. Course planning and calendar

The course is taught in 8 weeks in the period November-January.

Lectures will be held according to the schedule published on https://ciencias.unizar.es/calendario-y-horarios . Typically, every week will have consist of 8 hours, including theory, problems/introduction to the computer practice, and computer practice The precise dates and places will be reminded to the students via the virtual platform Moodle, so the students are advised to check their official (unizar) email account.

Evaluations of the practice sessions will take place throughout the course; Seminars schedule will be agreed with the students throughout the semester. The exam sessions will be established on the dates and places reported in https://ciencias.unizar.es/consultar-examenes

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=68455