Universitat Autònoma de Barcelona

2022/2023

Biochemistry

Code: 100938
ECTS Credits: 9

Degree	Type	Year	Semester
2500253 Biotechnology	FB	1	A

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Other comments on languages

The theory classes will be in Catalan, but most of the graphic material and the bibliography will be in English. The seminars and the answers to the questions of the exam can be in Catalan, Spanish or English.

Teachers

Margarida Julià Sapé

Prerequisites

There are not prerequisites to follow the course successfully. Nonetheless it would be desirable if students were familiar with basic knowledge of biology and chemistry.

Much of the literature is in the English language, which is also used in the figures projected in theory classes.

Objectives and Contextualisation

The subject Biochemistry includes a first part that explains the structural and functional characteristics of biomolecules, with a special emphasis on proteins and enzymes. The second part focuses on understanding bioenergetics, biosignaling and the main routes of metabolism. The general objective of this subject is to provide the basis of the biochemistry that are considered necessary for understanding specific subjects of the Degree in Biotechnology.
Specific objectives of the subject:
- To understand the structural characteristics of biological molecules, knowing how to draw conclusions about their stability, their function and their capacity for replication of structures.
- To understand the concepts of enzyme activity and kinetics in the context of biological reactions and their regulation.
- To describe the general mechanisms through which living organisms obtain and transform the energy of the environment.
- To know the main molecular mechanisms of biosignaling.
- To describe the main routes of intermediate metabolism of glucose, lipids and nitrogen compounds, their regulation and coordination.
- To know how to apply the knowledge to solve qualitative and quantitative problems.

Competences

- Describe the molecular, cellular and physiological bases of the organisation, functioning and integration of living organisms in the framework of their application to biotechnological processes.
- Interpret experimental results and identify consistent and inconsistent elements.
- Learn new knowledge and techniques autonomously.
- Obtain information from databases and use the software necessary to establish correlations between the structure, function and evolution of macromolecules.
- Read specialised texts both in English and one's own language.
- Search for, obtain and interpret information from the principal databases on biology, bibliography and patents and use basic bioinformatic tools.
- Use ICT for communication, information searching, data processing and calculations.
- Use analytical methodologies for assaying the biological activity of cellular components, especially enzymes, both in vitro and in vivo.
- Work individually and in teams

Learning Outcomes

1. Assess the suitability of the methods for determining enzyme activities and analyse the effect of the test conditions.
2. Calculate and interpret the kinetic parameters of substrate-enzyme reactions, by means of graphic methods using computer programmes.
3. Correctly use biochemistry terminology and the basic applications of bibliographic databases.
4. Define, at a basic level, the structure and functions of proteins and the biochemical and molecular bases for their folding and post-translational modification.
5. Describe the general properties of enzymes and interpret the basic mechanisms of enzyme catalysis.
6. Describe the principal metabolic pathways of glucids, lipids, amino acids and nucleotides, and their mechanisms of control.
7. Describe the principles of bioenergetics.
8. Explain the basic molecular mechanisms of signal transduction.
9. Explain the general processes for obtaining energy in living beings.
10. Identify molecular structure and explain the reactivity of the different biomolecules: glucids, lipids, proteins and nucleic acids.
11. Identify the principal mechanisms of enzyme inhibition, explain their biological significance and calculate and interpret the corresponding constants.
12. Interpret experimental results and identify consistent and inconsistent elements.
13. Learn new knowledge and techniques autonomously.
14. Possess an integrated vision of metabolism.
15. Read specialised texts both in English and one's own language.
16. Use ICT for communication, information searching, data processing and calculations.
17. Use the basic applications of databases on protein structures and sequences.
18. Work individually and in teams

Content

Lesson 1. Molecular elements and physical environment of living organisms.

Concept of biochemistry. Chemical elements in living organisms. Biomolecules. Structural hierarchy in the molecular organization of cells. Non-covalent interactions in aqueous systems. Biological relevance of water. Water ionization, ionic equilibrium and buffer systems.

Lesson 2. Bioenergetics principles.

Production and use of metabolic energy. Universality of the thermodynamics principles. Life as a process far from equilibrium; biochemical reactions and free energy. Basic processes in bioenergetics: Phosphate transfer and redox reactions. ATP and other phosphorylated compounds. Electron carriers.

Lesson 3. Proteins: primary structure and biological functions.

Protein types and functions. Amino acids structure and properties. Classification. Peptides and peptide bond. Composition and amino acid sequence of proteins. Protein sequence databases. Sequence alignments.

Lesson 4. 3D protein structure.

Levels of protein structure. Description of helix and folded sheets. Fibrous proteins. Globular proteins. Quaternary structure. Protein folding: key factors; chaperones. Conformational diseases. Prions. Protein structure prediction.

Lesson 5. Function and evolution of proteins: oxygen binding proteins.

Oxygen storage: Myoglobin. Oxygen transport: Hemoglobin. Hemoglobin and cooperativity. Analysis of cooperativity. Hemoglobin variants: physiological adaptation and molecular pathology. Examples of protein evolution.

Lesson 6. Carbohydrates.

Types and functions. Monosaccharides, description and properties. Glycosidic bond. Oligosaccharides. Polysaccharides. Glycoproteins and glycolipids. Carbohydrates as information carrier molecules.

Lesson 7. Lipids and biological membranes.

Lipid types and functions. Fatty acids. Storage and membrane lipids. Cholesterol and derivatives. Fat soluble vitamins. Eicosanoids. Lipoprotein structure and function. Biological membranes.

Lesson 8. Biological catalysts.

Nature and function. Enzyme classification and nomenclature. Catalytic effects in chemical reactions: general mechanisms. Description of enzymatic mechanisms. Initial velocity. Enzyme kinetics: the hypothesis of Michaelis-Menten. Enzyme cofactors. Two substrate reactions. Enzyme inhibition. Regulation of enzyme activity: allosteric changes, covalent modifications and changes in the enzyme concentration. Biomedical and biotechnological applications.

Lesson 9. Nucleic acids: Structure levels.

Nucleic acids: nature and function. Nucleotides. The primary structure of nucleic acids. Secondary structure: the model of Watson and Crick and alternative models. Tertiary structure: DNA supercoiling and transfer RNA. Protein-DNA complex: chromosome organization. DNA denaturation and renaturation.

Lesson 10. Introduction to metabolism.

Concept of metabolism and metabolic pathways. Metabolism stages. Control and compartmentalization of metabolic pathways. Experimental approaches for metabolism study.

Lesson 11. Biosignaling.

Hormones, neurotransmitters and other primary messengers. Membrane and internal cell receptors. Molecular mechanisms for signal transduction: receptor enzymes, G protein-coupled receptors and ion channels. Second messengers. Integrated response of different signals both at cytoplasm and nucleus levels.

Lesson 12. Carbohydrate metabolism (1).

Glucose metabolism. Glycolysis. Fermentations. Feeder pathways for glycolysis. Gluconeogenesis. Coordinated regulation of glycolysis and gluconeogenesis. The pentose phosphate pathway.

Lesson 13. Carbohydrate metabolism (2).

Glycogen metabolism: synthesis, breakdown and coordinatedregulation. Coordination in the metabolic control of glucose and glycogen: relevance of metabolic tissue specialization.

Lesson 14. Core routes in oxidative metabolism.

Acetyl-CoA production. Citric acid cycle. Energy balance and control. Anaplerotic reactions. Glyoxylate cycle.

Lesson 15. Electron transport and oxidative phosphorylation.

Mitochondrial electron transport chain. Origin and utilization of reduced substrates. Chemiosmotic coupling: ATP synthase and oxidative phosphorylation. Mitochondrial transport systems. Oxidative phosphorylation control. Energy balance of the oxidative metabolism.

Lesson 16. Photosynthesis.

Basic processes in photosynthesis. Photosynthetic pigments. Energy absorption of light. Electron transport and phosphorylation. CO_2 assimilation and Calvin cycle. Photosynthesis control. Photorespiration.

Lesson 17. Lipid metabolism.

Triglycerides use in animals. Lipoproteins. Description and control of the fatty acid oxidation pathway. Ketogenesis. Description and control of fatty acid biosynthesis pathway. Triglyceride and phospholipid biosynthesis. Cholesterol metabolism.

Lesson 18. Nitrogen compounds metabolism.

Nitrogen cycle. Intracellular degradation of proteins. Basic mechanisms of amino acid degradation. Fate of the carbon skeleton. Ammonia excretion and the urea cycle. Amino acid biosynthesis. Nucleic acid and nucleotide degradation. Nucleotide recovery and *de novo* synthesis. Biomedical applications of nucleotide analogs.

Lesson 19. Metabolism Integration.

Coordination of metabolism between liver, muscle, adipose tissue and brain. Main control hormones. Stress and metabolism adaptation.

Methodology

Biochemistry consists of theoretical classes, classes of resolution problems and tutor sessions. The following describes the organization and the teaching methodology that will be followed in these three types of training activities.

Theory classes:

The content of the theory program will be taught mainly by the teacher in the form of master classes with audiovisual support. Presentations used in class by the teacher will be previously available on the Virtual Campus of the subject. It is recommended to have this material as a class support. It is advisable to consult the recommended books in the Bibliography section of this teaching guide regularly to consolidate and clarify, if necessary, the contents explained in class. It is also advisable to use the links that are indicated in the presentations of the different themes and that contain videos and animations related to the processes explained in class.

Problem classes:

In these sessions the class group will be divided into two groups (A and B). You need to consult which group you belong to and attend the corresponding classes.

These sessions are scheduled during the second semester of the course and will be devoted to the resolution of experimental problems related to the contents of the theory program. It is intended that these classes serve to consolidate the contents previously worked in theory classes and also facilitate the knowledge of the techniques used in biochemistry, the interpretation of scientific data and the resolution of problems based on real experimental situations.

The collection of problems that will need to be worked out will be available on the Virtual Campus.

Tutor sessions

Individual tutorials will be carried out at the request of the students. In the event that the number of applications was high, especially in the face of partial exams, a classroom tutoring could be held before each partial, which would be announced ona timely basis through the Virtual Campus. The objective of these sessions will be to resolve doubts, review basic concepts and guide the sources of information consulted.

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Classes of problem resolution	15	0.6	13, 16, 2, 1, 11, 12, 15, 14, 18, 3, 17
Theory classes	55	2.2	13, 2, 4, 1, 7, 6, 5, 8, 9, 11, 10, 15, 14, 18
Type: Supervised			
Tutor sessions	0	0	4, 1, 7, 6, 5, 8, 9, 10, 14
Type: Autonomous			
Individual work	105	4.2	13, 16, 2, 4, 1, 7, 6, 5, 8, 9, 11, 10, 12, 15, 14, 18, 3, 17
Learning exercises	39	1.56	13, 16, 2, 12, 15, 18, 3, 17

Assessment

The evaluation of this subject will be done with three partial tests and two tests of problem solving.

Individual assessment through:

- Three partial tests with quiz questions and short answer questions. The first one has a weight of 26% of the overall grade. The other two have a weitght of 27% of the overall grade. Minimum score of each test: 3,5 out of 10.
- Two problem-solving tests that will be done on the days of the second and third partial tests. Each one has a weight of 10% of the overall grade. Minimum score of each test: 3,5 out of 10.
-To participate in the recovery the 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 and have obtained a minimum qualification in the average of the subject of 3.5.
-In the case where scores of more than 3,5 have been obtained and the qualifications obtained in one of the partial tests or problem-solving tests are desired, the day in which the recoveries are called, the examination of the part can be carried out corresponding It must be borne in mind, however, that the fact of carrying out one of these recovery tests implies the renunciation of the previous qualification

Global assessment of the subject:

To pass the subject, you must obtain a global grade equal to or greater than 5 points out of 10 and the minimum grade of 3,5 in the three partial tests and the two for solving problems. If in any of these tests the qualification is less than 3,5, the final maximum grade will be 3,5 points out of 10.

The students will obtain the "Non-Valuable" qualification when the evaluation activities carried out have a weighting of less than 67% in the final grade.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Partial exams	80	8	0.32	13, 4, 1, 7, 6, 5, 8, 9, 11, 10, 15, 14, 18, 3
Problem solving	20	3	0.12	13, 16, 2, 1, 11, 12, 14, 18, 17

Bibliography

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web links

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Software

No specific software is required