UAB
Universitat Autònoma de Barcelona

Biosignalling and Metabolism

Code: 100759
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500004 Biology	FB	2

Contact

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Teachers

Ana Paula Candiota Silveira

Teaching groups languages

You can view this information at the end of this document.

Prerequisites

There are no official prerequisites. However, students are expected to have gained knowledge from subjects of the first year of Biology degree, in particular contents from the subjects of Chemistry, Cell Biology and especially the ones related to Structure and function of Biomolecules, such as principles of bioenergetics, enzymology, structure and function of carbohydrates, lipids, proteins and nucleic acids.

Objectives and Contextualisation

The subject Biosignalling and Metabolism is the second part of the subject "Biochemistry" of the Biology Degree dealing with processes related to living organisms functioning, in each organizational level, from a basic and general point of view, as expected from a second-course subject. The general objective of this subject is to describe the signal transduction mechanisms, as well as the main metabolic pathways and their regulation and coordination at the molecular level. It has the goal of providing the basics of the molecular and metabolic aspects necessary for the follow-up of various subjects of the Degree in Biology.

Specific objectives of the subject:

- To get familiarized with the main molecular mechanisms of signal transduction.

- To describe the main metabolic pathways of carbohydrates, lipids, and nitrogen-containing compounds, their regulation and coordination.

- To describe the components of the electron transport chain, its coupling with oxidative phosphorylation and the production of metabolic energy.

- To describe photosynthesis and its regulation.

- To describe the integration of metabolism with special emphasis on mammals.

- Application of the knowledge acquired for solving qualitative and quantitative problems.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Apply statistical and computer resources to the interpretation of data.
- Be able to analyse and synthesise
- Be able to organise and plan.
- Carry out functional tests and determine, assess and interpret vital parameters.
- Isolate, identify and analyse material of biological origin.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Obtain information, design experiments and interpret biological results.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
- Understand the processes that determine the functioning of living beings in each of their levels of organisation.

Learning Outcomes

1. Analyse a situation and identify its points for improvement.
2. Apply statistical and computer resources to the interpretation of data.
3. Be able to analyse and synthesise.
4. Be able to organise and plan.
5. Calculate and interpret the kinetic and thermodynamic parameters that define enzyme reactions.
6. Correctly describe the principal metabolic pathways and their mechanisms of control and integration.
7. Correctly use the terminology of biochemistry and its text and reference books.
8. Critically analyse the principles, values and procedures that govern the exercise of the profession.
9. Describe on the molecular scale the mechanisms that operate in the cell: the replication of genetic material, its expression in the form of proteins and, finally, metabolism.
10. Describe the components of the electronic transport chain, its coupling with oxidative phosphorylation and the generation of metabolic energy.
11. Describe the metabolism of glucids, lipids, amino acids and nucleotides.
12. Identify the most suitable experimental approaches to study the structure and function of biomolecules.
13. Propose new methods or well-founded alternative solutions.
14. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.

15. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
16. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
17. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
18. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
19. Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
20. Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.

Content

THEORY

Topic 1. Basics of metabolism.

Concepts of metabolism and metabolic pathway. Stages of metabolism. Free energy in biological processes. Coupled reactions. Role of ATP and other phosphorylated compounds in metabolism. Oxide-reductions in biochemical processes. Role of the electron transporters in metabolism.

Topic 2. Basic concepts of metabolic regulation.

Regulation of enzymatic activity. Allosteric enzymes. Regulation by covalent modification. General aspects of gene expression regulation. Control and compartmentalization of metabolic pathways.

Topic 3. Biosignalling.

Hormones, neurotransmitters, and other primary messengers. Membrane and intracellular receptors. Molecular mechanisms of signal transduction. Integration of effects at cytoplasmic and nuclear levels.

Topic 4. Carbohydrate metabolism.

Degradation of glucose: glycolysis and of pentose phosphate pathway. Fermentation. Gluconeogenesis. Synthesis and degradation of glycogen. Use of other carbohydrates. Coordination in control of glucose and glycogen metabolism: the importance of tissular metabolic specialization.

Topic 5. Central routes of oxidative metabolism.

Production of acetyl-CoA. The citric acid cycle. Energy yield and regulation. Anaplerotic reactions. The glyoxylate cycle.

Topic 6. Electronic transport and oxidative phosphorylation.

Mitochondrial electron transport chain. Origin and use of reduced substrates.Chemiosmotic coupling: ATP synthase and oxidative phosphorylation. Mitochondrial transport systems. Regulation of oxidative phosphorylation. Energy yield of oxidative metabolism.

Topic 7. Photosynthesis.

The basic process of photosynthesis. Photosynthetic pigments. Absorption of light energy. Electron transport and photophosphorylation. Assimilation of CO_2 and photosynthetic biosynthesis of sugars (Calvin cycle). Regulation of photosynthesis. Photorespiration and C_4 cycle.

Topic 8. Lipid metabolism.

Use of triacylglycerols in animals. Metabolism of lipoproteins. Description and regulation of the fatty acid oxidation pathway. Ketogenesis. Description and regulation of the fatty acids biosynthetic pathway. Biosynthesis of triacylglycerols and phospholipids. Cholesterol metabolism.

Topic 9. Metabolism of nitrogen-containing compounds.

The nitrogen cycle. General characteristics of the synthesis and degradation of amino acids. Metabolic fate of the carbon skeleton of amino acids. Removal of ammonia and the urea cycle. General characteristics of the metabolism of the nucleotides. Biomedical applications of nucleotide analogs: AIDS, cancer.

Topic 10. Integration of metabolism.

Specific tissue metabolism. Coordination between the metabolisms of the liver, muscle (skeletal and cardiac), adipose tissue, and brain. Main regulatory hormones. Stress and adaptations of metabolism.

PROBLEMS

The problems will focus on some aspects of the theory program. They may concentrate on certain aspects, such as the enzymatic reactions of oxidation-reduction, transaminations, etc. A dossier with the problem statements will be delivered through the Virtual Campus.

LABORATORY PRACTICES

There will be two sessions of 4 hours about the following themes:

1- Measurement of the enzymatic activity of pyruvate kinase in rat muscle and liver.

2- Extraction and identification of the lipids present in food.

The protocols and questionnaires will be delivered through the Virtual Campus and students may print and bring them to the practical session.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practice	8	0.32	1, 5, 17, 4
Problem-solving classes	8	0.32	2, 5, 13
Seminar with variable topic (English activity)	2	0.08	20, 19, 8, 16, 7
Theoretical classes	32	1.28	20, 19, 8, 6, 11, 10, 12, 18, 14, 15
Type: Supervised			
Mentoring sessions	6	0.24	1, 13, 3, 4, 7
Type: Autonomous			
Individual study	60	2.4	8, 17, 3, 4
Self-learning exercises	16	0.64	18, 17, 14, 15

Training activities are distributed into four sections: theoretical classes, problem-solving classes, seminars with variable topic and laboratory practical classes, each one with a specific methodology. These activities can be complemented by mentoring sessions if needed.

Theoretical classes

The teacher will explain the contents of the subject matter with audiovisual support which will be further available for students at the "Campus Virtual". The language of the support material will be Catalan, Spanish or English. These sessions will be the most important part of the theoretical section.

Problem-solving classes

During the course, 8 hours will be devoted to problem-solving classes.

Students will be divided into 2 subgroups, and lists with the composition of groups will be made available at the course starting. Students should attend the classes planned for his/her subgroup.

At the beginning of the semester, a problem statement dossier for the course will be distributed through the Virtual Campus, which will be solved throughout the sessions. In a limited number of sessions spread throughout the semester, the problem instructors will present the necessary experimental and calculation principles to work on the problems, explaining the guidelines for their resolution. Students will work on the problems outside of class hours. The in-person sessions will be dedicated to solving problems previously worked on outside the classroom. Students, in groups of 3-4, will discuss their solutions to the problems/cases and defend them in class.

Seminars with variable topic (activity in English)

They will be conducted in the same subgroups as the problem-solving classes. The topic will be related to the course but will not be part of the theoretical syllabus and will not be subject to evaluation. The session planning consists of a 5-minute presentation per group of students, on a topic to be definedjointly.

Laboratory practice

Students will be divided into eight subgroupsand group compositions will be announced in advance. In order to ensure proper development and safety of practical sessions, only changes clearly justified and previously agreed with theory and laboratory teachers will be accepted. It is mandatory that moving a student towards another group is accompanied by the corresponding change from a student of the other group. Students should attend to the class with lab coat, chemical safety googles, the practice protocols printed and read (they will be made available through "Campus Virtual"), and a notebook to write down data obtained in class.

On the established days, students will be called to the Biochemistry laboratory to perform basic experiments for biomolecules properties determination and analysis. The lab work and its evaluation will be performed in groups of two or other compositions suggested by the corresponding teacher. After each session, a questionnaire may be delivered by each group with results and answers to the proposed questions.

Mentoring sessions

These sessions will be individual and planned according to students' requests. The objective of these sessions is to solve queries, refresh basic concepts and sources for consulting, and foster discussions about self-learning issues, or issues proposed by teachers. These sessionswill not be expository and will not 'advance' in official subjects, being devoted to discussion.

Resources available at "Campus Virtual"

Teaching guide

Slides from theoretical classes

Laboratory practice protocols

List of self-learning themes and suggested reading sources

Schedule of teaching activities (theoretical/problem classes, laboratory practices, evaluations)

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Laboratory work evaluation	10	8	0.32	1, 5, 12, 17, 4
Problem-solving exams	20	3	0.12	2, 5, 13, 17, 16, 15
Theoretical exams	70	7	0.28	20, 19, 8, 9, 6, 11, 10, 18, 17, 14, 3, 7

This subject will have a continuous performance evaluation. The objective of the continuous evaluation is to foster students' efforts along the different topics, as well as monitoring their understanding and progress.

Theoretical evaluation:

Individual evaluation consisting of:

- Two partial exams with multiple choice and also development questions. The weight of each partial exam is 30% of the overall global score. There are no requirements for attendance.

- One retake exam with multiple choice questions and development questions corresponding to the first or second partial exams. To be eventually eligible for the application of the retake process for final grading, the student should have been evaluated in a set of activities equaling at least two thirds of the final score of the course or module. Thus, the student will be graded as "No Avaluable" (Not Assessable) if the weighting of all conducted evaluation activities, before application of the retake evaluation derived grades, is less than 67% of the final score.

Students obtaining a grade below 4.0 out of 10.0 of one or both partial exams should attend to the retake exam (for the first, second or both partials).

It is possible to improve grades obtained in partial theoretical exams standing for the retake exam. However, the final score will be the one obtained in the retake exam, regardless it is better, equal or worst to the partial exam.

The overall weight of theoretical evaluation will be 60%.

Problem-solving evaluation:

The problem-solving part will have continuous assessment. This will be broken down into three parts: 1) solving problems/cases and defending them in the classroom in groups of 3-4 people (5%); 2) working on and delivering problems in class (5%); 3) individual examination assessment of problems (10%, i.e. 5% each partial exam). Lack of attendance in the problem sessions will negatively impact the individual grade.

The assessment of the problems is continuous throughout the course and will not be recoverable.

The overall weight of problem-solving evaluation will be 20%.

Laboratory practice evaluation:

Group evaluation consisting of:

- Presentation of the obtained results during laboratory work and answers to the proposed questions. Behaviour and conduct in the laboratory will be also taken into consideration.

Attending to the practical sessions is mandatory. Students will be graded as "No Avaluable" (Not Assessable) when absence is above 20% of the planned classes.

Only exceptional and properly justified group changes will be accepted and documentary proof should be provided. In case of justified non-attendance to a practical session and the impossibility to attend to a different group, this session will not be taken into account for calculating the final score.

The overall weight of laboratory practice evaluation will be 10%.

Single Assessment

Students who chose to perform final single assessment might attend to the laboratory practical sessions (PLAB) in presential sessions and must pass; it will have a weight of 10%.

The single assessment will consist of a synthesis examination (with multiple choice questions and also questions to develop) about contents of the whole theory and problems program.

The qualification obtained in the synthesis examination is 80% of the final qualification in the subject; the practical sessions qualification is 10% and the remaining 10% come from problem-solving questions

The single assessment will take place at the same date of the last continuous evaluation examination and will have the same system for retake evaluation. At the same day, students must deliver the solved problems and the questions proposed in the moodle for delivery as commented before. In order to pass the subject, students must have a minimum qualification of 5 /10 in each one of its parts (synthesis examination, PLAB, delivery).

Calculating scores

The three components are indivisible, meaning participation and evaluation in all of them are required to pass the course. The final grade is calculated with the theory component accounting for 60%, the problem-solving component 30%, and the practicals the remaining 10%. The course will be considered passed when the final grade is equal to or greater than 50 out of a maximum of 100.

The course cannot be passed if one or more theory partial exams have a grade lower than 4.0. In this case, the maximum grade that can be recorded will be 4.5.

Other remarks:

Students who are unable to attend an individual assessment due to a justified cause (such as illness, death of a first-degree relative, or accident) and provide the corresponding official documentation to the Degree Coordinator, will have the right to take the assessment on another date.

Students who need to retake the course in the recovery exam will not be eligible for the highest grade of honors ("matrícula d'honor") but can achieve a maximum grade of excellent. Students who take the recovery exam forfeit their partial exam grade, and the final grade will be that of the recovery exam.

Students will receive the grade of "Not Evaluable" when the completed assessment activities account for less than 67% of the final grade. This means that students must have taken both midterm exams if they wish to be eligible for the recovery exam, andabsence from amidterm exam will result in a "Not Evaluable" grade.

Repeating students will not be required to carry out the teaching activities or assessments of the competencies already passed from the second enrollment of the course onwards. These include group work in problem-solving classes, practicals, and submission of assignments.

Bibliography

Due to the request of providing as many remote resources as possible, relevant examples of bibliography fully available through "ARE UAB" (https://www-uab-cat.are.uab.cat/biblioteques/). There are several additional resources, you will find below some preselected ones:

Berg, Jeremy M. ; Tymoczko, John L. ; Stryer, Lubert. Bioquímica: con aplicaciones clínicas . Ingebook (UAB) 2013

ISSN: 9788429194128 (online). 7ª ed. Editorial Reverté

https://bibcercador.uab.cat/permalink/34CSUC_UAB/avjcib/alma991009089459706709

Fromm, Herbert J. Essentials of Biochemistry

ISBN: 978-3-642-19623-2. Springer

https://bibcercador.uab.cat/permalink/34CSUC_UAB/1c3utr0/cdi_askewsholts_vlebooks_9783642196249

Gerald Litwack. Human Biochemistry

ISBN: 978-0-12-383864-3. Academic Press

https://bibcercador.uab.cat/permalink/34CSUC_UAB/1c3utr0/cdi_proquest_ebookcentral_EBC6818682

Donald Voet. Fundamentos de Bioquímica: La vida a nivel molecular

ISBN: 978-607-9356-96-5.

https://bibcercador.uab.cat/permalink/34CSUC_UAB/1eqfv2p/alma991007007959706709

Basic resources that can be borrowed on-site at the faculty library:

Berg, JM, Tymoczko, JL, Gatto, GJ i Stryer, L. "Biochemistry" (2015).Berg, JM, Tymoczko, JL, Gatto, GJ y Stryer, L. "Biochemistry"(2015). 8ª ed. 8ª ed.WH Freeman, New York. WH Freeman, New York.Edició traduïda: "Bioquímica" (2013). Edición traducida: "Bioquímica" (2013).7ª ed. 7ª ed.Ed. Ed.Reverté. Reverté.Traduït de la 7ª ed. Traducido de la 7ª ed.anglesa de l'any 2012. Ed. inglesa del año 2012. Ed.WH Freeman. WH Freeman.www.whfreeman.com/stryerwww.whfreeman.com/stryer

Horton, R., Moran, L., Scrimgeour, G., Perry, M. i Rawn, D. "Principios de Bioquímica" (2007).Horton, R., Moran, L., Scrimgeour, G., Perry, M. y Rawn, D. "Principios de Bioquímica" (2007). 4ª ed. 4ª ed.Ed. Ed.Pearson. Pearson.Traduït de la 4ª ed. Traducido de la 4ª ed.anglesa de l'any 2005, Ed. inglesa del año 2005, Ed.Pearson. Pearson. També hi ha la 5a edició en anglès: Moran, L., Horton, R., Scrimgeour, G., Perry, M., and Rawn, D. 'Principles of Biochemistry' (2013) Pearson International Edition. También existe la 5ª edición en inglés: Moran, L., Horton, R., Scrimgeour, G., Perry, M., and Rawn, D. 'Principles of Biochemistry' (2013) Pearson International Edition.

McKee, T i McKee, JR "Bioquímica. Las bases moleculares de la vida" (2014) 5ª ed.McKee, T y McKee, JR "Bioquímica. Las bases moleculares de la vida" (2014) 5ª ed. McGraw-Hill-Interamericana, Madrid. McGraw-Hill-Interamericana, Madrid.Traduït de la 5ª ed. Traducido de la 5ª ed.anglesa de l'any 2013, ed.

inglesa del año 2013, ed.Oxford University Press. Oxford University Press.També hi ha la 6a edició en anglès 'Biochemistry. También existe la 6ª edición en inglés 'Biochemistry.The Molecular Basis of Life' (2015). The MolecularBasis of Life '(2015).

Nelson, DL i Cox, MM "Lehninger-Principios de Bioquímica" (2014) 6ª.Nelson, DL y Cox, MM "Lehninger-Principios de Bioquímica" (2014) 6ª. ed. ed.Ed. Ed.Omega. Omega. Traduit de la 6ª ed. Traducido de la 6ª ed.anglesa de l'any 2013. També hi ha la 7a edició en anglès (2017). inglesa del año 2013. También existe la 7ª edición en inglés (2017).Ed. Ed.WH Freeman. WH Freeman.www.whfreeman.com/lehninger/ www.whfreeman.com/lehninger/ Tymoczko, JL, Berg, JM i Stryer, L. "Bioquímica. Curso básico" (2014).

Tymoczko, JL, Berg, JM y Stryer, L. "Bioquímica. Curso básico" (2014). 2ª ed. 2ª ed.Ed. Ed.Reverté, Barcelona. Reverté, Barcelona.Traduït de la 2ª ed. Traducido de la 2ª ed.anglesa de l'any 2013. inglesa del año 2013.

Voet D., Voet JG i Pratt CW "Fundamentos de Bioquímica.Voet D., Voet JG y Pratt CW "Fundamentos de Bioquímica. La vida a nivel molecular" (2016) 4ª ed. Ed. Médica Panamericana. Traduït de la 4ª ed. anglesa de l'any 2013. La vida a nivel molecular "(2016) 4ª ed. Ed. Médica Panamericana. Traducido de la 4ª ed.Inglesa del año 2013.

Software

There are no specific software for this subject. However, routine software for text edition, calculation sheet, and PDF reading will be needed.

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	121	Catalan	first semester	morning-mixed
(PAUL) Classroom practices	122	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	121	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	122	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	123	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	124	Catalan	first semester	morning-mixed
(TE) Theory	12	Catalan	first semester	afternoon