Teaching Guide				
Identifying Data				2023/24
Subject (*)	Molecular and Metabolic Biochemistry		Code	610G04023
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Third	Obligatory	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Bioloxía			
Coordinador	Barreiro Alonso, Aida Inés	E-mail	aida.barreiro@udc.es	
Lecturers	Barreiro Alonso, Aida Inés Insua Pombo, Ana Maria Nogueira Prieto, Natalia María Vila Sanjurjo, Antón	E-mail	aida.barreiro@udc.es ana.insua@udc.es natalia.nogueriap@udc.es anton.vila@udc.es	
Web				
General description	The contents of this course will allow students to know and understand the molecular mechanisms associated with the processes of transmission, expression and variation of genetic material, as well as techniques of massive analysis of nucleic acids and proteins. It will also allow them to know and understand the mechanisms of bioenergetics and the main chemical reactions that take place in the cell together with their regulation. The knowledge acquired will be indispensable for other subjects of the degree in Nanoscience and Nanotechnology.			

Study programme competences / results	
Code	Study programme competences / results
A3	CE3 - Reconocer y analizar problemas físicos, químicos, matemáticos, biológicos en el ámbito de la Nanociencia y Nanotecnología, así como plantear respuestas o trabajos adecuados para su resolución, incluyendo el uso de fuentes bibliográficas.
A6	CE6 - Manipular instrumentación y material propios de laboratorios para ensayos físicos, químicos y biológicos en el estudio y análisis de fenómenos en la nanoescala.
A7	CE7 - Interpretar los datos obtenidos mediante medidas experimentales y simulaciones, incluyendo el uso de herramientas informáticas, identificar su significado y relacionarlos con las teorías químicas, físicas o biológicas apropiadas.
A8	CE8 - Aplicar las normas generales de seguridad y funcionamiento de un laboratorio y las normativas específicas para la manipulación de la instrumentación y de los productos y nanomateriales.
B3	CB3 - Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética
B4	CB4 - Que los estudiantes puedan transmitir información, ideas, problemas y soluciones a un público tanto especializado como no especializado
B6	CG1 - Aprender a aprender
B7	CG2 - Resolver problemas de forma efectiva.
B8	CG3 - Aplicar un pensamiento crítico, lógico y creativo.
C3	CT3 - Utilizar las herramientas básicas de las tecnologías de la información y las comunicaciones (TIC) necesarias para el ejercicio de su profesión y para el aprendizaje a lo largo de su vida
C6	CT6 - Adquirir habilidades para la vida y hábitos, rutinas y estilos de vida saludables
C7	CT7 - Desarrollar la capacidad de trabajar en equipos interdisciplinares o transdisciplinares, para ofrecer propuestas que contribuyan a un desarrollo sostenible ambiental, económico, político y social.
C8	CT8 - Valorar la importancia que tiene la investigación, la innovación y el desarrollo tecnológico en el avance socioeconómico y cultural de la sociedad

Learning outcomes

Learning outcomes	Study programme competences / results		
Identify the main metabolic pathways in the cell, their regulation and integration.		B3 B4	
Recognize the principles of bioenergetics.		B3 B4	
Recognize the systems of replication and transmission of genetic information, as well as their regulation.		B3 B4 B6 B8	
Solve basic problems of molecular and metabolic biochemistry.	A3	B3 B4 B6 B7 B8	C3 C8
Apply the main biochemical techniques for the study of molecular and metabolic biochemistry.	A3 A6 A7 A8	B3 B4 B6 B7 B8	C3 C6 C7 C8

Contents	
Topic	Sub-topic
TOPIC 1. DNA replication	Semiconservative DNA replication. Enzymology of the replication. Telomere synthesis. Replication of mitochondrial and chloroplast DNA.
TOPIC 2. Synthesis and processing of RNA.	Classes of RNA. RNA polymerases. Promoters and transcriptional apparatus. Transcription in prokaryotes and eukaryotes: initiation, elongation and termination. Interrupted genes: exons and introns. Processing of eukaryotic pre-mRNA. Synthesis and processing of pre-rRNA. Synthesis, processing and editiong of the different RNAs.
TOPIC 3. Mutation and DNA repair.	Mutation molecular basis. DNA Repair mechanisms.
TOPIC 4. Molecular mechanism of genetic recombination,	The role of genetic recombination. Gene conversion. Models of homologous and site-specific recombination.
TOPIC 5. OMICs.	Methodology for genome and genome expression studies.
TOPIC 6. Translation and protein processing.	Central dogma in molecular biology. Ribosomes and tRNAs. Translation cycle: initiation, elongation, and termination. Genetic code and genetic decoding.
TOPIC 7. Regulation of gene expresssion.	Regulation od gene expression in bacteria. Operons. Regulation of gene expression in eukaryotes.Changes in chromatin structure. Transcription, RNA processing and mRNA stability control. Control at the level of translation.
TEMA 8. Proteomics.	the proteome. Protein sequencing methods. Proteomic studies using mass spectrometry. Different strategies for proteome analysis.
TOPIC 9. Bioenergetics and introduction to metabolism.	Anabolic and catabolic pathways. Compartmentalization. Need for coordination and interaction between the different routes. Transport of metabolites across cell membranes. Oxidation reduction in energy production. Generation of ATP: substrate-level phosphorylation, oxidative phosphorylation and photosynthetic phosphorylation as energy production systems.
TOPIC 10. Glycolysis and catabolism of hexoses.	Location of the routes. Stages and pathway regulation. Fermentations. Relationship with the pentose phosphate pathway.

TOPIC 11. TCA cycle.	Location of the route. Conversion of pyruvate to acetyl-CoA. Study of the pyruvate dehydrogenase complex and interaction with other routes. Anaplerotic routes, importance of mitochondrial shuttles and balances.
TOPIC 12. Gluconeogenesis.	Definition and localization, metabolic need for this route. Glyoxylate cycle.
TOPIC 13. Glycogen metabolism.	The reserve polysaccharide glycogen. Biosynthesis and degradation of muscle and liver glycogen. Regulation. The role of the liver in the maintenance of blood glucose.
TOPIC 14. Specific metabolism of plants.	Photosynthesis. The Calvin cycle. Photorespiration. Regulation. Sucrose metabolism and starch.
TOPIC 15. Lipid Metabolism.	Lipid catabolism: lipolysis, beta-oxidation. Biosynthesis of fatty acids, triglycerides, membrane lipids and steroids. Regulation of lipid metabolism. Metabolism of ketone bodies.
TOPIC 16. Metabolism of amino acids and derivatives.	Digestion and degradation of intracellular proteins. Nitrogen removal of amino acids. Urea cycle. Ammonia transport to the liver. Fate of the carbon skeleton of amino acids. Amino acid biosynthesis. Regulation. Purine and pyrimidine nucleotides metabolism. Regulation.
TOPIC 17. Integration of metabolism.	Metabolic profiling of major organs. Key connections between routes: glucose-6-phosphate, pyruvate and acetyl CoA. Metabolic adaptations to stress. Fasting, exercise.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	B3 B6 B8 C8	28	54	82
Laboratory practice	A6 A7 A8 B3 B4 B6 C6 C7	9	6	15
ICT practicals	A7 B3 B6 B7 B8 C3	6	4	10
Problem solving	A1 A2 A3 B2 B4 B6 B8	8	17	25
Diagramming	B6 B8	0	12	12
Mixed objective/subjective test	B3 B4 B8	4	0	4
Personalized attention		2	0	2
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	The topics of the subject will be taught by the professors with the help of audiovisual media. The relevant documentation will be available to the students in the Virtual Campus.
Laboratory practice	Practial classes will be carried out in the laboratory so that students learn how to handle basic scientific instruments used in Biochemistry and Molecular Biology.
ICT practicals	Exercises requiring the consultation of databases and the use of bioinformatics tools will be carried out.
Problem solving	Practical problems/questions will be solved in smaller groups of students to deepen the practical application of the concepts explained in the lectures.
Diagramming	Creation of a metabolic map by diagrams of the metabolic pathways that occur in the cell and that allows interrelation and connection of different pathways.
Mixed objective/subjective test	Written test used for learning assessment, which may combine different types of questions: multiple-choice, association, explanatory, or calculation and problem-solving questions.

Personalized attention	
Methodologies	Description

Laboratory practice Diagramming Problem solving	For all students, personalized tutoring will be provided, focused on guidance for the realization of problems, resolution of doubts and clarifications. This personalized attention will be carried out throughout the course and upon request of the student. Students will also be able to request tutoring and solve specific doubts by e-mail.

Assessment			
Methodologies	Competencies / Results	Description	Qualification
Laboratory practice	A6 A7 A8 B3 B4 B6 C6 C7	Laboratory practices are considered a compulsory attendance activity to pass the subject. The evaluation will consist of an objective test in which questions will be asked on the basis and applications of the practical clases carried out.	10
Diagramming	B6 B8	A metabolic map integrating the metabolic pathways that take place in the cells will be made.	10
ICT practicals	A7 B3 B6 B7 B8 C3	The degree of understanding of the analyses performed and knowledge of the bioinformatics tools used will be assessed. The test requires the use of a computer connected to the internet and equipped with the bioinformatics programs to be used.	10
Mixed objective/subjective test	B3 B4 B8	Evaluation of the knowledge acquired both in the lectures and in the problem classes by test questions, essay questions, definitions, questions to relate and/or questions that require providing a solution.	70

Assessment comments

LABORATORY PRACTICES are compulsory. Absence from practicals must be duly justified in order to pass the course.
To be evaluated, it is mandatory to take tests on theory (mixed test), laboratory practices, and ICT practices.
To pass the subject a 5 must be achieved and have >4,5 in the mixed tests and an average qualification in the practical >4,5 (laboratory and ICT). If the qualification resulting from the sum of all the assessable activities is equal to or higher than 5, but the indicated requirements are not met, the qualification would be 4.0 (fail).
The grade of Non Attendance(NP) will be applied to the students that do no attend the official exam.
Honors will be preferably awarded among students with a score of 9 or higher in the January opportunity.
There will be a midterm exam and, in case of achieving a grade higher than 4,5 it will not have to be repeated in the January and July opportunities.
On the second opportunity (July), students may choose to: (A) adopt the evaluation criteria of the first opportunity (specified in the EVALUATION section); or (B) take the tests corresponding to theory (mixed test), laboratory practice sessions, and ICT, with the mixed test representing 80% of the total grade. If the student chooses option B, he/she must inform the teacher responsible for the subject 10 days before the exam.
In the case of students with part-time dedication and exemption from attendance, additional measures may be adopted so that the subject can be passed. These measures may include flexibility in the date of submission of essays, flexibility in the hours of practices, or grading through a global assessment test of learning outcomes.
FRAUDULENT ACTIVITIES: In the situationthat any fraudulent activity is observed during tests or evaluation activities,the measures established in current University regulations will be taken.

Sources of information

Basic	- Luque J, Herráez A. (2010). Biologia Molecular e Ingenieria Genetica. Hardcourt - Feduchi, E., Romero, C.S., Yáñez, E., García-Hoz Jiménez, C. (2021). Bioquímica. Conceptos esenciales. Médica Panamericana - Mathews C.K., Van Holde K.E., Appling D.R. y Anthony-Cahill S.J. (2013). Bioquímica. Pearson - Nelson, D.L, Cox, M.M. (2018). Lehninger. Principios de Bioquímica. Omega - Stryer, L., Berg, J.M. y Tymoczko, J.L. (2015). Bioquímica. Reverté - Klug, W.S., Cummings, M.R., Spencer, C.A . (2013). Conceptos de Genética. Pearson/Prentice Hall - Pierce, B.A. (2015). Genética: un enfoque conceptual. Médica Panamericana - Klug, W.S., Cummings, M.R., Spencer, C.A., Paladino, M.A., Killian, D.J. (2020). Concepts of Genetics. Pearson Education - Pierce, B.A. (2020). Genetics: a conceptual approach. Freeman
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Structural Biochemistry/610G04019 Cell Biology/610G04003 Integrated Basic Laboratory/610G04004
Subjects that are recommended to be taken simultaneously
Microbiology and Immunology/610G04024
Subjects that continue the syllabus
Fundamentals of Biotechnology/610G04029
Other comments
Gender PerspectiveAccording to the different regulations applicable to university teaching, the gender perspective must be incorporated in this subject (non-sexist language will be used, bibliography of authors of both sexes will be used, the intervention of male and female students in class will be encouraged...).We will work to identify and modify sexist prejudices and attitudes and will influence the environment to modify them and promote values of respect and equality.Situations of gender discrimination should be detected and actions and measures will be proposed to correct them. Green Campus Program Faculty of SciencesTo help achieve an immediate sustainable environment and comply with point 6 of the "Environmental Statement of the Faculty of Science (2020)", any documentary homework to be carried out in this subject:a. They will be requested mostly in virtual format and computer support.b. If on paper:- No plastics will be used.- Double-sided printing shall be used.- Recycled paper shall be used.- Drafts shall be avoided.