

Modeling Biological Processes

Academic Year:

2018/2019

Course	Bachelor's degree on Bioinformatics				
Scientific Area	Biotechnology				
ECTS Credits	5	Curriculum Unit code	CVD001	Year	3
				Semester	1
				Type	Compulsory
Prerequisites					
Contact Hours					
	Lecture Sessions	22,5	Lecture-Practical Sessions		Practical and Laboratory Sessions
					30
	Tutorial	7,5	Placement		Seminar
	Fieldwork		Other		Autonomous Study
					75
Responsible	Telma Margarida Cotovio Guerra Santos			Position	Adjunct Professor
Lecturers				Position	
Learning Outcomes	<p>This UC goal is to provide students with the mathematical skills to model and simulate biological/biochemical systems from a kinetic/metabolic perspective. This stems from the biochemical systems theory, in which biochemical systems can be modelled using differential equations, encompassing not only kinetics and flows but also regulation processes and compartmentation. This UC also includes models of pharmacokinetic origin.</p>				
Syllabus	<ol style="list-style-type: none"> 1. Modelling enzymatic reactions: enzyme kinetics; mechanisms of activation and inhibition; mathematical modelling of one enzyme systems – mass action laws, power laws and Henri-Michaelis-Menten law 2. Modelling metabolic networks I: using mass action laws and power laws to describe a 1-compartment metabolic system; system analysis under the framework of metabolic control analysis 3. Modelling metabolic networks II: understanding parallel alternative pathways and what triggers switching among them 4. Modelling metabolic networks III: the role of genes, single gene, probabilistic prokaryotic gene and eukaryotic cis-regulatory control modelling 5. Modelling metabolic networks IV: the case of drugs 6. Modelling compartments I: flow between compartments; transporters 7. Modelling compartments II: a basic overview of the cell as a multitude of communicating compartments; inter-compartment signalling as an approach to extracellular modelling 8. Modelling compartments III: pharmacokinetics 				
Teaching Methodologies	<p>Teaching</p> <ol style="list-style-type: none"> 1. 1,5 h weekly demonstrative lectures 2. 1,5 h weekly exercises class that will be focused on show-casing in a large number of simple examples the various mathematical models that arise in this area. 				
Evaluation	<p>Continuous: the work of each hands-on class will be graded and all grades of these classes will be averaged (minimum average grade: 9.5 in 20), contributing 50% to the final UC grade; a final written test (minimum grade: 9.5 in 20) will contribute 50% to the final UC grade.</p> <p>By exam: final exam (minimum grade: 9.5 in 20). The course grade will be the exam grade.</p>				

Evidence of the syllabus coherence with the curricular unit's intended learning outcomes

Chapters 1 to 4 of the syllabus, which rely on biochemical systems theory, form an introduction to the formality of regulation and metabolism, and will introduce students to the basic mathematical formulations of these topics. Chapter 5 will expand the previous knowledge by applying it to drug metabolism. Chapters 6 to 8 will deal with the role of compartmentalization in the various aspects of metabolism and regulation, which will allow students to understand the basics of modelling complex systems like a cell and also allow them to model the action of drugs including their distribution throughout the various tissues and organs. Taken together, all the topic of this UC forms a body of knowledge that will allows students to develop their own projects.

Evidence of the teaching methodologies coherence with the curricular unit's intended learning outcomes

By the end of this UC students will be able to address a number of modelling problems in the area of biochemical processes, by identifying the main variables, describing the problem using a mathematical approach, simulate the system and analyse the results of the simulations. These goals require not only that the students are familiar with the various techniques in biochemical process modelling, which will be introduced to them in lectures, and will be evaluated in written in either test or exam form, but also demands that students know how to apply the different possible approaches, which will be explored in exercise classes, which will also be graded. Completion of this UC requires students to have at least a functional knowledge of both the theoretical and practical topics included in the syllabus.

Bibliography

Fell, D., *Understanding the Control of Metabolism* (Frontiers in Metabolism), Portland Press, ISBN 978-1-855-78047-7.
Bower, J.M., Bolouri, H. (eds.), *Computational Modeling of Genetic and Biochemical Networks*, A Bradford Book, ISBN 978-0-262-52423-0.
Britton, N.F., *Essential Mathematical Biology*, Springer, ISBN 978-1-852-33536-6.
Peters, S.A., *Physiologically-Based Pharmacokinetic (PBPK) Modeling and Simulations: Principles, Methods, and Applications in the Pharmaceutical Industry* Hardcover, Wiley, ISBN 978-0-470-48406-7.

Observations