Universitat Autònoma de Barcelona

2019/2020

Systems Biology

Code: 101950
ECTS Credits: 6

Degree	Type	Year	Semester
2500890 Genetics	OB	3	2

Contact

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Use of Languages

Principal working language: catalan (cat)

Some groups entirely in English: No

Some groups entirely in Catalan: Yes

Some groups entirely in Spanish: No

Prerequisites

Fundamental pre-grade knowledge in Algebra, Differential Calculus, Chemistry and Biochemistry.

Good comprehension of English written scientific publications and textbooks

Basic computer user skills (Windows, Word, Excel,...).

Be enrolled or have passed the Systems Biology module included in Integrated Laboratory VI.

Objectives and Contextualisation

Systems biology is a rapidly evolving field which fosters a new approach to solve biological problems through a combination of experimental data and the use of computer models with both predictive and explanatory power. The systems biology approach is centered in the integrated study of the network components (genes, enzymes, metabolites,…) and their interactions, revealing key emerging properties and complex dynamic behavior.

Historically, although it might be argued that the concept is much older, the systems biology approach evolves as a response to the enormous data accumulation from genomics, proteomics, transcriptomics, metabolomics,... and also due to the exponential increase in computer power allowing to go further in the analysis, interpretation and deeper understanding of the 'omics' data.

The first objective of the course will be to review the motives and origins of the discipline while offering a perspective of its relevance in the near future.

The second objective is to introduce the student to the tools and methods most commonly used. Thus the course will evolve from the mathematical description of the system, through the alternative methods of solution, towards the analysis of the resulting behavior. As a result the student will know and be able to use the most frequent basic tools used nowadays in the field.

The third objective will be to apply the acquired knowledge to model systems of the three most studied subsystems, namely metabolic, genetic and signal transduction networks. The emerging dynamics of those systems allows to see the main traits that arise in complex systems and understand the necessity of the 'systems' approach. An important part of this objective is performed as practical computer simulation sessions included in the Integrated Laboratory VI.

The fourth objective includes a firsthand appreciation of how this new approach is being applied in present day research. To this purpose the students will review real examples from scientific literature. Part of this objective will be fulfilled as a team work including the presentation of a reviewed paper to the rest of the students. This activity will favor a deeper understanding of the concepts learned, foster a wider view of its real impact as well as promoting the development of the student communication skills.

The subject is presented gradually, advancing from the basic concepts towards the description of more complex systems allowing for a thorough understanding of the necessity to study systems as integrated units.

The general objective is to allow the student to acquire the systems perspective of today's biology.

Competences

- Apply knowledge of theory to practice.
- Apply scientific method to problem solving.
- Be able to analyse and synthesise.
- Design experiments and interpret the results.
- Develop self-directed learning.
- Know and interpret the metabolic and physiological bases of organisms.
- Perceive the strategic, industrial and economic importance of genetics and genomics to life sciences, health and society.
- Reason critically.
- Use and manage bibliographic information or computer or Internet resources in the field of study, in ones own languages and in English.

Learning Outcomes

1. Apply knowledge of theory to practice.
2. Apply scientific method to problem solving.
3. Be able to analyse and synthesise.
4. Defend the relevance of progress in the generation and interpretation of data on a genomic scale for our understanding and technological manipulation of organisms.
5. Describe the analysis of metabolic control.
6. Design experiments and interpret the results.
7. Develop self-directed learning.
8. Explain the basics of metabology/metabolics and their methods.
9. Reason critically.
10. Use and manage bibliographic information or computer or Internet resources in the field of study, in ones own languages and in English.

Content

1.- Introduction and definitions

    1.1 The 'systems' perspective

    1.2 Key general concepts. Emergence and robustness.

2.- Systems description and study

    2.1 Top-down vs bottom-up approximations

    2.2 Timescales

    2.2 Deterministic vs. stochastic approaches

2.3 Dynamics vs steady state

2.4 Review of fundamental mathematical concepts

2.5 Introduction to system dynamics

2.6 Parameter determination

2.7 Structure, kinetics and thermodynamics

3. Networks and biological systems

3.1 Metabolic networks in steady state

3.2 Metabolic control analysis

3.3 Networks and genetic circuits

3.4 Signal transduction networks

Methodology

Along the learning process, the teaching methodology will be fundamentally based on the student's work and the professor will guide the student either in the process of acquisition and interpretation of the most relevant information as well as in the student's personal work. The student will collect as much learning evidences as possible in the student portfolio as detailed in the evaluation paragraphs. In this context, and according to the learning objectives of the course, the type of learning activities will include theory classes, exercise and problem solving classes, practical computer exercises and tutor sessions.

Theory classes: Were the main basic conceptual topics and the most relevant information will be provided so that the student can develop its autonomous learning. Computer slides (ppt or pdf format) will be available to the student in the virtual campus.

Seminar and problem solving sessions: These sessions will be done in a reduced subgroup of students of the class. Exercises, previously provided, will be explained and/or solved so that they contribute to learn and clarify the knowledge provided along the course. In those sessions, the students will also explain their peers the solution proposed and the pathway and difficulties encountered while solving them, so that the experience is shared among all of them. The exercises will be delivered through the virtual platform before the exercises are solved in class.

Team work: The students will develop a short essay based on a scientific publication of the field and will present it to their peers in class. This activity provides the opportunity to personally contribute for example by doing some directly related genetic, metabolic or signal transduction computer simulations. This information can be included in the tests to assess the student's learning progress.

Practical computer sessions: Part of the learning outcomes will be acquired through practical computer sessions. Those sessions are formallyincluded in the Molecular Systems Biology module within Integrated Laboratory VI and therefore evaluated separately. Nevertheless they are necessary to achieve the learning outcomes of this topic. Those practical sessions will be done using ad-hoc software. Those exercises will allow the student to become familiar with the models and type of data most common in the field and their use. Those exercises will be done using existing free software.

Tutoring: It will be possible to perform a few tutor sessions, individually or in a group of students, if it is requested by the students. The main objective will to solve doubts, review basic concepts or guide in the process of selecting additional sources of information.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Seminars and problem solving sessions	15	0.6	
Theoretical lessons	30	1.2	
Type: Supervised			
Support sessions to individual or team work	2	0.08	
Type: Autonomous			
Solve exercises individually with or without a computer	40	1.6	
Student portfolio preparation, review references, study, ...	40	1.6	
Team work	19	0.76	

Assessment

Evaluation of the student's acquired skills or competences and learning outcomes, will be based on the 'student's portfolio' which collects all available evidences .

At the end of the course the student will provide his/her student portfolio for evaluation in digital format (zip/pendrive/cd/dvd/cloud storage such as OneDrive, GoogleDrive, ...).

The contents of the student's portfolio have to be:

- Student's introductory letter

Brief summary of the previous student's knowledge on the main subject of the course. This can be used as a reference at the end of the course to better asses the progress reached.

- Index of the student's portfolio

Lists de content of the portfolio provided by the student. The portfolio must have a fixed part of its content, proposed by the professor, which cannot be lower than 85% of the total content. The student can add, if so decided, a variable part of the content which can never be higher than 15% of the total content.

Learning evidences

- Exercises solved (25%)

Along the course, the student will perform a series of exercises, either manually as well as using a computer, which will subsequently be solved in class by one of the students. Those exercises will be provided by each student along the course as well as at the end of the semester as part of the student's portfolio. Part of those exercises will be given a qualification at the end of the course. Should the exercises not be provided along the course and/or not included in the student's portfolio, it will be penalized with a decrease of up to 40 % of the qualification of the exercises.

- Team work (20%)

Students will have to perform a team work based on a scientific publication on Systems Biology. The team, composed of a small number of members, will review the selected paper and if relevant, will attempt to reproduce any computer simulations using the corresponding free software. The work will also be presented to the rest of the students by all the team members. One of the main objectives of this part will be to transmit the information and knowledge gained by the group to the rest of the students. With the purpose to evaluate the level of success in transferring that information, the rest of the students will evaluate the received information using and evaluation rubric. Nevertheless the presented information can also be evaluated at the progress test or at the final examination.

- Progress tests (45%)

Two tests will be performed along the course to evaluate the progress in achieving the learning outcomes. Should the student not to perform such tests or reach a qualification below 3.5, the student will have to perform a final test covering all the subjects of the course.

Personal reflection on the learning process

- Summary of the learning process. Logbook (5%)

Reasoned summary of the personal learning process divided into the different evidences. The description should identify the difficulties encountered or errors committed and the way they were solved. (Should be a short text not describing 'what' has been learned but 'how' was it learned).

- Self-evaluation or co-evaluation

Each student should evaluate its own level of knowledge reached along the course as well as the contribution of each of the colleagues in the team work. The professor could take those into account when considering the final qualification.

- Other evidences. (Miscellany; hotchpotch) (5%)

Will contain any other evidence that the student considers that has significantly contributed to the learning outcomes and was not provided by the professor. (other exercises, readings, other computer simulations, etc...).

Computer simulation practice

The student will include in the student's portfolio, as an additional learning evidence, any computer file resulting from the computer exercises performed in the Molecular Systems Biology module included within 'Integrated Laboratory VI' together with the corresponding summary document. Nevertheless the Molecular Systems Biology module within 'Integrated Laboratory VI' is formally independent of this course and will not be evaluated here.

Alternatively

Final examination/Retake (only if continuous evaluation is failed) (100%):

Optionally, if the student shows insufficient progress, does not reach the minimum average evaluation level in the progress tests, or if is repeating the semester course, exists the possibility of taking a Final Exam/Retake including all the topics of the course. To be eligible for the retake process, the student should have been previously evaluated in a set of activities equaling at least two thirds of the final score of the course or module. It must be taken into account that if the student takes this option any previous qualification, deriving from the continuous evaluation activities, will be discarded and not considered furthermore.

Other aspects:

- Not Evaluable: Any student not performing at least two thirds (67%) of the evaluation activities described previously will be qualified as 'No Avaluable'. Also any student not reaching the minimum average qualification in the progress tests and not taking the Final Exam/Retake, will be qualified as 'Not Evaluable'.

- Matrícula de honor (MH). Excellent with honor or special mention. Grant a qualification with honor is a personal decision of the professorship responsible of the course. UAB regulations specify that an MH can only be given to students with a final qualification equal or above 9.00. Furthermore, it can only be given up to a 5% of the total number of students enrolled in the course.

- Calendar: The dates of any evaluation activity and those of delivery of the team work will be given during the first class of the course. Those dates could be changed as a result of schedule reorganization or an adaptation to any unknown event at this time. Those changes will always be communicated through the virtual platform (Moodle) as it is understood as the main communication channel between students and professors.

- Plagiarism: Irrespective of any other measure that may be adopted, and according to the actual academic regulations, any irregular action committed by a student resulting in a variation of the result of any evaluation activity, will receive a qualification of zero. Therefore, to copy or let any other one to copy, during a test, and exercise or a practical activity will result in its failure. Should this activity be necessary to pass the course, the complete course will not be passed. Any activity qualified this way cannot be recovered. Therefore the complete course will be failed without the opportunity to pass it during the same semester.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Learning process description	5%	0	0	7, 9, 3
Other evidences	5%	0	0	2, 1, 4, 5, 7, 6, 8, 9, 3, 10
Progres test	45%	4	0.16	2, 1, 5, 6, 3
Solving exercises	25%	0	0	2, 1, 5, 7, 6, 9
Team work	20%	0	0	2, 1, 4, 5, 8, 9, 3, 10

Bibliography

Primary references

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