Subject identification

Subject	11010 - Systems biology
Credits	0.76 in-class (19 hours) 2.24 distance (56 hours) 3 totals (75 hours).
Group	Group 1, 2S
Teaching period	2nd semester
Teaching language	English

Lecturers

Lecturers	Timetable for student attention					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Manuel Alberto Matias Muriel	There are no defined sessions					

Degrees where the subject is taught

Degree	Character	Academic year	Studies
Master's Degree in Physics of Complex Systems	Optional		Postgraduate degree

Contextualisation

This is one of the optional courses of the Structural Module of the master of Physics of Complex Systems. The goal of the course is to highlight some of the design principles of biological systems, and to provide a mathematical framework in which these principles can be used to understand biological networks. Recent research has shown that there are just a few regulatory circuits (also known as motifs) that biological systems used to regulate themselves, and that are found profusely in biological networks.

Requirements

Essential requirements

It is required that the student has taken first the "Dynamical Systems and Chaos" course of this Master.

Skills

This course develops both specific and generic competences.

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Specific

1. E8: To know to characterize generic behavior of dynamical systems and their instabilities..
2. E9: To know stability analysis techniques and know how to build bifurcation diagrams..
3. E11: To know how to apply dynamical systems techniques to physical, chemical, biological and social systems..

Generic

1. TG1: To be able to describe, both mathematically and physically, complex systems in different situations.
2. TG2: To acquire the capacity to develop a complete research plan covering from the bibliographic research and strategy to the conclusions..

Content

Theme content

1. Introduction
   Introduction of the scope and approach of the course. Some basic biological concepts.
2. Transcription Networks
   Basic concepts: activators and repressors. Hill input functions and Michaelis-Menten kinetics. Elements of Transcription Networks. Dynamics of simple gene regulation.
3. Network Motifs I
   Autoregulation: negative and positive.
4. Network Motifs II
   Feed-forward loop gene circuits. Single Input Modules.
5. Network Motifs at work
   Developmental transcription networks. Signal transduction networks. Negative feedback and oscillator motifs. Motifs for information processing.
6. Robustness of biological circuits
   An example: bacterial chemotaxis. Robust patterning and precision in Development.
7. Optimal Gene Circuit Design
   Costs, benefits and fitness functions of biological circuits.

Teaching methodology

In-class work activities

Modality	Name	Typ.Gr.	Description
Theory classes	Theory classes	Large group (G)	Lectures explaining the theoretical concepts given by the professor.

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Modality	Name	Typ.Gr.	Description
Practical classes	Practical sessions	Large group (G)	Resolution of examples, problems, and questions.
Assessment	Oral presentation	Large group (G)	Each student will be given an individualized assignment that covers several of the topics of the course. Besides a written report, the student has to give an oral presentation to the whole class.

Distance education work activities

Modality	Name	Description
Individual self-study	Exercises	The student has to solve exercises assigned and present the solutions in written form.
Individual self-study	Realization of the assignment	The student must solve the individual assignment, prepare a report and organize an oral presentation.
Individual self-study	Study and understanding theoretical concepts	This activity aims at the understanding of the theoretical concepts and techniques explained in the lectures

Riscs especifics i mesures de protecció

Les activitats d'aprenentatge d'aquesta assignatura no comporten riscs específics per a la seguretat i salut de l'alumnat i, per tant, no cal adoptar mesures de protecció especials.

Workload estimate

Modality	Name	Hours	ECTS	%
In-class work activities		**19**	**0.76**	**25.33**
Theory classes	Theory classes	13	0.52	17.33
Practical classes	Practical sessions	5.5	0.22	7.33
Assessment	Oral presentation	0.5	0.02	0.67
Distance education work activities		**56**	**2.24**	**74.67**
Individual self-study	Exercises	21	0.84	28
Individual self-study	Realization of the assignment	25	1	33.33
Individual self-study	Study and understanding theoretical concepts	10	0.4	13.33
	Total	**75**	**3**	**100**

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to

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whether the subject work plan will be carried out through the schedule or through another way included in the Campus Extens platform.

Student learning assessment

Oral presentation

Modality	Assessment
Technique	Oral tests **(Non-recoverable)**
Description	Each student will be given an individualized assignment that covers several of the topics of the course. Besides a written report, the student has to give an oral presentation to the whole class.
Assessment criteria	Accuracy and quality of the work as well as the clarity in the oral exposition.

Percentage of final qualification: 20% following path A

Exercises

Modality	Individual self-study
Technique	Papers and projects **(Non-recoverable)**
Description	The student has to solve exercises assigned and present the solutions in written form.
Assessment criteria	Accuracy of the answers. Clarity and quality of the explanations.

Percentage of final qualification: 50% following path A

Realization of the assignment

Modality	Individual self-study
Technique	Papers and projects **(Non-recoverable)**
Description	The student must solve the individual assignment, prepare a report and organize an oral presentation.
Assessment criteria	Suitability of the introduction and motivation. Accuracy of the work. Clarity of the ideas and explanations. Relevance of the conclusions. Quality of the written report.

Percentage of final qualification: 30% following path A

Resources, bibliography and additional documentation

Basic bibliography

Uri Alon, An introduction to Systems Biology. Design Principles of Biological Circuits, (Chapman & Hall/ CRC, Boca Raton, FL, 2007).

Complementary bibliography

Bruce Alberts et al., Molecular Biology of the Cell, (Garland Science, New York, 2008) (5th Edition)

Other resources

1. J.J. Tyson, K.C. Chen, and B. Novak, *Sniffers, buzzers, toggles*

and blinkers: dynamics of regulatory and signaling pathways in the cell, Curr. Opin. Cell Biol. **15**, 221-231 (2003).
2. R. Milo, S. Shen-Orr, S. Itzkovitz, N. Kashtan, D. Chklovskii, and U. Alon, *Network Motifs: Simple Building Blocks of Complex Networks* Science, **298**, 824-827 (2002).
3. U. Alon, *Network motifs: theory and experimental approaches* Nat. Rev. Genet. **8**, 450-461 (2007)

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