Universidad Zaragoza

Year : 2019/20

26703 - Human biochemistry

Syllabus Information

Academic Year: 2019/20
Subject: 26703 - Human biochemistry
Faculty / School: 104 -
229 -

Degree: 304 - Degree in Medicine
305 - Degree in Medicine

ECTS: 6.0
Year: 305 - Degree in Medicine: 1
304 - Degree in Medicine: 1

Semester: First semester
Subject Type: Basic Education
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 learning process designed for this subject is based on the following:

The activities programmed for the course are the same in the different groups at the School of Medicine in Zaragoza and the School for Health and Sport Sciences in Huesca.

The course is composed of 40 one-hour lectures, 10 hours of laboratory sessions, and 10 hours of seminars. Students will also have to carry out and present 4 tutored reports.

With regard to the lectures, the materials for each chapter will be available at the Photocopying Service at least one week before the beginning of that chapter lectures, so that students can peruse it in advance. These materials will also be available through the webpage dedicated to this subject in the ADD (University's teaching website).

Seminars will be organized around 2 hour sessions and will be used to discuss the functional-structural properties of biomolecules.

Laboratory sessions of two hours are taught in small groups of 15 students each. Student performance will be assessed through specific questions included in the final text exam.

Tutored reports will be carried out individually and their themes will be related to the main contents of the subject. This activity also aims to develop the transversal learning competence of using Internet based communication and knowledge resources.

4.2.Learning tasks

The course includes the following learning tasks:

- 1. Lectures
- 2. Seminars
- 3. Laboratory sessions: students will be informed about the risks and hazards they may become exposed to in the laboratories, and about actions to be taken in case of an accident. Students will be asked to sign a consenting form binding them to follow security rules before they can take part in the laboratory sessions. Students can request more information from the Unit for Prevention of Labor Risks at http/uprl.unizar.es/estudiantes.html
- 4. Tutored reports
- 5. Clinical cases
- 6. Tutorial sessions with professors of the subject.
- 7. Evaluation

4.3.Syllabus

The course will address the following topics:

CHAPTER I: AMINO ACIDS AND PROTEINS

- Lecture 1. Amino acids, Structure, properties, and classification of proteinogenic amino acids. Stereochemistry. Acid-base properties of amino acids.
- Lecture 2. Proteins. Composition of proteins. Classification. Functional diversity of proteins. Primary structure. Peptide bond. Acid-Base properties of peptides. Peptides of biological interest.
- Lecture 3. Spatial conformation of proteins. Regular conformations of polypeptide chain: a-helix and b-sheet secondary structures. Collagen helix. Non-covalent forces determining and stabilizing the secondary structure.
- Lecture 4. Conformation of globular proteins: tertiary and quaternary structures. Myoglobin: structure. Heme group binding to protein and oxygen. Quaternary structure: hemoglobin. Types of hemoglobin. The tertiary structure of globins. Oxygen saturation curves for myoglobin and hemoglobin. Regulation of hemoglobin oxygenation. Bohr effect. Fetal and S hemoglobin. Thalassemias.
- Lecture 5. Enzymes. General properties of enzymes. Specificity. Classification and nomenclature. Distribution of enzymes. Isoenzymes. Enzymes in clinical diagnostics. Enzyme quantification.
- Lecture 6. Enzyme kinetics. Catalysis and enzyme mechanism of action. Enzyme kinetics: Michaelis-Menten equation and its transformations. Effects of pH, temperature and enzyme concentration in enzymatic reaction speed. Enzyme inhibitors.
- Lecture 7. Regulation of enzyme activity. Metabolic regulation. Induction, repression, and derepression. Proenzymes. Antienzymes. Feedback and covalent modification.
- Lecture 8. Vitamins. Hydrophilic vitamins and their roles as coenzymes. Structure and function. Lipophilic vitamins. Structure and function.

Laboratory sessions:

- Session 1: Serum protein electrophoresis in cellulose acetate strips.
- Session 2: Clinical case I: Clinical Enzymology.
- Session 3: Clinical case II: Vitamin B12 deficit and vitamin D toxicity.

Learning activities:

Lectures: 10 hours

Laboratory sessions: 5 hours

Student autonomous work: 18.5 hours.

CHAPTER II: STORAGE AND USE OF GENETIC INFORMATION

- Lecture 9. Nucleic acids. Structure and properties of nucleosides and nucleotides. DNA structure: a double helix. DNA supercoiling. Topoisomerases. Chromatin structure. RNA: structure and types. Degradation of nucleic acids.
- Lecture 10. DNA replication. General characteristics of replication: semiconservative, bidirectional. Mechanisms for DNA replication in prokaryotes. Primosome and replisome. DNA reparation. Replication origin.
- Lecture 11. DNA transcription: RNA synthesis. Prokaryote transcription. Post-transcriptional modifications of rRNAs and tRNAs. Ribozymes.
- Lecture 12. Translation of genetic message: protein biosynthesis. The genetic code. Translation machinery:

involved molecules. Activation and binding of amino acids to tRNA: aminoacyl tRNA synthetases. Prokaryote protein synthesis. Post-translational modifications. Differential characteristics os eukaryote protein synthesis. Inhibitors of protein synthesis.

- Lecture 13. Mitochondrial genetic system. Gene organization. Replication and transcription of mammal DNA. RNAs processing. Regulation of expression.

Laboratory Session:

Session 4: Nucleic acids: Isolation and purification of DNA.

Learning activities:

Lectures: 6 hours

Laboratory sessions: 2 hours

Student autonomous work: 10 hours.

CHAPTER III: INTRODUCTION TO INTERMEDIARY METABOLISM

- Lecture 14. Intermediary metabolism. Concept. Catabolic, anabolic and amphibolic routes. Bioenergetics: exergonic and endergonic processes. Energetic coupling. Energy-rich compounds: chemical characteristics. Transferred chemical groups. Types of energy-rich bonds. Enzymes and coenzymes involved in biological oxydoreduction processes.

Learning activities:

Lectures: 3 hours

Student autonomous work: 4.5 hours.

CHAPTER IV: METABOLISM OF CARBOHYDRATES

- Lecture 15. Glycolysis. Glucose uptake by tissues. Stages of glycolysis. Pyruvate metabolic fates. Metabolic and hormonal regulation of glycolysis. Stoichiometry and energy balance. Cori's cycle. Other hexoses incorporation of glycolytic pathway. Pyruvate oxidation to acetyl-CoA.
- Lecture 16. Citric acid cycle. Cycle's role within intermediary metabolism. Cellular localization. Metabolic reactions and their regulation. Cycle's energy balance. Anaplerotic reactions.
- Lecture 17. Biological oxidation and respiratory chain. Components of the respiratory chain. The sequence of respiratory chain components. Oxidative phosphorylation. Structure and function of ATP synthetase. Chemiosmotic hypothesis. Specific transport systems in the mitochondria's inner membrane: translocases. System of mitochondrial shuttles. ATP balance in glucose total oxidation. Reactive oxygen species, antioxidant defenses, and human disease.
- Lecture 18. Gluconeogenesis. Specific reactions. Metabolic and hormonal reactions. Stoichiometry and energy balance. Enzymatic differences between glycolysis and gluconeogenesis. Alterations in gluconeogenesis in humans.
- Lecture 19. Glycogen metabolism and its regulation. Glycogen stores and their physiological role. Glycogenolysis. Synthesis of Glycogen. Hormonal regulation of glycogen metabolism in muscle and liver. Glycogen phosphorylase system. Glycogen synthetase system. Dephosphorylation of enzymes: phosphatases. Glycogenosis.
- Lecture 20. Pentose phosphate pathway. Reactions of the oxidative phase. Reactions of non-oxidative phase. Regulatory mechanisms. Enzymatic defects. Glucuronic acid pathway.
- Lecture 21. Heteroside metabolism. General properties. Biosynthesis of glycoproteins: N-glycans and O-glycans. Control of glycoprotein biosynthesis. Glycoprotein catabolism. Biosynthesis and degradation of proteoglycans. Mucopolysaccharides.

Laboratory sessions

Session 5: Carbohydrates: Starch hydrolysis and determination of reducing sugars.

Learning activities:

Lectures: 9 hours

Laboratory sessions: 2 hours

Student autonomous work: 12 hours.

CHAPTER V: LIPID METABOLISM

- Lecture 22. Adipose tissue metabolism and fat mobilization. Lipolysis. Hormonal regulation of lipolysis. Lipolysis products fate.
- Lecture 23. Fatty actid oxidation. Fatty acid activation in cytosol and transport inside mitochondria. Carnitine as shuttling molecule. Mitochondrial beta-oxidation of even-and odd-chain saturated fatty acids. Energy balance.
- Lecture 24. Ketonic bodies metabolism. Ketogenesis. Use of ketonic bodies by extrahepatic tissues: cetolysis. Regulation of fatty acid beta-oxidation and ketogenesis.
- Lecture 25. Biosynthesis of fatty acids: lipogenesis. Biosynthesis of even-and odd-chain saturated fatty acids.

Sources of acetyl-CoA and NADPH for lipogenesis. Malonil-CoA formation. Enzymatic and co-enzymatic components of fatty acid synthase. Metabolic reactions. Regulation of synthesis of fatty acid. Fatty acid chain elongation. Biosynthesis of mono-and polyunsaturated fatty acids.

- Lecture 26. Eicosanoid biosynthesis. Eicosanoid precursors. Metabolism of arachidonic acid. Biosynthesis of eicosanoids: cyclooxygenase pathway and lipoxygenase pathway. Catabolism of eicosanoids. Mechanism of action of eicosanoids and its clinical significance.
- Lecture 27. Metabolism of complex lipids. Biosynthesis of triacylglycerides. Biosynthesis of phosphoacylglycerides: de novo pathway and saving pathway. Phosphoacylglycerides degradation. Biosynthesis and degradation of sphingolipids.
- Lecture 28. Metabolism of cholesterol. Whole-body cholesterol balance. Biosynthesis of cholesterol. Mevalonate formation. Mevalonate transformation into squalene. Squalene transformation into cholesterol. Control of cholesterol synthesis.: HMG-CoA reductase. Cholesterol transport. Diseased caused by alterations in cholesterol metabolism.
- Lecture 29. Cholesterol derivatives with physiological significance in the human body. Biliary acids. Biosynthesis of primary and secondary biliary acids. Regulation of biliary acid synthesis. Enterohepatic circulation. Cholesterol excretion. Steroid hormones from adrenal cortex and gonads: biosynthesis and degradation. Biosynthesis of 1,25-dihydroxycholecalciferol.
- Lecture 30. Integration of lipid metabolism. Exogenous and endogenous lipid transport. Liver metabolic control. Fatty liver degeneration. Reverse cholesterol transport.

Laboratory Session:

Session 6: Metabolism Clinical cases.

Learning activities:

Lectures: 7 hours

Laboratory sessions: 1 hour

Student autonomous work: 11 hours.

CHAPTER VI: METABOLISM OF NITROGEN COMPOUNDS

- Lecture 31. The general reaction in amino acid catabolism. Transamination reactions. Oxidative deamination. Decarboxylation. Ammonia fate. Glutamine formation and ammonium excretion. Urea cycle and its regulation. Enzymatic defects in the urea cycle.
- Lecture 32. The fate of carbon skeleton from amino acids. Routes for amino acid carbon skeleton incorporation into different metabolic intermediates. Glycogenic and ketogenic amino acids.
- Lecture 33. Conversion of amino acids into specialized products. Creatine and creatinine formation. Creatinine excretion rate as muscle mass index. Tryptophan: serotonin precursor. Malignant carcinoid syndrome (argentaffin cell tumors). Metabolism of g-aminobutyrate.
- Lecture 34. Metabolism of purines and pyrimidines.
- Lecture 35. Metabolism of Hemoglobin. Biosynthesis and regulation of porphyrins and heme group. Porphyrias: definition and classification. Biosynthesis of hemoglobin. Catabolism of hemoglobin: metabolism of bilirubin, and biliary pigment formation. Jaundice.

Learning activities:

Lectures: 6 hours

Student autonomous work: 9 hours.

Laboratory Sessions at School of Sciences for Health and Sports

- Laboratory 1: Introduction to working in the biochemistry laboratory
- Laboratory 2: Handling a pH-meter. Titration Curve of an amino acid
- Laboratory 3: Protein Quantitative Determination
- Laboratory 4: Isolation and hydrolysis of Starch
- Laboratory 5: Protein Electrophoresis
- Laboratory 6: Determining the enzymatic activity
- Seminar 1: Formulation of carbohydrates
- Seminar 2: Formulation of lipids
- Seminar 3: Formulation of nucleic acids
- Seminar 4: Metabolic interrelationships

4.4.Course planning and calendar

Schedule for face-to-face activities and Tutored reports deadlines.

Summary of learning-teaching activities schedule.

ACTIVITY	ON-SITE HOURS	FACTOR	AUTONOMOUS EFFORT/OFF-SITE HOURS	TOTAL
Lectures	40	1.5	60	100
Seminars	10	1.5	15	25
Laboratories	10	0.5	5	15
Tutored Reports			6	6
Exams			4	4
Total	60		90	150

Activities and Calendar

The provisional schedule for this subject is shown below. This provisional planning is subject to modifications by the School.

Week	Lecture	Laboratory	Seminars/Tests	Off-site activities/Tutored Reports
1	Chapter I (3h)	Distribution of activities		Distribution of Tutored Reports
2	Chapter I (3h)	Seminar on proteins		
3	Chapter I (3h)	Seminar on carbohydrates		
4	Chapter I (1h) Chapter II (2h)	Seminar on carbohydrates		
5	Chapter II (3h)	Seminar on lipids		
6	Chapter II (1h) Chapter III (2h)	Seminar on lipids	Partial Evaluation	
7	Chapter III (1h) Chapter IV (2h)	Laboratory sessions		
8	Chapter IV (3h)	Laboratory sessions		
9	Chapter IV (3h)	Laboratory sessions		

10	Chapter IV (1h) Chapter V (2h)	Laboratory sessions		
11	Chapter V (3h)	Laboratory sessions		
12	Chapter V (2h) Chapter VI (1h)	Laboratory sessions		
13	Chapter VI (3h)	Laboratory sessions		Correction of Tutored Reports
14	Chapter VI (1h)	Laboratory sessions	Final Evaluation	

Exams calendar is determined by the School before the beginning of the course and can be checked on the following links:

Facultad de Medicina de Zaragoza:

First Year Grade of Medicine Schedules

Facultad de Ciencias de la Salud y el Deporte de Huesca:

Grade of Medicine program and schedules

4.5.Bibliography and recommended resources

Updated bibliography for this subject can be consulted through the University Library webpage:

http://psfunizar7.unizar.es/br13/eBuscar.php?tipo=a