Universitat Autònoma de Barcelona

2018/2019

Biochemistry

Code: 100938
ECTS Credits: 9

Degree	Type	Year	Semester
2500253 Biotechnology	FB	1	A

Contact

Name: Victoria Nogués Bara
Email: Victoria.Nogues@uab.cat

Use of languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Teachers

Xavier Parés Casasampera
Mohammed Moussaoui

Prerequisites

There are not prerequisites to follow the course successfully. Nonetheless it would be desirable if students were familiar with basic knowledge of biology and chemistry.

Much of the literature is in the English language, which is also used in the figures projected in theory classes.

Objectives and Contextualisation

The subject Biochemistry includes a first part that explains the structural and functional characteristics of biomolecules, with a special emphasis on proteins and enzymes. The second part focuses on understanding bioenergetics, biosignaling and the main routes of metabolism. The general objective of this subject is to provide the basis of the biochemistry that are considered necessary for understanding specific subjects of the Degree in Biotechnology.
Specific objectives of the subject:
- To understand the structural characteristics of biological molecules, knowing how to draw conclusions about their stability, their function and their capacity for replication of structures.
- To understand the concepts of enzyme activity and kinetics in the context of biological reactions and their regulation.
- To describe the general mechanisms through which living organisms obtain and transform the energy of the environment.
- To know the main molecular mechanisms of biosignaling.
- To describe the main routes of intermediate metabolism of glucose, lipids and nitrogen compounds, their regulation and coordination.
- To know how to apply the knowledge to solve qualitative and quantitative problems.

Content

Lesson 1. Molecular elements and physical environment of living organisms.

Concept of biochemistry. Chemical elements in living organisms. Biomolecules. Structural hierarchy in the molecular organization of cells. Non-covalent interactions in aqueous systems. Biological relevance of water. Water ionization, ionic equilibrium and buffer systems.

Lesson 2. Bioenergetics principles.

Production and use of metabolic energy. Universality of the thermodynamics principles. Life as a process far from equilibrium; biochemical reactions and free energy. Basic processes in bioenergetics: Phosphate transfer and redox reactions. ATP and other phosphorylated compounds. Electron carriers.

Lesson 3. Proteins: primary structure and biological functions.

Protein types and functions. Amino acids structure and properties. Classification. Peptides and peptide bond. Composition and amino acid sequence of proteins. Protein sequence databases. Sequence alignments.

Lesson 4. 3D protein structure.

Levels of protein structure. Description of helix and folded sheets. Fibrous proteins. Globular proteins. Quaternary structure. Protein folding: key factors; chaperones. Conformational diseases. Prions. Protein structure prediction.

Lesson 5. Function and evolution of proteins: oxygen binding proteins.

Oxygen storage: Myoglobin. Oxygen transport: Hemoglobin. Hemoglobin and cooperativity. Analysis of cooperativity. Hemoglobin variants: physiological adaptation and molecular pathology. Examples of protein evolution.

Lesson 6. Carbohydrates.

Types and functions. Monosaccharides, description and properties. Glycosidic bond. Oligosaccharides. Polysaccharides. Glycoproteins and glycolipids. Carbohydrates as information carrier molecules.

Lesson 7. Lipids and biological membranes.

Lipid types and functions. Fatty acids. Storage and membrane lipids. Cholesterol and derivatives. Fat soluble vitamins. Eicosanoids. Lipoprotein structure and function. Biological membranes.

Lesson 8. Biological catalysts.

Nature and function. Enzyme classification and nomenclature. Catalytic effects in chemical reactions: general mechanisms. Description of enzymatic mechanisms. Initial velocity. Enzyme kinetics: the hypothesis of Michaelis-Menten. Enzyme cofactors. Two substrate reactions. Enzyme inhibition. Regulation of enzyme activity: allosteric changes, covalent modifications and changes in the enzyme concentration. Biomedical and biotechnological applications.

Lesson 9. Nucleic acids: Structure levels.

Nucleic acids: nature and function. Nucleotides. The primary structure of nucleic acids. Secondary structure: the model of Watson and Crick and alternative models. Tertiary structure: DNA supercoiling and transfer RNA. Protein-DNA complex: chromosome organization. DNA denaturation and renaturation.

Lesson 10. Introduction to metabolism.

Concept of metabolism and metabolic pathways. Metabolism stages. Control and compartmentalization of metabolic pathways. Experimental approaches for metabolism study.

Lesson 11. Biosignaling.

Hormones, neurotransmitters and other primary messengers. Membrane and internal cell receptors. Molecular mechanisms for signal transduction: receptor enzymes, G protein-coupled receptors and ion channels. Second messengers. Integrated response of different signals both at cytoplasm and nucleus levels.

Lesson 12. Carbohydrate metabolism (1).

Glucose metabolism. Glycolysis. Fermentations. Feeder pathways for glycolysis. Gluconeogenesis. Coordinated regulation of glycolysis and gluconeogenesis. The pentose phosphate pathway.

Lesson 13. Carbohydrate metabolism (2).

Glycogen metabolism: synthesis, breakdown and coordinatedregulation. Coordination in the metabolic control of glucose and glycogen: relevance of metabolic tissue specialization.

Lesson 14. Core routes in oxidative metabolism.

Acetyl-CoA production. Citric acid cycle. Energy balance and control. Anaplerotic reactions. Glyoxylate cycle.

Lesson 15. Electron transport and oxidative phosphorylation.

Mitochondrial electron transport chain. Origin and utilization of reduced substrates. Chemiosmotic coupling: ATP synthase and oxidative phosphorylation. Mitochondrial transport systems. Oxidative phosphorylation control. Energy balance of the oxidative metabolism.

Lesson 16. Photosynthesis.

Basic processes in photosynthesis. Photosynthetic pigments. Energy absorption of light. Electron transport and phosphorylation. CO_2 assimilation and Calvin cycle. Photosynthesis control. Photorespiration.

Lesson 17. Lipid metabolism.

Triglycerides use in animals. Lipoproteins. Description and control of the fatty acid oxidation pathway. Ketogenesis. Description and control of fatty acid biosynthesis pathway. Triglyceride and phospholipid biosynthesis. Cholesterol metabolism.

Lesson 18. Nitrogen compounds metabolism.

Nitrogen cycle. Intracellular degradation of proteins. Basic mechanisms of amino acid degradation. Fate of the carbon skeleton. Ammonia excretion and the urea cycle. Amino acid biosynthesis. Nucleic acid and nucleotide degradation. Nucleotide recovery and *de novo* synthesis. Biomedical applications of nucleotide analogs.

Lesson 19. Biotransformation: Cytochrome P450.

Cytochrome P450: Biological functions. Inhibitors. Electron transport systems. Other oxygenation reactions.

Lesson 20. Metabolism Integration.

Coordination of metabolism between liver, muscle, adipose tissue and brain. Main control hormones. Stress and metabolism adaptation.