Universidad Zaragoza

Academic Year/course: 2021/22

29302 - Biochemistry and molecular biology

Syllabus Information

Academic Year: 2021/22
Subject: 29302 - Biochemistry and molecular biology
Faculty / School: 229 - Facultad de Ciencias de la Salud y del Deporte
Degree: 442 - Degree in Odontology
ECTS: 6.0
Year: 1
Semester: First semester
Subject Type: Basic Education
Module:

1. General information

2. Learning goals

3. Assessment (1st and 2nd call)

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as lectures, seminars, laboratory sessions, and autonomous work and study.

4.2. Learning tasks

This course is organized as follows:

- **Seminars**: The seminars will be organized in sessions of one hour and are organized in two ways:
  - Students will work on different topics of Biochemistry expansion and reinforcement of the theoretical teaching, to achieve the learning outcome 1, 2 and 3.
  - part of the seminars will be used to remember information about the structure of the different immediate principles.
- **Practice sessions** are held in sessions of 2 hours for each group of 12 students. Each group is expected to complete a practice each 15 days. There will be a short question for qualifying the practices in the final exam, apart from the continuous assessment.
- **Tutored work** will be done in groups of 3-4 students and will be related to the handling of literature on the field of study and use of the Internet as a means of communication and source of information.

PART I. STRUCTURE AND CATALYSIS

Practical teaching activities:

Introduction to laboratory work. Use of automatic pipettes. Determining the pH of a solution.

Introduction to spectrophotometry. Quantitative determination of proteins.

Teaching and learning activities:
Lecture: 11h
Seminars: 1 h
Laboratory sessions: 4 h
Mentored Work: 3 hours of tutoring
Student Self study: 22 h Study

PART II INTRODUCTION TO INTERMEDIARY METABOLISM INTERMEDIATE
Teaching and learning activities:
Lecture: 2
Student Self study: 4h study

PART III CARBOHYDRATE METABOLISM
Practical teaching activities:
Enzymatic and Acid Hydrolysis of starch and identification of the reducing sugars
Teaching and learning activities:
Lecture: 8
Seminars: 1 h
Laboratory sessions: 2 hours
Mentored Work: 3 hours of tutoring
Student Self study: 15h study

PART IV LIPIDS METABOLISM
Teaching and learning activities:
Lecture: 9.
Seminars: 1 h
Mentored Work: 3 hours of tutoring
Student Self study: 18h study

PART V.- AMINO ACID METABOLISM AND NITROGEN COMPOUNDS
Teaching and learning activities:
Lecture: 6
Seminars: 2 h
Mentored Work: 3 hours of tutoring
Student Self study: 12h study

PART VI.- ENERGY PRODUCTION
Teaching and learning activities:
Lecture: 3
Student Self study: 5h study

PART VII. INFORMATION PATHWAYS

Practical teaching:
Obtaining DNA

Teaching and learning activities:
Lecture: 7
Seminars: 2 h
Laboratory sessions: 2 hours
Mentored Work: 3 hours of tutoring
Student Self study: 11h study

4.3. Syllabus

This course will address the following topics:

PART I. STRUCTURE AND CATALYSIS

1. Water

Chemical bonds. Weak Interactions in Aqueous Systems. Ionization of Water, Weak Acids, and Weak Bases. Buffering against pH changes in biological systems.

2. Amino Acids

Structure, properties, and classification of amino acids.

3. Peptides, and Proteins

Peptide bond. Properties and composition of proteins. Structure of the peptide bond. Classification of proteins. Functions.

4. The Three-Dimensional Structure of Proteins

Protein Structure: Protein secondary structure, a-helix. ß sheet. Collagen structure. Protein tertiary, Myoglobin structure. and quaternary structures Protein denaturation and folding. Heme structure. Hemoglobin structure. Oxygenation. cooperative effects. conformational changes. Regulation of oxygenation: Effect of CO_2. Böhr effect. Effect of 2,3-DPG.

Hemoglobinopathies.

5. Enzymes

Concept and general characteristics. active center of the enzyme. Mechanism of action. Derivation of the Michaelis-Menten equation. Enzymatic activity. specific activity. Experimental determination of Km and Vmax. Enzymes in clinical diagnosis. Quantification of enzymes. Enzyme Kinetics as an approach to understanding mechanism.examples of enzymatic reactions. Regulatory Enzymes. Covalent modification mechanisms. Allosteric regulation.

6.- Vitamins

7. Cofactors

Redox cofactors. Coenzymes nicotinamide derivatives. Structure, function, mechanism of action. flavin cofactors. Structure, function, mechanism of action.

Transfer cofactors. Structure and Function: Tetrahydrofolate. Coenzyme B_{12}. Pyridoxal phosphate. Coenzyme A.

Carboxylation / decarboxylation cofactors. Structure and Function: Biotin. Thiamine pyrophosphate.

PART II INTRODUCTION TO INTERMEDIARY METABOLISM INTERMEDIATE

8.- Intermediate Metabolism

Metabolism. Concept. catabolic, anabolic and amphibole routes. exergonic and endergonic processes. energy coupling. Energy-rich compounds: chemical characteristics. chemical groups transferred. Types of bonds rich in energy. Enzymes and co-enzymes involved in biological redox processes.

PART III CARBOHYDRATE METABOLISM

Structure carbohydrates. Monosaccharides Disaccharides. Carbohydrate absorption. Glucose transporters and glucose. Isomerism. Polysaccharides. Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids. Carbohydrates as Informational Molecules: The Sugar Code.

9. Carbohydrates and Glycobiology.

Glucose uptake by tissues. Stages of glycolysis. Description of the enzymatic steps. Regulation and energy balance. Cori cycle. Incorporation of different monosaccharides. Launchers recovery cytoplasmic NADH. Entry of pyruvate into the mitochondria. Pyruvate dehydrogenase complex.

10. Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway

Glycolysis. Feeder Pathways for Glycolysis. Fates of Pyruvate under Anaerobic Conditions: Fermentation. Gluconeogenesis. Pentose Phosphate Pathway. *Gluconeogenesis immediately after glycolysis, discussing their relatedness, differences, and coordination and setting up a completely new chapter on metabolic regulation that follows. Mechanisms of phosphohexose isomerase and aldolase. The mechanism of glyceraldehyde 3-phosphate dehydrogenase.*

11. The Metabolism of Glycogen

Regulation of Metabolic Pathways. Coordinated Regulation of Glycolysis and Gluconeogenesis. Coordinated Regulation of Glycogen Synthesis and Breakdown.,

PART IV LIPIDS METABOLISM

12. Lipids

Lipids

Lipids. general properties, classification, and biological functions. fatty acids: Nature and properties. Structures and physicochemical properties of triacylglycerols.

Lipid complexes. Structures and physicochemical glycerophospholipids (lecithins, cephalins, Plasmalogens, and cardiolipin) and sphingolipids (ceramides, sphingomyelins, and glycosphingolipids) properties.

Structures, properties and biological functions of terpenes (vitamin A, vitamin E, vitamin K), steroids (cholesterol, vitamin D, steroid hormones, bile acids) and prostaglandins.

12. Fatty Acid Catabolism

Digestion, Mobilization, and Transport of Fats. Lipoproteins: General properties and function of QM, VLDL, IDL, LDL, and HDL. Digestion and absorption of fats. Transport of exogenous and endogenous fat. Dyslipidemia.

The role of perilipin phosphorylation in the control of fat mobilization. Oxidation of Fatty Acids: The energy balance oxidation. Regulation of fatty acid oxidation. Ketone Bodies. Role of acetyl-CoA in the integration of fatty acid oxidation and synthesis Medical consequences of genetic defects in fatty acyl?CoA dehydrogenases .

21. Lipid Biosynthesis

Biosynthesis of Fatty Acids. Fatty acid synthetase enzyme complex. Formation of malonyl-ACP. Biosynthesis of palmitate. The elongation and desaturation of fatty acid chains. Regulation of fatty acid biosynthesis. Biosynthesis of Triacylglycerols.

Biosynthesis of Membrane Phospholipids. Biosynthesis of Cholesterol, Steroids, and Isoprenoids. *Glyceroneogenesis and the triacylglycerol cycle between adipose tissue and liver, including their roles in fatty acid metabolism (especially during starvation) and the emergence of thiazolidinediones as regulators of glyceroneogenesis in the treatment of type II diabetes.*

The regulation of cholesterol metabolism at the genetic level, with consideration of sterol regulatory element-binding proteins (SREBPs).

PART V.- AMINO ACID METABOLISM AND NITROGEN COMPOUNDS

14. Amino Acid Oxidation and the Production of Urea

Metabolic Fates of Amino Groups. Transamination: *Description of the interplay of the pyridoxal phosphate.* Nitrogen Excretion and the Urea Cycle. Pathways of Amino Acid Degradation. *Genetic defects in urea cycle enzymes. The regulatory function of N-acetylglutamate synthase. Description of the interplay of cofactors in serine and glycine metabolism*

15. Amino Acid Oxidation: carbon skeleton

Destination of carbon atoms in the degradation of amino acids: ketogenic and glucogenic amino acids. Phenylalanine degradation.

16. Biosynthesis of Amino Acids, Nucleotides, and Related Molecules

Biosynthesis of Amino Acids. *Functions precursor amino acids:* Biosynthesis and degradation of nucleotides. Heme structure synthesis. *Tryptophan demo Serotonin precursor. GABA metabolism. Formation of creatine and creatinine.*

Amino acid metabolism in the liver. hormonal regulation of amino acid metabolism: insulin and glucagon

Teaching and learning activities:

Theory classes: 6

Seminars: 2 h

Mentored Work: 3 hours of tutoring

Student Self study: 12h study

17. The Citric Acid Cycle

Reactions and regulation of the Citric Acid Cycle. The Glyoxylate Cycle. Mechanism for pyruvate carboxylase, isocitrate dehydrogenase and citrate synthase.

18. Oxidative Phosphorylation

Oxidative Phosporylation. Electron-Transfer Reactions in Mitochondria. ATP Synthesis. Regulation of Oxidative Phosphorylation.

Teaching and learning activities:

Theory classes: 3

Student Self study: 5h study

PART VI. INFORMATION PATHWAYS

Nucleic acids.

Structure and properties of nucleosides and nucleotides. Structure of DNA: the double helix. DNA supercoiling. Topoisomerase. Chromatin structure. RNA: structure and types.

19. DNA Metabolism

DNA Replication. In prokaryotic cells. Primosome and replisome. Origin of replication. DNA Repair.

20. RNA Metabolism

DNA-Dependent Synthesis of RNA. *Mechanisms of* RNA Processing. RNA-Dependent Synthesis of RNA and DNA. *mRNA processing:5' cap of eukaryotic mRNAs*
Structure of bacterial RNA polymerase and its mechanism of action.

21. Protein Metabolism

Translation of the genetic message: protein biosynthesis. The genetic code. Machinery translation: molecules involved. Binding and activation of amino acids to tRNAs, aminoacyl-tRNA synthetases. Protein synthesis in prokaryotes. posttranslational modifications. Differential characteristics of protein synthesis in eukaryotes. Inhibitors of protein synthesis.

22 Mitochondrial genetic system.

Genetic organization of mitochondrial DNA. DNA replication and transcription in mammals. RNA processing. Regulation of

expression.

23. Regulation of Gene Expression

Principles of Gene Regulation. Regulation of Gene Expression in Prokaryotes. Regulation of Gene Expression in Eukaryotes.

4.4. Course planning and calendar

The course is structured as follows:

- 40 hours of participatory lectures
- 10 hours of laboratory practices
- 10 hours of seminars
- completion and submission of a protected work.

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course will be provided on the first day of class or please refer to the Faculty of Health and Sports Sciences website and Moodle.

4.5. Bibliography and recommended resources

To consult the bibliography and recommended resources, you must access the *Recommended Bibliography* link.