Universitat Autònoma de Barcelona

2019/2020

Biochemistry

Code: 102662
ECTS Credits: 8

Degree	Type	Year	Semester
2502445 Veterinary Medicine	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: Yes
Some groups entirely in Spanish: No

Teachers

Anna Maria Bassols Teixidó
Antonio Casamayor Gracia

External teachers

Jorge Pérez Valle

Prerequisites

There are no official prerequisites, but it is convenient that the student has assimilated the basic principles of chemistry and biochemistry.

Objectives and Contextualisation

This subject must allow the student to understand that the biological processes of animals have a chemical basis and that they can be explained in these terms.

They must understand the structural bases of these processes, as well as the structure-function relationship in the different types of biological compounds: carbohydrates, lipids, proteins and nucleic acids.

Likewise, they must know the bases of metabolism that allow them to understand the biochemical foundations of physiology and pathology, with special emphasis on animal species of veterinary interest.

Finally, thy must understand the molecular basis of the transmission of genetic information and its regulation.

The specific training objectives are to know and understand:

- The basic elements of biological chemistry: functional groups, chemical equilibrium, principles of bioenergetics, enzymatic kinetics, redox potential, isomers and stereoisomers.

- The structure and function of proteins, carbohydrates, lipids, nucleotides and vitamins.

- The structure of nucleic acids and the processes of replication, transcription, translation and gene expression regulation.

- The energy metabolism of carbohydrates.

- The metabolism of lipid reserves, lipoproteins, cholesterol and complex lipids.

- The metabolism of nitrogen compounds: amino acids, porphyrins and nucleotides.

- The main mechanisms of metabolism integration and the molecular bases of metabolic adaptations and alterations.

- The foundations and applications of the main biochemical techniques and methodologies.

Practical activities related to this discipline are carried out in the Integrated Laboratory subject

Competences

- Analyse, synthesise and resolve problems and make decisions.
- Demonstrate knowledge and understanding of the physical, chemical and molecular bases of the main processes in the animal organism.
- Seek and manage information related with professional activity

Learning Outcomes

1. Analyse, synthesise and resolve problems and make decisions.
2. Describe the basic principles of kinetic and enzymatic regulation.
3. Describe the main functional groups of biological interest and their chemical properties.
4. Distinguish the mechanisms for transmitting and regulating the genetic information pf a cell.
5. Establish the molecular basis of different physiological and pathological processes.
6. Explain the basic structures of the main biological molecules.
7. Explain the main metabolic pathways.
8. Identify the fundaments for the determination of biochemical parameters of diagnostic interest in the laboratory and evaluate their relevance individually and in profiles in the diagnosis.
9. Integrate different metabolic elements in a global overview of the organism.
10. Recognise the main types of organic reactions and apply these concepts to biological processes.
11. Seek and manage information related with professional activity

Content

PART 1. THE CHEMISTRY OF LIVING BEINGS

Unit 1.- Introduction to the chemistry of living beings. Carbon bonds: simple and multiple. Classification of organic compounds: degree of oxidation and functional groups of biological interest. Cis-trans isomerism. Stereochemistry concepts. Enantiomers Chiral compounds and their importance in living systems. Diastereoisomers. Properties of water and importance of the aqueous medium for living organisms.

Unit 2.- Aliphatic and aromatic hydrocarbons. Alcohols, ethers, epoxides and phenols. Carbonyl compounds: aldehydes and ketones. Carboxylic acids and their derivatives: esters, amides, chlorides and acid anhydrides. Nitrogen organic compounds: Amines, amides and nitriles. Heterocyclic compounds with nitrogen, oxygen and sulphur.

Unit 3.- Chemical equilibrium. Equilibrium constant. Acid-base balance. pH and buffer solutions. Its importance in biology.

Unit 4.- Basic concepts of thermodynamics. Bond energies. Free energy (G^o) and spontaneous processes. Relationship between ΔG^o and Keq. The ATP as an energy currency. Structural bases of the free energy change during the hydrolysis of ATP. Transfer of phosphate groups.

Unit 5.- Oxidation-reduction reactions. Redox pairs. Electrode potentials and prediction of redox reactions. Nernst equation. Importance of redox reactions in biochemistry.

Unit 6.- Constituents of proteins: amino acids. Structure and properties.

Unit 7.- The amino acid sequence of proteins. The peptide bond. The primary structure of proteins. Peptide sequencing.

Unit 8.- Three-dimensional structure of proteins. Secondary structure The α-helix and the β sheet. Tertiary structure. Quaternary structure. Structural domains. Native conformation and denaturation.

Unit 9.- Fibrous proteins. α-keratin, fibroin and collagen

Unit 10.- Oxygen-binding proteins. Structure of myoglobin and hemoglobin. The oxygen-binding centre. Cooperativity andallosterism. Allosteric effectors. Abnormal hemoglobins

Unit 11.- Catalytic proteins: enzymes. General properties Classification. Substrates and cofactors. Isozymes. Enzymatic catalysis.

Unit 12.- Enzyme kinetics. The Michaelis-Menten equation. Meaning of Km y Vmax. Effects of pH and temperature on enzyme activity. Enzymatic inhibition. Main mechanisms of catalysis.

Unit 13.- Mechanisms of regulation of enzymatic activity: Regulation of enzyme concentration. Allosteric enzymes. Reversible covalent modification. Protein-protein interactions. Changes in subcellular localization. Irreversible covalent modification (proteolysis)

Unit 14.- Vitamins. Structure, function, requirements and vitamin deficiency.

PART 2. METABOLISM AND METABOLIC REGULATION

Unit 15.- Study of the regulation of metabolic pathways. Localization of regulation sites. Study of the properties of the enzymes involved. Crossing points. Development and verification of a theory of regulation.

Unit 16. Biochemical study of carbohydrates. Generalities. Families of monosaccharides. Natural oligosaccharides. Storage and structural polysaccharides.

Unit 17.- Glycolysis. Overview and phases. Stages of the process of the formation of pyruvate from glucose.

Unit 18.- Formation of acetyl CoA from pyruvate and tricarboxylic acid cycle. Anaplerotic pathways. Glyoxylic acid cycle. Synthesis and degradation of disaccharides. Metabolic pathways of fructose and galactose.

Unit 19.- Oxidation-Reduction and electronic transport. Redox potentials and free energy change. Electronic transport route: the respiratory chain. Inhibitors The mitochondria and oxidative phosphorylation. Coupling of oxidative phosphorylation to electronic transport. The mechanism of oxidative phosphorylation.

Unit 20.- Lactate formation and gluconeogenesis. Use of energy by the muscle. Anaerobic glycolysis. Lactate destination. Gluconeogenesis. Other precursors. Distinctive reactions of gluconeogenesis.

Unit 21.- Pentose phosphate pathway. Obtaining reducing power. Glucuronic acid pathway.

Unit 22.- Metabolism of glycogen. Glycogen as a storage form of glucose. The degradation and synthesis of glycogen and its control.

Unit 23.- Biochemical study of lipids. Fatty acids. Waxes. Triglycerides. Phosphoglycerides. Sphingolipids and glycolipids. Cholesterol.

Unit 24.- Oxidation of fatty acids. Mobilization of lipid reserves. b-oxidation. Ketone body's metabolism.

Unit 25.- Biosynthesis of storage lipids. Biosynthesis of saturated fatty acids. The formation of malonyl-CoA. The fatty acid synthetase complex.

Unit 26.- The biosynthesis of cholesterol and derivatives. The route to mevalonate, the formation of prenyl group and synthesis of polyprenilic chains. Formation of cholesterol. Bile acids and sex hormones.

Unit 27.- Digestion and absorption of lipids. Lipoproteins. Composition and metabolism.

Unit 28.- Metabolism of structural lipids. Phosphoglycerides. Sphingolipids: sphingomyelin, cerebrosides and gangliosides. Phosphatidylinositol cycle. IP3 synthesis.

Unit 29.- Degradation of amino acids. Release and elimination of nitrogen. Deamination and transamination. Urea cycle.

Unit 30.- Catabolism of the carbon skeletons of amino acids. Ketogenic and gluconeogenic amino acids. The integration of the chains in the different metabolic pathways. Aminoacid diseases. The reserve of monocarbonate groups and their relation to amino acid metabolism and its regulation: folic acid derivatives and S-adenosylmethionine.

Unit 31. - Nitrogen fixation, overview of amino acid biosynthesis and its regulation. Essential and not essential amino acids.

Unit 32.- The replacement of porphyrins. Nomenclature and synthesis of porphyrins. Porphyrias. Degradation of hemoglobin. Jaundices. The biliary pigments.

Unit 33.- Structure and metabolism of nucleotides. Nucleotide biosynthesis: purines and pyrimidines. Biosynthesisof deoxyribonucleotides. Degradation of purines and pyrimidines.

PART 3. REPLICATION, TRANSCRIPTION, TRANSLATION AND THEIR REGULATION

Unit 34.- Nucleic acids. DNA and its structure. The equivalence of bases. The double helix. Nucleosomes.

Unit 35.- DNA: genetic role and replication. Semiconservative replication. DNA polymerases. Okazaki fragments. DNA replication: initiation, elongation and termination. DNA repair

Unit 36.- Transcription and regulation of gene expression in prokaryotes. Promoters of prokaryotes. Start and end of the synthesis. Lactose operon.

Unit 37.- Transcription and regulation of gene expression in eukaryotes. Promoters and enhancers. Transcription factors. Chemical modifications of histones and DNA.

Unit 38.- mRNA processing in eukaryotes. Introns and splicing. Post-transcriptional modifications of rRNA and tRNA.

Unit 39.- The genetic code. The nature of the code and its main characteristics. The triplets of bases. The transfer RNA as adapter in the protein synthesis.

Unit 40.- Proteins synthesis . Activation of amino acids. Characteristics of aminoacyl tRNA synthetases. Direction of the synthesis. Initiation, elongation and termination. Introduction to the synthesis of proteins in eukaryotes.

SEMINARS

SBQ1. Chromatographic techniques.

SBQ2. Electrophoresis

SBQ3. Metabolites of clinical interest

SBQ4. Enzymes of clinical interest

SBQ5. Cell signalling

SBQ6. Integration of metabolism

SBQ7. Biochemical aspects of animal production diseases

SBQ8. Recombinant DNA techniques.

Methodology

To achieve the learning process the methodology used in this subject combines the theoretical classes where the teacher exposes the most relevant aspects of each topic and the active self-learning on the part of the student on topics of interest.

The subject is based on the following activities:

• Face-to-face classes with ICT support where the basic concepts of the subject are explained.

• Seminars and discussion of problems: Presentation by the teacher of specific topics and discussion in reduced groups.

• Autonomous work of the student, individually or in a group, for the study and preparation of topics proposed by the teacher or the student. This work involves the search and choice of information in various scientific information sources. The presentations are public, they must include multimedia material and ICT support and are followed by a discussion of the topic.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Seminars and discussion of problems	8	0.32	1, 3, 2, 4, 5, 6, 7, 8, 9, 10
Theoretical classes	58	2.32	3, 2, 4, 5, 6, 7, 8, 9, 10
Type: Supervised			
Preparation of self-learning work	30.5	1.22	1, 11, 3, 2, 4, 5, 6, 7, 9, 10
Type: Autonomous			
Study and bibliographic inquiry	99	3.96	3, 2, 4, 5, 6, 7, 8, 9, 10

Assessment

The evaluation system is organized in two modules. Module 1 includes the scores of the theory exams and seminars (80%), and Module 2 which includes the self-learning work note (20%). The final grade is obtained from the sum of the qualifications of these modules, with the conditions described below.

Module 1. Theory and seminars.

- Evaluation system: Test with multiple choice answers.

- Weight in the global rating: 80%.

There will be three partial tests throughout the course, one for each of the parts described in the "Contents of the subject". Each test will consist of approximately 25 questions that will also include seminar questions.

The specific weight of each partial in the final grade is 25% for the first partial, 35% for the second and 20% for the third.

Each partial is independent and if a grade equal to or greater than 5.0 is obtained, the subject of this partial will be approved. In case of failing one of the three partials with a grade equal to or greater than 4.0 or two of the three partials with a grade equal to or greater than 4.5, it will be allowed to do the weighted average with the mark of the other partial and self-learning (20 % of the final grade). If this grade is equal to or higher than 5.0, the subject will be considered as passed. If it is less than 5.0, only the failed partials will be examined (that is, with a grade lower than 5.0).

In the final exam the student will be examined of the partials that have not been passed according to the previous criterion. There will be an independent examination for each partial.

To pass the subject, students who are examined in a single partial must obtain a grade equal to or greater than 4.0 and obtain a 5.0 in the average weighted with the rest of the marks.

In case of examining two or more partials and to do the weighted average with the rest of the partials and the self-learning mark, a grade equal to or greater than 4.0 in one of the partials (and in the rest, equal or greater than 5.0) must be obtained. Alternatively, marks equal or greater than 4.5 in two partials (and in the other partial a mark equal or greater than 5.0) must be obtained. If the weighted average is equal to or greater than 5.0, the subject will be considered as passed.

The subject will not be considered as passed in the case of taking a mark below 4.0 in any of the partial.

It will not be considered as passed if marks less than 5.0 are obtained in the three partials.

Any student, regardless of the score obtained in the partial tests, may opt to examine the entire syllabus for the final exam to improve their marks. In this case, the final grade will be calculated from the mark obtained in this last exam.

Those students who, not having passed by partials, do not submit to the recovery exam will be considered non-evaluable.

Module 2. Self-learning.

- Assessment system: The oral presentation of the work will be evaluated, as well as the competence when discussing the topic.

- Weight in the global rating: 20%.

The completion of self-learning work is mandatory, as well as attendance at your presentation session and therefore, the student who does not make the presentation will be classified as Not Evaluable or Failed, depending on their situation and regardless of the grade obtained in the exam.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Partial examinations	80%	2	0.08	3, 2, 4, 5, 6, 7, 8, 9, 10
Presentation and discussion of self-learning work	20%	2.5	0.1	1, 11, 3, 2, 4, 5, 6, 7, 8, 9, 10

Bibliography

Nelson, D.L., & Cox, M.M. Lehninger Principios de Bioquímica. 7a edición. Ed. Omega. 2018.

Stryer, L., Berg, J. M., & Tymoczko, J. L. Bioquímica. 7ª edición. Ed. Reverté. (2013)

Stryer, L., Berg, J., Tymoczko, J & Gatto, G. Biochemistry. Ninth Edition (2019)