COURSE DESCRIPTION

COURSE DETAILS

Title (of the course): **BIOQUÍMICA**
Code: 101452
Degree/Master: **GRADO DE VETERINARIA** Year: 1
Name of the module to which it belongs: FORMACIÓN BÁSICA COMÚN
Field: CIENCIAS BÁSICAS
Character: BASICA
Duration: SECOND TERM
ECTS Credits: 6
Classroom hours: 60
Face-to-face classroom percentage: 40%
Study hours: 90
Online platform: http://moodle.uco.es/m1819/

LECTURER INFORMATION

Name: GARCÍA FERNÁNDEZ, JOSÉ MANUEL (Coordinator)
Department: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Area: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Office location: Edificio Severo Ochoa, 1a planta, ala Este. C6E120
E-Mail: jmgarcia@uco.es Phone: 957211075
URL web: http://www.uco.es/grupos/adapromet/Home.html

Name: DIEZ DAPENA, JESUS
Department: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Area: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Office location: Edificio Severo Ochoa, 1a planta, ala Este. C6E130
E-Mail: bb1didaj@uco.es Phone: 957211075
URL web: http://www.uco.es/grupos/adapromet/Home.html

Name: GÓMEZ BAENA, GUADALUPE
Department: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Area: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Office location: Edificio Severo Ochoa, 1a planta, ala Este. C6E110
E-Mail: v52gobag@uco.es Phone: 957211075
URL web: http://www.uco.es/grupos/adapromet/Home.html

Name: JURADO CARPIO, JUAN
Department: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Area: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Office location: Edificio Severo Ochoa, 2a planta, ala Norte, C62N100
E-Mail: ge2jucaj@uco.es Phone: 957218082

Name: LÓPEZ GRUESO, MARÍA JOSÉ
Department: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Area: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
E-Mail: Phone:

Name: PRIETO ALAMO, MARIA JOSE
Department: BIOQUÍMICA Y BIOLOGÍA MOLECULAR

COURSE DESCRIPTION

Area: BIOQUÍMICA Y BIOLOGÍA MOLECULAR
Office location: Edificio Severo Ochoa, 2a planta, ala Norte, C62N100
E-Mail: bb2pralm@uco.es Phone: 957218082

PREREQUISITES AND RECOMMENDATIONS

Prerequisites established in the study plan

No requirements

Recommendations

It is convenient for students of this subject to fulfill previously the subjects of Animal, Vegetal and Molecular Biochemistry, and Physics-Chemistry.

INTENDED LEARNING OUTCOMES

CE2	To facilitate the acquisition of knowledge of the physical and chemical principles of biological processes and their applications in Veterinary Science.
CE3	The molecular foundations of biological processes.

OBJECTIVES

The main objective of this subject is that students could achieve an integrated vision of biochemistry, which allows them to understand the molecular basis of life, to know the functioning of living organisms at this level, and to perceive their ability of response and adaptation to different physiological and/or environmental variables. More specifically, it is intended that students understand the common molecular logic that underlay the functioning of all living beings, and the differential aspects that lead to biodiversity. On the other hand, students should acquire an overview of some defects in these molecular processes that can lead to various diseases.
In addition students should develop the ability to understand, compare and relate concepts and apply them to a specific problem, as well as acquire skills in basic techniques in a biochemistry laboratory.

CONTENT

1. Theory contents

1. Theory contents
I. Proteins and enzymes.
1. Amino acids and peptides. Functions of proteins. Amino acids isomerism. Acid-base proprieties of amino acids. Kinds of amino acids: hydrophobic, non charged polar, acidic and basic. Derivative amino acids. UV light absorption. The peptide bond. Peptides of biological interest.
2. Proteins. Importance, conformation and structural levels. Secondary structure: alpha helix and beta sheet. Beta gyres. Tertiary structure: motifs and domains. Quaternary structure. Stabilizing interactions. Globular proteins: myoglobin (function, structure, O2 binding) and hemoglobin (comparison to myoglobin, O2 binding, cooperativity, Bohr effect, H+ and CO2 transport, effect of 2,3-BPG). Collagen: supercoiled structure. Proteins involved in the control of gene expression: DNA binding structural motifs.
3. Enzymes. Nature and properties. Nomenclature and classification. Coenzymes and prosthetic groups. Mode of action of enzymes: bioenergetics of catalysis. Complex enzyme-substrate: active site, induced adjustment. Effect of temperature and pH. Clinical and biotechnological applications. Regulation of metabolic pathways. Regulation of enzymes. Allosteric enzymes: structural and kinetic properties. Covalent regulation. Proteolytic activation of zymogens. Isoenzymes.
II.Bioenergetics and metabolic integration.
4. Bioenergetics. Redox cycle of Biosphere. Energetic coupling. Basic thermodynamic concepts: ΔH, ΔS and ΔG. Quantification of ΔG. Relationship between ΔG, ΔE and Keq. Energy transfer: activated intermediates and coupled reactions. Oxidation-reduction reactions. Free energy in a redox reaction.
5. Membranes and transport. Biomembranes: composition and structure. Membrane lipids: glycerophospholipids and sphingolipids. Transport mechanisms and kinetics. Types of transport. Mediated passive transport. Primary active transport: Na+/K+ bomb. Secondary active transport: use of ionic gradients to transport other molecules. Bioenergetics of transport.
6. Intercellular communication. Basic components of the intercellular communication. Signal molecules. Types of receptors: membrane and intracellular receptors. Membrane receptors linked to ionic channels. Membrane receptors linked to G protein. Second messengers: AMPC, Ca2+ and diacylglycerol. Intracellular receptors. Action mechanism of steroid hormones.
7. Introduction to metabolism. Krebs cycle. Global view of metabolism. Metabolic pathways: catabolism and anabolism. Regulation. Functions of the Krebs cycle. Formation and isomerization of citrate. Oxidative decarboxylation. Substrate-level phosphorylation. Regeneration of oxaloacetate. Energetic balance and regulation. Amphibolic character of the cycle. Anaplerotic reactions.
8. Respiratory chain and oxidative phosphorylation. Electron transport chain: complexes and transporter proteins. Structure and mechanism of

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ATP-synthase. Oxidative phosphorylation and respiratory control. Uncouplers and phosphorylation inhibitors. Chemiosmotic mechanism. Use of ΔμH+ energy from by mitochondria.
III. Carbohydrate metabolism.
9. Glycolysis, fate of pyruvate and gluconeogenesis. Global view of glycolysis. Phases: preparative (conversion of trioses-phosphate in glucose) and productive (oxidation-reduction of trioses-phosphate). Glycolytic utilization of other sugars and glycerol. Energetic balance of glycolysis. Pyruvate as a metabolic crossroad. Lactic and alcoholic fermentation. Oxidative decarboxylation of pyruvate: pyruvate dehydrogenase complex. Gluconeogenesis from pyruvate and other gluconeogenic substrates. Cori and alanine cycles.
10. Glycogen metabolism. Reserve polysaccharides (glycogen). Glycogen catabolism. Biosynthesis of glycogen. Glycogen phosphorylase and glycogen synthase.
11. Regulation of carbohydrate metabolism. Mutual regulation of glycolysis and gluconeogenesis: hexokinase, phosphofructokinase and pyruvate kinase. Regulation of the pyruvate dehydrogenase complex. Regulation of glycogen metabolism.
12. Pentose phosphate metabolism. Nature and goals of the pentose phosphate pathway. Oxidative pathway. Isomerization and interconversion reactions. Polyvalence of pathways.
IV. Lipids metabolism.
13. Triacylglycerols catabolism. Fatty acids and triacylglycerols. Fat reserves, lipolysis and regulation. Activation and penetration of fatty acids in mitochondria. Beta oxidation of fatty acids: enzymology, energetic balance. Beta oxidation of insaturated and odd number of carbon atoms fatty acids. Ketone bodies metabolism.
14. Biosynthesis of fatty acids. Synthesis of malonil-CoA. Synthase of fatty acids. Elongation of palmitate. Establishment of fatty acids: essential fatty acids. Regulation of fatty acids synthesis. Biosynthesis of triacilglycerols and phospholipids.
15. Metabolism of steroids and lipoproteins. Synthesis of cholesterol from acetilCoA. Structure and function of lipoproteins. Synthesis of bile acids and steroid hormones.
V. Metabolism of nitrogen molecules.
16. Metabolism of amino acids. General view of proteins and amino acids metabolism. Transamination and oxidative deamination. Fate of N: glutamate dehydrogenase, differences between tissues. Fate of carbon skeletons: malic enzyme, degradative families, congenital mistakes. NH4+ incorporation to carbon skeletons: glutamine synthetase and its regulation. Families in the biosynthesis of amino acids. Essential and non essential amino acids.
17. Nucleotide metabolism: Nitrogen bases, nucleosides and nucleotides. Biosynthesis of purine nucleotides. Purine bases recovery pathway. Regulation of purine nucleotides biosynthesis. Biosynthesis of pyrimidine nucleotides and its regulation. Interconversion of mono, di and tri-P nucleotides. Biosynthesis of deoxyribonucleotides and their regulation.
18. Nitrogen excretion. Origin and fate of NH4+. Removal of NH4+. Urea cycle: reactions, relationship with Krebs cycle. Removal of N from nitrogen bases.
19. Integration of metabolism. Basic principles of metabolism. Regulation of metabolic pathways. Main metabolic pathways of control points. Specialized metabolic functions of different organs. Metabolic fluxes as a function of the nutrition state.
20. Short overview of the research carried out by the teachers.
In this activity Antonio López Lozano and María del Carmen Muñoz Marín, belonging to the Postdoctoral staff of the Dpt. of Biochemistry and Molecular Biology (University of Córdoba), will participate.

2. Practical contents

CLASSROOM PRACTICES.
CP I. AMINO ACIDS AND PEPTIDES. Problems and questions on the acid-base properties of amino acids. Determination of pI and electrophoretic mobility of amino acids and peptides.
CP II. ENZYMATIC KINETICS. Problems and questions on the bioenergetics of enzymatic catalysis. Lineweaver-Burk equation: Km and Vmax calculation. Effect of inhibitors on the kinetic parameters.
CP III. BIOENERGETICS AND ENERGETIC METABOLISM. Problems and questions on basic thermodynamic concepts, difference of potential between two redox pairs, relationship between ΔG, ΔE, Keq, activated intermediaries and coupled reactions, Krebs cycle, respiratory chain and oxidative phosphorylation.
CP IV. TRANSPORT. Problems and questions on transport bioenergetics: Na+/K+, ATPase, Ca2+-ATPase and secondary active transport systems. CP V. BIOMOLECULES METABOLISM. Problems and questions on carbohydrate, lipids and nitrogen biomolecules.
LABORATORY PRACTICES. These practices will be taught by María del Crmen Muñoz Marín.
LP1. Quantitative analysis of proteins by the Lowry method.
LP2. Quantitative analysis of glucose by the glucose oxidase method.
LP3. Kinetics of alkaline phosphatase in Escherichia coli. Effect of the reaction time. Determination of Vmax and Km.
LP4. Acid and enzymatic hydrolysis of glycogen.

METHODOLOGY

General clarifications on the methodology. (optional)

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Each of the face-to-face activities will be approached as follows:
Theory academic sessions using the master class system. There are 19 units which will be taught in classrooms to full groups, stimulating the participation through questions and dialogue with students. Presentations will be used, and the corresponding pdf handouts will be available for students in the moodle platform.
Academic sessions to solve numeric problems and practical cases related to metabolism: topics requiring biochemical calculations are explained, in order to allow students to solve quantitative problems, and realistic questions on different metabolic situations are posed. Related topics will be taught, asking for volunteers to solve problems in the blackboard. There will be problem collections with their solutions available in moodle.
Laboratory practices academic sessions: Laboratory practices (LP 1-4) introduce students in the methodologies used in Biochemistry, getting them familiar with the experimental procedures with different biomolecules. They will be taught in the Department laboratories (basement of the Severo Ochoa building). Protocols of practices will be available in moodle. It is compulsory to attend each practice with its protocol and a laboratory coat!
Bibliographic consultations: Several chapters will be read by each student along the course, in which they will study and understand topics selected by the teachers. They will be evaluated in the classroom through a series of written questions.

Methodological adaptations for part-time students and students with disabilities and special educational needs

Part-time students will be provided with the necessary information, in addition to the attention in the tutorial session timetable, to ensure that they will have all the resources required to pass the subject.

Face-to-face activities

Activity	Large group	Medium group	Total
Assessment activities	3	-	*3*
Case study	-	11	*11*
Lab practice	-	10	*10*
Lectures	36	-	*36*
Total hours:	***39***	***21***	***60***

Off-site activities

Activity	Total
Activities	*21*
Reference search	*9*
Self-study	*60*
Total hours:	**90**

WORK MATERIALS FOR STUDENTS

Placement booklet - *http://moodle.uco.es/m1819/*
Exercises and activities - *http://moodle.uco.es/m1819/*
Coursebook - *http://moodle.uco.es/m1819/*

EVALUATION

	Tools		
Intended learnig outcomes	**Case studies**	**Final exam**	**Reading tests**
CE2	x	x	x
CE3	x	x	x
Total (100%)	**20%**	**68%**	**12%**
Minimum grade.(*)	**5**	**4.5**	**4.5**

(*) Minimum grade necessary to pass the course

Method of assessment of attendance:

Se tendrá en cuenta la asistencia activa y participativa a las prácticas de aula y prácticas de laboratorio.

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General clarifications on instruments for evaluation:
A Final exam will be made on the date determined by the Faculty of Veterinary Medicine. In this exam the concepts taught in lectures and during classroom practices (case study) will be evaluated. It will be up to 68% of the total score of the subject.
Laboratory practices (Practical cases and examples): Each practice will be evaluated by the student's participation and the interest demonstrated during its execution. Laboratory practices will be also evaluated by the obtained results and by a test that will be made immediately after each practice. This calification will be up to 20% of the total.
Reading tests (about bibliographic consultations) and classroom practices: The comprehension of the bibliographic consultations will be evaluated with written questions about each chapter. This activity can provide up to 6% of the final mark. The classroom practices will evaluate by participation and by the resolution of questionnaires. This section will be valued with 6% of the final mark.
In order to pass the subject, it is essential to obtain at least 45% of the final exam points, being all parts of the program compensated and it is also compulsory, to obtain 50% of the laboratory practice points. The score of the different activities will compute in the final mark only when the above mentioned requirements have been achieved and the minimum score required in each of the items reached. In order to pass the subject it is necessary to obtain a score equal to or greater than 5 points out of 10.
Teachers can select specific students for oral examination, and even to carry out a second oral examination, upon suspicion of fraud.

Clarifications on the methodology for part-time students and students with disabilities and special educational needs:
Part-time students will follow the same evaluation system as the rest of students. Nevertheless, particular considerations of students with the formal consideration of part-time students will be taken into account.

Qualifying criteria for obtaining honors: *It will be awarded to students with the maximum mark, provided it is equal or higher than 9.*

BIBLIOGRAPHY

1. Basic Bibliography:

BERG JM, TYMOCZKO, JL, GATTO GJ & STRYER L (2015) Biochemistry. (8th Ed), Freeman MacMillan.
NELSON DL & COX MM (2017) Lehninger Principles of Biochemistry. (7th Ed), MacMillan.
VOET D, VOET JG & PRATT (2016) Fundamentals of Biochemistry: Life at the Molecular Level (5th Ed), Wiley.

2. Further reading:

GARRETT RH, GRISHAM CM (2013). Biochemistry (5th Ed.), Brooks/Cole, Cengage Learning.
DEVLIN TM (2011). Textbook of Biochemistry with clinical correlations. (7th Ed.), John Wiley & Sons, Inc.

COORDINATION CRITERIA

- Tasks performance
- Visits organization

The methodological strategies and the evaluation system contemplated in this Course Description will be adapted according to the needs presented by students with disabilities and special educational needs in the cases that are required.