Universidad Zaragoza

Year : 2019/20

63100 - Systems & Synthetic Biology

Syllabus Information

Academic Year: 2019/20
Subject: 63100 - Systems & Synthetic Biology
Faculty / School: 100 - Facultad de Ciencias
Degree: 572 - Master's in Quantitative Biotechnology
ECTS: 6.0
Year: 1
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

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 "Biological modelling" courses during the second semester

1.3.Recommendations to take this course

It is recommended to have basic knowledge of computer programming (any language), ordinary differential equations, linear algebra, molecular and cellular biology.

2.Learning goals

2.1.Competences

Basic and General

01 - To order, analyze critically, interpret and synthesize information

02 - To obtain information from different types of sources and evaluate their reliability

03 - To acquire a significant degree of independence

04 - To formulate, analyze, evaluate and compare new or alternative solutions to different problems

05 - To communicate results in a clear and unambiguous way, using suitable presentation tools and with the limitations imposed by time or space.

Specific

01 - Ability to build a biological network from the experimental data present in the literature

02 - Capacity to characterize the network from the point of view of its structural properties

03 - Knowledge of the characteristics and functions of the main networks of biological interest

04 - Knowledge of the dynamic processes that take place in the biological networks

05 - Capacity to propose 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 by direct interaction in the classroom, rewarding active participation during the lectures, and solution of the homework proposed by the teacher during the practice sessions.

2: (10% of the final grade). Seminars on the topics proposed by the teacher

3: (45% of the final grade) Written exam, 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 achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, 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.

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.

4.2.Learning tasks

The course includes the following learning tasks:

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

- Practice sessions, where students can apply and consolidate the theoretical understanding by means of 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.

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

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

- analytical solution of ordinary differential equations (ODEs);

- graphical analysis of ODEs;

- numerical integration of 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. Network dynamics: boolean networks; Michaelis-Menten and Hills dynamics.

4.4.Course planning and calendar

Lectures will be held on Tuesdays (9:00- 11:00) and Thursdays (9:00-10:00 and 11:00-14:00, with three hours of practice sessions, during the first semester of the academic year. The precise dates and places will be communicated to the students via the virtual platform Moodle, so the students are advised to check their moodle email account.

Seminars schedule will be agreed with the students throughout the semester.

The course is taught during 10 weeks in the first semester, indicatively from the second half of October to the second half of January.

Examinations: one exam at the end of the semester.

4.5.Bibliography and recommended resources

The recommended literature is available also on the University Library website

(biblioteca.unizar.es)

Markus Covert, "Fundamental of Systems Biology. From Synthetic Circuits to Whole-cell Models", CRC Press 2015 (978-1420084108)

Brian P. Ingalls, "Mathematical Modeling in Systems Biology: An Introduction", MIT Press 2013 (ISBN: 978-0262018883)

Uri Alon, "An Introduction to Systems Biology. Design Principles of Biological Circuits", Chapman & Hall 2006 (ISBN 978-1584886426)