COURSE PROGRAM

Academic Year: 2024/2025

Identification and characteristics of the course				
Code	501826		ECTS Credits	6
Course name (English)	Biochemistry			
Course name (Spanish)	Bioquímica			
Degree programs	Chemistry			
Faculty/School	School of Sciences			
Semester	2^0	Type of course	Core skills	
Module	Core module			
Matter	Biological Chemistry			
Lecturer/s				
Name		Office	E-mail	Web page
Francisco de Asís Iñesta Vaquera		DBQ9	finestavaquera@unex.es	https://bit.ly/3MvMv8F
Subject Area	Biochemistry & Molecular Biology			
Department	Biochemistry & Molecular Biology & Genetics.			
Coordinating Lecturer (If more than one)				

Competencies
Core skills (CS)1: Students demonstrate knowledge and understanding of a subject area that builds on the foundation of secondary education, and is usually at a level that, while supported by advanced textbooks, also includes some aspects involving insights from the cutting edge of field of study.
CS2: Students know how to apply their knowledge to their work or vocation in a professional way and have the skills that are usually demonstrated through the development and defense of arguments and problem solving within their area of study.
CS3: Students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include reflection on relevant issues of a social, scientific or ethical nature.
CS4: Students transmit information, ideas, problems and solutions to both specialized and non-specialized audiences.
CS5: Students develope those learning skills necessary to undertake further studies with a high degree of autonomy.
Broad Skills (BS)1: Students engage in the intellectually stimulating and satisfying task of the learning process.

BS2: Students develop a special interest in learning Chemistry, valuing its importance in scientific, industrial, economic, environmental and social contexts.
BS3: Students develop a solid and balanced foundation of chemical knowledge and practical skills in a way that enables them to function safely in a chemical laboratory.
BS4: Students develop skills/capacities for understanding, interpretation, application and transmission (orally and in writing) of their chemical, theoretical and practical knowledge.
Transferable skills (TS)1: Ability to, a) Correct use of the method of induction and generation of new ideas. b) Analysis and synthesis. c) Organization and planning. d) Work in an international context. e) Both oral and written expression. f) Critical reasoning. Problem solving. g) Decision making. h) Teamwork (also of an interdisciplinary nature) and leadership to direct and execute the tasks of the chemical laboratory and in complex industrial facilities.
TS4: Development of personal learning skills. Acquisition of skills in interpersonal relationships, leadership, creativity and adaptation to new situations.
TS5: Demonstration of sensitivity towards environmental issues.
TS6: Recognition of diversity and multiculturalism.
TS7: Commitment to respect human rights, equality between men and women, the culture of peace and ethical values.
TS8: Motivation for high quality work.
TS9: Knowledge of a foreign language.
TS10: Use of the most appropriate information and communication technologies (ICTs) in each situation
Specific Skills (SS)13: To know the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes.
SS18: Ability to function safely in a chemical laboratory, which is specified in the handling of products, materials and chemical instrumentation through appropriate methodologies and with strict compliance with the stipulated safety regulations. Risk assessment.
SS19: Evaluation, interpretation and synthesis of data and chemical information. Obtaining, processing and treatment, through computational techniques, of chemical data.
SS21: Interpretation of data derived from observations and measurements in the laboratory.
SS23: Knowledge of a foreign language.
SS24: Use of the most appropriate information and communication technologies (ICTs) in each situation
SS27: Ability to relate Chemistry with other disciplines.

Contents

Course outline

In this course, the structures of the main biomolecules are described in the first place, focusing on the structure-function relationship. The objective is to understand the protein structure, enzymology, the structure and function of carbohydrates, lipids and nucleic acids, and the flow of genetic information.

The second part describes the main metabolic routes of degradation and biosynthesis of biomolecules, their bioenergetic aspects, their regulation and the coordinated functioning that exists between them. Likewise, it will contribute to favoring the understanding of the bases of the interaction of chemical compounds with different metabolic pathways and their effects on cell function. Finally, the potential of biochemical biotechnology in both the chemical and agri-food industries will be highlighted.

The content of this is summarized in the following descriptors: Amino acids, peptides, secondary, tertiary and quaternary structure of proteins. Enzymes and enzyme kinetics. Protein research techniques. Structure and function of carbohydrates and lipids. Biomembranes. Nucleosides and nucleotides. Biosynthesis of DNA, RNA and proteins. Carbohydrate metabolism in animals and plants. Metabolism of fatty acids and nitrogenous compounds. Xenobiotic metabolism.

Course syllabus

Name of lesson 1: INTRODUCTION TO BIOCHEMISTRY.
Contents of lesson 1: Biological structures. metabolic processes. Expression and transmission of genetic information. Biochemistry and Biotechnology.
Description of the practical activities of lesson 1: Not applicable.

Name of lesson 2: COMPOSITION AND STRUCTURE OF PROTEINS.
Contents of lesson 2: Structure, properties and classification of amino acids.
Peptides and peptide bond. Primary, secondary, tertiary and quaternary structure of proteins. Protein structure-function relationship: fibrous proteins, myoglobin, hemoglobin.
Description of the practical activities of lesson 2: Demonstration 1: Determination of protein concentration.

Name of lesson 3: ENZYMES.
Contents of topic 3: Basic concepts. Classification of enzymes. enzyme cofactors. active center. enzyme specificity
Description of the practical activities of lesson 3: not applicable.

Name of lesson 4: ENZYME KINETICS.
Contents of lesson 4: Kinetics of enzymatic reactions. Michaelis-Menten equation. Determination of kinetic parameters. Enzyme inhibition.
Description of the practical activities of lesson 4: Demonstration 3: Kinetics and enzymatic inhibition.

Name of lesson 5: PROTEOMICS RESEARCH

Contents of topic 5: Isolation of proteins. Chromatographic separations: Ion exchange chromatography. Gel filtration chromatography. Affinity chromatography. protein electrophoresis. Spectroscopic techniques. Description of the practical activities of topic 5: Demonstration 2: Molecular exclusion chromatography.
Name of the lesson 6. STRUCTURE AND FUNCTION OF CARBOHYDRATES and LIPIDS Carbohydrates: Monosaccharides and disaccharides. storage polysaccharides. Structural polysaccharides. Lipids: Storage lipids. Fatty acids and triacylglycerols. Structural lipids: phospholipids, sphingolipids, glycolipids, and cholesterol. Description of the practical activities of topic 6: not applicable.
Name of lesson 7: BIOLOGICAL MEMBRANES AND TRANSPORT THROUGH MEMBRANES Contents of lesson 7: Components of biological membranes. Structure and properties of membranes. Transport systems through membrane. Description of the practical activities of lesson 7: Not applicable.
Name of lesson 8: DNA, STRUCTURE AND REPLICATION Contents of lesson 8: DNA structure. Types and function. DNA replication and its regulation. Mutagenesis and repair. recombinant DNA. Description of the practical activities of lesson 8: Not applicable.
Name of lesson 9: RNA STRUCTURE AND TRANSCRIPTION Contents of lesson 9: RNA structure. Types and function. Transcription: RNA biosynthesis and maturation. Regulation of gene expression during transcription. Description of the practical activities of lesson 9: Not applicable.
Name of lesson 10: PROTEIN BIOSYNTHESIS: TRANSLATION Contents of lesson 10: Genetic code. Translation: stages. Description of the practical activities of lesson 10: Not applicable.
Name of lesson 11: PRINCIPLES OF BIOENERGY AND INTRODUCTION TO METABOLISM. Contents of lesson 11: General principles of bioenergetics. Free energy and reaction coupling. Phosphorylated compounds and energy transfer. Electron carriers: reducing power. Introduction to metabolism. Description of the practical activities of lesson 11: Not applicable
Name of lesson 12: GLYCOLYSIS AND GLUCONEOGENESIS. Contents of lesson 12: Glycolysis, enzymatic stages. Pyruvate destinations. Incorporation of other monosaccharides in glycolysis. Gluconeogenesis. Basic aspects of the regulation of glycolysis and gluconeogenesis. Bioenergetics of glycolysis and gluconeogenesis Description of the practical activities of lesson 12: Not applicable
Name of lesson 13: GLYCOGEN METABOLISM. Contents of lesson 13: Glycogen metabolism, general concepts. Glycogen phosphorylase and glycogen synthase Basic concepts of hormonal regulation of glycogen metabolism. Description of the practical activities of lesson 13: Not applicable
Name of lesson 14: PENTOSE PHOSPHATE PATHWAY. Contents of lesson 14: Nature and objectives of the route. oxidative phase. Conversion of pentoses to hexoses. metabolic significance of the pathway. Description of the practical activities of lesson 14: Not applicable

Name of lesson 15: TRICARBOXYLIC ACIDS CYCLE. Contents of lesson 15: Oxidative decarboxylation of pyruvate. Stages of the cycle, global balance. Amphibolic character of the cycle, anaplerotic reactions. Glyoxylate cycle. Basic concepts of the regulation of the tricarboxylic acid cycle. Description of the practical activities of lesson 15: Not applicable
Name of lesson 16: MITOCHONDRIAL RESPIRATORY CHAIN AND OXIDATIVE PHOSPHORYLATION. Contents of lesson 16: Redox reactions in living beings. Respiratory chain: sequence of electronic transport. Mechanism of oxidative phosphorylation: F0F1-ATP synthase. Bioenergetics of breathing. Description of the practical activities of lesson 16: Not applicable
Name of lesson 17: PHOTOSYNTHESIS AND HEXOXE BIOSYNTHESIS IN PLANTS. Contents of lesson 17: Basic aspects of photosynthesis. Light absorption: photosynthetic pigments. Non-cyclic and cyclic transport of electrons. Photophosphorylation. Carbon reactions: stages I and II. Regulation of photosynthesis. Cycle C4. Description of the practical activities of lesson 17: Not applicable
Name of lesson 18: FATTY ACIDS OXIDATION. Contents of lesson 18: Fat reserves, fat mobilization. Transport of fatty acids into the mitochondria. Fatty acids Beta-oxidation: energy balance. Unsaturated fatty acids oxidation. Saturated fatty acids oxidation. Ketone body metabolism. Description of the practical activities of lesson 18: Not applicable
Name of lesson 19: FATTY ACIDS BIOSYNTHESIS. Contents of lesson 19: Formation of malonyl-CoA. Fatty acid synthetase complex: elongation cycle. Subsequent elongation: biosynthesis of unsaturated fatty acids. Regulation of fatty acid metabolism. Description of the practical activities of lesson 19: Not applicable
Name of lesson 20: AMINO ACIDS METABOLISM. Contents of lesson 20: Catabolism of amino acids: destiny of the carbonated skeletons. Biosynthesis of non-essential amino acids. Biosynthesis of essential amino acids. Description of the practical activities of lesson 20: Not applicable.
Name of lesson 21: DISRUPTION OF CELL METABOLISM BY XENOBIOTICS. Contents of lesson 21: Exposure to chemical compounds: the exposome. Concept and classification of xenobiotics. Sources of chemical contamination and exposure to xenobiotics. Molecular bases of toxicity. Xenobiotic metabolism: phases 0, I, II and III. Chemical contaminants of interest. Description of the practical activities of lesson 21: Not applicable

Educational activities

Student workload in hours by lesson		hours	Practical activities in hours				Monitoring activity in hours	Homework in hours
Lesson	Total	L	HI	LAB	COM	SEM	SGT	PS
Introductions	1	1						
1	5,5	2						3,5
2	8	1,5		3		3,0		3,5
3	9	2						7
4	8,5	1,5						7
5	5	2						3
6	14	2		3		4,0		2
7	11,5	1,5		5		3,0		2
8	3,5	1,5						2
9	4	2						2
10	5,5	1,5						4
11	6,5	1,5						5
12	4,5	1,5						3
13	6	2						4
14	3,5	1,5						2
15	5	2						3
16	5	2						3
17	4,5	1,5						3
18	4,5	1,5						3
19	3,5	1,5						2
20	3,5	1,5						2
21	5,5	3,5						2
Assessment	22,5	2,5						20
Total	150	39,0		11,0		10		90,0

L: Lectures (85 students)
HI: Hospital internships (7 students)
LAB: Laboratory or field practices (15 students)
COM: Computer room or language laboratory practices (20 students)
SEM: Problem classes or seminars or case studies (40 students)
SGT: Scheduled group tutorials (educational monitoring, ECTS type tutorials)
PS: Personal study, individual or group work and reading of bibliography

Teaching Methodologies

1. Theory and practical lectures: an expository method that consists on the presentation by the teacher of the contents on the matter under study. It also includes the resolution of sample problems by the teacher.
2. Resolution, analysis and discussion of proposed practical problems: method based on the problem statement by the teacher and their resolution in the classroom. Students develop and interpret appropriate solutions from the application of problem solving procedures.
3. Problem-based learning: teaching/learning method that has as its starting point a problem that the teacher has designed and that the student solves autonomously or guided to develop certain previously defined competencies.
4. Evaluation: Learning situation / evaluation in which the student takes a test that serves to reinforce the learning of it and as an evaluation tool.

Learning outcomes

To know and understand the relationship between structure and function of the most important biomolecules.

To know and understand the fundamental parameters that control enzymatic activity.

To know and understand the basic aspects of the biosynthesis of biomolecules.

Know and understand the basic aspects of cellular metabolism.

Assessment systems

ASSESSMENT CRITERIA:

The following aspects will be assessed:
- Theoretical knowledge and practical activities.
- Student attendance and participation in class.
- The degree of participation and attitude in the laboratory, as well as the skills acquired.

ASSESSMEMT TECHNIQUES:

In accordance with the regulations for the evaluation of the learning results and the competences acquired by the students in the official degrees of the UEx (Rectoral Resolution of 10/26/2020 published in DOE nº 212 of 11/03/2020) students may choose between the two evaluation systems to carry out:

1st option: "*Continuous evaluation*"

To opt for this type of evaluation, the student must participate in the proposed activities, such as seminars and workshops. The grades/assessments from activities proposed during the course will not be taken into consideration for subsequent assessments.

1. Exam: individual test that can take different forms (long/short answers, multiple choice, problems, virtual self-assessments, etc.) or be a combination of these (70% weighting).

2. Active participation in the subject: continuous assessment method based on the delivery of short bibliographic essays on questions raised in the classroom (5 essays in total; 20% maximum weighting; 4% each essay). The teacher will publish the details and rubric for the evaluation of work in the virtual classroom. These marks will not be carried over to following exams.

3. Resolution of exercises and problems related to the subject contents, including demonstrations: test consisting of the development and interpretation of appropriate solutions from the application of routines, formulas or procedures to transform the information initially proposed by the teacher. This activity will be carried out in the classroom (10% maximum weighting: 5% questions about demonstrations in the exam; 5% problem solving in class). These marks will not be carried over to following exams.

To pass the subject through continuous assessment it will be necessary to obtain a minimum of 3 points out of 7 in the theory exam.

2nd option: *"global assessment"*

The student must request this type of evaluation in writing within the first three weeks of the semester. This modality will be evaluated by means of an exam that consists of theory questions, demonstrations and theoretical and/or numerical questions.

Exam structure:

a) Written test: multiple choice questions on all topics, to assess the understanding of all the concepts explained (70% maximum of the final mark).

b) Short development written test that may include one or more questions of the type problem or issue related to the entire syllabus of the subject, including demonstrations (30% maximum of the final grade).

Remaining calls or *"extraordinary"*:

It will be evaluated exclusively through a theoretical exam like the one used in the single global evaluation.

In order to pass the subject through a *global evaluation*, it will be necessary to obtain a minimum of 5 points out of 10 in the exam.

Bibliography (basic and complementary)

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- DEVLIN T.M. "Bioquímica". Reverté, 4ª edición en español, 2004.
- LEHNINGER. "Principios de Bioquímica". Ed. Omega, 6ª Edición. 2011
- LODISH H., BERK A., MATSUDAIRA P., KAISER C.A., KRIEGER M., SCOTT M.P., ZIPURSKY L., DARNELL J. "Molecular Cell Biology". Médica Panamericana, 5ª edición, 2005.

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- MATHEWS C.K., Van HOLDE K.E., AHERN K.G. "Bioquímica". Addison Wesley, 3ª edición en español, 2002.
- McKEE T., McKEE J.R. “Bioquímica: La base molecular de la vida”. McGraw-Hill Interamericana, 3ª edición en español, 2003. SOPORTE INFORMATICO EN CD.
- NELSON D.L., COX M.M. "LEHNINGER: Principios de Bioquímica". OMEGA, 4ª edición, 2006.
- STRYER L., BERG J.M., TYMOCZKO J.L. "Biochemistry". Reverté 2017.
- VOETT D., VOETT J., PRATT C. "Fundamentos de Bioquímica: La vida a nivel molecular". Médica Panamericana, 4ª edición 2016.
- WERNER M-E., “Bioquímica” Reverté, 2008.
- Lesley Stanley. Molecular and Cellular Toxicology: An Introduction. Ed. Wiley, 2014.

Websites:

https://pubmed.ncbi.nlm.nih.gov

http://www.whfreeman.com/stryer

http://www.sciencedirect.com/

http://apps.webofknowledge.com/MEDLINE

Other resources and complementary educational materials

LABORATORY EQUIPMENT

- Equipment for protein chromatography experiments.
- UV-VIS spectroscopy equipment.
- Centrifuge, stirrers, thermostatic baths.