Metabolic Biochemistry

Code: 103276
ECTS Credits: 6

2024/2025

Degree	Type	Year
2501922 Nanoscience and Nanotechnology	OB	2

Contact

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Teaching groups languages

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

Prerequisites

The student must have completed the courses "Principles of Biochemistry" and "cell biology" which belong to the basic training of the first year of the degree in Nanoscience and Nanotechnology.

Objectives and Contextualisation

The Metabolic Biochemistry subject constitutes the second part of the subject "Fundamentals of Biochemistry" of *Nanoscience and Nanotechnology* and in it we study the processes that determine the functioning of living organisms in each of its levels of organization from a basic and general point of view, as befits a second year course. The general aim of the course is to describe at the molecular level the mechanisms that take place in a cell, both from the point of view of the transfer of energy, as well as the transmission of signals and description of its metabolism in order to provide the foundations of molecular and metabolic aspects and basic concepts.

Specific objectives of the course:

- Learn about the main mechanisms of transmission of energy.
- Understand the molecular mechanisms of signal transduction.
- Describe the main routes of the intermediary metabolism of carbohydrates, lipids and nitrogen compounds, its regulation and coordination.
- Describe the components of the electronic transport chain, its coupling to the oxidative phosphorylation and the obtaining of metabolic energy.
- Know how to apply the knowledge studied for qualitative and quantitative problem solving.

Competences

- Adapt to new situations.
- Apply the concepts, principles, theories and fundamental facts of nanoscience and nanotechnology to solve problems of a quantitative or qualitative nature in the field of nanoscience and nanotechnology.
- Apply the general standards for safety and operations in a laboratory and the specific regulations for the use of chemical and biological instruments, products and materials in consideration of their properties and the risks.
- Be ethically committed.

- Communicate orally and in writing in one's own language.
- Demonstrate knowledge of the concepts, principles, theories and fundamental facts related with nanoscience and nanotechnology.
- Handle the standard instruments and materials of physical, chemical and biological testing laboratories for the study and analysis of phenomena on a nanoscale.
- Interpret the data obtained by means of experimental measures, including the use of computer tools, identify and understand their meanings in relation to appropriate chemical, physical or biological theories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
- Operate with a certain degree of autonomy.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise the terms used in the fields of physics, chemistry, biology, nanoscience and nanotechnology in the English language and use English effectively in writing and orally in all areas of work.
- Resolve problems and make decisions.
- Show motivation for quality.
- Show sensitivity for environmental issues.
- Work correctly with the formulas, chemical equations and magnitudes used in chemistry.

Learning Outcomes

1. Adapt to new situations.
2. Be ethically committed.
3. Communicate orally and in writing in one's own language.
4. Correctly handle the separation and analysis equipment used in biochemistry and molecular biology laboratories.
5. Correctly resolve energy metabolism problems.
6. Correctly use the necessary computer tools to interpret and expose the results obtained.
7. Evaluate the danger and risks of the use of samples and reagents, and apply suitable safety precautions for each case.
8. Identify and distinguish the protocols for using complex equipment for characterisation, analysis and manipulation of biomolecules and cells.
9. Identify and situate safety equipment in the laboratory.
10. Identify the mechanisms for synthesis and degradation of biomolecules, and their regulation.
11. Justify the results obtained in the laboratory from biomolecule separation, purification and characterisation processes on the basis of knowledge on their structure and properties.
12. Learn autonomously.
13. Manage the organisation and planning of tasks.
14. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
15. Operate with a certain degree of autonomy.
16. Propose creative ideas and solutions.
17. Reason in a critical manner
18. Recognise the English terms employed in biochemistry, molecular biology, microbiology, immunology and in subjects related with nanoscience and nanotechnology.
19. Recognise the energy bases of metabolism.
20. Resolve problems and make decisions.
21. Safely handle chemical and biochemical reagents.
22. Safely use laboratory instruments used in biochemistry, microbiology, cell cultures and bioanalysis.
23. Show motivation for quality.
24. Show sensitivity for environmental issues.
25. Understand texts and bibliographies in English on biochemistry, molecular biology, microbiology, immunology and in subjects related with nanoscience and nanotechnology.
26. Use the suitable strategies for the safe elimination of reagents, microorganisms, cells and nanomaterials.

27. Work correctly with the formulas, chemical equations and magnitudes used in chemistry.

Content

THEORY

Unit 1. Basic concepts of metabolism.

The concept of metabolism and metabolic pathway. Stages of metabolism. Free energy for biological processes. Coupled reactions. Role of ATP in metabolism and other phosphorylated compounds. Oxido-reductions in biochemical processes. Role of electron transporters in the metabolism. Control and compartmentalization of metabolic pathways. Mechanisms of enzymatic catalysis.

Unit 2. Biosignaling mechanisms.

Hormones, neurotransmitters and other primary messengers Intracellular and membrane receptors. Molecular mechanisms of signal transduction. Integration of nuclear and cytoplasmic effectors.

Unit 3. Metabolism of carbohydrates.

Degradation of glucose: Glycolysis and via of the phosphate pentoses. Fermentation. Gluconeogenesis. Synthesis and degradation of glycogen. Use of other carbohydrates. Coordination in the control of the metabolism of glucose and glycogen: importance of the metabolic specialization of the tissues.

Unit 4. Central routes of the oxidative metabolism.

Production of acetyl-CoA. Citric acid cycle. Energy performance and regulation. Anaplerotic reactions. Glyoxylate cycle.

Unit 5. Electronic transport and oxidative phosphorylation

Mitochondrial electronic transport chain. Origin and use of small substrates. Quimiosmotic coupling: ATP synthase and oxidative phosphorylation. Mitochondrial transport systems. Regulation of the oxidative phosphorylation. Energy balance of oxidative metabolism.

Unit 6. Photosynthesis.

Basic process of photosynthesis. Photosynthetic pigments. Light energy absorption. Electronic transport and photophosphorylation. Assimilation of the CO_2 and biosynthesis of photosynthetic carbohydrates (Calvin cycle). Regulation of photosynthesis. Fotorespiration and C_4 cycle.

Unit 7. Metabolism of lipids.

Use of triacilglicerols for animals. Lipoprotein metabolism. Description and regulation route of fatty acids oxidation. Cetogenesis. Description and regulation of the biosynthesis of fatty acids. Biosynthesis of triacilglicerols and phospholipids. Metabolism of cholesterol.

Unit 8. Metabolism of nitrogenous compounds.

The nitrogen cycle. General characteristics of the synthesis and degradation of amino acids. Fate of the carbon atoms of the amino acids. Removal of ammonia and the urea cycle. General characteristics of nucleotide metabolism. Biomedical applications of nucleotide analogues.

Unit 9. Integration of metabolism.

Tissue-specific metabolism. Coordination between the metabolism of the liver, muscle (skeletal and cardiac), adipose tissue and the brain. The main regulatory hormones. Adaptation of metabolism to diverse physiological conditions.

PROBLEMS

The problems refer to some aspects of the theory. The particularities of the some parts of the theory determine that the practical problems focus only in specific themes, such as enzymatic reactions of oxidation-reduction, specific steps of the metabolic pathways, etc. The problems' list will be delivered at the beginning of the semester through the Moodle/Virtual Campus site.

LABORATORY PRACTICE

There will be three sessions of 5 hours each:

1-determination of the concentration of ethanol in alcoholic beverages.

2-determination of Pyruvate kinase activity in the liver and muscle of rat.

3-identification and extraction of lipids present in the food.

The script and the practices will be posted at the beginning of the academic year at the Moodle/Virtual Campus of the subject and the students are required to print it and bring it the day of the first practice session.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	30	1.2	10, 12, 18, 19, 25
Practicum	15	0.6	4, 6, 9, 11, 13, 15, 17, 20, 21, 22, 27
Problems teaching	8	0.32	5, 12, 17, 20, 27
Type: Supervised			
Tutories	6	0.24	3, 12, 13, 17, 20
Work submission by Virtual Campus	4	0.16	5, 10, 12, 15, 17, 18, 19, 25
Type: Autonomous			
autonomous work	60	2.4	3, 10, 12, 15, 16, 17, 18, 19, 25, 27
problem solving and synthesis project	22	0.88	5, 15, 17, 20, 27

The training activities are divided into three sections: theory lessons, tutorials and laboratory practicals, each of them with their specific methodology. These activities may be complemented by mentoring sessions.

All related information will be available at the virtual campus.

Classes of theory

The teacher will attach at the Virtual Campus the contents of the theoretical lessons together with the support of audiovisual material. All the documentation will be available to students at the Moodle/Virtual Campus site. This support material will be written in Catalan, Spanish or English. The theretical lectures will conform the main part of the theory.

Classes of problems

All problems will be available at the virtual campus. The tacher will provide the answers for some of the problems, selecting the most representative of each type. Additionally, if necessary, the teacher will provide additional subject of theory to solve the problems corresponding to any of the parts.

As indicated later in the evaluation section, the correction of some of these problems will be taken into account in the final qualification, as complementary to the note obtained in the individual assessment.

Synthesis project:

Preparation of a bilbiography project related to some applications of the theoretical contents.

Laboratory practice

It is necessary to come to practical training with lab coat, glasses for protection against splashes, the protocolof practices (available in Moodle/Virtual Campus) printed and previously read and a notebook to jot down observations made and data obtained during the practicum.

In the days set out in the schedule, the students will attend the laboratory session on: Basic Biochemistry Methodology for the determination of properties and analysis of biomolecules. The practices evaluation will be carried out based on a questionnaire related to the results of the experiment and the related theoretical basis. Attendanceat practical training is mandatory, except in cases where there is a proved justified reason. The qualifications of practices attended in previous years will be considered as valid for final evaluation.

Delivery of works by the Moodle/Virtual Campus

At the end of each block of the topics of theory, a collection of questions that must be answered in a given period of time and will be delivered through the Moodle/Virtual Campus tool. The questions will be related to concepts explained in the theory sessions and also with issues of learning that can be found and studied by means of the student autonomous learning.

Tutorials

Individual tutorial sessions will be held at the request of the students. The goal of these sessions will be to solve doubts, revise the basics, and carry out discussions on the topics for which there are programmed autonomous learning or that have been proposed by the teachers.

Material available at the Moodle/Virtual Campus:

Educational guide

Presentations used by teachers in classes of theory

Protocols for the practicum

List and additional learning topics to classes of theory

Calendar of educational activities (Theory and lab classes,tutoring, assessments, deliveries, etc.).

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
Continous evaluation	10	0.5	0.02	5, 19
Practicum questionaire	10	1	0.04	1, 2, 3, 4, 7, 8, 9, 11, 12, 13, 15, 20, 21, 22, 23, 24, 26
Problems Exam	10	1	0.04	3, 5, 6, 20
Synthesis project	10	0.5	0.02	1, 3, 5, 10, 13, 14, 15, 16, 17, 18, 19, 20, 25, 27
Theory Partial or final Exams	60	2	0.08	5, 10, 17, 19

The evaluation of this course will include partial examinations and a final test. The purpose of the continuous assessment is to encourage the efforts of the student throughout the course, allowing the monitoring of the student understanding of the subject. The final test is used to check that the student has achieved the necessary degree of integration of subject knowledge.

Theory

Individual assessment by:

- Two partial tests with multiple-choice questions, the second partial test will be performed the day of the final test. No pre-established requisites will be necessary to do the partial tests.
- A final test with multiple-choice questions that will cover the entire course. The recovery examination is aimed at those students who either have not been able to be present the first and/or second partial or have not obtained a mark higher than 3.3.
- Continuous assessment at the end of each bloc of themes by questions related to the theoretical concepts explained.

Although the tests are partial qualifiers, it is possible to improve the obtained mark on the occasion of the last exam. The second qualification will be considered in case it is better than the one obtained in the first examination. Otherwise, if the grade obtained in the second chance is less than 1 point or more than the first note obtained, the final note will be calculated as the average of the two notes.

For the adjudication of the maximum award of honor qualification preference will be given to the marks obtained in midterms' exam.

The weight of the assessment of theory will be 65% of the total.

Problems

Evaluation by test:

- Two partial tests where you will have to solve a problem for each block of the agenda.
- A final testcorresponding to each of the two partial tests. This exam is aimed at students who have not passed one of the partial tests.

Continuous assessment:

The weight of the continuous assessment of teory and problems will be 5% of the total, including the mark obtained from delivery of responses to continuous assessment tests and

assessment of problems solved during the course: Resolution of problems solved at home or in class and delivered.

Synthesis project

The weight to the synthesis project corresponds to 10%

Practices

Group assessment:

- Presentation of the results questionnaire corresponding to the practical session. It will also be taken into account the attitude and behavior in the laboratory.

Attendance to laboratory practicals is mandatory. Group changes will be accepted only in exceptional circumstances and provided with documentary justification. In case of justified no attendance to any of the practice sessions, the student has the option to do it in a different group than the first assigned. If this is not possible to organize, the session shall not be considered in the calculation of the final practices mark.

The weight of the assessment of practices will be of 10% of the total.

Marks

The three sections are inseparable, so the student must participate and be evaluated in all of them in order to overcome the course. The final grade will be calculated according to the parameters listed in the table presented below, so that the section of the exam of theory has a 65% of the note, the section on problems 10%, the synthesis project a 10%, the practice a 10% and the delivery of Problem/Theory responses to continuous assessment tests with a 5%. The course will be overcame when the final mark is equal to or greater than 50 for a maximum of 100. However, in order to overcome the course it is prerequisite to have achieved at least a note top 30% of each section (theory, problems and practices).

Other considerations

Students who cannot attend a test of individual evaluation for ajustified reason and provide the official documentation to the Grade Coordinator and/or coordinator of the course, shall be entitled to perform the test at a different date.

In any case, students who are in a situation that, with justified cause, could not attend the partial exams, can be evaluated by means of the final exam. In addition, in order to obtain a final grade, laboratory practices are mandatory in all cases.

It is considered that a student will get the grade Not Presented when the assessment of evaluation activities carried out do not allow it to achieve the overall grade of 5 on the assumption that he had obtained the highest grade in all of them. For example, if a student only attends classes and laboratory practices but only examines one of the partial theory, he would have participated in activities that did not provide 50% of the note (see table below) and would have a rating of Not Presented.

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. Thus, the student will be graded as "No Avaluable" if the weighthin of all conducted evaluation activities is less than 67% of the final score.

Rules for improving your mark:

It is possible to improve the note of the midterms exam on the occasion of the Recovery Examination. The second note obtained will be considered as final if this one is higher than the one obtained in the first test.

When the obtained note at the second chance is less than 1 point or more than the first note obtained, the final note considered will be the average of the two notes.

The student will have 10 minutes at the start of the test to decide whether or not to perform the test.

In the decision of the final mark, it will also be considered as an additional criterion the attitude of the students in the class throughout the course.

The students that have passed the practicum or continued evaluation from previous years will not have to attend again the lab course or perform the continued evaluation.

Calculation of the final Mark

Final mark = T * 0.65 +A*V* * 0.05 + Probl * 0.10 + SP * 0.10 + Pract * 0.10

T (Final theory mark: it may be the average of 2 partial or a final exam)

AV-final mark of delivery of responses of continuous assessment

Probl-final mark of exam problems (can be the average of 2 partial or final exam)

AVP (continuous assessment of problems mark)

SP (Synthesis Project)

Pract-practice mark

To pass the course the final mark should be ≥ 5

Single Evaluation Modality:

All Laboratory practices are compulsary.

Students who have chosen the single evaluation modality must take a final test that will consist of a theory exam, where they must develop a topic and must answer a series of short questions. Next, they will have to do a problem test where they will have to solve a series of exercises similar to those that have been worked on in the Classroom Practices sessions. When finished, they will deliver the reports of the practices. The student's grade will be the weighted average of the three previous activities, where the theory exam will account for 80% of the grade, the problem exam 10% and the practice part a 10%. If the final grade does not reach 5, the student has another opportunity to pass the subject through the recovery exam that will be held on the date set by the coordination of the Degree. In this test you can recover 90% of the grade corresponding to the theory and problems. The laboratory part is not recoverable.

Bibliography

Basic bibliography

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Complementary Bibliography:

Integration and control of metabolism / Naa A. Adamafio, Laud K. N. Okine, Jonathan P. Adjimani. iUniverse 2012

Labster Virtual Lab Experiments:Basic Biochemistry. Aaron Gardner · Wilko Duprez Sarah Stauff er · Dewi Ayu Kencana Ungu Frederik Clauson-Kaas. Springer 2019. EBook accessible a la biblioteca UAB

The Leaf: A Platform for Performing Photosynthesis. William W. Adams III, Ichiro Terashima. Springer 2018. EBook accessible a la biblioteca UAB

Web links

You will find updated links in the Moodle/Virtual Campus section.

Software

No specific software is required

Language list

Information on the teaching languages can be checked on the CONTENTS section of the guide.