Biochemistry II

Code: 100876
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500252 Biochemistry	FB	2

Contact

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Teaching groups languages

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

Prerequisites

There are no official prerequisites. However, it is assumed that the student has acquired the knowledge taught in previous courses of the first year of the degree of Biochemistry, in particular the contents of those of Organic Chemistry of Biochemical Processes, Microbiology, Histology, Cell Biology and in particular of Biochemistry I, such as those referring to principles of bioenergetics, enzymology, structure and function of carbohydrates, lipids, proteins and nucleic acids.

Objectives and Contextualisation

The subject Biochemistry II constitutes the second part of the subject "Biochemistry" of the Degree in Biochemistry. Biochemistry II covers the basic aspects of the metabolic pathways, the associated energy changes, their physiological significance, their interconnections and response to biological signals from a basic and general point of view, as corresponds to a second year subject. The general objective of the subject is to provide the students the basics of the metabolic aspects necessary for the follow-up of many subjects of the Degree in Biochemistry.

Specific objectives:

- Describe the general mechanisms through which living beings obtain and transform the energy of the environment.

- To know the main molecular mechanisms for the transduction of biological signals.

- Describe the transporters of metabolites through the membranes.

- Describe the central pathways of the metabolism of carbohydrates, lipids, amino acids and nucleotides.

- Know the components of the electronic transport chains, their coupling with oxidative phosphorylation or photophosphorylation, and how metabolic energy is obtained.

- Give an overview of the interconnections between the metabolic pathways, as well as the mechanisms that regulate them in a coordinated way and their alterations in various physiopathological situations.

- Know how to apply the acquired knowledge to solve qualitative and quantitative problems.

- Know how to handle the bibliography and apply the information resources for the search of information.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Collaborate with other work colleagues.
- Describe intercellular and intracellular communication systems that regulate the proliferation, differentiation, development and function of animal and plant tissues and organs.
- Describe metabolic routes, their interconnections and their physiological significance, and also understand the mechanisms that regulate their activity to satisfy physiological needs.
- Interpret experimental results and identify consistent and inconsistent elements.
- Introduce changes in the methods and processes of the field of knowledge to provide innovative responses to the needs and demands of society.
- Manage bibliographies and interpret the information in the main biological databases, and also know how to use basic ICT tools.
- Manage information and the organisation and planning of work.
- Read specialised texts both in English and one's own language.
- 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.
- Use ICT for communication, information searching, data processing and calculations.

Learning Outcomes

1. Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
2. Collaborate with other work colleagues.
3. Correctly use the terminology of biochemistry and its text and reference books.
4. Describe correctly the structural and thermodynamic bases of cell bioenergetics and transport across membranes.
5. Describe the metabolism of glucids, lipids, amino acids and nucleotides.
6. Identify the components of the electronic transport chain, its coupling with oxidative phosphorylation and the generation of metabolic energy.
7. Identify the principal metabolic pathways and their mechanisms of control and integration.
8. Interpret experimental results and identify consistent and inconsistent elements.
9. Introduce changes in the methods and processes of the field of knowledge to provide innovative responses to the needs and demands of society.
10. Manage information and the organisation and planning of work.
11. Read specialised texts both in English and one's own language.
12. Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
13. Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
14. Understand the molecular mechanisms responsible for signal transduction.
15. Use ICT for communication, information searching, data processing and calculations.

Content

Theory.

Topic 1. Basic concepts of metabolism.

Energy needs of living things. Laws of Thermodynamics. Free energy in biological processes. Sources of energy and carbon in living things. Metabolism and metabolic pathways. Phases of metabolism. Concept of homeostasis. Free energy changes from chemical reactions. Coupled reactions. Role of ATP and other phosphorylated compounds in metabolism. Energy transfers in metabolism. Oxide-reductions in biochemical processes. Role of electron transporters in metabolism. Control and compartmentalization of metabolic pathways. Experimental methods for the study of metabolism.

Topic 2. Biosignaling.

Characteristics of signal transduction processes. Hormones, neurotransmitters, growth factors and other primary messengers. Membrane and intracellular receptors. Molecular mechanisms of signal transduction. Integration of cytoplasmic and nuclear effects.

Topic 3. Carbohydrate metabolism.

Glucose transporters. Glucose degradation: glycolysis. Fermentations. Gluconeogenesis. Cori Cycle. Regulation of glycolysis and gluconeogenesis. Phosphate pentose pathway.

Topic 4. Glycogen metabolism and coordination in the control of carbohydrate metabolism.

Glycogen synthesis and degradation. Coordination in the control of glucose and glycogen metabolism. Metabolism of other carbohydrates and other pathways of glucose metabolism.

Topic 5. Central routes of oxidative metabolism.

Metabolic pathways leading to the formation of acetyl coA. The pyruvate dehydrogenase complex. Citric acid cycle. Energy efficiency and regulation. Amphibolic nature of the cycle: connections with biosynthetic pathways. Anaplerotic reactions. Glyoxylate cycle.

Topic 6. Electronic transport and oxidative phosphorylation.

Mitochondrial electronic transport chain. Origin and use of reduced substrates. Chemiosmotic coupling: ATP synthase and oxidative phosphorylation. Mitochondrial transport systems. Regulation of oxidative phosphorylation. Energy balance of oxidative metabolism (example of glucose). Protein uncouplers and thermogenesis. Photosynthesis: Electronic transport and photophosphorylation. Comparison between photosynthesis and oxidative phosphorylation. Regulation of photosynthesis. Photorespiration and C4 cycle.

Topic 7. Metabolism of lipids.

Use of triacylglycerols in animals. Lipoprotein metabolism. Description and regulation of the oxidation pathway of fatty acids. Ketogenesis. Fatty acid biosynthesis: Activation of acetyl-CoA and fatty acid synthase. Elongation of the carbon chain and formation of unsaturations in fatty acids. Biosynthesis of triacylglycerols and phospholipids. Metabolism of cholesterol and its derivatives.

Topic 8. Metabolism of nitrogen compounds: Metabolism of amino acids.

Nitrogen cycle. General characteristics of amino acid synthesis and degradation. Destiny of the carbon atoms of amino acids. Ammonia removal and urea cycle. Hemo metabolism.Synthesis of amines of biological interest.

Topic 9. Nitrogen compound metabolism: Nucleotide metabolism.

General characteristics of the metabolism of purine and pyrimidine nucleotides. Deoxyribonucleotide synthesis: Regulation of ribonucleotide reductase. Biomedical applications of glutamine and nucleotide analogues: AIDS, cancer.

Topic 10. Integration of metabolism.

Metabolic specialization of tissues. Metabolic characteristics of the liver, muscle and adipose tissue. Metabolic adaptations to various pathophysiological situations: changes associated with various nutritional states, exercise and the effects of stress. Metabolic disorders in diabetes and obesity. Biotransformation and detoxification of drugs.

PROBLEMS

The problems refer to some aspects of the Theory program. The characteristics of the various parts of the syllabus mean that problem statements can focus on certain aspects such as enzymatic reactions (oxidation-reduction, chemical group transfer, etc.) that are used in various stages of metabolism, its regulation in response to the activation of different signaling pathways and its importance in various pathophysiological conditions. Problem statements will be delivered through the Virtual Campus in advance of the class of problems to be addressed.

Delivery of works by the Virtual Campus:

Two works will be proposed through the Virtual Campus, which will have to be solved by the teams (of three / four people) of students formed at the beginning of thecourse. THe work must be submitted before a specific date, announced through the Virtual Campus.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problems classes	10	0.4	15, 2, 14, 4, 5, 10, 6, 7, 8, 11, 3
Theory classes	35	1.4	1, 13, 12, 14, 4, 5, 6, 7, 8, 9, 11, 3
Tutorials	6	0.24	14, 4, 5, 6, 7, 8, 3
Type: Supervised			
Submission of homework by the Virtual Campus	12	0.48	15, 14, 4, 5, 10, 6, 7, 8, 11, 3
Type: Autonomous			
Study - autonomous work	72	2.88	

The subject of Biochemistry consists of theoretical classes, classes of resolution of practical cases and problems, delivery of works by the Virtual Campus and tutorials.

Theory classes:

The content of the theory program will be taught by the teacher in the form of master classes. The presentations used by the teacher in class will be available to students on the Virtual Campus of the subject in advance of the beginning of each of the topics of the course. These expository sessions will constitute the most important part of the theory section. It is recommended that students regularly consult the books recommended in the Bibliography section of this teaching guide in order to consolidate and clarify, if necessary, the contents explained in class.

Classes of problems:

It is intended that these classes serve to consolidate the contents previously worked in the theory classes and for the student to become familiar with some of the experimental strategies used in biochemistry, with the interpretation of scientific data and the resolution of problems based on real experimental situations.

For the classes of problems, the students will be divided into two groups (A and B) whose lists will be made public at the beginning of the course. The student must consult which group he belongs to and attend the classes corresponding to his/her group.

There will be 10 sessions of problems for each group, which will be dedicated to the resolution of practical cases and experimental problems related to the contents of the theory program. The statements of the problems of the subject that will be solved throughout the sessions will be delivered through the Virtual Campus.

In a limited number of sessions distributed throughout the semester, the teacher will present the experimental and calculation principles necessary to work on the problems, explaining the guidelines for their resolution and, if necessary, teaching a complementary part of theory to facilitate their resolution. The Virtual Campus tool will indicate the problems that will be solved in each session. Students will work on these problems outside class hours, in work groups of three to four people that will be organized at the beginning of the semester and will be maintained throughout the course. When the session arrives, each of the problems will be solved by one of the different working groups, chosen at random. After each session, the groups of students who have solved the problems, will deliver the final resolution that will be deposited in the Moodle classroom. During some sessions, statements will be proposed that will be solved immediately. The teacher will ensure that all groups could publicly explain their problem-solving proposals throughout the semester. As indicated in the evaluation section, the public resolution of the problems will be considered in the final grade.

Submission of works for the Virtual Campus:

Periodically, a set of questions will be proposed through the Virtual Campus that students must solve before a specific date.

The student will send the answers to the teacher through the file delivery tool of the Virtual Campus. The file must be in pdf format, not being able to exceed the maximum file size allowed by the platform. It should be remembered that this application does not allow the delivery of files beyond the established deadline.

This activity aims to work on the competence of teamwork, by organizing students in work groups in which all members must actively participate in the resolution of questions.

The methodology of this activity will be the following:

- At the beginning of the course students will be organized in groups of three/four people, registering the groups through the Virtual Campus before the deadline indicated by the teacher.
- The groups will work on the questions indicated for this activity outside class hours.
- The works will be delivered through the Virtual Campus. The qualification obtained will be applicable to all members of the work group to which the student belongs.

The statements of the deliveries will be published through the Virtual Campus where the delivery dates will also be indicated.

Tutorials

Individual tutorials will be held at the request of the students. If the number of applications is extremely high, especially for partial exams, a classroom tutorial could be carried out before each theory partial (two in total), which will be announced in a timely manner through the Virtual Campus. The objective of these sessions will be to resolve doubts, review basic concepts and guide on the sources of information consulted. These sessions will not be expository nor in them will advance matter of the official agenda but will be sessions of debate and discussion.

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
Evaluation of homework sent by the Virtual Campus	10%	6	0.24	15, 14, 4, 5, 10, 6, 7, 8, 11, 3
Evaluation of problems	20%	3	0.12	2, 14, 4, 5, 6, 7, 8, 3
Theory partial exams or unique final examination	70%	6	0.24	1, 13, 12, 14, 4, 5, 6, 7, 8, 9

This subject includes two types of assessment: continuous and unique.

Continuous assessment.

The objective of continuous assessment is to encourage students' effort throughout the course, allowing them to evaluate their degree of follow-up and understanding of the subject.

Theory (70% of the overall grade)

Individual evaluation through:

Two partial tests with multiple-choice questions and short questions, which will be eliminatory if their qualification is equal to or greater than 4 (out a maximum grade of 10). The weight of each test will be 35% of the overall grade.

A test of recovery of theory partials with multiple-choice questions and short questions corresponding to the first and / or second partials. Students who have obtained a grade lower than 4.0 (out of 10) in the previous exam of one or both partials will have to take the recovery exam of the corresponding partial (s) (first partial, second partial or both). To participate in the recovery, students must have been previously evaluated in a set of activities whose weight equals to a minimum of two thirds of the total grade of the subject or module. Therefore, students will obtain the "non-Valuable" qualification when the evaluation activities carried out have a weighting of less than 67% in the final grade.

The total weight of the theory evaluation will be 70% of the overall grade.

Evaluation by the Virtual Campus: (10% of the overall grade)

Periodically (2 times during the course), a set of questions will be proposed that must be solved before a specific date. The works prepared in groups of 3 or 4 people will be delivered through the Virtual Campus. For the assessment, not only the correct resolution of the work but also its approach and presentation will be considered. The whole group will receive the same grade. If deemed necessary, the teacher may request that a questionnaire regarding the group's work be completed individually. Although the results of this questionnaire will not initially have a specific weight in the grade of the subject, in case of detecting negative evaluations of a person by the rest of the members of their group that show that they have not participated in the work, the qualification obtained by the group will not be applied or may be reduced. The total weight of the evaluation by Virtual Campus will be 10% of the overall grade.

Problems (20% of the overall grade)

1-Individual evaluation:

There will be a test where problems related to those previously treated in the classes of problems will have to be solved. This test will be done shortly after the end of the problem classes. The weight of this test will be 15% of the overall grade.

The exam of recovery of problems will be done simultaneously with the test of recovery of the partials of theory. Students who have not obtained a grade equal to or greater than 4.0 (out of 10) in the problem test will have to take the problem recovery exam.

The weight of the individual evaluation of problems will be 15% of the overall grade.

2- Team evaluation:

During the classes of problems it will be necessary to work in a team to solve the problems, which will be exposed in class and will be evaluated. This activity will be done in groups of 3-4 students. The weight of the evaluation of team problems will be 5% of the overall grade.

The total weight of the evaluation of problems will be 20% of the overall grade.

In all cases, in addition to knowledge, the acquisition of written communication skills will be considered.

Examination-based unique assessment.

Theory (70% of the overall grade)

Individual evaluation through:

A final test, which will be carried out simultaneously with the second partial exam of the subject, in which the subject will be that of the whole subject. In this test there will be multiple choice questions and short questions. The weight of this test will be 70% of the overall grade.

Deliveries through the Virtual Campus: (10% of the overall grade).

The content and rules of this section are the same as those described under the heading of continuous assessment.

Problems (20% of the overall grade).

There will be a test where problems related to those previously treated in the classes of problems will have to be solved. This test will be done shortly after the end of the problem classes. The weight of this test will be 15% of the overall grade. Students who have chosen the single assessment will have to solve a supplementary problem that will be formulated (and delivered) through the virtual campus tool, which will have a weight of 5% of the overall grade.

In all cases, in addition to knowledge, the acquisition of written communication skills will be taken into account.

Theory and/or problem recovery test.

Students who have obtained a grade lower than 4.0 (out of 10) in the single assessment test, in the theory and / or problems part, will have to take the corresponding recovery exam: theory and / or problems.

Global evaluation of the subject.

In case of continuous evaluation, the global evaluation of the subject will include the qualifications of the two partial theory tests, the problem test, as well as the delivery of group work. Out of a total of 10 points, it will be necessary to obtain a global grade equal to or greater than 5 points to pass the subject.

In the case of single assessment,the overall evaluation of the subject will include the qualification of the final theory test and the problem test, as well as the delivery of group work. Out of a total of 10 points, it will be necessary to obtain a global grade equal to or greater than 5 points to pass the subject.

Students who cannot attend an individual assessment test for justified reasons (such as illness, death of a first-degree relative or accident) and provide the corresponding official documentation to the teacher or degree coordinator, will be entitled to take the test in question on another date.

The three sections (Theory, Problems and Works by Virtual Campus) are inseparable, so that the student must participate, and be evaluated, in all three to pass the subject.

Bibliography

Basic bibliography (alphabetical order)

Appling, Dean Ramsay, Spencer J Anthony-Cahill, and Christopher K Mathews. *Biochemistry: Concepts and Connections / Dean R. Appling; Spencer J. Anthony-Cahil; Christopher K. Mathews.* Second edition. Harlow, England: Pearson Education Limited, 2019. Print.

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Berg, Jeremy M. (Jeremy Mark) et al. *Biochemistry / Jeremy M. Berg, Gregory J. Gatto, Jr., Justin K. Hines, Jutta Beneken Heller, John L. Tymoczko, Lubert Stryer*. Tenth edition. New York: Macmillan Learning, 2023. Print.

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Nelson, David L. (David Lee) et al. *Lehninger Principles of Biochemistry / David L. Nelson, Michael M. Cox, Aaron A. Hoskins.* 8th edition. New York, NY: Macmillan International Higher Education., 2021. Print.

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Voet, Donald, Judith G Voet, and Charlotte W Pratt. *Voet's Principles of Biochemistry / Donald Voet, Judith G. Voet, Charlotte W. Pratt*. Global edition. Singapore: John Wiley & Sons, 2018. Print.

https://bibcercador.uab.cat/permalink/34CSUC_UAB/1gfv7p7/alma991010604568306709

Specialized Bibliography.

Frayn, K. N. (Keith N.), and Rhys D. (Rhys David) Evans. *Human Metabolism:A Regulatory Perspective / Keith N. Frayn and Rhys D. Evans*. Fourth edition. Hoboken, NJ: Wiley-Blackwell, 2019. Print.

https://bibcercador.uab.cat/permalink/34CSUC_UAB/1gfv7p7/alma991010834534806709

Material available on the Virtual Campus.

Presentations used by the teacher in theory classes.

A dossier with the formulation of the problems to work in problems classes.

Software

Software

Some of the software that will be used during the semester will be:

COPASI.

COPASI is a program to simulate and analyze metabolic networks and their dynamics.

http://copasi.org/

PYMOL.

It is a program for molecular visualization.

https://pymol.org

JSME and CHEMSKETCH.

https://www.acdlabs.com/resources/free-chemistry-software-apps/chemsketch-freeware/

https://jsme-editor.github.io/

Software that allows to draw the structures of chemical structures.

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	321	Catalan	first semester	afternoon
(PAUL) Classroom practices	322	Catalan	first semester	afternoon
(TE) Theory	32	Catalan	first semester	afternoon