

**COURSE DATA****DATA SUBJECT****Code:** 33046**Name:** Biochemistry**Cycle:** Undergraduate Studies**ECTS Credits:** 10**Academic year:** 2026-27**STUDY (S)**

Degree	Center	Acad. year	Period
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**SUBJECT-MATTER**

Degree	Subject-matter	Character
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**COORDINATION**

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**SUMMARY**

The subject of "Biochemistry" is included within the field of "Molecular and Genetic basis of living organism", which is compulsory in the degree in Biology. This course has 26 credits ECTS offered in the second year of the career, through two annual courses: "Biochemistry" (10 ECTS) and "Genetics" (10 ECTS), and a four-month course on "Molecular Methods in Biology" (6 ECTS).

The main objective of the subject of "Biochemistry" is to provide to the students with basic knowledge about the structure and function of biomacromolecules, about the different forms of the energy used by living organisms, and about the central metabolism and its regulation studied from an integrated point of view.

FOR STUDENTS ENROLLED IN THE 2010 CURRICULUM (OLD CURRICULUM, 1100-BIOLOGY DEGREE, IN THE PROCESS OF BEING PHASED OUT): DUE TO THE IMPLEMENTATION OF THE NEW BIOLOGY DEGREE CURRICULUM, THIS SUBJECT IS IN THE PROCESS OF BEING PHASED OUT AND IS THEREFORE ONLY OFFERED WITHOUT TEACHING (SD). THIS MEANS THAT IT WILL NOT HAVE ANY ASSOCIATED CLASSROOM TEACHING ACTIVITIES AND THAT THE SUBJECT WILL BE ASSESSED SOLELY BY MEANS OF A THEORETICAL-PRACTICAL EXAM.

STUDENTS ON THE OLD CURRICULUM WHO DO NOT PASS THIS COURSE IN ANY OF THE 2024-25 OR 2025-26 EXAM SESSIONS WILL BE REQUIRED TO ADAPT TO THE NEW CURRICULUM IN ORDER TO CONTINUE THEIR UNDERGRADUATE STUDIES IN BIOLOGY.



## PREVIOUS KNOWLEDGE

## RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

## OTHER REQUIREMENTS

## COMPETENCES / LEARNING OUTCOMES

### 1100 -

Capacidad de búsqueda de información y análisis crítico de textos científicos.

Capacidad de comunicación oral y escrita.

Capacidad de resolución de problemas.

Capacidad de trabajar en equipo.

Capacidad para presentar, discutir y extraer conclusiones de los resultados de los experimentos científicos.

Capacidad para trabajar correctamente en los laboratorios de Bioquímica, Genética y Biología Molecular, incluyendo seguridad, manipulación, eliminación de residuos y registro anotado de actividades.

Capacidad para utilizar la instrumentación básica en los laboratorios de Bioquímica, Genética, Biología Molecular y Celular.

Comprender el método científico.

Conocer la estructura y función de las biomoléculas.

Conocer las rutas metabólicas y su regulación.

Conocer los fundamentos de la catálisis enzimática y su regulación.

Conocer los mecanismos de replicación, transcripción, traducción y modificación del material genético.

Conocer los mecanismos de señalización celular.

Conocer los procesos biológicos de obtención y transformación de energía.

Saber hacer análisis de datos científicos.

Skills in analysis and synthesis.



## DESCRIPTION OF CONTENTS

### 1. Introduction

Item 1: Introduction. Biochemistry and its relationship to other sciences. Chemical composition and characteristics of living matter. Structure and properties of water. The weak interactions in aqueous media.

### 2. Structure and function of proteins (Block 1)

Item 2: Structure of the proteins. Aminoacids. The peptide bond and the primary structure. Secondary structure. Tertiary structure and quaternary structure: Domains. Fibrous proteins and globular proteins. Folding and denaturizing of proteins.

Item 3: Dynamics of proteins. Functional classification of proteins. Binding of ligands. Cooperativity and allostherism. Study of the myoglobin and the hemoglobin.

### 3. Enzymology (Block 2)

Item 4: Chemical nature of enzymes. Active center. Enzyme specificity. Classification and nomenclature of enzymes. Enzymatic catalysis. Cofactors.

Item 5: Enzyme kinetics. Model of Michaelis-Menten. The effect of pH and temperature. Enzyme inhibition.

Item 6: Molecular mechanisms of enzymatic regulation. Regulation of enzyme concentration. Allostherism. Covalent modification of enzymes. Amplification of signals.

### 4. Structure and function of nucleic acids (Block 3)

Item 7: Structure and organization of the nucleic acids. Informational metabolic processes. Primary structure. Secondary structure: Model of Watson and Crick. High order structures; the circular and supercoiled DNA. Organization of the genomes and structure of the genes.

Item 8: Molecular mechanisms of the genetic information flux. DNA polymerases; enzymology of elongation of the polynucleotide chain. Enzymology of RNA synthesis. Mechanism of transcription. The genetic code. The mechanism of translation.

Item 9: Genomics and proteomics. Methods for the analysis of nucleic acids and proteins. Study of evolutionary relationships through the structure of biomacromolecules.

Item 10: ATP-ADP system. Thermodynamics of life. Biochemistry of ATP. Coupling between endergonic and exergonic reactions. Energy sources and strategies for the generation of ATP.

Item 11: Biomembranes and transport. Composition, structure and properties of biological membranes. Thermodynamics of the transport across the membrane. Classification of transport systems. Chemiosmotic theory and ATP synthase.

Item 12: The respiratory chain. Function of the respiratory chain. Thermodynamics of the redox reactions. Classes of electron carriers: structure, organization and process. Oxidative phosphorylation. Respiratory control. Inhibitors and uncouplers.



## 5. Bioenergetics (Block 4)

Item 10: ATP-ADP system. Thermodynamics of life. Biochemistry of ATP. Coupling between endergonic and exergonic reactions. Energy sources and strategies for the generation of ATP.

Item 11: Biomembranes and transport. Composition, structure and properties of biological membranes. Thermodynamics of the transport across the membrane. Classification of transport systems. Chemiosmotic theory and ATP synthase. Item 13: The photosynthetic chain. Function of the photosynthetic chain. Photosynthetic pigments. Photosystems. Organisation and process of the electron carriers. Photophosphorylation.

## 6. Intermediary metabolism (Block 5)

Item 14: Overview of intermediary metabolism. Organization of the metabolism. Catabolism and anabolism. Characteristics of the metabolic pathways and their regulation. Steps of the degradation of carbohydrates, lipids and proteins.

Item 15: The acetyl-CoA and the citric acid cycle. The citric acid cycle. Origin and destiny of the acetyl-CoA. The citric acid cycle: enzymatic steps. Regulation of the citric acid cycle. Amphibolic and anaplerotic character of the citric acid cycle.

Item 16: Metabolism of carbohydrates. Glycolysis: enzymatic steps and its regulation. Destinations of the pyruvate. Gluconeogenesis: enzymatic steps and its regulation. Coordinated regulation of glycolysis/ gluconeogenesis by hormones. The Cori cycle. The glyoxylate cycle. The glycogen metabolism and its regulation. The pathway of the pentose phosphates. The Calvin cycle: autotrophic CO<sub>2</sub> fixation. Photorespiration.

Item 17: Metabolism of lipids. Digestion, absorption and transport of the triglycerides and the lipoproteins. Mobilization of lipid storages. Degradation of fatty acids: beta-oxidation. Synthesis of fatty acids. Coordinated regulation of lipid metabolism. Synthesis and uses of ketone bodies.

Item 18: Metabolism of the nitrogen-containing compounds. Oxidative degradation of amino acids. Nitrogen excretion. Nitrogen cycle in the biosphere. Nitrogen fixation. Biosynthesis of amino acids. Nucleotide metabolism.

Item 19: Integration of metabolism. Overview of the metabolism. Metabolic patterns on tissues and organs. Hormonal control of the energy metabolism. Metabolic adaptations: fasting-feeding cycle, diabetes, exercise.

## 7. Problems of Biochemistry

1. pH buffer solutions (3 sessions de 1 h)
2. Enzyme kinetics (3 sessions de 1 h)
3. Bioenergetics (3 sessions de 1 h)

6 sessions de 3 h

1. Preparation of buffer solutions: Checking the buffering capacity. Study of protein solubility as a function of the pH. Isoelectric point. (3 h)
2. Separation of proteins by ion exchange and size exclusion chromatographies. Electrophoretic separation of proteins: Cellulose acetate and SDS-PAGE. (3 h)



## 8. Laboratory practices

6 sessions de 3 h

1. Preparation of buffer solutions: Checking the buffering capacity. Study of protein solubility as a function of the pH. Isoelectric point. (3 h)
3. Enzymatic activity assay of the alkaline phosphatase. Determination of kinetic parameters. Effect of an inhibitor on the kinetic parameters (3 h)
4. Preparation of DNA and electrophoretic analysis of a plasmid with restriction enzymes (3 h)
5. Effect of the wavelength on the reducing capacity of the chloroplasts (3 h)
6. Metabolism of carbohydrates. Alcoholic fermentation. Quantification of liver glycogen (3 h)

## WORKLOAD

### PRESENCIAL ACTIVITIES

Activity	Hours
<b>Total hours</b>	<b>0,00</b>

### NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	10,00
Independent study and work	140,00
Preparation of lessons	0,00
Preparation for assessment activities	0,00
Resolution of case studies	0,00
<b>Total hours</b>	<b>150,00</b>

## TEACHING METHODOLOGY

The development of the course is divided into:

### Theory lectures and questions

They consist of about 50 one-hour classroom sessions (approximately 2 sessions per week), in which the "master class" format will basically be used. The professor will show the most relevant information of the subject mainly using audiovisual media. The documents needed to follow the lectures will be published in the Aula Virtual.

Between these sessions, interspersed with theory classes, generally at the end of each of the blocks of the



program, classes of questions are taught (may be up to 5 in each quarter). These sessions will encourage to the student participation through the resolution of questions. Before any of the sessions, the professor may request some written question resolved. This activity will reveal how students assimilate concepts and, thus, to better evaluate the student work.

### **Sessions of problems**

Nine sessions of one-hour length will be provided throughout the course: 6 sessions in the first four-month period and 3 in the second four-month period. The last session of each period will be used to solve a written test in the classroom. A list of problems with the results will be provided. In addition, at the Aula Virtual will be available explanations of theoretical knowledge to solve model problems as well as some solved examples. The professor may request the delivery of any of the problems solved.

### **Sessions of laboratory**

The attendance is mandatory. There will be 6 sessions of 3 hours length (4 in the first four-month period and 2 in the second four-month period). The students will have before the session a notebook containing the script for the sessions, with a small theoretical introduction and a detailed protocol of the session. The students should prepare at home the session and to response to a brief questionnaire, provided before each session, that it must be submitted on the day of the session.

### **Supervised tutorials sessions**

There will be 12 tutorial sessions (3 in each four-month period), with groups of 16 students where the professor will resolve questions about the content of the course (theory, problems and laboratory). These sessions could be also used to carry out evaluation activities.

### **Interdisciplinary project: Preparation and exposure of a seminar**

The activity is mandatory, interdisciplinary and transversal, It is common to all subjects of the second course of the degree in Biology (Cellular and Tissular Biology, Developmental Biology, Biochemistry, Botany, Genetics, Methods in Molecular Biology, Processes and Mechanisms of Evolution, and Zoology). The activity consists in the preparation and presentation of a seminar by a working group (3 students). The theme of the seminar, linked to one of the participating subjects, will be decided by lottery from among those proposed by the teachers. Each group will have a tutor who will supervise the preparation and presentation of work. The tutor will meet 4 times with the work group throughout the course. Each group will also have a co-tutor (among the professors of the course) to review the final work. The oral presentation will last 30 minutes and should involve to the 3 members of the group. The exhibition will be evaluated by the tutor and by the co-tutor. The attendance at the presentations is compulsory for all students. Details regarding this activity will be published in the Aula Virtual.

Alternatively to this activity, it can make other interdisciplinary activity of a project of educational



innovation supported by the CAT.

#### **Attendance to the conferences and other activities**

The student must attend conferences and other activities that will be programmed throughout the course. Subsequently, the students can submit a summary related to the subject.

#### **Reading and summarize a general book**

The student can read a scientific book, related to the subject of Biochemistry, among those proposed by the teachers. Subsequently, students can submit a reading file, following the model available in the Aula Virtual.

NOT APPLICABLE FOR STUDENTS ENROLLED WITH THE 2010 STUDY PLAN (OLD STUDY PLAN, 1100, IN THE PROCESS OF EXTINCTION) DUE TO THE IMPLEMENTATION OF THE NEW STUDY PLAN: SEE THE SUMMARY SECTION.

## **EVALUATION**

### **Evaluation of the subject**

The evaluation will be done along the course. It will combine the assessment resulting from direct contact with each student during lectures and tutorials sessions, with the appropriate resolution of writing questions and those proposed during lectures, with the work carried out by students and with examinations marks. To pass the course, it will be necessary to obtain an overall rating equal to or greater than 5 out of 10, having passed each of the parts: theory, questions and practices. The qualifications of questions, laboratory, interdisciplinary work, class participation, and reading and review of popular books will be added once past the contents of theory.

### **Evaluation of the theoretical lectures**



The result of this evaluation will be 7,0 points of the final course score.

There will be a midterm exam, suitable to pass the material, after the first four-month period about the contents for the issues of introduction and blocks 1, 2 and, and a second exam at the end of second four-month period (containing subject of blocks 4 and 5). In this exam it may also undertake a review of the contents of the first partial. The exams will be past due with a score greater than or equal to 5 (of 10). It will also evaluate the student's participation in the resolution of questions as well as the discussion of these questions in classes and tutorials. The qualifications of the approved exams, or the whole theory, will be saved only until the second call.

### **Evaluation of the problems**

The result of this evaluation corresponds with 1,0 point in the final course score. The last session of each term problems will be devoted to carrying out a partial qualifying round test. In the first four-month period the exam shall be conducted on the contents of "buffer pH Solutions" and "Enzymology", and in the second four-month period on "Bioenergetics." The problems will be considered approved if the course score earned in each of the two partial tests are equal or superior to 5 (of 10).

There will be a final test of problems, to be performed in conjunction with the examination of the theory, in which students will be examined for any party that has not been surpassed in the partial tests. The passing score on the problems will be saved until the second call.

### **Evaluation of the laboratory**

This part will represent up to 1,0 point in the final course score. The laboratory sessions will be evaluated by two partial exams, the attitude and use in the laboratory and the correction of the practical questionnaires. In the first four-month period, the exam will be on practices 1 to 4. In the second, the practices 5 and 6. The laboratory practices are considered as passed when the marks of the two written tests are equal or superior to 5 (of 10).

There will be a final written exam for the laboratory sessions that will be done together with the theoretical exam, in which students will examine the parts not passed on partial exams. In case of approval the laboratory practices, but not the subject as a whole, the marks of practices will be saved for the year after.

### **Evaluation of the interdisciplinary project**

The evaluation of the interdisciplinary project will involve 1.0 points from the overall subject. In the evaluation will participate the tutor and the co-tutor of the work. The evaluation will consider the contents and the oral presentation. The projects selected for presentation at the Congress of Biology will have an additional qualification corresponding to 10% of the mark of the activity. The mark of the interdisciplinary project will be saved for the next course.

If the interdisciplinary project is not executed, it will not be possible to pass the course connected with the work. For the subject of Biochemistry, if suspended for not having done this activity, the marks earned in the other parts of the course (theory, laboratory and practices) will be saved for the next year, provided they



are approved. If interdisciplinary project is not done, and this is not related to Biochemistry, the final score will include the marks obtained in the other parts of the course and must be equal to or greater than 5.

### **Evaluation of the reading and summarize a general book and other activities**

The activities will be evaluated with a maximum score of 0,5 points, which will be added to the score of the rest of the course.

### **Evaluation of the second call**

It will follow the same evaluation criteria that have been exposed for the first call and it consist of a unique exam of theory (7,0 points), problems (1 point) and laboratory (1,0 point) of the subject. The interdisciplinary project is not done more than once during the course.

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## **REFERENCES**

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