



## COURSE DATA

## Data Subject

Code	34699
Name	Biochemistry
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

## Study (s)

Degree	Center	Acad. year	Period
1206 - Degree in Dentistry	Faculty of Medicine and Odontology	1	First term

## Subject-matter

Degree	Subject-matter	Character
1206 - Degree in Dentistry	4 - Biochemistry	Basic Training

## Coordination

Name	Department
DONATO MARTIN, MARIA TERESA	30 - Biochemistry and Molecular Biology

## SUMMARY

**Biochemistry** is a compulsory subject in the first course of the *degree in Dentistry* that is taught during the first quarter. The activities under this subject are developed in classroom and laboratory practical classes. Biochemistry introduces basic concepts of composition and functioning of living organisms from a molecular point of view. It describes the principal biological molecules, their structure and functional characteristics, covering basic aspects of Enzymology, Molecular Biology, Signaling, Bioenergetics, Metabolism and Immunology. In addition, it pays special attention to the specific molecular characteristics of dental tissues, including their formation, dynamics and stability within the environment of the mouth, and gives an introduction to Clinical Biochemistry and Molecular Pathology. Biochemistry is a multidisciplinary field, closely related to other important subjects of the degree in Dentistry, especially Biology, Microbiology, Biophysics, Physiology and Biomaterials



## PREVIOUS KNOWLEDGE

### Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

### Other requirements

Basic knowledge of Chemistry, Biology and Physics

## OUTCOMES

### 1206 - Degree in Dentistry

- Comprender las ciencias biomédicas básicas en las que se fundamenta la Odontología para asegurar una correcta asistencia buco-dentaria.
- Comprender y reconocer la estructura y función normal del aparato estomatognático, a nivel molecular.
- Conocer de los procesos generales de la enfermedad, entre los que se incluyen la infección, la inflamación, las alteraciones del sistema inmune, la degeneración, la neoplasia, las alteraciones metabólicas y los desórdenes genéticos.
- Conocer, valorar críticamente y saber utilizar las fuentes de información clínica y biomédica para obtener, organizar, interpretar y comunicar la información científica y sanitaria.
- Conocer del método científico y tener capacidad crítica para valorar los conocimientos establecidos y la información novedosa. Ser capaz de formular hipótesis, recolectar y valorar de forma crítica la información para la resolución de problemas, siguiendo el método científico.
- Conocer y entender las condiciones bioquímicas que repercuten en la salud bucal.
- Conocer los procedimientos y pruebas diagnósticas clínicas y de laboratorio, conocer su fiabilidad y validez diagnóstica.
- Conocer los procesos generales de enfermar, curar y reparar, entre los que se incluyen la infección, la inflamación, la hemorragia y la coagulación, la cicatrización, los traumatismos y las alteraciones del sistema inmune, la degeneración, la neoplasia, las alteraciones metabólicas y los desordenes genéticos.
- Saber compartir información con otros profesionales sanitarios y trabajar en equipo.
- Promover el aprendizaje de manera autónoma de nuevos conocimientos y técnicas, así como la motivación por la calidad.

## LEARNING OUTCOMES



By completing the course, the students will know the structure and properties of the main types of biological molecules, especially proteins and nucleic acids. They will likewise be able to understand and explain the relationship between the structure and properties of those molecules and the mechanisms involved in their function. This will also include understanding, at a qualitative level and for selected examples, the principles that determine the interaction between proteins and their physiological ligands, including the concepts of cooperativity and allosterism, the catalytic activity of enzymes, the processes of transformation and transfer of energy within cells and the molecular mechanisms of cell signaling. On the other hand, they will know the composition, structure, properties and stability conditions of calcified tissues of teeth and their relationship to the biochemical conditions within the mouth, understanding as well the connection between the above properties and dental disease. Finally, students will know and understand the key metabolic processes, linking them in in an integrated way

## DESCRIPTION OF CONTENTS

### 1. Water and its importance to life

Structure and physicochemical properties of water. Weak interactions in aqueous solution: Ionic interactions, dipole interactions, hydrogen bonds and hydrophobic effect. Acid-base reactions in aqueous solution.

### 2. Major biological molecules and their properties

Common organic functional groups in biological molecules. Small biological molecules. Biological Macromolecules

### 3. Amino acids, peptides and proteins

Types and properties of amino acids. Modified amino acids. The peptide bond. Examples of important peptides and their functions. Types of proteins.

### 4. Protein structure

Levels of structure. Primary, secondary, tertiary and quaternary structure. Denaturation of proteins. Structure-function relationships.

### 5. Fibrous proteins. Collagen

Properties and functions of fibrous proteins. The collagen synthesis, structure, and function.



## **6. Globular proteins. Hemoglobin**

Properties and functions of globular proteins. Importance of protein dynamics. Protein-ligand interactions. Cooperativity and allosterism. Oxygen transport in hemoglobin.

## **7. Enzymes**

Biological catalysts. Active site. Types of enzymes. Enzyme cofactors: vitamins. Enzyme kinetics. Chemical kinetics and enzyme kinetics. Michaelis-Menten model.

## **8.**

Regulation of enzymes.

Enzyme regulation. Molecular mechanisms of enzyme regulation. Allosteric enzymes. Enzyme inhibition. Regulation by covalent modification. Isozymes.

## **9. Structure of Nucleic Acids**

Types of nucleic acids. Structure and properties of the double helix of DNA. Supercoiling. Structure of RNA.

## **10. Replication**

Molecular mechanism of replication. Molecular origin of mutations. Error correction mechanisms.

## **11. Gene Expression**

Molecular mechanism of transcription. Post-transcriptional modifications. Regulation of transcription. The genetic code. Molecular mechanism of translation. Folding and post-translational maturation of proteins.

## **12. Basic principles of hormone action**

Metabolic functions of hormones. Effects on oral structures. Mechanisms of hormone action.

## **13. Introduction to intermediary metabolism**

Ebergy supply to the cell. Catabolism and anabolism. Molecules of high energy content. Basic principles of regulation.



#### **14. Cellular energy metabolism, oxidative pathway**

Tricarboxylic acid cycle: reaction sequence, function and control. Mitochondrial electron transport. Oxidative phosphorylation. Respiratory control. Reactive oxygen species.

#### **15. Intermediary metabolism of glycosides**

Glycolysis. Destinations of pyruvate. Anaerobic oxidation, fermentation. Gluconeogenesis. Coordinated regulation of glycolysis and gluconeogenesis. Glycogen metabolism and its regulation. Pentose phosphate pathway.

#### **16. Intermediary metabolism of lipids**

Mobilization of lipid reserves. Oxidation of fatty acids. Metabolism of ketone bodies. Biosynthesis of fatty acids. Regulation of fatty acid metabolism. Cholesterol metabolism. Lipoproteins.

#### **17. Intermediary metabolism of amino acids**

Origin and fate of amino acids. Biosynthesis. Amino acids as precursors of other biomolecules. Catabolic deamination. Destination of the carbon chain. Synthesis of urea.

#### **18. Metabolic integration.**

Interconnections of the metabolic roads. Cooperation intertisular. Metabolic profiles. Metabolic integration in situations fisiopatològicas of interest.

#### **19. Biochemical basis of inflammation**

Elements involved in the inflammatory reaction. Biochemistry of inflammation: plasma and tissue mediators.

#### **20. Metabolism of phosphorus and calcium**

Distribution and functions of calcium and phosphate. Homeostasis, control and possible alterations of the calcium-phosphorus system in bone and dental tissues.

#### **21. Biochemistry of calcified tissues of teeth**

Organic and inorganic molecules in the enamel, dentin and cementum. Physical properties of calcified tissues of the teeth: connection with their composition.





## **22. Structure and formation of dental apatite**

Types and properties of calcium phosphate. Crystal structure of apatite. Biomineralization and Epitaxy. Synthesis and maturation of dentin and enamel.

## **23. Dynamics and stability of the enamel**

Solubility equilibrium of enamel. Ion exchange reactions. Influence of pH. Regulatory role of saliva. Biochemistry and prevention in Dentistry. Fluor, action way.

## **24.**

### **SEMINARS:**

Seminar 1. Ionic equilibria in aqueous solutions. pH scale. Ionization equilibria of weak acids and weak bases. Buffer solutions. Concept of pKa and isoelectric point.

Seminar 2. Bioenergetics. Thermodynamics of metabolic pathways. Molecules with high energy content.

Seminar 3. Respiratory control. Inhibition and uncoupling of oxidative phosphorylation. Reactive oxygen species. Questions of Biochemistry (I).

Seminar 4. Questions of Biochemistry (II).

Seminar 5. Questions of Biochemistry (III).

Seminar 6. Questions of Biochemistry (IV)

### **PRACTICES:**

Practice 1. Basic Techniques of Biochemistry and Molecular Biology.

Practice 2. Databases, modelling and analysis of protein structures.

Practice 3. Introduction to biochemistry laboratory

Practice 4. Spectrophotometric determination of protein concentration.

Practice 5. Electrophoretic analysis of serum proteins

Practice 6. Clinical enzymology: determination of enzymatic activities in serum samples.



## WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	33,00	100
Classroom practices	15,00	100
Laboratory practices	12,00	100
Study and independent work	30,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	40,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	5,00	0
<b>TOTAL</b>	<b>150,00</b>	

## TEACHING METHODOLOGY

In the lectures, theoretical contents will be presented and explain. Most complex aspects will be developed with more detail in the Seminar sessions, which will include also discussion of questions and exercises with active participation of students.

In the labs, students will carry out common Biochemical Tests and analysis. These practical sessions will be supported by a brief introduction on the basis of the methods employed, the objectives of each practice, expected outcomes and the correct way to interpret the results.

## EVALUATION

The evaluation will be based on an assessment of learning for both, theoretical contents and practical skills.

For the theoretical part, an exam will be made, based on 16 short questions. This will correspond to 75% of the final score. The evaluation of the practical part will correspond to 25% of the final score.

The evaluation of the practical part will correspond to 25% of the final score. The assessment of practices will be made as follows: i) Students will be valued through questions corresponding to the background and objectives of each practice, to be resolved in a personalized way at the beginning of each session. The results of these assessments will correspond to 1/3 of the total score for practices. ii) A final exam will be made with 20 multiple-choice questions, relating to the methods used for the practices, their use in the laboratory, the results and their interpretation. The score from this test corresponds to 2/3 of the total score for practices.



To pass the course, all of the following conditions must be met:

- Attendance at practices is mandatory
- The score of the theory part must reach at least 45% of its maximum value (4.5 out of 10)
- The practice score must reach at least 40% of its maximum value (4 out of 10)
- The overall score (sum of the theory and practical parts, taking into account the percentage value of each part) must reach at least 50% of its maximum value (5 out of 10).

Students are reminded of the great importance of carrying out evaluation surveys of all the teaching teachers of this subject.

## REFERENCES

### Basic

- LOZANO TERUEL, J.A. (2000). Bioquímica y Biología molecular para ciencias de la salud. 2ª ed. McGraw Hill-Interamericana, Madrid.
- MÜLLER-ESTERL, W. (2008). Bioquímica. Fundamentos para Medicina y Ciencias de la Vida. Reverté, Barcelona.
- TYMOCZKO, J., Berg, J.M., Stryer, L. (2014), Bioquímica. Curso Básico. Reverté.
- STRYER, L. Berg, J.M. y Tymoczko, J. (2008), Bioquímica. 6ª ed. Reverté, Barcelona.

### Additional

- NELSON, D. L., y Cox, M. (2007), Lehninger: Principios de Bioquímica. 5ª ed. Omega.
- MCKEE, T y McKee J.R. (2009), Bioquímica: las bases de la vida. 4ª ed. McGraw-Hil. México.
- DEVLIN, T.M. (2004). Bioquímica: libro de texto con aplicaciones clínicas. 4ª ed. Reverté, Barcelona.
- HERRERA, E (2014). Bioquímica básica. Elsevier, Barcelona.