

28401 - Biology and Biochemistry

Syllabus Information

Academic year: 2023/24

Subject: 28401 - Biology and Biochemistry

Faculty / School: 105 - Facultad de Veterinaria

Degree: 451 - Degree in Veterinary Science

ECTS: 9.0

Year: 1

Semester: Annual

Subject type: Basic Education

Module:

1. General information

The Biology subject aims to transmit knowledge and analytical skills related to evolution, the formation of populations and species, the influence of the plant world on animal production and how human actions affect populations. Biochemistry aims to provide students with a basic understanding of biological molecules and their metabolism, which will be applied in subsequent years on pathology, nutrition, animal genetics, reproductive procedures and food technology. Both subjects are aligned with various Sustainable Development Goals (<https://www.un.org/sustainabledevelopment/es/>). The acquisition of the learning results of the subject provides training and competence to contribute to the achievement of the objectives: 4. Quality Education, 5. Gender Equality, 8. Decent Work and Economic Growth, 12. Responsible Consumption and Production.

2. Learning results

In order to pass this subject, the students shall demonstrate they has acquired the following results:

1. Is able to identify and know the structure of biomolecules, the metabolic reactions of transformation and synthesis of these biomolecules, as well as the mechanisms of regulation.
2. Is able to describe the mechanisms of metabolic energy production and transformation.
3. Is able to explain how the set of inanimate molecules that constitute living organisms influence each other to constitute, maintain and perpetuate life.
4. Is able to manage in a Biology and Biochemistry laboratory and master the basic tools and techniques for research such as making and staining simple preparations for visualization by optical microscopy, obtaining samples of animal origin and quality analysis, calibration and use of automatic pipettes, spectrophotometry and calculations with biological repercussions.
5. Is able to handle the most relevant sources of information.
6. Is able to define and describe evolution as a process of genesis and change of living things.
7. Is able to analyse and enumerate the basis of the mechanisms that allow directing animal and plant selection with application in the veterinary field.
8. Is able to remember and understand the diversity of living beings, their classification and nomenclature.
9. Is able to analyse and recall the relationships of organisms with each other and with the environment.
10. Is able to value the contribution of plant systems biology to the veterinary agronomic environment.

3. Syllabus

Syllabus of the subject of BIOLOGY

BLOCK I: ORIGIN OF LIFE AND BIOLOGICAL DIVERSITY

- Exploration and classification of life: Definition of Biology. Introduction to the study of biological

diversity. Classification of the diversity of life: classification systems and nomenclature. Unity in the diversity of life: the concept of evolution

- Origin and evolution of life: Life and living beings: ideas about the generation of life. Primitive conditions on Earth made the origin of life possible. Hypothetical sequence of primitive cell formation. Different energetic strategies: heterotrophs and autotrophs. Evolution of prokaryotes and the oxygen revolution. Origin of eukaryotic cells. Multicellularity evolved several times in eukaryotes.

BLOCK II: EVOLUTIONARY PROCESSES

- Evolution: history of the theory and evidence: Historical overview: ideas against evolution and evolutionary ideas prior to Darwin. The construction of Darwin's theory: descent with modification and natural selection.

Evidence of the evolutionary process: Biogeography, fossil record, homologies and direct observation. After Darwin: synthetic theory of evolution.

- Topic 4.-The evolution of populations: Key concepts: gene, allele and genetic reservoir. Variability in a population: quantification, origin and maintenance. Hardy-Weinberg equilibrium. Causes of changes in the genetic composition of a population: Gene flow, genetic drift, non-random mating and natural selection.

Topic 5- Speciation and macroevolution: Biological concept of species: reproductive isolation. Exploration of reproductive barriers. Modes of speciation: allopatric and sympatric speciation. Macroevolution: Convergent and divergent evolution, adaptive radiation and extinctions. The rate of speciation: Gradualism and intermittent equilibria

Topic 6.- Reconstruction and use of phylogenies: Definition of phylogeny, phylogenetic tree and clade. How are phylogenetic trees constructed? Parsimony, information sources and molecular clocks. Relationship of phylogeny to classification

Topic 7- Taxonomy and phylogeny of species of veterinary interest: The tree of life: prokaryotes and eukaryotes. The Eukarya domain: protists, plants, fungi and animals. Classification of the Kingdom Animalia and phyla of veterinary interest: invertebrates and vertebrates.

BLOCK III: PLANT BIOLOGY

- Topic 8.- Plant origin and diversity: Origin of terrestrial plants. Biochemical and morphological evidence. Adaptations to terrestrial life. Definition of the plant kingdom. Diversification of plants: plant phylogeny. Vascular plants: general characteristics. Seed plants: the evolutionary advantage of seeds. Characteristics and diversity of angiosperms. Importance in agriculture.

Topic 9- Structure and organization: Organs of a plant: structure, types and function. Tissue systems:

dermal, vascular and fundamental. Plant cells: Fundamental differences with animal cells: cell wall, vacuoles and plastids. Some specific types of plant cells. Organization of tissues in each organ

Topic 10- Transport in vascular plants: Transport of water and minerals: Roots absorb water and minerals from the soil. Role of root hairs and mycorrhizae. Ascent of water and minerals from the root through the xylem. Regulation of perspiration. Transport of organic nutrients: translocation. Symbiosis with nitrogen-fixing bacteria

Topic 11.- Reproduction in angiosperms: Sexual reproduction: Life cycle of angiosperms. Pollination and double fertilization. Asexual reproduction: mechanisms and application in agriculture

Topic 12- Growth and development: Stoppage of embryo growth inside the seed: dormancy. Resumption of embryo growth: Seed germination. Plant growth, primary growth, apical meristems. Secondary growth, lateral meristems.

Topic 13. -Plant hormones or phytohormones: Definition of phytohormones. Main groups of phytohormones: Auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids and defence hormones. Role in growth and development, responses to stimuli and defence against herbivores.

Practical teaching:

Practice 1: Introduction to the use of the optical microscope. Observation and comparison of animal and plant cells.

Practice 2: Cell count and viability.

Practice 3: Observation of subcellular organelles: plastids. Study of osmotic phenomena.

Practice 4: Observation of yogurt bacteria.

Syllabus of the subject BIOCHEMISTRY

BLOCK I.- PROTEINS AND ENZYMES.

Topic 1. Proteins and peptides. Composition, characteristics. Structure of the peptide bond. Protein functions.

Topic 2. Protein structure. Primary structure. Secondary structure: α Helix. β sheet. Tertiary structure: Myoglobin. Quaternary structure: Haemoglobin. Oxygenation. Cooperative effects. Conformational changes. Regulation of oxygenation: Effect of CO₂. Böhr effect. Effect of 2,3-DPG. Hemoglobinopathies.

Topic 3. Enzymes. Concept and characteristics. Classification and nomenclature. Enzymes as catalysts. Isoenzymes.

Topic 4. Active centre of the enzyme. Concept and general characteristics. Mechanism of action of chymotrypsin.

Topic 5. Kinetics of enzymatic reactions. Initial speed, maximum speed. Michaelis-Menten equation. Enzymatic activity. Experimental determination of Km and Vmax.

Topic 6. Regulation of enzyme activity. Due to changes in gene expression. Due to changes in environmental conditions. Mechanisms of enzymatic inhibition. Mechanisms of covalent modification. Allosteric regulation.

Topic 7. Oxidation-reduction cofactors. Coenzymes derived from Nicotinamide. Structure, function, mechanism of action. Flavinic cofactors. Structure, function, mechanism of action.

Topic 8. Transfer cofactors. Structure and function: Tetrahydrofolate. Coenzyme B12. Pyridoxal Phosphate. Coenzyme A.

Topic 9. Carboxylation/decarboxylation cofactors. Structure and function: Biotin. Thiamine Pyrophosphate.

Topic 10. Energy metabolism. Catabolism and anabolism. Coupled reactions. ATP. Energy regulation. Cellular energy level. Phosphorylation potential.

Topic 11. Oxidative phosphorylation. Electronic transport chain. Oxidative phosphorylation. Chemiosmotic model. ATP synthase.

Block II.- CARBOHYDRATE METABOLISM

Topic 12. Glycolysis Phases. Description of the enzymatic stages. Regulation and energy balance. Incorporation of different monosaccharides.

Topic 13. Fates of pyruvate. Fermentations. Entry of pyruvate into the mitochondrion. Pyruvate dehydrogenase complex. Cytoplasmic NAD⁺ recovery shuttles.

Topic 14. Krebs cycle. Enzymatic stages. Amphibolic nature. Regulation. Energy yield from glucose degradation.

Topic 15. Pentose phosphate pathway. Functions. Phases of the path. Enzymatic stages. Regulation according to cellular needs. Glucose 6-phosphate flux.

Topic 16. Glucose biosynthesis. Main paths. Gluconeogenesis. Reconversion of lactate into muscle glucose. Cori Cycle. Gluconeogenesis from amino acid intermediates of the krebs cycle. Gluconeogenesis in ruminants. Regulation of glycolysis and gluconeogenesis.

Topic 17. Glycogen metabolism. Glycogen. Glycogen synthesis. Glycogen degradation. Metabolic and hormonal regulation of glycogenolysis and glycogenesis. Degradation and synthesis amplifying cascades.

Block III.- LIPID METABOLISM

Topic 18. Lipids. General properties, biological functions and classification. Fatty acids: Nature and properties.

Topic 19. Simple lipids. Structures and physicochemical properties of triacylglycerides and waxes.

Topic 20. Complex lipids. Structures and physicochemical properties of glycerophospholipids and sphingolipids.

Topic 21. Unsaponifiable lipids. Steroid structures, properties and biological functions (cholesterol, vitamin D, steroid hormones, bile acids).

Topic 22. Macromolecular structures of lipids. Composition. Formation of bilayers (biological membranes) and monolayers (lipoproteins and lipid droplets). General properties and function of QM, VLDL, IDL, LDL and HDL.

Topic 23. Lipid metabolism. Oxidation of fatty acids. Types of adipose tissue. Mobilization of neutral fats. Activation and transport of fatty acids to the mitochondria. β -oxidation of even-chain saturated fatty acids. Energy balance of the β -oxidation. Regulation of fatty acid oxidation. Metabolism of ketone bodies.

Topic 24. Biosynthesis of fatty acids. Carbon sources and NADPH. Fatty acid synthetase enzyme complex. Formation of Malonil-ACP. Palmitate biosynthesis. Elongation and desaturation of fatty acid chains. Regulation of fatty acid biosynthesis. Triacylglyceride biosynthesis.

Topic 25. Cholesterol biosynthesis. Cholesterol balance in the organism. Intestinal absorption. Cholesterol biosynthesis. Regulation of cholesterol biosynthesis and uptake.

Topic 26. Biosynthesis of eicosanoids. Arachidonic acid as a precursor of eicosanoids. Biosynthesis of prostaglandins and thromboxanes via cyclooxygenase. Biosynthesis of leukotrienes via lipoxygenase. Biological repercussions.

Topic 27. Metabolic coordination. Metabolic interactions between the main lipid metabolizing organs. Digestion and absorption of fats. Exogenous and endogenous transport. Main hormones that control lipid metabolism in mammals.

BLOCK IV.- METABOLISM OF AMINO ACIDS AND NITROGEN COMPOUNDS

Topic 28. Amino acid degradation I. General characteristics. Loss of the amino group of amino acids: transamination and oxidative deamination. Fate of ammonium ion: ammonium ion toxicity and transport from peripheral tissues to the liver. Amino acids from muscle. Glucose-alanine cycle. Ammonium excretion. Urea cycle: stages, cellular localization, energy balance and genetic defects.

Topic 29. Amino acid degradation II. Fate of carbon atoms in the degradation of amino acids: ketogenic and glucogenic amino acids. Phenylalanine degradation.

Topic 30. Amino acid biosynthesis. Nitrogen cycle. Biological nitrogen fixation: organisms capable of nitrogen fixation, enzymatic mechanisms and regulation. Essential and non-essential amino acids. Biosynthesis of non-essential amino acids.

Topic 31. Precursor functions of amino acids. Amino acids as precursors of biomolecules. Biosynthesis and degradation of porphyrins: main stages and genetic defects.

Topic 32. Nucleotide metabolism. Nucleotide nomenclature: purine and pyrimidine. Purine nucleotide biosynthesis: main steps and regulation. Biosynthesis of pyrimidine nucleotides: main steps and regulation.

Purine degradation: stages and genetic defects. Degradation of pyrimidines.

Topic 33. Regulation of amino acid metabolism: Overview of amino acid metabolism in the liver. Hormonal regulation of amino acid metabolism: insulin and glucagon.

Topic 34. Metabolic integration: Metabolic integration between tissues and organs. New integrative molecules.

Practical teaching:

1. Introduction to laboratory work. Calibration of automatic pipettes.
2. Introduction to spectrophotometry. Quantitative determination of proteins.
3. Quantitative determination of plasma cholesterol by spectrophotometry.
4. Determination of lactate dehydrogenase (LDH) enzyme activity.
5. Verification of acquired competencies: the student will perform one of the four practices individually, and will present a detailed report of the results obtained, using a scientific format.

4. Academic activities

1: BIOLOGY

1. Theoretical face-to-face classes: 20 h.
2. Practical laboratory classes: 10 h.
3. Student's autonomous work: 45 h of study.

2: BIOCHEMISTRY

1. Theoretical face-to-face classes: 40 h.
2. Seminars: 5 h.
3. Practical laboratory classes: 15 h.
4. Student's autonomous work: 65 h of study.

The completion of the practical laboratory classes is mandatory.

5. Assessment system

1: BIOLOGY

The assessment of the theoretical and practical teaching will be carried out by means of a written test with only one correct answer. A correct answer represents one point, a failure subtracts 0.2 points. It will be necessary to obtain 50% of correct answers and it will represent 60% and 30% of the final grade, respectively. Lab practices are mandatory and online quizzes will be given to assess continuous learning, which will account for 10% of the grade. The final grade in this subject will represent 33.3% of the grade for the subject.

2: BIOCHEMISTRY

The assessment system includes a written test of partial or final evaluation with multiple-choice questions with only one correct answer. A correct answer represents one point, a failure subtracts 0.2 points. It will be necessary to obtain 50% of correct answers, pass a practical test of the laboratory practices and an evaluation of the ability to handle information through the comprehension of selected scientific texts that will be assessed through a written test. The first midterm exam will account for 40% and the second midterm for 60% of the theoretical teaching grade. The grade for theoretical teaching will account for 70%, practical teaching for 25% and the evaluation of information management skills for 5% of the final grade for the biochemistry subject. The final grade represents 66.6% of the grade for the subject.

Practical and/or theory may be passed independently (the grade is saved for subsequent exams).

One part will be compensated if the grade is higher than or equal to 4.5 and if the other part is passed. In no case will grades lower than 5 be kept.

Students who do not attend classes or practices will be entitled to a final exam that will include the entire subject matter (theory, practices and reading of selected scientific texts). This exam will follow the structure and be governed by the grading standards set forth above.