Universidad Zaragoza

Year : 2019/20

27217 - Biochemistry

Syllabus Information

Academic Year: 2019/20
Subject: 27217 - Biochemistry
Faculty / School: 100 -

Degree: 452 - Degree in Chemistry

ECTS: 7.0
Year: 3
Semester: Second semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

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, solving-problem sessions, laboratory sessions, autonomous work and study.

Students are expected to participate actively in class throughout the semester.

Further information regarding the course will be provided on the first day of class.

4.2.Learning tasks

The course includes the following learning tasks:

- Formative activity 1: Acquisition of basic knowledge of Biochemistry (3,5 ECTS). Methodology: Lectures and Tutoring.
- Formative activity 2: Purification and analysis of biomolecules (2 ECTS). Methodology: Laboratory sessions. Work in groups.
- Formative Activity 3: Case study analysis, problem solving and database consultation (1,5 ECTS). Methodology: Problem-based learning, consultation of biochemical databases. Group and individual.

4.3.Syllabus

The course will address the following tasks:

- **Topic 0. Introduction to Biochemistry.** Interdisciplinary character of Biochemistry. A historical view of its development. The impact of the discoveries in Biochemistry in the society. Biotechnology as a modern human activity.

THE CHEMICAL SUPPORT OF LIFE

- **Topic 1. Chemical composition of living matter.** Principal characteristics of living matter. Elements and molecules present in living beings. The importance of water in Biology. Molecular interactions.
- **Topic 2. General characteristics of biomolecules:** carbohydrates, lipids, proteins, nucleic acids: properties and structure.

ENZIMOLOGY

- **Topic 3. Enzymes: catalysis and kinetics.** General properties of enzymes. Enzyme classification and nomenclature. Catalysis and activation energy. Enzymatic activity determination. Enzyme kinetics: K_m y V_{max} definition and experimental determination. Turnover number k_{cat} y k_{cat}/K_m definition. Influence of pH and temperature on the rate of enzymatic reactions. Zymogens and proteolytic activation of enzymes.
- **Topic 4. Enzyme regulation.** Reversible and irreversible inhibition. Regulation of enzymatic activity: allosteric enzymes, reversible covalent modification.

METABOLISM

- **Topic 5. Introduction of the study of metabolism.** The cycle of matter and flow of energy in the biosphere. Origin of biological energy. Organization of the metabolic pathways. Oxidation of food compounds as the source of biological energy. ATP as the energy exchange molecule. Techniques for the study of metabolism.

Carbohydrate metabolism

- **Topic 6. Glycolysis.** The utilisation of glucose and other dietary carbohydrates. The two phases of glycolysis: reactions and enzymes involved. Regulation of glycolysis. The different fates of pyruvate: respiration or fermentation. Degradation of other monosaccharides by glycolysis.
- **Topic 7. The citric acid cycle.** Cellular localization. Oxidation of pyruvate by the pyruvate dehydrogenase complex. Regulation. The reactions of the citric acid cycle. The intermediates of the cycle as substrates for biosynthetic reactions. Anaplerotic reactions. Regulation of citric acid cycle. The glyoxylate cycle.
- **Topic 8. The pentose phosphate pathway of glucose oxidation.** Biological role of the pathway in different tissues. Anabolic and catabolic role of the pathway: oxidative and non-oxidative phases. Interconnection between glycolysis and the pentose phosphate pathway.
- **Topic 9. Gluconeogenesis.** Common and specific enzymes in glycolysis and gluconeogenesis. Thermodynamically irreversible reactions. Stoichiometry and energetic yield of the gluconeogenic pathway. Regulation of key enzymes. Origin of the substrates used for the synthesis of glucose.
- **Topic 10. Glycogen metabolism.** The role of glycogen in animals. Glycogen degradation. Glycogen synthesis. Coordinated regulation of glycogen metabolism: the role of metabolic cascades. Diseases due to defects in the glycogen metabolism.

Energy transduction mechanisms

- **Topic 11. Electron transfer and oxidative phosphorylation.** The mitochondria and the membrane systems. The electron transport chain: multiprotein complexes and electron carriers. The generation of a proton gradient as a form of conserving the energy. Electron transport inhibitors. Coupling of electron transport and proton transfer. Uncouplers. The chemiosmotic theory to explain the energy conservation: ATP synthesis. The ATP synthase complex.
- **Topic 12. Photosynthesis: transforming the light energy.** The anatomy and organization of chloroplasts. Photosynthetic pigments in plants and algae. Light absorption and light-driven electron flow. The photochemical reaction centre. Photosynthetic electron transport chain: from water to $NADP^+$. Photosystems I and II. Final balance of the photosynthetic reactions: ATP and NADPH synthesis. The dark phase of photosynthesis, the synthesis of glucose and the Calvin Cycle. Photorespiration and its meaning.

Fatty acids metabolism

- **Topic 13. Fatty acids catabolism.** Digestion, mobilization and transport of fatty acids. Absorption of dietary fats in the small intestine. Transport of lipids in animals: albumin and plasmatic lipoproteins. Activation and transport of fatty acids into the mitochondria. b-oxidation of fatty acids. Energy balance. Ketonic bodies, synthesis and

degradation. The use of ketone bodies as a source of energy.

- **Topic 14. Biosynthesis of fatty acids.** Similarities and differences between the biosynthetic and degradative pathways. Acetyl-Co and bicarbonate as precursors of fatty acid synthesis: the formation of malonyl-CoA. Synthesis of fatty acids: stoichiometry, and energy balance. Origin of cytosolic NADPH and Acetyl-CoA. Essential fatty acids. Desaturation and elongation of fatty acids. Hormone regulation of stored triglycerols mobilization.
- **Topic 15. Biosynthesis of cholesterol.** Cholesterol as precursor of active biological molecules. Transport and cellular internalization of cholesterol: action mechanism of transport by lipoproteins. Regulation of cholesterol synthesis: Hidroxymethylglutaryl-CoA reductase and LDL receptors. Diseases of cholesterol metabolism.

Metabolism of nitrogen compounds

- **Topic 16. Degradation of nitrogen compounds.** Digestion of proteins. Continuous replacement of proteins in living organisms. Amino acid degradation. General reactions. Transamination and oxidative degradation. The urea cycle and its relation with the citric acid cycle. Metabolic degradation of carbon skeletons from amino acids. Glycogenic and ketogenic amino acids. Genetic disorders in the amino acids metabolism.
- **Topic 17. The sources of biological nitrogen.** The nitrogen cycle. Biological nitrogen fixation: the nitrogenase complex. Nitrification and denitrification processes. The incorporation of ammonia into carbon skeletons: glutamate dehydrogenase, glutamate synthase and glutamine synthetase. Regulation of nitrogen metabolism.
- **Topic 18. An overview of metabolism.** Reciprocal relationships between different organs in animals. The main metabolic pathways in the different organs: liver, adipocyte, brain, muscle. Metabolic adaptations to different physiological and pathological situations: fasting, prolonged exercise, diabetes.

MOLECULAR GENETICS AND GENETIC ENGINEERING

- **Topic 19. Principal processes of DNA and RNA metabolism.** Replication and reparation of DNA. Mutations. RNA synthesis and post-transcriptional RNA modifications. RNA translation: protein synthesis.
- **Topic 20. Introduction to the DNA recombinant technology.** Gene cloning: vectors, genomic libraries, cDNA construction. Characterization and expression of cloned genes. Applications of recombinant DNA technology: gene modification in bacteria, plants and animals. Transgenic animals. The polymerase chain reaction.

LABORATORY SESSIONS PROGRAM

- Electrophoresis technique applied to proteins
- Enzymatic activity
- Carbohydrates characterization
- Purification and quantification of lipids (cholesterol)
- DNA isolation

4.4.Course planning and calendar

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 Facultad de Ciencias web (https://ciencias.unizar.es/grado-en-quimica-0).

Specific dates of the different activities will be announced during the classes, bulletin boards or by ADD (Moodle2 Platform).

- All the publishers of the recommended books have web page where additional material can be found accessible to students (problems and tests solved, figures, animations, etc...)
- Support to the training through resources available in the assigned place to the subject in ADD (Moodle2 Platform)

4.5.Bibliography and recommended resources

http://biblos.unizar.es/br/br_citas.php?codigo=27217&year=2019