1. OVERVIEW

Subject Area	Biochemistry II
Degree	Bachelor's Degree in Medicine
School/Faculty	Biomedical and Health Sciences
Ac. Year	1º
ECTS	4
Type Language(s)	Compulsory
Delivery Mode	Spanish
Semester	On campus
	2º

2. INTRODUCTION

Biochemistry II is taught in the first year of the Degree in Medicine. It forms part of students' basic learning and provides a sound base for academic and professional development. Biochemistry currently has a huge contribution to modern scientific medicine mainly due to its ability to identify the molecular bases of many pathological processes. The spectacular and continued progress in biochemical concepts and techniques applied to the study of disorders is seeing exponential growth which is revolutionising medical practice. Therefore, Biochemistry is an essential part of the core learning for Health Science professionals in general and particularly for future doctors.

3. SKILLS AND LEARNING OUTCOMES

Key skills (CB, by the acronym in Spanish):

- CB1: Students will demonstrate their knowledge and understanding of a study area that builds on general secondary school education, and will usually be at the level where, with the support of more advanced textbooks, they may also demonstrate awareness of the latest developments in their field of study.

General skills (CG, by the acronym in Spanish):

- CG7: Understand and recognise the normal structure and function of the human body. This includes studies of molecules, cells, tissue, organs and systems in the different stages of life.

Cross-curricular skills (CT, by the acronym in Spanish):

- CT1: Communication: ability to engage in active listening, ask questions and respond in a clear and concise way, as well as to effectively express ideas and concepts. This includes concise and clear written communication.
- CT3: Teamwork: ability to integrate and collaborate actively with other people, areas and/or organisations to reach common goals, evaluate and integrate contributions from the rest of the group members and create a good working environment.
- CT4: Adaptability: ability to detect, interpret and respond to a changing environment. Ability to equip themselves and work effectively in different situations and/or with different groups or individuals. This means adapting to change depending on circumstances or needs. It involves the confidence to take on crucial challenges on a personal or group level, maintaining a good physical and mental health to allow work to be carried out effectively.
- CT8: Planning and organization: ability to set objectives and choose the right means to fulfil them through the efficient use of time and resources.
- CT10: Independent learning: the ability to govern your own development by choosing the most effective lines of action, strategies, tools and opportunities to independently learn and apply knowledge to practice.

Specific skills (CE, by the acronym in Spanish):

- CE 1.1.1: Recognising the structure and function of cells. Biomolecules. Metabolism. Metabolic regulation and integration.
- CE 1.1.2: Understanding the fundamentals of human nutrition. Cell communication. Excitable membranes. The Cell Cycle. Cellular differentiation and proliferation. Gene expression, information and regulation. Heredity. Embryo development and organogenesis.
- CE 1.2.2: Using basic laboratory techniques and materials. Interpreting a normal analysis. Using macroscopic, microscopic and imaging techniques to recognise the morphology and structure of tissue, organs and systems. Performing functional tests and determining vital signs and how to interpret them. The basic physical examination.

Learning outcomes (RA, by the acronym in Spanish):

- Recognise the main classes of biomolecules and explain their function or activity in terms of their chemical structure.
- Understand how biomolecules interact to give rise to supramacromolecular structures.
- Understand the structure and properties of water to know the structure of macromolecules, their properties and biological functions.
- Be aware of the general principles of enzymology and understand the importance of enzymes as essential tools in cell metabolism.
- Understand the main metabolic strategies in living beings for obtaining and using energy.
- Breakdown the metabolic processes and the main classes of biomolecules, their interactions and their bioenergetic budgets.
- Analyse the role of biological membranes in the processes of generation and use of biological energy and the compartmentalisation of the vital processes.
- Understand the molecular bases of the signal transduction pathways.
- Associate the metabolic alterations in the physiopathological processes with the most common biochemical analysis parameters, evaluate the origin of these changes and the physiological consequences of these alterations.
- Evaluate the biochemical processes as a fundamental basis for life and all the vital processes and functions.
- Be aware of the principles of the main biochemical techniques, particularly those most used in diagnosis (electrophoresis, ELISA, etc.).

The following table shows how the skills developed in the course match up with the intended learning outcomes:

Skills	Learning outcomes
CB1, CG7, CT1, CT3, CT8, CT10, CE1.1.1, CE1.2.2	Recognise the main classes of biomolecules and explain their function or activity in terms of their chemical structure.
CB1, CG7, CT1, CT3, CT8, CT10, CE1.1.1	Understand how biomolecules interact to give rise to supramacromolecular structures.
CB1, CG7, CT1, CT3, CT8, CT10, CE1.1.1	Understand the structure and properties of water to know the structure of macromolecules, their properties and biological functions.
CB1, CG7, CT1, CT3, CT8, CT10, CE1.1.1	Be aware of the general principles of enzymology and understand the importance of enzymes as essential tools in cell metabolism.
CB1, CG7, CT1, CT3, CT8, CT10, CE1.1.1	Understand the main metabolic strategies in living beings for obtaining and using energy.

CB1, CG7, CT1, CT3, CT8, CT10, CE1.1.1	Breakdown the metabolic processes and the main classes of biomolecules, their interactions and their bioenergetic budgets.
CB1, CG7, CT1, CT3, CT8, CT10, CE1.1.1	Analyse the role of biological membranes in the processes of generation and use of biological energy and the compartmentalisation of the vital processes.
CB1, CG7, CT1, CT3, CT8, CT10, CE1.1.1	Understand the molecular bases of the signal transduction pathways.
CB1, CT1, CT3, CT4, CT8, CT10, CE1.1.1	Associate the metabolic alterations in the physiopathological processes with the most common biochemical analysis parameters, evaluate the origin of these changes and the physiological consequences of these alterations.
CB1, CT1, CT3, CT4, CT8, CT10, CE1.1.1	Evaluate the biochemical processes as a fundamental basis for life and all the vital processes and functions.

4. CONTENTS

1.- Structure and function of carbohydrates
1.1.-Structure
- 1.1.1.-Monosaccharides
  - 1.1.1.1.-Physicochemical properties
  - 1.1.1.2.-Derivatives of monosaccharides
  - 1.1.1.3.-Glycosidic bond
  - 1.1.2.-Oligosaccharides
  - 1.1.2.1.-Disaccharides
  - 1.1.2.2.-Biological importance
- 1.1.3.-Polysaccharides
  - 1.1.3.1.-In reserve: starch and glycogen

1.1.3.2.-Structural: cellulose, glycosaminoglycans and bacterial wall
1.2.- Function
- 1.2. 1.-Glycolysis
  - 1.2.1.1.-Preparation phase
  - 1.2.1.2.-Beneficial phase
  - 1.2.1.3.-Destinations of piruvate
- 1.2.2.-Fermentation
  - 1.2.2.1.-Lactic fermentation
  - 1.2.2.2.-Alcoholic fermentation
- 1.2.3.-Gluconeogenesis
- 1.2.4.-Pentose phosphate pathway
- 1.2.5.-Regulation of glycolysis and gluconeogenesis
- 1.2.6.-Glycogen metabolism
  - 1.2.6.1.- Glycogen degradation
  - 1.2.6.2.- Glycogen synthesis
  - 1.2.6.3.- Regulation of hepatocyte and in the muscle

2.- Citric acid cycle
2.1.-Production of Acetyl-CoA
2.2.-Citric acid cycle reactions
2.3.-Energy balance
2.4.-Anaplerotic reactions
2.5.-Regulation
3.-Oxidative phosphorylation
3.1.-Electron transfer reactions
3.2.-ATP synthesis
3.3.-Regulation

4.- Lipid structure and function

4.1.- Structure

4.1.1-Storage lipids

4.1.1.1-Fatty acids

4.1.1.2.-Triglycerides

4.1.1.3.-Waxes

4.1.2.-Structural lipids

4.1.2.1.-Phosphoglycerides

4.1.2.2.-Spingholipids

4.1.2.3.-Sterols

4.1.3.-Lipids with other biological functions

4.1.3.1.-Phosphatidylinositols

4.1.3.2.-Eicosanoids

4.1.3.3.-Steroidal hormones

4.1.3.4.-Bile acids

4.1.3.5.-Vitamins

4.1.3.6.-Dolichol

4.1.3.7.-Coenzyme Q10

4.1.4.-Lipids and biological membranes

4.2.- Function

4.2.1.- Beta oxidation of fatty acids

4.2.1.1.-Carnitine shuttle mechanism

4.2.1.2.-Oxidation of saturated fatty acids

4.2.1.3.-Oxidation of unsaturated fatty acids

4.2.1.4.-Oxidation of odd-chain fatty acids

4.2.1.5.-Regulation

4.2.1.6.-Omega-oxidation of fatty acids (in ER).

4.2.1.7.-Ketone bodies

4.2.1.8.-Beta-oxidation of fatty acids in peroxisomes

4.2.2 . - Biosynthesis of lipids

4.2.2.1.-Biosynthesis of fatty acids

4.2.2.1.1-Formation of Malonyl-CoA (cytosol)

4.2.2.1.2-Fatty acid synthase complex (cytosol)

4.2.2.1.3-Regulation

4.2.2.1.4-Long-chain fatty acids (SER and mitochondria)

4.2.2.1.5-Desaturation of fatty acids (SER)

4.2.2.2.-Biosynthesis of phospholipids

4.2.2.3.-Biosynthesis of cholesterol and its derivatives

4.2.2.3.1-Synthesis of cholesterol

4.2.2.3.2-Regulation

4.2.2.3.3-Synthesis of steroidal hormones

4.2.2.3.4-Synthesis of bile acids

4.2.2.3.5-Synthesis of vitamin D

5.- Digestion, absorption and plasma lipid transport

5.1.- Processing of lipids in the diet

5.2.- Plasma lipoproteins

5.3.- Cholesterol uptake

6.- Metabolism of amino acids

6.1.-Oxidation of amino acids

6.1.1-Deamination of amino acids

6.1.2-Urea cycle

6.1.3-Regulation of the urea cycle

6.1.4-Degradation of carbonate skeletons

6.2.-Biosynthesis

6.2.1.-The nitrogen cycle

6.2.2.-Carbonate skeletons

6.3.- Porphyrins

7.- Metabolism of nucleotides

7.1.-Degradation of nucleotides
7.1.1.-Catabolism of purine nucleotides
7.1.2.-Catabolism of pyrimidine nucleotides
7.2.-Biosynthesis
7.2.1.- Purines
7.2.2.-Pyrimidines
7.2.3.-Retrieval routes
7.3.-Associated diseases
8.-Metabolic integration
8.1.-Integration of cell metabolism
8.2.-Metabolic specialisation of tissues and organs
8.3.-Homoeostasis of glucose
8.4.-Feed-fast cycle
8.5.-Metabolism and stress

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- Problem-based learning.
- Case study sessions
- Specialised seminars
- Lectures
- Learning based on specific laboratory teaching.

6. LEARNING ACTIVITIES

The types of learning activities, plus the amount of time spent on each activity, are as follows:

Learning activity	Number of hours	Attendance mode
Theory/practical learning activities.	46 h	100
Directed learning activities.	11 h	100
Knowledge tests	1 h	100
Self-study	30 h	0
Tutorials	12h	100
TOTAL	**100 h**	

7. ASSESSMENT

The assessment methods, plus their weighting in the final grade for the course, are as follows:

Assessment system	Weighting
Practical content (activities and laboratory practice)	25%
Attitude	5%
Objective tests	70%

The objective tests assessment includes the evaluation of the theory content (50%) and skills and knowledge acquired during the practical subject activities (20%).
Assessment of the practical section includes: integrated activities following the work station learning model (WSLA), problem solving, literature analysis, clinical case studies, and more. They also include an assessment of the student's attitude.

On the Virtual Campus, when you open the subject area, you can see all the details of your assessment activities and the deadlines and assessment procedures for each activity.

8. BIBLIOGRAPHY

The recommended bibliography is indicated below:

- Baynes y Dominiczak, eds. Bioquímica Médica. 4ª ed. Elsevier. 2015
- Ferrier. Bioquímica/ Series Editor: Harvey. 7ª ed. Wolters Kluwer 2018.
- Koolman, Jan. Bioquímica humana: texto y atlas. 4a ed. Madrid: Médica Panamericana, 2012.
- Lehninger, Albert Lester, Nelson, Cox. Lehninger Principios de Bioquímica. 7ª Ed. Barcelona Omega 2019.
- Feduchi. Bioquímica: conceptos esenciales. 3ª ed. Editorial Médica Panamericana. 2021.
- Meisenberg G. Principios de Bioquímica Médica. 2018. Elsevier.

The recommended bibliography is indicated below:

- Springer *ebooks* collection:
- Metabolic Syndrome and Diabetes. Marina Kurian, Bruce M. Wolfe, Sayeed Ikramuddin. 1st ed. 2016. Springer Science+Business Media New York. http://dx.doi.org/10.1007/978-1-4939-3220-7.
- Metabolic Acidosis. Donald E. Wesson. 1st ed. 2016. Springer Science+Business Media New York. http://dx.doi.org/10.1007/978-1-4939-3463-8
- Transcriptomics and Gene Regulation. Jiaqian Wu.1st ed. 2016. Springer Science+Business Media Dordrecht. http://dx.doi.org/10.1007/978-94-017-7450-5
- DNA Replication, Recombination, and Repair. Fumio Hanaoka, Kaoru Sugasawa.1st ed. 2016. Springer Japan. http://dx.doi.org/10.1007/978-4-431-55873-6
- Reviews of Physiology, Biochemistry and Pharmacology Vol. 170. Bernd Nilius, Pieter de Tombe, Thomas Gudermann, Reinhard Jahn, Roland Lill, Ole H. Petersen. 1st ed. 2016. Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-31492-1.
- RNA Processing. Gene W. Yeo.1st ed. 2016. Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-29073-7.
- Biochemistry and Molecular Biology. Dirk Hoffmeister. 3rd ed. 2016. Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-27790-5
- Modified Nucleic Acids. Kazuhiko Nakatani, Yitzhak Tor. 1st ed. 2016. Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-27111-8.
- Epigenetics - A Different Way of Looking at Genetics. Walter Doerfler, Petra Böhm. 1st ed. 2016. Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-27186-6.
- A Time for Metabolism and Hormones. Paolo Sassone-Corsi, Yves Christen. 1st ed. 2016. http://dx.doi.org/10.1007/978-3-319-27069-2.
- Hepatic De Novo Lipogenesis and Regulation of Metabolism. James M Ntambi. 1st ed. 2016. Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-25065-6.
- The Initiation of DNA Replication in Eukaryotes. Daniel L. Kaplan. 1st ed. 2016. Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-24696-3.
- Long Non-coding RNAs in Human Disease. Kevin V. Morris. 1st ed. 2016. Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-23907-1.
- RNA/DNA and Cancer. Joseph G. Sinkovics. 1st ed. 2016. Springer International Publishing Switzerland. http://dx.doi.org/10.1007/978-3-319-22279-0.

Mobile and tablet applications:

- https://itunes.apple.com/us/app/case-files-biochemistry-3/id955265985?mt=8
- https://itunes.apple.com/es/app/biochemistry-genetics-lange/id915478575?mt=8.