Introduction to the Biochemistry of Animal Organisms [504]

COURSE OUTLINE

(1) GENERAL

SCHOOL	ANIMAL BIOSCIENCES		
ACADEMIC UNIT	DEPARTMENT OF ANIMAL SCIENCE		
LEVEL OF STUDIES	Undergraduate [Required]		
COURSE CODE	**504**	**SEMESTER**	**3rd**
COURSE TITLE	INTRODUCTION TO THE BIOCHEMISTRY OF ANIMAL ORGANISMS		

INDEPENDENT TEACHING ACTIVITIES	**WEEKLY TEACHING HOURS**	**CREDITS**
Theory lectures	2	
Laboratory	2	
		4

COURSE TYPE	Foundation
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS:	NO
COURSE WEBSITE (URL):	-
TEACHING STAFF:	Theory: E. Zoidis Laboratory: E. Zoidis / I. Poulopoulou / A. Mavrommatis

(2) LEARNING OUTCOMES

Learning outcomes

Upon successful completion of the course, students will be able (according to Bloom) to:

- Understand the chemical reactions that take place in living animal organisms and the role of biochemistry in life processes (**Knowledge / Comprehension**).
- Describe the structures of macromolecules and explain how they interact with each other (**Knowledge / Comprehension**).
- Understand the methodology and techniques used for the study of macromolecules (**Knowledge / Comprehension / Application**).
- Explain the principles of enzymology and the biological roles of enzymes in animal organisms (**Knowledge / Comprehension / Analysis**).
- Describe the flow of genetic information, the role of nucleic acids, and the structure and function of biological membranes (**Knowledge / Comprehension**).
- Integrate knowledge of biomolecules with the basic processes involved in metabolic pathways of animal organisms (**Comprehension / Analysis / Synthesis**).
- Understand the production, homeostasis, and consumption of energy, highlighting evolutionarily conserved metabolic processes (**Knowledge / Comprehension / Analysis**).
- Describe intermediary metabolism and its regulation, including the flow of information from genes to proteins and the roles of different types of RNA (**Knowledge / Comprehension / Analysis**).

General Competences

- Individual and group work
- Producing new research ideas
- Design and management of projects
- Promotion of free, creative and inductive thinking
- Respect for the natural environment

(3) SYLLABUS

- Definition and object of biochemistry. Monomers and characteristics of biological polymers. Relation between form and function. Chemical bonds in biochemistry. Energy transformations. Water and its biological functions.

- Key organic and inorganic molecules used by living systems.
- Structural and functional classifications of proteins. Primary Structure: amino acids are linked by peptide bonds to form polypeptide chains. Secondary structure: polypeptide chains can fold into regular structures such as the α-helix, the β-sheet, and turns and loops. Tertiary structure: water-soluble proteins fold into compact structures with non polar cores. Quaternary structure: polypeptide chains can assemble into multi-subunit structures. The amino acid sequence of a protein determines its three-dimensional structure.
- Purification of proteins. Determination of amino acid sequences by automated Edman degradation. Immunology techniques to investigate proteins. Peptide synthesis by automated solid-phase. Three-dimensional protein structure determination by NMR spectroscopy and X-Ray crystallography.
- Structure of nucleic acids. Nucleic acid chains with complementary sequences can form a double-helical structure. DNA is replicated by polymerases that take instructions from templates. Gene expression is the transformation of DNA information into functional molecules. The genetic code. Amino acids are encoded by groups of three bases starting from a fixed point. Most eukaryotic genes are mosaics of introns and exons.
- Basic tools of gene exploration. Recombinant DNA technology. Manipulation of eukaryotic genes. Novel proteins by site-specific mutagenesis.
- Enzymes are powerful and highly specific catalysts. Classification of enzymes. Mechanisms of enzyme action. Free energy is a useful thermodynamic function for understanding enzymes. Enzymes accelerate reactions by facilitating the formation of the transition state. Catalytic strategies. The Michaelis-Menten model and the kinetic properties of enzymes. Regulation of enzyme activity. Enzymes can be inhibited by specific molecules. Isozymes: means of regulation specific to distinct tissues and developmental stages. Covalent modifications and regulating enzyme activity. Activation of enzymes by specific proteolytic cleavage.
- Monosaccharides. Complex carbohydrates. Carbohydrate attachment to proteins: glycoproteins.
- Classification and characterization of lipids. Simple and complex lipids. Fatty acids are key constituents of lipids. Types of membrane lipids. Common features and the diversity of biological membranes. Compartments bounded by internal membranes.
- Active and passive transport of molecules across a membrane. ATP hydrolysis ions transport across membranes. Secondary transporters. Ion channels. Gap junctions and communication between cells.
- Characterization of metabolism. Coupled and interconnecting reactions. Oxidation of carbon fuels and cellular energy. Metabolic pathways. Signal-transduction pathways.
- Glycolysis: an energy-conversion pathway in many organisms. Control of the glycolytic pathway. Synthesis of glucose from non-carbohydrate precursors. Reciprocal regulation of gluconeogenesis and glycolysis.
- Entry to the citric acid cycle and metabolism through it are controlled. The citric acid cycle as source of biosynthetic precursors.
- Oxidative phosphorylation in eukaryotes and mitochondria. Oxidative phosphorylation and electron transfer. The four complexes of the respiratory chain: three proton pumps and a physical link to the citric acid cycle. Proton gradient and synthesis of ATP. Regulation of cellular respiration and the need for ATP.
- Generation of NADPH and synthesis of five-carbon sugars. The metabolism of glucose 6-phosphate by the pentose phosphate pathway and its coordination with glycolysis.
- Glycogen breakdown and the interplay of enzymes. Phosphorylase's regulation by allosteric interactions and reversible phosphorylation. Epinephrine and glucagon signal the need for glycogen breakdown. The different pathways for glycogen synthesis and degradation. Reciprocal regulation of glycogen breakdown and synthesis.
- Triacylglycerols are highly concentrated energy stores. Processing stages for the utilization of fatty acids as fuel. Additional steps for the degradation for certain fatty acids. Synthesis and degradation of fatty acids by different pathways. Elongation and unsaturation of fatty acids by accessory enzyme systems.
- Degradation of proteins to amino acids and its regulation. Removal of nitrogen. Ammonium ion and its conversion into urea in most terrestrial vertebrates. Carbon atoms of degraded amino acids act as major metabolic intermediates. Digestion and absorption of proteins. The biosynthesis of amino acids and its regulation. Inborn errors in amino acid metabolism.
- Synthesis of the pyrimidine ring and of purine bases. Key steps in nucleotide biosynthesis.
- Cholesterol biosynthesis and its regulation. Important derivatives of cholesterol: bile salts and steroid hormones.
- DNA replication, recombination, and repair. RNA synthesis and splicing. Types of RNA molecules. Protein Synthesis. The control of gene expression.
- Highly interconnected pathways. Metabolic profiles of different organs. Food intake and starvation induced metabolic changes. Hormonal control of metabolism.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	In class, face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	- PowerPoint and video presentations. - Communication with students via e-mail. - Teaching support through access to on-line databases etc.
TEACHING METHODS	

Activity	***Semester workload***
Lectures	26
Laboratory practice	26

	Individual exercises	25
	Group project	23
	Course total (25 h of workload per ECTS)	***100***
STUDENT PERFORMANCE EVALUATION	The evaluation on the course's theory consists of: 1. Final written examination on the course's theory (80-100%), consisting of: I. Evaluation of elements of the course's theory II. Short-answer questions III. Multiple choice questions 2. Personal written essay and its presentation The evaluation on the course's laboratory practice is determined by the final written examination (100%) consists of: I. Evaluation of elements of the course's theory II. Short-answer questions III. Multiple choice questions	

(5) ATTACHED BIBLIOGRAPHY

- Diamandides G. (2017). Intoduction in Biochemistry, 4th Edition, University Studio Press, Thessaloniki, Greece
- Katinakis P. (2007). Biochemistry, 2nd Edition, Embryo Editions, Athens, Greece
- Berg J.M., Tymoczko J.L. and Stryer L. (2002). Biochemistry, 5th Edition, International Edition, New York